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C. RENEWAL OF LICENSE NUMBER	Pt. Amanda	Road, P. O. Box 628
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ITEM 5. Radioactive Material

a) Element and Mass Number:

Uranium 238

b) Chemical and/or physical form:

Depleted uranium is a component of Catalyst 21, which is a fine powder consisting of uranium oxide (UO₃), antimony oxide (Sb₂O₅) and silicon oxide (SiO₂). The catalyst was utilized by the licensee between 1965 and 1971 in the production of acrylonitrile. Residual catalyst is present in sludges from that operation which have accumulated in four impoundment basins. The catalyst is also present in lesser quantities in the soils underlying the subject impoundment basins.

Maximum amount which will be possessed at any one time:

The activity level of the sludge in each of the four impoundment basins has been analyzed to estimate the total amount possessed. The activity in the underlying soil is estimated to penetrate to a depth of one foot below the sludge-soil interface at an average activity of 35 pCi/g. At the time of submission of this application, sludges from two of the four impoundment basins (V-1 Pond and Celite Pond) have been transferred into another of the impoundment basins (Deepwell Pond). To facilitate this move, a partition was installed in Deepwell Pond, creating two separate sludge storage areas, known as South Deepwell Pond and North Deepwell Pond (see note on the following page). All Deepwell Pond sludge was then transferred to North Deepwell Pond. Celite Pond sludge was also transferred to North Deepwell Pond. V-1 Pond sludge was transferred to South Deepwell Pond. Contaminated soil from V-1 Pond was excavated and stockpiled in Celite Pond. As the result of these mobilizations, the total curies within the four impoundment basin area are distributed as follows:

Basin	Curies in Sludge	Curies in Underlying Soil
Burn Pond	4.69	0.11
Deepwell Pond North Area South Area	0.69 1.13	0.05 0.06
Celite Pond	0.00	0.48
V-1 Pond	0.00	0.00
TOTALS	6.51	0.70

The total curies within the four impoundment basins area is 7.21 curies. This is the maximum amount involved in the pond closure. Additionally, onsite and subject to decontamination and decommissioning are 1.56 curies at the Acrylo I manufacturing area and 0.88 curies at SWMU No. 102 landfill. Therefore, the total on site is 9.65 curies.

Note: Preliminary sludge stabilization testing performed in 1989 developed individual admix recipes for proper stabilization and solidification of each of the four sludges. The stabilization recipes for Deepwell Pond sludge and Celite Pond sludge were found to be similar so Celite Pond sludge was combined with Deepwell Pond sludge in the north area of Deepwell Pond. V-1 Pond sludge was found to require a dissimilar admix recipe from the other sludges, so it had to be stored separately. Hence, the partition was built and V-1 Pond sludge was transferred to south Deepwell Pond in order to facilitate cleanout of V-1 Pond.

ITEM 6. Purpose(s) for which license material will be used.

Until 1971, the licensed material, depleted uranium, was used on site as a raw material in the manufacture of an acrylonitrile catalyst, known as Catalyst 21. In turn, the catalyst was used on site for the manufacture of acrylonitrile. Spent catalyst was shipped off site for uranium recovery, but small amounts were entrained in various waste streams which now reside in four mixed waste ponds. There is no current usage of depleted uranium on site, nor are there any plans to use depleted uranium in the future.

This modification to License SUB-908 is being submitted to seek USNRC approval to bury the remaining catalyst, in the form of catalyst contaminated sludge and soil, in three onsite disposal cells. The cells will conform to USEPA RCRA requirements since the catalyst contaminated sludge and soil also contain RCRA hazardous wastes and are therefore classified as mixed wastes subject to both USNRC and RCRA regulations.

This license amendment application includes a Safety Analysis Report (Appendix A) and Pathway Analysis (Appendix B) pertinent to the proposed burial.

ITEM 7. Individual(s) responsible for radiation safety program and their training and experience.

The radiation safety program at the site is the joint responsibility of two designated Radiation Safety Officers: Joseph H. Mutz and Robert J. Ryan. Mr. Martz will be the primary RSO for the pond closure project with Mr. Ryan as his back-up. Mr. Martz and Mr. Ryan are authorized as plant radiation officers according to Amendment No. 5 of License No. SUB-908, effective July 8, 1992. Both individuals have attended the Ohmart Radiation Safety Course.

Mr. Martz holds a B.S. degree in Education with a science minor from the University of Findlay (Ohio). He also holds a M.S. in Personnel Services from the University of Dayton. He has worked at BP Chemicals for twelve years, with the last five being in the capacity of the plant safety coordinator. He has attended many safety courses and seminars, including the Ohmart Radiation Safety Course in 1990, with an Ohmart refresher course in 1993.

Mr. Ryan has an associate degree in electronics from Lima Technical College and is currently working on a B.S. in computer systems from the University of Findlay (Ohio). He has worked at BP Chemicals for 32 years, and has been involved with radioactive source gauges and radiation safety since 1990. He attended the Ohmart Radiation Safety Course in 1990 and completed refresher training at Ohmart in 1993.

ITEM 8. Training for individuals working in or frequenting restricted areas.

A Health and Safety Plan has been prepared for use in conjunction with this project and other plant projects involved with decontamination and decommissioning of the site. The Health and Safety Plan is included in this application as Appendix D. Included in Appendix D are the training requirements for individuals working in or frequenting restricted areas. The training is discussed in general terms in Section 2.3.2 of the Plan and are discussed in detail in Section 5.0 of the Radiological Control Plan (Appendix A of the Health and Safety Plan).

ITEM 9. Facilities and Equipment.

BP Chemicals does not currently use radioactive material at its Lima, Ohio facility. Radioactive material was last used at the facility in 1971. Since then all equipment except one reactor (Acrylo II-B reactor) have been either dismantled and shipped offsite for disposal at Envirocare of Utah, or have been decontaminated for unconditional release. Acrylo II-B Reactor contains radioactivity which has penetrated into its interior walls and cannot be non-destructively discontaminated. It will be decontaminated at the end of its useful service life.

The facilities which currently contain the waste are as follows: four surface impoundments which contain 7.21 curies in soil and sludge; the grounds at the Acrylo I manufacturing area which contain 1.56 curies in soil; and a landfill (SWMU No. 102) which contain 0.88 curies in soil and debris. The surface impoundments are the subject of this license amendment. They are described in Section 1.1 of Item 11.

ITEM 10. Radiation Safety Program

A full description of the radiation safety program for the pond closure project is given in Appendix D -Health and Safety Plan (HSP). The HSP and its appendices, including the Radiological Control Plan (Appendix A of the HSP) provide detailed descriptions of all essential areas of concern including the following:

	Area of Concern	Location in HSP
ź.	Personnel Monitoring Devices	Appendix A, Sections 6.2, 9.0, 10.0
2	Bioassays	Appendix A. Section 10.8
3.	Surveys and Monitoring	Appendix A. Section 6.0, 9.2, 10.0
4.	Radiation Detection Instruments and Instrument Calibration	Appendix A, Section 9.0, 10.0
5.	Radiation Safety Procedures	Appendices A, B, C, I, K, L, M

APPLICATION FOR MODIFICATION OF MATERIAL LICENSE

BP CHEMICALS, INC., LIMA, OHIO

LICENSE NO. SUB-908

ITEM 11. WASTE MANAGEMENT

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1.0 DESCRIPTION OF WASTE

1.1 INTRODUCTION

BP Chemicals, Inc. (BPC) currently owns and operates the Chemical Production Facility in Lima, Ohio. This site, formerly called the Vistron Corporation, contains facilities and areas previously contaminated with low levels of depleted uranium. The presence of this radioactive material is attributable to the production and utilization of Acrylonitrile catalyst material containing depleted uranium.

BPC is seeking the permission of the United States Nuclear Regulatory Commission (USNRC) to dispose of limited quantities of radioactive material at the BPC facility in Lima, Ohio. BPC is applying, under the provisions of 10 CFR Part 20.302, to dispose of the material in RCRA designed closure cells located on the BPC site. Materials to be disposed are currently located in surface impoundments, hereinafter called ponds, that contain sludges classified as radioactive and hazardous mixed wastes under the Atomic Energy Act of 1957, as amended, and the Resource Conservation and Recovery Act (RCRA), respectively. The ponds contain sludges contaminated with depleted uranium, organics, and heavy metals.

1.2 WASTE DESCRIPTION

The four ponds received waste streams from the manufacture of acrylonitrile and contain RCRA hazardous wastes. From 1965 to 1971, the acrylonitrile manufacturing process also used a catalyst that contained depleted uranium. The catalyst waste is the source of radioactivity in the ponds. Because of the presence of the hazardous waste, the four ponds were permitted under the interim status provisions of RCRA and were listed on BPC's 1980 Part A RCRA permit application. Also, due to the use of the catalyst, the ponds were included in the USNRC license granted to BPC and its predecessor companies for the possession of depleted uranium. The ponds were operated until the enactment of the 1988 land ban when they were taken out of service and haven't been used since. The following table lists by pond the influent waste source and the approximate area of each pond:

Pond	Source of Influent	Approx. Area (Acre)
Deepwell	Acrylonitrile process wastes including bottom stream from wastewater stripper, bottom stream from acetonitrile column and bottoms from acetonitrile purification column	0.5
Burn	Off-specification acetonitrile waste and excess waste from Deepwell Pond	0.6
Celite	Excess wastes from Deepwell Pond and spilled acrylonitrile waste	0.8
V-1	Waste from caustic cleaning operations	1.0

The Deepwell, Celite, and Burn Ponds were used to manage waste generated from the manufacture of acrylonitrile. The waste is classified as EPA listed wastes K011, K013, and K014. In addition, the Celite Pond received spillage from a 1986 acrylonitrile spill (EPA listed U009) and the Burn Pond received wastewater containing off-specification acetonitrile (EPA listed U003). The V-1 Pond received wastes that had a pH above 12.5 which resulted in a characterization as RCRA waste D002 (corrosive). Historical information indicates the presence of reactive sulfides in the Burn Pond. However, recent test data show these levels to be below EPA limits. The sludges in all four ponds contain waste catalyst and are therefore classified as radioactive mixed waste.

As previously mentioned, the source of the radiological contamination is a catalyst known as Catalyst 21. This catalyst contained UO_3 , Sb_2O_5 , and SiO_2 . The specific source of the radioactive contamination is the uranium oxide, UO_3 .

The following sections summarize the quantities and concentrations of the waste materials to be disposed.

1.3 CONCENTRATIONS OF WASTE

Four types of mixed waste have been identified for processing and disposal. They are contaminated soil, sludges, water, and debris. The following presents the estimated concentrations of radiological contaminants identified for each type of waste.

1.3.1 SOIL

In order to characterize the distribution and magnitude of residual depleted uranium contamination in the soil, a radiological characterization survey was performed by Chem Nuclear Systems Incorporated from November, 1989 to January 1990, as part of the decommissioning plan developed for the BPC site. Additional information on the extent and concentrations of radiological contamination in the soil around the V-1 Pond was obtained during the V-1 Pond cleaning effort performed by Halliburton NUS in 1993.

In the Chem Nuclear study, radiological contaminated soil was encountered under and around the ponds. The overall results of the soil sampling indicated localized areas of radiological contamination, with the majority around the Burn Pond. The results of this survey are summarized in the following table:

Pond	Number of Surface and Subsurface Samples	Number of Samples Above 35 pCi/g
Deepwell	52	4
Burn	60	16
Celite	76	6
V-1	53	3

In 1993, 30,000 cubic yards of RCRA hazardous and radioactively contaminated soil was excavated from the bottom and sidewalls as part of the V-1 Pond closure. Although only the top few feet of depth exhibited radiation levels equaling or exceeding 35 pCi/g, the excavation proceeded to a depth which varied between 10 feet and 12 feet. At this depth the measured radioactivity averaged 6.8 pCi/g (with a standard duration of 0.63) compared to a background level of 2.6 pCi/g.

1.3.2 SLUDGE

In January of 1994 Halliburton NUS evaluated the radiological contamination in the sludges. These results are summarized in the following table.

Pond	Number of Samples	Average Activity (pCi/g)
Deepwell / Celite	18	146
Burn	36	296
V-1	21	76

Chemical characterization was also performed on the pond sludges. The results of this work are summarized in Tables 1.2-1 and 1.2-2.

1.3.3 WATER

The disposal of rain water is an ongoing activity. Under the conditions of Amendments Number 6 and 7 of the existing license, 8.5 millon gallons of this rain water have been treated for the removal of uranium (to a level at or below 30 pCi/l), and has been discharged to the Plant Deep Well Injection System. All water which collects in the pond closure area will be treated and disposed of in accordance with current license requirements as described in Section 3.6.

1.3.4 DEBRIS

Various types of debris have been encountered or generated during the sludge movement operations. The debris includes:

- asbestos board
- wood/cardboard/paper
- steel and plastic pipe/hoses
- concrete
- plastic (including liner materials, insulation and personal protective equipment)
- polymerized plastic resin

The activities for these various types of debris are equal to or less than the activities of the corresponding sludges or soil from which they came.

1.4 QUANTITIES OF WASTE

Because of the V-1 Pond cleaning operations and the consolidation of the sludges into the Deepwell Pond, the V-1 Pond no longer contains contaminated materials. The contaminated soil from V-1 Pond is stored in the Celite Pond, and the V-1 Pond sludge is stored in the Deepwell Pond. Also, the sludge that was in the Celite Pond has been moved to the Deepwell Pond for storage prior to processing. Therefore, the information in the following table is reflective of the current site conditions, where the information presented in Section 1.2 on waste concentrations is based on the original source and does not consider the soil and sludge movement of the past two years.

An estimate of the quantities of contaminated soil, sludge, water and debris is presented in the following table. Also included in this table are estimates of the number of Curies contained in each source.

Location	Waste Type	Volume (ft ³)	Total Activity (Ci
Deepwell Pond	Soil	386,050	0.11
	Sludge (Deepwell & Celite Sludges in Southern 1/2 of the Pond)	171,500	1.13
	Sludge (V-1 Sludge in Northern 1/2 of the Pond)	267,300	0.69
	Water	20,000	0.00
Burn Pond	Soil	126,950	0.11
	Sludge	397,440	4.69
	Water	50,000	0.00
Celite Pond	Soil	1,355,670	0.48
	Sludge	0.00	0.00
	Water (in secondary containment)	7,000	0.00
V-1 Pond	Soil	0.00	0.00
	Sludge	0.00	0.00
	Water	0.00	0.00
Stockpiled Debris	Asbestos board	300	0.00
	Wood/cardboard/paper	100	0.00
	Pipe and hose	1,000	0.00
	Concrete	500	0.00
	Plastic materials	500	0.00
	Polymerized plastic resin	400	0.00
TOTAL		2,784,710	7.21

As presented in the table, the total estimated Curie content of the materials to be processed and disposed is 7.21. Also, the total amounts of the different types of materials are:

Soil	$1,868,670 \; {\rm ft}^3$
Sludges	836,240 ft ³
Water	77,000 ft^3
Debris	$2,800 {\rm ~ft}^3$

The above are estimates of the quantity of material in place. Due to the future addition of reagents for sludge processing and solidification the actual quantity of sludge material to be placed in the cells will increase. This is discussed further in Section 3.5.

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1.5 CHELATING AGENTS

Material to be disposed of under this application consists of sludge and soil contaminated with depleted uranium and hazardous waste, combined with solidification reagents, as described in the Section 3.5. No chelating agents are known or suspected of having been used, nor will any be used in conjunction with the material being disposed.

2.0 EVALUATION OF DISPOSAL OPTIONS

The wastes contained in Burn Pond, Deepwell Pond, V-1 Pond and Celite Pond are classified as mixed wastes which are subject to regulation by both USNRC and RCRA hazardous waste regulations. Options which would be available if the wastes were only radioactive or only RCRA hazardous are not available because the wastes are both radioactive and RCRA hazardous. Following is a review of all known disposal options and the USNRC and USEPA (and Ohio EPA) regulations which impact them.

2.1 NO ACTION ALTERNATIVE

This option consists of maintaining the current status of the ponds as continued long term storage and maintenance. The ponds would continue to be managed as hazardous waste units as required by BPCI's RCRA permits.

Advantages

The primary advantage of the no action alternative is its low cost. The continued monitoring of ground water and the treatment and disposal of surface water would require only moderate annual operating cost. Maintenance and repair costs for the ponds would be low compared to other maintenance costs incurred at BPCI. In addition, leaving the material in place minimizes the potential for increased occupational exposures.

Disadvantages

The primary disadvantage of the no action alternative is its unacceptability as a long term solution to both Ohio EPA and USNRC. Ohio EPA has specifically ordered the closure of the ponds as a condition of the facility's RCRA permit. With regard to the USNRC, the guidance provided in SECY 81-576 would indicate that the sludge portion of the waste be excavated and reburied, and that institutional controls be imposed to limit future use of the site.

Also, BPCI is concerned with the risk assumed by leaving the waste in ponds and the potential liability due to accidental release.

2.2 ON SITE DIRTY CLOSURE

The on-site dirty closure consists of removing the water from the ponds and treating it to remove the hazardous and radioactive constituents. After the removal of the water, the ponds are filled as is with a cap installed to prevent surface water contamination. A surface water drainage system could also be provided to prevent erosion and cap damage.

Advantages

The primary advantage for the on-site dirty closure is the low cost. By investing in the extra cost of a cap and a surface water drainage system, this alternative is superior to the no action alternative in that it provides engineering controls to prevent surface water contamination. Thus the operating cost associated with surface water treatment and disposal is eliminated.

Disadvantages

The primary disadvantage of this alternative is similar to that of the no action alternative. It is doubtful that the Ohio EPA would view the provision of a cap and surface water drainage system as sufficient controls for protecting ground water. Therefore, it is unlikely that a dirty closure could be approved by Ohio EPA. Since USNRC does not accept a cap as a long term barrier to



prevent exposures, this alternative is equivalent to the no action alternative and is equally unacceptable to USNRC.

2.3 DISPOSAL AT A COMMERCIAL DISPOSAL SITE WITHOUT TREATMENT

This alternative consists of excavating all mixed wastes and transporting it untreated for burial at a commercial disposal site licensed to accept mixed wastes.

Advantages

This alternative complies with the currently accepted USNRC requirements. Public and regulatory concern over ultimate disposal of the contaminated sludge would be alleviated. There is one commercial disposal site, Envirocare of Utab. licensed to accept mixed wastes.

Disadvantages

The RCRA Land Ban has gone into effect. This regulation (40 CFR 268) prohibits land based disposal of the subject mixed waste without the provision f appropriate treatment for the hazardous components of the waste. Therefore, no licensed facility in the United States can accept such waste unless it is first treated to meet RCRA standards. The only exception to the Land an is a current variance for mixed waste debris which expires on May 8, 1994. At the BPC site, soil and sludge constitute the majority of the mixed waste with debris constituting less than 0.1 percent of the total. Therefore, the debris variance is of not benefit to the project and the option of offsite disposal without treatment is not viable.

2.4 DISPOSAL AT A COMMERCIAL DISPOSAL SITE WITH TREATMENT

The USEPA has not established a specific treatment standard for the treatment of K011, K013 and K014 mixed wastes, but, in the absence of a specific standard, the USEPA has indicated that the standard for regular K011, K013 and K014 shall apply. For solid wasted this standard is incineration.

Advantages

This alternative complies with currently accepted USNRC requirements and USEPA requirements. Following incineration the mixed waste could be buried at a commercial mixed waste disposal site licensed to accept mixed wastes. This alternative meets the requirements of the RCRA Land Ban.

Disadvantages

In 1992 Scientific Ecology Group, Inc. (SEG) was preparing to apply for permits and licenses to operate an incinerator for the treatment of mixed wastes. Since that time, SE⁺ has decided not to pursue this activity. There are currently no operating incinerators licensed for mixed wastes, nor are any likely in the foreseeable future. Without the availability of an incinerator, the USEPA treatment standard for K011, K013 and K014 cannot be met. Therefore, this option is not viable.

Also, if mixed waste incineration were available, the cost for transportation, treatment and burial would be between \$500 and \$1,000 per cubic foot of mixed waste. For the volume of waste at the BPC Lima site (7.2 million cubic feet) the cost could be up to \$2.7 billion dollars. This is cost prohibitive to BPC.



2.5 ON-SITE TEMPORARY STORAGE FOLLOWED BY OFF-SITE PERMANENT DISPOSAL AT A FUTURE COMMERCIAL DISPOSAL SITE

This alternative consists of maintaining the current status of the sludge ponds until the compact's LLRW disposal facility is available. Then the waste would be excavated, removed, and shipped to the new facility for disposal.

Advantages

The primary advantage of this alternative is the acceptability to USNRC and the lower cost for transportation to the Ohio disposal site. The material would be disposed of in a secure facility which will be licensed under 10 CFR Part 61. The long term environmental and public impacts at the storage locations will be reduced to negligible levels, and public and regulatory concern over ultimate disposal of the material in the sludge ponds would be alleviated.

Disadvantages

The primary disadvantage of the alternative is that incineration is required according the to the RCRA Land Ban prior to burial. Without incineration, the waste cannot be shipped to any offsite location for burial without violation of USEPA regulations. The waste would have to be maintained in its current status until such time that incineration became available, and until the Midwest Compact Site was selected, licensed and developed. Further, the site is not likely to be permitted under RCRA for disposal of mixed wastes. Also it is not likely that the Midwest Compact Commission will be interested in dedicating 2.7 million cubic feet of the site's capacity for the disposal of 3.94 curies of depleted uranium from BPC.

Another disadvantage is that storing the waste onsite is the increase in the likelihood of migration of the contaminants. The favorable site geology would minimize this likelihood, however, this migration would increase the probability of the contaminants to come in contact with the biota, and with man.

In summary, this alternative is not attractive since, although it would be in conformance with regulatory objectives, there would be an uncertain waiting period associated with the start up of a new compact disposal site and the availability of incineration. In addition, the cost of disposal would be similar to the cost for incinerations followed by burial at Envirocare of Utah, except that the transportation cost would be reduced.

2.6 ONSITE PERMANENT DISPOSAL UNDER 10 CFR PART 20.302

The onsite disposal alternative consists of removing the contaminated material from its present locations and disposing of this material is the three RCRA designed disposal cells under the provisions of 10 CFR Part 20.302. The proposed action entails disposal of the material onsite in cells which meet hazardous waste landfill design criteria.

Advantages

The primary advantage of this alternative is that the public and regulatory concern over disposal of the material would be alleviated because the environmental and public health impacts would be minimized to AL.ARA standards. There would be no need to acquire additional lands for this purpose since the material would be disposed of within the BPC property. This will minimize the transport distance and this the disadvantages associated with the offsite transport options. In addition, the occupational exposures associated with this option would be minimized. In preliminary discussions with State and Federal officials, no major regulatory impediments of this



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alternative have been identified, although conformance with the requirement so Ohio Senate Bill SB-130 will have to be worked out through the Ohio Department ... Health and Ohio EPA.

Disadvantages

The primary disadvantage associated with this alternative is the fact that there is not precedent in which similar volumes of mixed waste have been disposed of under 10 CFR Part 20.302/ BPC and USNRC will have to work together to address any public and regulatory concerns over the long-term risk to human health and the environment.

2.7 CONCLUSION

The 2.6 alternative is the preferred choice since: 1) this option will best meet occupational, environmental and public ALARA objectives; 2) projected costs are much lower than for off-site disposal; 3) no major unsolved regulatory issues have been identified; and 4) problems associated with transportation are not an issue.





3.0 SUMMARY OF REMOVAL EFFORTS

Technical specifications for the various phases of construction are supplied in Appendix F.

Sections of the specifications include:

- Excavation and Backfill
- Sludge Mobilization
- Stormwater Drainage Systems
- Sludge Stabilization
- Process Equipment
- Geosynthetic Liner
- Concrete
- Site Restoration
- Fences and Gates

3.1 CONSTRUCTION SEQUENCE

The proposed sequence is based on stabilizing sludge and placing stabilized sludge, contaminated soil and debris in closure cells constructed in the V-1, Celite, and Burn and Deepwell Pond locations.

In 1992 and 1993, under the conditions of the existing license, contaminated sludges from the V-1 and Celite Ponds were temporarily placed into the Deepwell Pond, and contaminated soil removed from the V-1 Pond was temporarily placed into the Celite Pond. Debris was removed from the ponds and placed in temporary storage within the controlled access area. At the time of submission of this application, the V-1 Pond has been cleaned and the site is ready for cell construction. A radiological survey and evaluation of the cieaned V-1 Pond area has been completed in accordance with (Draft) NUREG 5849 and a release report was submitted to the USNRC on January 24, 1994. The results of the survey show that the levels are at or near site background levels. Pending the NRC's confirmation of the radiological survey and approval of this license application, the V-1 Pond area is available for cell construction.

Prior to sludge and soil removal activities, it was anticipated that the contaminated sludges and soils would be contained by closure cells in the V-1 and Celite areas only. However, additional quantities of contaminated sludges and soils were encountered in the V-1 and Celite Ponds than was originally estimated. Therefore, a third cell has been included in the area of the Burn and Deepwell Ponds (referred to as the Burn Pond Cell).

The proposed activity sequence pertinent to this application starting with the construction of the V-1 Cell is as follows:

- 1. Construct V-1 Cell.
- 2. Process and stabilize sludge contained in Burn and Deepwell Ponds and place into V-1 Cell.





- Excavate contaminated soil from Burn and Deepwell Ponds, and place it in the V-1 Cell. Quantities of soil which exceed the capacity of the V-1 Cell may be temporarily stockpiled on top of the V-1 Cell to facilitate the cl nout of the Burn and Deepwell Ponds.
- 4. Perform risk assessment to secure OEPA approval for leaving chemically contaminated soil in place in the Deepwell and Burn Ponds (if necessary).
- 5. Perform radiological release survey of Burn and Deepwell Ponds.
- 6. Construct Burn Pond Cell.
- 7. Remove stockpiled soil from Celite Pond and place into the Burn Pond Cell.
- 8. Excavate contaminated soil from Celit Pond and place in the Burn Pond Cell. Quantities of soil which exceed the capacity of the Burn Pond Cell may be temporarily stockpiled on top of the Burn Pond Cell to facilitate cleanout of the Celite Pond.
- 9. Place mixed waste debris in Burn Pond Cell.
- 10. Perform risk assessment to secure OEPA approval for leaving chemically contaminated soil in place in Celite Pond (if necessary).
- 11. Perform radiological ease survey of the Celite Pond.
- 12. Construct Celite Cell.
- 13. Place all remaining stockpiled soil in Celite Cell.
- 14. Restore final cap grades for cells.
- 15. Iastall caps on all cells.

This sequence is depicted in Figures 3.1-1 to 3.1-4.

The primary activities involved in accomplishing the work listed above include:

- 1) Site preparation
- 2) Construction of cell liner
- 3) Sludge transfer
- 4) Sludge processing
- 5) Dewatering and water management
- 6) Soil removal
- 7) Temporary storage
- 8) Debris removal and storage
- 9) Construction of cover system

The performance of the release surveys is not included with the above listing because it is covered in the USNRC approved document entitled "Soil Sampling Plan, Mixed Waste Pond Closure Project, BP Chemicals, Inc., Lima, Ohio", dated July 26, 1993 (Ref. 30). The primary activities listed above are discussed in more detail in the following sections.

3.2 SITE PREPARATION

Construction trailers have been brought on site as part of Division I sludge and soil removal work previously performed, and are placed as shown on Figure 3.1-1. Project work area limits have been established which delineate the pond work area from the rest of the site. Within the work area are project construction controlled access zones, controlled entry and exit points, and decontamination areas. The project work limits and the controlled access zones are separated from the rest of the plant area using existing site fencing, new chain link fencing, and temporary snow fencing and/or barriers. Signs are posted on fences to inform workers that entry into the areas is restricted and will list a contact or procedures to be followed if entry is needed (refer to Technical Specifications in Appendix F for information on the fences and signs). In addition, a personnel and site monitoring system has been developed for the work (refer to the Project Health and Safety Plan provided in Appendix D).

3.3 CONSTRUCTION OF LINER

The closure cells will be equipped with a liner and cover system that meets the requirements of RCRA. Since this work will be done with clean materials, exposure and contamination concerns do not apply. However, clean work will be performed in parallel with work involving contaminated materials, and precautions outlined in the Health and Safety Fian (Appendix D) will be taken. Controlled Access Areas will be rigidly maintained and mon. 'ored to ensure that any potential for contamination of clean areas is as low as possible.

3.4 SLUDGE TRANSFER

The sludges from the V-1 and Celite Ponds have been removed using earth moving equipment (bulldozers and excavely, and transferred to the Deepwell Pond via lined dum; trucks. The material we associated and moved in a wet condition to minimize the potential for air born contamentical. All work was performed in accordance with the Project Health and Safety Pla. The Safety Analysis Report for the Movement of the Sludges (approved by the NRC 6. December 10, 1991). All sludge transfer activities have been and will be performed in a manner which minimizes the release of air contaminants such as particulates, and volatile organics.

The V-1 sludge is currently stored under water in the northern half of the Deepwell Pond, the Celite and Deepwell Pond sludges are under water in the southern half of the Deepwell Pond, and the Burn Pond sludges remain under water in the Burn Pond. A lime slurry has also been applied to the top surface of all sludges to cover the sludges while they remain in these ponds.

3.5 SLUDGE PROCESSING

The sludge stored in the Burn and Deepwell Ponds will be pumped to the sludge process area unless it is too dense, in which case it will be excavated and hauled by truck. In the processing area the sludge will be combined with predetermined amounts of the solidification reagents and water in a mixer. The solidification reagents used, their percent applied for each sludge type, and method of mixing are currently being finalized. It is anticipated the mixing reagents will be gypsum and soil at the ratios listed in Table 3.1-1.

3.6 WATER MANAGEMENT

The stormwater collected in the ponds and water generated during the sludge processing will be managed as illustrated in Figure 3.6-1. The following are the specific sources of potentially contaminated water to be managed:

Water generated from decontamination activities. Stormwater collected in the ponds and waste pile area. Construction area stormwater. Water generated during the sludge processing operations.

Stormwater falling in the V-1, Deepwell and Burn Ponds is collected in these ponds. Stormwater that falls on the storage pile in the Celite Pond area is collected by a temporary storage basin constructed to the west of the pile.

The potentially contaminated water collected is then transferred to the Burn or Deepwell Pond for chemical treatment. Chemical treatment consists of lime, ferrous sulfate and polymer additions to precipitate out any uranium contamination in solution or suspension. After allowing the precipitated solids to settle in the pond, the water is pumped to Frac Tanks for storage until sampling. If the results show concentrations of radioactivity below 30 pCi/l it is transferred to the plant Deep Well Injection System for disposal. If the water is above 30 pCi/l, it is returned to the ponds for further treatment. Additional treatment, including filtration, will be provided as necessary, to meet the 30 pCi/l standard throughout the course of the project. All activities associated with this work will be done in compliance with the Project Health and Safety Plan.

Solids generated during the water management operations will be processed with the sludge. Debris such as spent filters will be disposed of with the sludge in the cells.

3.7 SOIL REMOVAL

After the sludges have been removed from the ponds and pond bottoms exposed, the upper 3 to 6 inches will be scraped off using a excavator or equivalent piece of equipment. It will be transferred using standard lined dump trucks. The soil being transferred will all be in a moist state to reduce potential dust emissions.

After the upper 3 to 6 inches of soil have been removed from the pond, the excavated surface will be sampled and tested for indicator parameters as outlined in the Soil Sampling Plan referenced above (dated July 26, 1993). If results show the soil remaining to be contaminated, further excavation of chemically contaminated soil is not practical due

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to cell capacity constraints or because of infringement on the surrounding plant, an assessment of the potential risk of not removing the additional soil will be performed. Contaminated soil will be removed to the extent necessary to limit the maximum concentration of U^{238} to 35 pCi/g above background. As discussed in earlier sections of this application, contaminated soil encountered in the V-1 Pond has been removed and is stored in the Celite Pond area. Clean soil has also been (and will be) excavated and stored on site for use in the cell liner and/or cap systems.

All soil removal, transfer, and storage has been, and will be performed in accordance with the Project Health and Safety Plan and Safety Analysis Report contained in the attached appendices. All sampling and analytical work shall follow the procedures found in the approved Sampling Plan and Project Quality Assurance/Quality Control (QA/QC) Plan found in Appendix E.

3.8 DEBRIS REMOVAL AND PLACEMENT

Contaminated debris encountered during the work will be decontaminated or disposed of in the closure cells. Offsite disposal of contaminated debris is not allowed after May 1994 due to land ban restrictions.

3.9 TEMPORARY SLUDGE AND SOIL STORAGE

Because of the limited capacity of the individual cells, and the sequence of cleaning and cell construction, contaminated soil and sludge have been, and will be moved and temporarily stored in the ponds or constructed cell areas throughout the duration of the project. Soil temporarily stockpiled on top of the ponds or cells may be placed at steeper side slopes and to a higher elevation than called for in the cell design specifications until it can be removed and placed into a cell. After the stockpiled soil is removed from these cell areas, the cell cap design grades will be restored and caps installed. The additional soils stockpiled on top of the materials in these cells will also provide a surcharge loading and add to the compaction of the wastes, thereby minimizing settlement of the cap after it is installed. Stormwater that comes into contact with the stored contaminated materials will be collected and managed in accordance with the procedures described in Section 3.6 and the areas around the storinge piles will be monitored for air borne contamination per the requirements as stated in the Project Health and Safety Plan.

3.10 CONSTRUCTION OF COVER SYSTEMS

After all of the contaminated materials have been placed into the cells and the final grades established, the cover systems will be placed on the cells. The cover systems will be constructed using the same means and methods as the liner systems, and will meet the requirements of RCRA.





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3.11 SUMMARY OF PROJECTED IMPACTS DURING CONSTRUCTION

3.11.1 Introduction

The impacts during closure are addressed in the Safety Analysis Report (SAR) which is contained in Appendix A of this document. The SAR addresses the mobilization and stabilization of the sludge and its placement into the closure cells. An SAR which addresses the interim mobilization of sludge and contaminated soil necessary for the construction of the lined closure cells, was submitted separately and was approved by the USNRC on December 10, 1991.

3.11.2 Dose Assessment Methods

The dose assessment methods used for the analysis are described in Appendix A. The methods were taken from USNRC documents or published methods for impact assessment.

3.11.3 Scenarios Modeled

In the SAR, the impacts from normal operation involving direct exposure to equipment and conduits containing contaminated material were considered. Internal exposure will not be likely during normal operation because all work with the sludge will be done in enclosed vessels or conduits or in wet and contained conditions. When removing contaminated soil and in the event personnel need to work with items that contains loose contamination, they will be equipped with anti-contamination equipment. The highest anticipated exposure during normal operation is estimated to be less than 0.005 mrem/hr, which is equivalent to background exposure.

Also in the SAR, contingency conditions such as fires, truck accidents and pipe ruptures were considered. The maximum anticipated impacts from these scenarios is less than 2.5 mrem.

3.11.4 Radon

Radon is not considered in the closure period impact assessment because the radioactive contamination in the pond is depleted uranium which does not contain radium.

3.11.5 Conclusions

Based on the results of the SAR included in Appendix A, the maximum radiological impact of normal closure operations will be less than background levels. The potential radiological impact of accidents will be less than 2.5 mrem to the maximally exposed individual.



4 0 PACKAGING OF MATERIAL

The sludge will be processed as described in Section 3.5 and placed into the disposal cell in bulk. However, the disposal cell functions as a containment package which will prevent the migration of radionuclides to satisfy the staff position requirements of Section 3.4.2 of NUREG-1101, Vol. 1 (Ret. 34).

5.0 DISPOSAL LOCATION

5.1 SITE LOCATION

The BPC facility is located in the southeast one-quarter of Section 2 and the northeast onequarter of Section 11, Shawnee Township, Allen County, Ohio. The location is shown in Figure 5.1-2. BPC proposes to place stabilized contaminated sludges and soil in three lined cells constructed in the area of four ponds where the sludges were contained. The location of the ponds is shown in Figure 5.1-1.

5.2 PROPERTY USES

The BPC plant has been in operation since 1955, with facility expansion and diversification taking place in 1959, 1965, 1970, and 1973. In 1993, the nitrogen fertilizer manufacturing portion of the facility was sold to Arcadian Ohio, L.P.. The remaining BPC portion of the complex currently manufactures acrylonitrile, acetonitrile, hydrogen cyanide, Barex® resin and acrylonitrile catalyst. Between 1965 and 1971, the facility produced and used an acrylonitrile catalyst that contained depleted uranium known as Catalyst 21. Catalyst 21 is the source of radioactivity which causes the mixed waste classification of the wastes in the ponds. The characteristics of the material contained in the ponds are described in Section 1.0.

The approximately 105-acre facility is regulated at the state level by the OEPA under RCRA. On the federal level, it is a USEPA permitted facility under the RCRA program. The land use is compatible with the surrounding industrial uses.

5.3 NEIGHBORING ENVIRONS

The proposed site for disposal of the depleted uranium contaminated materials, the BPC facility, is owned and operated by BPC. The property, as shown on Figure 5.1-2, is bounded on the west by Arcadian Ohio LP Nitrogen Fertilizer Manufacturing facility, the Ottawa River, the east by the BP Refinery, the north by the EP Refinery, and the south by Shell Oil Terminal and Buckeye Road. It is located at latitude 40° 43' 0" and longitude 84° 07' 46".

5.3.1 NEARBY PROPERTIES

Land uses surrounding the BPC facility are shown in Figure 5.3-1. Generally, land use to the north, east and south of the site is industrial. Land use west of the property is industrial, residential, and agricultural. The closest non-industrial land use is 0.3 miles from the ponds.

5.3.2 NEARBY RESIDENCES

The nearest residence is located to the west of the site across from the Ottawa River along Adgate Road, 500 feet from the BP property boundary, and approximately 0.4 miles from the ponds.

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5.3.3 SURFACE WATER

The surface water in the vicinity of the disposal site is the Octawa River, 0.25 miles to the we of the Ponds Area.

5.3.4 WATER WELLS

All neighboring properties are on city water supply. The only water wells are 9 production water supply (industrial) wells belonging to BP Oil and BPC (refer to Section 7.0 for more information on wells). The nearest other water supply wells for industrial use are 0.3 miles south of the ponds. The nearest domestic well is over one mile southwest of the ponds.

6.0 INSTITUTIONAL CONTROLS

6.1 PROPERTY OWNERSHIP

The property is owned and operated by the applicant, BPC.

6.2 PROPERTY ACCESS CONTROL

The disposal area is located entirely within BPC property and is a limited access installation. Access to BPC property is restricted by fences and manned security gates, and only personnel with appropriate identification are allowed onto the premises. The public is restricted from this site. The plant itself is surrounded by a 6 foot chain link fence, and all traffic to and from the fenced area of the plant is restricted and controlled by security guards. There is a staff of guards on duty 24 hours per day and no one is admitted into the facility without the proper clearance.

Because plant personnel are already on site, provisions to restrict non-essential personnel from the disposal area will be enforced. The disposal cells will be surrounded by chain link fences with locked gates. Warning signs reading "Danger - Unauthorized Personnel Keep Out" will be posted and maintained around the closed containment cells. The signs will be legible from a distance of at least 25 feet and in sufficient numbers to be seen from any approach.

6.3 PERIOD OF RESTRICTED ACCESS

The applicant intends to continue operation of the facility, inclusive of the disposal units, beyond the emplacement of the mixed waste. A notation will be recorded on the deed to BPC property containing the closed area indicating that the property is being used to manage hazardous waste and that its use is restricted under OAC 3745-66-19.

It is anticipated that BPC will be in operation for many years in the future and that the security described above will remain. OEPA post-closure requirements will extend for at least 30 years. This time frame exceeds that of the three year minimum controlled access period specified in NUREG 1101-1.

If the situation changes, BPC will make arrangements for similar security provisions to remain in place until the end of the post closure period. The following activities will take place during this period:

- Inspection and monitoring of the cover system;
- Maintenance of the cover, including regular mowing and erosion prevention;
- Monitoring of settlement, if any;
- Inspection and maintenance activities associated with security;
- Inspection and maintenance of leachate collection and detection system;
- Inspection and monitoring activities associated with the groundwater monitoring program; and
- Collection and treatment of leachate (if needed).

6.3.1 ADMINISTRATIVE PROCEDURES

In accordance with OAC 3745-66-18, a copy of the approved post-closure plan and any revisions will be kept at the BPC facility in Lima, Ohio. Questions raised during the post-closure care period should be directed to:

BP Chemicals, Inc. Manager, HSE PO Box 628 Lima, OH 45802

The post-closure plan will be amended whenever changes in operating plans or facility design, or events that occur during the post-closure period affect the post-closure plan. If an amendment is required because of a change in operating plans or facility design, or because of events that affect the post-closure plan, a modification will be requested in writing and submitted to OEPA within 30 days.

6.3.2 INSPECTION PLAN

Throughout the post-closure care period at the site, inspections of the disposal cells will include inspection of the final cover, groundwater monitoring system, leachate collection and detection system, security systems and benchmarks. In the event that remedial actions are necessary, the actions will be identified and their completion documented. All completed records and documents will be maintained on-site for 30 years.

Inspection forms will itemize the following:

- Damage or breaches to fences, locks, and signs
- Proper functioning of the cover drainage system
- Evidence of erosion
- Evidence of burrowing animals
- Evidence of any deep-rooted vegetation
- · Evidence of settlement
- The presence of water in the leachate collection and leak detection systems
- Evidence of water quality deterioration

The inspection program will be conducted by individuals trained in the review, evaluation, and performance of the particular task associated with the inspection element.

6.3.3 SPECIFIC POST CLOSURE PLAN REQUIREMENTS

The specific post-closure care requirements for the facility include:

- Security/fencing repair
- Erosion damage repair to cover
- Settlement/subsidence repair to cover
- Mowing and reseeding/replanting
- Drainage trench repair
- Pumping, sampling, and proper disposal of any leachate collected; and
- Groundwater monitoring and well maintenance

Specific aspects of these requirements are discussed below.

<u>Security</u>: The entire fence and gate surrounding the site will be inspected quarterly (four times per year) for any breaches or damage, including damage to fence posts, fence fabric, entrance gates, locks and signs. All deficiencies will be repaired.

<u>Settlement and/or Erosion</u>: Inspection will be performed on a quarterly basis and after severe rainfall events. Bare spots or areas exhibiting erosion will be seeded/planted. Should any areas show significant washout, seeding of the damaged area and/or minor regrading will be completed and documented. As settlement and erosion can damage the grade necessary for positive drainage, any areas with these problems will be regraded and reseeded or planted.

<u>Synthetic Liner</u>: In the event severe settlement or localized subsidence has occurred, the synthetic liner in the cap will be inspected. The cover soil will be removed carefully by hand or with hand equipment so as not to damage the synthetic liner. Liner punctures and/or tears will be repaired by patches in accordance with the liner manufacturer's recommendations. The area will be regraded to the appropriate grades and then replanted.

<u>Mowing and Revegetation</u>: The grass will be mowed regularly in order to allow inspection of the cover. At these times, any deep-rooted or woody vegetation that may have established itself on the cover soil will be removed so that deep-root growth will not compromise the integrity of the compacted clay or synthetic liner. Revegetation of bare areas will be completed when indicated by the quarterly inspections. Any repairs of erosion damage and subsequent revegetation will be consistent with the original process of seeding, fertilizing, and mulching outlined in the Technical Specifications contained in Appendix F.

<u>Drainage Ditch Repair</u>: Drainage swales will be inspected quarterly and after severe rainfall events. The swales will be checked for erosion and sediment accumulation. Accumulated sediment will be removed when its depth exceeds 6 inches in the main channel. Erosional activity that results in ponding or rutting in the channels will be mitigated (as needed) by placing riprap stone in the channel.

Leachate Collection and Detection System Maintenance: Leachate management procedures are described in Section 8.1.1. The automatic leak detection and leachate removal equipment will be inspected on a quarterly basis. During these inspections the sumps will be checked for the presence of leachate with a standard water level indicator and the detection and transfer systems will be tested.

7.0 GEOTECHNICAL AND HYDROGEOLOGICAL EVALUATION

7.1 BACKGROUND

The northeast corner of the BPC Lima facility is known as the East Pond Area. The East Fond Area includes six ponds: the Celite Pond, the V-1 Pond, the V-2 Pond, the Burn Pond, the Outfall Pond, and the Deepwell Pond. The pond locations are shown on Figure 5.1-2. All of the ponds, except the Outfall and V-2 Ponds, contain radioactive mixed waste. None of these four ponds are presently in service. The following description is based on the period of operation which ended in 1988. The V-1 Pond received acrylonitrile manufacturing caustic washing wastes. The Burn Pond received miscellaneous process wastes from the manufacture of acrylonitrile, and sludges transferred from Deepwell Pond. The Deepwell Pond received waste liquids destined for Deep Well disposal. The Celite Pond was used as an overflow unit for the Deepwell Pond and received sludges dredged from the Deepwell Pond.

Investigations have been performed to evaluate the geotechnical and hydrogeological conditions at the site for the purpose of designing closure cells and to provide a baseline for environmental monitoring. The information obtained from these studies and studies performed for other purposes is summarized below. Presently there are ten bedrock monitoring wells and 24 monitoring wells that tap sand zones in the glacial till which can provide ground-water samples.

7.2 PREVIOUS SUBSURFACE INVESTIGATIONS

Information regarding the subsurface material at the BPC facility was derived from water well, monitoring well and foundation boring logs. All of the boring logs available were included in the RCRA Part B Permit Application. Figure 7.2-2 shows the locations of all wells and borings at the facility. Additional information was obtained from published sources (Ref., number 21 and 23).

The earliest records available are from foundation borings drilled in 1965. In the last 22 years, over 200 test borings have been drilled on BPC property. The logs indicate that the borings were drilled to varying depths, providing useful information regarding the soil types, location of bedrock and water-bearing zones. Due to the fact that the borings were performed by several different drilling companies and different terminologies were used to describe the soils, some degree of interpretation was needed to correlate between logs. Also, because many of the borings were shallow (15 feet or less), the presence or absence of a particular deposit below the bottom of the boring was inferred from other nearby deeper borings.

Initially, interim status RCRA monitoring focused on the unconsolidated materials above the bedrock. In August of 1981, a monitoring well system was installed in the pond area by Keck Consulting Services (Ref. number 17). The system consisted of five wells, four of which were designed to monitor the bedrock/drift interface. These wells were designated E-1, E-2d, E-3, and E-4. In addition, one shallow well, E-2s, was installed. Of these wells, E-1, E-2d, E-3, and E-4 have been consistently dry. These wells were installed to meet RCRA requirements of that time. As part of the continuing investigation into this site, Keck performed a Bouguer gravity survey in July of 1982 (Ref. number 18), and Bowser-Morner followed with the installation of three additional wells, C-5, C-6, and C-7 (Ref. number 7). These wells were installed to provide additional information and to aid in the interpretation of existing data.

In 1985, an additional 15 borings were drilled in the pond area in an attempt to find saturated zones in the till that could be monitored. Five of these borings were angle holes which were drilled adjacent to and underneath the ponds to determine whether or not there were fractures in the till which may allow the vertical movement of fluids. Monitoring wells were then installed in eight of the 15 borings at various depths in the soils. These wells were designated 85-E-2 through 12. Of the eight wells, four wells provided a sufficient volume of water for ground-water sampling.

Also in 1985, all of the available boring and well data were compiled and analyzed for the RCRA Part B Permit Application. Complete details of each of the above-mentioned borings and well installation projects are given in the RCRA Part B Permit Application, and are not repeated here. The difficulty in conclusively assessing the continuity of ground-water saturation within the glacial till led the Ohio EPA to required an interim status bedrock monitoring program.

This change in monitoring strategy led to the design and installation of a bedrock monitor well network in late 1985 (TG-series wells in Figure 7.4-2). Because water levels in the non-pumping water supply wells were known to be substantially below the top of the bedrock, each bedrock monitor well was drilled far enough into the Tymochtee and Greenfield to obtain an amount of water adequate for sampling without penetrating the prolific Lockport. The resulting depths of the eleven TG-series wells vary from 122 to 210 feet. An Ohio EPA site inspection in 1986 indicated that the bedrock monitoring network was adequate and sampling began in the TG-series wells.

During a subsurface investigation related to the closure of the East Ponds in late 1987, four wells were constructed some 20 feet into the top of bedrock. These wells encountered perched water within the Tymochtee and two of the wells produced enough water to sample. Based on these new data, the 91-T series wells were installed in the upper Tymochtee in early 1991 (Figure 7.4-2).

In 1991, four quarterly background samples were collected from the 91-T series wells and statistical analysis was performed with the first detection monitoring event in 1992. The analysis indicated a statistically significant increase in the concentration of chemical indicator parameters between the upgradient well and the compliance wells. A ground-water assessment was performed and it was concluded that the facility had not affected the ground water. Detection monitoring has been reinstated and it is anticipated that the existing ground-water monitoring program which utilizes the 91-T series wells will be expanded to meet the monitoring requirements of the East Ponds closure plan.



7.3 GEOLOGY

7.3.1 REGIONAL GEOLOGY

The BPC facility sits on the eastern edge of a buried preglacial valley (Ref. number 21). The valley is one of many which comprised the ancient river system known as the Teays. The Teays system was formed in the Tertiary period and was buried by glacial debris during the Quaternary period. The local valley which trends north-south has been found to be over 200 feet deep in the center with valley floor elevations below 600 feet MSL. Figure 7.3-1 shows the regional bedrock topography in the vicinity of the site.

The present surface topography of the region is a result of the repeated glaciations during the Pleistocene, which modified the bedrock topography. The advances and retreats of the glaciers filled the valleys of the Teays River system with alternating sheets of clay tills and outwash sands and gravels. As each successive glacial event occurred, the deposits of the preceding glaciers were buried in the low areas while the high regions were scoured by the enormous ice sheet.

The glacial deposits in most of northwest Ohio consist largely of till, a non-stratified and poorly permeable mixture of clay and rock fragments. The till may be interbedded in places with "lenses" or bodies of sand and gravel, usually thin and discontinuous, but becoming thicker locally where the bedrock is relatively deep.

No published studies are available or have been made of the subsurface glacial geology in the area. Well logs on file with the Ohio Department of Natural Resources indicate that the bedrock valley to the west contains at least two major sand and gravel units bounded by clay till units. The sand units have been observed to pinch out against the bedrock valley walls, as shown in Figure 7.3-2, while the clay units are draped over the valley fill, the valley walls and the interstream divides.

The last advance of the Wisconsian Age glacier began about 25,000 years ago, and ended in the region around Lima approximately 14,000 years ago with the melting of the ice. The BPC plant is located on a ground moraine between the Fort Wayne and Wabash end moraines, as shown on Figure 7.3-3, which shows the most recent surficial deposits from the last glacial advance. These end moraines mark the position of a stand of ice during a period of time when rate of advance of the glacier equaled the rate of melting at the front of the glacier. The present course of the Ottawa River through Lima parallels the front of the Fort Wayne moraine.

The carbonate bedrock units of Silurian age were laid down as sediments in a warm shallow sea and as the sea withdrew, were exposed to the land surface. Erosion over the millions of years since the emergence of these rocks formed a generally level surface in most of northwest Ohio, deeply cut in places by valleys of ancient streams. The glaciers, moving over and melting from the land only a few thousand years ago, left a residuum of clay, rock fragments, sand and gravel on the bedrock (Ref. number 21 and 23).



7.3.2 SITE STRATIGRAPHY

Many of the approximately 200 borings drilled to date extended to bedrock. A bedrock topography map of the pond area revised to reflect data obtained through 1987 is presented as Figure 7.3-4 (Ref. number 3).

Available boring data indicates that unconsolidated materials consist of 30 to over 100 feet of glacial till with various discontinuous beds of intertill sands. The glacial materials are thinnest on the east side of the site where bedrock topography is the highest, and are thickest in areas where the bedrock is found at greater depths. The soil profiles submitted with the RCRA Part B Permit Application (Figures 7.3-6 and 7.3-7) indicate that the glacial till units could be further subdivided into two distinct units, an uppermost brown clay and an underlying gray silt and/or clay till. The location of these profiles is shown on Figure 7.2-1.

The underlying gray silt and/or clay till is from 10 to 30 feet thick and appears to exist under all parts of the facility except parts of the northwest corner. The gray till lies either directly on bedrock or over a thin sand unit. The brown and gray tills are very similar texturally and could be interpreted to be the same genetic unit. The brown color could then be interpreted as representing the effects of weathering on the gray parent material.

A third till unit is identified in a few of the deeper borings. It is a coarser-grained clay till with larger amounts of sand and gravel, as well as cobbles. It is found generally only below elevation 825 feet MSL, and ranges from 2 to 15 feet thick, being thickest where bedrock is the deepest. Many boring logs report thin layers of sand within this unit.

The boring logs indicate some discontinuous permeable units occur within the till. These include silts and sandy silts, and sands and gravels with varying amounts of finer grained material. The sand units generally fall within two or three distinct horizons. An upper sand zone is between the brown and the gray clay tills. A second sand zone is below the gray till zone and on top of either bedrock or the third cobbly till. Figure 7.3-5 outlines the areas where these two zones occur.

The upper sand zone found between the brown and the gray clay tills was not encountered under the East Pond area. The second sand unit which is found underneath the gray clay and/or silt till is found almost exclusively at elevations below 830 feet MSL, with a few exceptions as high as 835 feet MSL. For purposes of this report, this unit is called the "lower" sand. The lower sand is generally not found where the surface of the bedrock rises above elevation 830 feet MSL. Figure 7.3-5 illustrates this with a "zero thickness" line drawn between areas where the lower sand is and is not found. At boring locations where this unit was penetrated, it was found to overlie either bedrock or a third till unit which is apparently distinctly coarser than the gray silt and/or clay till; notably, it appears to contain more gravel and cobbles. The soil profiles presented on Figures 7.3-6 and 7.3-7 illustrate the stratigraphic position of the sand between the bedrock and the gray till. Section B-B on Figure 7.3-6 in particular illustrates how the sand occurs in topographic low areas in the bedrock and pinches out against the bedrock when the elevation of the bedrock exceeds 830 feet MSL.



Figure 7.3-1 and 7.3-4 indicates that the top of the bedrock surface slopes gently to the west under most of the facility. In the region under the East Pond area, bedrock is found between elevations 820 and 830 feet MSL, gradually sloping to 796 feet MSL at water supply well #3, just east of the main office. The slope increases abruptly under the southwest corner of the facility. The lowest recorded point is at location water supply well #1, where a 745 foot MSL elevation for the bedrock surface is indicated. Water well #1 may be located above a narrow valley in the bedrock, as depicted in Figure 7.3-4, which is a tributary to the larger buried valley beneath the Ottawa River.

A Bouguer gravity survey was performed by Keck Consulting Services in July, 1982. This survey was limited to the area around the Deluge Pond. Data obtained from this survey appear to represent the trends of the bedrock surface although the survey did not give actual elevations. Comparison of the Bouguer map and known bedrock data indicate that the shallow rock is found under Bouguer highs, and that deeper rock is found under Bouguer lows.

The bedrock in the area is comprised of the Salina, Lockport, and Sub-Lockport groups of the Silurian age (Ref.number 33). The two members of the Salina Group which are found in the area are the Tymochtee and the Greenfield. The Tymochtee, which is a shaley dolomite, is found above an elevation of approximately 690 feet MSL. Underlying the Tymochtee is the Greenfield dolomite. The bottom of the Greenfield is found between elevations 640 and 660 feet MSL. The Greenfield is underlain by the Lockport Group, also of the Silurian age, which has a thickness of about 100 feet in the area. The bottom elevation of this unit, the Lockport, is at an elevation of 550 feet MSL. The Lockport is a prolific aquifer used by BPC as the source of process water for their Lima facilities. The Sub-Lockport Group underlying the Lockport is approximately 60 feet thick, finer-grained, and considered the lowermost underground source of drinking water (USDW) in the region. Beneath the Sub-Lockport Group, the Cincinnati Shales of the Ordovician Age form an impermeable base to the fresh water aquifer.

In sum, low permeability glacial till underlies the entire site. The till is 30 to 35 feet thick in most of the eastern half and becomes thicker to the west toward the bedrock valley that generally underlies the Ottawa River. In places near the western boundary of the site, the depth to bedrock may be 140 or more feet. The till contains traces to thin layers of sand, silt, and gravel in the eastern half of the site. These sandy interbeds become thicker and more numerous in the western part where the bedrock is relatively deep.

The bedrock has been subdivided into three principal stratigraphic units based on relatively minor lithologic differences in the carbonates. The Salina Group is composed of two impure dolomite units, the Tymochtee and Greenfield Dolomite. The Tymochtee Dolomite forms the upper bedrock surface, and its thickness varies depending upon the degree of preglacial erosion. On site, the Tymochtee Dolomite has a maximum thickness of over 130 feet. The Greenfield Dolomite of the Salina Group is about 30 feet thick. The Lockport Dolomite is a fairly pure, crystalline and light-colored dolomite about 100 feet thick and supplies most of the ground water pumped on site. The Sub-Lockport is a poorly permeable dolomite about 60 feet thick that forms the lowermost USDW. The thickness of the entire carbonate rock sequence is on the order of 320 feet.



7.3.3 GAMMA LOG DATA REVIEW

Gamma logs were developed for 31 borings and monitoring wells and reviewed to evaluate their ability to distinguish the geologic units present at the site (Ref. number 3). The logs were compared with the descriptions on the boring logs of sampled soil from augers and split spoons. The variability of the soil sampling intervals in the gamma logged borings sometimes necessitated looking at other adjacent, more detailed, boring logs for soil information.

Gamma logs are measurements of the natural radioactivity of soil and rock units that contain radioactive isotopes of elements (such as potassium, thorium and uranium) that give off detectable gamma rays as they decay. Generally, the counts (i.e., gamma rays emitted during disintegration) are recorded for a period of one minute (cpm). Clay minerals are more likely to contain the radioactive isotopes that emit gamma rays than the minerals contained in silt, sand and gravel. The effect of the depleted uranium in the ponds is unknown. Uranium itself yields alpha particles, not gamma rays; however, many of the daughter products of uranium disintegration do emit gamma rays.

Reductions in the natural gamma count rate in the soils are likely to be due to increases in the percentage amounts of silt, sand, gravel or cobbles that are encountered as a component of the soil. In addition, thin interbeds of coarse sand and gravel with variable amounts of interstitial clay and silt will decrease the overall gamma count rate.

The review of the gamma data identified six distinctive zones. These are as follows:

Zone 1: 1500 to 1800 cpm; counts increase with depth; of variable magnitude.

Zone 2: 1500 to 2000 cpm, or more; deflection to the right.

- Zone 3: 1100 to 1700 cpm; deflection to the left; generally a broad-shaped curve with a pattern of repetitive small variations in the count rate.
- Zone 4: 900 to 1200 cpm; stronger deflection to left than Zone 3, yet still shows a repetitive pattern of small variations.

Zone 5: 800 to 1000 cpm; stronger deflection to left with massive curve shape.

Zone 6: 400 to 900 cpm.

Figure 7.3-8 shows a composite idealized gamma log of a soil profile showing the six zones. The actual gamma log profiles will not necessarily contain all of the zones, nor will they necessarily be in the indicated order. Occasionally, transitional zones would be identified that would not fit in any category, and are expressed, for example as, Zone 2-3.

With the exception of Zones 1 and 6, the zones can be found in various sequences and at various depths. Zone 1 is correlated with fill material, as identified on the boring logs. The variable magnitude of the counts reflects the variability of the fill material. Zone 2 appears correlatable to very clay-rich soils. Zone 3 has slightly lower gamma counts than Zone 2,

which appears to reflect a higher silt and sand content. Zone 4 appears to be correlatable with soils that have approximately equal amounts of silt and clay present. Zone 5 correlates with sand and gravel zones. Variability in the counts for sand and gravel zones is due to variable amounts of interstitial clay and silt. Cleaner sands have lower counts. Zone 6 is the Tymochtee dolomite formation. Variation in the counts within the Tymochtee are due to variability of the shale content which is composed of lithified clay minerals.

It should be noted that many of the zones have overlapping characteristic counts per minute. This indicates that solely using the gamma data for differentiation of the units is likely to lead to errors.

The gamma log profiles for Zones 1 and 2 may lend themselves to being reinterpreted to account for possible radioactive surface contamination. The fill materials in many locations are composed of gravel and crushed limestone. Rain and melted snow would be expected to wash any contamination through the gravel. As the soil material underlying the fill is generally low permeability clay, any contamination would tend to concentrate at the fill/clay interface. This may be the source for the high cpm that are characteristic of Zone 2. Zone 2 is generally only found at the surface.

The stratigraphy of the site has been differentiated into an upper brown till and a lower gray till. This review of the gamma logging data indicated that neither the brown nor gray tills has a gamma signature distinctive enough to provide a basis for differentiation. This may be interpreted as either the two colored tills have such similar sources that the gamma signatures are indistinguishable, or that the two colors are related to weathering effects on a single homogeneous deposit.

7.3.4 CONCLUSIONS

Based on the preceding analysis, the following is a list of the strong points regarding the soil conditions and ground-water monitoring program at the BPC facility.

- 1. The data base clearly indicates that there are 20 to 30 feet of low permeability clay material under the bottoms of the ponds in the East Pond area.
- Available permeability data indicate that all natural clay soil permeabilities are on the order of 10⁻⁷ or 10⁻⁸ cm/sec.
- 3. The permeable sand zones are confined to discrete elevations and boundaries.

7.4 HYDROLOGY

7.4.1 HYDROGEOLOGY

7.4.1.1 Confining Unit

As was explained in Section 7.3, the site is generally underlain by glacial deposits, which overlie the carbonate bedrock. Much road building and other construction has occurred at the facility over the years, so that the upper part of the till, as well as the residual soil

developed on it, have been disturbed in places. Fill dirt, including sand and gravel, has been brought on-site for construction purposes. Many of the boring logs report this "foreign" material in the top few feet, which may contain locally perched water tables. Beneath the fill and elsewhere where no fill is present, the glacial till is reported chiefly as clay or clay-till of low permeability. Reported permeabilities *cf* till samples collected in the East Pond area ranged between $4.6 \ge 10^{-8}$ and $5.2 \ge 10^{-7}$ cm/sec. A summary of permeability data is presented on Table 7.4-1.

Figure 7.4-5 presents an isopach map of the thickness of clay soils from the surface to the top of the first sand zone encountered, or to the top of bedrock. The isopach contours for the clay material above the upper sand zone and the lower sand zone are separated on the map. Clay thickness above the upper sand zone is generally 10 feet or less. Where the upper sand zone is absent, the clay thickness varies from 20 to 30 feet.

7.4.1.2 Principle Aquifer

Carbonate rocks (limestone and dolomite) beneath the till are the chief source of ground water both at the site and throughout the Lima area. Modest amounts of water may be obtained from the Salina Group, particularly at the top of bedrock where the dolomites were exposed to weathering prior to glaciation. For many years, the Salina was thought to be dewatered, as evidenced by the water levels below 650 feet MSL in the supply wells. During a subsurface investigation related to the closure of the East Ponds in late 1987, four wells were constructed some 20 feet into the top of the bedrock. These wells encountered perched water within the Tymochtee and two of the wells produced enough water to sample. Based on these new data the TG-series wells were reevaluated by caliper logging, packer testing, and pumping tests to determine the nature and extent of the perched zones of saturation (Ref.number 35). The perched zone proved to be relatively continuous across the East Pond area and another network of RCRA monitoring wells (91-T series wells) was installed in the upper Tymochee in early 1991.

The transmissivities (T) of some of the zones of saturation within the Tymochtee and Greenfield dolomites were calculated from packer testing performed in the TG-series wells during 1988. T values ranged from less than 10 gallon per day per foot (gpd/ft) to 10,000 gpd/ft (Ref.number 35) and the lateral extent of an individual zone was typically very limited.

The Lockport group is the only bedrock unit in this region potentially capable of supplying the quantities of water needed for industrial and municipal uses. The Lockport has been fully penetrated in 13 water supply wells on the BPCI site and in several other industrial wells on nearby properties. The primary water-producing zone in these wells has been reported to be at an elevation of roughly 580 ft MSL in several of the wells (Ref.number 38) which may represent base level of the preglacial stream channels (Ref.number 40).

According to a 1981 report by Leggette, Brashears & Graham (Ref.number 39) pumpage at that time amounted to about 3.5 million gallon per day (MGD), mostly from 5 wells ranging in depth from 383 to 415 feet. Water levels in the aquifer were on the order of 200 feet



below land surface and somewhat deeper than this in the pumping wells. Water levels were essentially stable at these pumping rates and the report stated that pumpage probably could be increased to about 5 MGD.

A wide range of transmissivity (T) values have been reported from the testing of the supply wells. Leggette, Brashears, & Graham (Ref.number 38) reported T values as high as 60,000 gpd/ft from some of the first supply wells in 1954-55, while testing of additional wells in 1970 indicated an average T of 35,000 gpd/ft. The reduction in T through time was attributed to dewatering the upper one-third of the aquifer. Tests on several low-yielding supply wells on-site have indicated T values of 2,000 to 4,000 gpd/ft, indicating significant heterogeneity in the Lockport..

Currently, BPCI produces about 1000 to 1200 gpm (1 44 to 1.73 MGD) of cooling water from two clusters of supply wells. Within the pumping center "B" composed of supply wells 1,3 and 7, two of the three wells are operated at one time to obtain about 750 gpm. Pumping center "C" contains supply wells 8, 9, and 13. Either well 8 or 9 is operated separately at about 375 gpm. while well 13 is a back-up well and not used during normal operations.

BP Oil Refinery utilizes three wells simultaneously (pumping center "A") to supply a total of 1.44 MGD of cooling water while keeping a fourth well off-line. Supply wells R-34 and R-35 are pumped at average cooling rates of 245 gpm each, R-36 averages 505 gpm, and R-32 is generally held in reserve.

Water levels in the Lockport are dominated by the cone of influence created by pumping about 3 MGD from BPC and the BP Refinery. Because of the reduction in pumpage in the past decade, water levels in the aquifer have risen somewhat, from about 200 feet below land surface to about 140 feet in wells that penetrate the full aquifer thickness. In wells that penetrate less than the full aquifer thickness, water levels are much higher, attesting to low vertical permeabilities in the bedrock and the existence of perched water zones in the carbonate rocks.

7.4.1.3 Movement of Water in the Glacial Till

Monitoring of shallow ground water at the site since 1981 gives insight into how the ground water moves into the unconsolidated sediments (Ref.numbers 3, 17, 21, 22 and 33). Water in the top few feet of weathered till moves chiefly through fractures and other openings enlarged by root growth and freeze/thaw processes. The deeper till deposits contain few if any openings, and any ground-water movement would be exceedingly slow. water can potentially move rapidly in sand and gravel beds within the till if these relatively permeable beds have well developed recharge and discharge areas. Significant recharge may occur where the sand and gravel beds are near the surface and the overlying till is relatively permeable, such as in the weathered zone. Likewise, discharge may occur downgradient in similar areas where the till is relatively permeable, or where the sand and gravel beds may crop out at the surface, perhaps giving rise to spring zones. No springs or seeps have been located on-site or along the Ottawa River banks.



Most sands and gravel beds, or "lenses," in the till at this site are not continuous over large areas and may be totally enclosed within a till matrix of low permeability. In cases where recharge is adequate but no discharge exists, the sand and gravel beds, though fully saturated, may not transmit significant quantities of water. Conversely, where deep sand and gravel lenses discharge readily into the bedrock but have no appreciable recharge through overlying till, the lenses are dry.

Strong hydraulic gradients downward exist between all of the saturated zones, and in most cases, the water in each zone is below the base of the zone which lies directly above it. Horizontal gradients in the shallow zones generally follow the surface topography westward toward the Ottawa River and the buried valley beneath it. Some of the shallow sands show a more erratic pattern as they reflect more local near-surface conditions. Due to the isolated nature of many of the sand zones, rates and amount of ground-water flow are believed to be extremely low.

7.4.1.4 Movement of Water in the Bedrock

A radial ground-water flow pattern is generated by large-scale pumping in the deep carbonate aquifer. The potentiometric contours in Figure 7.4-1 reflect head conditions in the regional carbonate aquifer. Water level data are not sufficient to define local conditions in the deep aquifer, but Figure 7.4-4 shows the location of the three pumping centers (A, B, and C) which are responsible for a regionally extensive cone of influence in the Lockport. The ultimate discharge for the perched bedrock zones, as well as the Lockport, is believed to be the water supply wells.

The hydraulic gradients of these saturated : nes can be defined locally where an individual permeable horizon persists. Figure 7.4-2 shows contoured water-level elevations of the uppermost zone of saturation in the Tymochtee underlying the hazardous waste management area and is taken from measurements of the detection monitoring system during June 1, 1993. This contour surface appears to be more influenced by the spatial variations in T and vertical hydraulic conductivity than the pumping effects from the supply wells to the west and north. This localized flow system was characterized to determine the monitoring requirements associated with the surface impoundments, but this level of detail is not available for other portions of the facility.

7.4.1.5 Comparison of Ground Water Levels

The monitoring wells in the East Pond area fall into two general categories: those above rock and those placed into the bedrock. Thirteen other wells are located around the East Pond area at various depths above the bedrock. A review of the well logs indicated that these 13 wells could be separated into three categories based on the location of the screen. These are wells located in clay directly on top of the rock, wells located in clay only, and wells located in permeable sands and gravels. Only six of the 13 wells contain water.

Eight wells are located in clay materials directly above bedrock. These wells are 2-81-E-1, 2-81-E-4, 85-E-5, 85-E-7, 85-E-8, 85-E-9, 85-E-10 and 85-E-12. The wells are set generally between elevation 828 and 840 feet MSL, with the exception of 2-81-E-4 which was set at 822 feet MSL. Five of these wells, 2-81-E-1, -E-4, -E-8, -E-9, and -E-10, are apparently dry

and have no connection to any ground water zones. With the exception of well 2-81-E-4, each of these dry wells is stopped at or just above the top of the lower sand zone. The lower sand is not present at well 2-81-E-4.

The remaining t¹ ree wells located in clay material on top of rock contained water. These are wells 85-E-5, -E-7, and -E-12. Each of these wells is screened at an elevation above the level of the lower sand zone. Static elevations for the ground water range between 852 and 858 feet MSL, with an exception at elevation 844. This is approximately 30 feet above the level of water measured in the uppermost bedrock monitoring well system, indicating that there is little hydraulic connection between zones just above and below bedrock surface.

The second group of wells consists of three wells that are screened within the clay tills. These are wells 2-81-E-2s, 2-81-E-3, and 85-E-11. These wells are screened between elevations 831 and 849 feet MSL and range between 2 and 15 feet above the top of the lower sand zone. Two of the wells, 2-81-E-3 and 85-E-11, are dry, indicating no connection with any saturated zones. Well 2-81-E-2s contains water at elevation 862 feet MSL.

The third group of wells is screened in a gravel unit. This group consists of two wells, 2-81-E-2d and 85-E-6. Both of these wells are screened between 826 and 829 feet MSL (within the lower sand zone), and contain water levels between 827 and 831 feet MSL. The similarity of the water levels in these two wells suggests some degree of interconnection within the lower sand zone. Comparison of water elevations between adjacent wells 2-81-E-2d and 2-81-E-2s illustrates the lack of hydraulic connection between zones of differing depths.

Based on the above analysis, it appears that more than half of the wells above bedrock in the East Pond area are located in zones that are unsuitable for the transport of liquids. The dry wells support the laboratory permeability data that indicate low permeability of the clay material. Six wells appear to be located in positions suitable for the monitoring of fluid migration. Wells 85-E-5, 85-E-7, and 85-E-12 are apparently monitoring fluids that occur at the soil/bedrock interface. Well 2-81-E-2s is monitoring a very shallow wet zone within the clay till. Wells 2-81-E-2d and 85-E-6 are both monitoring the lower sand zone.

7.4.2 DOMESTIC WELLS

The nearest production wells for plant process water are located about ½ mile from the East Pond area. The closest domestic wells are outside of the plant boundary more than one mile from the East Pond area.

7.4.3 GROUND-WATER MONITORING PLAN

Upgradient Wells:

T-9 Shallow bedrock well drilled in August, 1988.

Downgradient Wells:

91-T2 Drilled in February, 1991 adjacent to old monitor well TG-2.
91-T6 Drilled in February, 1991 adjacent to old monitor well TG-6.
91-T7 Drilled in February, 1991 adjacent to old monitor well TG-7.
91-T8 Drilled in February, 1991 adjacent to old monitor well TG-8.
91-T10 Drilled in February, 1991 adjacent to old monitor well 87-10.
91-T11 Drilled in February, 1991 adjacent to old monitor well 87-11.
91-T12 Drilled in February, 1991 to replace old monitor well 87-12.
91-T13 Drilled in February, 1991 to replace old monitor well 87-13.
91-T14 Drilled in March, 1991 adjacent to Celite Pond.

Water quality sampling in the 91-T series wells was initiated in 1991 for the following parameters:

Group I:	acetonitrile acrylonitrile ammonia arsenic barium cadmium chromium cyanide fluoride lead mercury nitrate silver	endrin lindane methoxychlor toxaphene 2,4,-D 2,2,5-TP Silvex radium gross alpha gross beta coliform bacteria turbidity selenium sulfide
Group II:	chloride manganese sodium	iron phenols sulfate
Group III:		specific conductance total organic halogen

Group I parameters were sampled during the first year only, Group II parameters are measured annually, and Group III parameters are measured semiannually.

7.4.4 GROUND WATER QUALITY

Based on the water quality data that has been collected from the approved RCRA interim status monitor well system, it is concluded that there has been no migration of hazardous materials to the aquifer beneath the surface impoundments. While total dissolved solids (TDS) and sulfates in the water produced from these wells exceed the USEPA's Secondary Drinking Water Standards, these values fall into the range that is known to occur naturally in the bedrock aquifer in this region. Annual ground-water monitoring reports are submitted to the Ohio EPA, as required.



7.4.5 SURFACE WATER

Surface water in the vicinity of the BPC facility consists of the Ottawa River, approximately ¼ mile to the west of the East Pond Area. Drainage from the site which reaches the river is routed through the plant storm water management system which is permitted by the OEPA.

7.4.5.1 Past Floods

The major floods of record at Lima normally have been caused by fairly warm rains falling on snow-covered or frozen ground. Occasional flooding is experienced due to intense summer thunderstorms. Figure 7.4-6 shows the flood prone areas and Figure 7.4-7 shows the location of the disposal units relative to the flood hazard areas. The duration of floods in this area is generally about two days, but may extend to three or four days during extreme high water conditions. The maximum flood of record in Lima was occurred March 1913, with floods of lesser intensity occurring in April 1904, December 1916, January 1937, March 1939, May 1943, June 1957, January 1959, February 1959 and April 1964. Smaller floods have occurred at more frequent intervals with minor flooding in lower areas occurring almost annually.

7.4.5.2 Hypothetical Floods

There are many individuals and firms who do not want to take, nor can afford to take, any flood risk. Industries or public buildings that have operations or functions which do not require that they be located near a stream will undoubtedly wish to locate in areas where the flood risk is small. To permit this choice to be made over a wide range of degree of risk, it is usually necessary to compute several hypothetical floods. One of these is dusigned as the Standard Project Flood (SPF). It is defined as the flood which would result from a storm having the most severe combination of meteorologic and hydrologic conditions considered to be reasonably characteristic of the geographic region. Each river basin has its own. The SPF profile and flood outlines shown for this study should be interpreted as those of an extremely rare return period. This type of flood for the Ottawa River is based upon a 13.8 inch rainfall over the entire watershed within one twenty-four hour period. Such a flood would have an estimated 20,710 cfs peak flow within the city of Lima. Although it is possible to have a flood of this magnitude, it would be an extremely rare event, generally beyond the limits of economic consideration. As can be seen on Figure 7.4-6, the water level in the plant area during the SPF is below elevation 840 feet MSL, which is more than 15 feet below the lowest ground elevation in the East Pond area.

For comparison and guidance purposes, computations were made and flood profiles and outlines were developed for other hypothetical floods having recurrence intervals of twenty years and fifty years. This was done at the request of the Ohio Department of Natural Resources, with the concurrence of the Maumee Conservancy District, to provide a basis for the local flood plain use regulations.

Floods are random occurrences dependent on a combination of meteorological factors and channel conditions. The time of occurrence of a flood cannot be predicted but it is possible to state with some assurance the chance of a flood of a specific size occurring in any one year. The prediction is referred to as frequency or recurrence interval. Frequency can be stated in terms of the number of floods in a specified number of years, or as a percent. For example, once in twenty years, or a five percent chance of occurrence in any one year. Such a flood would have a recurrence interval of twenty years. No matter how it is stated, frequency or recurrence interval, the prediction is based upon a study of the records so that the longer the record, the more accurate the prediction. The end result of the study is a discharge-frequency relationship which is usually shown graphically. Table 7.4-2 is based upon such a curve and shows the recurrence intervals for various floods on the Ottawa River based on the Allentown gauge.

7.5 METEOROLOGY

7.5.1 CLIMATIC CONDITIONS

The average monthly temperature and precipitation as measured by the National Weather Service at the Dayton Airport are presented in Table 7.5-1. The lowest recorded temperature was -28°F on February 13, 1899; the highest recorded temperature was 108°F on July 22, 1901. Table 7.5-2 presents a summary of the highest, lowest and mean temperature and annual precipitation for the period 1981 to 1990.

The evapotranspiration rate has been calculated by using the Blancz-Cridelle equation with the appropriate coefficient for grass, and the percent of annual daytime hours based on the latitude for Lima, Ohio. This information is presented in Table 7.5-3 and 7.5-4.

7.5.2 WATER BALANCE

Precipitation data is shown in Tables 7.5-1 and 7.5-2. Evapotranspiration data and rates are shown in Tables 7.5-3 and 7.5-4.

7.6 <u>RESOURCES</u>

7.6.1 LOCAL LAND USE

The map in Figure 5.3-1 indicates the land uses surrounding the BPC facility. Generally, land use to the north, east and south of the site is industrial, and dominated by BPC to the south and west, and the BP Oil refinery to the north. West of the property, land use is industrial, residential, and agricultural. The closest non industrial land use is 0.3 miles from the ponds.

7.6.2 NEARBY RESIDENCES

The closest residence is located west of the site across the Ottawa river, along Adgate Road.

7.6.3 NATURAL RESOURCES

The only known natural resource in the vicinity of the site, other than water, is oil. The area around the plant and refinery contained one of the original oil fields in North America.



7.7 MAPS

The pond area lies approximately 2000 feet east of the Ottawa River. The ground surface around the ponds has an elevation of approximately 860 feet MSL which is approximately 30 feet higher than that of the Ottawa River. All of the ponds in the East Pond area are approximately 10 to 15 feet deep from the top of the dike, except for the Outfall Pond, which is only 5 feet deep. The elevation of the tops of the dikes around all the ponds is approximately 870 feet MSL, while the bottom of the ponds are found between elevations 865 and 855 feet MSL. Please refer to Figure 5.1-1.

Surface elevations of the BPC facility area generally decrease from east to west toward the Ottawa River. The East Pond area has some relief because of the existing dikes that surround each pond. The change in elevation in this area is from approximately 868 feet MSL (USGS datum), starting at the eastern portion of the site, to 856 feet MSL near the western site limits. This difference of 12 feet in elevation in approximately 920 feet of horizontal distance constitutes an approximate 1.3% slope. Because of this sloping grade, and in order to maintain consistent depth (capacity) of each pond, the dikes located along the northern and southern edges gradually increase in height from east to west. T. ...s, the western edge of the Celite, V-1, Deepwell, and Burn ponds have a maximum relief of 7,8,5, and 2 feet, respectively.

Because of the site grade discussed above, the natural surface water drainage is from east to west and is directed to drainage swales along the road that bisects the site and to the swales parallel and northwest of the railroad tracks.

7.8 SITE STABILITY AND PERFORMANCE

There is no evidence of surface or subsurface instability at the site. Although the site is underlain by carbonate rocks, there is no evidence of karst topography in the area. Soils susceptible to collapse have not been encountered. The overconsolidation of the clay tills by glaciation precludes the potential for settlement. The flat terrain in the vicinity of the site, which represents a topography more than 14,000 years in age, indicates a low potential for erosion and mass wasting. The site elevation is well above Standard Project Flood levels.

The closure cells have been designed to minimize the possibility of natural hazards impacting the long-term stability of the facility. This will be accomplished by having regular inspections of the containment cells, including inspection of the final cover, groundwater monitoring system, leachate collection and detection system, security systems, and benchmarks. For each inspection, an inspection report form will be completed. In the event that remedial actions are necessary, the actions will be identified and their completion documented. For information on inspection see Section 6.0.

7.9 PAST DISPOSALS

BSC has completed a partial clean-up of the manufacturing areas where Catalyst 21 was produced and used. Of the partial clean-up, a portion has been released by the USNRC, a portion has been decontaminated and awaiting release from USNRC, and a portion of the Acrylo II-B reactor and same soil under Acyclo #1 manufacturing facilities are awaiting



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decontamination and decommissioning activities. This work has been documented in past submittals to USNRC. Waste generated has been packaged and shipped to the Envirocare facility in Utah.

7.10 POST CLOSURE IMPACTS

7.10.1 INTRODUCTION

The radiological impacts which might occur after construction were analyzed by performing a pathway analysis. The pathway analysis considered both the sludge and contaminated soils which are to be placed into the cells.

7.10.2 DOSE ASSESSMENT METHODS

The radiological impacts were evaluated using the RESRAD code, version 5.03. The RESRAD computer code was developed for the U.S. Department of Energy to calculate the radioactivity cleanup standards at Formerly Utilized Sites Remedial Action Program (FUSRAP) and Surplus Facilities/Management Program Sites. Additionally, the code is able to perform the assessment of the resulting Total Effective Dose Equivalents (TEDE) in millirem per year resulting from radioactive materials left at a site.

The volumes and activities of soil and sludge were estimated from the characterization data discussed elsewhere in this document. A detailed description of the input values for the various cases modeled are presented in Appendix B. The scenario modeled are described in the following section.

7.10.3 SCENARIO MODELED

In order to assess the long term impacts, the scenario modeled consisted of three parts. The first part modeled the stabilized Burn Pond sludge, the second modeled the stabilized Deepwell Celite and V-1 Pond sludge, and the third modeled the soils. In all cases, conservative assumptions were made in order to over estimate the radiological impacts of the cells. No credit was taken for the geotechnical liners and leachate collection systems required for a RCRA designed cell. It is assumed after closure that the cells are abandoned and the cell cap is allowed to erode. Additionally, the distribution coefficients (k_d) for the soils beneath the closure cells assumed to be extremely low (10 ml/g). Also, in order to fully utilize the RFSRAD model effectively, it is assumed that the contaminated materials are evenly spread throughout the four pond areas in layer thicknesses as listed in Appendix B.

Simplistically, it is assumed that the cells consist of three layers of contaminated materials. The bottom two layers being stabilized sludge contaminated with depleted uranium and listed hazardous wastes. The top layer consists of residually contaminated soils containing mixed waste which originated from under and around the four ponds.

The first two parts of the pathway scenario assume that each of the stabilized sludge layers are homogeneously mixed as a result of the stabilization process and placed into a cell. The layers of stabilized sludge are then covered with the residual soils and the RCRA cap.



It is assumed that the erosion rate of the soils is equivalent to the erosion rate of the RCRA cap (0.15 cm/yr).

The third part of the pathway scenario assumes that the residually contaminated soil from the bottom of the four ponds is homogeneously mixed, placed in a layer on top of the stabilized sludge and covered with a 1.5 meter cap of compacted clay.

As with any modeling work, results are based upon the input conditions or data. As many factors as possible are based upon measured conditions at the BPC facility and are presented in Appendix B.

The source term used for the stabilized sludges is estimated from the total activity measured in the ponds and is presented in Section 1.0. The estimated total activity is based upon measured activities of samples taken in each pond.

The source term for the residually contaminated soil was estimated from the measured activities of soil from the bottom of the V-1 pond after removal of the sludge from the pond (and assumes that 1-foot of soil that was under the sludges has an activity of 33 pCi/g). The activity is based upon the measured U-238 activity and calculated for U-234 and U-235 using the depleted uranium ratios from the Health Physics Manual of Good Practices for Uranium Facilities. Daughters are assumed to be in secular equilibrium and are decay corrected by the RESRAD code.

The analysis scenario, depicted graphically on Figure 7.10-1 considers migration of contaminated leachate through water, direct exposure, and inhalation and ingestion of fugitive dusts as a result of inadvertent intrusion and exposing of the closure rell.

7.10.4 RADON

Radon is not considered in the closure period impact assessment because the radioactive contamination in the ponds is depleted uranium which does not contain radium.

7.10.5 CONCLUSION

The results of the long term analysis indicate that the total maximum anticipated dose from the stabilized sludge and soils when placed into a RCRA design closure cell is 0.556 mrem per year which is less than 10.0 mrem per year.

8.0 CLOSURE CELL DESIGN

8.1 CONTAINMENT CELL DESIGN DESCRIPTION

The closure cells have been designed in accordance with RCRA section 3004(o) to contain the stabilized waste and to protect human health and the surrounding environment. To meet this objective, the design includes a low-permeability cover on top of the waste material, and a double liner and leachate collection/detection system under the waste material. The cover will minimize the migration of liquids into the waste. The double liner leachate collection/detection system will prevent the migration of any hazardous constituents out of the waste and into the surrounding environment, if liquids should penetrate the cover. Also included in the design is a storm water collection system that will effectively manage storm water runoff from the containment area. A complete set of design drawings are included as a part of the application.

8.2 CONTAINMENT CELL CAPACITY

A Plan View of the closure cells is shown on Figure 3.1-1.

The cells have been designed to contain up to approximately 3,912,300 ft³ of total material. The current estimate of solidified sludge and excavated soil waste material to be placed into these cells totals approximately 3,062,700 ft³. This design allows for 22% excess capacity (or 849,600 ft³).

As sludge and soil removal efforts proceed, the identified quantities may change. If necessary, the design capacities of the second and third cell will be modified to accommodate the change in quantities. Should a design change become necessary, all necessary regulatory notifications will be made and approvals secured.

8.3 LINER SYSTEM

The double liner and leachate collection/detection system will consist of a 36-inch-thick lowpermeability clay layer (K <10⁻⁷ cm/sec), a 60-mil HDPE liner, layer of geonet drainage material, an upper 60-mil HDPE liner covered with a geonet drainage layer, and a geotextile and 12 inches of protective cover separating the waste form the underlaying geotextile, liner, and drainage layers (refer to Drawing 18 of 26). The protective layer will consist of washed sand and have a hydraulic conductivity of 10⁻² cm/sec or more.

The liner and leachate collection/detection systems are designed and will be constructed to minimize the migration of hazardous constituents into the surrounding environment. The liners will act as barriers against the migration of liquid, and the geonet drainage layers will collect liquids that might leach out of the wastes and through the liner barriers.

The 36-inch-thick low-permeability clay layer will be constructed using clay excavated during construction (if clean), and/or from an engineer-approved borrow source. The borrow soils investigation has been performed by the construction contractor to locate appropriate borrow soils and the appropriate amount for construction of the low permeability clay liner.

The results of this investigation are presented in Section 8.9. Specifications for material to be used for the low-permeability clay layer are found in Appendix F. During construction, the amount of borrow material used may be reduced by utilizing a portion of the existing material which will be excavated from below the zone of contamination. This material will be replaced and compacted in order to break up fluid pathways.

A bulldozer will push the clay over the prepared surface in loose lifts not to exceed 8 inches (loose thickness). The clay will then be compacted, utilizing a sheepsfoot roller (or similar device) to achieve the specified density. The surface of the finished clay layer will be smooth, uniform, and free of any sudden changes in grade. Specifications for placement of the clay and the determination of the optimum moisture content and density are found in Appendix F. The surface of the clay layer will be graded at a minimum slope of 2% in the direction of the leachate collection pipes associated with the geonet drainage layers. Based on slope stability analyses performed, the side slope of the clay layer leading from the top of the cell berm to the cell floor will be graded to a slope not exceeding 2:1 (horizontal to vertical), as shown on Figure 8.3-1. These slopes are designed for factors of safety of 2.0 for static and 1.7 for dynamic load conditions.

Following the installation of the clay layer, the secondary liner consisting of a 60-mil thick HDPE synthetic membrane will be placed over the smoothed clay surface. A trench system will be used to anchor the liner system components during cell construction and waste placement. The membrane liner will be constructed and installed according to BPC's and the manufacturer's specifications. Quality Assurance/Quality Control measures will be observed during construction to assure that quality materials are used, proper fieldseaming techniques are employed, and to document liner testing. Specifications governing the HDPE liner installation are provided in Appendix F, a report discussing the HDPE liner compatibility with the solidified wastes is in Appendix H, and the QA/QC procedures to be followed for providing and installing the liner are included in Appendix E. Liner compatibility testing has been performed in accordance with USEPA SW-846 Method 9090 using a leachate generated from samples of sludge solidification reagents and a synthetic leach medium manufactured developed in accordance with USEPA SW-846 Method 1312. This medium simulates acid rain conditions to reproduce the chemical composition of leachate anticipated from the solidified waste. Results of this testing are included in Attachment B of Appendix H. These results do not reveal any trends which suggest the liner will be adversely affected by the leachate.

Above the secondary liner will be the leak detection system. This system will consist of a ¹/₄inch thick HDPE geonet layer with a transmissivity equal to or greater than the transmissivity of a 12-inch thick layer of sand with a hydraulic conductivity of 10⁻² cm/sec while under the applied loading of the solidified waste. Therefore, the proposed design meets or exceeds the minimum technology requirements of RCRA.

The slope of the geonet layer on the bottom of the cells will be approximately 2% in the direction of a 4-inch diameter perforated drain pipe. The drain pipe will be placed within gravel bedding that is surrounded by an 8-oz. geotextile as shown on Figure 8.3-2. The maximum slope of the drain pipe will be 4% and will be in the direction of a collection sump. The combined geonet and 4-inch pipe drainage system will remove liquids rapidly so little or no head of liquing the sustained on the secondary liner. Specifications for



materials and construction methods for the leak detection system components are contained in Anpendix F. Procedures for QA/QC of the leak detection system installation are presented in Appendix E.

The 4-inch drain pipe will empty into a 6-inch diameter PVC pipe sump. The ground surface surrounding the top of the sump will be graded to drain water away from the structure. This will prevent inadvertent infiltration of storm water. The sump will be placed in the location as shown on the plan view, Figure 3.1-1.

Above the secondary drainage layer (i.e., geonet) will be the primary liner consisting of another layer of 60-mil HDPE. This primary liner will serve as the first barrier to any leachate produced by the waste. It will be constructed and installed in a manner consistent with the liners previously discussed.

On top of the primary liner will be the primary leachate collection system. It will be constructed of ¼-inch geonet and 4-inch diameter perforated pipe (as described above for the leak detection drainage layer and system and as shown on the detail of Figure 8.3-3). The geonet with geotextile above it are designed to function as the hydraulic equivalent of a 12-inch-thick layer of sand with a hydraulic conductivity of 10^{-2} cm/sec under the applied loading of the waste and cap above it. The primary leachate sump is shown on Figure 8.3-4 and is identical to the leak detection sump and will be constructed and installed in a similar manner. Its location is shown on the plan view of Figure 3.1-1.

The two collection systems will be definitive and separate, allowing for easy identification of the source of any water collected in each separate sump (i.e., if leachate is produced from the stabilized waste it will be collected in the leachate collection sump).

As previously discussed in Section 8.1, automatic leak detection equipment will be installed in each sump and will activate automated pumps to remove it to a leachate collection storage tank. From the tank, the leachate will be disposed by injection into the Deep Well.

Placed above the primary leachate collection layer will be a layer of 8-oz geotextile. The geotextile will separate the overlying protective soil layer from the geonet and \underline{r}_* otect the geonet from clogging. It will be placed in accordance with the manufacturer's recommendations and as outlined in the specifications found in Appendix F.

The uppermost layer of the liner and leachate collection/detection system is a 12-inch-thick protective cover. This layer will consist of engineer-approved washed sand material, placed in 12-inch loose lifts and compacted using equipment as outlined in the specifications found in Appendix F. No equipment will be allowed directly on the underlying gectextile; 12 inches of soil must be in place before any equipment is placed. The layer will protect the liner and collection/detection system from damage that might occur in the placement of the solidified waste and the associated equipment.

As noted throughout this text, more detailed information relating to the construction and materials associated with the liner and leachate collection/detection system is available in the specifications found in Appendix F and in Figures 8.3-1 through 8.3-4. Instead of installing each layer separately, composite materials made of geofabric, HDPE, and geonet

may be used; if such alternatives are used, their components will meet or exceed the requirements set forth herein.

After the installation of the liner and collection/detection system, the waste will be mixed with the appropriate stabilization constituents and placed on the protective cover layer. The stabilized waste will be placed in wet lifts that will be allowed to cure. Contaminated soil excavated from the pond bottoms and sidewalls will be placed over the stabilized sludge in lifts no greater than 8 inches and compacted. This soil is predominantly clay.

8.4 LEACHATE CONTROL

Once the waste is stabilized and is placed into the lined cell, it will be isolated from the environment. In the event that water penetrates the cover barriers, migration of contaminants is not anticipated because the waste will be in a solidified and stabilized form that reduces its potential to leach. Should this waste form not perform as anticipated, the leachate collection system forms the first line of defense: it permits any leachate to be removed from the cells for treatment and disposal. If the liner that contains the leachate collection system is penetrated, a second liner with an additional detection and withdrawal system is provided.

The collection sumps for the leachate collection and detection systems will be equipped with automatic leak detection and removal equipment. Any leachate that collects in the sumps will be stored in a leachate collection storage tank. From the tank, collected leachate will be disposed of by Deep Well injection following analysis showing compliance to USNRC standards. If it fails to comply with USNRC standards, appropriate treatment will be provided.

The automatic leak detection and leachate removal equipment, as well as the sumps, will be inspected on a quarterly basis. During these inspections the sumps will be checked for the presence of leachate with a standard water level indicator, and the detection systems will be tested.

8.5 COVER SYSTEM

The multi-layer cover will be placed on top of the solidified waste and will be more than 5 feet in thickness. It will consist of a 24-inch-thick low permeability clay layer (K <10⁻⁷ cm/sec), a 60-mil thick high density polyethylene (HDPE) liner, a 12-inch thick drainage layer comprised of coarse granular material a geotextile layer, and a 24-inch-thick vegetative cover layer consisting of 16" of select backfill and 8" of topsoil cover, as shown in Figure 8.4-1. The cover is designed and will be constructed to minimize the downward migration of liquids; divert liquids which may percolate through the cap surface; require minimal maintenance; promote drainage while maintaining stable slopes; minimize erosion of the final cover. In addition, the geosynthetic components of the cover system must be able to support the weight of the materials over them.

The low-permeability clay layer will be constructed using clay from the excavation of the cells (if clean), or an engineer-approved borrow source. After the stabilized waste has been placed and allowed to cure, the clay will be placed over the landfill consistent with the



methods presented in the discussion of the liner above, and as detailed in the specifications provided in Appendix F. The resulting clay layer surface will be graded to the slope as shown on Figure 8.3-1.

Following installation of the clay layer, a layer of 6-oz nonwoven geotextile will be placed over it, and this in turn will be covered with a 60-mil thick textured HDPE synthetic membrane. The membrane will be constructed and installed in accordance with the procedures and requirements mentioned above for the double liner and leachate collection/detection system. Specifications governing the HDPE liner installation are also presented in Appendix F and QA/QC procedures in Appendix E. Details showing the liner anchor trench and the placement of a HDPE "boot" around pipes that protrude through the membrane are presented on Figure 8.4-2.

The membrane will be covered with a 12-inch thick drainage layer of sand. The drainage material will conform to the specifications presented in the recommended construction procedures (Appendix F), and have a minimum permeability of 10⁻² cm/sec. The drainage material will be spread using conventional construction equipment (loader or bulldozer) to achieve a medium-dense state. No equipment will operate on the liner until it is covered by at least 12 inches of material.

Additional compaction of the coarse drain material will not be required. Before further construction, perimeter moisture drainage pipes will be installed below in the drainage layer. The drain pipes, which will surround the perimeter of the cover area, will consist of 4-inch diameter perforated drain pipe.

A nonwoven geotextile will then be installed to protect the drainage layer from clogging. The geotextile allows free movement of water into the drainage layer while minimizing the migration of vegetative cover and soil particles.

A 24-inch thick layer of borrow soil suitable for supporting vegetation will be placed above the geotextile. It will consist of 16 inches of compacted clay from an approved borrow source with 8 inches of topsoil cover. The borrow soil will be tested before placement to ensure it exhibits an acceptable pH to support the growth of plant cover. Lime will be incorporated as necessary to ensure that the borrow soil exhibits a pH range between 6.0 and 7.0. This topsoil layer will be placed in loose lifts not to exceed 8 inches thick and compacted sufficiently to prevent rutting. The top surface of the cap will be brought to a final grade of 5% and the side slopes of the closure cell will be regraded to a maximum slope not greater then 3:1, horizontal to vertical (reference Figure 8.3-1).

The final slope of the cap will be maintained as outlined in Section 6.3.2. The maximum slope (3:1) is stable and will not be susceptible to erosion from a 25-year storm. However, to provide added protection, an interceptor ditch lined with polyethylene netting will be installed around the cap. This ditch will reduce the erosive potential of the storm runoff.

If the final caps result in a 3:1 slope and the facility can no longer support the maintenance needed for this slope, appropriate fill will be added to reduce the slope to 5:1 (horizontal to vertical).

8.6 SLUDGE SOLIDIFICATION

The material form of the solidified sludge must meet or exceed the requirements of the Ohio EPA Interim Final "Closure Plan Review Guidance Document." Although the NRC has regulatory jurisdiction over this disposal, it does not have waste form requirements for this type of waste. The waste form requirements of the Ohio EPA are that the unconfined compressive strength of the solidified sludge waste be 50 psi or greater. The Ohio EPA may accept lower than 50 psi compressive strength if the waste is capable of:

- 1. Exhibiting increased strength with time;
- 2. Supporting the final cap plus a safety factor of 2; and
- 3. Support the design load-bearing capacity plus a safety factor of 2.

8.7 FINAL GRADING AND ESTABLISHMENT OF VEGETATION

Within 48 hours of the on-site engineer's approval of the graded soil cover, all disturbed areas will be mulched with straw or a similar material to reduce erosion and retain soil moisture. Fertilizer will be spread at the rate of 700 pounds per acre of 10-10-10 fertilizer using a mechanical spreader to ensure even distribution. Seeding will be conducted in spring or fall. Seeding rates are specified in Appendix F. If necessary, the area will be watered to ensure seed germination and plant growth. An additional application of 700 pounds per acre of 10-10-10 fertilizer and 15 pounds per acre of approved seed mix will be applied in the following spring or fall of the year to encourage healthy plant growth. Cross sections of the final cover as it will appear on the closure cell are presented on Figure 8.4-2.

8.8 STORM WATER CONTROL

In or to minimize runoff on the cap slopes, an interceptor trench will be installed on the slop stween the toe and the crest of the cap. The storm water runoff from the cell caps and the interceptor trench will be directed to drainage swales located along the perimeter of each cell. Using the existing site grade, the swales lead into catch basins placed at design collection points to the west of the containment area. The catch basins will collect the storm water and direct it to an onsite storm sewer system. The storm sewer will direct the runoff to the Ottawa River. During construction, water collected that is considered or suspected to be contaminated will be pumped into the Burn Pond for disposal via the plant's Deep Well Injection System as previously discussed in Section 3.5. Water which is collected from areas outside of zones of contamination will be routed to the plant's storm water management system.

The system will be designed to handle peak flows as generated by the 25-year storm. The pipe sizing and sewer profiles will be developed during detailed design.

8.9 CONSTRUCTION BORROW

Two borrow sources have been identified for use during the project. One is the material excavated as a result of cell construction on-site. The second is the EOLM Landfill, located on Fort Amanda Road immediately east of the BP Refinery. It is estimated that approximately 40,000 cubic yards of borrow soils will be needed for liner and cap



construction. It is estimated that the on-site source combined with the EOLM Landfill contain more than enough material to meet this need.

In addition to identifying these sources of borrow and in accordance with Ohio EPA requirements, the clay found beneath the V-1 Pond excavation was used to construct a test fill pad to simulate the clay liner to be placed at the bottom of each cell. The results of this test found that if placed properly (per specified QA/QC criteria), the clay exceeded the requirements or performance criteria as specified by the Ohio EPA for a clay liner.

9.0 RECORD KEEPING

9.1 PERIOD OF STORAGE

Records of disposals made under the requested license will be maintained by the licensee until the Commission authorizes disposal of such records.

9.2 RECORD CONTENTS

The requirements for records are simplified by the nature of the waste. All of the contaminated waste will be disposed of in the disposal cells on site. Records of the disposal activities will be maintained until the Commission authorizes disposal of such records.

10.0 STATE AND LOCAL REQUIREMENTS

10.1 OTHER RELEVANT ENVIRONMENTAL PERMITS

The BPC facility currently holds the following environmental permits relevant to the closure project:

Deepwell Injection Permits (permitted by Ohio EPA):

No. 1 Deepwell: Permit No. 03-02-003-PTO-I (effective 10-18-93) No. 2 Deepwell: Permit No. 03-02-004-PTO-I (effective 10-18-93) No. 3 Deepwell: Permit No. 03-02-005-PTO-I (effective 10-18-93) No. 4 Deepwell: Permit No. 03-02-006-PTO-I (effective 10-18-93)

RCRA Permit (permitted by Ohio EPA)

TSD Facility Permit No. OHD 042 157 644 (effective 3-31-92)

10.2 RESTRICTIVE COVENANTS

Restrictive land use will be accomplished by recording a notation on the deed to the BPC property containing the closed area indicating that the property has been used to manage hazardous waste and that its use is restricted under Ohio Administrative Code (OAC) 3745-6619.

10.3 STATE REGULATION OF RADIOACTIVE WASTE DISPOSAL

The enactment of Ohio Senate Bill SB-130 in 1992 empowers the State of Ohio to regulate the disposal of radioactive waste within Ohio and consequently impacts the mixed waste pond closure project of BPC. The Ohio Department of Health and the Midwest Compact Commission are aware of the subject project. The commission has deferred to USNRC on the basis that it currently has primacy. BPC anticipates that the receipt of a USNRC license amendment authorizing onsite burial of mixed wastes at the Lima, Ohio facility together with the Ohio EPA's approval of the project closure plan received on September 20, 1993 will satisfy the requirements of SB-130. Nevertheless, BPC proposes to meet with the Ohio Department of Health and Midwest Compact Commission representatives to discuss state and regional jurisdiction over the project, and to secure all necessary approvals.

11.0 <u>REFERENCES</u>

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TABLE 1.2-1

SUMMARY OF SLUDGE CHARACTERIZATION DATA

CONSTITUENT, APPENDIX IX	V-1 POND	CELITE <u>POND</u>	BURN <u>POND</u>	DEEPWELL <u>POND</u>
Total Metal (mg/kg)				
Arsenic	1.0	4.5	2.8	3.2
Barium	65	44	28	59
Cadmium	0.9	0.9	0.8	0.5
Chromium	27	32	40	11.7
Lead	10.5	8.9	8.1	3.8
Mercury	0.14	0.15	0.05	0.6
Selenium	0.4	0.9	0.6	< 0.3
Silver	1.3	1.1	2.0	1.2
Total Organic (mg/kg)				
1,1,1-Trichloroethane	5.2	ND	ND	1.7
Trichloroethylene	ND	ND	- 7.8	D
Tetrachloroethylene	ND	ND	ND	1.4
Methyl Ethyl Ketone	4.9	D	D	ND
Acetone	2.8	D	D	D
Bromomethane	ND	ND	2.0	D
Bromoform	ND	ND	ND	ND
Chloroform	ND	D	ND	ND
1,1-Dichloroethylene	4.9	ND	ND	D
Methylene Chloride	ND	D	D	ND
Benzene	ND	ND	D	ND
Toluene	ND	ND	D	ND
Ethyl Benzene	ND	ND	D	ND
Acetonitrile	110	6.5	26.8	19.7
Acrylonitrile	ND	8.0	ND	4.0
Pyridine	ND	7.5	57	26
Methyl Pyridine	ND	ND	D	ND
Methyl Naphthalene	ND	0.5	D	ND
Phenol	ND	ND	D	ND
o-Cresol	ND	ND	D	ND
p,m-Cresol	ND	ND	D	ND
Inorganic (mg/kg)				
Total Cyanide	136	621	1695	3148



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TABLE 1.2-1 (Continued)

SUMMART OF	SLUDGEU	IARAU I ERIZ	ATION DAT	171
CONSTITUENT, APPENDIX IX	V-1 POND	CELITE <u>POND</u>	BURN <u>POND</u>	DEEPWELL <u>POND</u>
ICLP Metal (mg/l)				
Arsenic	0.4	0.5	0.9	0.6
Barium	0.12	0.51	0.24	0.46
Cadmium	< 0.005	0.006	0.005	0.013
Chromium	0.02	0.02	1.6	< 0.01
Lead	< 0.02	< 0.02	< 0.02	< 0.02
Mercury	< 0.0002	0.0002	0.0003	0.0002
Selenium	< 0.1	< 0.1	< 0.1	< 0.1
Silver	< 0.01	0.02	0.03	0.02
ρH	NT	8.04	NT	7.76
Reactivity (mg/kg)				
S	NT	NT	31	NT
CN-	NT	NT	3.4	NT

SUMMARY OF SLUDGE CHARACTERIZATION DATA

NT

 0.54^{**}

NT

0.54

 $> 180^{\circ} F$

0.29

D = Compound Detected Below Quantitation Level

ND = Not detected

Dry Density (g/cc)

** = Approximate

NT = Not tested

Ignitability

NT

0.50

TABLE 1.2-2

DESCRIPTION OF WASTE BY US EPA NUMBER

Pond	Description	Waste Code
Deepwell	Acrylonitrile process wastes including bottom stream from wastewater stripper, bottom stream from acetonitrile colum and bottoms from acetonitrile purification column	
Burn	Off-specification acetonitrile waste and excess waste from Deepwell Pond	K011, K013, K014, U003, D003
Celite	Excess waste from Deepwell Pond	K011, K013, K014 U009
V-1	Waste from acrylonitrile cleaning operations	D002

K011 - Bottom stream from the wastewater stripper in the production of acrylonitrile

K013 - Bottom stream from the acetonitrile column in the production of acrylonitrile

K014 - Bottoms from the acetonitrile purification column in the production of acrylonitrile

U003 - Acetonitrile - off-specification

D002 - Characteristic of corrosivity (caustic)

D003 - Characteristic of reactivity (sulfide)

U009 - Acrylonitrile - off-specification





TABLE 3.1-1

Sludge Source	Binder Agent	Application Percentage	Bulking Factor
V-1 Pond	Gypsum Soil	25% 100%	2.00
Celite and Deepwell Pond ¹	Gypsum Soil	25% 100%	2.45
Burn Pond	Gypsum Soil	25% 100%	1.98

SLUDGE AND BINDER AGENT MIXTURE SUMMARY

¹ The Deepwell and Celite Pond Sh dges were combined based on similar characterization results of these materials.

Note: These recipes are currently being verified with final results expected in the Spring of 1994.

TABLE 7.4-1

PERMEABILITY TEST RESULTS

Well I.D.	Depth	Elevation (ft)	Hydraulic Conductivity (cm/sec)
2-81-B-2	5'0"-5'8"	840.97-840.30	1.5 x 10-7
2-81-B-2	5'8"-6'4"	840.30-839.37	8.2 x 10 ⁻⁸
2-81-B-2	10'8"-11'4"	835.31-834.70	3.2 x 10 ⁻⁸
2-81-E-1	10.0"-10'7"	854.52-853.93	4.7 x 10 ⁻⁸
2-81-E-1	10'7"-11"3"	853.93-853.27	1.9 x 10 ⁻⁷
2-81-E-2	5'3"-5'11"	858.8-858.13	4.6 x 10 ⁻⁸
2-81-E-2	10'2"-10'10"	853.88-853.21	6.2 x 10 ⁻⁸
2-81-E-2	10'10"-11'6"	853.21-852.55	5.1 X 10-7
2-81-E-2	11'6"-12'2"	852.55-851.88	3.1 X 10 ⁻⁸
2-81-E-4	10'0"-10'7"	845.33-844.74	5.2 X 10 ⁻⁷
2-81-E-4	10'9"-11'5"	844.58-843.91	1.2 x 10-7
2-81-E-4	11'5"-12'1"	843.91-843.24	4.4 x 10 ⁻⁸
2-81-EB-6	6'3"-7'1"	857.25-856.41	3.0 X 10-7
2-81-EB-6	7'1"-7'9"	856.41-855.75	8.2 X 10 ⁻⁸
2-81-EB-6	11'7"-12'3"	851.91-851.25	5.0 X 10 ⁻⁸
2-81-EB-6	12'3"-13'	851.25-850.5	7.3 X 10 ⁻⁸
1-82-1	20'6"-22'6"	843.7-841.7	1.6 X 10 ⁻⁸
1-82-2	8'0"-10'0"	855.8-853.8	1.6 X 10 ⁻⁶ *
1-82-3	11'6"-13'6"	852.7-851.7	1.0 X 10-7
85-D	5'6"-6'0"	858.5-858.0	1.5 X 10 ⁻⁸
85-D	11'0"	853.0	6.6 X 10 ⁻⁸
85-D	16'0"	848.0	2.9 X 10 ⁻⁷
85-E-10	9'0"-11'0"	852.4-840.4	1.7 X 10 ⁻⁸
85-E-10	14'0"-16'0"	847.4-845.7	4.7 X 10 ⁻⁸
85-E-10	19'0-21'0"	842.7-840.7	4.0 X 10 ⁻⁸
85-E-10	24'0"-26'0"	837.7-835.7	8.2 X 10 ⁻⁸
85-F	4'0"-6'0"	856.0-854.0	7.1 X 10 ⁻⁸
85-F	9'0-11-0"	851.0-849.0	2.2 X 10 ⁻⁸
85-F	14'0"-16'0"	846.0-844.0	5.7 X 10 ⁻⁸
85-F	19'0"-21'0"	841.0-839.0	4.5 X 10 ⁻⁸

* Measured in clay fill material.



TABLE 7.4-2

FLOOD DISCHARGE-FREQUENCY RELATIONSHIP AT ALLENTOWN

Flood discharge cubic feet per square	Average recurrence internal in years	Comments
6,700	20	Hypothetical
7,740	40	Flood of record January 1959
8,100	50	Hypothetical
26,100	Greatly in excess of 100 years	Standard project flood







Month	Mean Daily Temperature (°F)	Avg. Total Precipitation (inches)
January	26.6	2.57
February	29.6	2.11
March	39.5	3.08
April	51.5	3.43
May	61.8	3.69
June	71.0	3.81
July	74.7	3.37
August	73.0	3.10
September	66.4	3.39
October	54.5	2.01
November	42.1	2.64
December	31.8	2.51

METEOROLOGICAL DATA 1

¹ Data were recorded by the National Weather Service at the Dayton, Ohio Airport.







SUMMARY OF CLIMATOLOGICAL DATA (1981-1990)

	M	Temperatu ean	re (°F)		Precipitation (in)
Year	Max	Mir	Highest	Lowest	Total
1981	59.1	41.3	91	-6	40.75
1982	59.7	42.1	91	-18	40.71
1983	62.1	42.7	99	-17	36.58
1984	61.2	42.4	95	-17	36.12
1985	61.1	42.4	91	-2	35.47
1986	61.8	44.4	91	-1	43.83
1987	62.1	43.5	94	-2	36.36
1988	60.2	39.6	100	-8	28.03
1989	59.5	39.6	96	-17	32.53
1990	63.0	43.4	96	+4	52.46

$T(F^{\circ})$ $T(C^{\circ})$ Month P T+17.8 P(T+17.8) U(mm) U(in) 14.80 Jan 26.60 -3.00 6.76 1.00 38.86 1.53 Feb -1.33 29.60 16.47 6.72 1.11 42.98 1.69 Mar 39.50 4.17 21.97 8.33 1.83 71.08 2.80 51.50 28.63 8.95 2.56 99.55 3.92 Apr 10.83 May 61.80 16.56 34.36 10.02 3.44 133.72 5.26 21.67 71.00 154.53 39.47 3.98 6.08 June 10.08 23.72 July 74.70 4.24 164.84 6.49 41.52 10.22 5.92 Aug 73.00 22.78 40.58 9.54 3.87 150.37 Sept 66.40 19.11 36.91 8.39 3.10 120.30 4.74 Oct 54.50 12.50 30.30 7.75 2.35 91.22 3.59 2.41 Nov 6.72 42.10 5.6123.41 1.57 61.11 17.69 51.67 2.03 Dec 31.80 -0.117.52 1.33

CONSUMPTIVE USE OF WATER BY GRASS





Month	Evapotranspiration (inches)			
Jan	1.53			
Feb	1.69			
Mar	2.80			
Apr	3.92			
May	5.26			
June	6.08			
July	6.49			
Aug	5.92			
Sept	4.74			
Oct	3.59			
Nov	2.41			
Dec	2.03			

EVAPOTRANSPIRATION RATE (PER MONTH) BY GRASS¹

¹ These values were determined by an equation from "Water Quality" Tchobangolous, George and Edward D. Schroeder, 1987, which is as follows

$$U = \frac{(45.7)(K_{bc})(T+17.8)(p)}{100}$$

where:

U = evapotranspiration (millimeters)

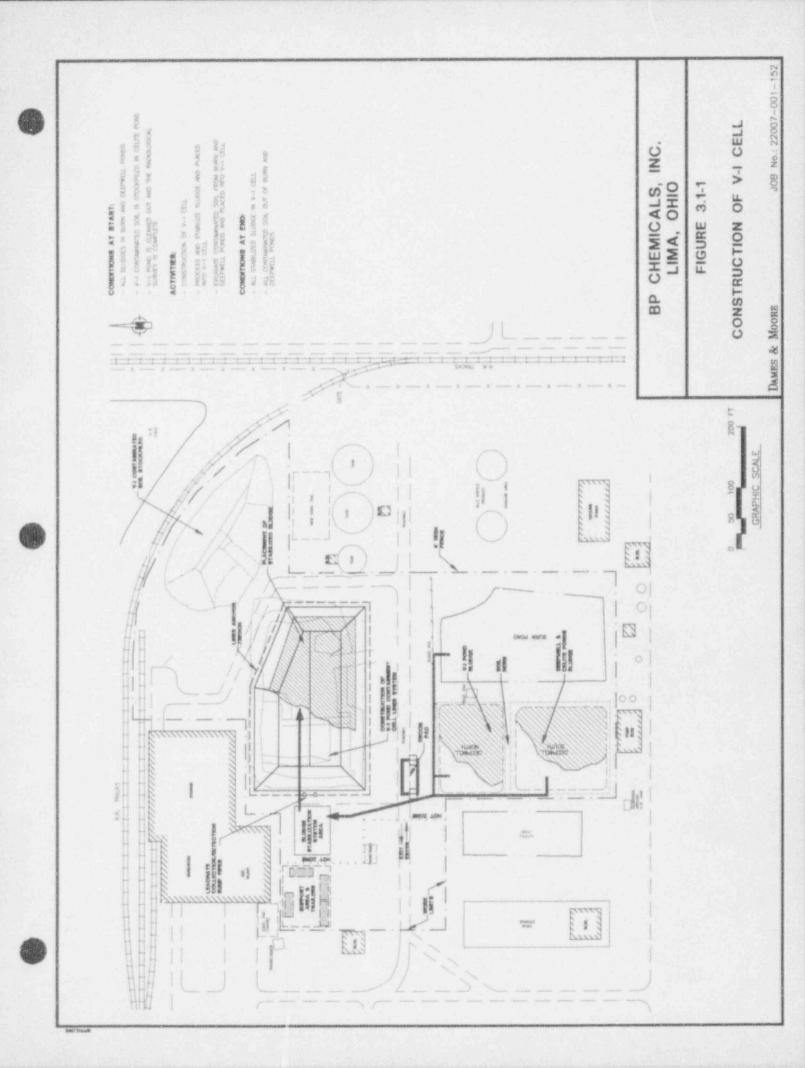
Kbc = Blaney-Criddle consumptive use coefficient (i.e., 0.85 for grass)

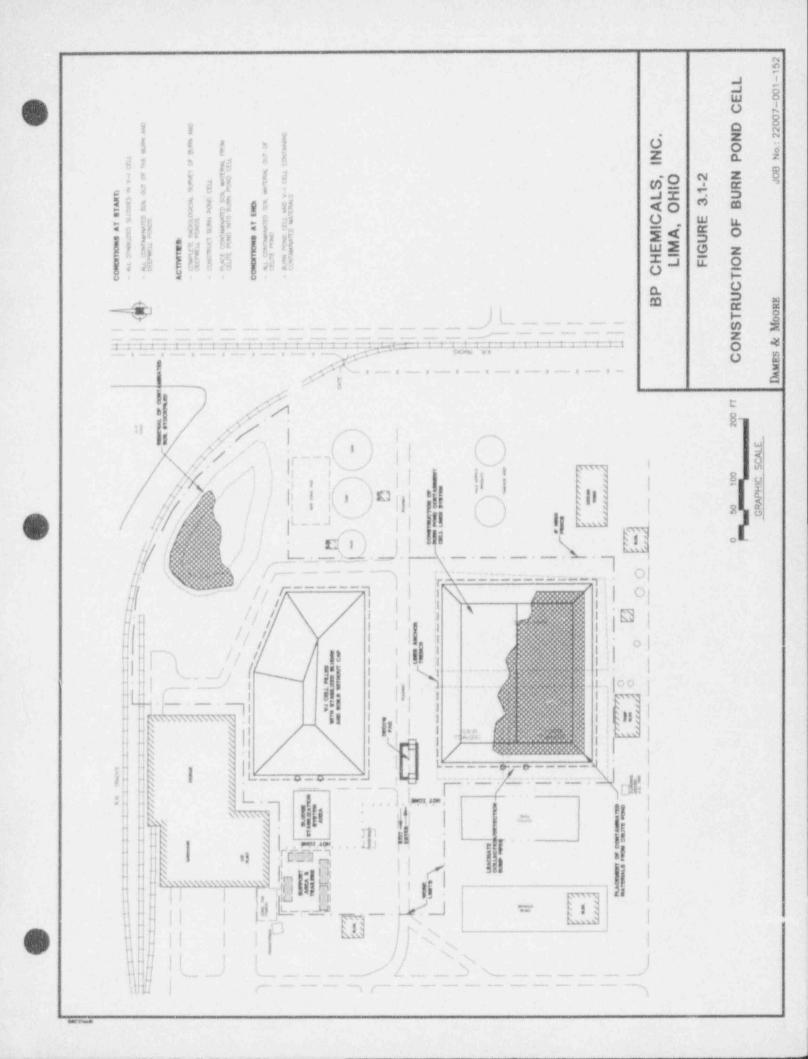
T = mean temperature for time increment

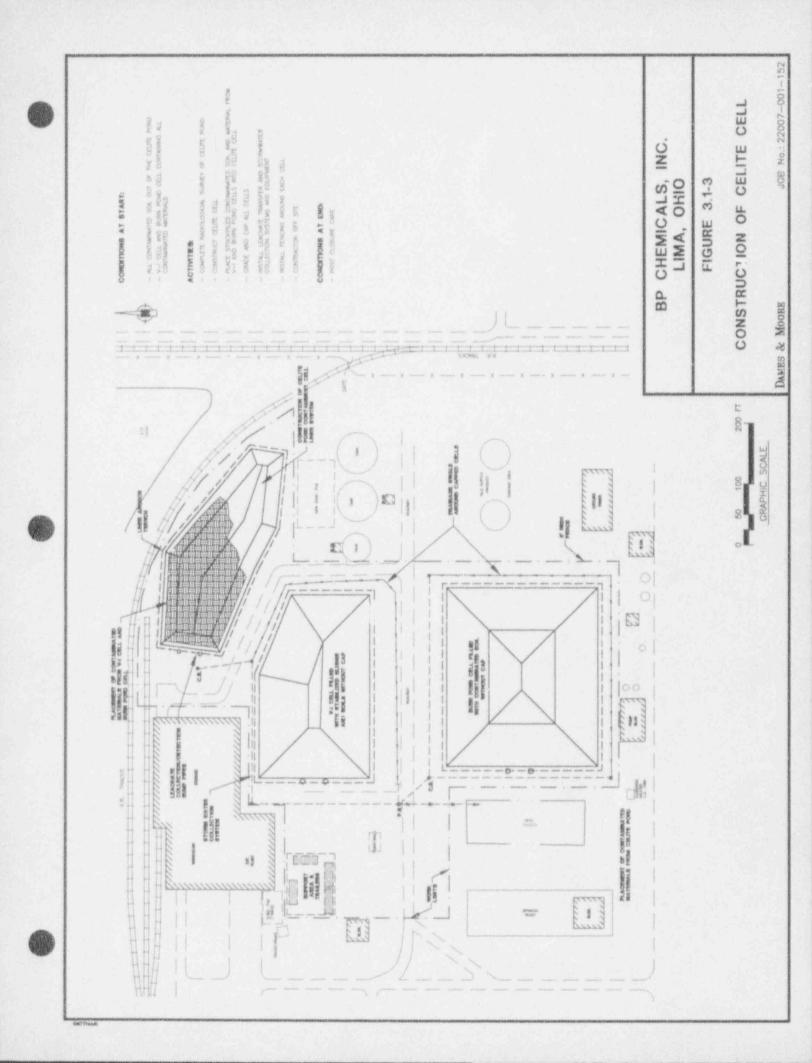
p = percent of annual daytime hours occurring during time increment (based on latitude of site, i.e., 40° north)

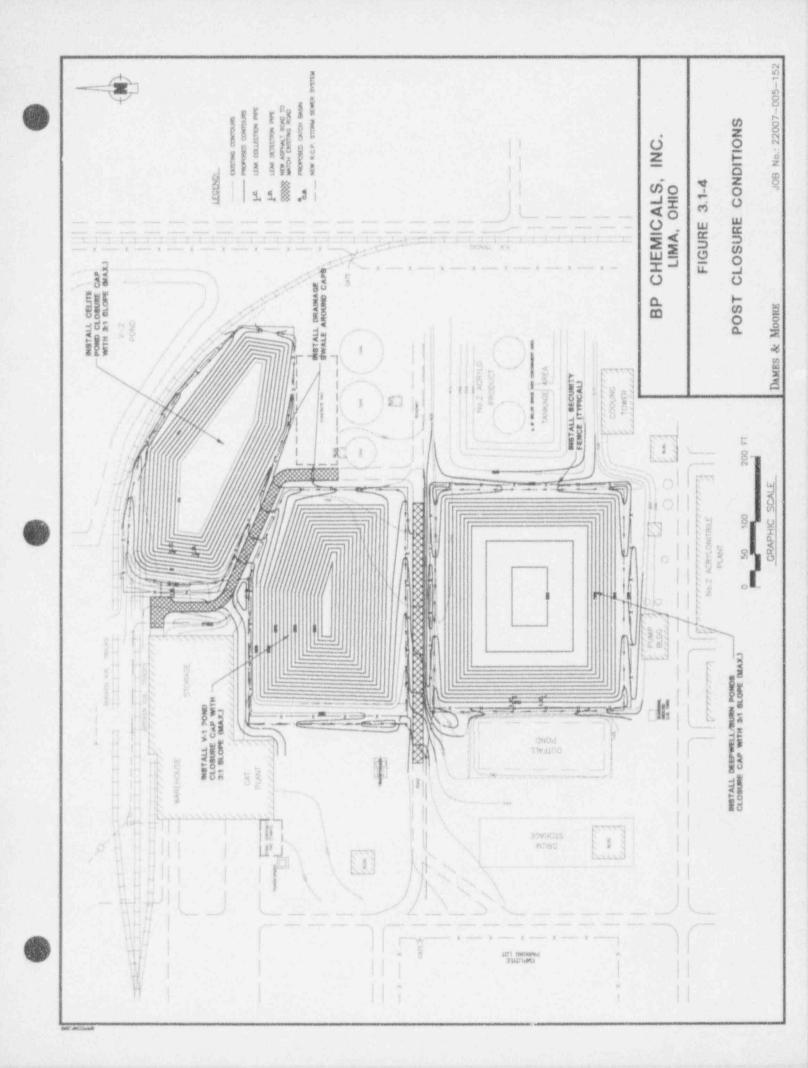


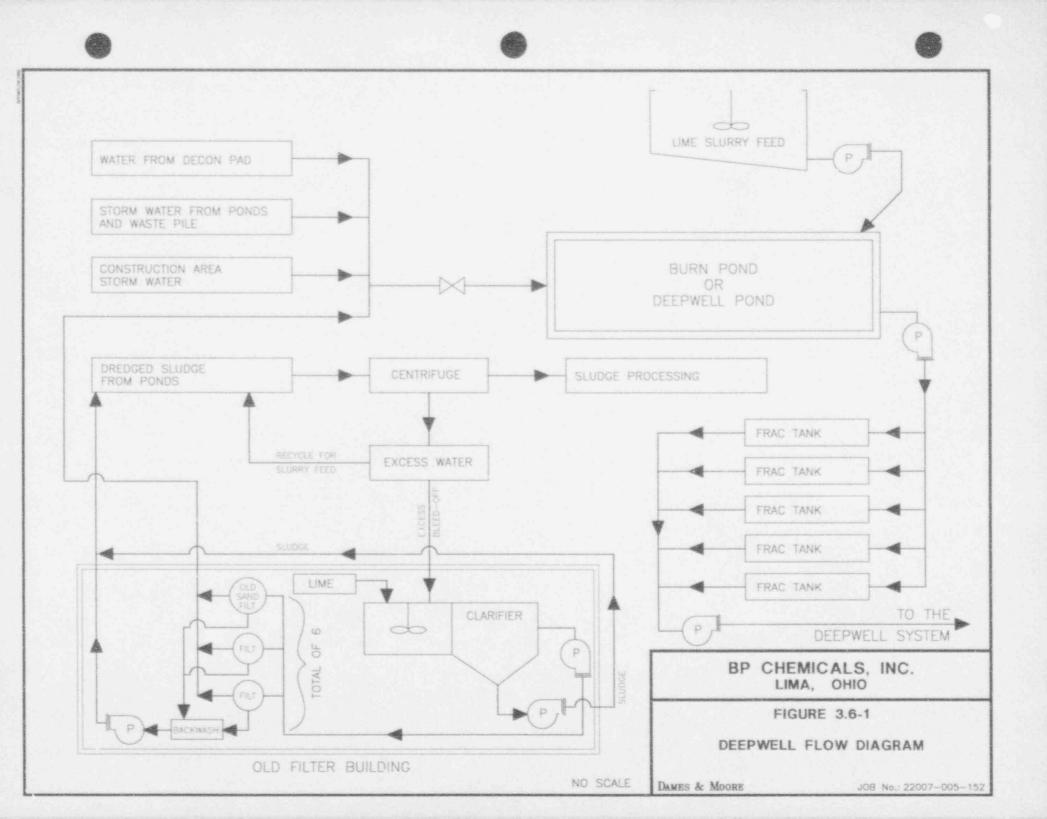


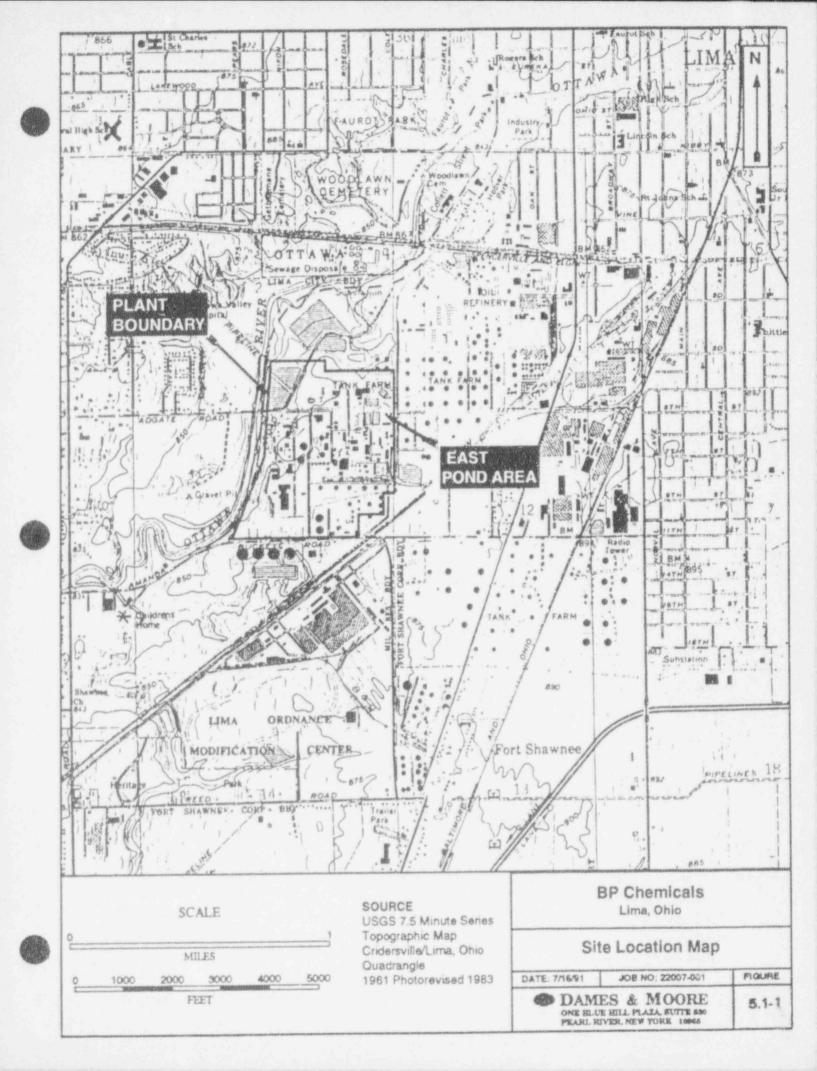


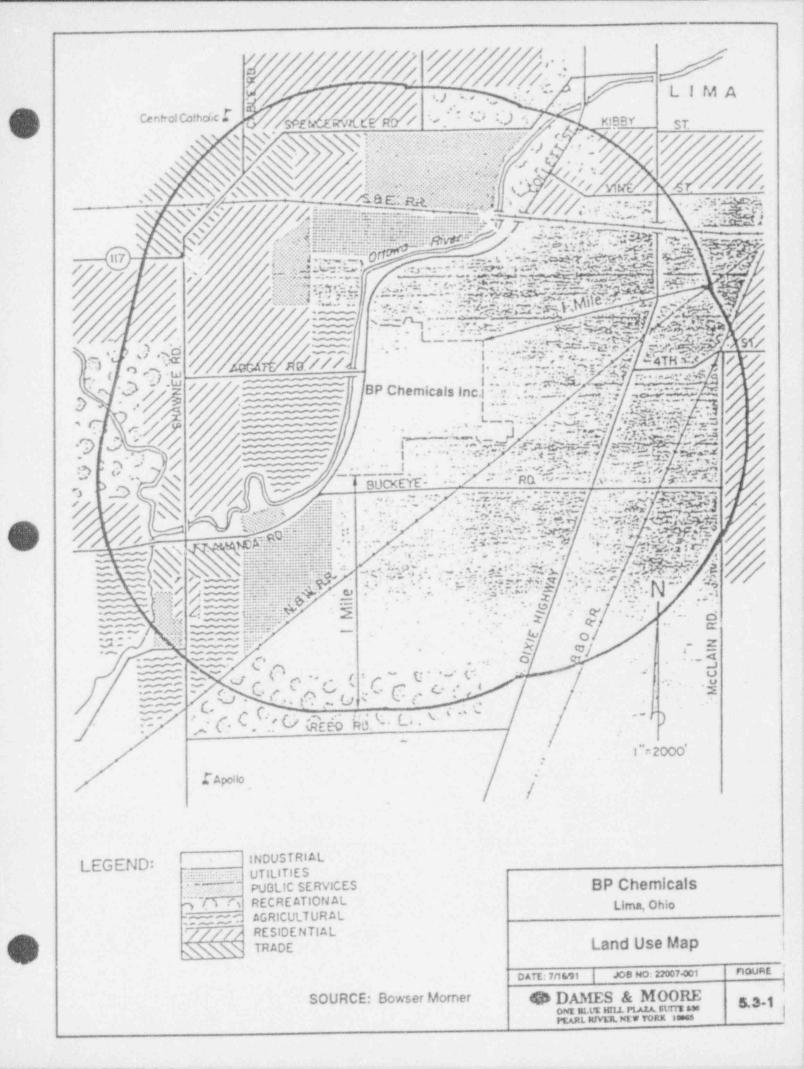


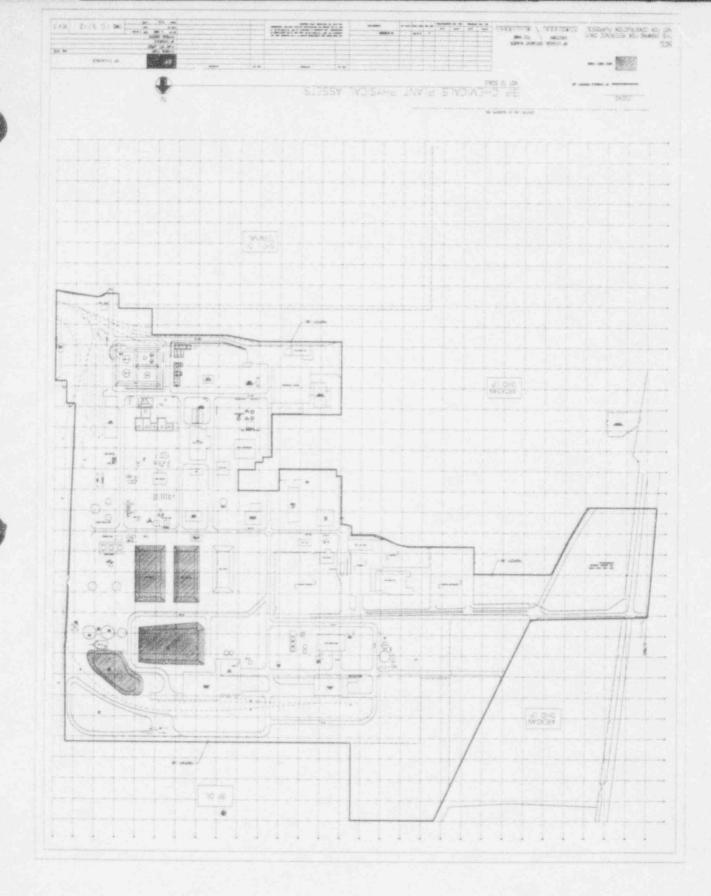


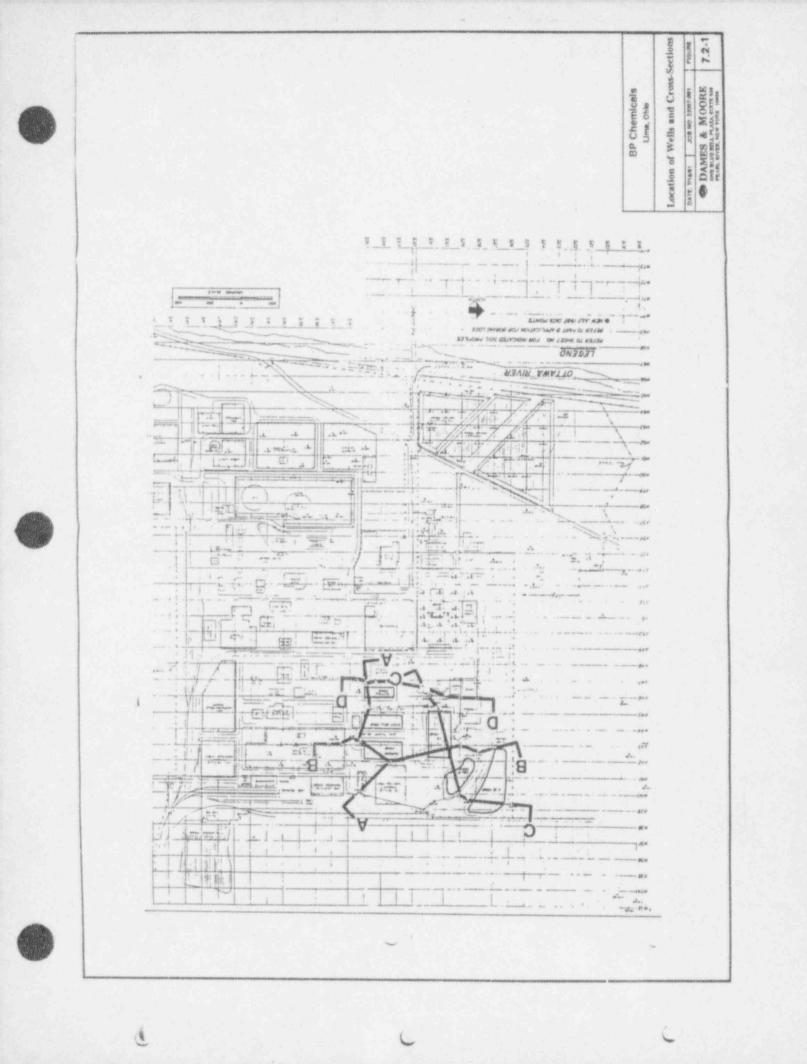












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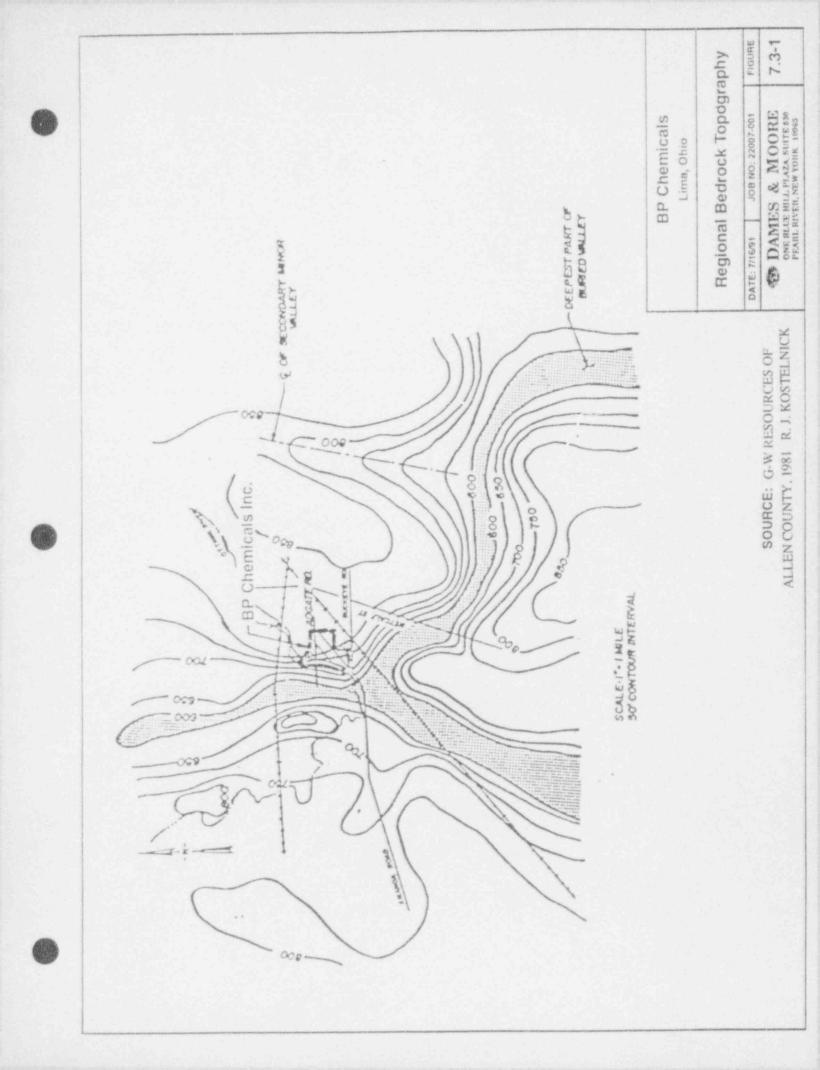
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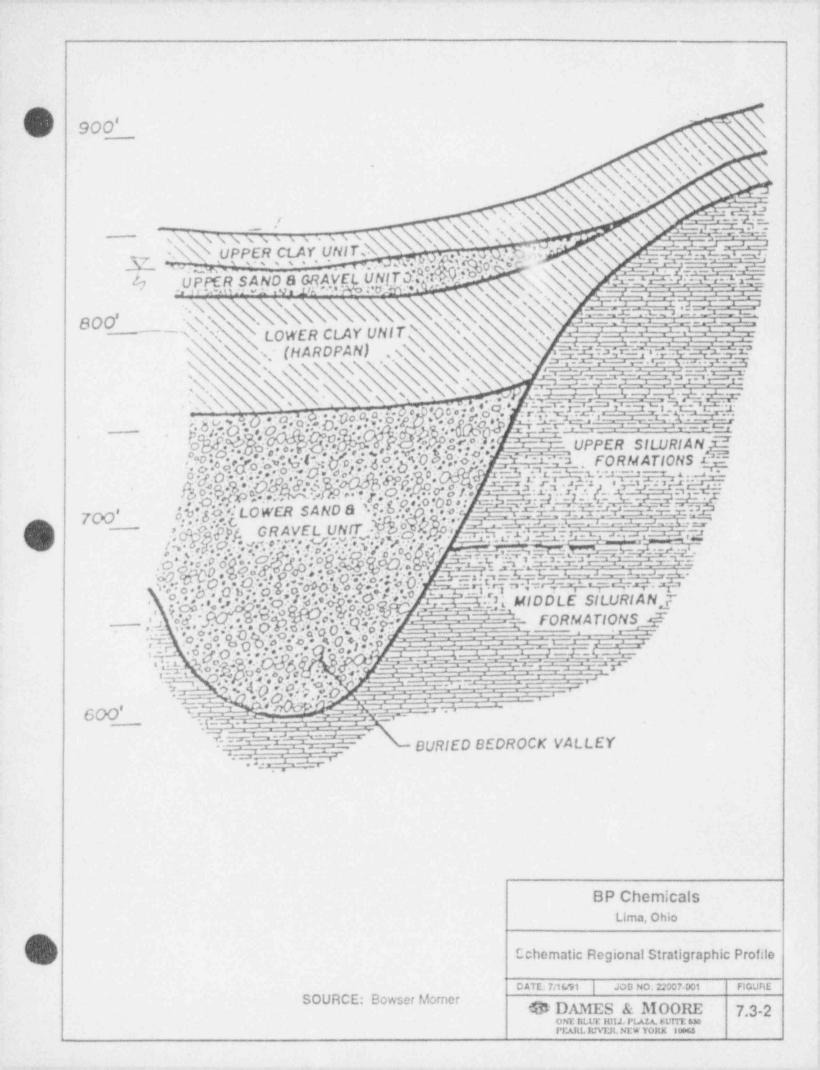
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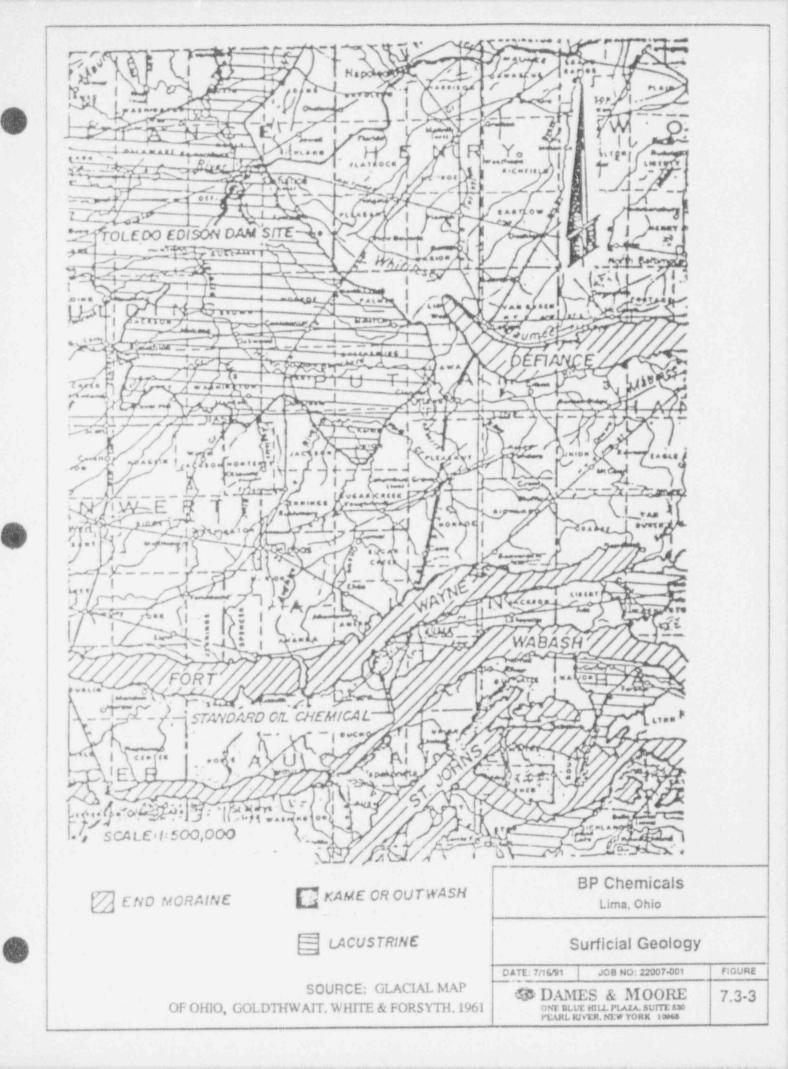
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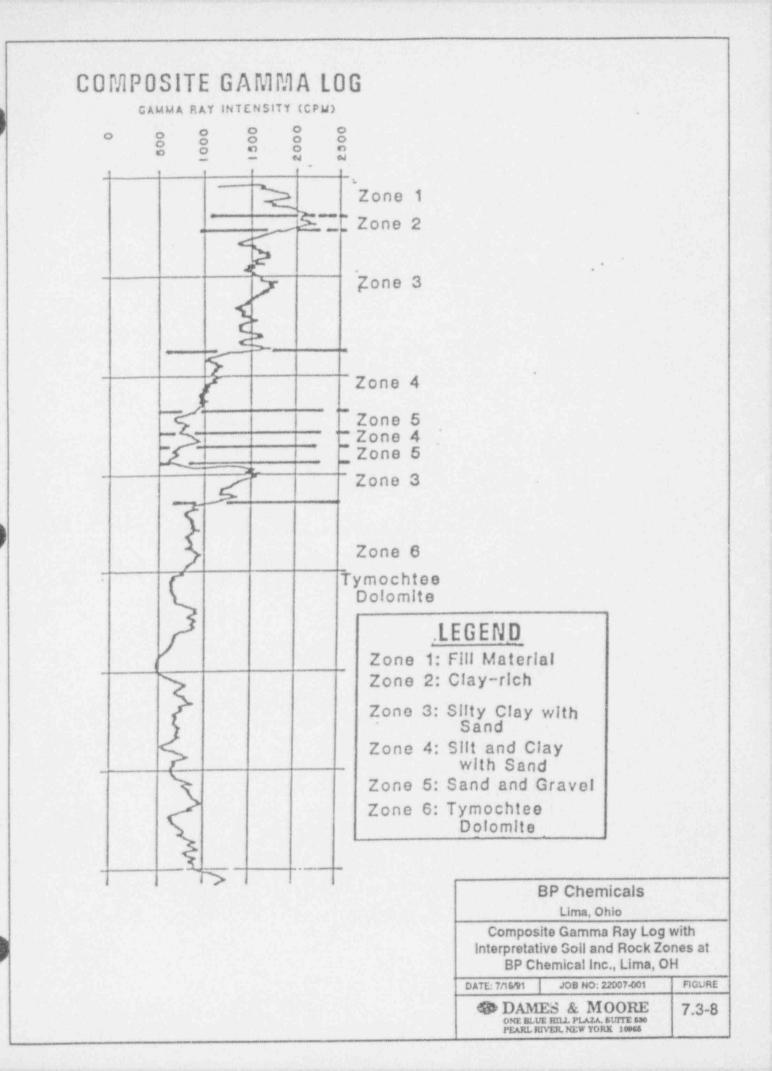
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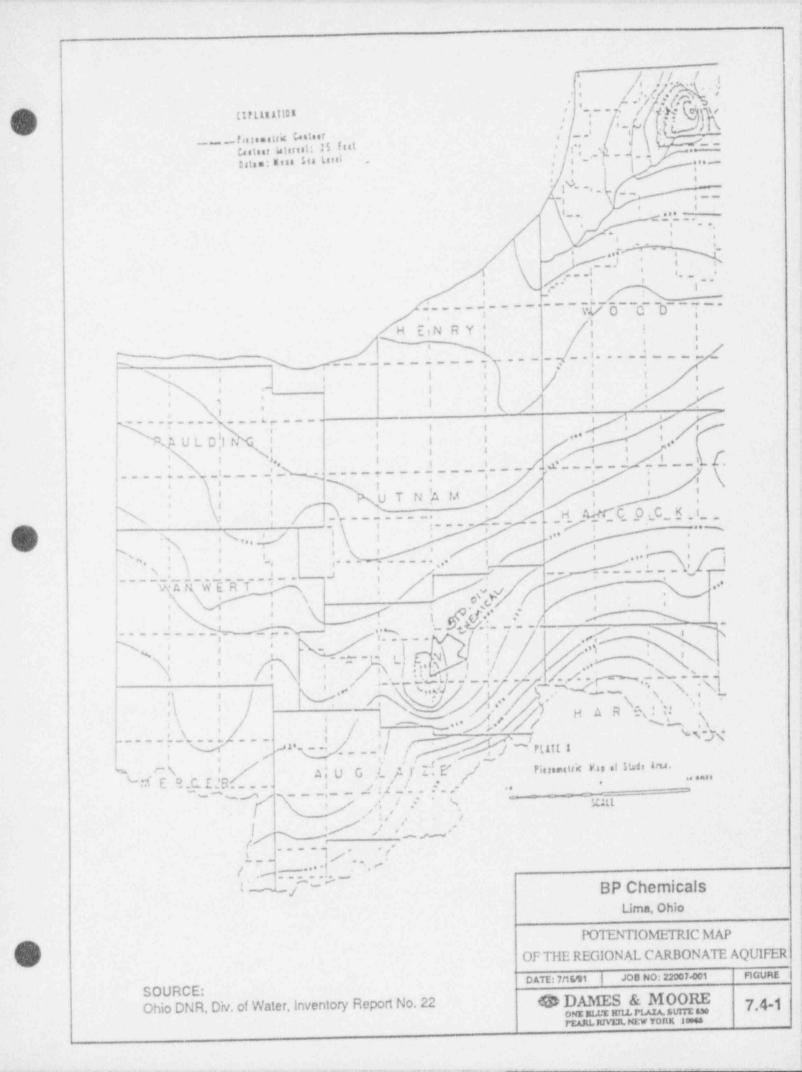
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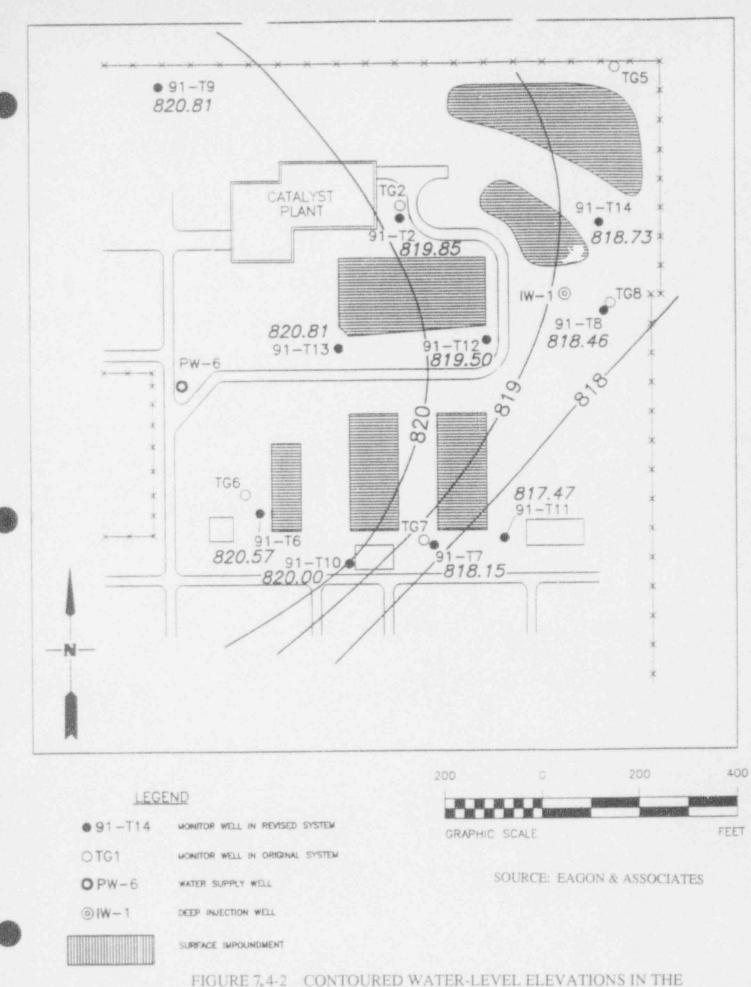




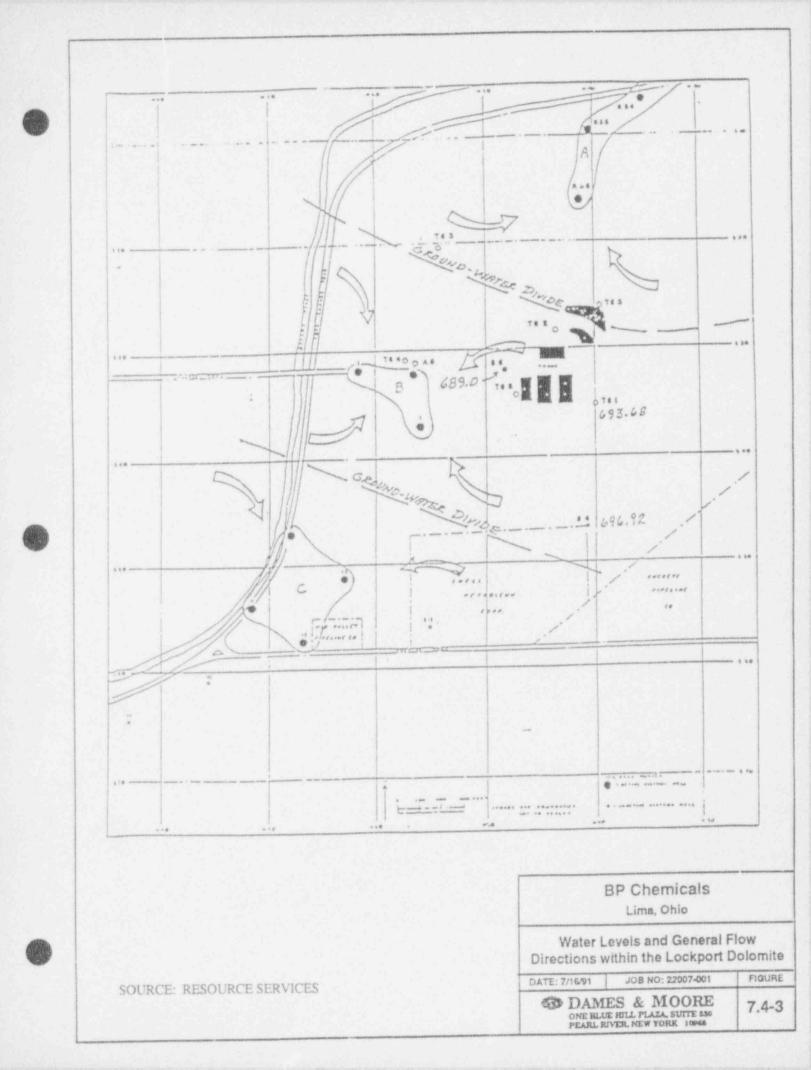


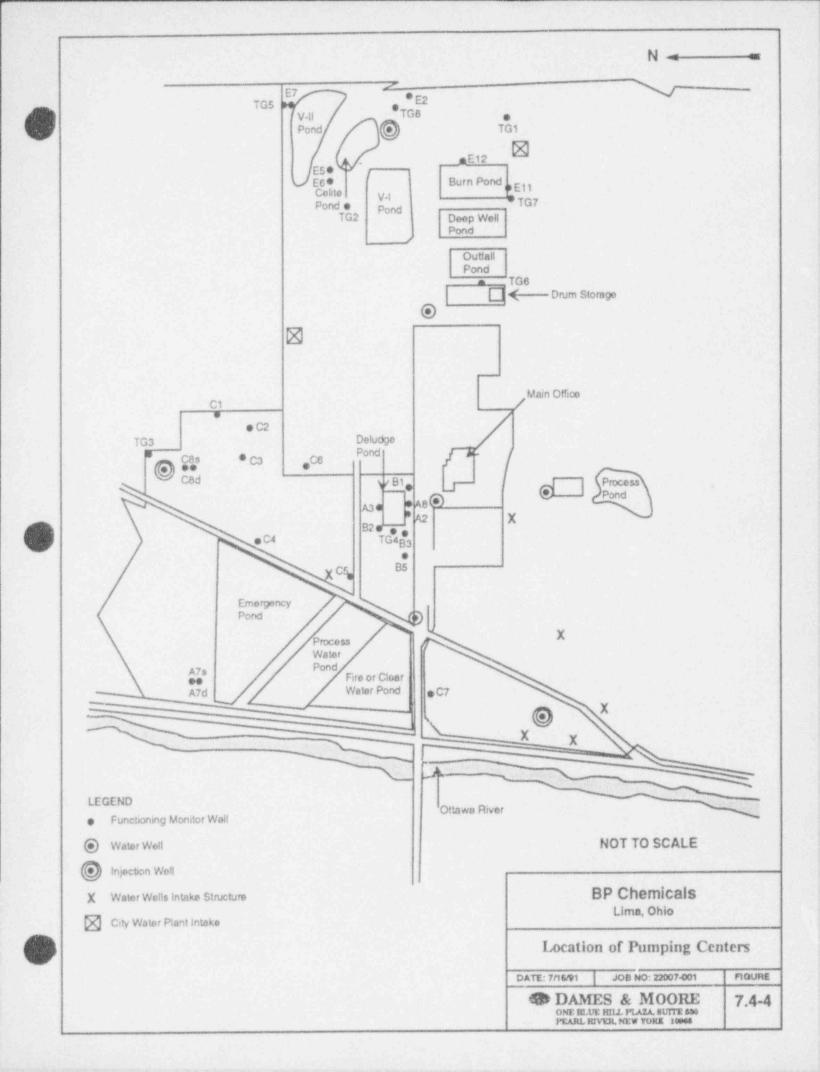


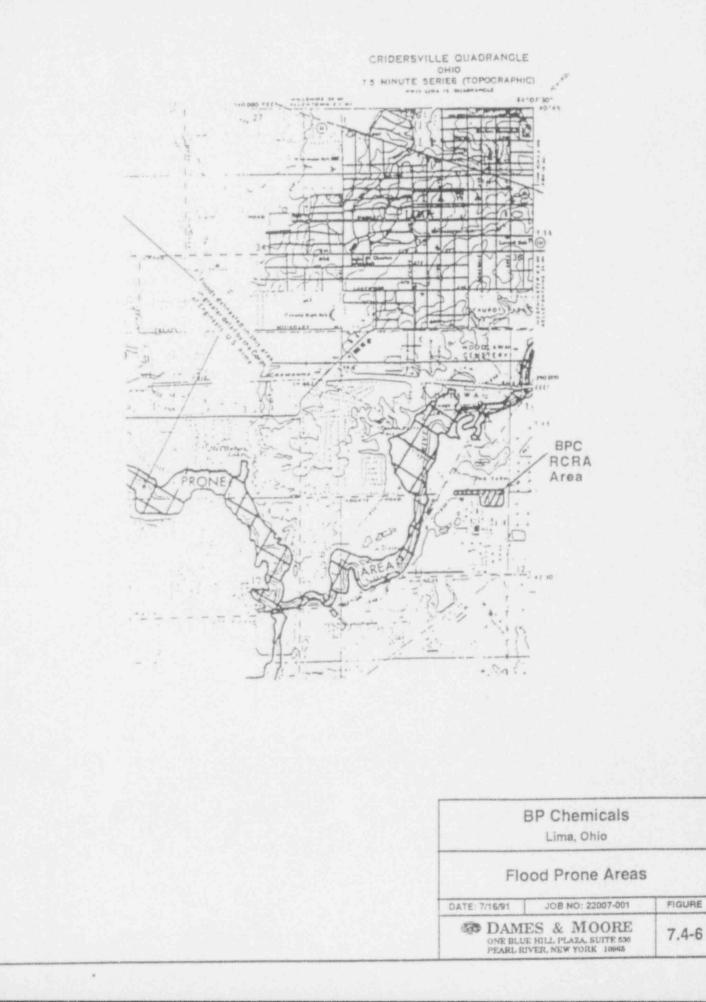


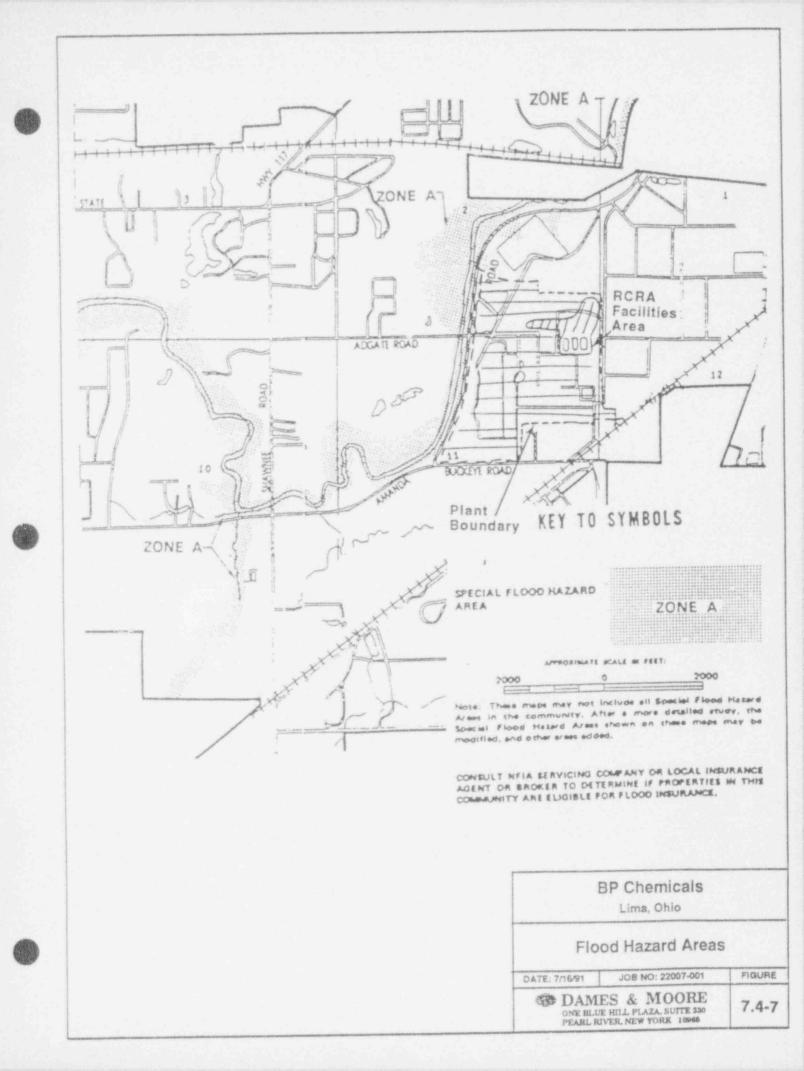


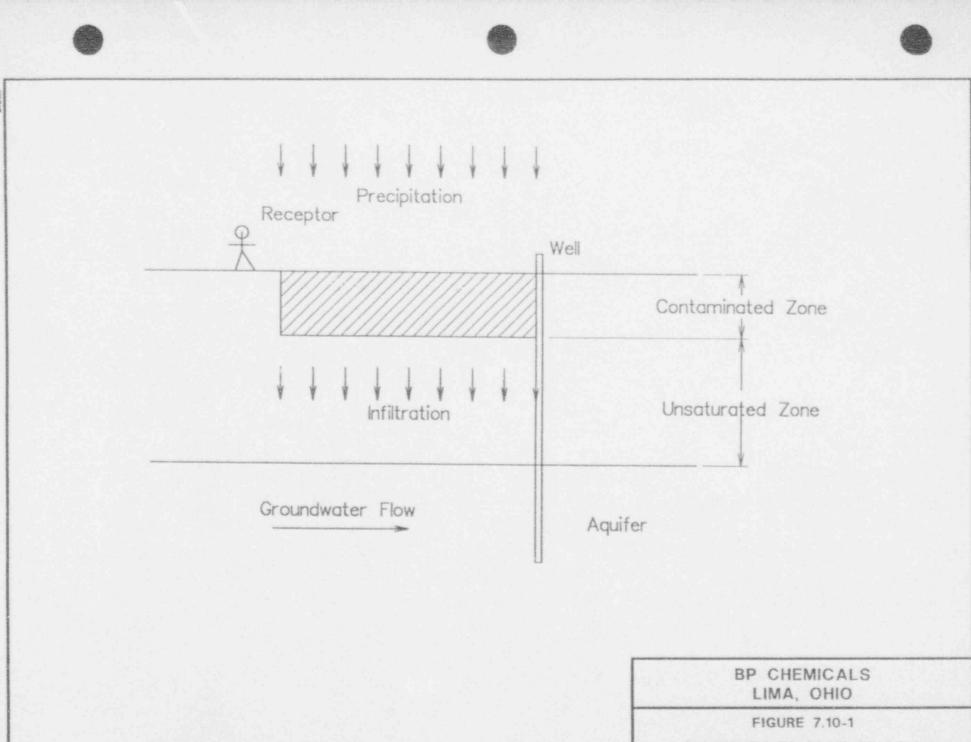
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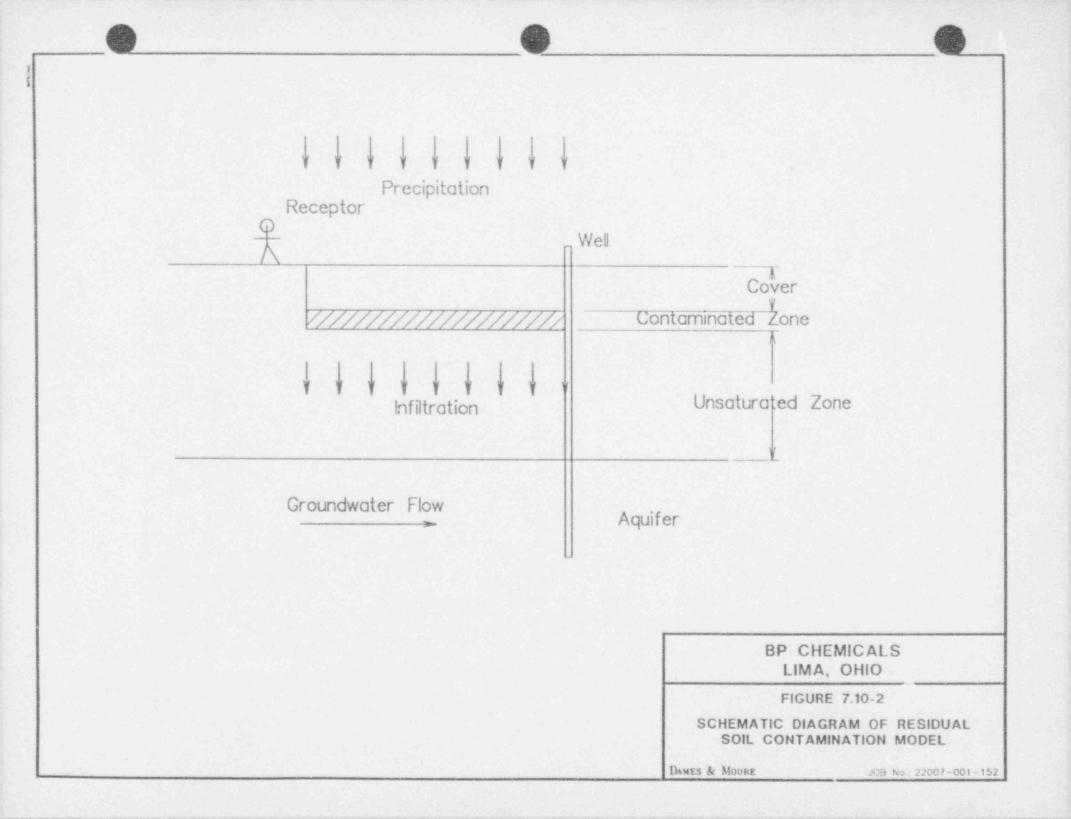


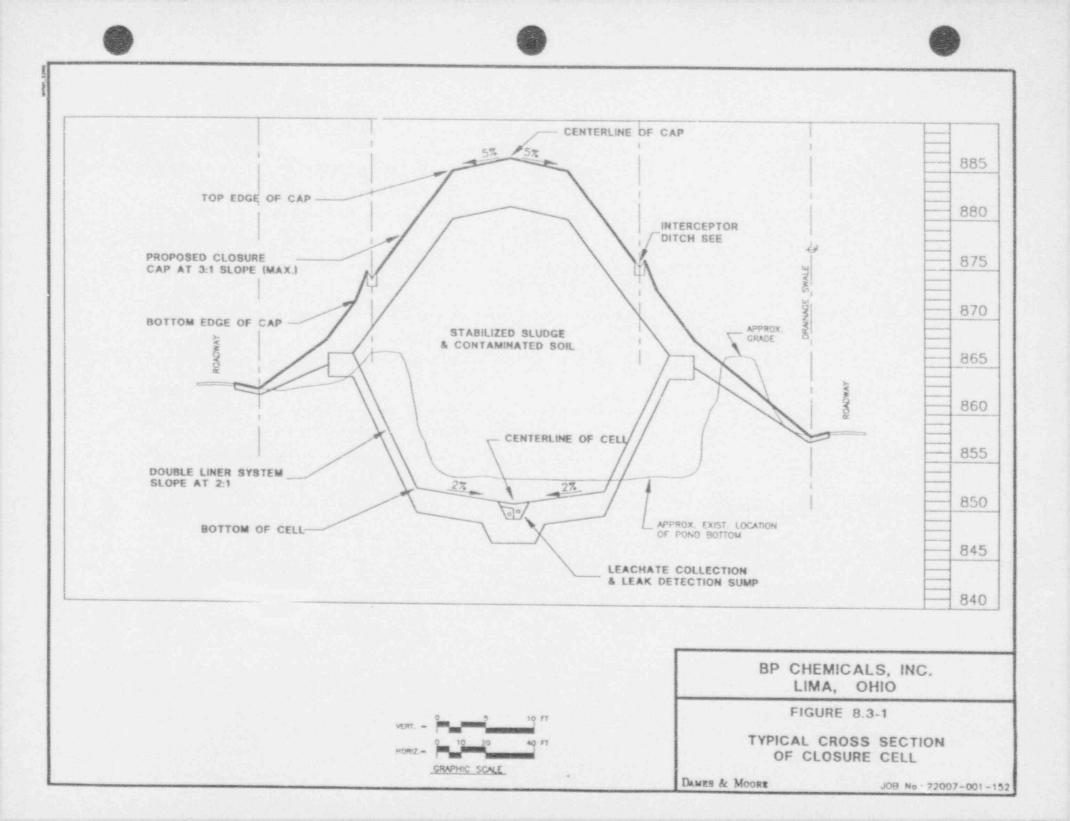


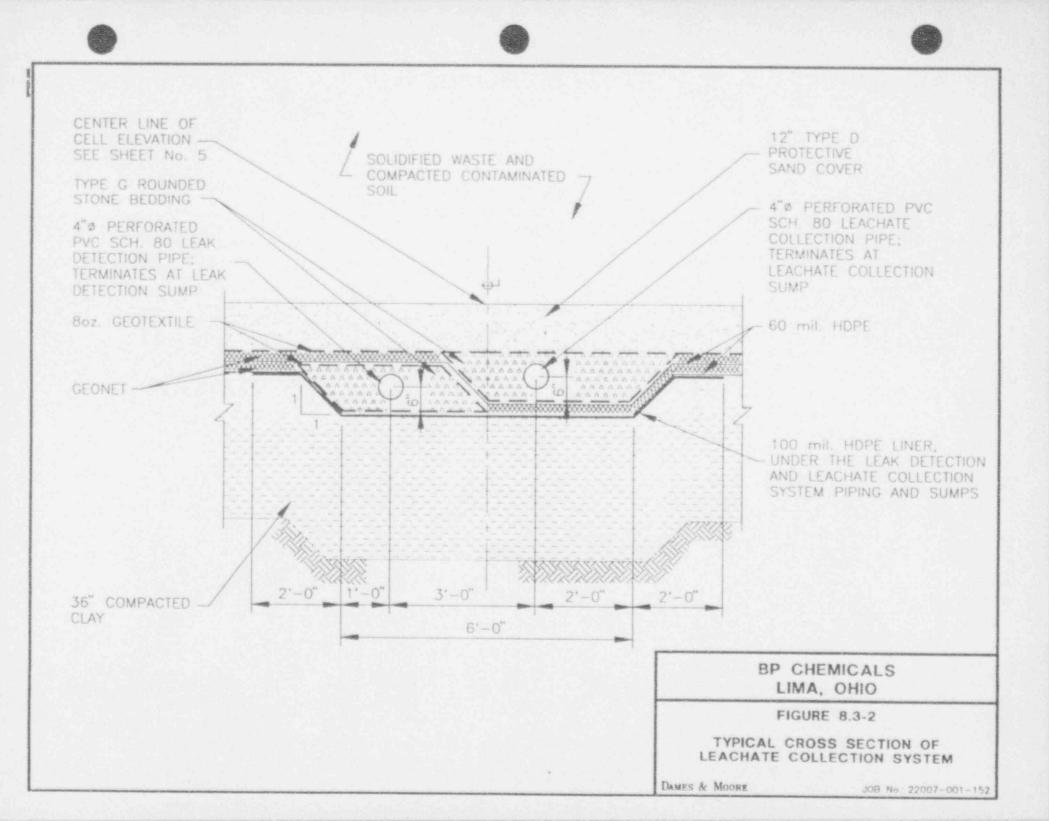
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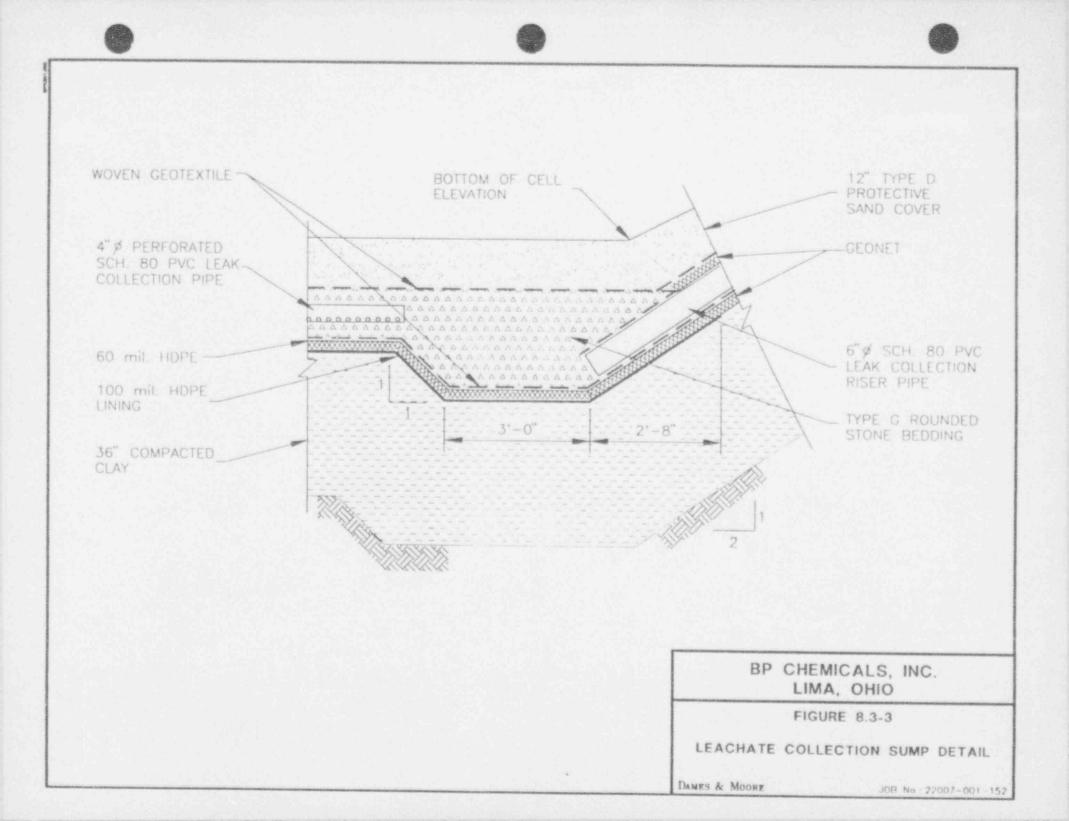
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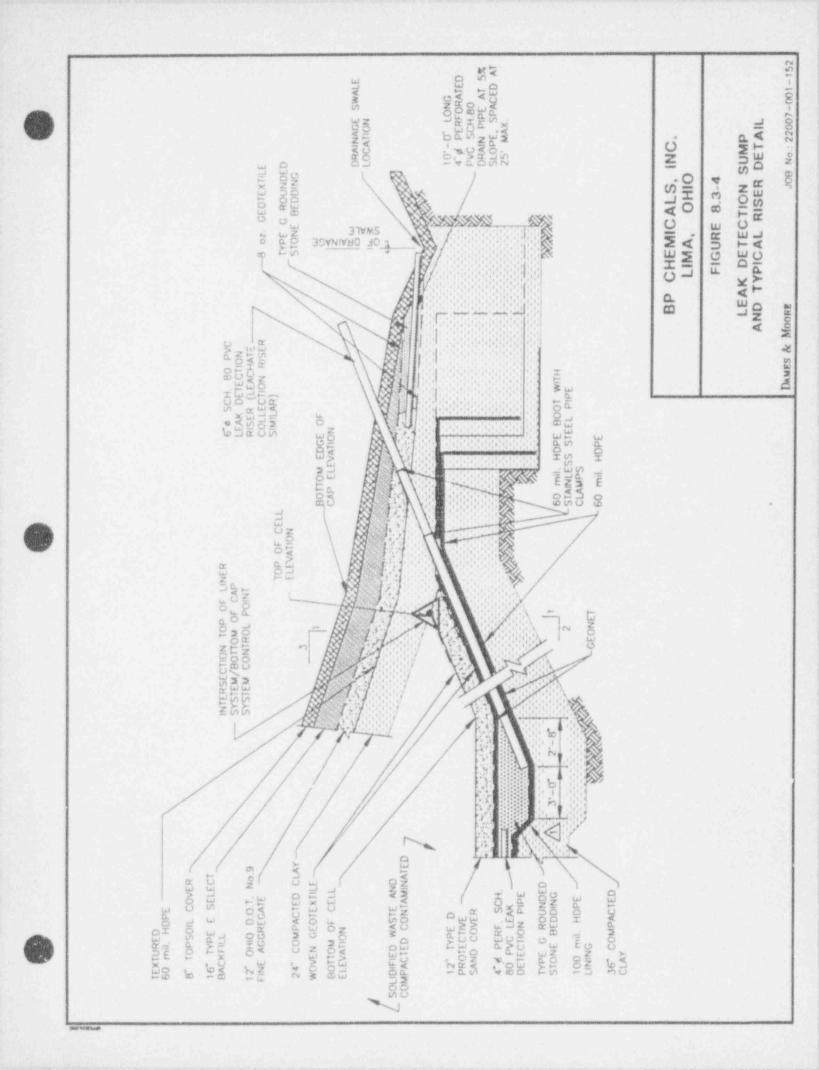
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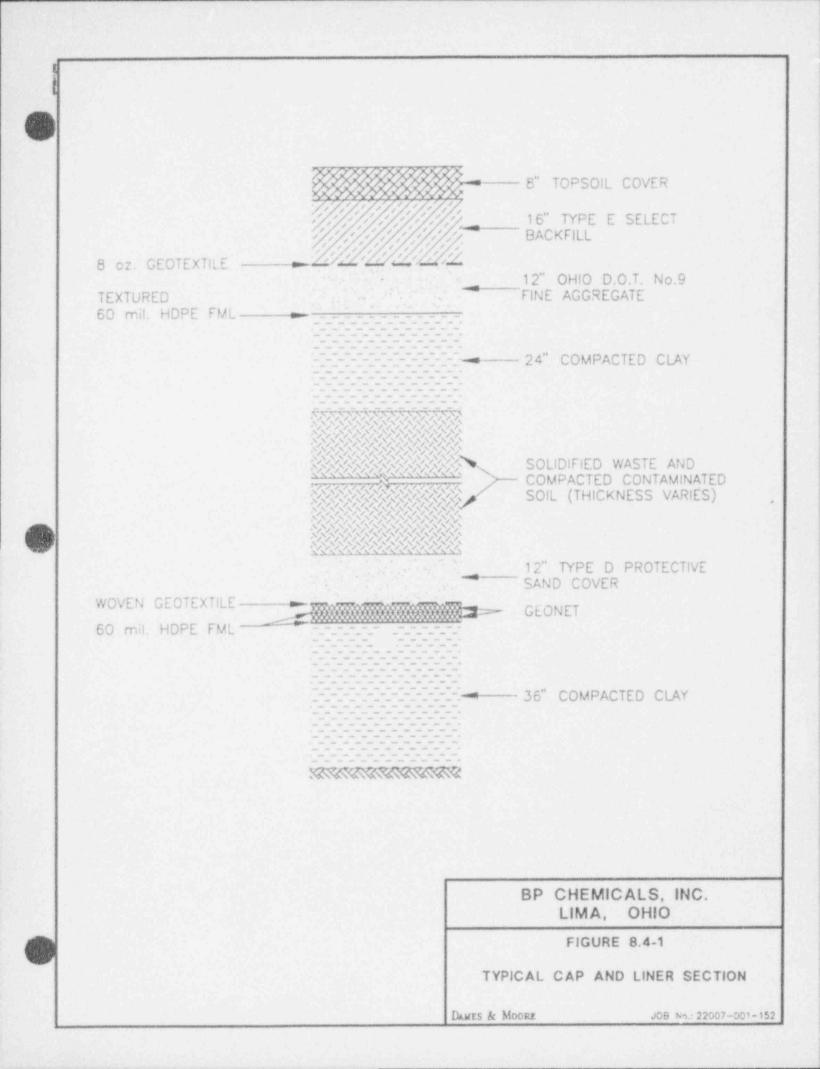


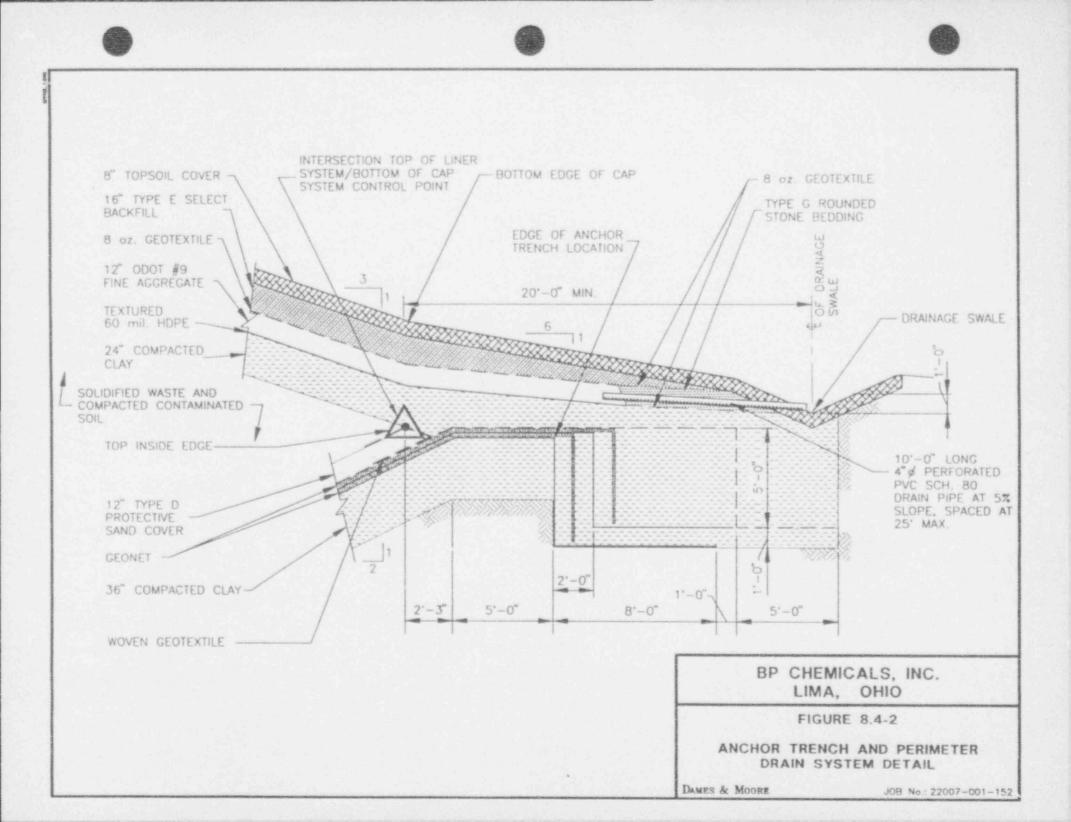


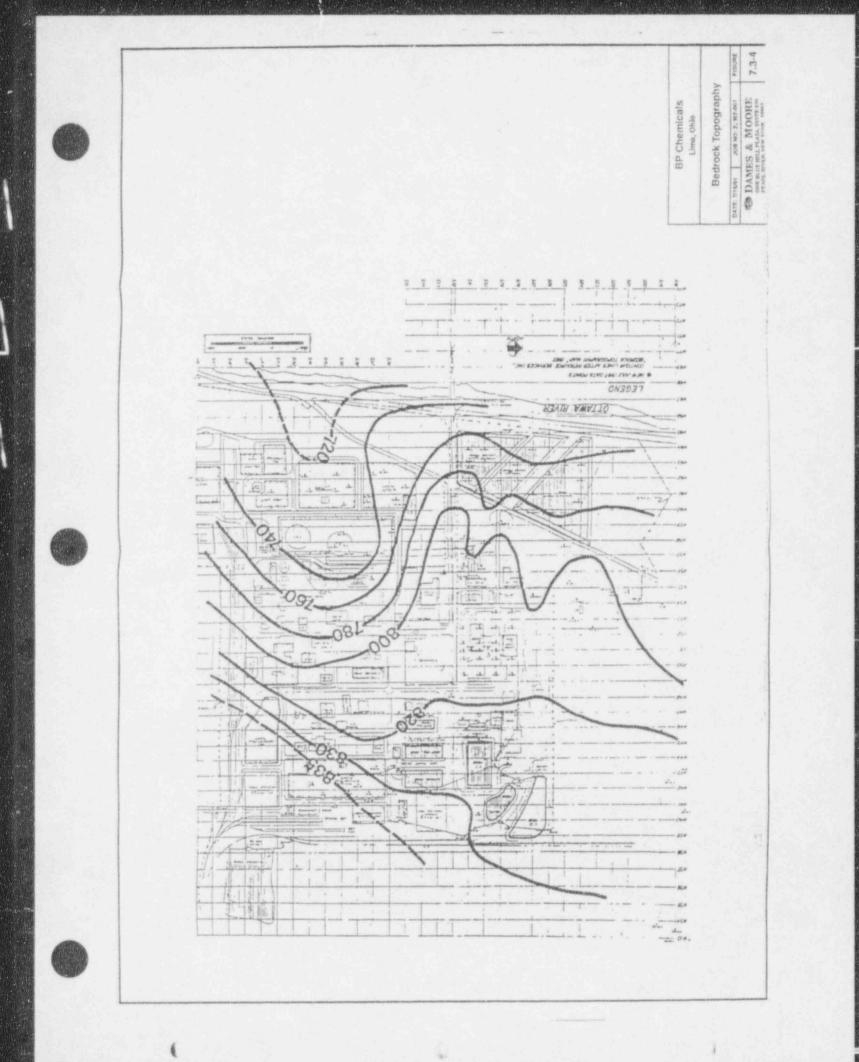


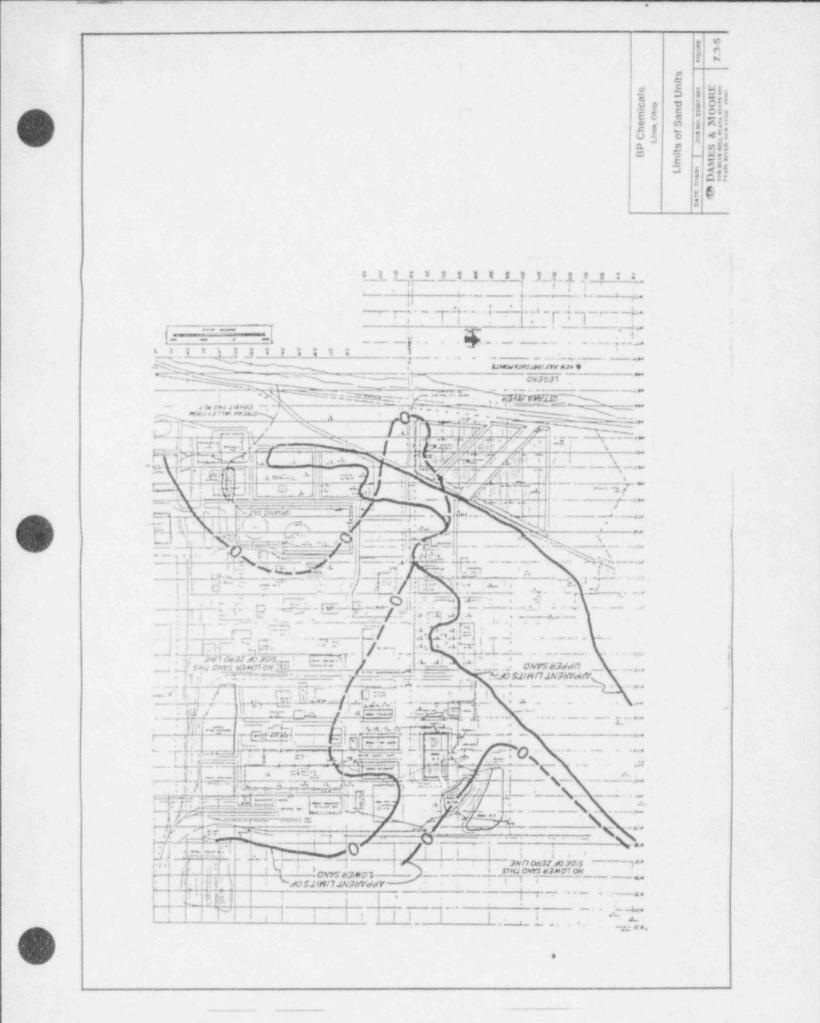


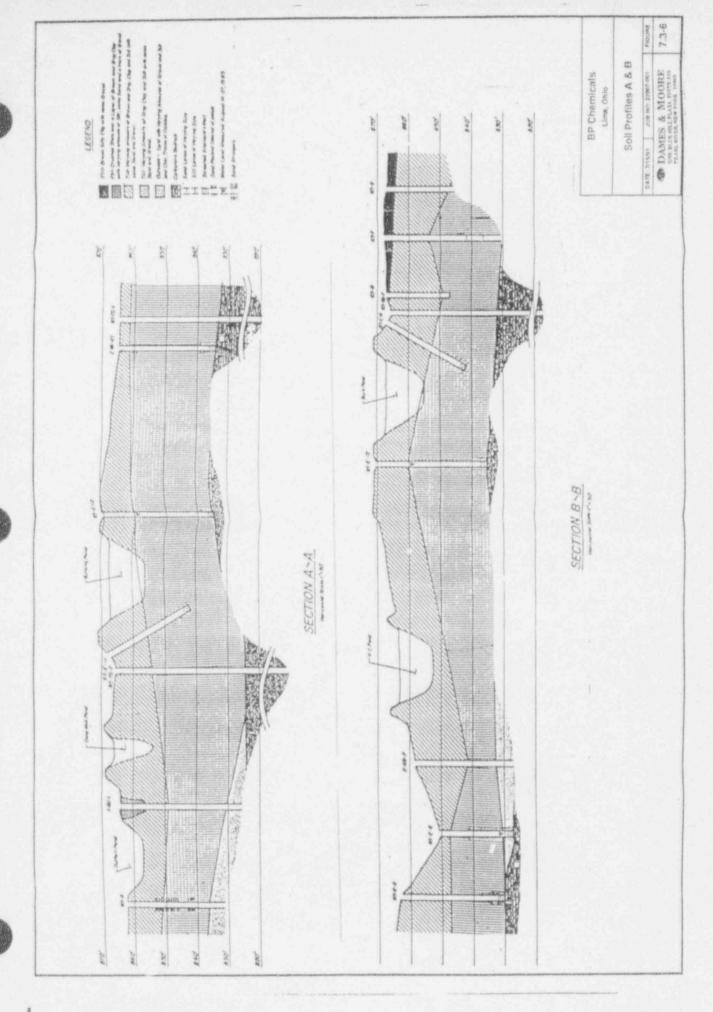






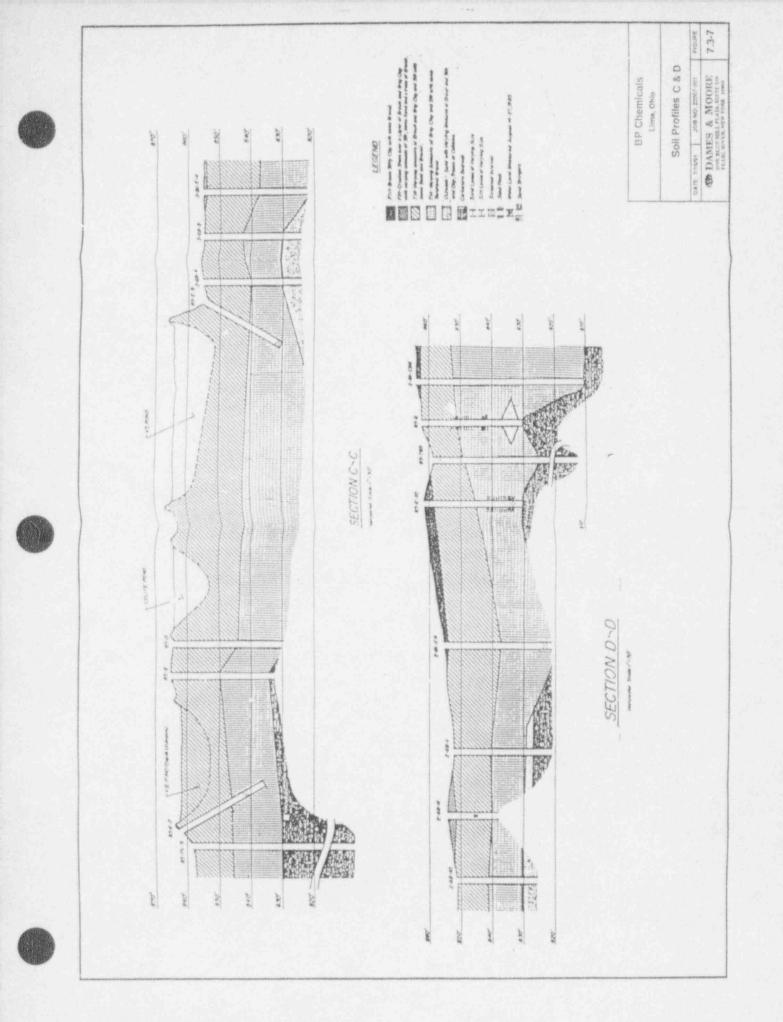


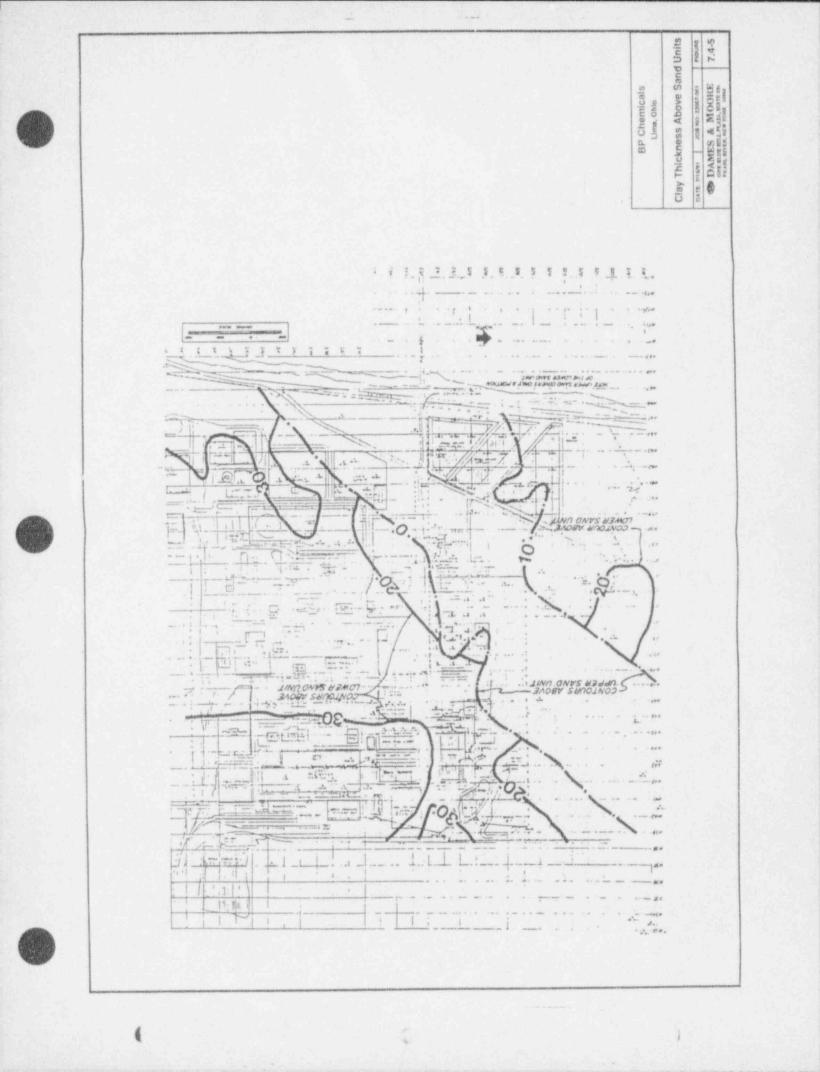




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SITE LOCATION MAP

GRAPHIC SCALE

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BP CHEMICALS, INC. LIMA, OHIO MIXED WASTE POND CLOSURE PROJECT

DRAWING INDEX

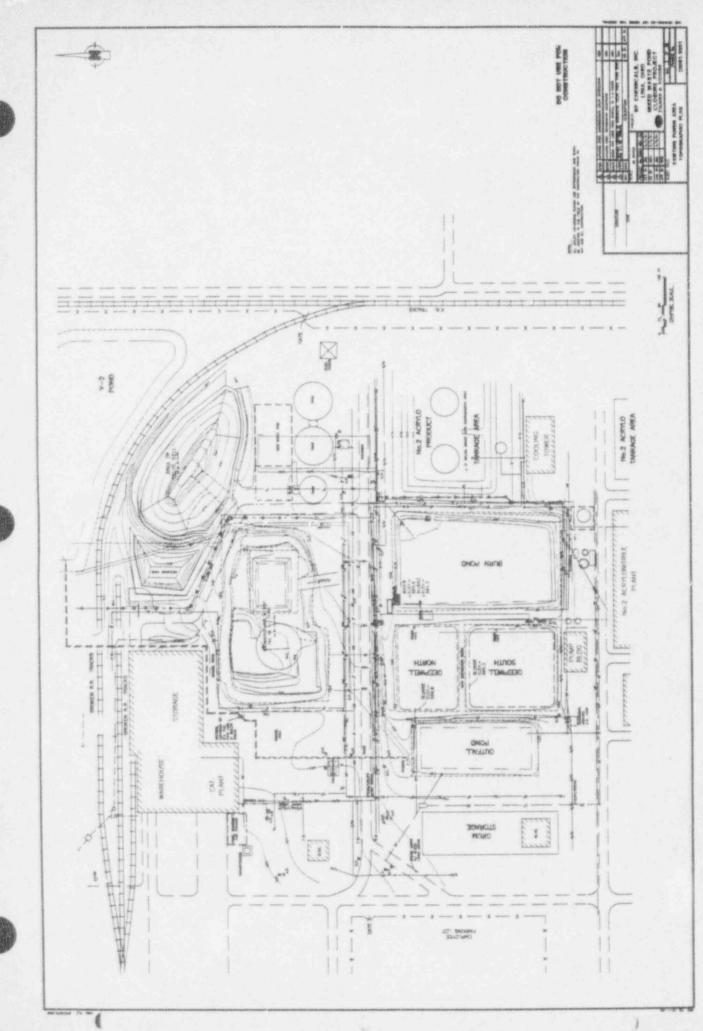
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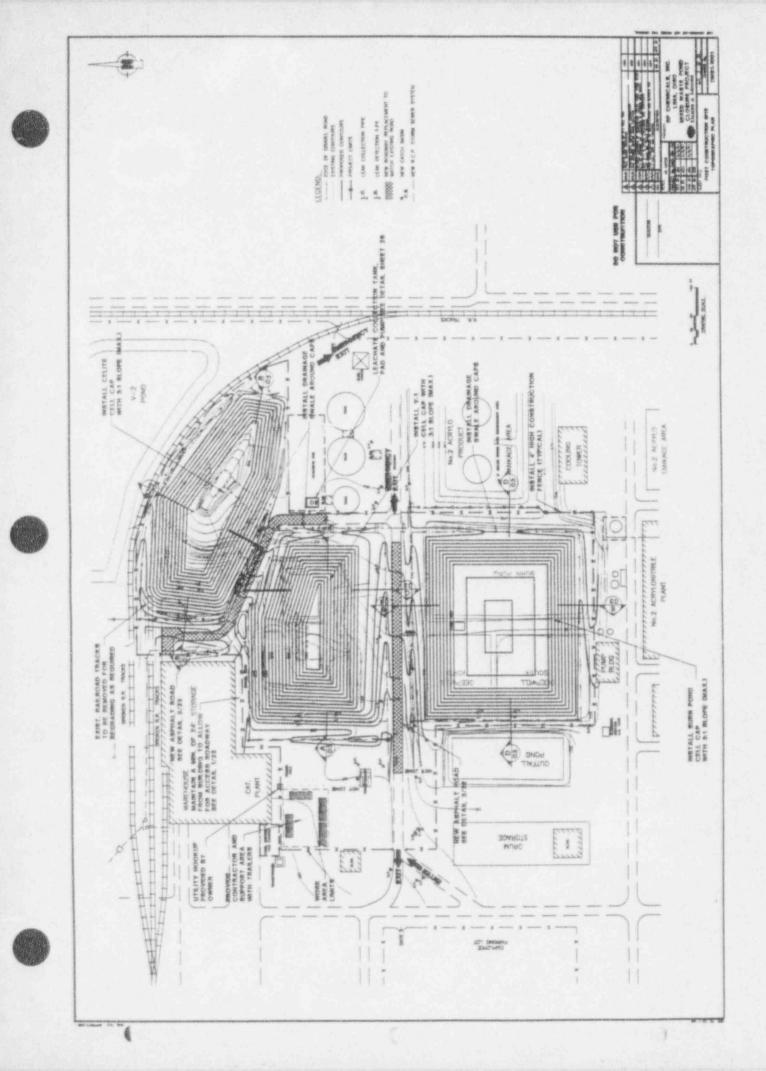


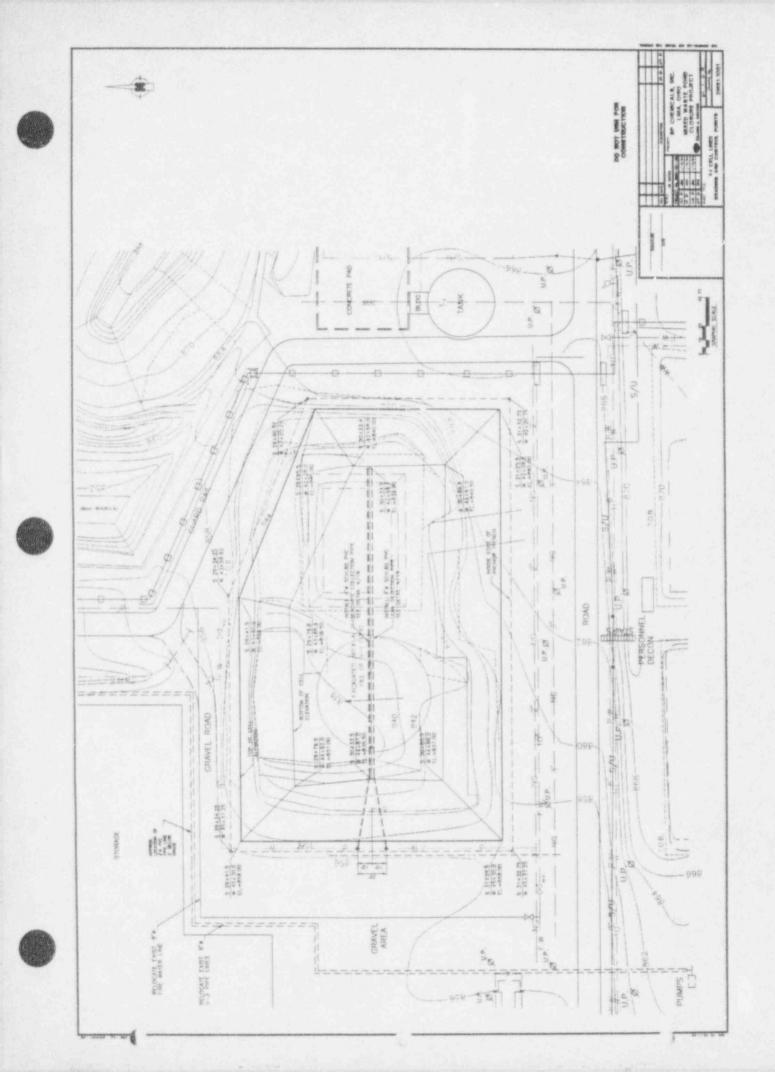
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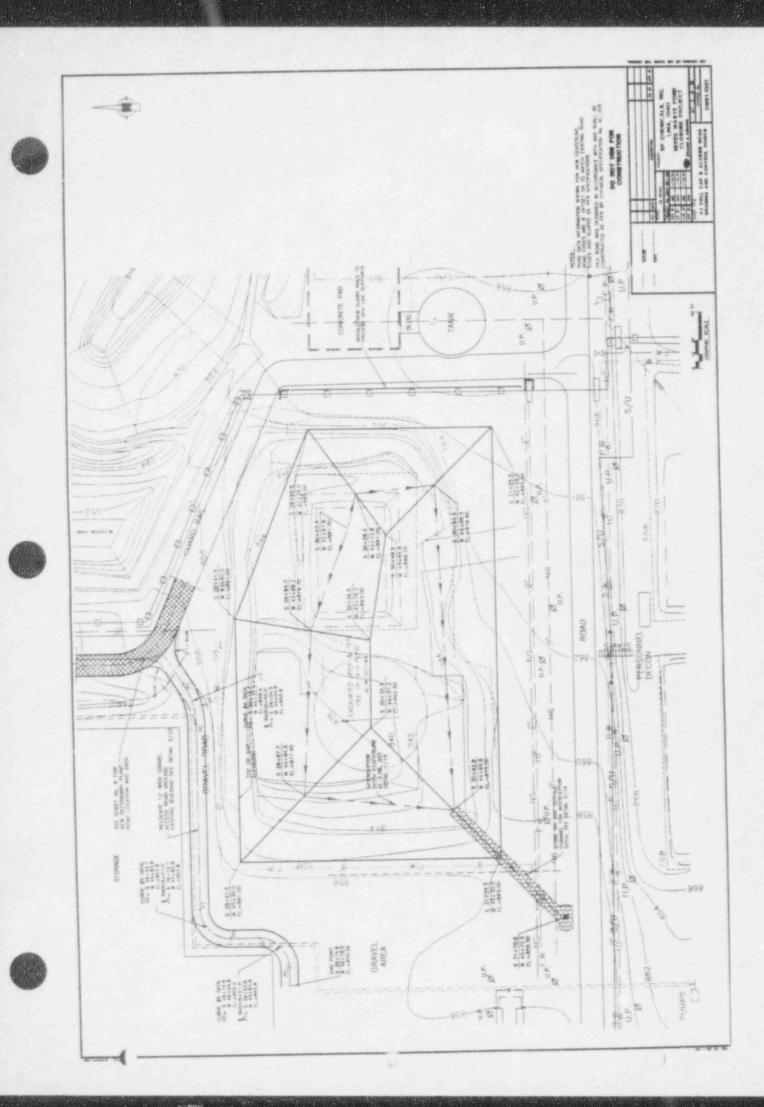
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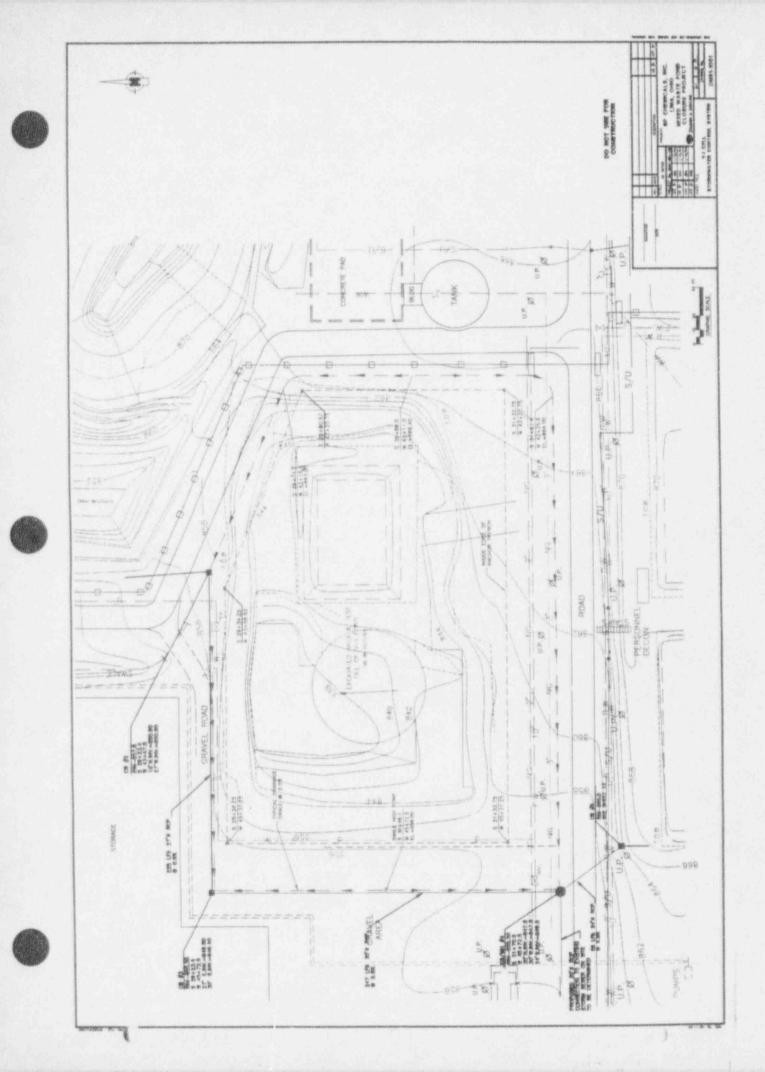


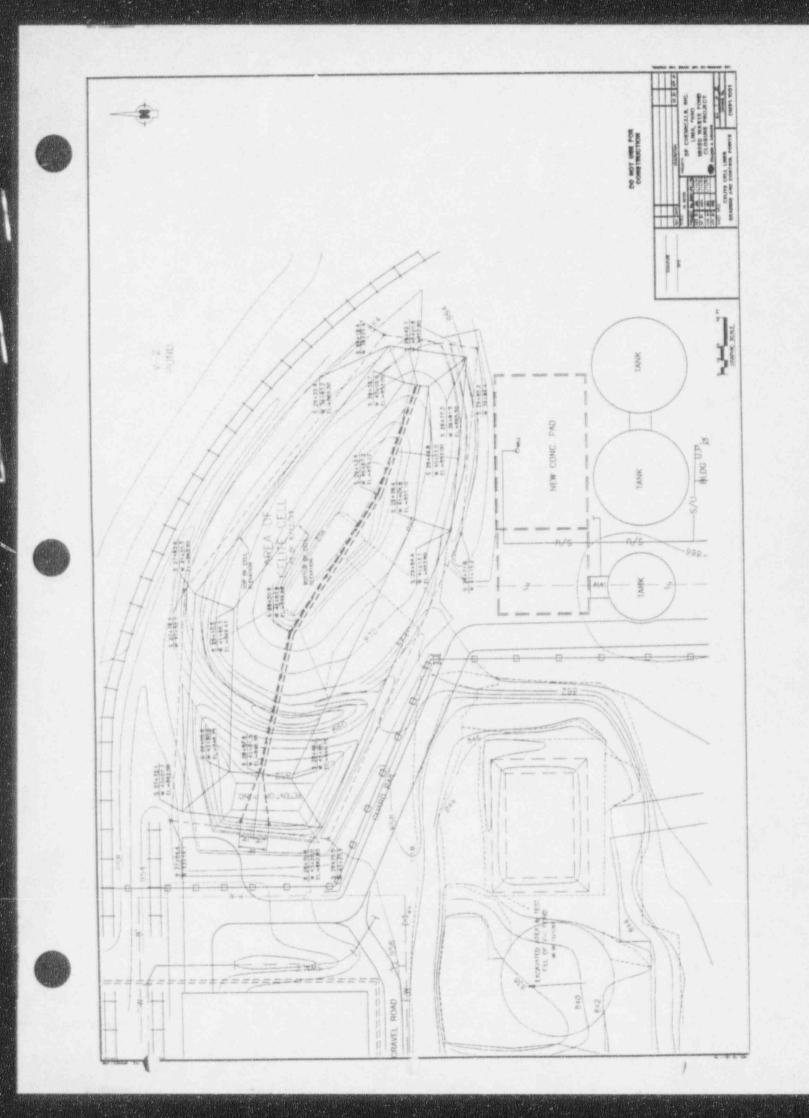


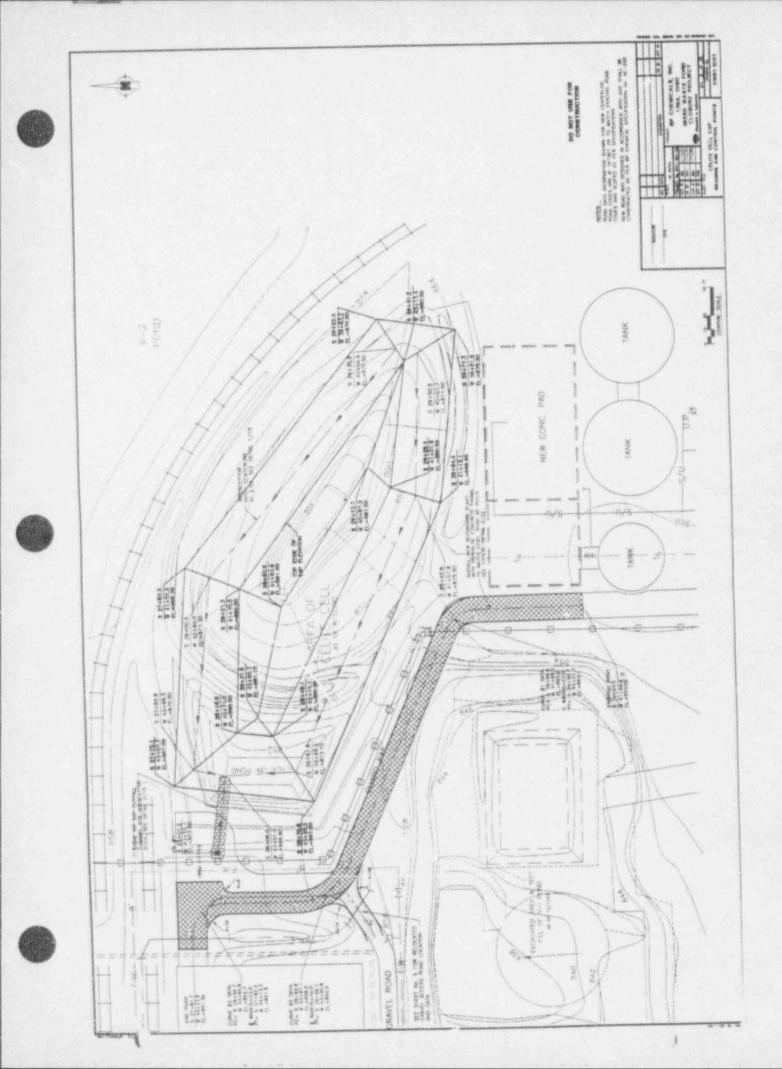


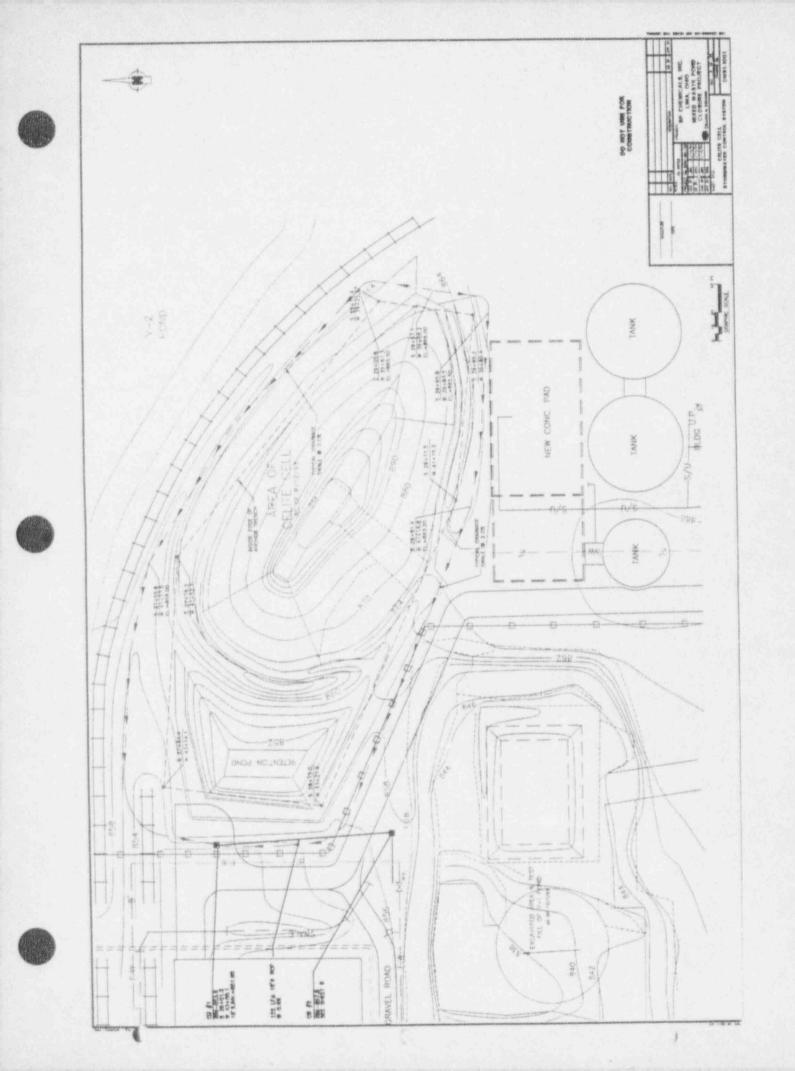


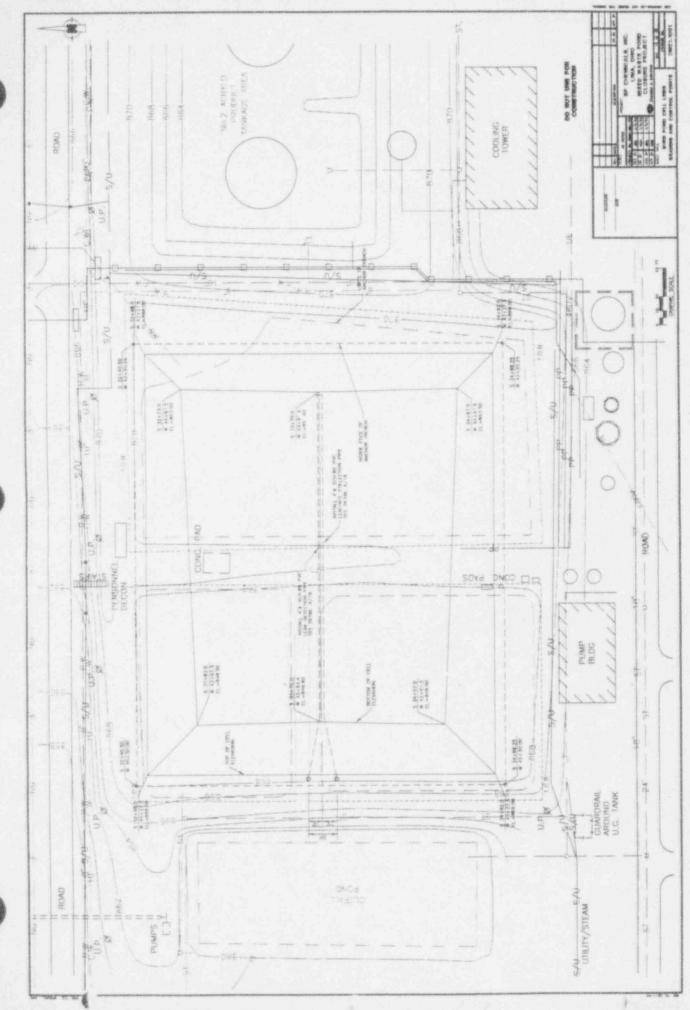
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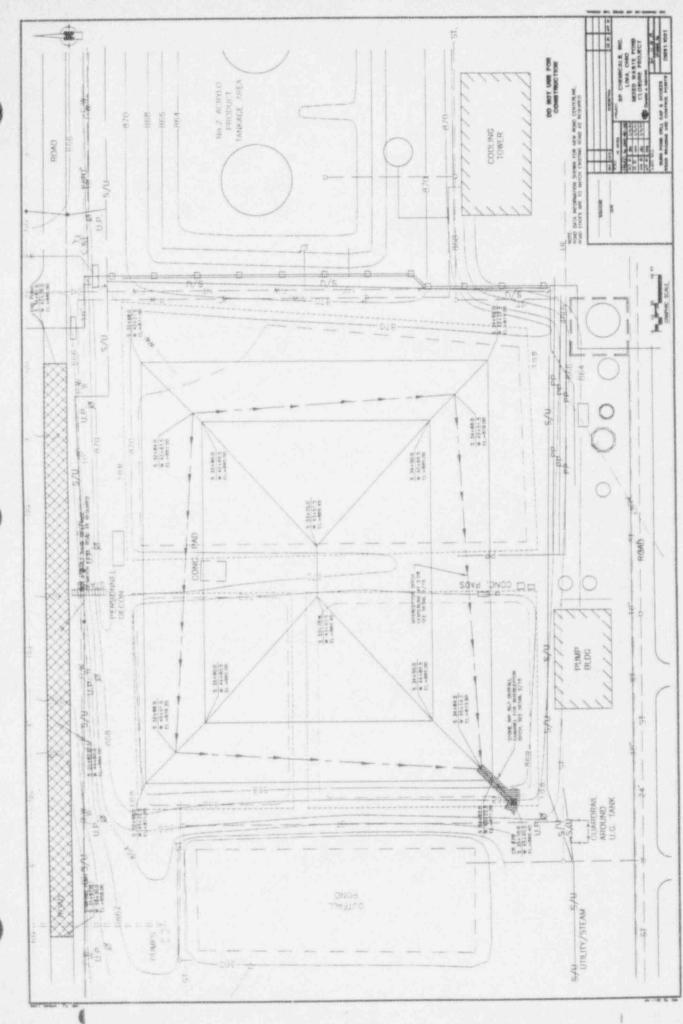


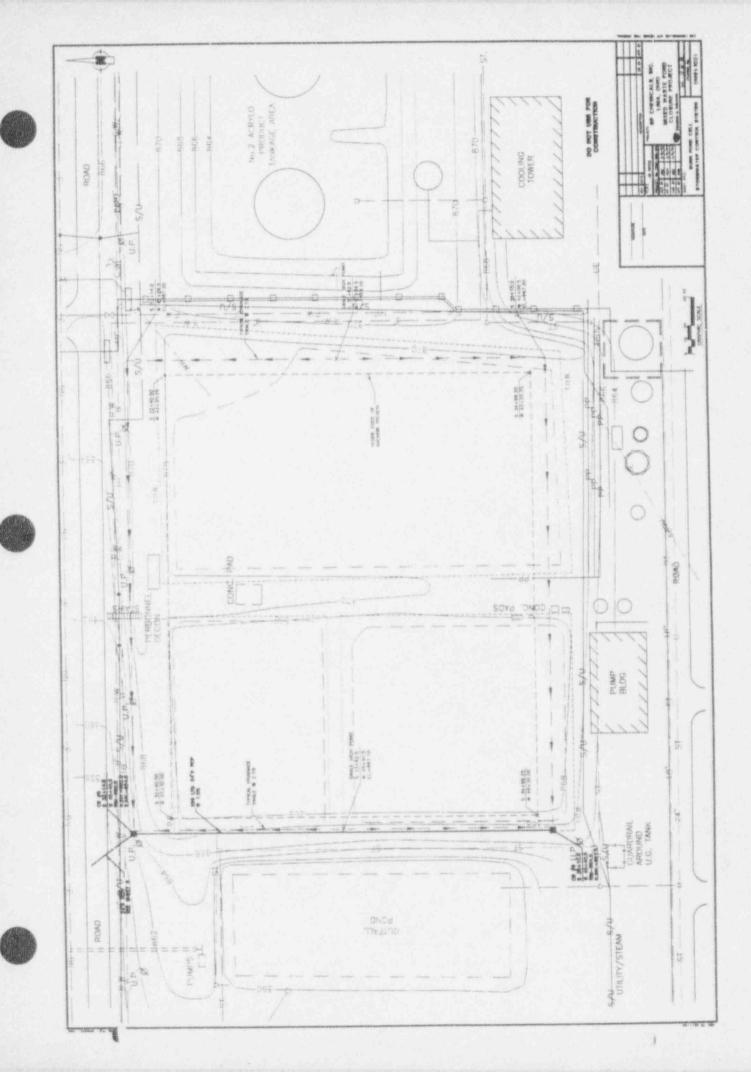


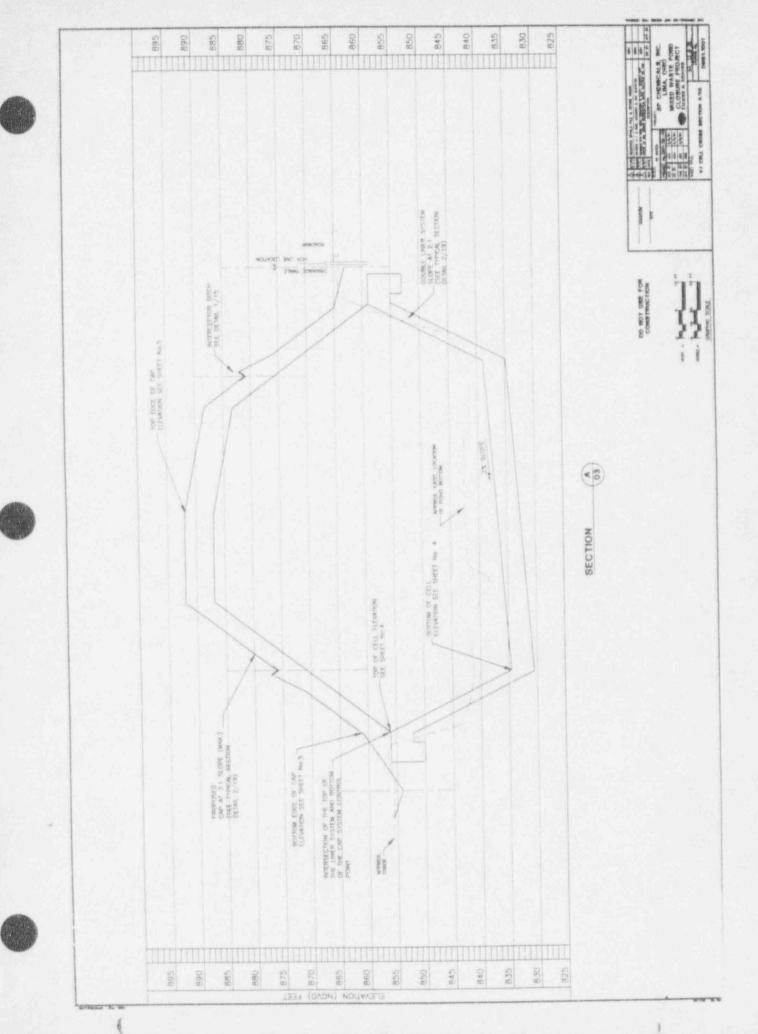


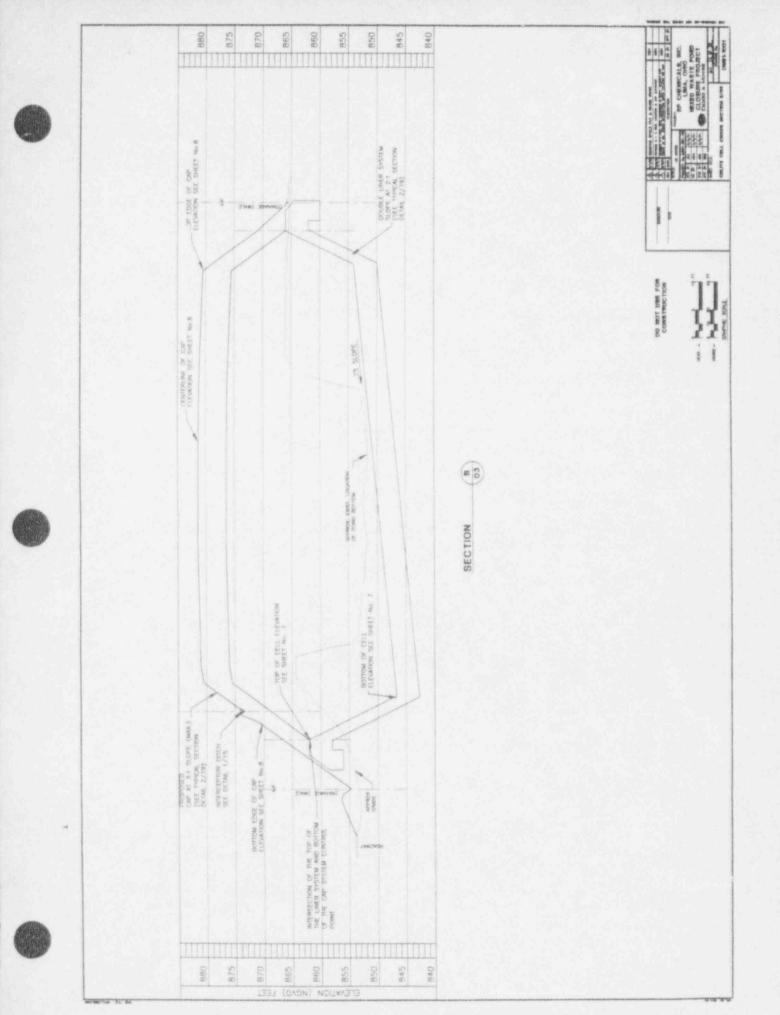








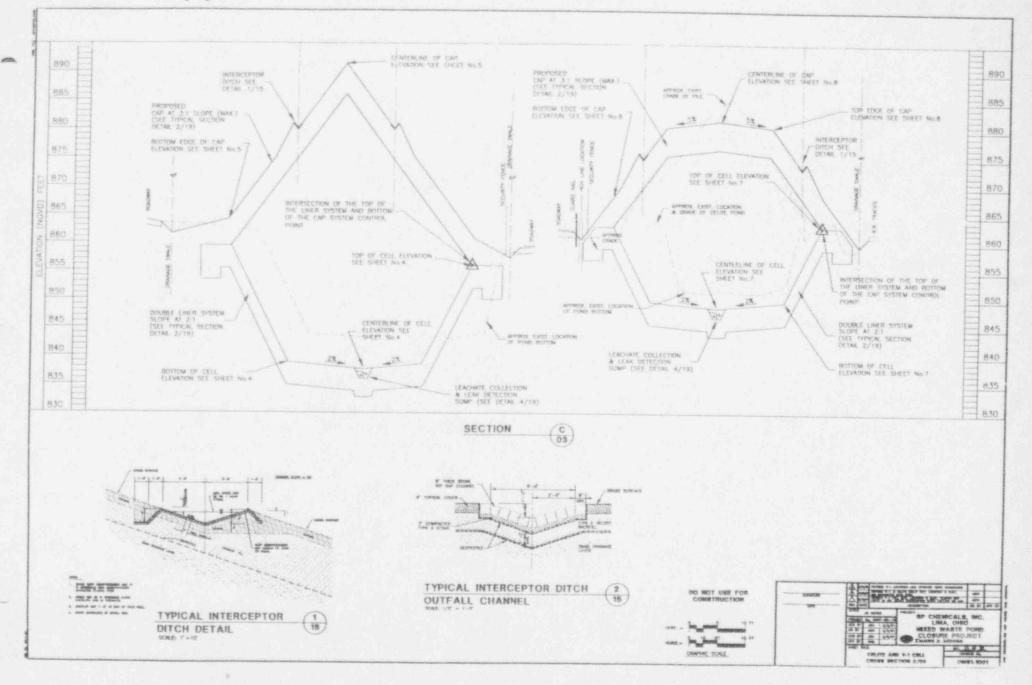


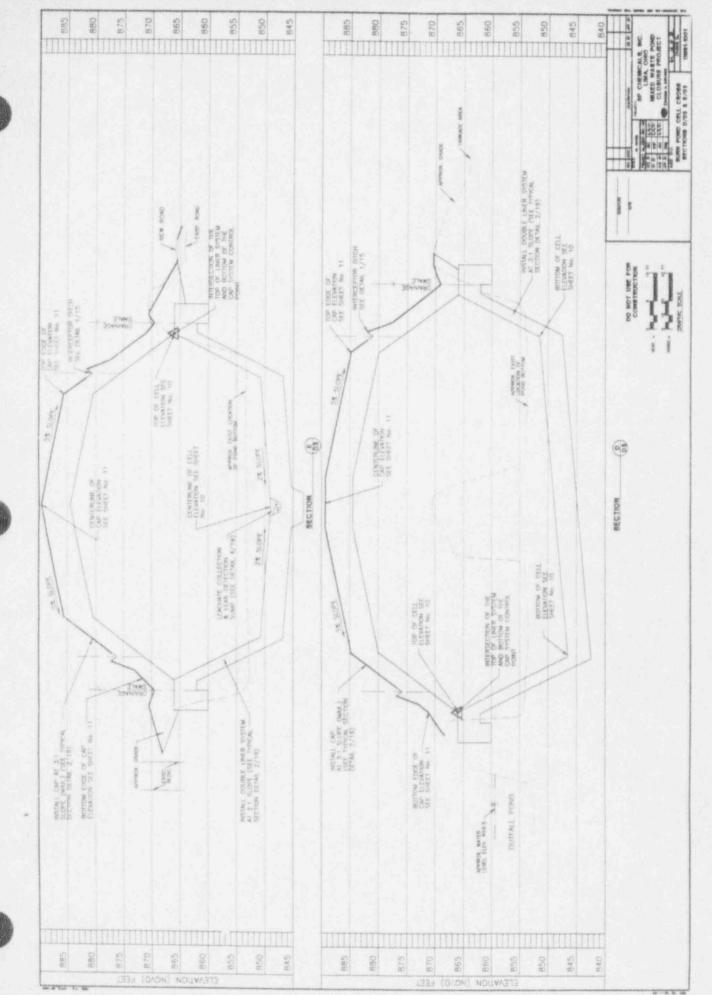


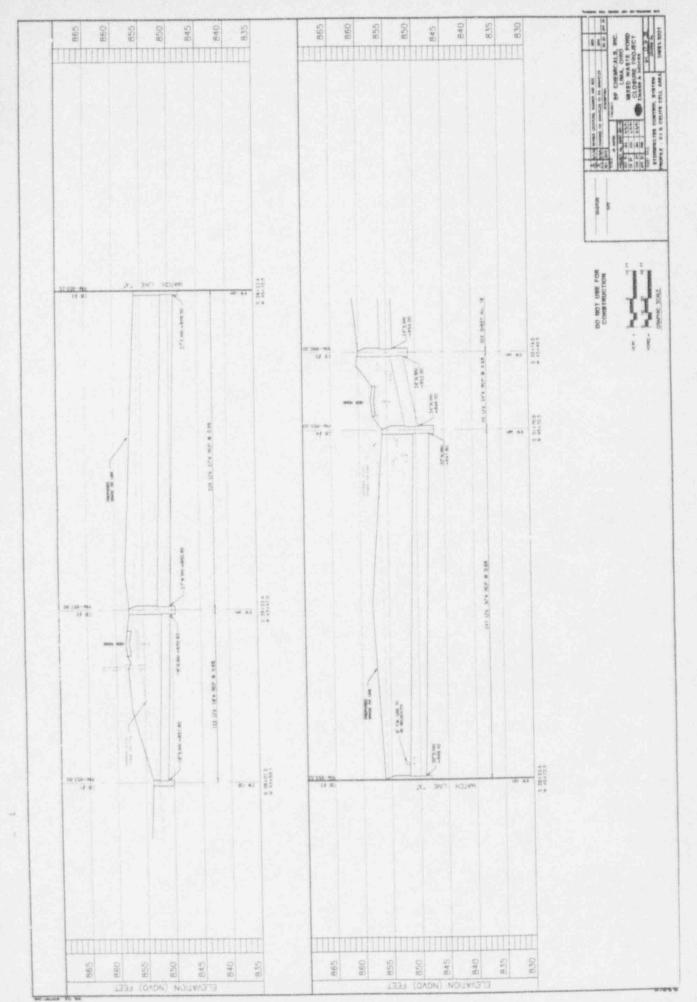




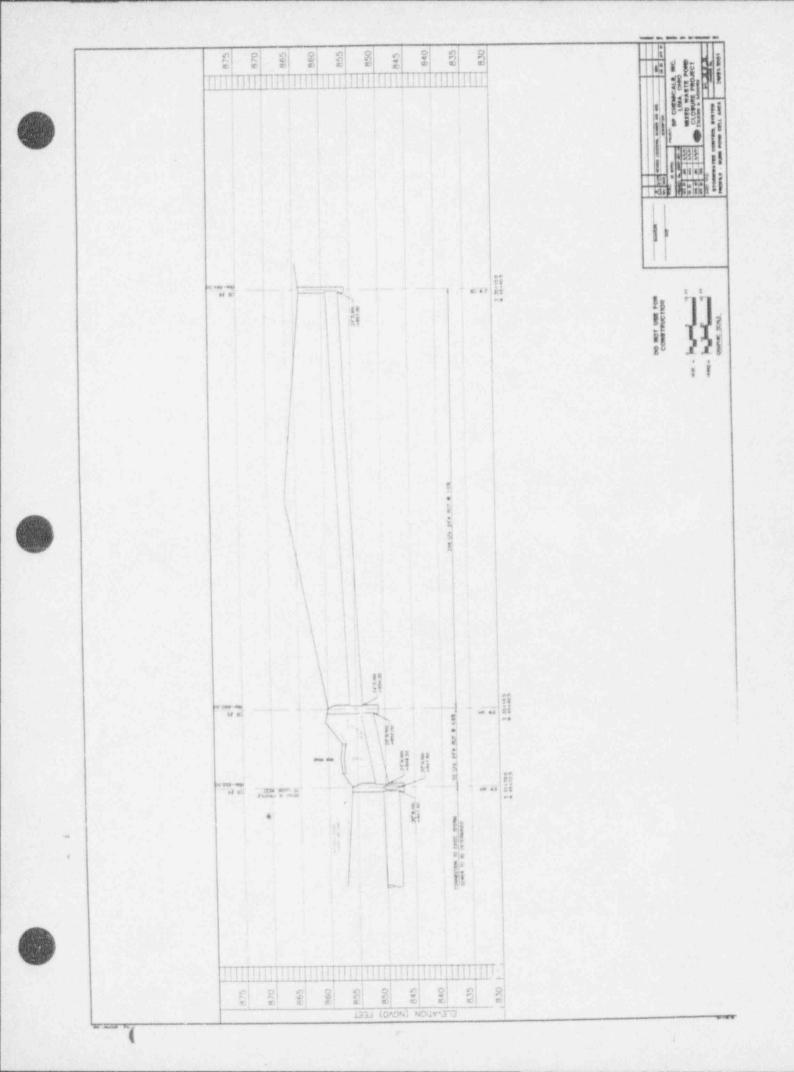


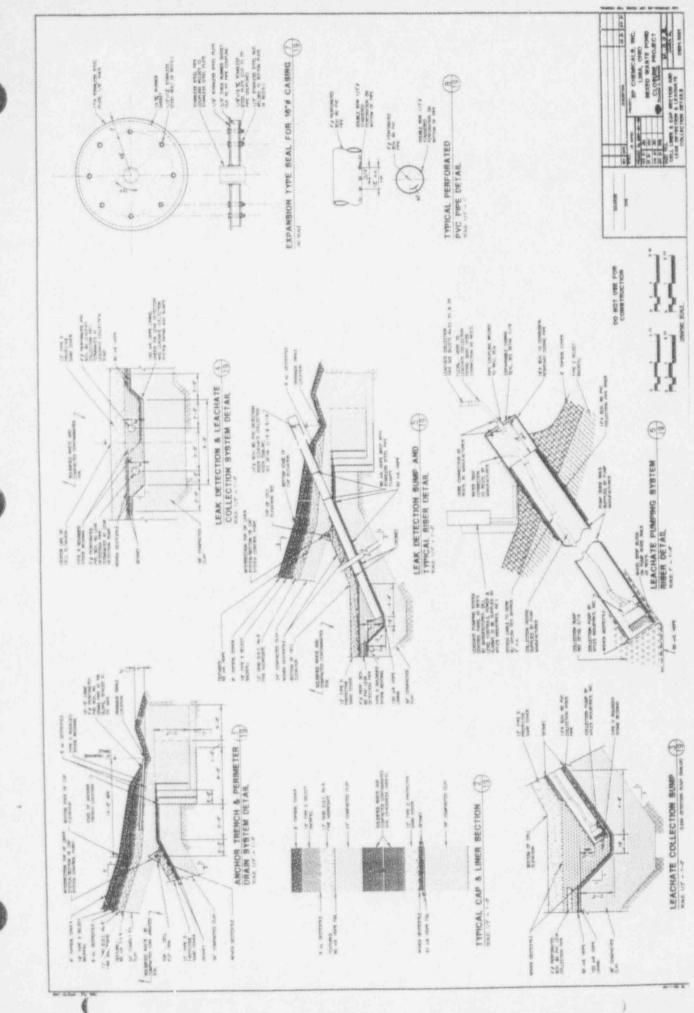


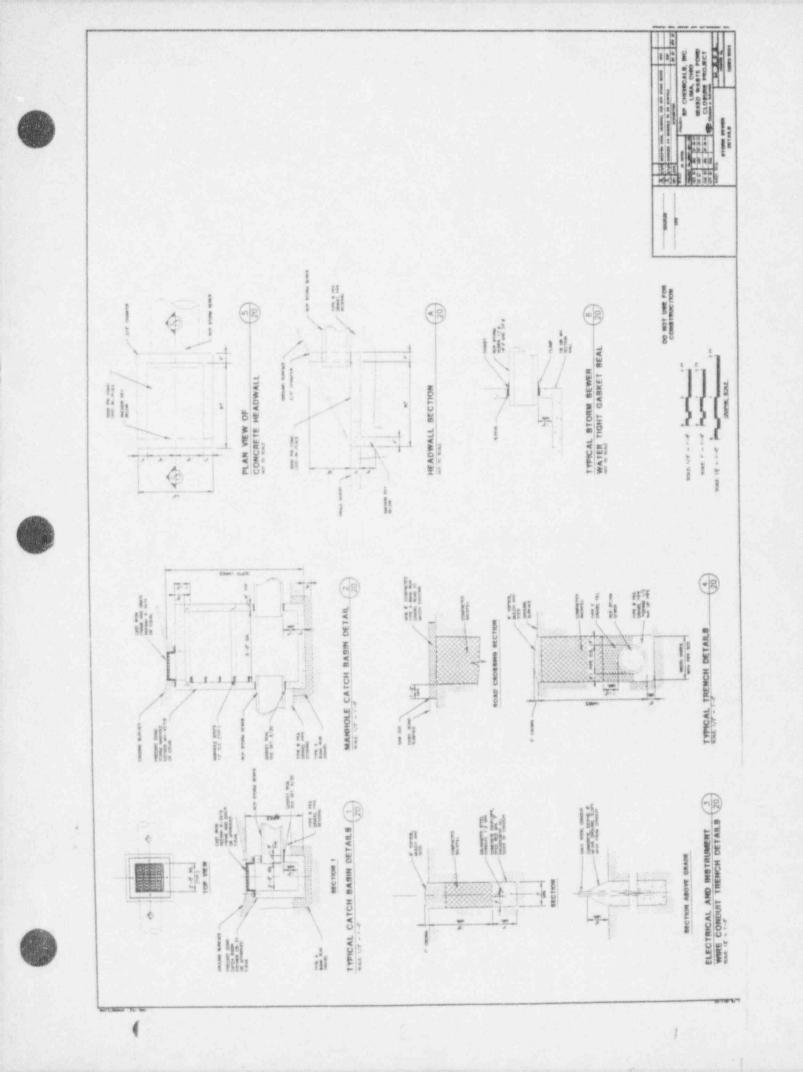


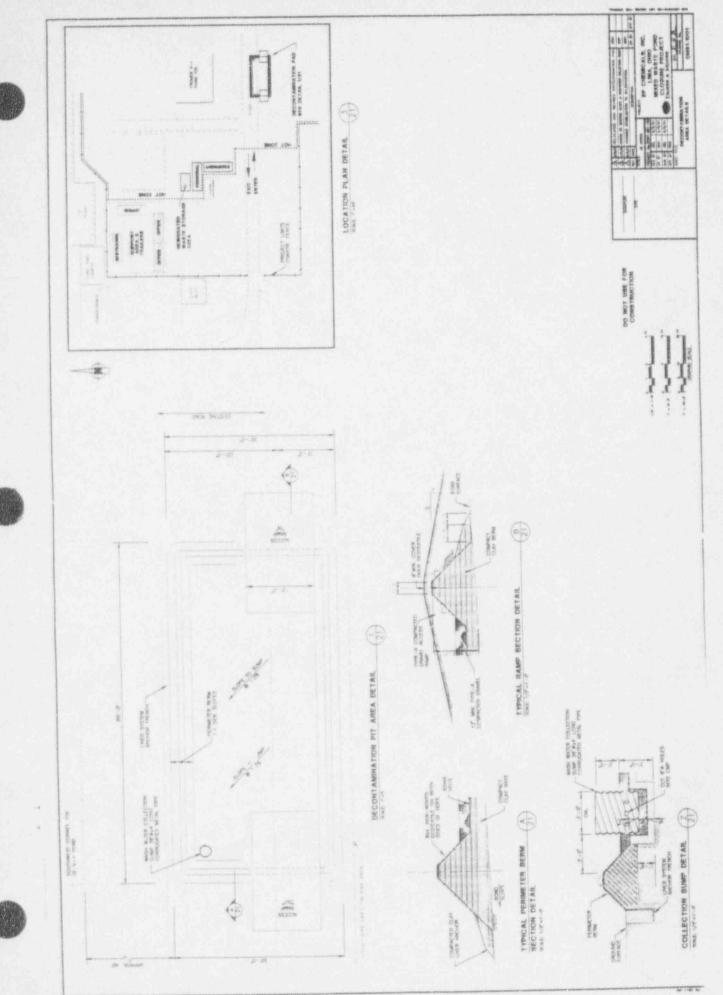


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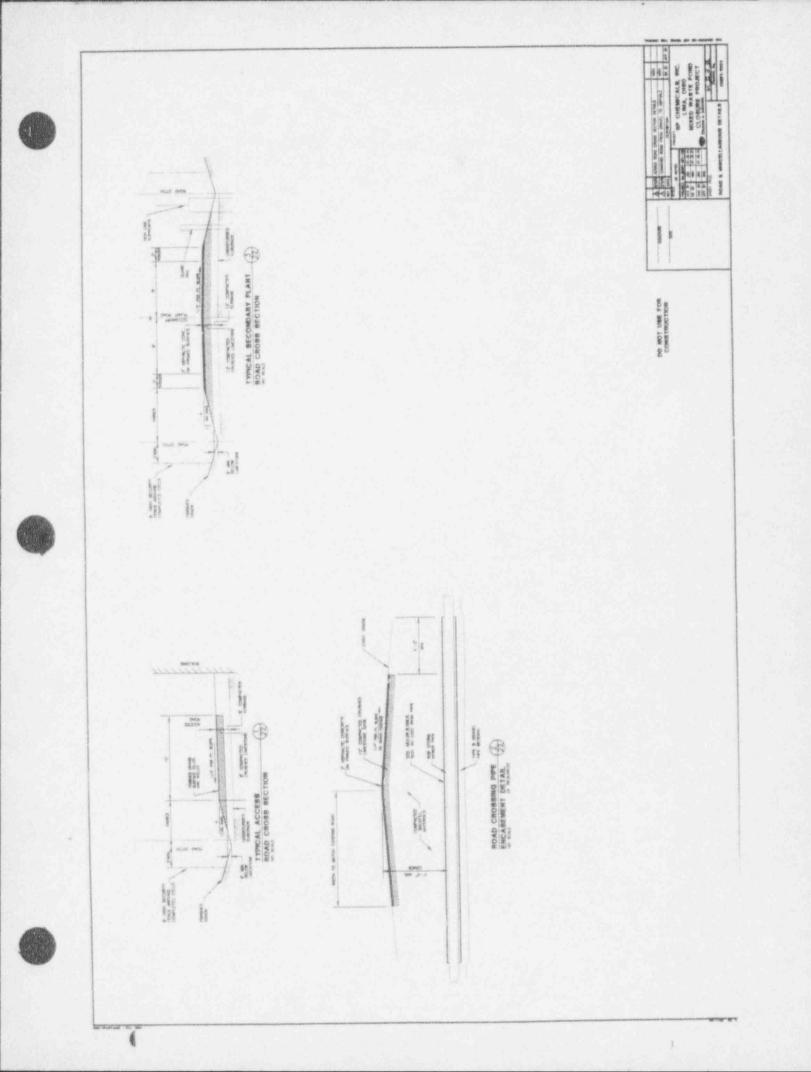


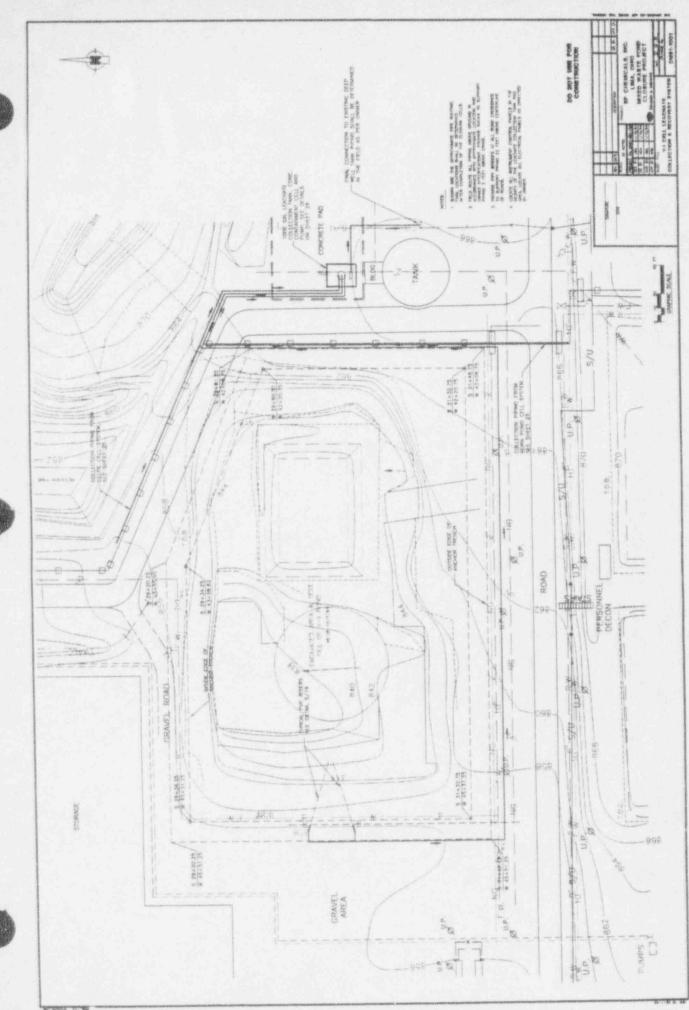


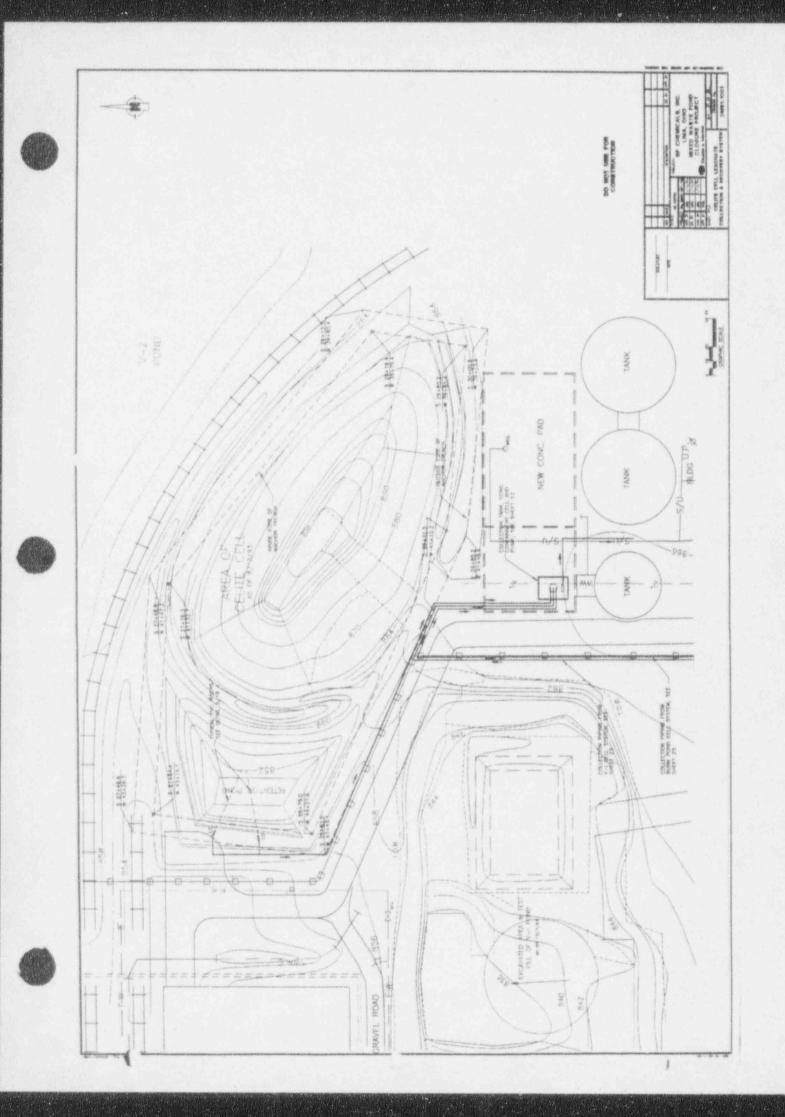


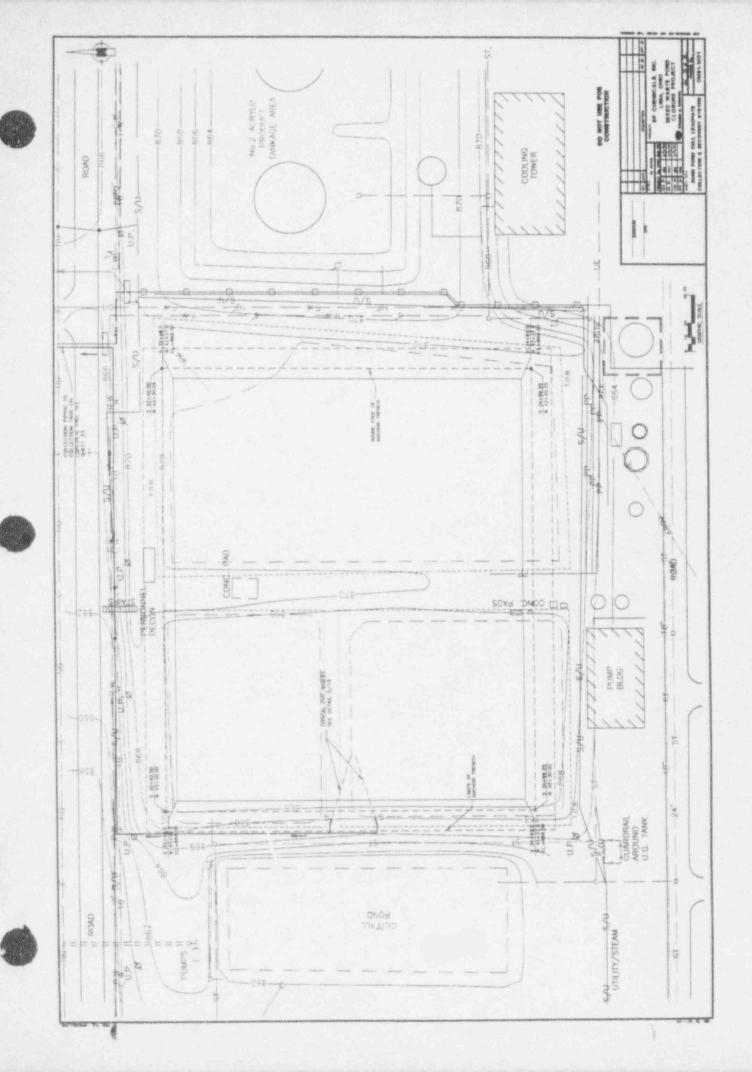


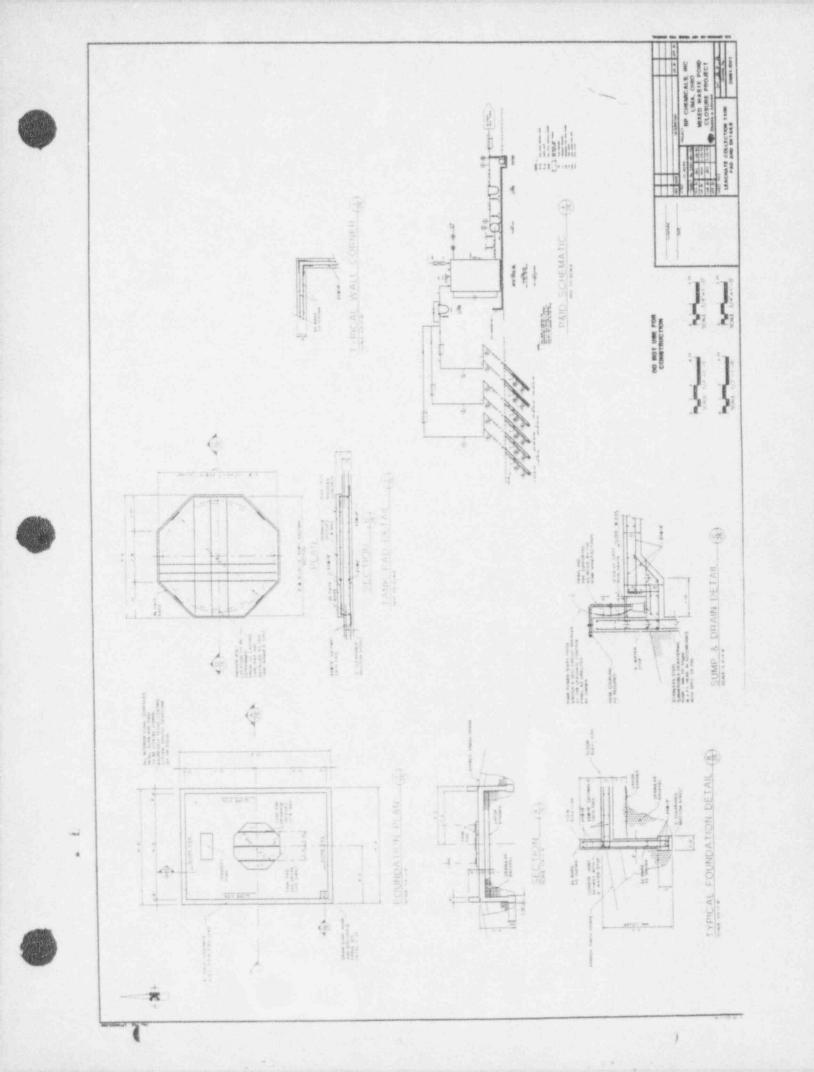
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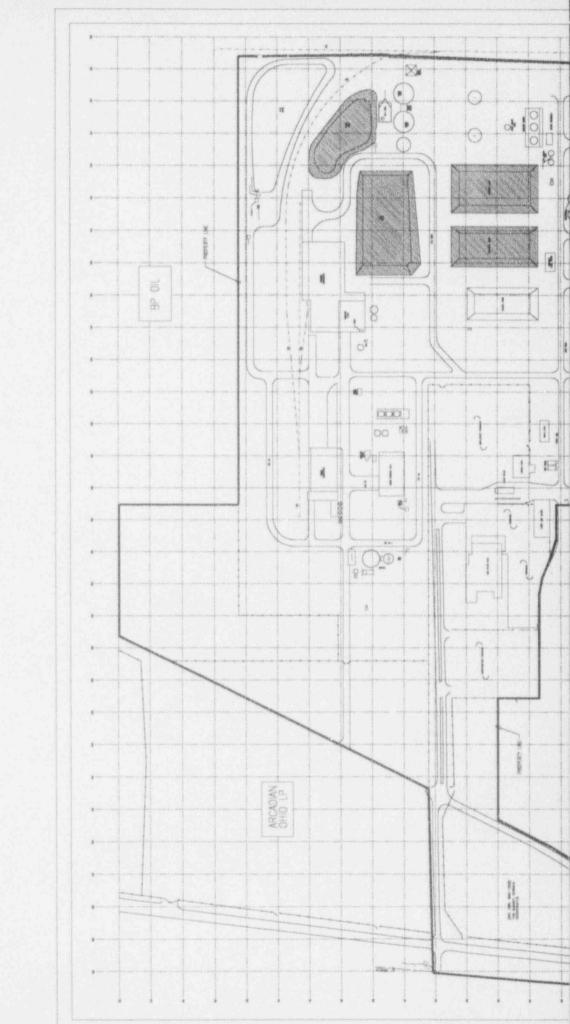




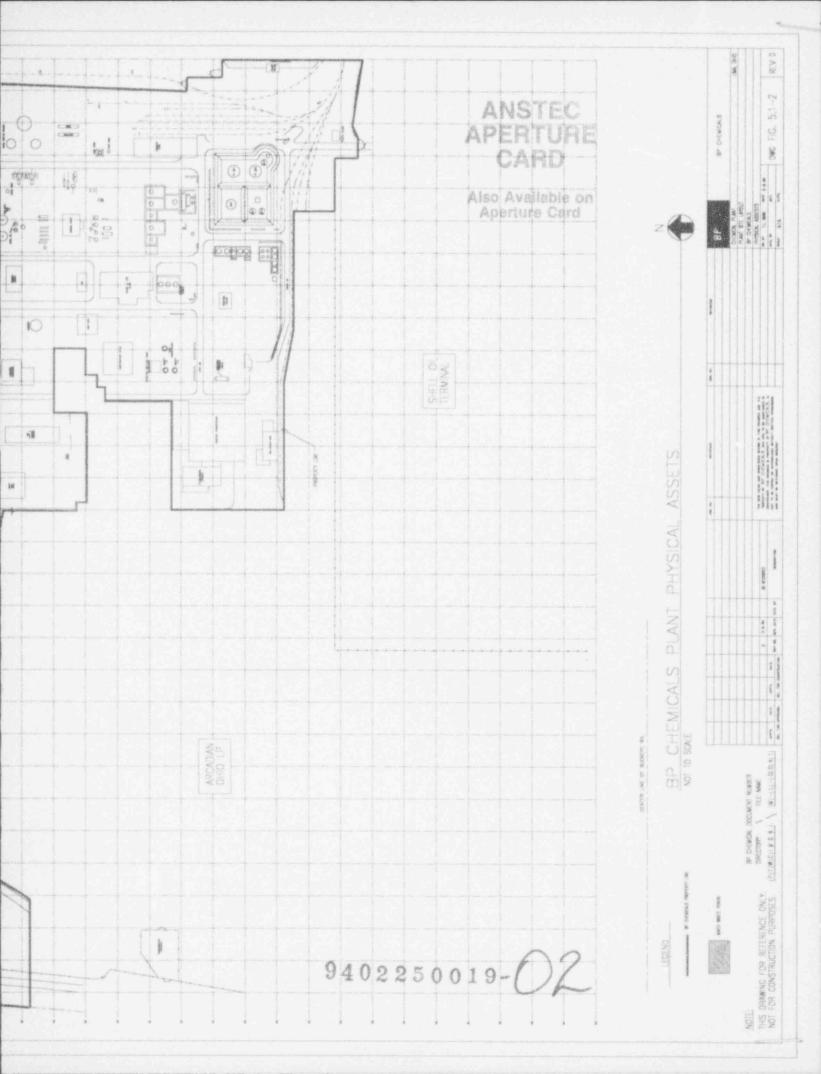


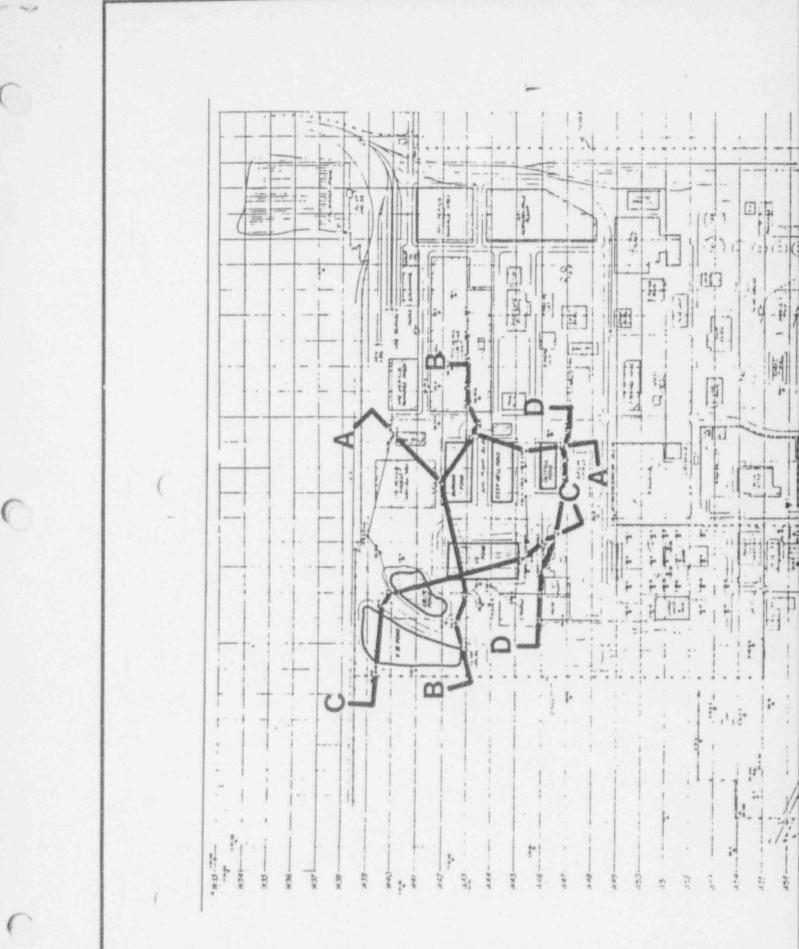


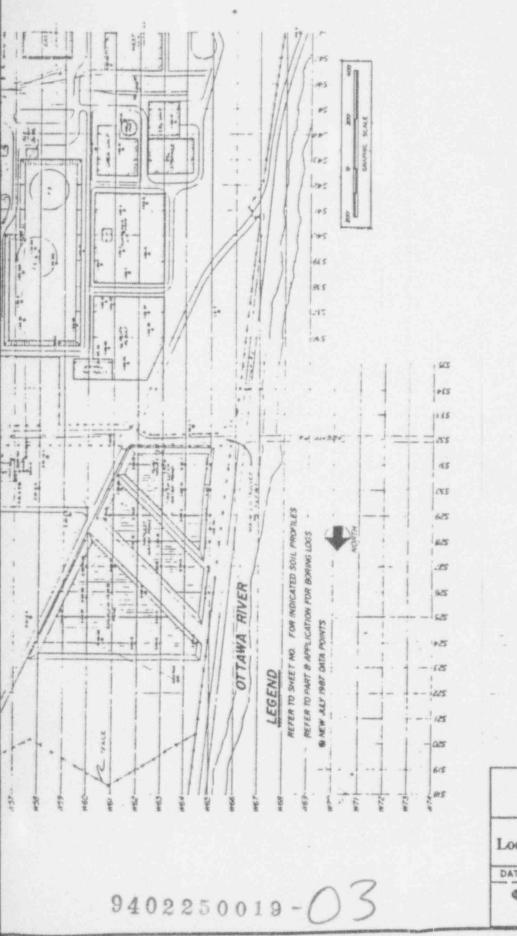


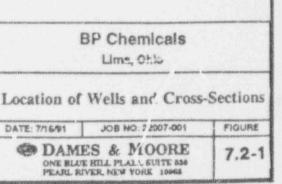


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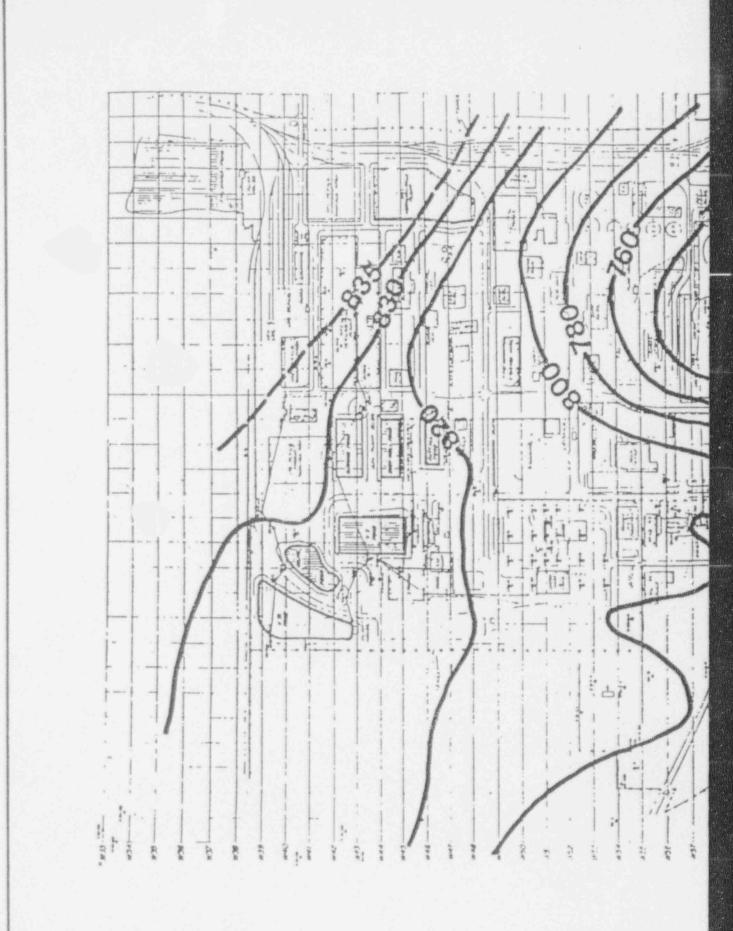


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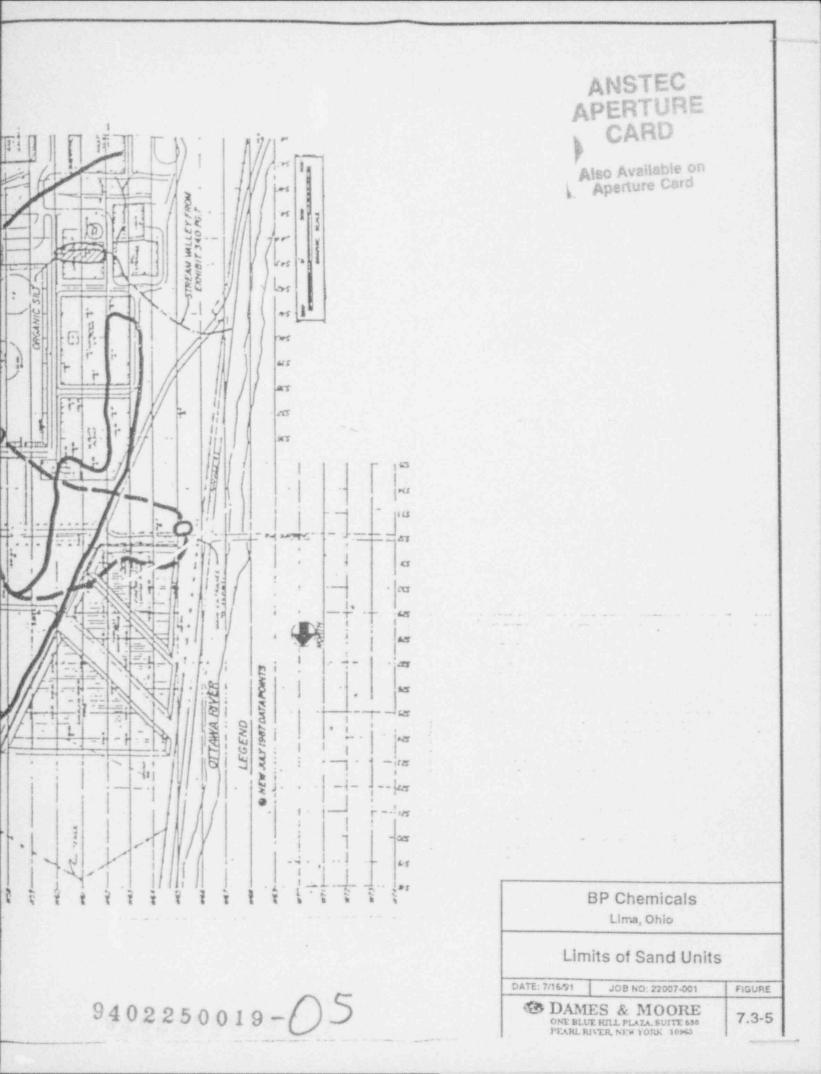
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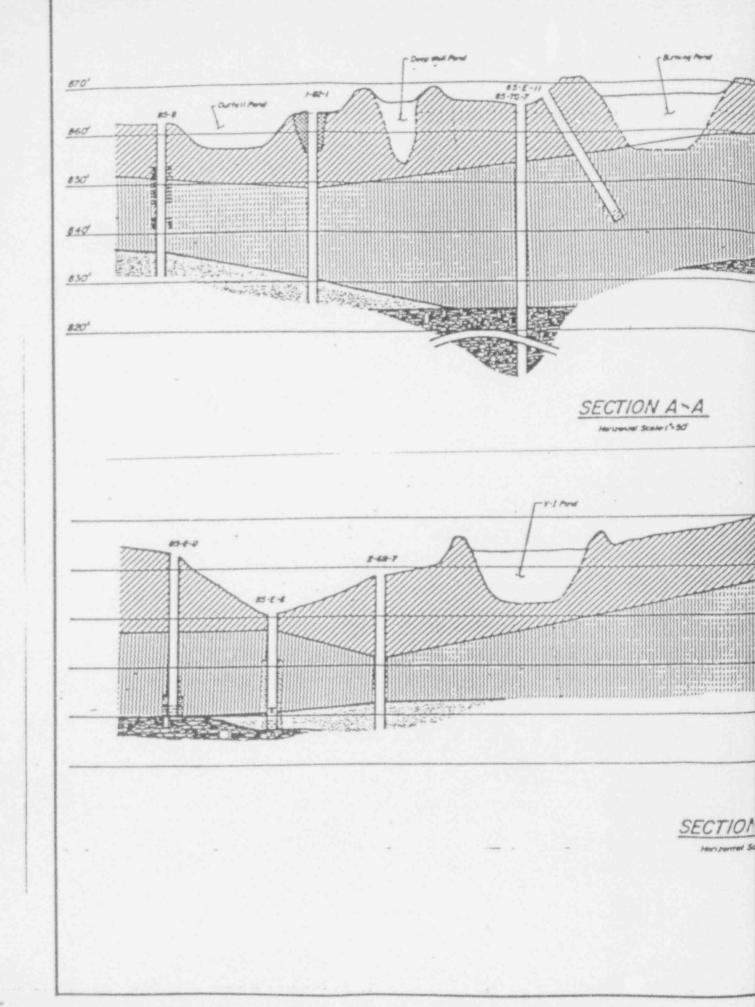


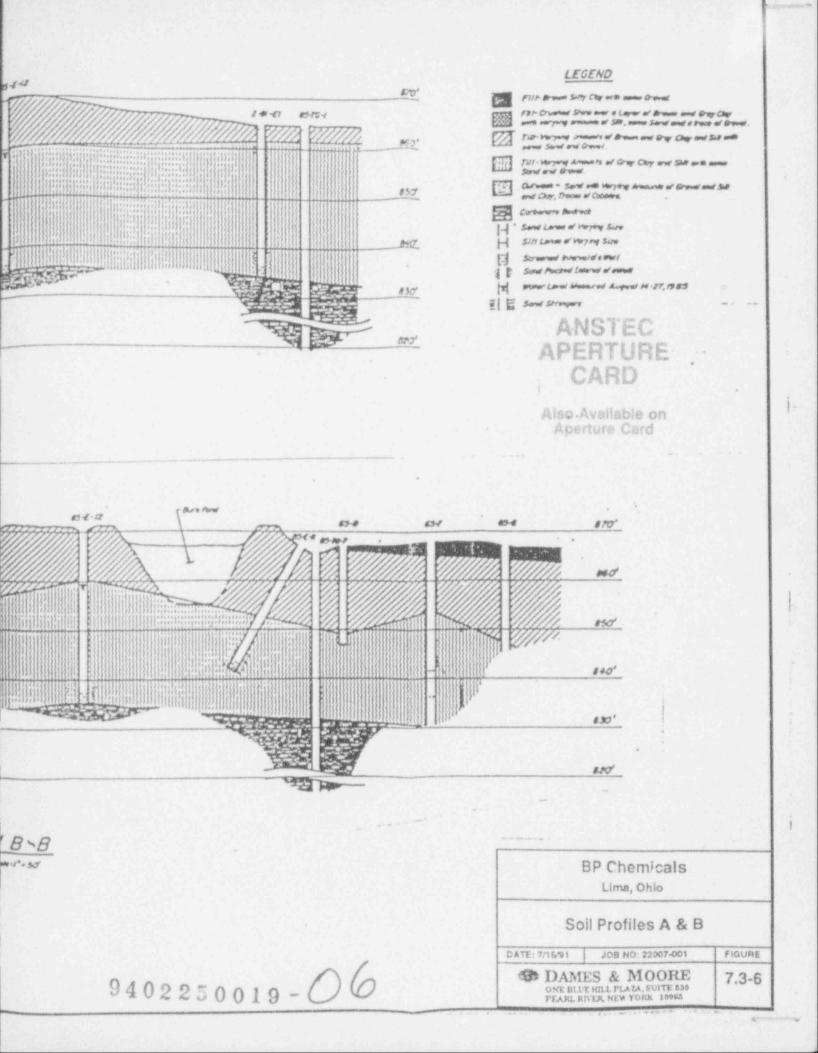
BP Chemicals Lima, Ohio Bedrock Topography DATE: 7/16/91 JOB NO: 22007-001 FIGURE DAMES & MOORE ONE BLUE HOLL PLAZA, SUITE 530 PEABL RIVER, NEW YORK 10965 7.3-4

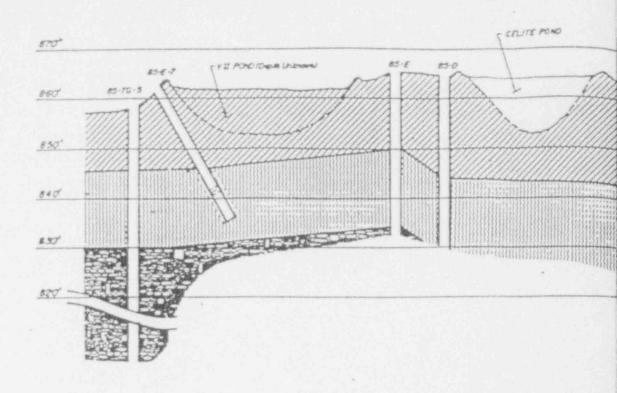
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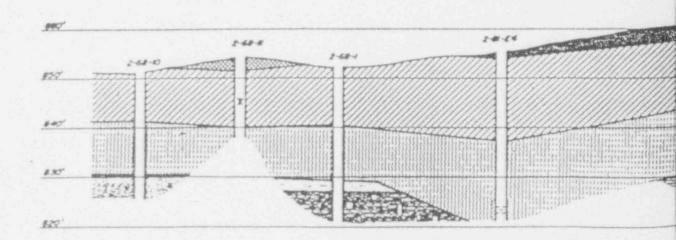






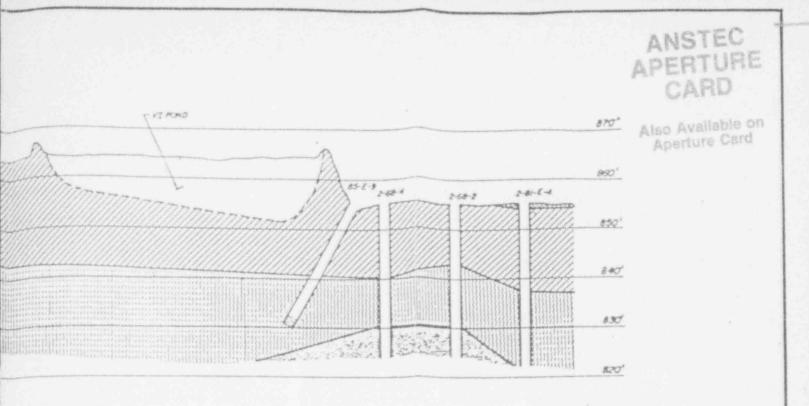






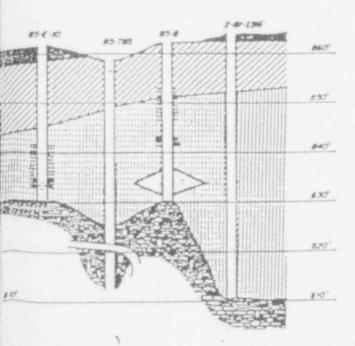
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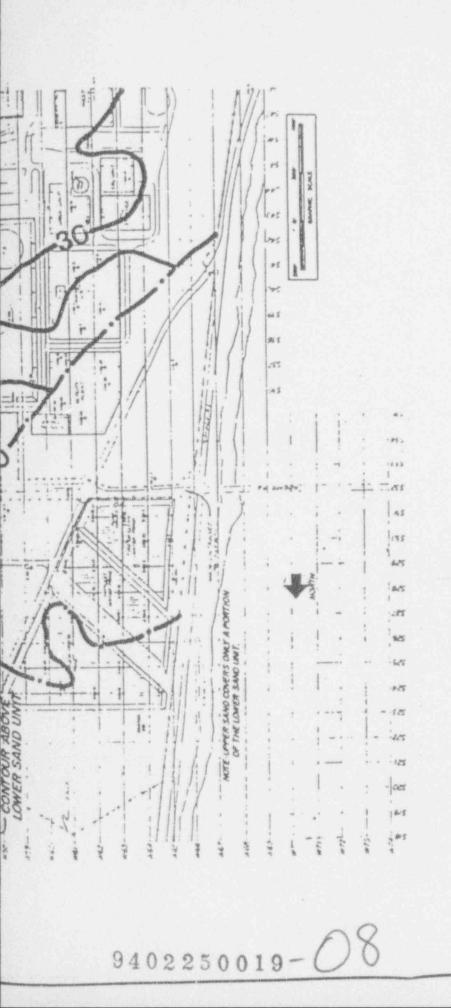
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BP CHEMICALS, INC. LIMA, OHIO MIXED WASTE POND CLOSURE PROJECTANSTEC

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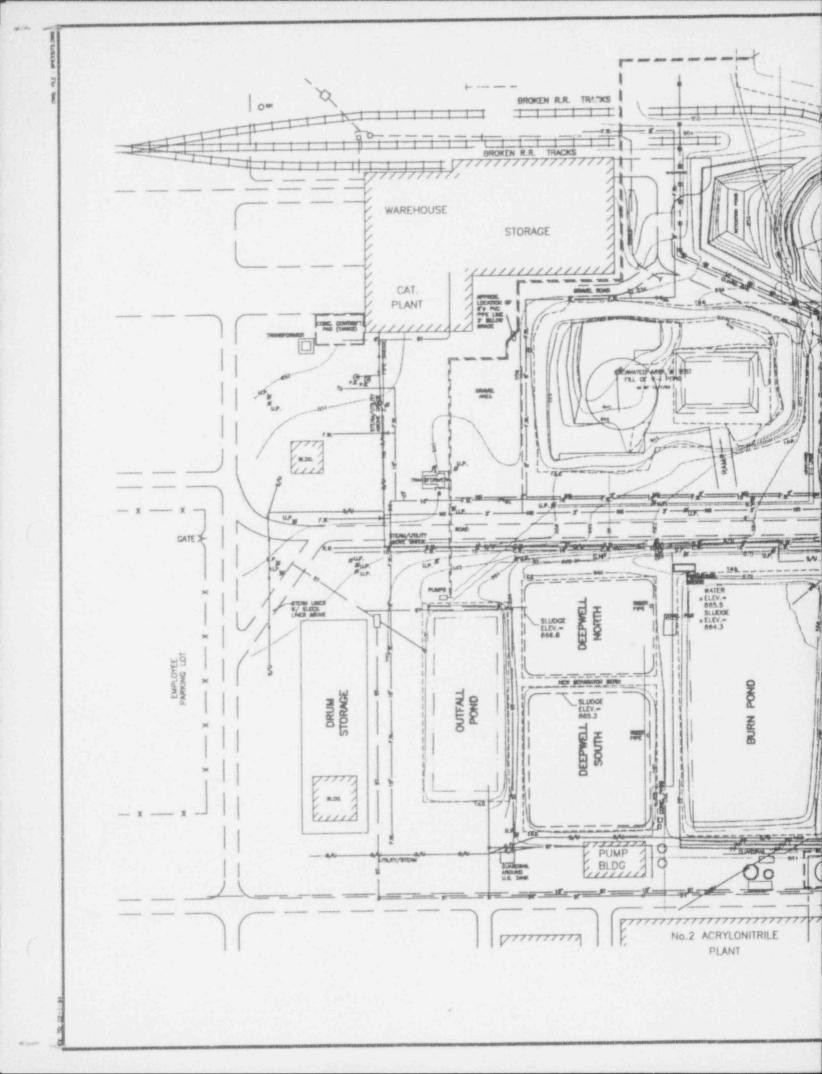
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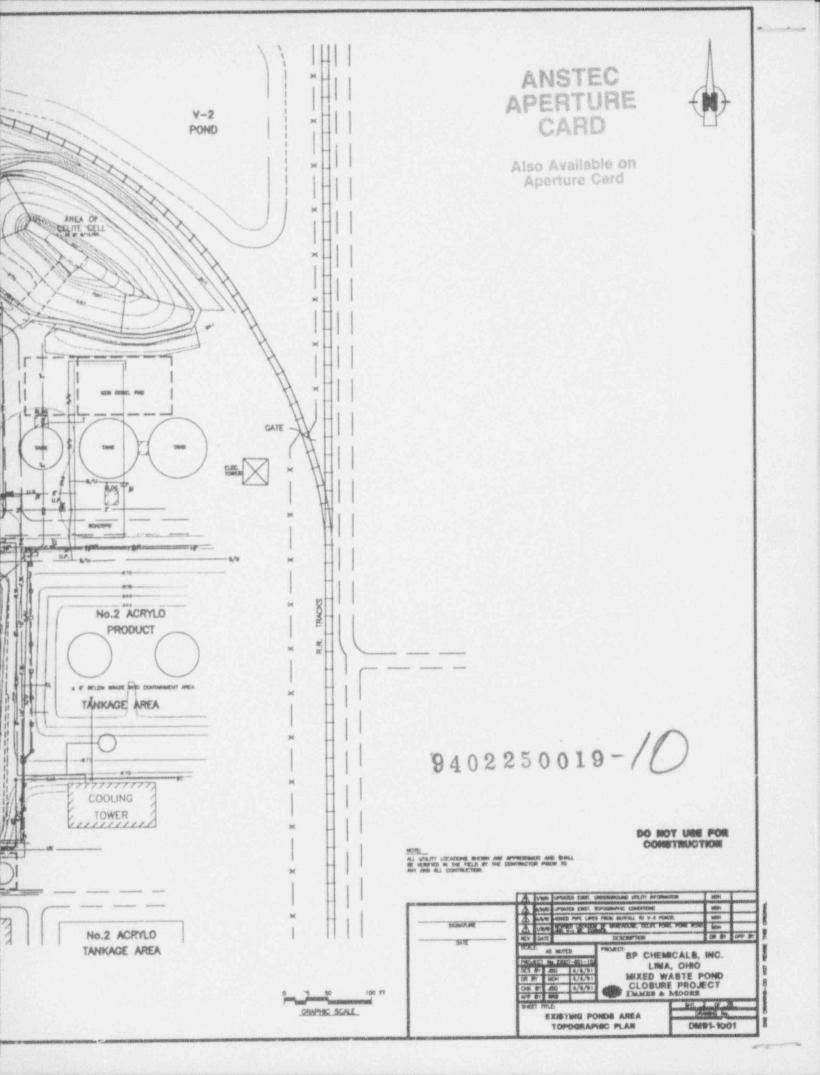
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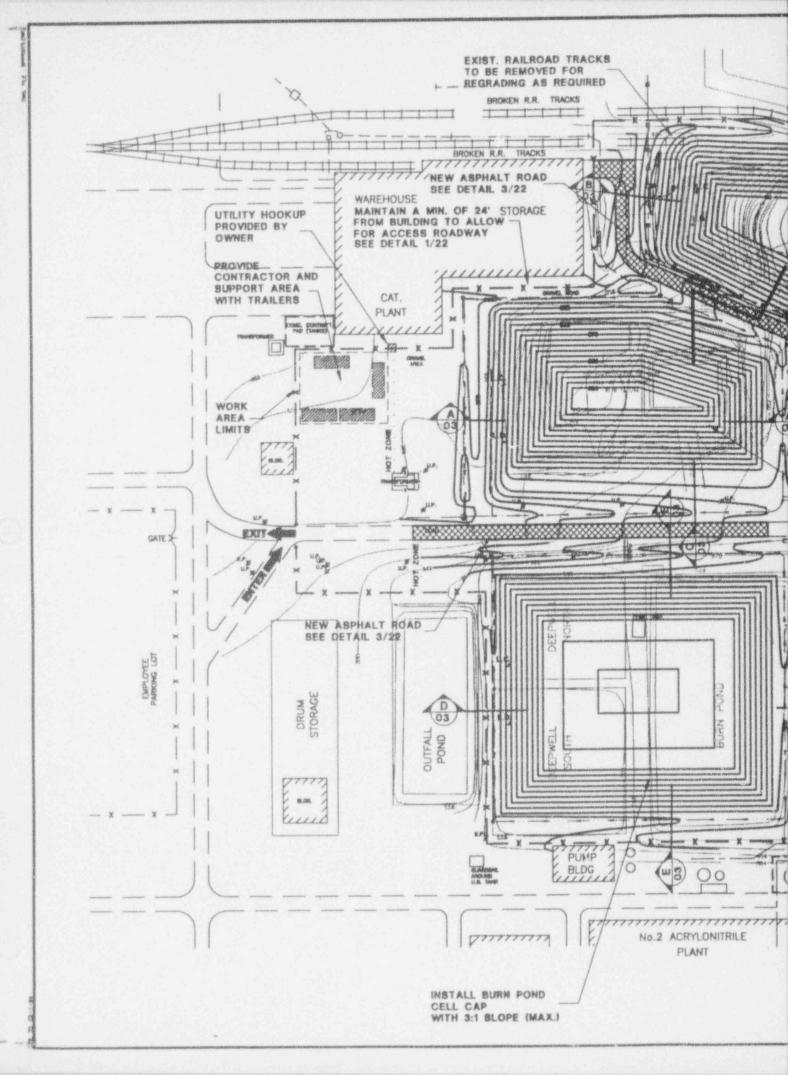
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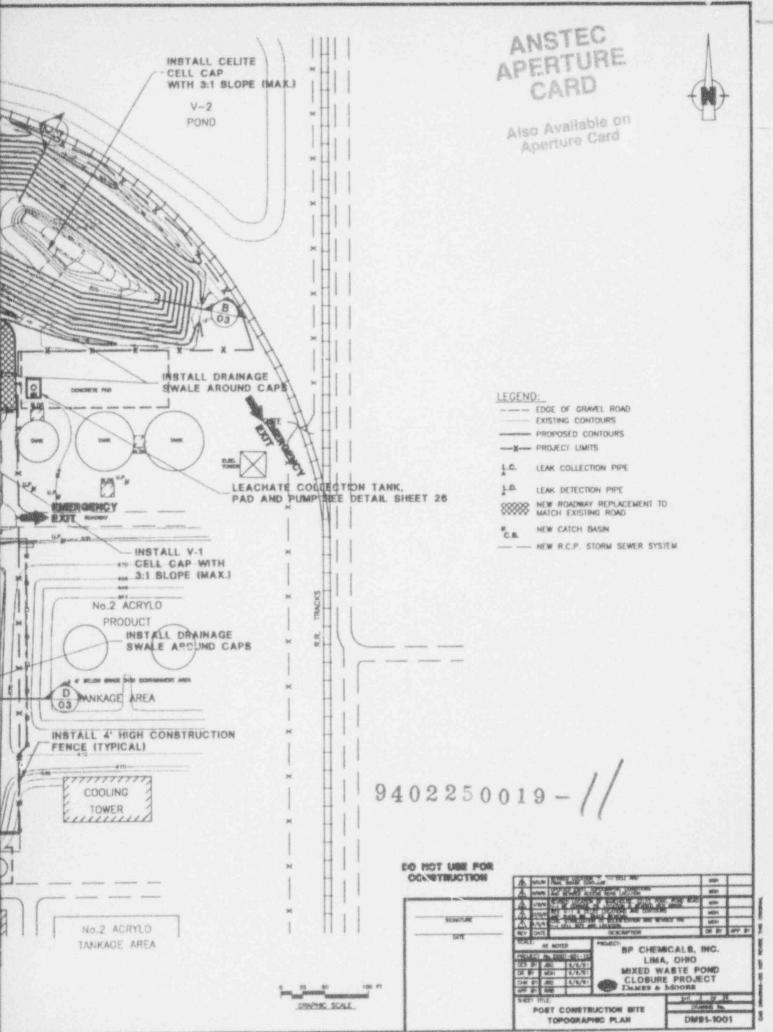
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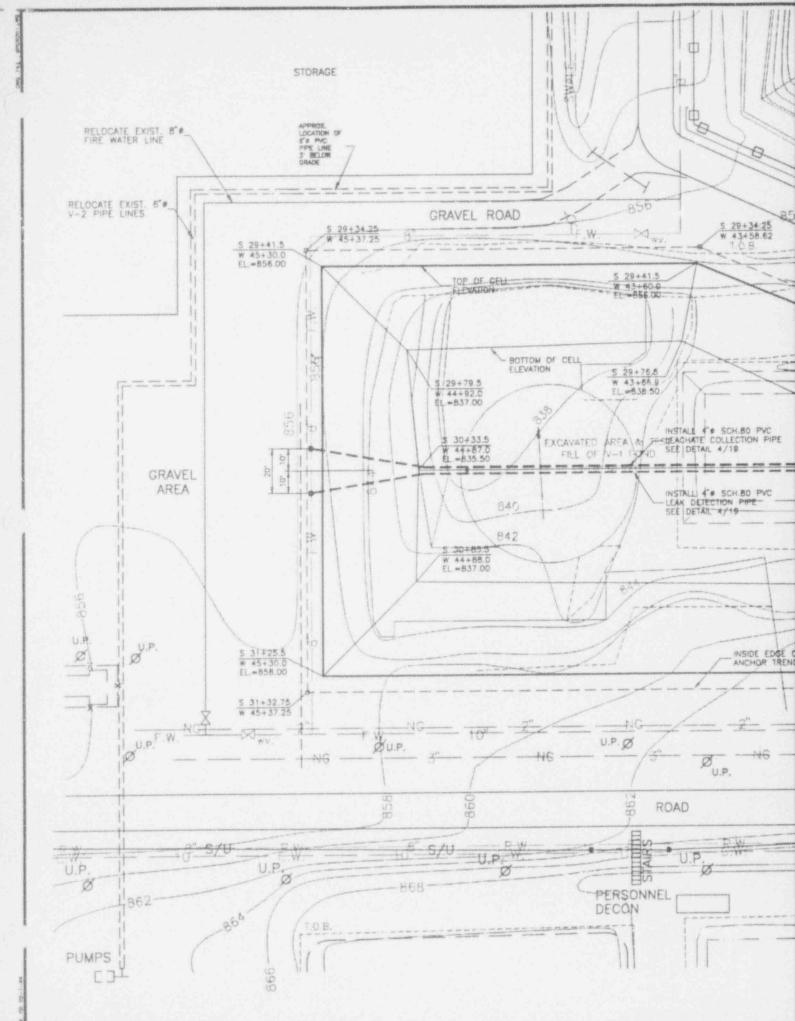




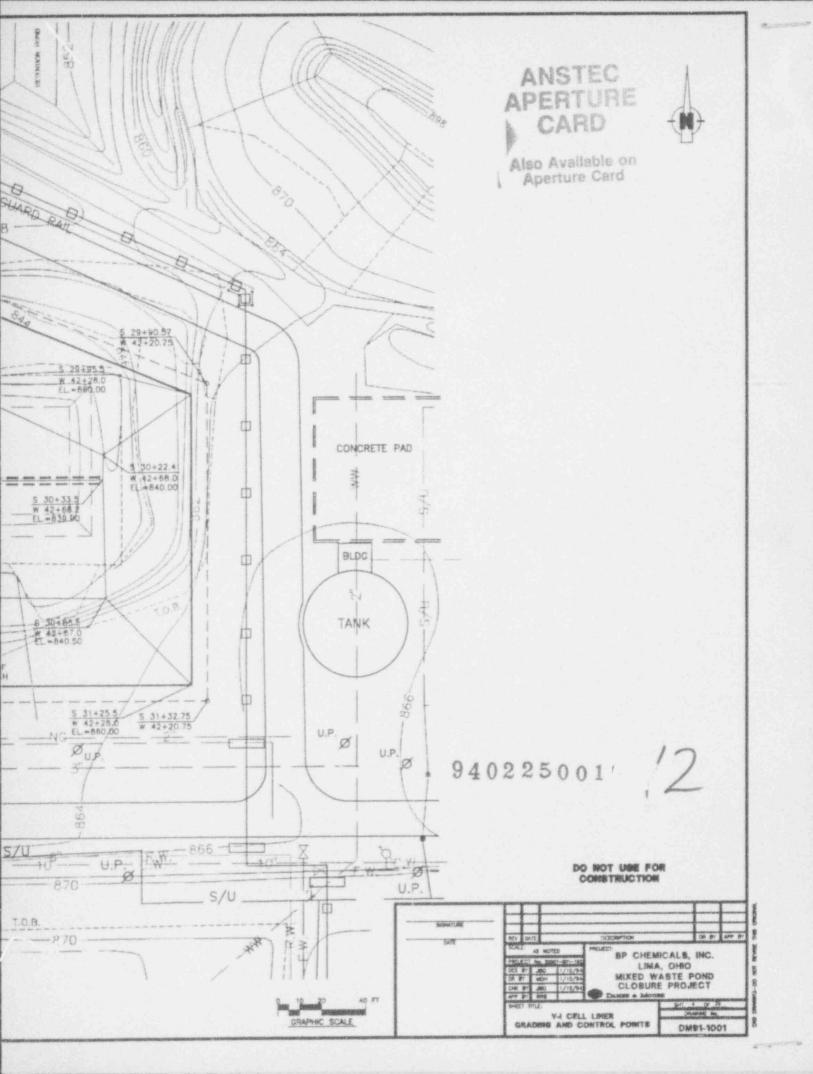


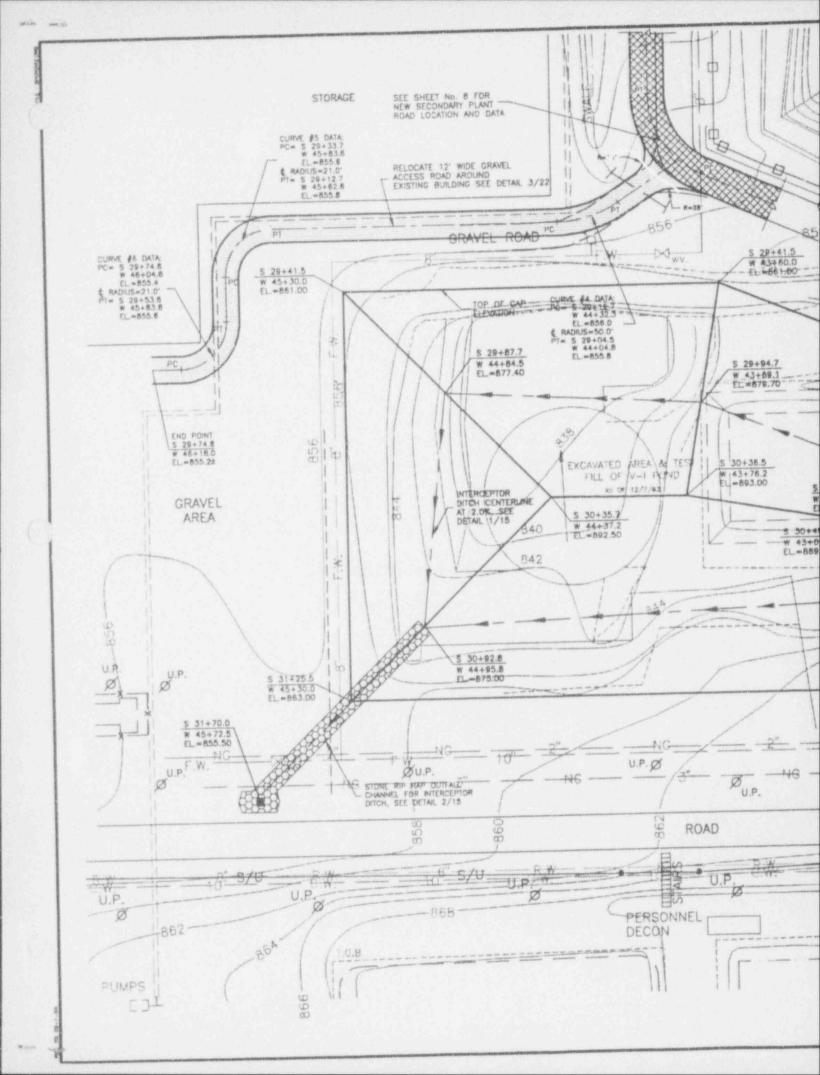


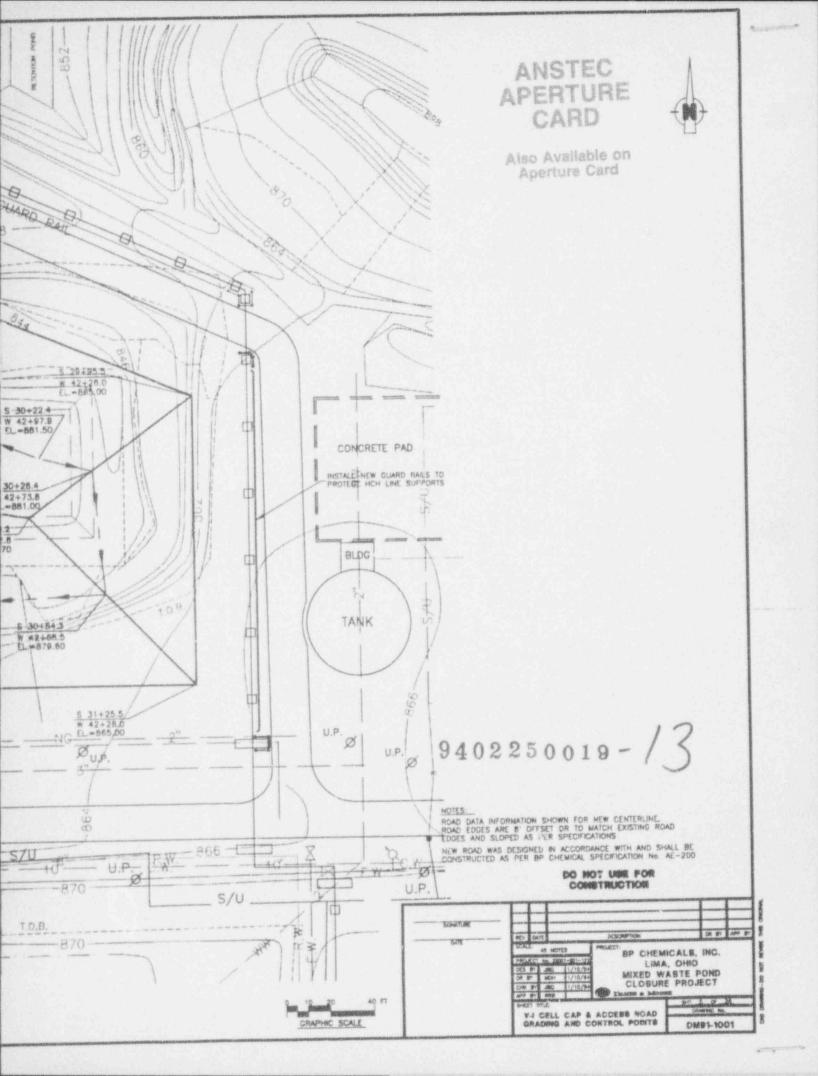
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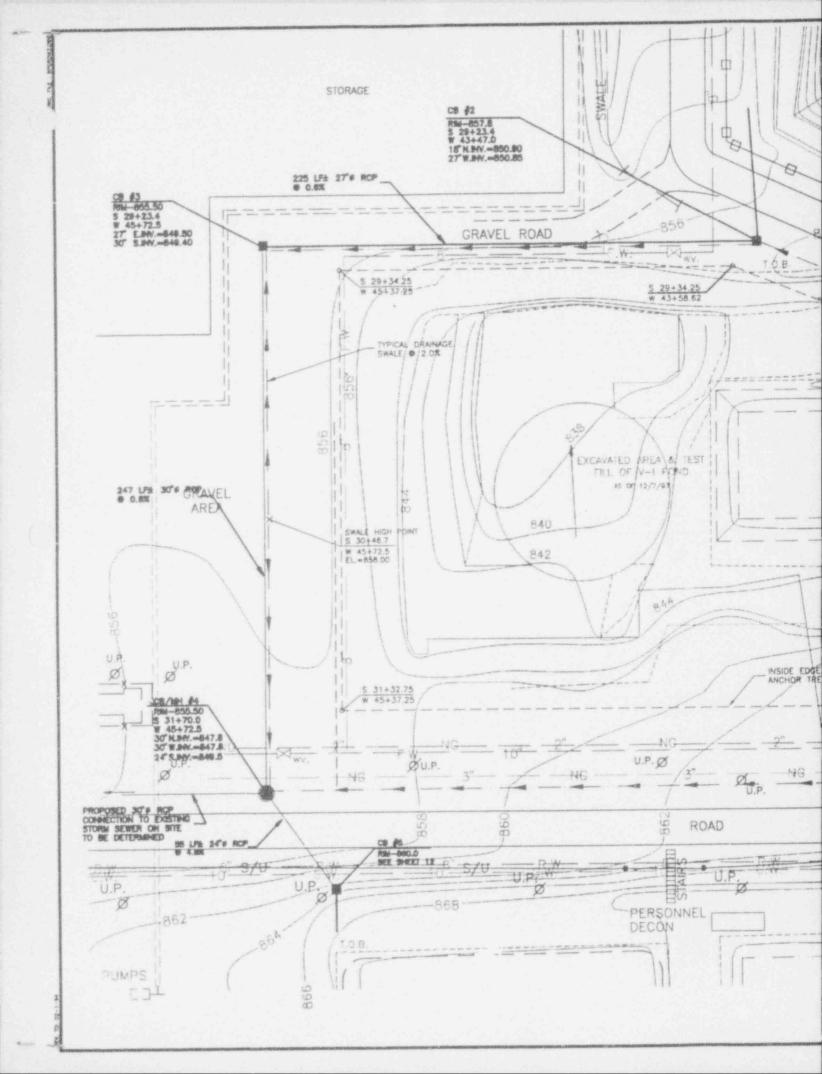


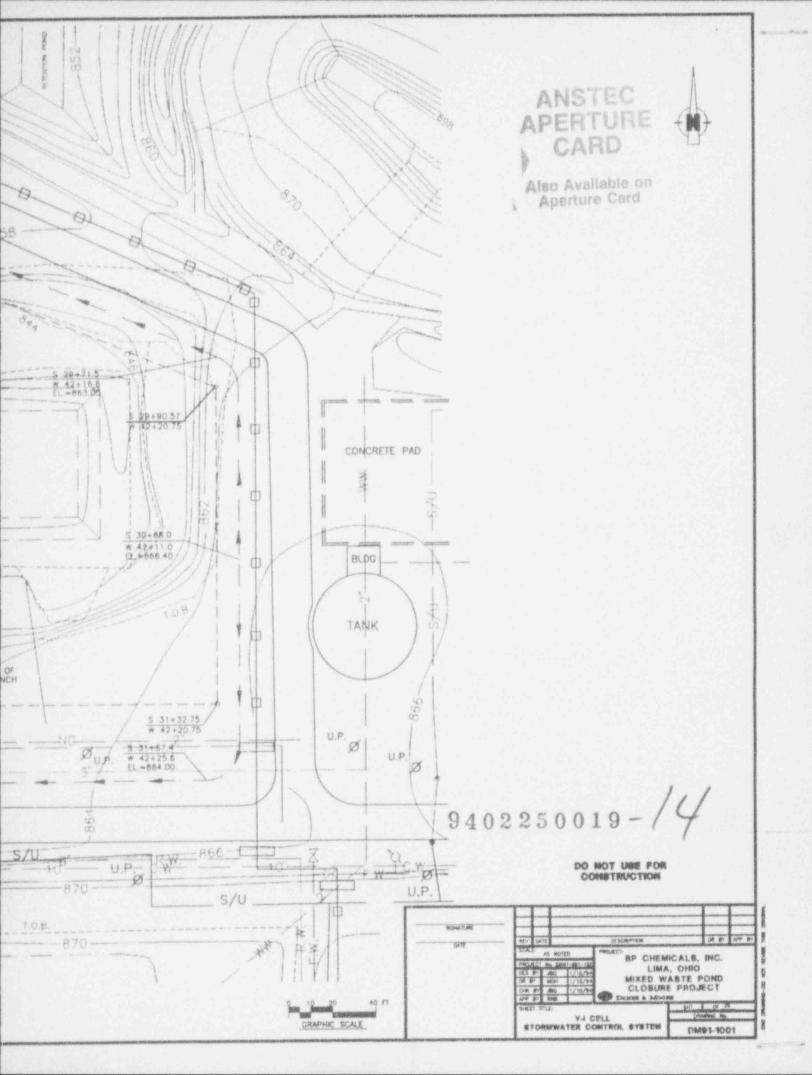
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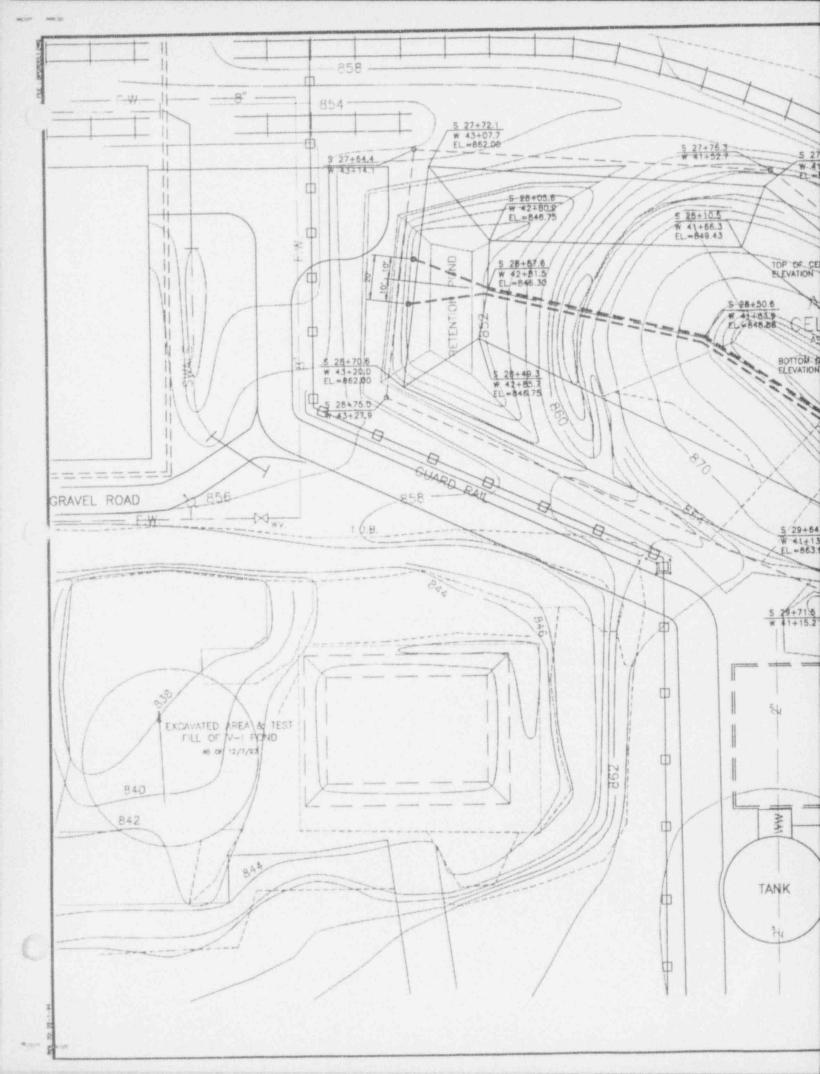


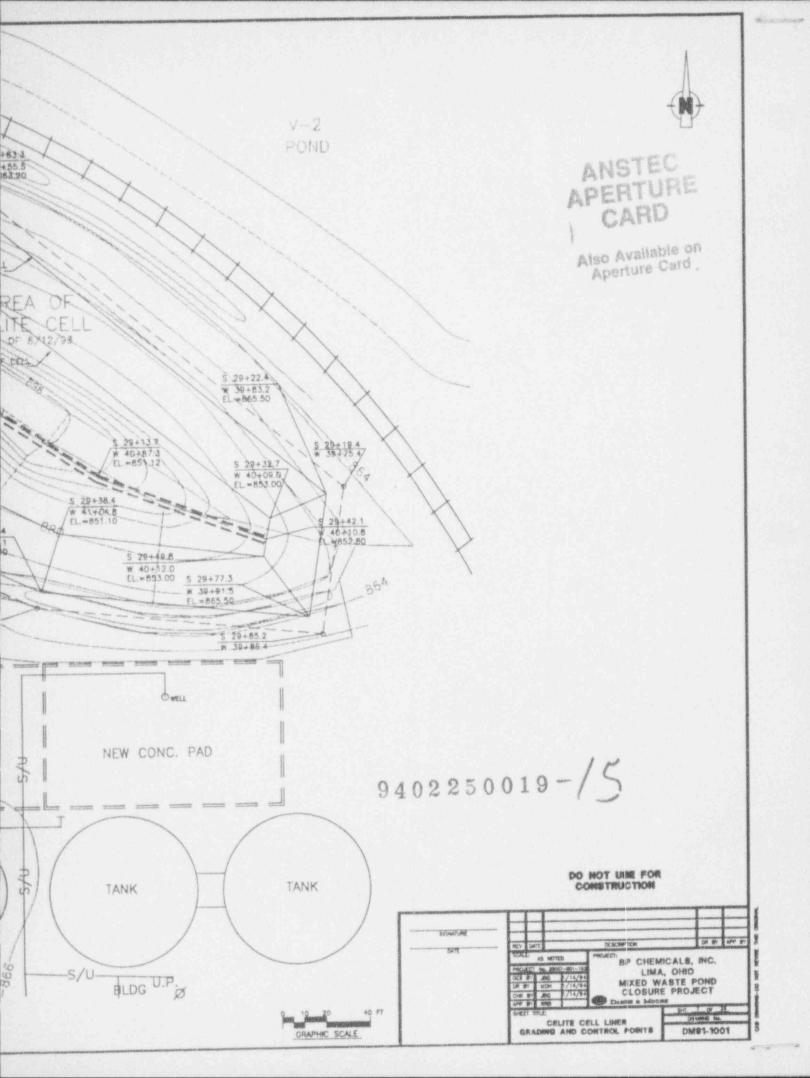


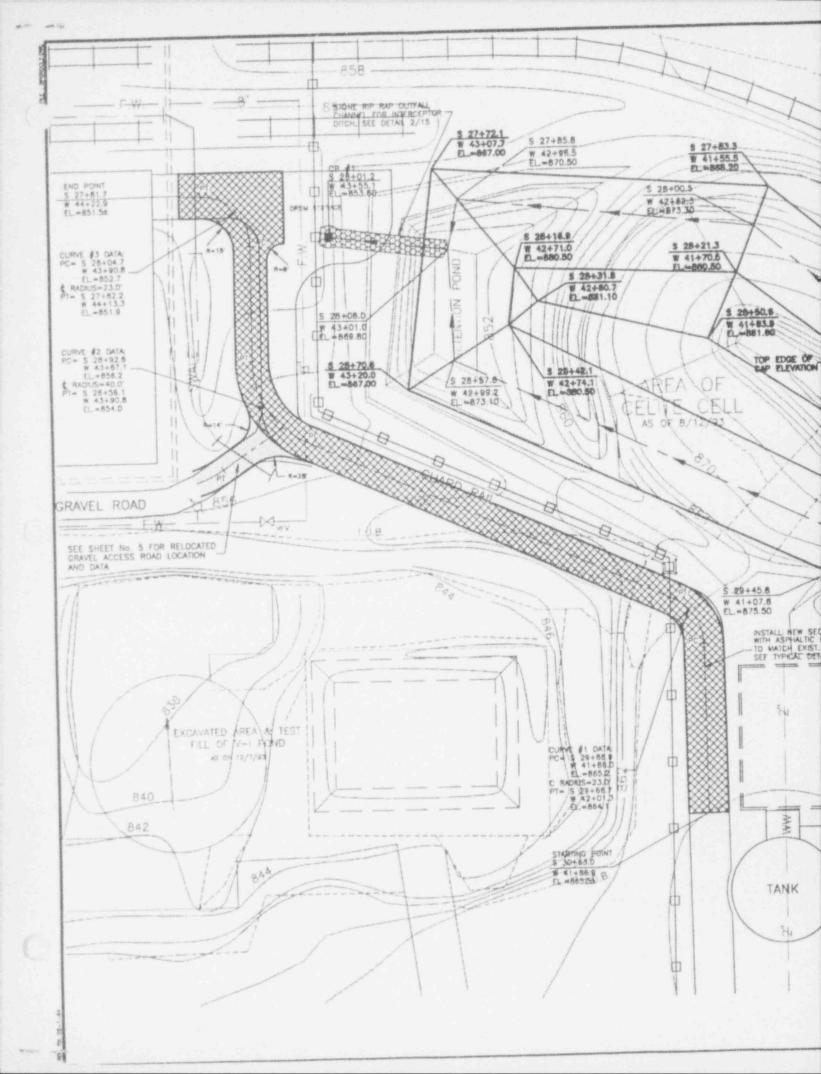


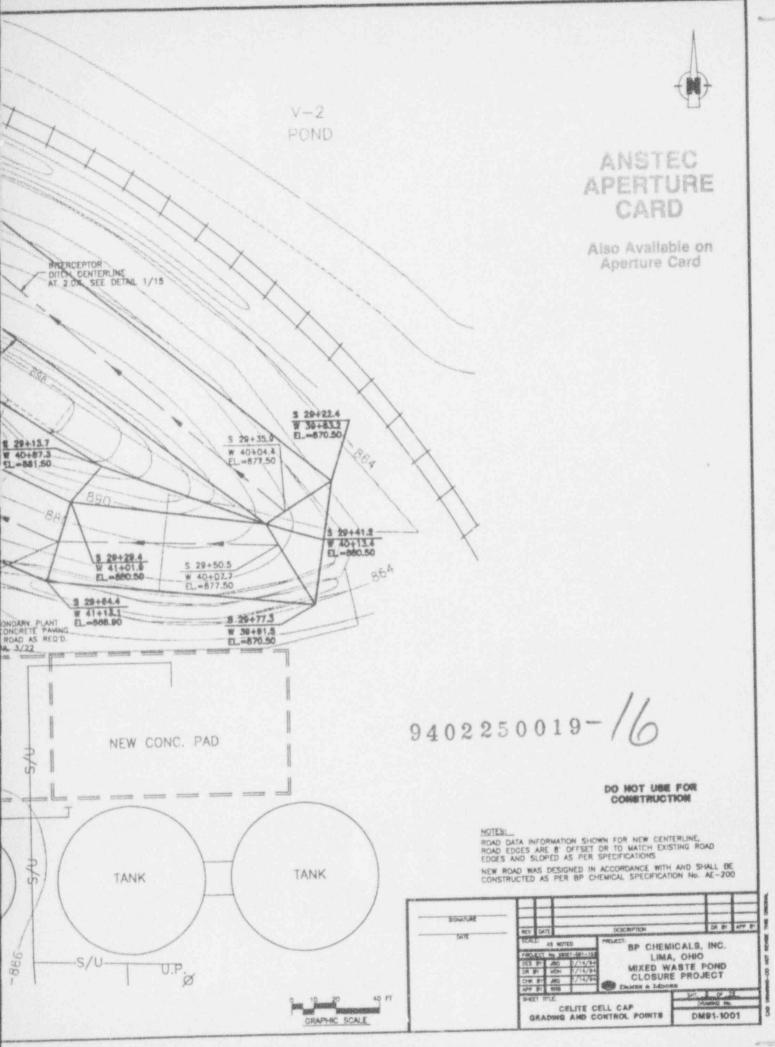




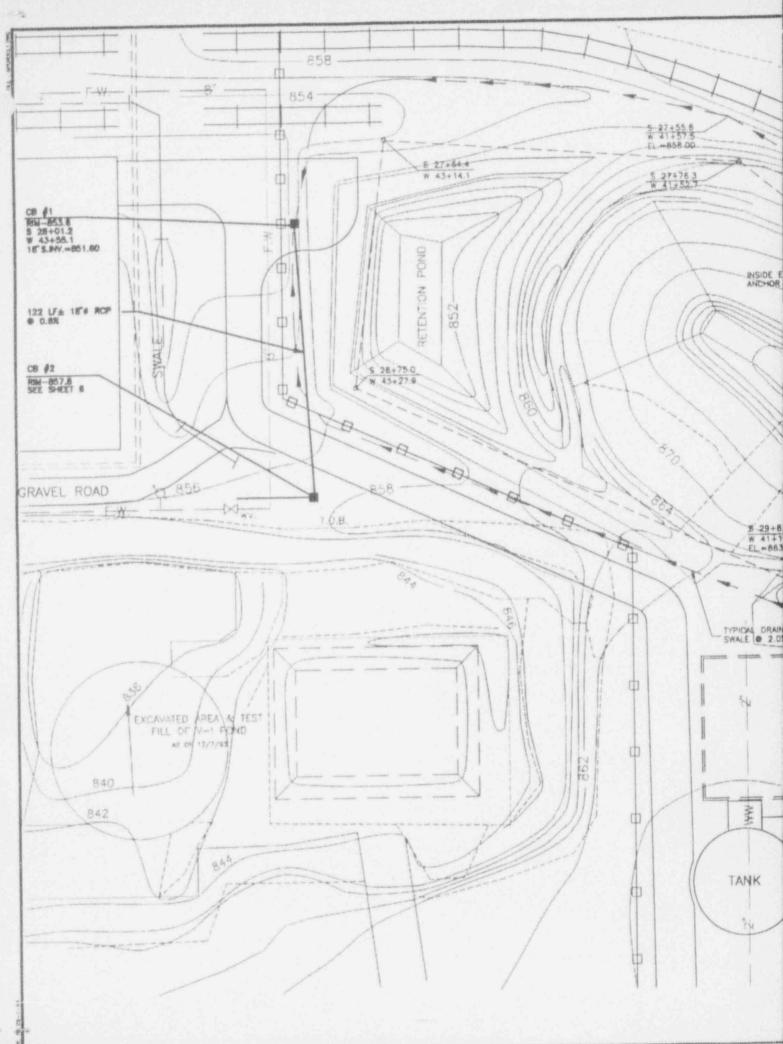


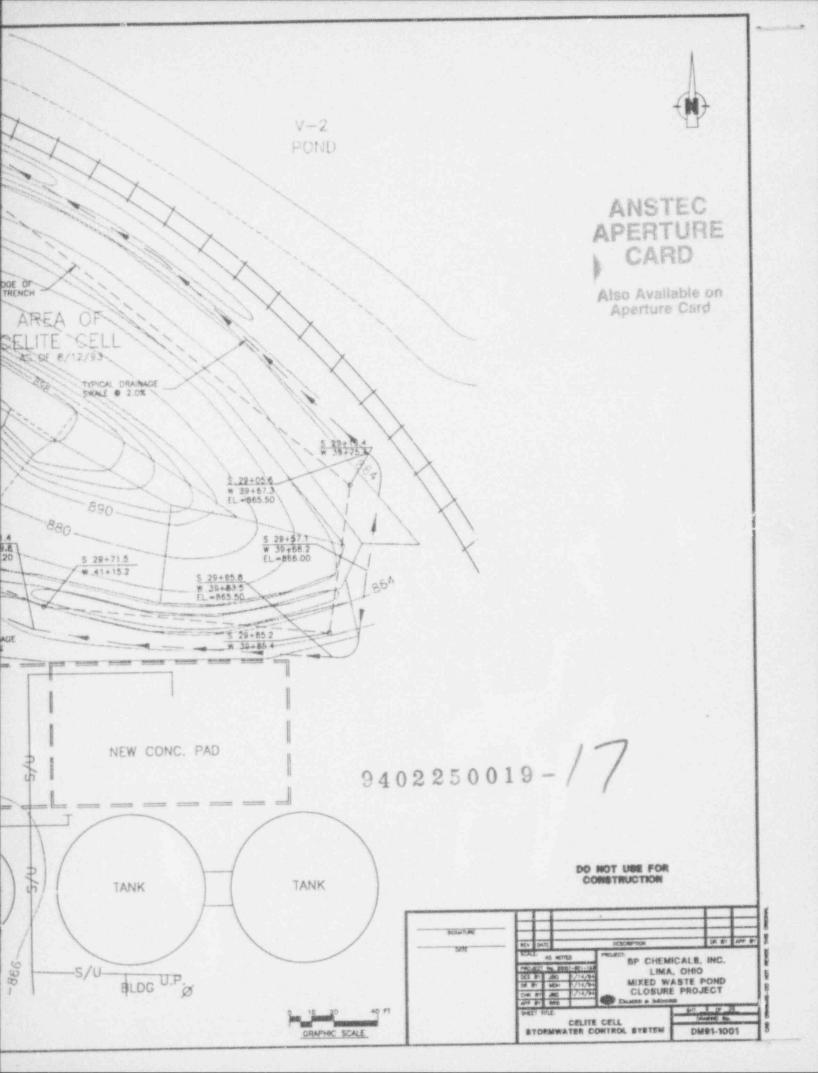


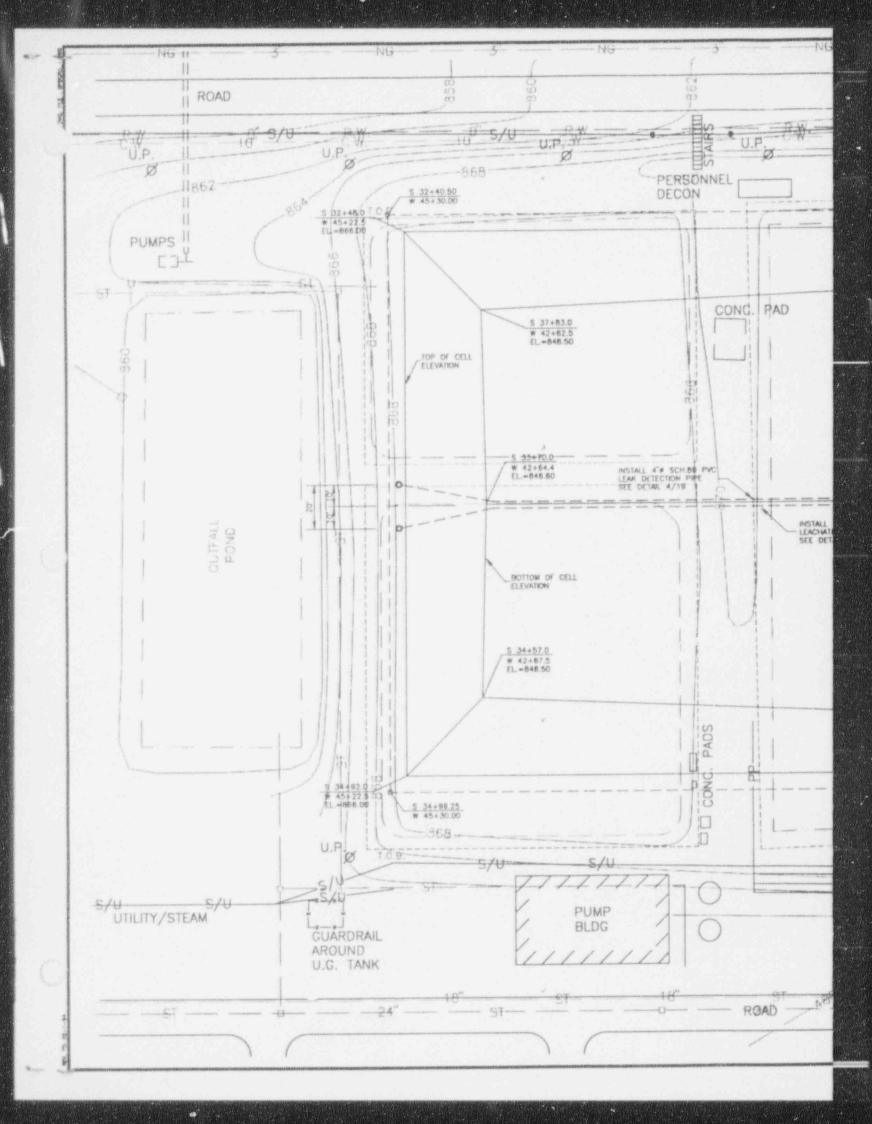


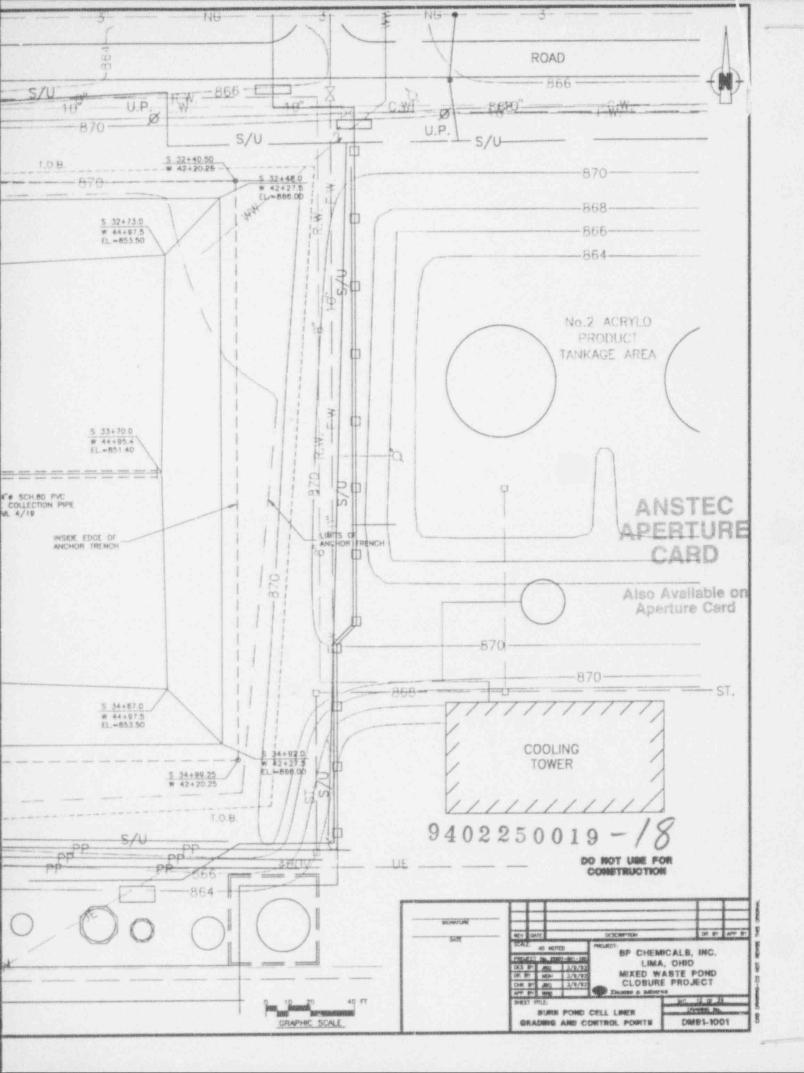


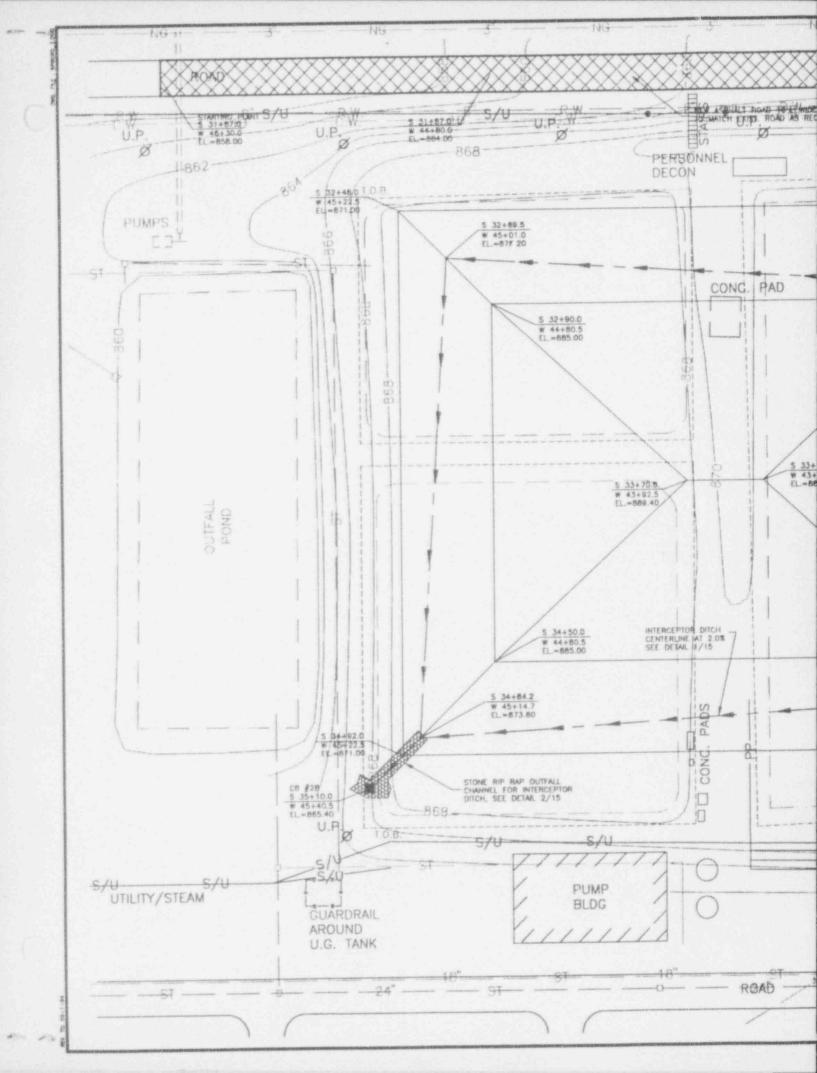
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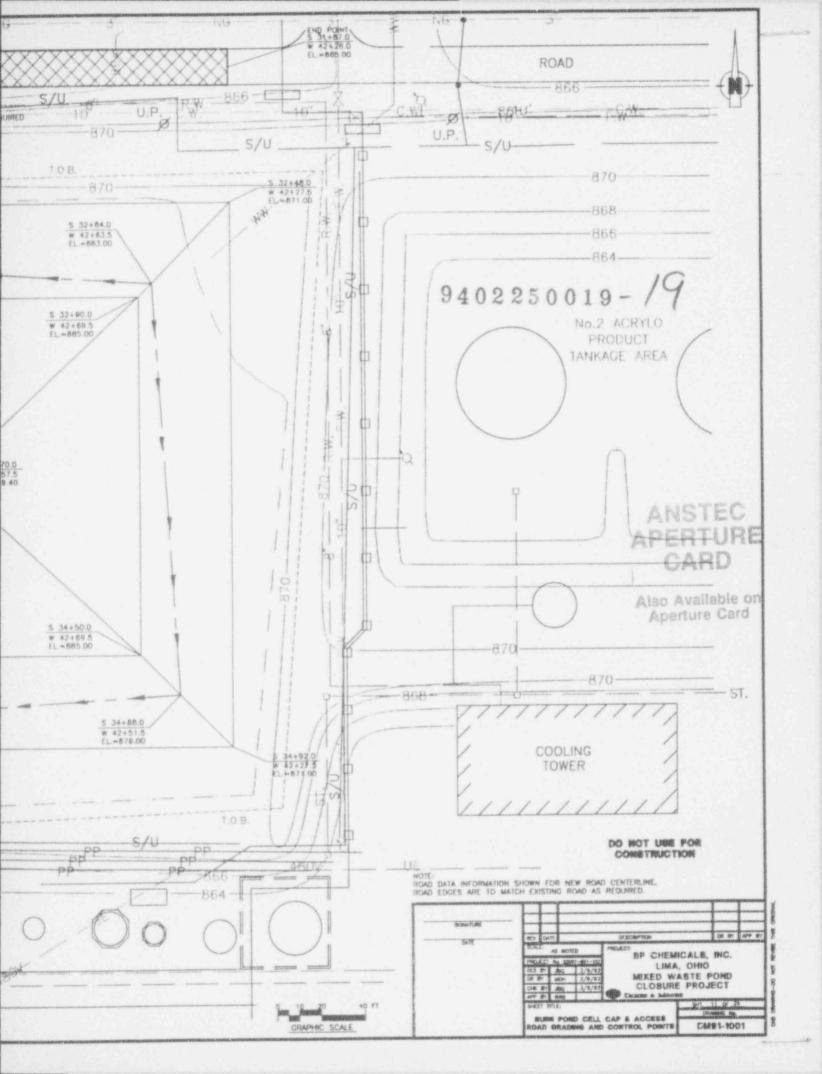


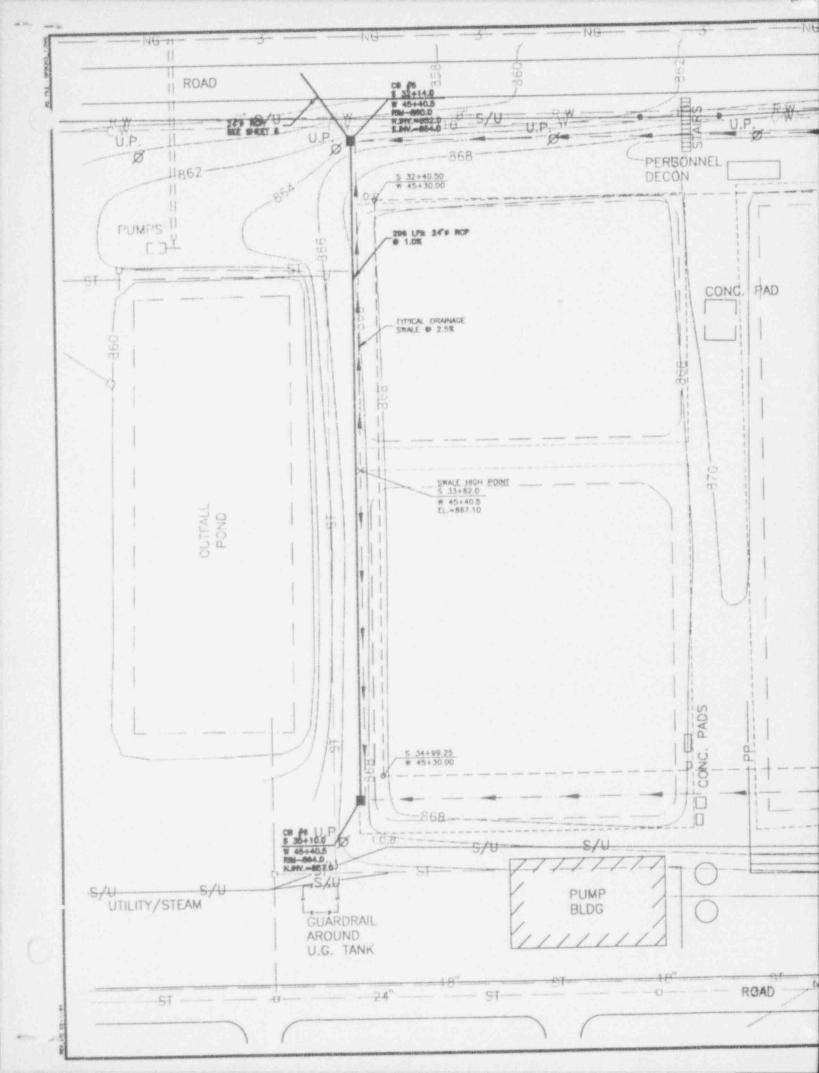


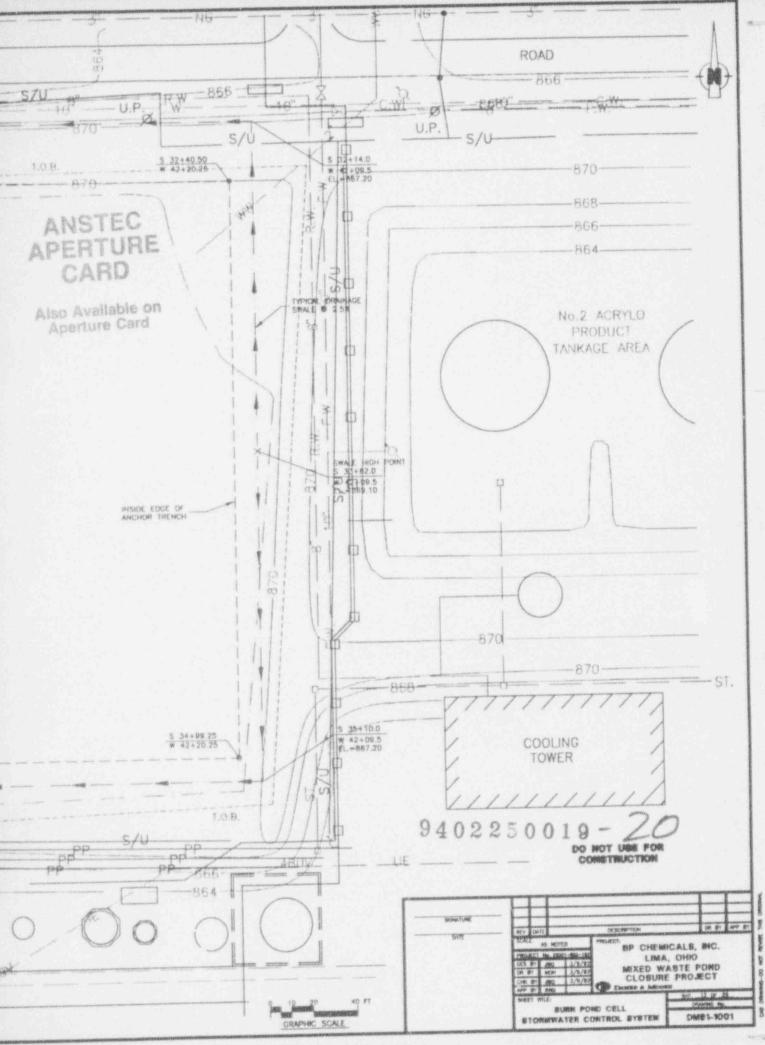


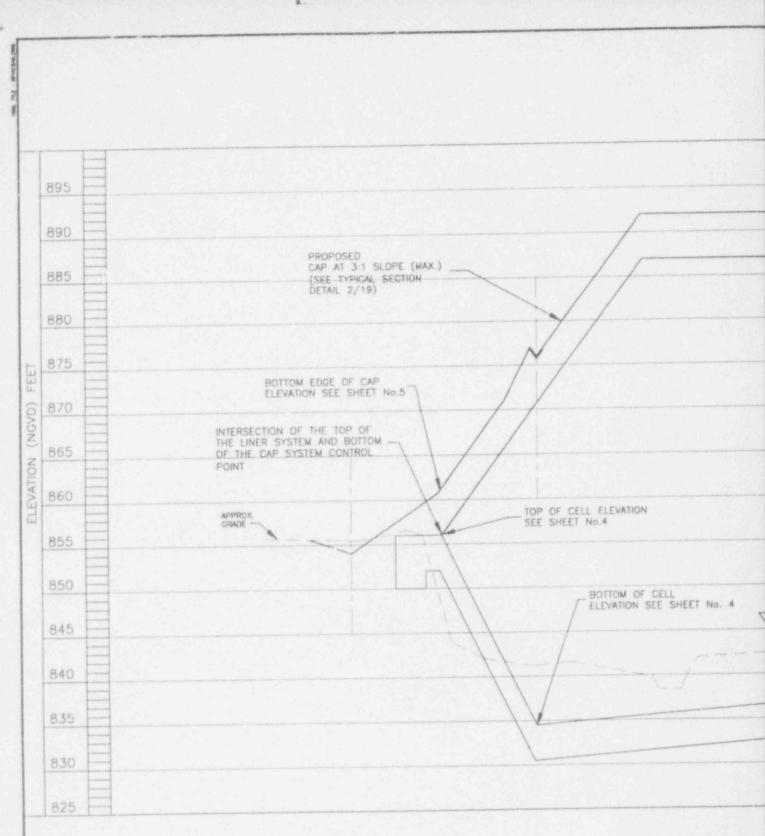






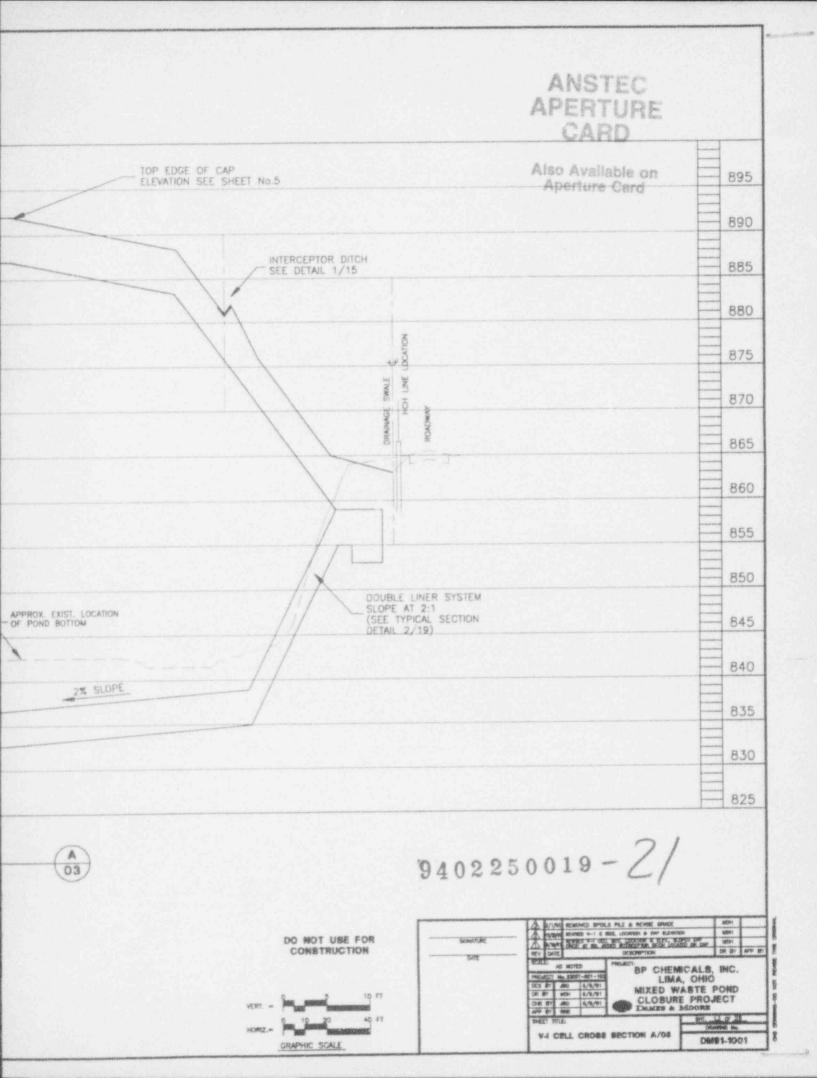


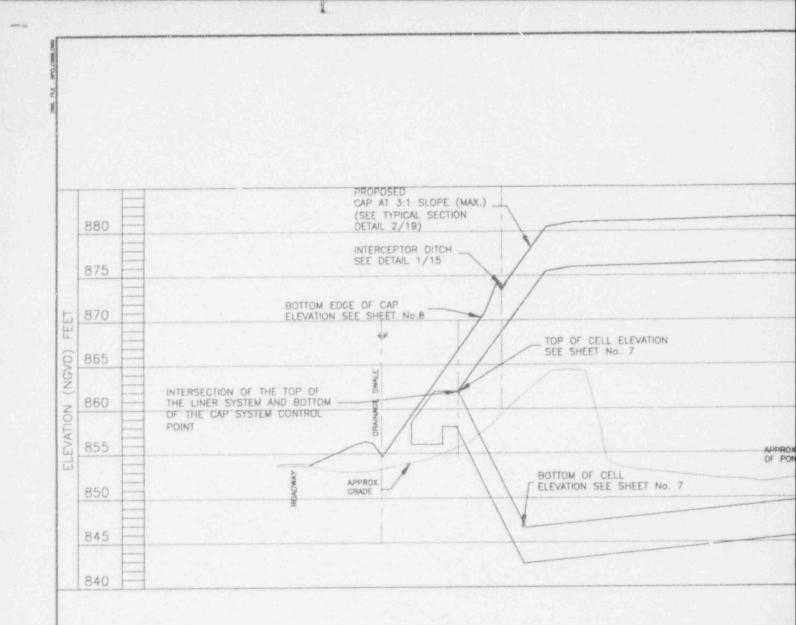




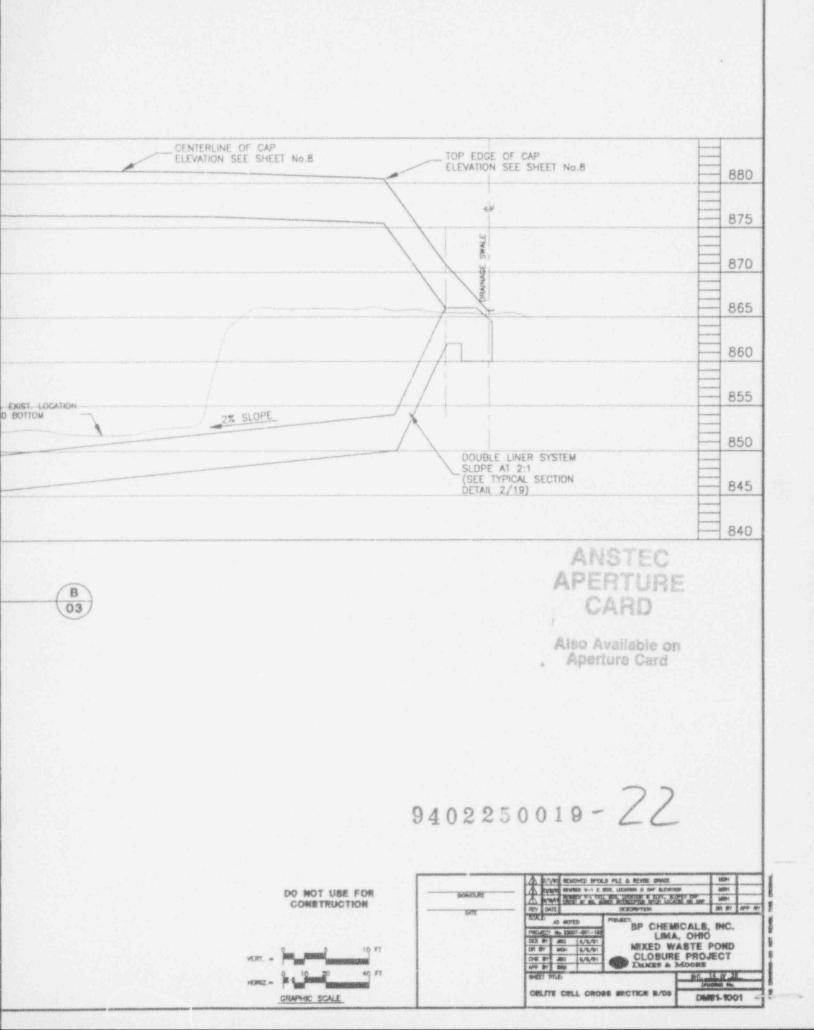
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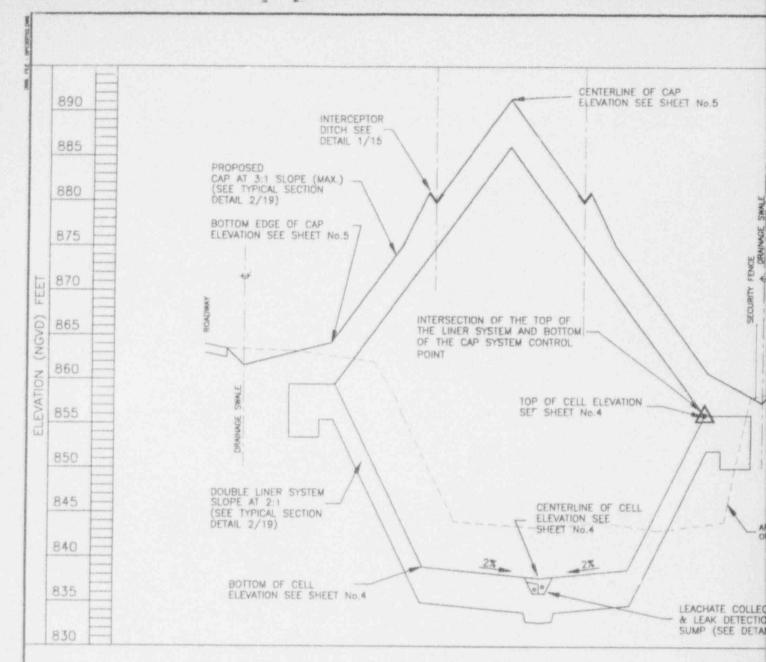
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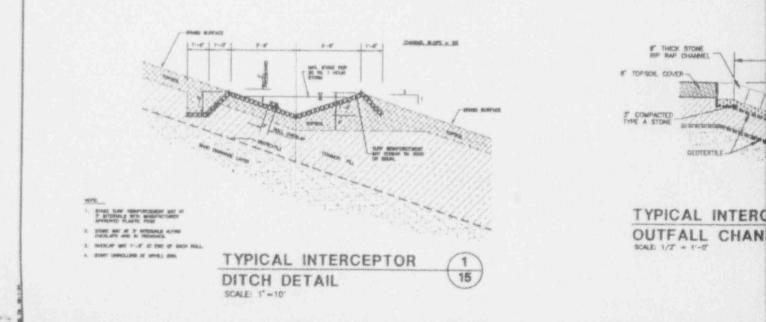


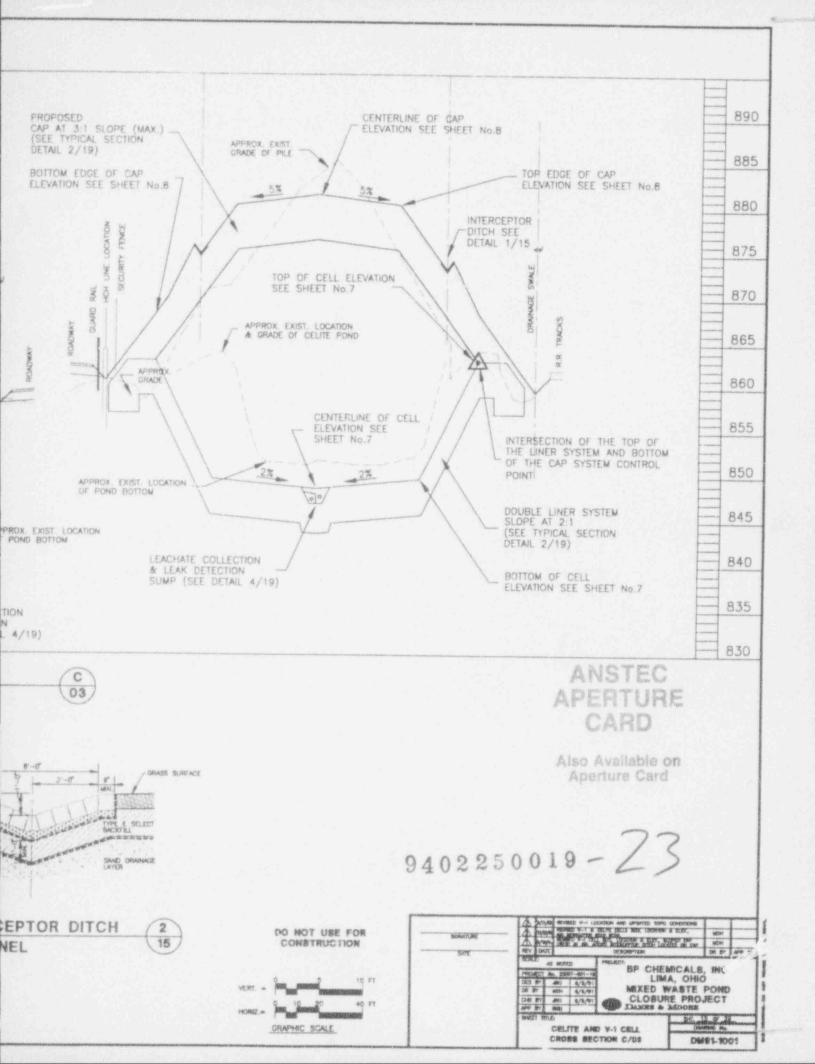
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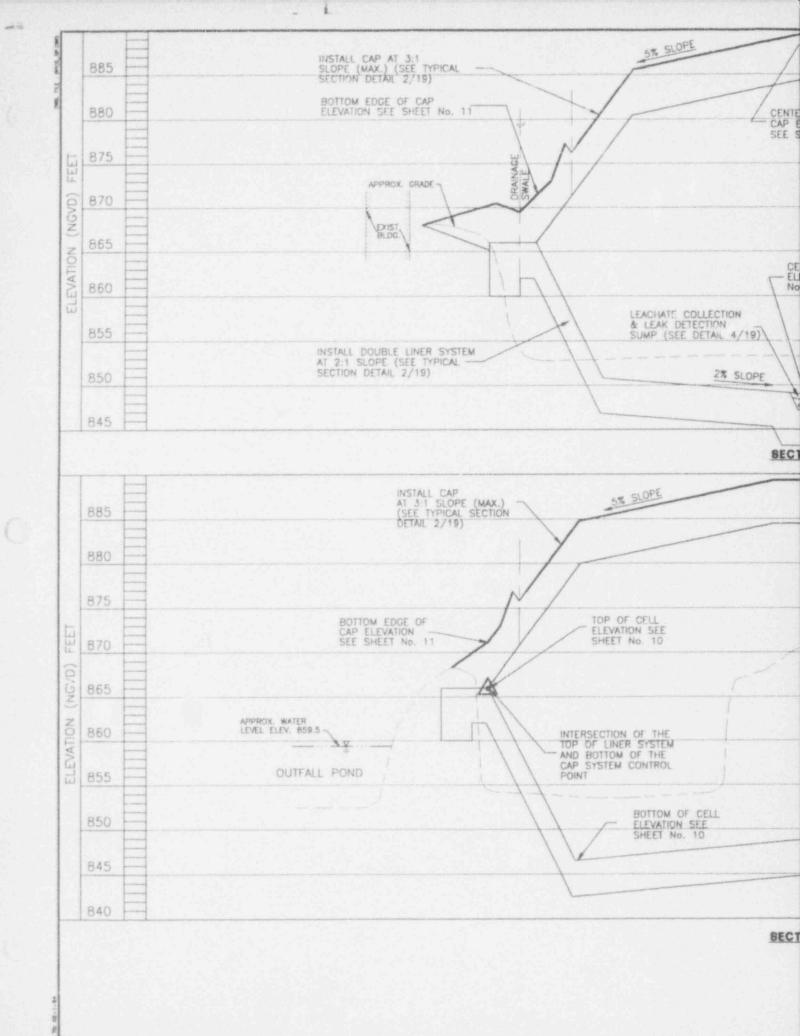




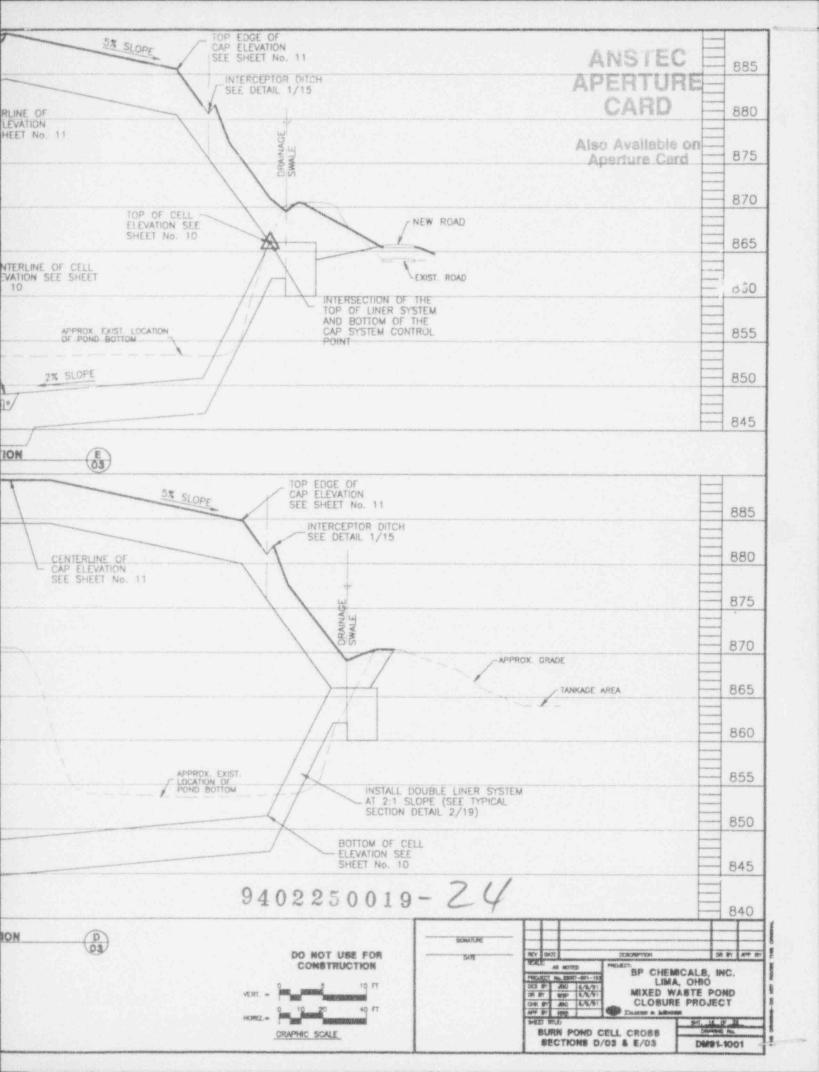
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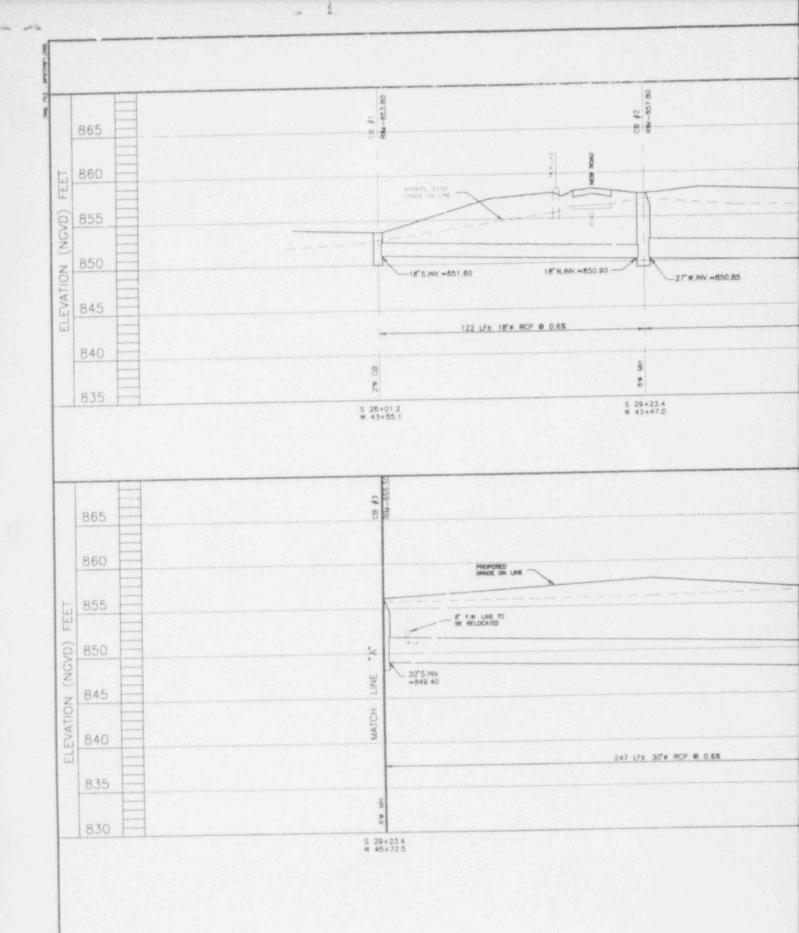




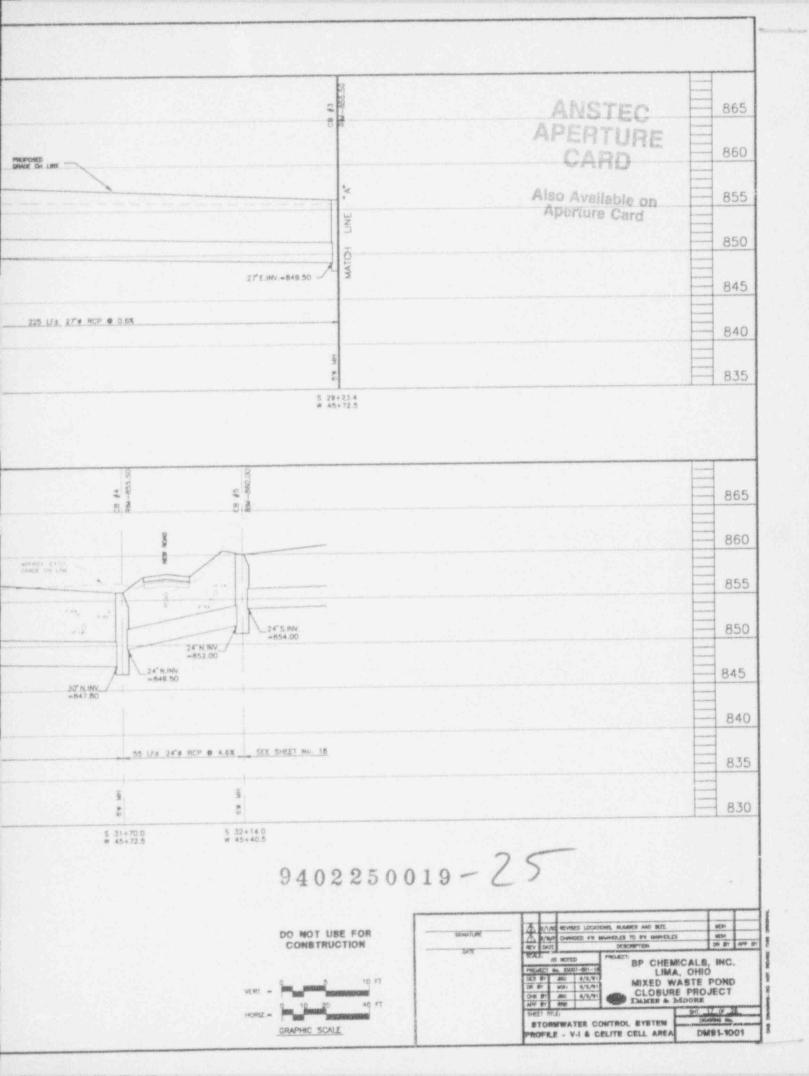


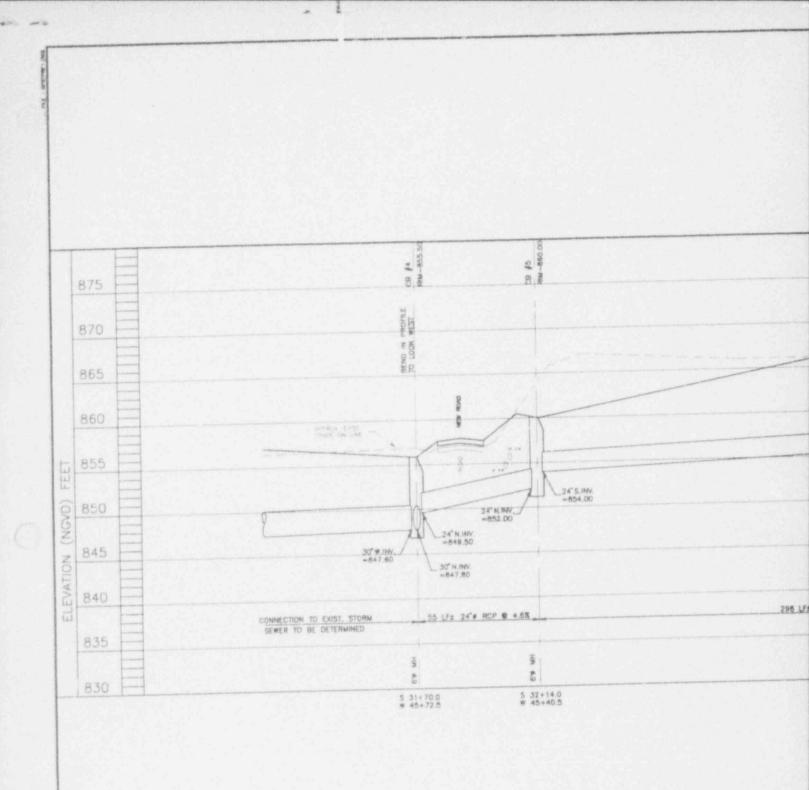
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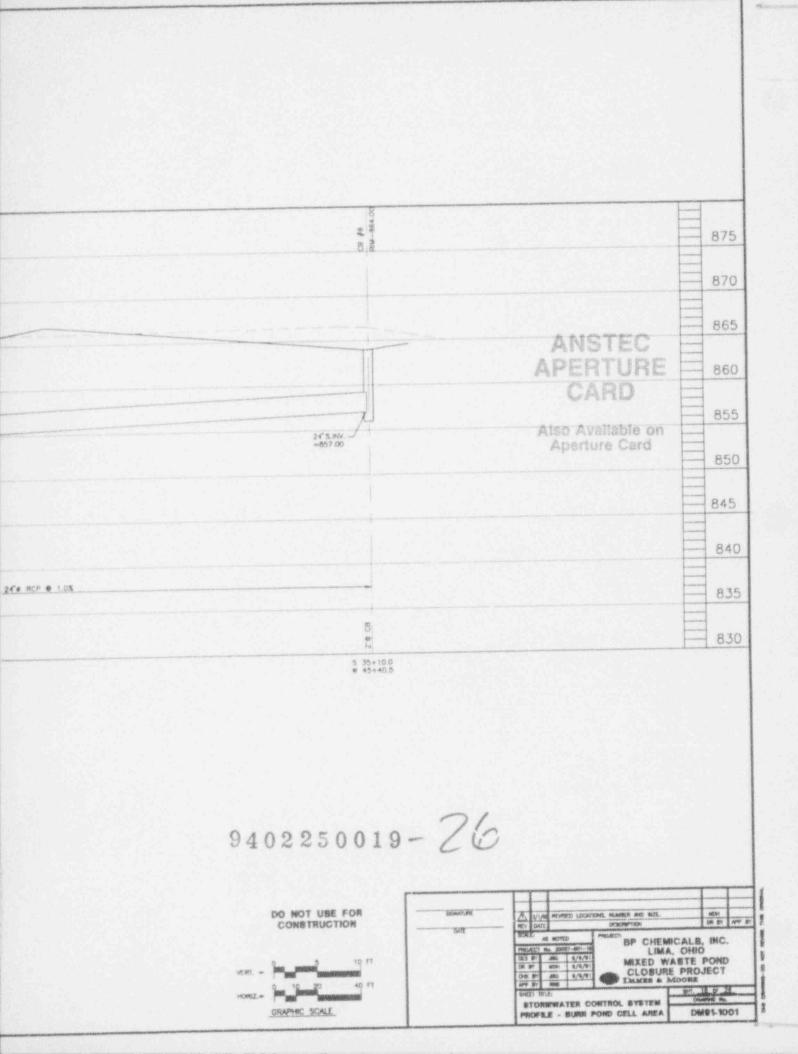




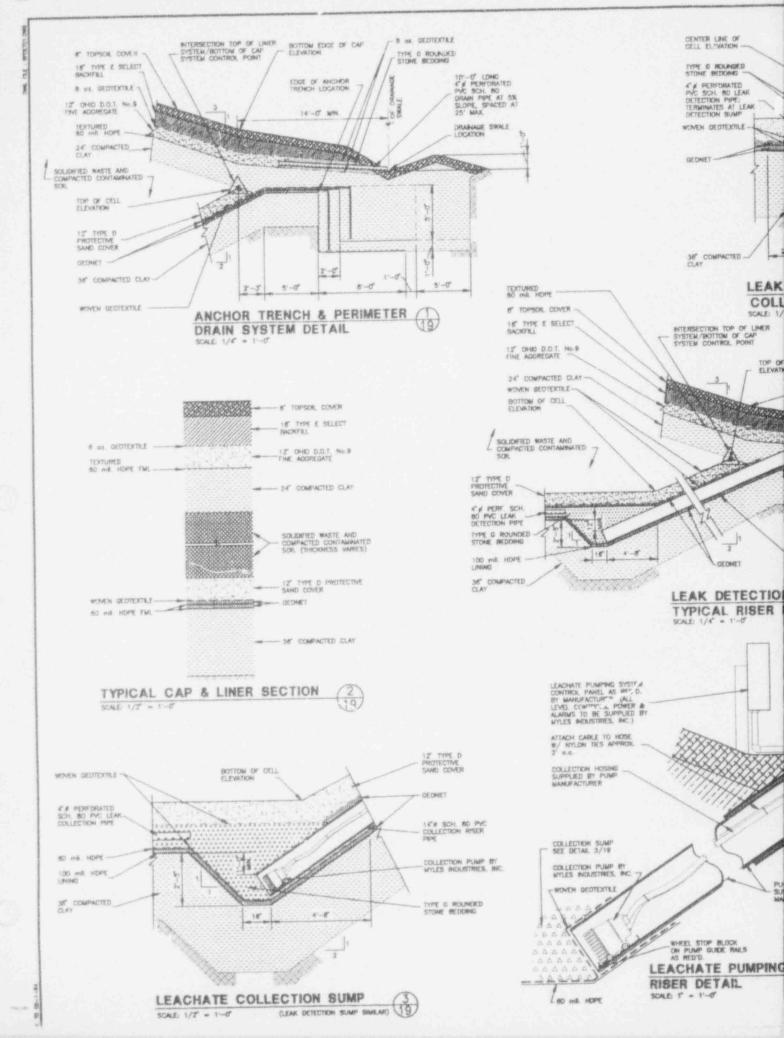
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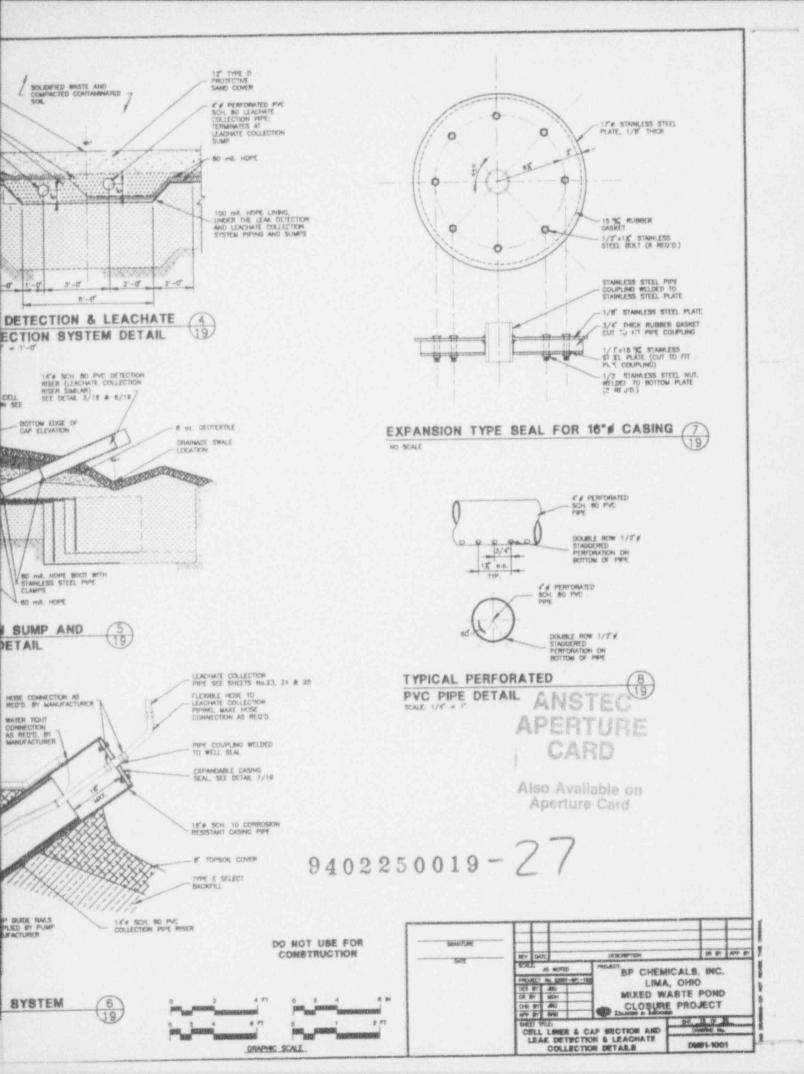


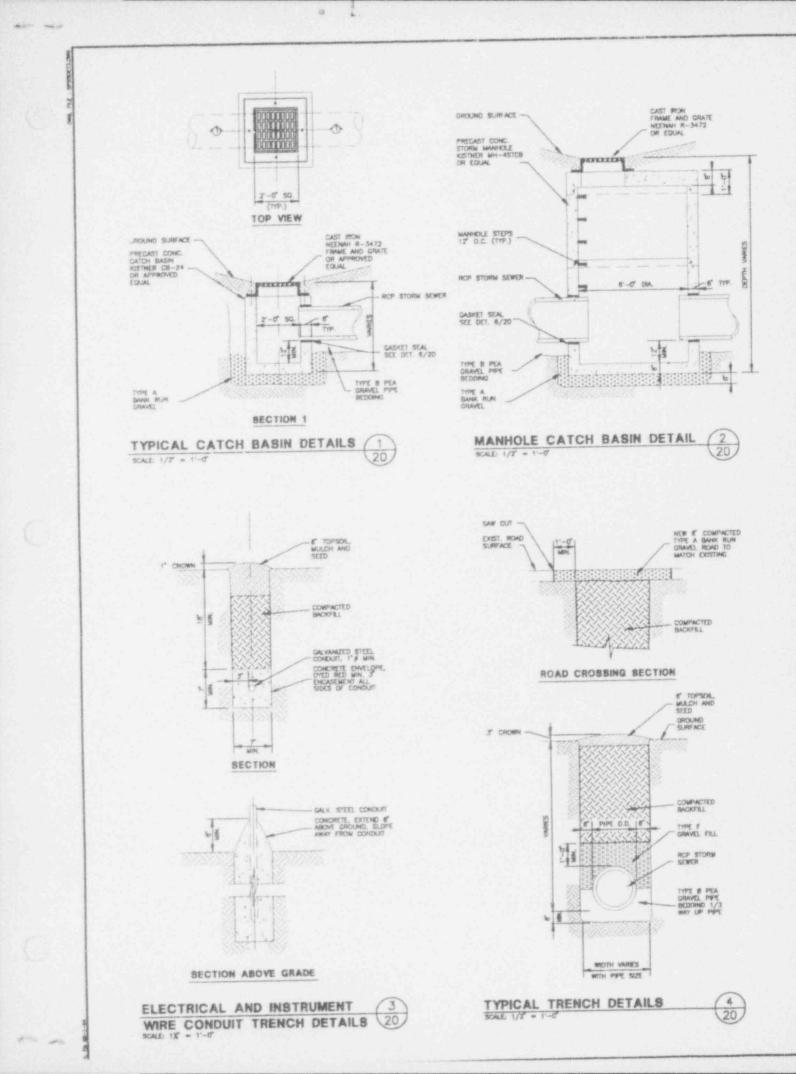


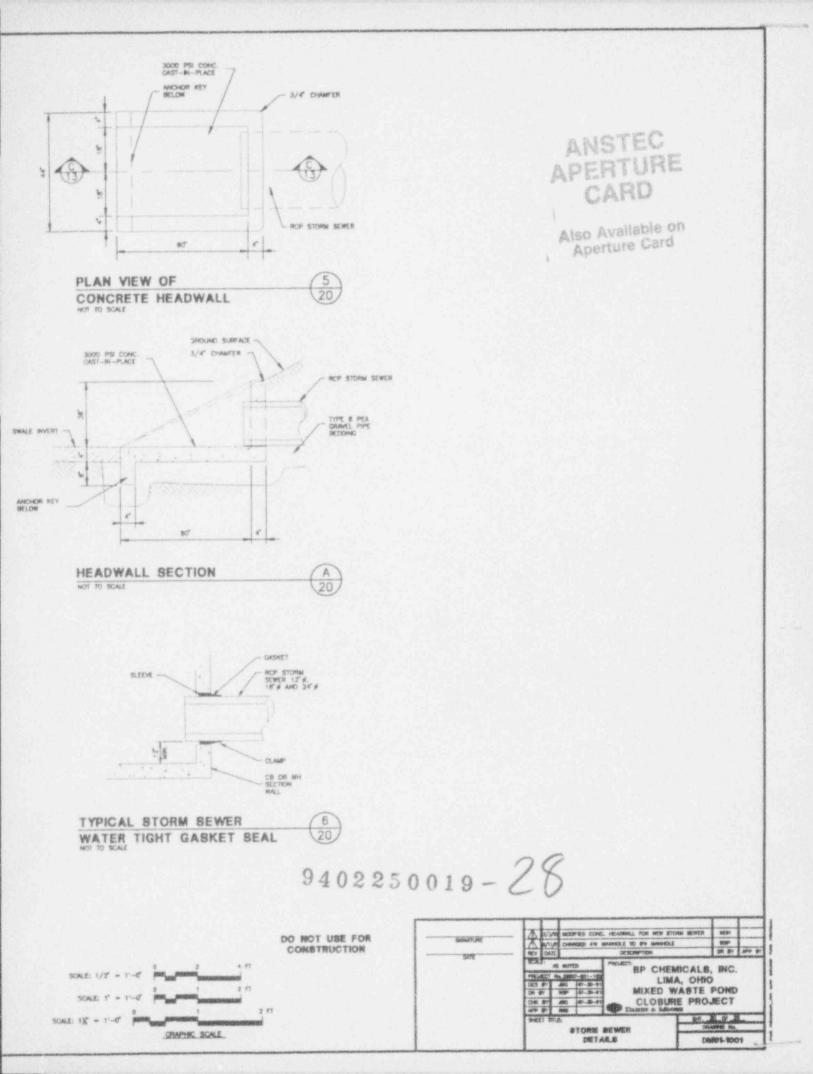


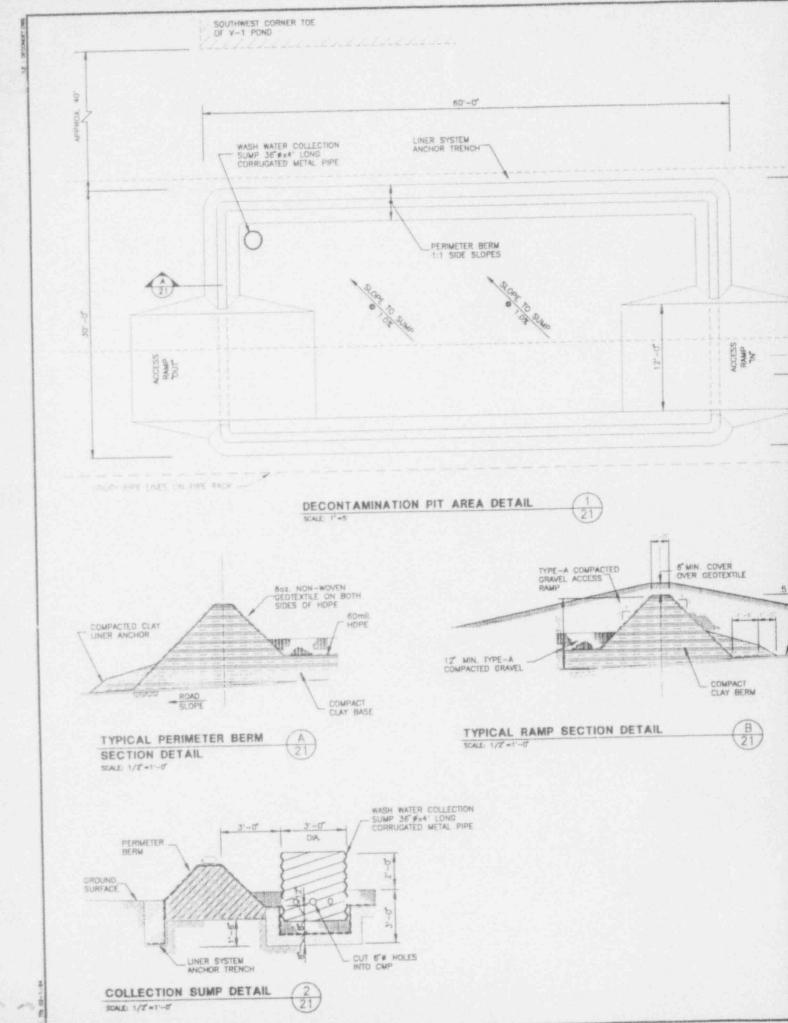






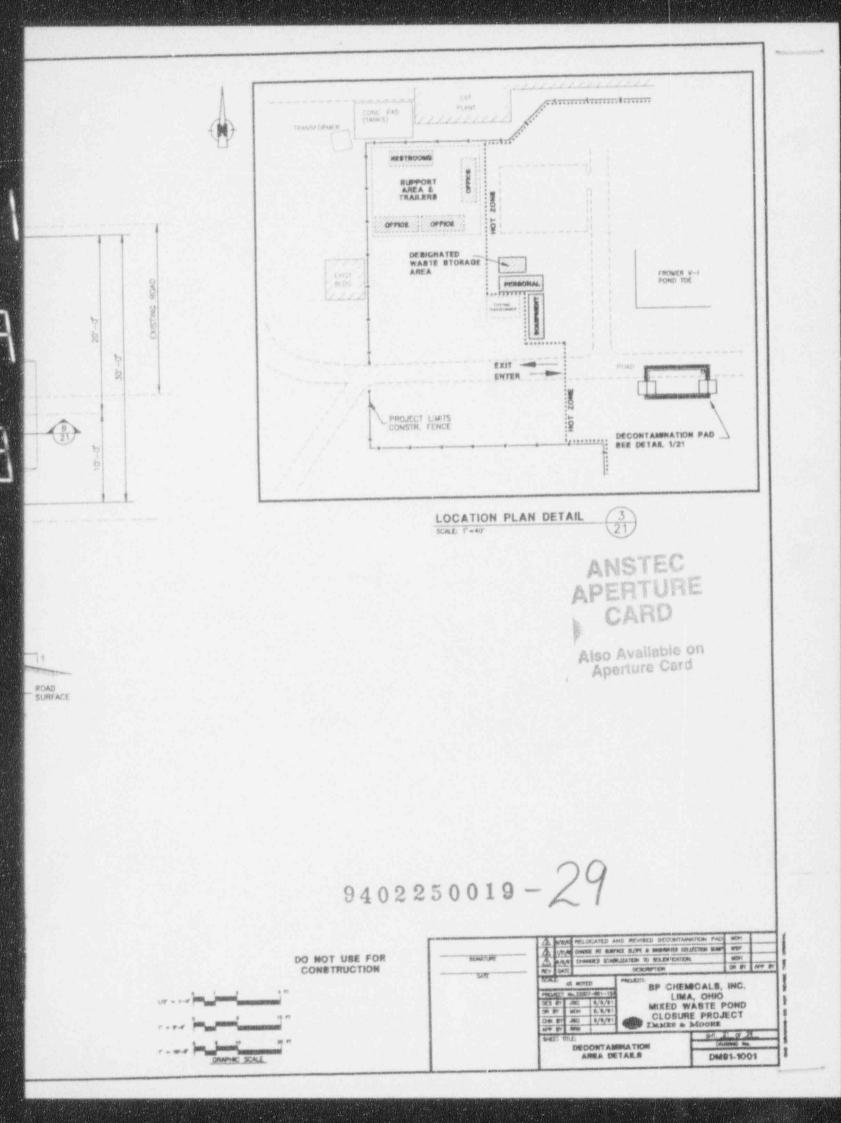


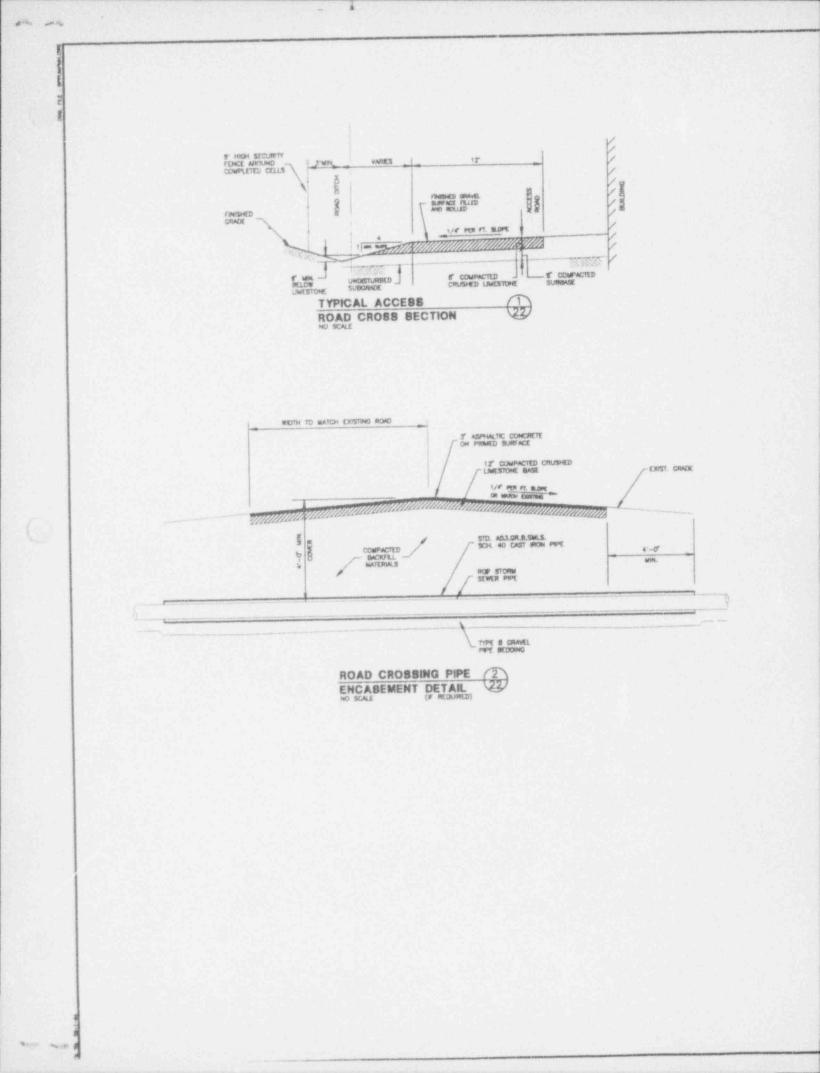


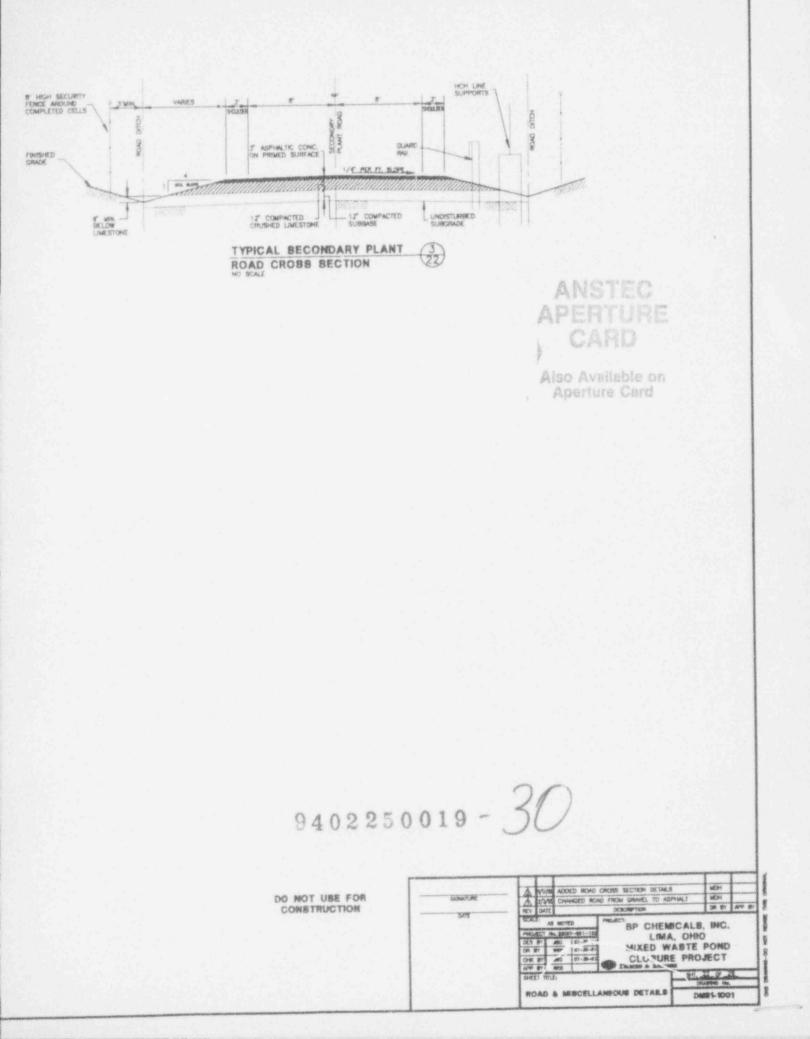


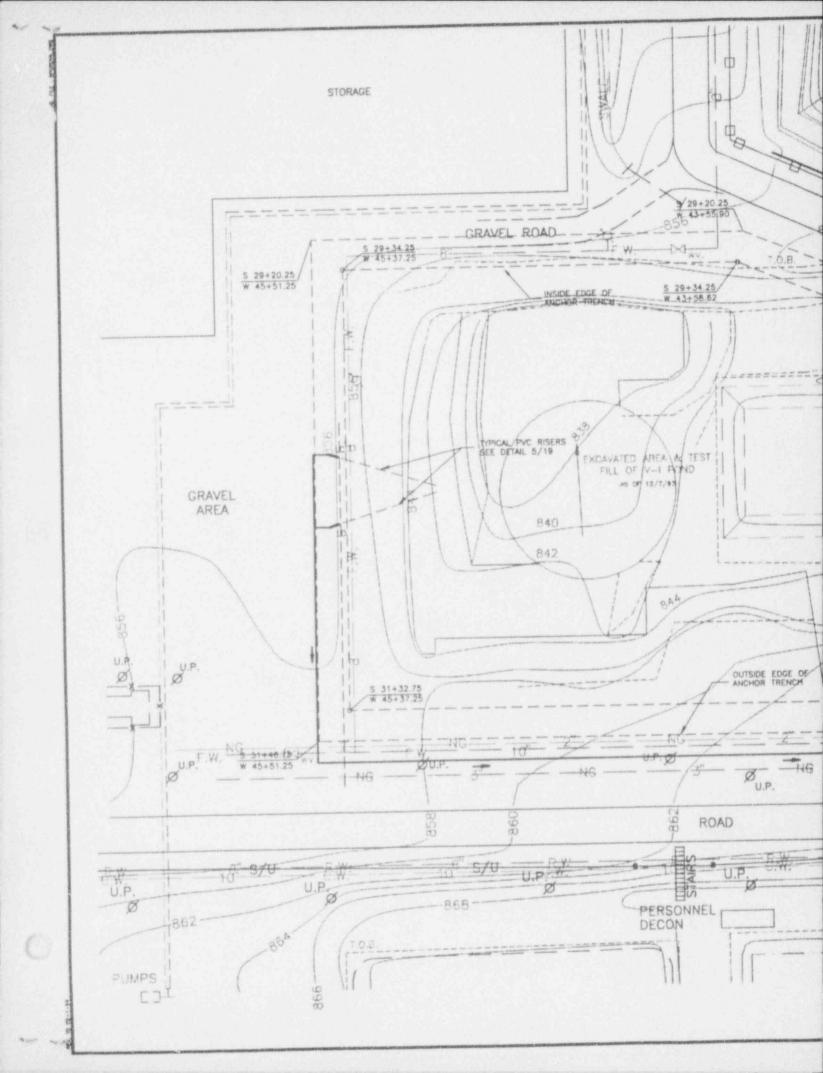
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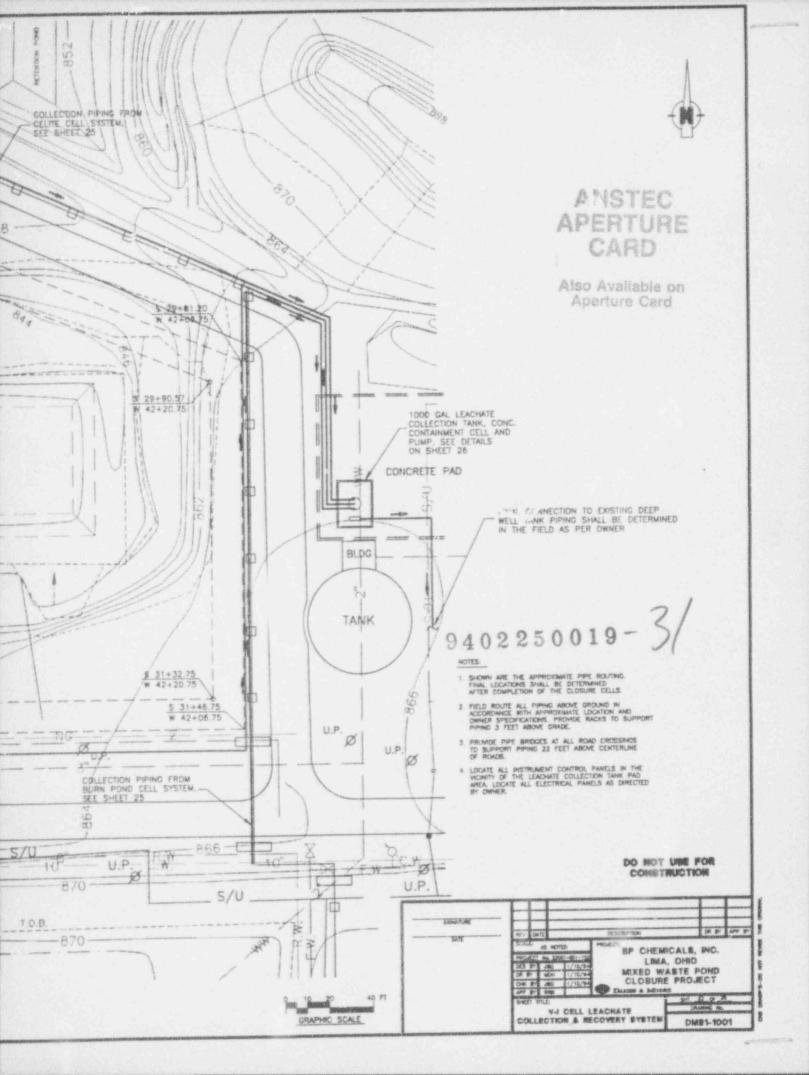
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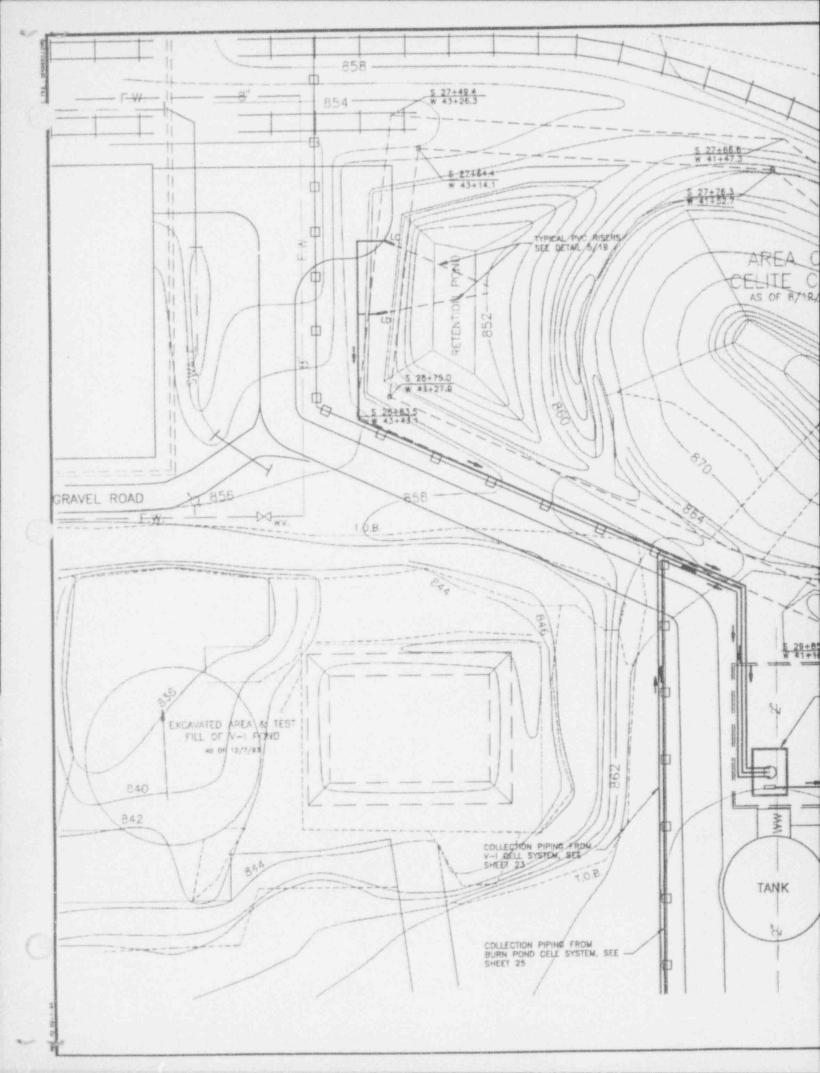


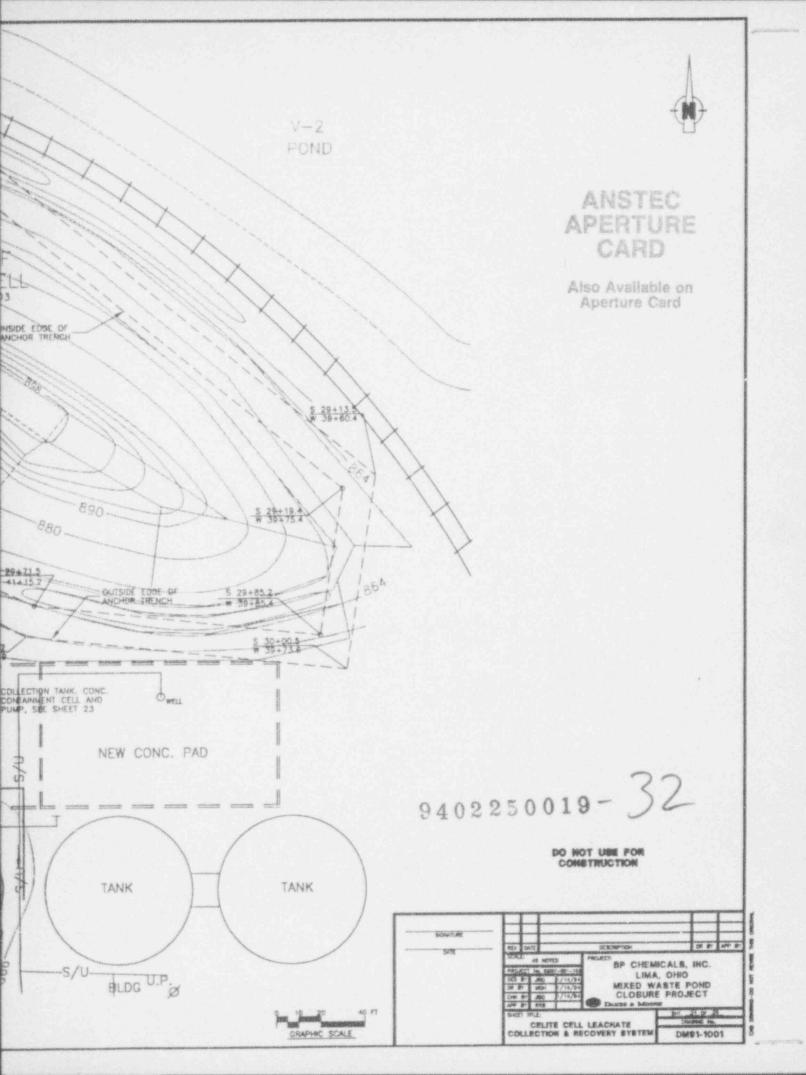


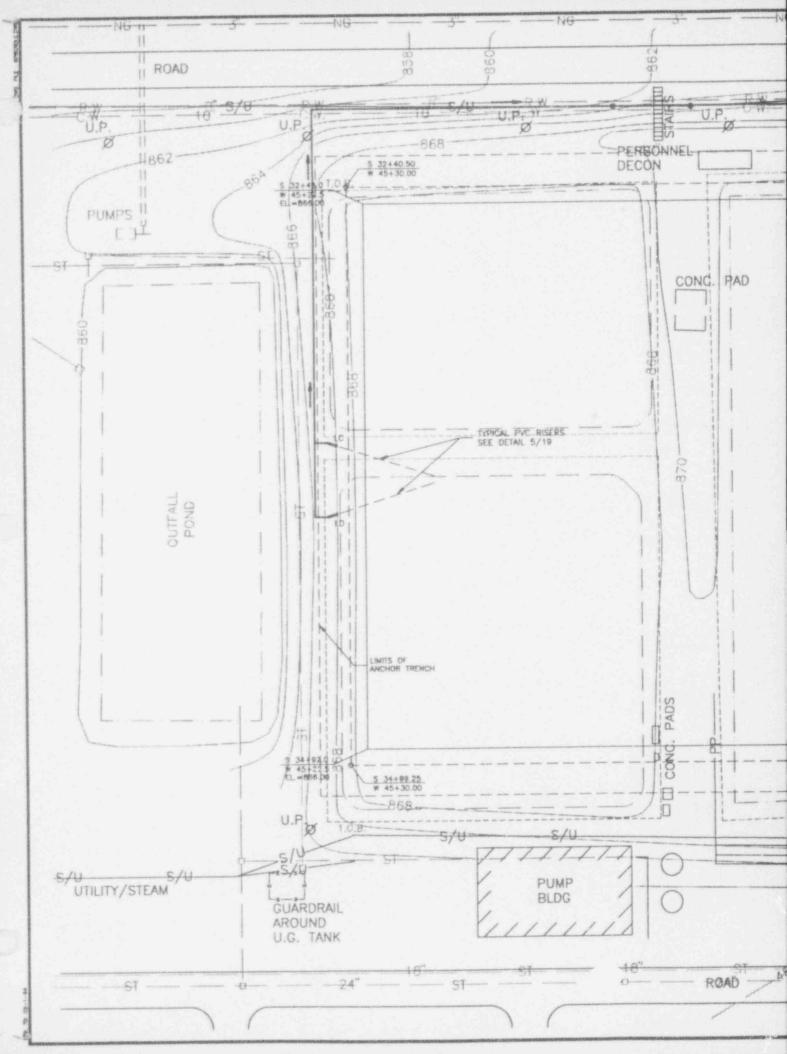


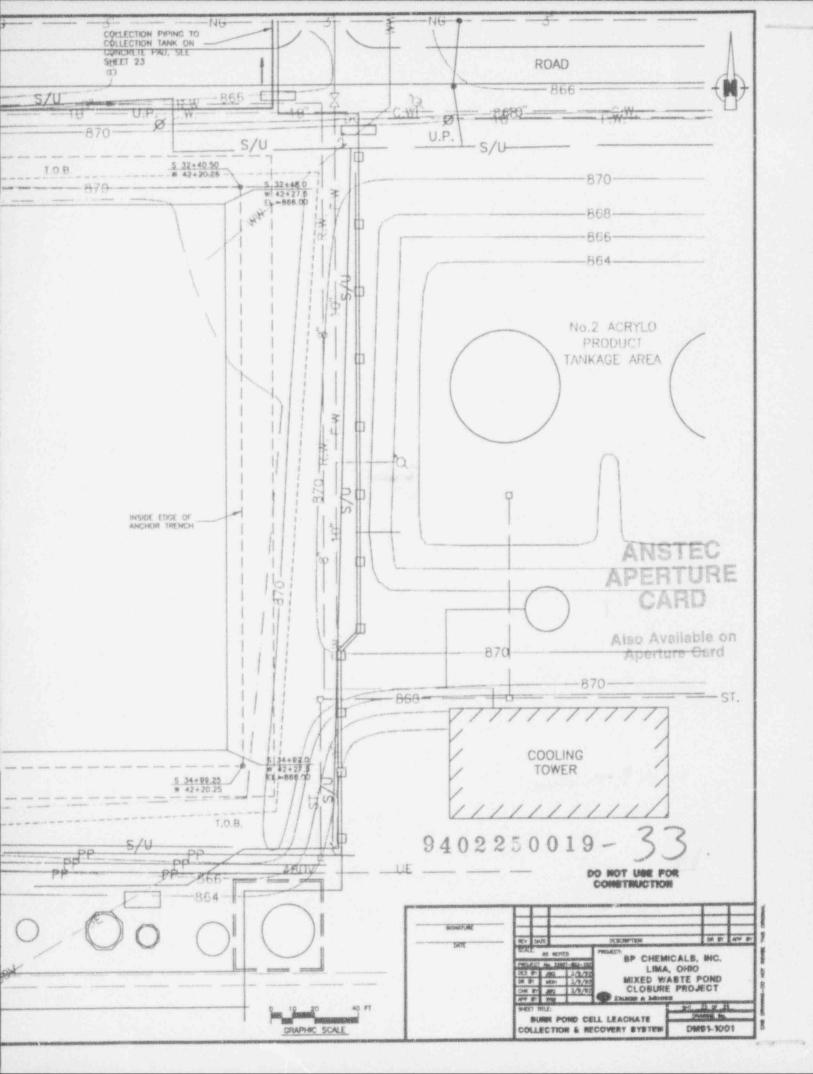




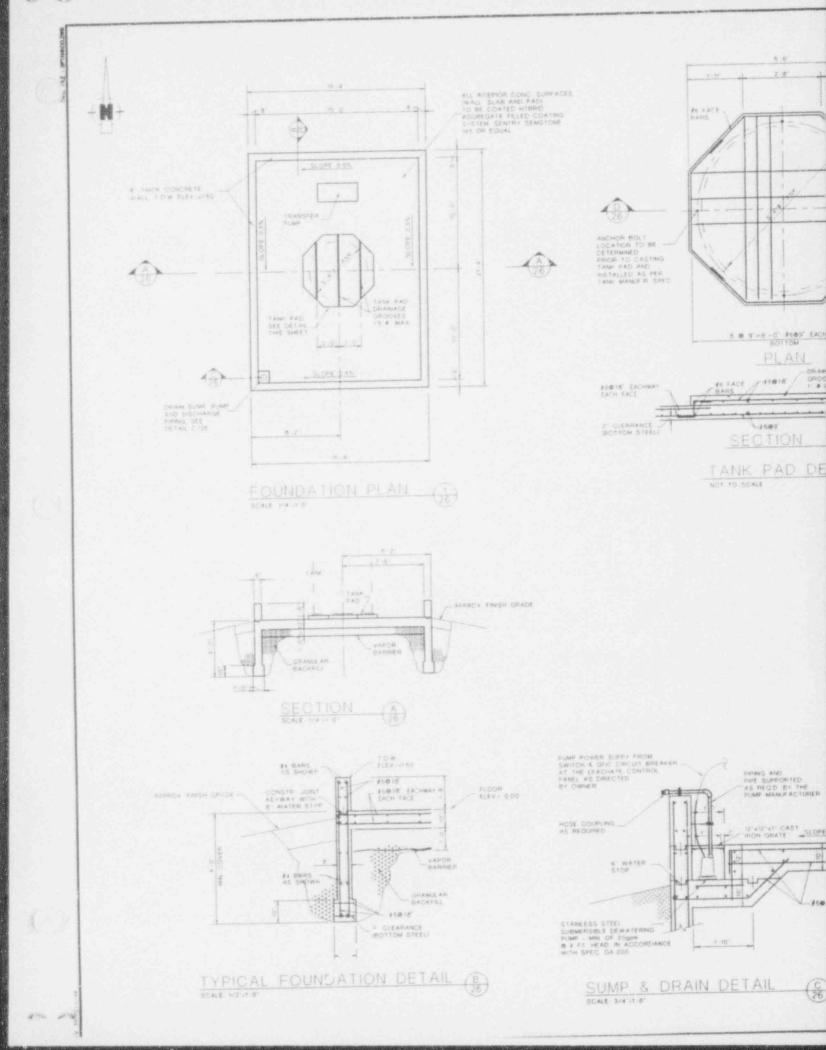


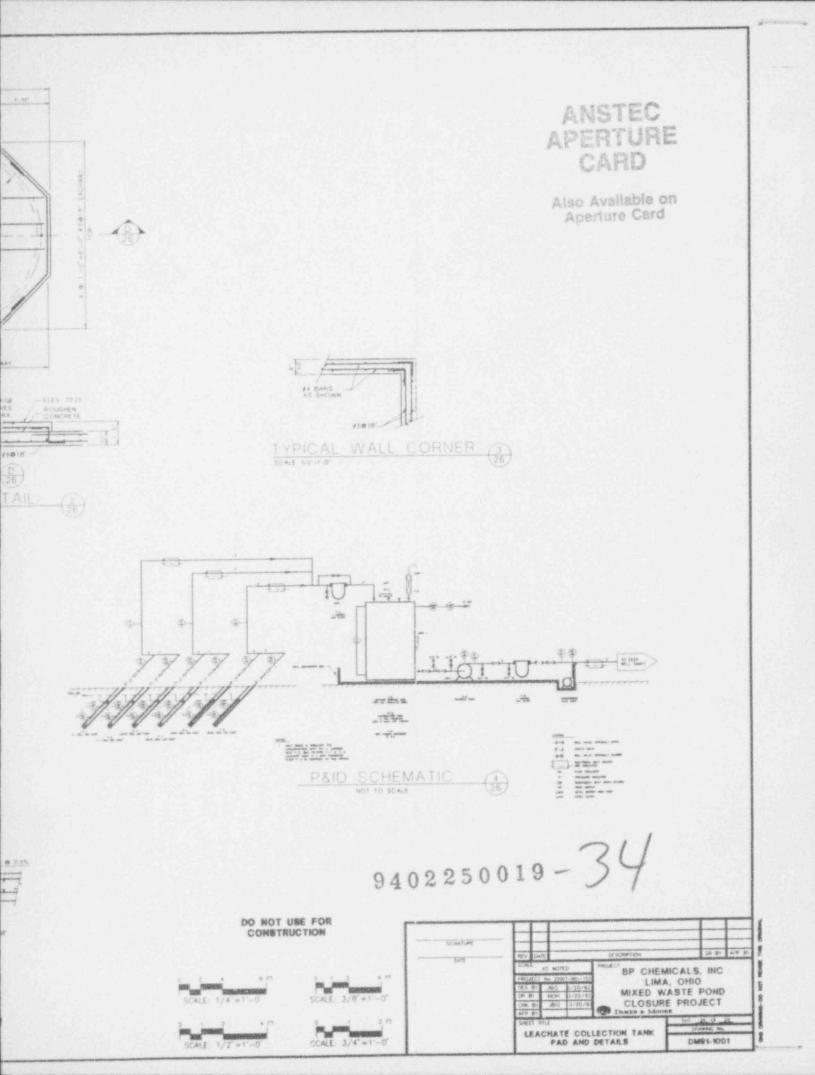






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APPENDIX A

SAFETY ANALYSIS REPORT CLOSURE ACTIVITIES

SAFETY ANALYSIS REPORT CLOSURE ACTIVITIES MIXED WASTE POND CLOSURE PROJECT BP CHEMICALS, INC. LIMA, OHIO

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SAFETY ANALYSIS REPORT CLOSURE ACTIVITIES MIXED WASTE POND CLOSURE PROJECT BP CHEMICALS, INC. LIMA, OHIO

1.0 INTRODUCTION

This document describes and evaluates the radiological safety aspects of the proposed closure activities of mixed waste sludges and contaminated soils for the Pond Closure Project at BP Chemicals, Inc.'s (BPC) Lima, Ohio facility. The Pond Closure Project consists of two major efforts: 1) sludge and contaminated soil mobilization and 2) closure.

The sludge and contaminated soil mobilization is Division 1 work and is a decontamination activity which will be performed under Sections 9 and 16 of the NRC License Sub-908 Amendment 3, dated August 1, 1988. Closure is Division 2 work which will be performed under an amendment to the subject NRC license.

Division 1 and 2 work activities constitute the comprehensive closure project which will leave the mixed waste solidified sludges and contaminated soils from four ponds within two RCRA designed closure cells constructed in three of the ponds.

The comprehensive plan is described in the Application to Amend NRC License SUB-908 to allow on-site disposal, which this SAR is appended, and in a Closure Plan submitted to the Ohio EPA. The sludge and contaminated soil mobilization (Division 1) were described in a separate SAR which was submitted for early review and approved by the NRC on December 10, 1991. This early review allowed the sludge mobilization to be performed in parallel with the license application review.

This document constitutes the Safety Analysis Report for Division 2 closure activities. For detailed information on the environmental setting, the facility background and waste material characteristics refer to the License Application Amendment text.

1.1 PROPOSED ACTION

The ponds involved in the closure project are illustrated in Plan View on Figure 1-1. Sludge treatment and transfer will consist of transferring the sludges from the Deepwell and Burn Ponds into the Sludge Processing area. Subsequently the stabilized sludge will be transferred for final disposal into the closure cells constructed in the V-1, Celite and Burn Pond areas. All of the work will be performed under enclosed and/or wet conditions to prevent the emission of fugitive dust. Safeguards will be built into the mobilization systems to minimize the impacts of accidents should they occur. The maximum radiological exposure resulting from normal operations will be 4E-03 mrem/hr, which is below the background radiation level reported for the State of Ohio. The maximum dose rate to a nuclear worker resulting from unexpected conditions is 28 mrem/hr, and to a non-nuclear worker the traximum dose rate is 3E-01 mrem/hr. Those doses are the result of an explosion in the mixer and a truck tipping over, respectively. Dose calculations and methodologies are provided in Sections 7.0.

The dose to residents in the area will be less than the doses calculated to the non-nuclear workers. This is because the distance between the nearest residence and the proposed activity is much greater (approximately 1.5 miles) than the distance from the ponds to the non-nuclear workers. An extremely conservative dose to residents was determined by equating the dose to the non-nuclear worker to the dose to residents in the area.

1.2 RELATIONSHIP TO OTHER ACTIVITIES

The closure work (Division 2) described in this document includes the transfer of contaminated material from the ponds to the sludge processing area, the processing of sludge through the solidification and stabilization system, and the transfer and placement of processed sludge into the containment cells. The disposal cells will be subsequently capped. The radiological evaluation of each activity will be discussed separately.

The following proposed construction sequence was developed:

- 1. Construct V-1 Cell.
- Process and stabilize sludge contained in Burn and Deepwell Ponds and place into V-1 Cell.
- Excavate radiologically contaminated soil from Burn and Deepwell Ponds, and stockpile it in the V-1 Cell.
- Perform risk assessment to secure OEPA approval for leaving chemically contaminated material in place.
- 5. Perform radiological release survey of Burn and Deepwell Ponds.
- 6. Construct Burn Pond Cell.
- 7. Remove stockpiled soil in Celite Pond and place into the Burn Pond Cell.
- 8. Excavate contaminated soil from Celite Pond.
- 9. Place mixed waste debris in Burn Pond Cell.
- Perform risk assessment to secure OEPA approval for leaving chemically contaminated material in place in Deepwell and Burn Pond areas (if necessary).
- 11. Perform radiological release survey of the Celite Pond.
- 12. Construct Celite Cell.



- 13. Place stockpiled soil in Celite Cell.
- 14. Restore final cap grades for cells.
- 15. Install caps on all cells.

This SAR covers the following activities:

- 1. Sludge removal
- 2. Soil removal
- 3. Sludge processing and stabilization
- 4. Transfer of processed sludge to disposal cell

2.0 SLUDGE REMOVAL

Sludges from the ponds which will be transferred at the start of the operations covered by this SAR are in the Deepwell and Burn Ponds. The sludge from these ponds will be moved to the processing plant by dredging with conventional dredging equipment or using standard excavation and hauling equipment. The material handling methods used will provide the maximum performance and protection of public health and safety, and limit exposure to waste management workers to levels which are As Low As Reasonably Achievable (ALARA) as required by the project specifications, BP's project Health and Safety Plan and the contractor's supplemental Health & Safety Plan. The selection of the method will be based on economic considerations during the bidding process and on conformance to the Closure Plan and to the applicable regulations. The procedures and equipment meeting present criteria are described below.

The sludge and bottom sediments collected from the ponds will be removed with a cutter pump (or equivalent). The pump will be equipped with a submerged auger/tiller cutterhead that feeds the sludges into the attached slurry pump. The pump in turn discharges into a flexible hose or conveyor system that empties into the destination point for the sludge. If sludge is encountered which is too dense to pump, it will be excavated and hauled by truck to the sludge processing area.

The dredging equipment will be moved back and forth in the ponds to directly transfer the contaminated sludge within a closed system. Thus, the amount of equipment becoming contaminated is minimized, and the ability to contain and control the contamination is greatly increased. The portion of the transfer hose that connects the source pond to its destination will be protected with a secondary outer sleeve or liner that will guard against leaks or accidental discharges into the surrounding areas.

The dredging operation will continue until all the sludges are removed and the underlying native soil is encountered. Figure 2-1 shows a plan view of the sludge transfer process. A schematic process flow diagram of the solidification system is illustrated on Figure 2-2.



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2.1 SITE PREPARATION

The area in which the sludge transfer and solidification operations take place will be considered a controlled access zone; the boundaries of the controlled access zone will be delineated by a temporary fence. The fence will be a 4-feet high wire fence with a 6-inch mesh size, and orange polyethylene safety netting attached to it. Prior to the start of construction, the contractor will submit for approval by BP, a Health and Safety Plan (HASP), Radiation Safety Plan (RSP) and a dosimetry program. All personnel who enter the controlled access zone will have undergone a radiation worker training program or be escorted by a trained radiation worker and will be required to use personal dosimetry in accordance with the dosimetry program in the contractor's Radiation Safety Plan. Anti-contamination clothing will be donned prior to entering the controlled access zone and be removed before departing.

All workers will perform a whole body frisk prior to leaving the controlled access zone, and all equipment will be checked for surface contamination prior to release. Workers who are to come in contact with loose contamination will wear disposable protective outer garments. These overgarments will be doffed as soon as the work is completed and before the worker leaves the immediate work area. Procedures for using, wearing and doffing protective clothing, respiratory protection, decontamination and air monitoring are contained in the HASP and RSP and will be included as part of the training required for all personnel working in restricted areas. No person who becomes contaminated will be allowed to leave the controlled access zone without the approval of the site Radiation Safety Officer.

Spill control and countermeasure equipment and materials will be available on the site to handle emergencies. This will include tarp materials to cover spilled materials and soil stored for temporary berms in order to prevent airborne transport of these materials. Fire control equipment will be provided by the contractor to supplement equipment at the plant and in the nearby community. The on-site radiation worker training will include emergency management procedures. At all times, there will be an individual on-site who is the designated emergency coordinator. Prior to the start of work, local emergency agencies, including fire companies, ambulance units and hospitals, will be notified of planned activities and provided with training necessary to deal with emergencies. This may include radiation worker training for fire fighters and procedures for medical treatment of injured contaminated workers. The training requirements for all workers will be included in the Radiation Safety Plan and dosimetry program, and will be in accordance with 10 CFR Part 19.

The potential for an off-site release from a spill is prevented by the site storm water drainage system, which will collect and contain for treatment storm water runoff from the construction area. Storm water collected in potentially contaminated areas will be treated and managed as described in Section 3.6 of the License Application text.

2.1.1 EQUIPMENT

The sludge will be removed from the ponds with a cutter pump (or equivalent). The pump will be equipped with a submerged auger/tiller cutterhead that feeds the sludges into the on-board slurry pump. The pump, in turn, discharges into a floating flexible hose or similar closed conveying system. The selection of the equipment used to dredge and move the sludge will be made by the contractor. The specifications require the contractor to submit shop drawings for approval by BP. The following discussion is based on the specifications which the equipment must meet.

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Both the transfer lines from the pond being dredged to the sludge processing area, and the recirculation lines from the sludge processing area back to the dredged pond will be double-contained lines. The inner, primary line will be a flexible hose and the outer sleeve will be a rigid pipe laid on the ground. The selection of materials is part of the means and methods of construction and is the responsibility of the contractor. The connectors to be used will be as recommended by the hose manufacturer for the project applications.

The outer sleeve, or secondary containment pipe, will be of ridged material construction, and have an inner diameter that is at least 2 inches greater than the largest outer diameter of the flexible hose connection(s) that it contains. The sections of rigid pipe will be coupled so they can accommodate angular deflection. The flexible hose and connections for both the hose and the pipe will be made of materials compatible with the slurry.

The flexible hose and the containment pipe will be pressure tested prior to the start of the dredging operations and each time the transfer line is moved. The flexible hose will be tested at a pressure that is 200 percent of the maximum pump output head, and the containment piping will be tested at 5 psig.

The pumping system will be equipped with a fail-safe pressure-sensitive automatic shutdown. The pump will operate only when the pressure switch indicates pressure in the line. In the event of a rupture in the primary transfer line (the hose), the pump will be automatically shut down and any material which leaked from the hose will be contained within the secondary containment (the pipe). Evidence of small leaks in the inner hose will be apparent from discharges into the ponds from the ends of the secondary containment piping. During the transfer of material, the radiation protection technician will examine the outer pipe for indications of leakage at the fittings. Samples of any leakage found will be collected and analyzed for radioactivity. Leakage will be contained and repairs will be made as soon as practicable. The leak area will be posted and controlled as "contaminated" until proven otherwise. Additionally, the radiation technician will evaluate direct radiation along the pipeline by directly monitoring the outside pipe wall with a micro R meter. Higher ranged survey meters will be available to the technician if the micro R meter is over ranged. The design of the failure-safe pressure-sensitive shutdown system is the responsibility of the contractor and must be submitted 10 days prior to the start of sludge mobilization activities. The system must be approved by BP and has the following operational requirements:

- 1. The pump will not operate if there is a pressure drop in the transfer line;
- 2. There is insufficient water over the cutter head; and/or
- 3. The liquid level in the receiving pond exceeds preset levels which at a minimum will correlate to a volume that exceeds eighty percent of the capacity of the receiving pond, or the pond freeboard is less than 2.5 feet.

To prevent accidental severing of the transfer line, it will be anchored to firm supports and at road crossings and near areas where equipment is being operated, and traffic barriers will be erected adjacent to it, or ramps will be constructed over it. The transfer line will be supported on the ground and anchored at intervals of no less than 50 feet. The anchors will be designed by the contractor for

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dead loads plus seismic loads, and will be approved by BP. Rigid concrete barriers, or temporary ramps designed for H20-S16 loading are required at all road crossings or locations where equipment will be operating, and will also be of a design which is approved by BP.

The cutter pump head and the transfer line discharge will both be maintained at least four feet below the water surface in the ponds. This will be assured by a level detector in the pond which will preclude pump operation if the pond surface drops below the preset limit. Because the cutter head is submerged, the system can be operated with no airborne excavation or discharges. The level detector in the pumped pond will not allow the pump to operate if the water level drops below preset levels. The cutter pump will be moved across the pond surface by a cable and winch system operated from the bank. The discharge pipe will be moved to different locations in the receiving pond with a crane located on the pond bank. An accidental overflow in the receiving pond will be prevented by the level detector which will prevent pump operation if the level in the Deepwell Pond rises above the allowable level 2 feet freeboard requirement.

Because the cutter pump transfers a mixture of water (approximately 90% to 95%) and solids (approximately 5% to 10%), a considerable volume of water will be required. To minimize waste generation, water will be recirculated from the Deepwell Pond back to the Celite and V-1 Ponds to maintain the nominal depth necessary for operation of the dredging equipment. The recirculating water line will also be equipped with a fail-safe pressure-switch that will shut off the pump if there is a drop in pressure. The pump will also be precluded from operating if the level detector in the Deepwell Pond senses a level below the operating limits (at least 2 feet of cover over the discharge pipe) or the level detector in the dredged pond (V-1 or Celite) indicates a level above the required freeboard elevation (2 feet below the crest of the dike).

All of the pumping will be performed under human control with the automatic fail-safe devices acting as backup. The cutter pump operator will always be at the control panel and the automatic shutdown system will be tested daily. During the course of the work, the discharge lines will be under constant visual observation; either by the pump operator discharge line handler, or an observer who is in verbal or radio contact with the pump operator.

It is estimated that a total of 5 key personnel will be required for the transfer operation. They will be assisted intermittently by an additional group of ten laborers during setup, moving and teardown. As is discussed in the next section, the dose to these workers is expected to be insignificant when compared to background levels. However, if measurable levels of radiation above background at the face of a work area are encountered, the distance from the ponds and the shielding provided by water in the ponds will minimize exposure. Equipment and instrumentation used to monitor exposure levels as well as specified action levels will be specified in the contractor's Radiation Safety Plan. The monitoring equipment will consist of beta/gamma survey meters, one of which will be a micro R meter. The ranges for the basic survey meter will enable measurement up to at least 5 R/hr and the highest scale for the micro R meter is 5000 μ R/hr (5 mR/hr). The lower detection limit for the micro R meter is essentially background. The work area background is estimated to be about 15 μ R/hr (0.015 mR/hr). This will be quantified after radiation technicians are mobilized to the site. The quality factor for beta and gamma radiation is 1, therefore, for the purpose of discussion, 1 mR/hr = 1 mrem/hr. However, a beta correction factor that may approach 10 and size of source to detector geometry will be considered to set true dose rates (mrem/hr) and action levels.



The dredging operation will continue until all the sludges are removed and the underlying clay soil is exposed. The interface between soil and sludge will be detectable by the increased resistance to dredging and the color of the dredge pipe discharge.

If additional water is needed to maintain cover limits, it can be obtained from the plant process water supply. If excess water from storms or other causes results in pond levels rising close to freeboard limits, the excess water will be treated and managed as described in Section 3.6 of the License Application.

In the event that the sludge consistency is such that mobilization with the dredge is not feasible, the sludge will be excavated and moved with trucks. The removal will be done using either a walking backhoe(s), a crane with a dragline, a Gradall[®], an excavator with an extended boom, or a combination of this equipment. For the removal effort in each pond a crew of six, an equipment operator, two truck drivers, two laborers and a foreman would perform the work. The freshly exposed sludges will be in a very moist or saturated state. Water will be sprayed on the surface as necessary to prevent drying, as drying could lead to a fugitive dust situation. The sludge will be transported with dump trucks (estimated volume of 6 cubic yards). The truckbeds will be lined with a membrane to facilitate decontamination. The trucks will also be covered during transport. All workers in this phase of the project will wear appropriate anti-contamination clothing, including respiratory protection.

2.2 POTENTIAL EXPOSURE FROM NORMAL OPERATING CONDITIONS

Under normal operating conditions, the sludge will be contained in a closed system at all times. The water in the ponds and the pond walls will form a natural container for the sludge as the cutter pump feeds the sludge from the pond bottom to the slurry pump. From the slurry pump, the sludge will be transferred through, and completely contained within, the double-walled transfer line. Because no release of sludge is anticipated, no inhalation or ingestion doses are estimated for normal system operation.

The maximum average activity level of the sludges is estimated to be 300 pCi/g. However, to model a more conservative condition, 500 pCi/g has been used for this analysis. Exposure to workers has been calculated assuming that a three-inch diameter transfer line constructed of flexible hose, within a five-inch diameter rigid pipe, with a wall thickness of 0.125 inches, will be used. This will support a flow rate of about 80 gpm which, with a 10% solids slurry, will remove all pond sludges within 8-10 weeks, consistent with project schedules. Sludge will make up 10% of the material transferred so the activity of the slurry was assumed to be 50 pCi/g.

The water carrier and the double containment pipe would essentially shield all the low energy (< 100 keV) gamma rays associated with depleted uranium. Therefore, the calculated dose rate at 1 meter from the surface of the pipe is 2.3E-06 mrem/hr, and the dose rate to a nuclear worker standing on the pond bank is calculated to be 2.0E-03 mrem/hr which is a fraction of natural background radiation in the area. Details of the calculations are given in Chapter 7.



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2.3 POTENTIAL EXPOSURE RESULTING FROM UNEXPECTED CONDITIONS

It is possible, although highly unlikely, that sludge could be released due to a break in the hose and containment pipe. Rupture of the double-walled containment pipe would cause maximum estimated exposure. The quantity of material released would be limited by the quick manual or automatic shutdown of the system. To estimate the impact of such an accident, it is assumed that a malfunction of the automatic shutoff would allow for three minutes of flow, plus the draining of the pipe contents onto the ground. This assumption was based on the estimated time it might take the observer to issue a signal and the pump operator to react in the event that there was a line breakage and the automatic shutdown failed. Based on the anticipated flow rate of 210 gpm, 10% solids and an activity of 500 pCi/g (conservative value), this accident would result in the release of 81.4 ft³ of sludge or approximately 610 gallons.

Because uranium oxide is almost insoluble, virtually all of the radioactive contamination is in the solid phase. However, to eliminate the potential for an off-site release of contamination, all liquid from the spill will be contained. It is expected that some of the liquid material would be absorbed into the ground, and some of the liquid with suspended solids would flow into the project storm-drainage system and be contained in the Burn Pond. Contamination absorbed onto the ground would be removed as part of the spill clean-up. Work to clean up the pond and the ground surface would be performed by trained radiation workers in appropriate anti-contamination clothing and respirators to minimize the potential for internal ender; so there are no anticipated internal exposures. The specific anti-contamination clothing is espiratory protection for spill response would be addressed in the Contractor's Radiation Safe (RSP) which will be submitted for approval by BPC.

The calculated external dose rate \pm 3.95E-05 mrem/hr. As was addressed in the previous section, this external exposure is insignificant when compared to background level of 5E-03 mrem/hr. Airborne transport of this material is not expected to result in significant internal or external dose to persons outside of the controlled access zone. Assuming a 10 mph wind blowing to the west, the inhalation dose received by the maximally exposed individual, a chemical plant worker standing at the controlled access zone boundary for 2 hours, would be .5E-02 mrem. This estimate is based on an evaporation rate of 32.35 g/s, between the slurry and the air, and a χ/Q of 10⁴ s/m³, both estimates being conservative. (The dose conversion factors utilized in the calculations were taken from NUREG/CR-4370 and ICRP-30.) The flux to the atmosphere is based on the assumption that the spill would spread very quickly and cover a circular area of 67.3 feet in diameter.

3.0 SOIL REMOVAL

After the sludge is removed and the ponds are dewatered, the exposed contaminated soil from the pond bottom will be scraped off, compacted, and placed on top of the solidified sludge in the disposal cells. The depth of the excavation will be determined by the conditions encountered and the confirmation sampling. The protocols are described in the USNRC approved Sampling and Analysis Plan dated July 26, 1993 (Dames & Moore, 1993c). The contaminated soil will be removed using either a walking backhoe(s), a crane with a dragline, a Gradall, an excavator with an extended boom, or a combination of this equipment. The freshly exposed soils are expected to be in a very moist or saturated state. Water will be sprayed on the surface as necessary to prevent drying, as drying can lead to a fugitive dust situation. The soil will be transferred to its final destination using dump trucks (estimated volume 6 cy = 162 ft^3). The truckbeds will be lined with a membrane to facilitate decontamination. The truck will also be covered during transport.

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A crew of six, an equipment operator, two truck drivers, two laborers and a foreman will perform the work to remove the soil from each pond. All workers in this phase of the project will wear appropriate anti-contamination clothing, including respiratory protection, while performing this work. A similar sized crew, using the same precautions and protective clothing, would perform the confirmation sampling.

Soil which is removed from beneath the ponds and verified "clean" by confirmation testing will be stockpiled in an area away from any contaminated materials, and may be used in the construction of the liner or cap systems.

3.1 POTENTIAL EXPOSURE FROM NORMAL OPERATING CONDITIONS

No internal doses have been considered during the excavation, transfer, and disposal of the contaminated soil. This is due to the fact that all workers will be wearing personal protective equipment and respirators. Additionally, the specifications require the contractor to keep the soil saturated during these activities to aid in the prevention of airborne releases. The absence of airborne contamination will be verified by monitoring with low and high volume samplers in accordance with the contractor's RSP. The sampling and analysis methodology will have a detection limit of no greater than 25% of the allowable release to air of U-238 or $2.5 \times 10^{-11} \,\mu\text{Ci/ml}$.

To provide conservative results, the highest activity level in the soil has been estimated to be 300 pCi/g (average activities are in the range of 9.1 pCi/g). The external exposure resulting from contaminated soil has been analyzed for three cases: 1) when an individual is near a large mass of the material, as in a loaded truck; 2) while an individual works on the excavated surface; and 3) while an individual is placing the compacted soil over the solidified sludge. Assuming a 6 cubic yard truck bed is full of this material, and the truck has a 0.125-inch thick steel side wall, the estimated dose rate at the side of the truck is 2.6E-03 mrem/hr to the maximally exposed individual, the truck driver. This dose is insignificant when compared to background for the maximally exposed individual even if the shielding provided by the truck body is neglected.

Similarly, the external dose rate from an infinite surface of soil with a depleted uranium activity of 300 pCi/g, such as might be encountered by workers standing on the excavated surface, is 3.9E-03 mrem/hr. Thus, the dose to workers would be a fraction of natural background radiation.

3.2 POTENTIAL EXPOSURE UNDER UNEXPECTED CONDITIONS

Three accidents involving the release of radioactivity due to transport and disposal of the soil have been considered. These three accidents are 1) a truck dumping a full load of contaminated soil; 2) a truck fuel tank fire resulting in contaminated soil becoming airborne; and 3) a worker falling onto the compacted soil. These three scenarios and their associated doses are presented below. Details of the calculations are given in Chapter Section 7.0

All trucks and excavation equipment will be operated with a great emphasis on safety. In the worst case, a full truck could accidentally overturn, causing a spill or the outbreak of a fire. This type of truck accident would be similar to a severance of the slurry pipeline as described in Section 5.2, with one exception: the volume of contaminated material would be greater. It is assumed that 6 cubic vard trucks would be used. Thus the analysis is based on a truck carrying 162 ft³ of contaminated

soil with an average activity of 300 pCi/g that is spread over a 300 ft² area. Since the workers inside the controlled access zone are wearing protective clothing and a respirator, the maximally exposed individual is assumed to be a non-nuclear plant worker at the boundary of the controlled access zone not wearing protective clothing or a respirator.

The estimated dose rate for the truck tipping accident is 5.76 mrem/hr. The spilled soil would be covered with tarpaulins or foam within a half an hour of the occurrence, so the maximum dose received by the individual at the controlled access zone would be less than 3 mrem. Response to the truck spill is expected to be faster than response to a pipe rupture since a smaller area is involved.

The worker dose from the cleanup activities would be similar to the dose received by workers during the soil excavation since the DCF is based on soil concentration which is assumed to be the same for all soil. This would be 4×10^{-5} mrem/hr to the maximally exposed individual.

In the event of a truck fire, it is assumed that the diesel fuel in the tanks on the truck would spread on the soil, catch fire and burn. The heat from the fire would dry some of the soil, and convection currents could cause soil particles to rise and be carried downwind. The closest deposition point is assumed to occur at the edge of the controlled access zone since workers inside the controlled access zone would have respiratory protection available. The exposure rate from inhalation at this point would be less than 14 mrem/hr. Because the contractor and BP would both have control equipment in the immediate vicinity of the accident, it was assumed that the fire could be extinguished within one half hour, so the dose received by the maximally exposed individual at the edge of the controlled access zone would be less than 7 mrem. Details of the calculations are given in Section 7.0.

For the case of a worker accidentally falling on the contaminated soil, it is assumed that the worker is exposed only to direct radiation resulting from being in close contact with the soil. For calculation purposes it is assumed that the soil will be compacted to a density of 110 lb/ft³ (1.76 g/cm³). This value is approximately ten percent greater than the original soil density, therefore the concentration of the compacted soil is 330 pCi/g. There will be no inhalation doses because, for this accident, the workers will be wearing respirators and protective clothing. A total exposure time of one minute is assumed, and the resulting dose to the individual is less than 7.25 x 10⁻⁵ mrem.

4.0 SLUDGE PROCESSING/STABILIZATION

The sludge will be pumped or conveyed from the Burn and Deepwell Ponds to the sludge processing area. If sludge is encountered which is too dense to pump, it will be excavated and hauled by truck to the sludge processing area. In the processing area, the sludge will be combined with predetermined amounts of the binder reagents and water in a mixer. The binder reagent application rate for each sludge source is given in Table 4-1. From the mixer, the processed sludge will then be transferred to a containment cell.

The specific processing equipment used, (i.e., pug mill mixer, silos, and conveyers), will be decided upon by the Contractor. The equipment will meet the performance criteria as described in the Closure Plan (Dames & Moore, 1991b), as well as the appropriate referenced regulations and guidelines.

4.1 STABILIZATION EQUIPMENT AND METHODS

The stabilization system is schematically depicted on Figure 2-2. Sludge will be delivered to the processing area either as a slurry in a pipeline or as a solid in truck. In the processing area, the sludge will be transferred into an equalization tank, where samples can be taken and, using the on-site laboratory, the moisture content and density of the sludge samples can be measured. If necessary, water can be added to the material, water can be removed from the sludge with a centrifuge or the amount of each agent used can be adjusted to ensure optimum results. Presently, the plan is to use a portable closed pug mill mixer to mix batches of the sludge with the stabilization reagents.

From the pug mill mixer, the treated sludge will be placed into the containment cell by pumping, or if the material cannot be pumped, by truck. It will be placed and compacted in the cell in formed lifts. The location of each batch will be documented. If required, forms will be used to contain the material until it has time to set. The size of the area will depend on the processing equipment used and the associated production rates. The lifts will generally not exceed one foot in height. This phase of the process is described further in Section 5.0.

The front end of the stabilization system will consist of:

- a slurry or cutter type pump (in the ponds) or a backhoe and trucks;
- flexible transfer hose (3" diameter);
- an equalization tank (approximately 270 ft3); and
- a flow through dewatering system.

The mixing and replacement system will consist of:

- a pug mill mixer equipped with a hood and ventilation system;
- an offgas scrubber system to remove ammonia and particulates from the pug mill mixer hood exhaust (if required);
- a concrete pump and/or dump trucks; and
- a concrete pump transfer line (flexible) and boom for remote placement of processed sludge (if required).

The sludge will be delivered from the Burn and Deepwell Ponds into the equalization tank. The sludges will be run through the centrifuge if thickening is necessary. The water generated will be pumped back to the ponds. From the equalization tank the sludge will be transferred to the pug mill mixer. Once in the pug mill, the sludge will be mixed with solidification reagents and water.

The treated sludge will be transferred from the mixers to the containment cells using a concrete pumping system or, if it cannot be pumped, by truck. It will be placed into the cells using a boom or front end loaders. Workers will be required to enter the cells for form placement and removal.

The potential capacity of the solidification system is limited by the decanting of solids from the slurry. Design throughput is planned for 48.3 CY per hour. Assuming that a mixing time of 10 minutes is used, the volume of material in the mixer at a given time will be less than 10 cubic yards.

4.2 POTENTIAL EXPOSURE FROM NORMAL OPERATING CONDITIONS

As with the soil removal operations described in Section 3.0, all processes will be conducted under wet and/or enclosed conditions. The sludge will be transferred using a double-walled system, which is a hose within a pipe. This system will be equipped with an automatic shutdown mechanism that is designed to actuate when there is a pressure drop (e.g., loss or no pressure in the line). It is anticipated that the only type of exposure to workers during normal conditions will be due to their closeness to the piping, tank and pug mill mixer.

The following assumptions were used in the calculations:

- The pumping rates are 27 ft³/min (approximately 210 gpm). This is 25 percent greater than the design throughput to account for surges. It is also assumed that two workers are needed to maintain the pumps and the lines for 50% of the working shift (4 hours each).
- The mixers will be closed systems equipped with negative off-gas treatment system (scrubber), mainly to collect and treat the ammonia generated (if required). This will also trap and prevent the airborne migration of particulates.
- The crew size for the sludge processing is assumed to be 2 workers per each system.
- Workers will be required to enter the cells for form placement and removal (approximately 50% of the working shift, or 4 hours each). The placement of the material will be in 12-inch lifts. There will be 3 operators per boom or loader.

For conservatism, no credit was taken for the shielding provided by the pipe and tank thickness, i.e., it is assumed that the workers are in close contact to the bare "mixed sludge" for half the shift (4 hours). Under these assumptions the resultant dose is 2.1E-03 mrem/hr.

4.3 POTENTIAL EXPOSURE UNDER UNEXPECTED CONDITIONS

It has been postulated that during the sludge processing operations the likelihood exists that some accidents could occur. Three possible accident scenarios have been analyzed:

- A sludge transfer line having a maximum flow rate of 27 ft³/min breaks and discharges some sludge onto the ground.
- A break or opening in the pug mill mixer resulting in the discharge of some sludge (if dried) into the surrounding atmosphere. A maximum flow rate of 5400 ft³/min, a discharge of 0.5 ft³ of material into the air (assuming that 100 ft³ of sludge leaks onto the ground before operations are stopped and a release fraction of 0.5%), and an exposure duration of 15 minutes in the contaminated plume are assumed for this calculation.

An explosion involving the pug mill mixer occurs causing the reagent mixture and sludge to be discharged into the atmosphere. In this case, it is assumed that 135 ft³ of sludge material are discharged into the ground and 5 ft³ are discharged into the air. A release fraction of 1% is assumed due to the relatively large amount of energy associated with an explosion.

The method of estimating the exposure from an accidental discharge of the sludge material through a break in the transfer line is described in Section 7.0.

The sludge could be released due to a break or opening in the pug mill mixer. The quantity of material released would be limited by the manual or automatic shutdown of the system. To estimate the impact of this type of accident, it is assumed that 30 seconds of flow out of the pug mill mixer would occur before shutdown of the system. Along with this unchecked flow, all the contents of the mixer would spill onto the ground. Based on the anticipated flow rate of 200 ft³/min, 100 ft³ of sludge material with a 40% moisture content would be released in this scenario. Although it is highly unlikely, due to the high moisture content of the sludge material, 0.5 ft³ of material is assumed to be released to the atmosphere over a 15-minute period. The atmospheric dispersion factors, χ/Q , are conservatively assumed to be 10^2 s/m³ at the site of the break and 10^4 s/m³ at the boundary of the controlled access zone. Airborne transport of this material does not result in significant external or internal exposures to persons standing by the leak or outside of the controlled access zone. The inhalation and immersion dose received by the maximally exposed individual, a chemical plant worker standing at the controlled access zone boundary, would be 9.69 x 10^2 mrem/hr. It is assumed that the spill area would be covered with tarpaulins, soil or foam within two hours, so the maximum dose received by this individual would be 0.2 mrem.

Another possible release of sludge could occur from an explosion in the plug mill mixer. Although this is unlikely, the plug mill mixer is assumed to spill 135 ft³ of sludge material onto the ground, and to release 5 ft³ of sludge material into the atmosphere from the force of the explosion. Similar to the scenario in which there is an opening or break in the pug mill mixer, the sludge material has a moisture content of 40% and the atmospheric dispersion values are 10^{-2} s/m³ at the site of the explosion and 10^{-4} s/m³ at the boundary of the controlled access zone. From the explosion, 1% of this airborne contaminated sludge is assumed to remain suspended in the air. This cloud is assumed to have a volume of 125,000 ft³ and to quickly disperse. The inhalation and immersion dose received by the maximally exposed individual, the radiological worker in the area of the pug mill mixer within 10 seconds. (This is based on an average walking speed of 3 mph and a maximum distance of 40 feet to exit the cloud.) The maximum dose received by this individual would be 7.7 x 10^{-2} mrem.

5.0 TRANSFER OF PROCESSED SLUDGE TO DISPOSAL CELL

The activities performed during this phase involve the transfer of the "treated" sludge from the sludge processing plant to the disposal cells (the final disposal site). At this point, the material will be placed in the disposal cell using flexible hoses connected to a pump (similar to the type used to pour concrete) or using front end loading equipment. Workers will be required to enter the disposal cells for form placement and removal during part of their shift. The material will be placed using 12-inch lifts.



Potential external exposures during normal conditions will be incurred by workers controlling the pipe line and placing and removing the forms. No inhalation exposures are anticipated since the workers will be wearing respirators. The resultant dose rate to the maximally exposed individual is 2.02 x 10^{-3} mrem/hr. Assuming that the workers spend half of their shift (4 hours) manning the lines and half placing and removing forms, the resultant dose is 8.1 x 10^{-3} mrem.

5.2 POTENTIAL EXPOSURE RESULTING FROM UNEXPECTED CONDITIONS

Potential exposures to workers during this phase could occur if there is an accidental break of a transfer line resulting in the processed material being discharged onto the ground. For calculation purposes, it has been assumed that the sludge has been diluted using volume increase information provided in Table 4-1. The Burn Pond has the highest activity, and therefore, to be conservative, the concentrations of the Burn Pond are used. The assumptions used in the calculation are that 81.4 cubic feet of stabilized sludge are discharged onto the ground. The material is almost all solid (the moisture content is 40% or less), and thus the release fraction (the amount that could become airborne) is a small fraction of the material discharged. External exposure results in a dose rate of 6.6×10^{-7} mrem/hr to the maximally exposed individual.

6.0 CONCLUSIONS

The maximum dose rate (28 mrem/hr) occurs as a result of the pug mill mixer explosion. Assuming the workers leave the area in 10 seconds, the total dose (inhalation plus immersion) is 7.7×10^2 mrem. Given the severity of the accident, it is our opinion that the sludge transfer and placement operations can be safely carried out without risk of exposure to workers or the general public.

7.0 CALCULATIONS

This section presents the details of the calculations described in Chapters 3 to 6.

7.1 DOSE CALCULATIONS FOR SLUDGE UNDER NORMAL OPERATIONS

7.1.1 SLUDGE REMOVAL

Normal operations during sludge removal and transfer activities include:

- Removal of sludge in pond;
- Sludge in transit to processing; and
- · Placement of processed sludge into disposal cell.

For this type of operations only external exposure was considered since no inhalation of contaminants is expected to take place because all operations will be performed under "wet" conditions.

For the sludge removal and transfer operations a sludge concentration of 500 pCi/g (conservative value corresponding to the Burn Pond) was used with a density of 0.54 g/cm3 (which is an estimate that corresponds to the slurried sludge).

The dose due to external exposure is calculated as follows:

$$R_i = C_i \cdot I_i \cdot PDCF_i \tag{7-1.1}$$

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where:

- R, = radiation dose equivalent or committed radiation dose equivalent from radionuclide "i" (mrem/yr)
- C_i = concentration of radionuclide "i" in the media of exposure (Ci/m³)
- I = interaction factor
- PDCF. = radionuclide specific pathway dose conversion factor (mrem/yr per Ci/m³)

Using a maximum average sludge concentration of 500 pCi/g, which corresponds to the Burn Pond, and a sludge density of 0.54 g/cm³ we obtain;

Concentration
$$\left(\frac{Ci}{m^3}\right) = (500\frac{pCi}{g}) \left(0.54\frac{g}{cm^3}\right) \left(\frac{1Ci}{10^{12}pCi}\right) \left(\frac{10^6 cm^3}{1m^3}\right) = 2.7 \times 10^{-4} \frac{Ci}{m^3}$$

The PDCF, for direct gamma exposure is PDCF-5, and for total body, for U-238 plus daughters is 6.55 x 10⁴ mrem/yr per Ci/m³. This value was taken from NUREG/CR-4370. The interaction factor, I, was assumed to be equal to 1.

Substituting the above values into equation 8-1.1 we obtain:

$$R = (2.7x10^{-4} \frac{Ci}{m^3}) (6.55x10^4 \frac{mrem}{yr} \frac{m^3}{Ci}) = 17.7 \frac{mrem}{yr}$$
$$R = (17.7 \frac{mrem}{yr}) (\frac{1year}{8760hr}) = 2.02x10^{-3} \frac{mrem}{hr}$$

A unique feature of MICROSHIELD is that it displays the user-selected geometry on the terminal screen while prompting for dimensions relevant to the geometry. The user then specifies source dimensions, shield dimensions and locations, and detector location; selects materials and densities for

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the source and shields; and specifies the radionuclide composition. The program offers a choice of Taylor, geometric progression (GP) and Berger buildup functions. The GP buildup function was used in this calculation.

MICROSHIELD calculates the total exposure rate (in mrein/hr) and the individual contribution from each energy group. For gamma photons with energies above 50 keV, a Roentgen (R) is equivalent to a rem for all practical purposes. The total gamma dose can then be calculated by multiplying the exposure rate by the exposure duration.

The source was modeled assuming a large cylinder from the end with a radius of 5 meters and a depth of 15 cm (this accounts for the plow layer). The source concentration used was 500 pCi/g (the highest average concentration in the study, which corresponds to the Burn Pond) and corresponds to 2.70E-04 μ Ci/cm³. This value was obtained by multiplying the maximum average concentration in pCi/g by the density in g/cm³.

Concentration
$$\left(\frac{\mu Ci}{cm^3}\right) = (500 \frac{pCi}{g}) (0.54 \frac{g}{cm^3}) \left(\frac{1\mu Ci}{10^6 pCi}\right) = 2.7 \times 10^{-4} \frac{\mu Ci}{cm^3}$$

This analysis assumes that the source has been allowed to decay for 5 years to account for the daughter products. The activities of the daughter products were determined by MICROSHIELD. In addition to U-238, the other main contributors to the dose rate are Pa-234m and Th-234. The resultant activities are given in Table 7-1. Calculation of buildup was performed using the GP method. The resultant dose rate is found to be 1.78E-03 mrem/hr.

Using the maximum of the two methods, the resultant dose rate to a worker standing next to the pond using the NUREG/CR-4370 approach is 2.02E-03 mrem/hr, which is a fraction of the natural background in the area.

7.1.2 SLUDGE IN TRANSIT TO PROCESSING

Direct whole body gamma doses from the transferring of sludge through the pipes was also calculated using the MICROSHIELD computer code. The sludge contained inside the pipe was modeled using a cylindrical source from the side. The cylinder was assumed to be 610 cm long and have a radius of 1.5 inches (3.81 cm). The worker was assumed to be standing 1 meter from the source. Note that no credit was taken from the shielding provided by the double pipe.

The concentration inside the pipe is 50 pCi/g which corresponds to 2.7E-05 μ Ci/cm³. This value was calculated assuming the slurry is 90% water. The source was also allowed to decay for 5 years to account for the daughter products. The isotopic breakdown is given in Table 8.1.

The stabilization mix for the Burn Pond sludge consists of 60 parts pozzolime*, 40 parts flyash, and 100 parts sludge by weight. The resultant dose rate to the worker due to the sludge in transit to processing is:

Dose Rate = 2.29×10^6 mrem/hr



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7.1.2 PLACEMENT OF SLUDGE AFTER PROCESSING

Exposure to the worker due to the sludge after processing was calculated using MICROSHIELD assuming a cylinder from the end geometry. Therefore, the concentration is (500)/2 = 250 pCi/g. This corresponds to $1.35\text{E}-04 \mu\text{Ci/cm}^3$. The same geometry and dimensions as for the sludge in pond calculations were used.

The resultant dose rate to a worker standing at 1 meter from the source is:

Dose Rate = 8.4×10^4 mrem/hr

7.2 DOSE CALCULATION FOR SOIL REMOVAL UNDER NORMAL OPERATIONS

Dose due to soil removal operations include dose to the truck driver transporting the soil and dose to the worker excavating the soil.

7.2.1 DOSE TO TRUCK DRIVER

For analysis purposes the highest concentration of soil C = 300 pCi/g was used. The estimated volume of soil in the truck was $V = 162 \text{ ft}^3 = 4.6 \text{ m}^3$. The mass of soil in the truck bed was determined as follows:

where:

$$\mathbf{m} = \mathbf{V} \cdot \boldsymbol{\rho} \tag{7-2.1}$$

m = mass of soil $\rho = bulk density of soil = 1.76 g/cm^3$

Substituting into equation (8-2.1):

 $m = 4.6 \text{ m}^3 \cdot 1.76 \text{ g/cm}^3 \cdot 1 \times 10^6 \text{ cm}^3/\text{m}^3 = 8.1 \times 10^6 \text{ g}$

The activity, A, of the soil material is:

 $A = m \cdot C$ $A = (8.1 \text{ x } 10^{6} \text{ g}) \cdot (300 \text{ pCi/g}) = 2.43 \text{ x } 10^{9} \text{ pCi}$ $A = 2.43 \text{ x } 10^{3} \text{ Ci}$

The isotopes contributing to the dose are U^{238} and its progenies. The dose to the driver is calculated assuming that the truck bed is 8 feet in length, 5 feet in width, and the soil is stacked 4.1 feet high. The driver is 1 foot away from the soil material.

The MICROSHIELD Computer Code was used to calculate the dose rate. The resultant dose rate is 2.6×10^3 mrem/hr.

(7-2.2)

7.2.2 DOSE TO WORKER

The dose rate to the worker is calculated using the concentration in the soil times the dose conversion factor (DCF). The concentration of the soil material, C = 300 pCi/g was used. The PDCF for U²³⁸ (NUREG/CR-4370) for soil volume is 6.55 x 10⁴ mrem/yr per Ci/m³.

Calculating the Dose Rate:

Dose Rate = C · DCF_{soil votume}

 $DoseRate = (300\frac{pCi}{g}) (1.76\frac{g}{cm^3}) (\frac{1Ci}{10^{12}pCi}) (\frac{10^6 cm^3}{1m^3}) (6.55 \times 10^4 \frac{mrem}{yr} \frac{m^3}{Ci})$ $DoseRate = 34.58 \frac{mrem}{yr}$ $DoseRate = (34.58\frac{mrem}{yr})(\frac{1yr}{8760hr}) = 4x10^{-3}\frac{mrem}{hr}$

7.3 DOSE CALCULATIONS FOR SLUDGE TRANSFER UNDER ACCIDENT CONDITIONS

This section presents the calculations for sludge pipe breaks into, during, and post processing.

7.3.1 PIPE BREAK INTO PROCESSING

7.3.1.1 External Exposure

For this scenario, it is assumed that a flexible pipe, with a 3-inch diameter carrying sludge (10% content) and water (90% content) at a flow rate of 27 ft³/min, breaks. It requires 3 minutes to stop the flow of the pipe. It is also assumed that the break occurs 20 ft from the pond containing a slurry of 10% sludge with a concentration, C, of 500 pCi/g.

The volume of the spill is determined assuming that the total volume spilled consists of 3 minutes of flow and that the sludge in the pipe drains completely.

$$V_p = (l)x(\frac{\pi d^2}{4}) \tag{7-3.1}$$

$$V_{r} = (\dot{m})(t)$$
 (7-3.2)

$$V_{i} = V_{y} + V_{i}$$
 (7-3.3)

where:

 $\begin{array}{rcl} V_{i} &=& total \ volume \ (m^{3}) \\ V_{p} &=& volume \ of \ pipe \ (m^{3}) \\ V_{f} &=& volume \ of \ flow \ (m^{3}) \\ m &=& flow \ rate \ (ft^{3}/min) \ = \ 27 \end{array}$

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(7.2-3)



l = length of pipe (ft) = 20

d = diameter of pipe (ft) = 0.25

t = duration of spill (min) = 3

 ρ_s = bulk density of sludge material (g/cm³) = 1.6

Substituting into equations (8-3.1), (8-3.2), and (8-3.3) yields:

$$V_p = (l)x(\frac{\pi d^2}{4}) = (20)(\frac{\pi (\frac{3}{12})^2}{4}) = 9.82x10^{-1} ft^3$$

$$V_{t} = (\dot{m})(t) = (1)(3) = 3yd^{3} = 81ft^{3}$$

Total Volume =
$$V_r = V_p + V_r = 81 ft^3 + 1.0 ft^3 = 82 ft^3 = 2.2 m^3$$

Since 10% of the mix is sludge material and the balance is water, the volume of sludge material, V_s , is:

$$V_{4} = 0.10 + V_{1}$$

$$V_{4} = 0.10 + 2.2 \text{ m}^{3} = 0.23 \text{ m}^{3}$$
(7-3.4)

The mass of sludge, m, released is determined by:

$$m_{s} = V_{s} \cdot \rho_{s}$$

$$m_{s} = (0.23 \text{ m}^{3})(1.6 \text{ g/cm}^{3} \cdot 1 \text{ x } 10^{6} \text{ cm}^{3}/\text{m}^{3})$$

$$m_{s} = 3.7 \text{ x } 10^{8} \text{ g}$$
(7-3.6)

The activity of the sludge, A, released is determined by:

$$A = m_{x} \cdot C$$
(7-3.6)

$$A = (3.7 \times 10^{5} \text{ g})(500 \text{ pCi/g}) = 1.9 \times 10^{8} \text{ pCi}$$

$$A = 1.9 \times 10^{4} \text{ Ci}$$

The total spill is assumed to have a constant depth of 0.25-inch. The radius of the spill is calculated using the following equation:

$$V_1 = h \cdot \pi \cdot r^2 \tag{7-3.7}$$

where:

 $V_1 = 2.31 \text{ m}^3$ h = depth of the spill (m) = 6.35 x 10³ m

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Rearranging equation (8-3.7), the radius of the spill, r, is then equal to:

$$r = \sqrt{\frac{V}{\pi h}}$$
 (7-3.8)
 $r = \sqrt{\frac{2.31}{\pi h}} = 10.8 m$

$$\sqrt{(\pi)(6.35 \times 10^{-5})}$$

The above information was used as input to a MICROSHIELD¹ computer run, assuming that a worker was standing in the spill for 1 minute and a bystander was standing 100 feet away for 2 hours from the center of the spill.

The dose rates as calculated by MICROSHIELD are:

Dose Rate_{worker} = 3.95×10^{-5} mrem/hr Dose Rate_{worker} = 8.01×10^{-7} mrem/hr

The total dose, H, to worker is calculated as follows:

 $H = \text{Duration} \cdot \text{Dose Rate}_{\text{worker}}$ $H = (1 \text{ min} \cdot \text{hr}/60 \text{ min}) \cdot (3.95 \text{ x } 10^5 \text{ mrem/hr})$ $H = 6.6 \text{ x } 10^7 \text{ mrem}$

The total dose, H, to bystander is calculated as follows:

 $H = \text{Duration} \cdot \text{Dose Rate}_{\text{bystander}}$ (7-3.10) $H = (2 \text{ hr}) \cdot (8.01 \text{ x } 10^7 \text{ mrem/hr})$ $H = 1.6 \text{ x } 10^6 \text{ mrem}$

7.3.1.2 Internal Exposure - Inhalation Dose

For inhalation doses, the evaporation rate of the sludge, E, was calculated as follows:

$$E(g/s) = 3.6 \times 10^{-10} (M \cdot P/T) \cdot u^{0.78} \cdot R^{1.89}$$
(7-4.11)

where:

R = radius of spill (cm) = 1076

 $M = molecular weight of H_2O = 18$

P = vapor pressure of liquid at 20°C (dynes/cm²)

T = temperature (°K)

(7-3.9)

¹The activity was for Uranium-238 and it was decayed for 5 years, therefore, the daughter and granddaughter products were used in calculating results.



 $P/T = @ 20^{\circ}C = 79.6$ u = wind velocity (cm/s) = 10 mph = 447

Substituting into equation (8-3.11)

 $E = 3.6 \times 10^{-10} ((18)(79.6))(447)^{0.78} (1076)^{1.89}$

$$E = 32.35 \frac{g}{s}$$

Based on the Class (Y) dose conversion factor for U-238 published by the ICRP (1979) of 3.2×10^5 Sv/Bq (1.2 x 10^{11} mrem/Ci) and a standard breathing rate of 1.2 m³/hr, the dose rate to an individual at the controlled access zone boundary would be:

 $(1.62 \times 10^{-12} \text{ Ci/m}^3)(1.2 \times 10^{11} \text{ mrem/Ci})(1.2 \text{ m}^3/\text{hr}) = 0.23 \text{ mrem/hr}.$

It is considered reasonable that the spill area could be covered with tarpaulins, soil or foam within two hours, so the maximum dose received by this individual, who represents a non-radiation chemical plant worker, would be on the order of 0.5 mrem.

7.4 DOSE CALCULATION FOR SOIL REMOVAL UNDER ACCIDENT CONDITIONS

7.4.1 TRUCK FIRE

Getting soil to burn is difficult unless the flammable agent is directly mixed with the soil. Regardless, a partition coefficient of 10^{-2} (typical for HEPA filter fires) and a very conservative χ/Q of 10^{-4} s/m³ are assumed. It is also assumed that only the material at the surface of the pile in the truck would be available for release. This area is estimated to be 300 ft². The activity available for release is the first 6 inches over the 300 ft² area. The maximum soil concentration, C, is 300 pCi/g.

The following is a description of how this dose was estimated. It was assumed that the diesel fuel would mix with the soil so as to mobilize soil particles to the atmosphere. Since the truck might catch fire during light wind conditions a very conservative χ/Q of 10^{-2} sec/m³ was used. The truck was assumed to tip over leaving a pile 15 feet by 20 feet in size. It was also assumed that the truck would carry 50 gallons of fuel which would spread over the surface. Because the transported soil would be saturated clay, it is assumed that 90 percent of the fuel would run off and soak into uncontaminated soil around the spill and 10 percent would soak into the contaminated soil, which has a porosity of 0.3. Thus a layer approximately .22 cm thick would be saturated and could mobilize during the fire.

It was assumed that a fire duration of one hour would be required to consume all of the fuel. The release rate would be:

 $((457) (609) (.22) cm^3) (1.9 g/cc) (300 pCi/g) (1 Ci/10^{12} pCi) = 3.5 x 10^{-5} Ci/hr$

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The concentration in air at the boundary would therefore be:

$$(3.5 \times 10^{-5} Ci/hr) (1 hr/3600 sec) (10^{-2} sec/m^3) = 9.7 \times 10^{-11} Ci/m^3$$

Based on the same inhalation DCF used in the calculations in Section 7.3.1, the exposure rate can be estimated as:

$$(9.7 \times 10^{-11} \text{ Ci}/m^3)$$
 $(1.2 \times 10^{11} \text{ mrem}/\text{Ci})$ $(1.2 \text{ m}^2/hr) = 14 \text{ mrem}/hr$

7.4.2 TRUCK TIPPING

Determining the volume of soil, V, available for release:

$$V = Surface Area \cdot Depth$$
(7-4.1)

$$V = (300 \text{ ft}^2) \cdot (0.5 \text{ ft})$$

$$V = 150 \text{ ft}^3 = 4.248 \text{ x } 10^6 \text{ cm}^3$$

Assuming that the bulk density, ρ , of the soil is 1.6 g/cm³, the total activity, A, available for release can be determined:

$$A = V \cdot \rho \cdot C$$
(7-4.2)

$$A = (4.248 \times 10^{6} \text{ cm}^{3}) \cdot (1.6 \text{ g/cm}^{3}) \cdot (300 \text{ pCi/g})$$

$$A = 2.0 \times 10^{9} \text{ pCi}$$

Assuming that 0.1% of the activity is released over a 5 second period, the release tate would be:

Release Rate =
$$0.001 \cdot A/Duration$$
 (7-4.3)
= $(0.001 \cdot 2.0 \times 10^{\circ} \text{ pCi}) / 5 \text{ s}$
= $4.0 \times 10^{\circ} \text{ pCi/s}$

The concentration, C, would then be:

 $C = Release Rate \cdot \chi/Q$ $= (4.0 x 10⁵ pCi/s) \cdot (10⁻⁴ s/m³)$ = 4.0 x 10¹ pCi/m³

An individual inhaling this concentration would then be exposed to a dose rate of:

Dose Rate _{Inhalation}	$= C \cdot DCF \cdot Duration$	(,)
Line dation of the	$= (40 \text{ pCi/m}^3) \cdot (1.2 \text{ x } 10^{11} \text{ mrem})$	/Ci)(1 Ci/10 ¹² pCi)(1.2 m ³ /hr)
	= 5.76 mrem/hr	

An individual inhaling this concentration for 30 minutes would then receive a dose of 2.9 mrem.



(7-4.4)

(7-4 5)

7.4.3 TRUCK TIP OVER CLEAN-UP (SPILL CLEAN-UP)

The spilled soil would be covered with tarpaulins or foam within a half an hour of the occurrence so the maximum dose received by the individual at the controlled access zone would be less than 4 mrem. Response to the truck spill is expected to be faster than response to a pipe rupture since a smaller area is involved.

The worker dose from the cleanup activities would be similar to the dose received by workers during the soil excavation since the DCF is based on activity per unit area, which is assumed to be the same for all soil. This would be 4×10^{-5} mrem/hr to the maximally exposed individual.

7.4.4 DOSE TO WORKER FALLING ONTO COMPACTED SOIL

The soil is assumed to be compacted 110% of the original density. Therefore, the concentration, $C_{compacted}$ of the soil material is increased by 10% of its original concentration, C:

$$C_{compacted} = C + 0.10 C$$

$$C_{compacted} = 300 \text{ pCi/g} + (0.10 + 300 \text{ pCi/g}) = 330 \text{ pCi/g}$$
(7.4.6)

If a worker falls onto the compacted soil, the dose rate would be:

$$DoseRate = (330 \frac{pCi}{g}) (1.76 \frac{g}{cm^3}) (\frac{1Ci}{10^{12}pCi}) (\frac{10^6 cm^3}{1m^3})(6.55 \times 10^4 \frac{mrem}{yr} \frac{m^3}{Ci}) = 38 \frac{mrem}{yr}$$

Dose Rate =
$$4.4 \times 10^{-3} \frac{mrem}{hr}$$

Assuming it takes the worker one minute to stand up and leave the area of compacted soil, the total dose to the worker would be:

Duration = 1 minute = 0.0167 hr Total Dose = Dose Rate \cdot Duration Total Dose = (4.4E-03 mrem/hr)(0.0167 hr) = 7.25 x 10⁵ mrem

(7-4.7)

7.5 DOSE CALCULATIONS FOR SLUDGE PROCESSING UNDER ACCIDENT CONDITIONS

Three scenarios were considered for the sludge processing operations: a break in the transfer line, break/opening in the pug mill mixer, and an explosion in pug mill mixer. The break in the transfer line scenario is the same as the one discussed in Section 7.3.1.

7.5.1 BREAK/OPENING IN PUG MILL MIXER

For this scenario, it is assumed that a break or opening in the pug mill mixer occurs such that it allows some sludge (if dried) to be discharged into the surrounding atmosphere. The flow rate of the pug mill mixer is 200 cubic feet per minute (com) and 0.5 ft³ of sludge is discharged into a plume over 15 minutes.

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The maximum sludge concentration is 500 pCi/g for the Burn Pond sludges. Since the reagent weight proportions for the Burn Pond stabilization mixture results in equal amounts (by weight) of sludge and reagents, the concentration in the pug mill mixer is calculated to be 250 pCi/g (calculated in Section 7.1.3).

The volume spilled onto ground is calculated assuming that it takes the operators 30 seconds to recognize the break and shut the line to the pug mill mixer. It is also assumed that the sludge in the mixer empties completely to the ground outside.

Volume of spill = $200 \text{ ft}^3/\text{min} \cdot 0.5 \text{ min}$ = 100 ft^3

According to this scenario, 0.5 ft³ of the spill is dry enough to be sent into a plume, therefore the activity, A, of the plume is:

$$A = C \cdot \rho \cdot V_a \tag{7-5.1}$$

where:

C = concentration of sludge = 250 pCi/g

 ρ = bulk density of the sludge = 100 lb/ft³ = 4.54 x 10⁴ g/ft³

 $V_{*} = volume of sludge sent into plume = 0.5 ft^{3}$

Substituting into (8-5.1)

 $\begin{array}{rcl} A &=& (250 \ pCi/g) \ \cdot \ (4.54 \ x \ 10^4 \ g/ft^3) \ \cdot \ (0.5 \ ft^3) \\ A &=& 5.7 \ x \ 10^6 \ pCi \end{array}$

The release rate to the atmosphere, assuming all 0.5 ft³ enters the plume is calculated as follows:

Release Rate = Activity/Duration Duration = 15 minutes = 900 s Release Rate = 5.7×10^6 pCi/900 s = 6.3×10^3 pCi/s

The airborne concentration, C_a, is determined using the following equation:

 $C_{*} = Release Rate \cdot \chi/Q$

7.5.1.1 Dose @ Worker

For the worker in the immediate area of the break, the atmospheric dispersion, χ/Q , is assumed to be 10², therefore C_a is:

$$C_s = (6.3 \times 10^3 \text{ pCi/s}) - (10^{-2} \text{ s/m}^3) = 63 \text{ pCi/m}^3$$

The 50-year effective whole body dose equivalent, H, received by an individual is:

Dose Rate = C_s ·	DCF		(7-5.3)
H = Dose Rate -			(7-5.4)

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(7-5.2)

The dose conversion factors used are given below:

Reference Used	Exposure and Isotope	DCF		
ICRP 30	Inhalation U ²³⁸ + Daughters	1.2 x 10 ¹¹ (mrem/Ci)		
NUREG/CR-4370	Immersion U ²³⁸ + Daughters	9.3 x 10 ⁻³ (mrem/hr per pCi/m ³)		

Assuming that it takes I minute to see the break and leave the area quickly, the dose, Hworker, would be:

For inhalation: Dose Rate = $(63 \text{ pCi/m}^3)(1.2 \text{ x } 10^{11} \text{ mrem/Ci})(1.2 \text{ m}^3/\text{hr})(1 \text{ Ci}/10^{12} \text{ pCi})$ Dose Rate = 9.1 mrem/hr $H_{\text{worker}} = (9.1) \cdot (1.67 \text{ x } 10^{-2} \text{ hr}) = 1.52 \text{ x } 10^{-1} \text{ mrem}$

For immersion: Dose Rate = $(63) \cdot (9.3 \times 10^3) = 5.9 \times 10^4$ mrem/hr H_{sorker} = $(5.9 \times 10^4) \cdot (1.67 \times 10^2 \text{ hr}) = 9.8 \times 10^3$ mrem

Total Dose = $1.52 \times 10^{-1} + 9.8 \times 10^{-3} = 1.62 \times 10^{-1}$ mrem

7.5.1.2 Dose to Bystander

For the bystander 100 feet away from the break, the atmospheric dispersion, χ/Q , is assumed to be 10⁻⁴, therefore C_a is:

 $C_a = (63 \text{ x } 10^3 \text{ pCi/s}) \cdot (10^{-4} \text{ s/m}^3) = 0.63 \text{ pCi/m}^3$

Assuming the individual remains at the boundary of the hot zone for 2 hours before the tarps are placed, covering the spill for cleanup, the dose rate would be:

For inhalation: Dose Rate = $(0.63 \text{ pCi/m}^3)(1.2 \text{ x } 10^{11} \text{ mrem/Ci})(1.2 \text{ m}^3/\text{hr})(1 \text{ Ci/}10^{12} \text{ pCi})$ Dose Rate = 0.091 mrem/hr

 $H_{\text{bostander}} = (0.091) \cdot (2) = 0.18 \text{ mrem}$

For immersion: Dose Rate = $(0.63) \cdot (9.3 \times 10^3) = 5.9 \times 10^3$ mrem/hr

 $H_{\text{homoser}} = (5.9 \text{ x } 10^3) \cdot (2) = 1.17 \text{ x } 10^2 \text{ mrem}$

Total Dose = $0.18 + 1.17 \times 10^2 = 0.2$ mrem

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7.5.2 PUG MILL MIXER EXPLOSION

For this scenario, it is assumed that a fire has occurred which caused an explosion in the pug mill mixer. The explosion causes the mixture of reagents and sludge to be discharged into the atmosphere. 5 cubic yards of material is spilled from the mill and 5 cubic feet of material is discharged into the air from the force of the explosion. It is unlikely that the mixture with a high moisture content will enter a plume, therefore a partition coefficient of 10⁻² (typical of HEPA filter fires) was assumed.

As calculated in the pug mill mixer break, the maximum sludge concentration, C, is 250 pCi/g.

There are two contributing factors to the pug mill explosion scenario, the exposure due to the large quantity of spilled material and the exposure due to the airborne material.

The activity of the spilled sludge is calculated to determine the effects of the spilled material using the following equation:

$$A_{c} = C \cdot \rho \cdot V \tag{7-5.5}$$

where:

 $A_s = activity of spilled sludge material (pCi)$

- ρ = bulk density = 100 lbs/ft³ = 1.61 x 10⁶ g/m³
- $V = volume of spill = 5 yd^3 = 3.82 m^3$
- C = sludge concentration = 250 pCi/g

$$A_{c} = (250 \text{ pCi/g}) \cdot (1.61 \text{ x } 10^{6} \text{ g/m}^{3}) \cdot (3.82 \text{ m}^{3}) = 1.54 \text{ x } 10^{9} \text{ pCi}$$

Although it is highly unlikely that the material will enter the atmosphere due to the moisture content of the sludge, the partition coefficient is assumed to be 10^{-2} , which is typical for HEPA filter fires. This assumes that 1% of the activity from the spill enters the atmosphere. The activity is assumed to be released over a 2-hour period, therefore:

$$Felease Rate = \frac{(A_s) (Partition Coefficient)}{Duration}$$
(7-6.6)

$$Release Rate = \frac{(1.54 \times 10^9 pCi) \ (0.01)}{7200 s} = 2,100 \frac{pCi}{s}$$

The airborne concentration is calculated as follows:

 $C_{\rm ai} = {\rm Release Rate} + (\chi/Q)_{\rm i}$

where:

 C_{ai} = airborne concentration of sludge material at location of "i" individual (pCi/m³) (χ/Q)_i = atmospheric dispersion value at location of "i" individual (s/m³)

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(7-5.7)

= 10^2 for the worker = 10^4 for the bystander

For the worker:

 $C_{worker} = (2100 \text{ pCi/s}) \cdot (10^2 \text{ s/m}^3) = 21 \text{ pCi/m}^3$

For the bystander:

 $C_{bystani} = (2100 \text{ pCi/s}) \cdot (10^4 \text{ s/m}^3) = 0.2 \text{ pCi/m}^3$

The effects of the airborne material are determined using the following equation:

$$A_s = C \cdot \rho \cdot V \tag{7-5.8}$$

where:

 $\begin{array}{rcl} A_{a} &=& \operatorname{activity} \ of \ airborne \ sludge \ material \ (pCi)\\ \rho &=& \operatorname{bulk} \ density \ = \ 100 \ lbs/ft^{3} \ = \ 1.61 \ x \ 10^{6} \ g/m^{3}\\ V &=& \operatorname{volume} \ of \ spill \ = \ 5 \ ft^{3} \ = \ 0.142 \ m^{3}\\ C \ =& \ sludge \ concentration \ = \ 250 \ pCi/g \end{array}$

Substituting into equation (8-5.8):

$$A_{c} = (250 \text{ pCi/g}) \cdot (1.601 \text{ x } 10^{6} \text{ g/m}^{3}) \cdot (0.142 \text{ m}^{3}) = 5.7 \text{ x } 10^{7} \text{ pCi}$$

Assuming that the release from the explosion is instantaneous and 1% of the airborne contaminated sludge is fine enough to remain suspended in a cloud of contamination, the airborne cloud released would then have an activity of $0.01 \cdot A_a$, which is 6.82×10^5 pCi.

The airborne concentration, C_a , due to the "cloud" of material is assumed to affect only the worker. This "cloud" is assumed to have dispersed to a low concentration, so that only the contamination due to the spilled material will affect the bystander. The "cloud," due to the force of the explosion, is assumed to cover a volume equivalent to a cube 50 feet in height, 50 feet in width, and 50 feet in length. The "cloud" volume, V_c , is 125,000 ft³ (3540 m³). Therefore:

$$C_{\text{worker}} = (1\% + A_a) / V_c$$

$$C_{\text{worker}} = (5.7 \times 10^5 \text{ pCi}) / (3540 \text{ m}^3) = 161 \text{ pCi/m}^3$$
(7-5.9)

The dose, H, received by an individual is given by:

 $H = Dose Rate \cdot Duration$ (7-5.10)

and

Dose Rate =
$$C_s + DCF$$
 (7-5.11)

The DCFs used in this scenario are the same as those used in Section 7.5.1.

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7.5.2.1 Dose to the Worker

For the worker, it is assumed that the worker remains 10 seconds in the contaminated cloud, breathing while immediately leaving the explosion area.

The airborne concentration seen by the worker would be the total of 21 pCi/m³ due to the spill and 161 pCi/m³ due to the "cloud", which is 182 pCi/m³. The duration is 10 seconds ($2.78 \times 10^{-3} \text{ hr}$).

For inhalation the dose rate is:

Dose Rate = $(182.4 \text{ pCi/m}^3)(1.2 \text{ m}^3/\text{hr})(1.2 \text{ x} 10^{11} \text{ mrem/Ci})(1 \text{ Ci/10}^{12} \text{ pCi})$

Dose Rate = 26 mrem/hr

 $H_{worker} = 26 \cdot (2.78 \times 10^3) = 7.3 \times 10^2 \text{ mrem}$

For immersion the dose rate is:

Dose Rate = $(182 \text{ pCi/m}^3) \cdot (9.3 \times 10^3 \text{ mrem/hr per pCi/m}^3) = 1.69 \text{ mrem/hr}$

 $H_{worker} = (1.69) \cdot (2.78 \times 10^3) = 4.7 \times 10^3 \text{ mrem}$

Total Dose Rate = 26 + 4.7 = 27.7 mrem/hr

Total Dose = $7.3 \times 10^2 + 4.7 \times 10^3 = 7.7 \times 10^2$ mrem

7.5.2.2 Dose to Bystander

For the bystander, it is assumed that the individual remains at the boundary of the hot zone for 2 hours before tarps cover the spill. The airborne concentration seen by the worker would be the total of 0.2 pCi/m³ due to the spill and assuming a χ/Q of 10⁻², 1.6 pCi/m³ for the cloud which is 1.8 pCi/m³.

For inhalation: Dose Rate = $(1.8 \text{ pCi/m}^3)(1.2 \text{ x } 10^{11} \text{ mrem/Ci})(1.2 \text{ m}^3/\text{hr})(1 \text{ Ci}/10^{12} \text{ pCi})$ Dose Rate = 2.6 x 10⁻¹ mrem/hr

 $H_{\text{bysamler}} = (2.6 \text{ x } 10^4) \cdot (2) = 5.2 \text{ x } 10^4 \text{ mrem}$

For immersion: Dose Rate = $(1.8 \text{ pCi/m}^3)(9.3 \text{ x } 10^3 \text{ mrem/hr per pCi/m}^3)$ Dose Rate = $1.7 \text{ x } 10^2 \text{ mrem/hr}$

 $H_{\text{bostnucker}} = (1.7 \text{ x } 10^2) \cdot (2) = 3.4 \text{ x } 10^2 \text{ mrem}$

Total Dose Rate = $2.6 \times 10^{-1} + 1.7 \times 10^{-2} = 2.8 \times 10^{-1}$ mrem/hr

Total dose = $5.2 \times 10^{-1} + 3.4 \times 10^{-2} = 5.5 \times 10^{-1}$ mrem

8.0 REFERENCES

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TABLE 4-1

Sludge Source	Binder Agent	Application Percentage ¹	Volume Increase (%)
Burn Pond	Gypsum Soil	25% 100%	98%
Celite/Deepwell Pond	Gypsum Soil	25% 100%	145%
V-1 Pond	Gypsum Soil	25% 100%	100%

SLUDGE AND BINDER AGENT MIXTURE SUMMARY

¹ By Weight of sludge.







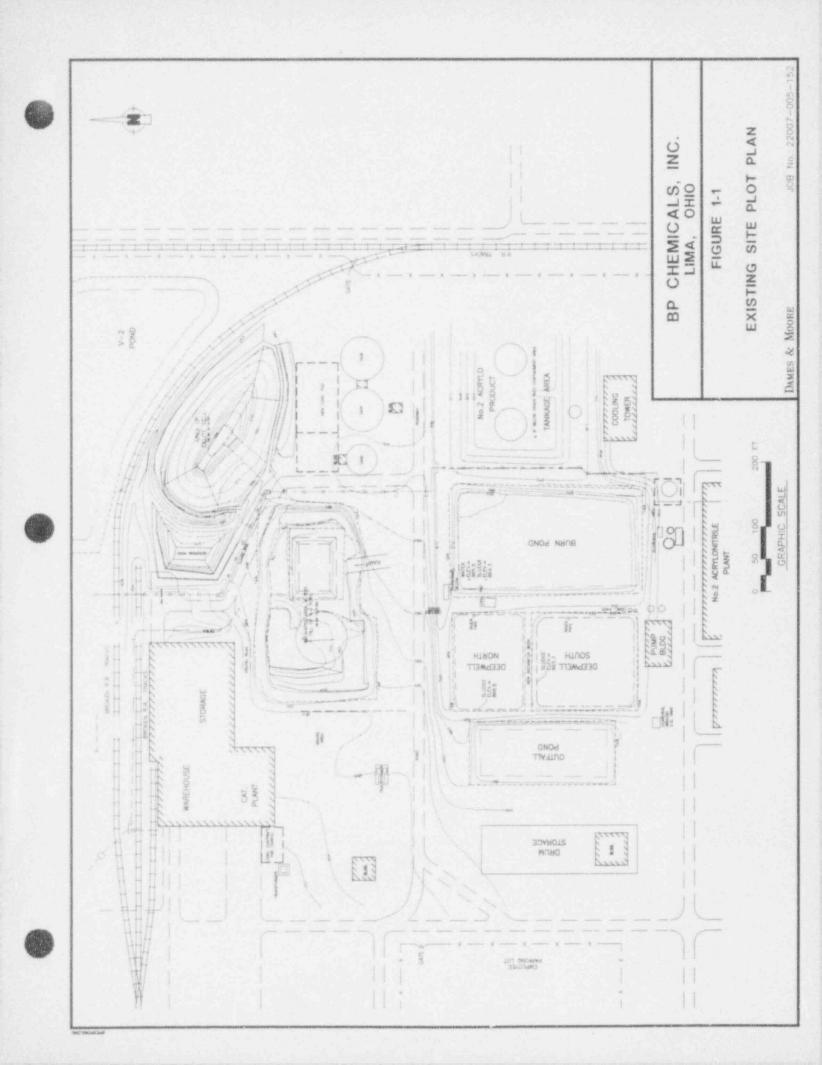


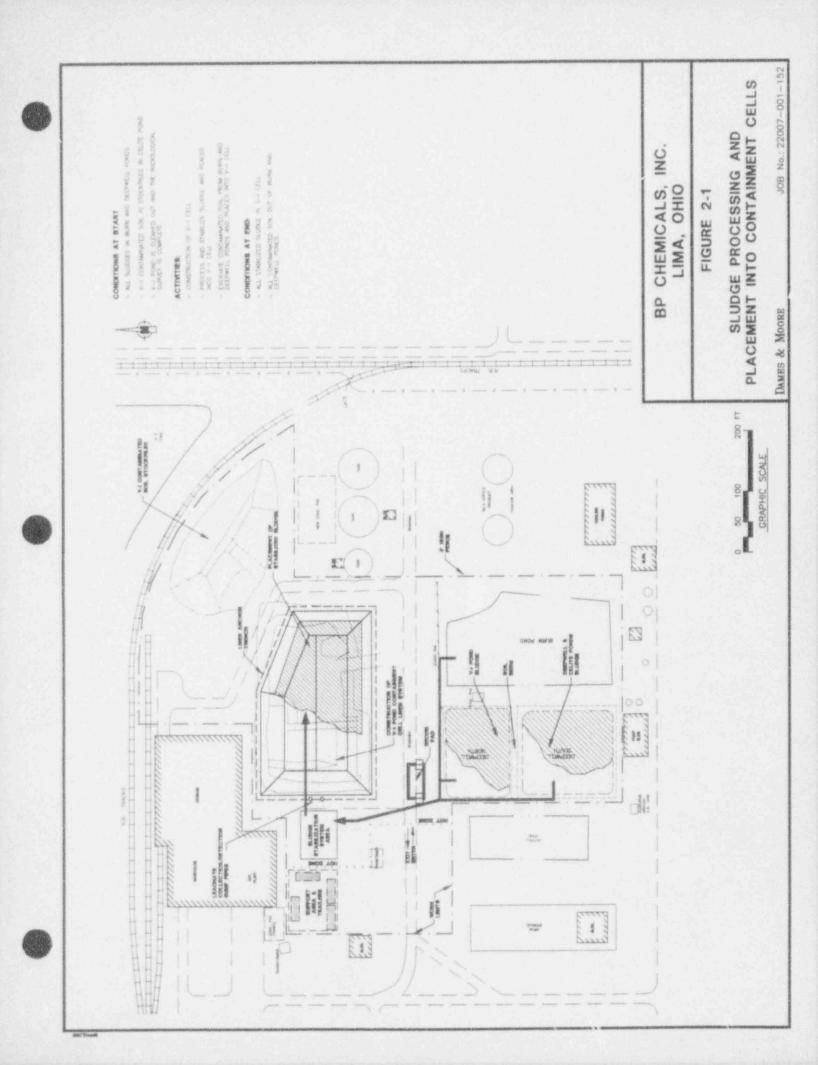
TABLE 7-1

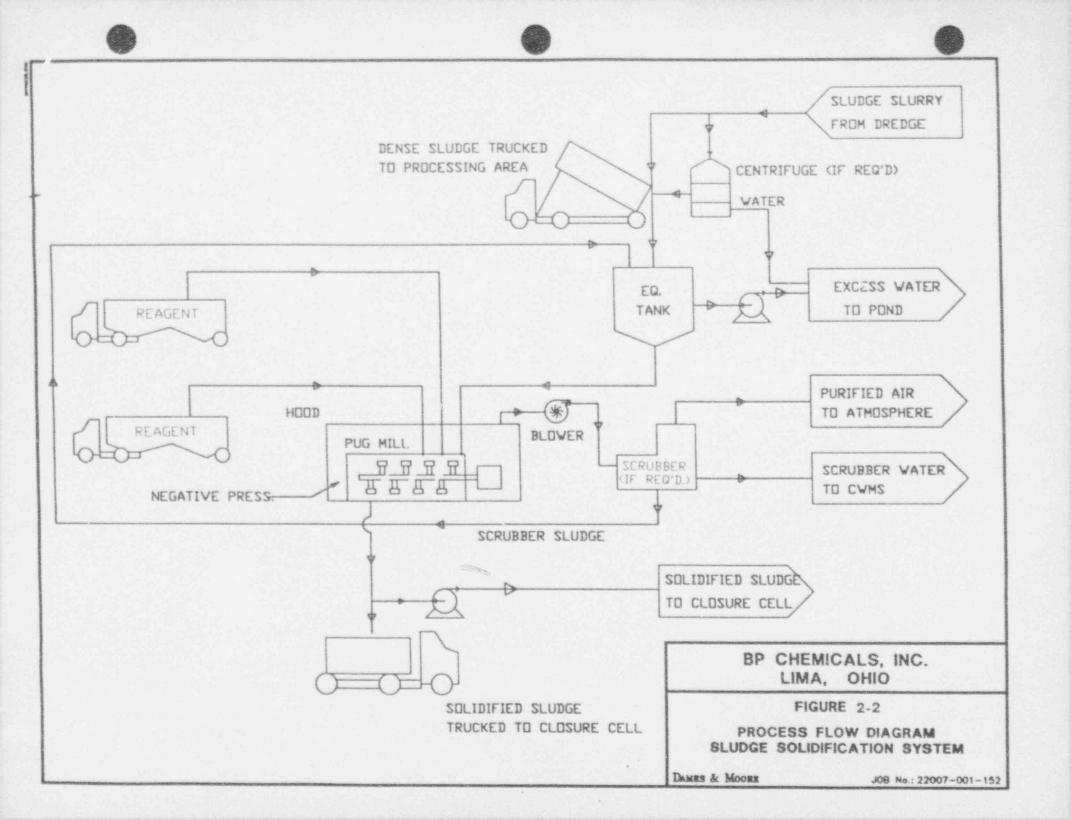
SOURCE TERM USED IN SLUDGE TRANSFER CALCULATIONS

Muelida	Sludg	e in Pond	Sludge	e in Transit	Processed 3	Processed Sludge Placement		
Nuclide	Curies	µCi/cc	Curies	μCi/cc	Curies	μCi/cc		
Pa-234	2.8E-06	2.4E-07	1.2E-09	4.3E-08	3.1E-06	2.6E-07		
Pa-234m	1.8E-03	1.5E-14	7.5E-07	2.7E-05	1.9E-03	1.6E-04		
Th-230	5.4E-13	4.6E-14	2.3E-16	8.3E-15	5.9E-13	5.0E-14		
Th-234	1.8E-03	1.5E-04	7.5E-07	2.7E-05	1.9E-03	1.6E-04		
U-234	2.4E-08	2.1E-09	1.0E-11	3.8E-10	2.7E-08	2.3E-09		
U-238	1.8E-03	1.5E-04	7.5E-07	2.7E-05	1.9E-03	1.6E-04		

February 8, 1994







APPENDIX B

ANALYSIS OF LONG TERM RADIOLOGICAL IMPACTS ON-SITE DISPOSAL

ANALYSIS OF LONG TERM RADIOLOGICAL IMPACTS ON-SITE DISPOSAL MIXED WASTE POND CLOSURE PROJECT BPC CHEMICALS, INC. LIMA, OHIO

1.0 INTRODUCTION

This document presents the methodology and results of a pathway analysis to estimate the long term radiological impacts which might be anticipated from the on-site disposal of radiologically mixed waste as part of the subject project. The document is submitted in support of the BP Chemical Inc. (BPC), formerly called the Vistron Corporation, application for on-site disposal pursuant to Section 20.302 of 10 CFR Part 20.

The BPC site contains facilities and areas previously contaminated with low-levels of depleted uranium (DU). The presence of radioactive material is attributable to the production of Acrylonitrile using a catalyst material containing DU. The material contaminated by the DU is also considered a hazardous was e under the Resource Conservation and Recovery Act (RCRA) based on its source or chemical composition. As such the disposition of the material is regulated by both the U.S. Nuclear Regulatory Commission (USNRC) and the Ohio EPA under authorization of the USEPA. The action which is evaluated in this report is considered disposal under NRC regulations and closure under USEPA and OEPA regulations. Since this report addresses the NRC's authority, the term disposal will be used.

Materials to be disposed on-site consist of sludge initially contained in four surface impoundments, herein after called ponds. The sludge and contaminated soil beneath will be removed from the ponds. Lined closure cells will be constructed on-site in the pond areas. The sludge will be solidified and placed into the cells along with contaminated soil. The cells will then be capped. Following the completion of closure, the cells will be monitored by BPC in accordance with OEPA requirements.

2.0 OBJECTIVE

The objective of this pathway analysis is to evaluate the long term radiological consequences of the on-site disposal.

3.0 DISCUSSION

In order to assess the radiological consequences of the proposed action, several scenarios were investigated:

- 1) No action
- 2) Close the ponds with the waste-in-place
- 3) Disposal at an existing commercial disposal site
- 4) On-site temporary storage followed by off-site permanent disposal
- 5) Treatment to remove hazardous constituents and disposal at a commercial LLRW site
- 6) Waste stabilization and shallow land burial in RCRA designed disposal cells



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Scenarios 1 through 5 comprise alternatives which were investigated earlier (references Section 2.0 of the License Application text) and found to be unacceptable from a regulatory standpoint. Therefore they will not be discussed here. This report only addresses Scenario 6.

The analysis of the sludge within the cells (Scenario 6) considered the long term breakdown of the cover system, liner, and stabilized waste form. This includes the loss of recognizability of the waste form.

The RESRAD computer code Version 5.03 was used to perform the calculations. RESRAD is a code developed by the Department of Energy for the assessment of impacts of residual radioactive soil contamination following decontamination. RESRAD calculates the dose to the maximally exposed individual due to the various pathways (water, direct, inhalation, etc.) at various times. Details of the RESRAD code have been provided in previous reports which are included in the list of references at the end of this document.

Since the RESRAD computer code used does not allow for the simulation of more than one contaminated zone at a time, the dose calculations had to be broken down into three parts:

- 1) contribution due to the stabilized sludge from the Burn Pond (bottom layer)
- contribution of the stabilized sludge from the Deepwell, Celite and V-1 Ponds (middle layer)
- 3) residual contaminated soil (top layer -- under the cover)

The following section describes the three parts analyzed.

3.1 DOSES RESULTING FROM STABILIZED SLUDGE AND SOIL IN THE CLOSURE CELLS

The planned option for closure of the pond areas is the stabilization of the sludge and subsequent placement, together with contaminated soil, in engineer-designed cells.

Note that for this scenario the stabilized sludges and contaminated soil were modeled as three layers. This was considered a reasonable assumption because of the stabilization processes. The total volume of stabilized sludge and soil to be placed into the cells were used to determine the masses of the cell.

The simulation was performed assuming that the stabilized Burn Pond Sludge would be placed first, with the stabilized Deepwell, Celite, and V-1 Sludges then placed on top of them. Finally, the residual soils and cover would be placed on top. This is depicted schematically on Figure 1 and as it will appear in the cell in Figure 2. The cover material is assumed to have a density of 1.73 g/cm³ and a thickness of 5 ft (1.5m). The cover is assumed to erode at a rate of 1.5 E-03 m/yr. Additional data used in the calculations are given in Appendix A (attached).

To compute the doses received by the maximally exposed individual, and to be consistent with cell design, the layers are considered individually. The stabilized sludge layers were modelled and the results presented in Tables 1 and 2. The maximum exposures occur as the cap erodes and the waste is exposed. The cell is assumed to consist of the 1.5 meter RCRA cap, 2.7 meters of residual soil, 1.95 meters of stabilized Deepwell, Celite, and V-1 Pond sludge, and 1.62 meters of stabilized Burn

Pond sludge. The maximum exposure pathways are due to direct exposure to the waste, inhalation of dust from the waste and ingestion of plant matter grown on the cell. Also, because the area to be covered by the cells is greater than 100 square meters, RESRAD models and the cells are as one area.

Table 3 presents the doses that are a result of the soils placed over the stabilized sludge. The exposure pathways are due to direct exposure to the soils, inhalation of dust from the soils and ingestion of plant matter grown on the cell.

Table 4 presents the sum of the doses to the maximally exposed individual as a result of the cells. The exposures after 1,000 years are estimated to be 5.56×10^{-1} millirem per year. This is assuming that no maintenance activities occur and the cover erodes at 0.15 centimeter per year.

4.0 CONCLUSIONS

The results of the long term impacts indicate that the total maximum anticipated dose from the stabilized sludge and soil contained in the cells after 1,000 years is lower than 10 mrem/yr.

000

The following are attached to and complete this document:

LIST OF REFERENCES

Table 1 Table 2	Results of Stabilized Burn Pond Sludges for all Pathways Results of Stabilized Celite, Deepwell and V-1 Pond Sludges for all Pathways
Table 3	Results of Soils for all Pathways
Table 4	Results of all Stabilized Sludge and Soils for all Pathways
Figure 1 Figure 2	Schematic Diagram of Residual Soil Contamination Model Typical Cross Section of Closure Cell

Appendix A - Detailed Input Data for the RESRAD Code



REFERENCES

- Argonne National Laboratory, 1989, A Manual for Implementing Residual Radioactive Material Guidelines, ANL/ES-160, DOE/CH8901, National Technical Information Service, 5285 Port Royal Road, Springfield, Virginia 22161.
- Bowser-Morner, Inc., 1987, Geological/Hydrogeological Study, Project Number 870738, Bowser-Morner, Inc., 420 Davis Avenue, Dayton, Ohio.
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- Chem-Nuclear Systems, Inc., 1990, Decommissioning Plan for BP Chemical, Inc., Project No. 48033 Chem-Nuclear Systems, Inc., 220 Stoneridge Drive, Columbia, South Carolina 29210.
- Dames & Moore, June 1993, Radiological Pathway Analysis of Residual Activity Below Closure Cells, Mixed Waste Pond Closure Project, BP Chemicals, Inc., Lima, Ohio
- Mercer, J.W., P.S.C. Rao, S.D. Thomas, and B. Ross, 1982, Description of Parameters and Data (and Typical Ranges of Values) Useful Evaluation of Migration Potential at Hazardous waste Management facilities, USEPA Contract 68-01-6464.
- National Council on Radiation Protection and Measurements. 1988. Measurement of Radon and Radion Daughters in Air. NCRP Report 97. NCRC Publications, 7910 Woodmont Avenue, Bethesda, Maryland 20814.
- Negin, C.A., 1980, Rad Decay, Version 3.03, Grove Engineering, Inc., 15215 Shady Grove Road, Rockville, Maryland 20850.
- United States Environmental Protection Agency. 1990. Code of Federal Regulations, Protection of the Environment, Health and Environmental Protection Standards for Uranium and Thorium Mill Tailings, Title 40, Part 192.12 (b)(1). United States Government Printing Office, Washington, D.C. 20402.
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- United States Nuclear Regulatory Commission, 1981. Disposal or On-site Storage of Thorium or Uranium Wastes from Past Operations, Federal Register, Volume 46, Number 205. Office of Nuclear Material Safety and Safeguards, Washington, D.C., 20555.
- United States Nuclear Regulatory Commission. 1991, Code of Federal Regulations, Energy Standards for Protection Against Radiation. Title 10, Part 20, Appendix B. United States Government Printing Office, Washington, D.C., 20402.



APH:94:035:006 BP







TABLE 1 RESULTS OF STABILIZED BURN POND SLUDGES FOR ALL PATHWAYS

Total Uranium (U-234, U-235 and U-238) (mrem/year)

YEARS

	0	1	10	100	200	400	500	600	800	1000
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WATER										
INDEPENDENT										
GROUND	0	0	0	0	0	0	0	0	1.05E-33	1.53E-32
DUST	0	0	0	0	0	0	0	0	0	0
RADON	0	1.03E-14	2.50E-12	1.75E-09	1.40E-08	1.18E-07	2.37E-07	4.25E-07	1.09E-06	2.33E-06
PLANT	0	0	0	0	0	0	0	0	0	0
MEAT	0	0	0	0	0	0	0	0	0	0
MILK	0	0	0	C	0	0	0	0	0	0
SOIL	0	0	0	0	0	0	0	0	0	0
WATER										
DEPENDENT										
WATER	0	0	0	1.32E-02	3.24E-02	7.38E-02	9.54E-02	1.17E-01	1.61E-01	2.05E-01
FISH	0	0	0	3.69E-04	1.03E-03	2.95E-03	4.10E-03	5.29E-03	7.82E-03	1.04E-02
RADON	0	0	0	8.65E-11	6.19E-10	8.13E-09	2.37E-08	5.73E-08	2.17E-07	5.74E-07
PLANT	0	0	0	1.01E-03	2.49E-03	5.68E-03	7.34E-03	9.01E-03	1.24E-02	1.58E-02
MEAT	0	0	0	6.69E-05	1.68E-04	4.26E-04	5.72E-04	7.25E-04	1.04E-03	1.36E-03
MILK	0	0	0	2.56E-04	6.18E-04	1.34E-03	1.09E-03	2.06E-03	1.85E-01	3.48E-03
TOTAL	0	1.03E-14	2.5E-12	1.49E-02	3.67E-02	8.42E-02	1.09E-01	1.34E-01	3.67E-01	2.36E-01

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TABLE 2 RESULTS OF STABILIZED CELITE, DEEPWELL AND V-1 POND SLUDGES FOR ALL PATHWAYS

Total Uranium (U-234, U-235 and U-238) (mrem/year)

					YEARS					
	0	1	10	100	200	400	500	600	800	1000
WATER										
INDEPENDENT										
GROUND	3.55E-25	3.60E-25	4.07E-25	1.39E-24	5.43E-24	8.37E-23	3.29E-22	1.29E-21	2.00E-20	3.08E-19
DUST	0	0	0	0	0	0	0	0	0	0
RADON	0	2.53E-14	6.15E-12	4.36E-09	3.52E-08	3.01E-07	6.12E-07	1.10E-06	2.87E-06	6.22E-06
PLANT	0	0	0	0	0	0	0	0	0	0
MEAT	0	0	0	0	0	0	0	0	0	0
MILK	0	0	0	0	0	0	0	0	0	0
SOIL	0	0	0	0	0	0	0	0	0	0
WATER										
DEPENDENT										
WATER	0	0	0	3.89E-03	1.01E-02	2.36E-02	3.07E-02	3.80E-02	5.27E-02	6.77E-02
FISH	0	0	0	1.08E-04	3.03E-04	9.11E-04	1.71E-03	1.71E-03	2.59E-03	3.54E-03
RADON	0	0	0	2.18E-11	1.91E-10	2.07E-09	1.43E-08	4.24E-07	5.81E-08	1.63E-07
PLANT	0	0	0	2.99E-04	7.79E-04	1.82E-03	2.92E-03	1.94E-07	4.06E-03	5.21E-03
MEAT	0	0	0	1.98E-05	5.17E-05	1.33E-04	2.33E-04	3.65E-08	3.42E-04	4.55E-04
MILK	0	0	0	7.56E-05	1.95E-04	4.32E-04	6.68E-04	7.72E-08	9.02E-04	1.14E-03
TOTAL	3.55E-25	2.53E-14	6.15E-12	4.39E-03	1.14E-02	2.69E-02	3.62E-02	3.97E-02	6.06E-02	7.81E-02

		R	SULTS OF							
					YEARS					
	0	1	10	100	200	400	500	600	800	1000
WATER INDEPENDENT										
GROUND	2.77E-11	2.81E-11	3.25E-11	1.36E-10	6.70E-10	1.62E-08	7.98E-08	3.93E-07	9.51E-06	2.30E-04
DUST	0	0	0	0	0	0	0	0	0	0
RADON	0	9.36E-14	2.28E-11	1.64E-08	0	0	0	4.19E-06	1.01E-05	2.04E-05
PLANT	0	0	0	0	0	0	0	0	1.09E-01	2.16E-01
MEAT	0	0	0	0	0	0	0	0	1.32E-03	2.63E-03
MILK	0	0	0	0	0	0	0	0	2.61E-06	5.19E-03
SOIL	0	0	0	0	0	0	0	0	0	0
WATER										
DEPENDENT				7 005 04	-	F 975 97	0.005.00	0.000.00	1 225 02	1 505 00
WATER	0	0	0	7.80E-04	2.20E-03	5.27E-07	6.92E-03	8.63E-03	1.22E-02	1.58E-02
FISH	0	0	0	2.16E-05	6.31E-05	1.94E-04	2.85E-04	3.86E-04	6.21E-04	8.66E-04
RADON	0	0	0	4.72E-12	4.44E-11	4.14E-10	1.02E-09	2.42E-09	1.04E-08	3.14E-08
PLANT	0	0	0	6.00E-05	1.69E-04	4.05E-04	5.32E-04	6.64E-04	9.37E-04	1.22E-03
MEAT MILK	0	0	0	3.95E-06 1.52E-05	1.12E-05 4.26E-05	2.91E-05 9.74E-05	4.02E-05 1.25E-04	5.25E-05 1.52E-04	7.94E-05 2.07E-04	1.08E-04 2.61E-04

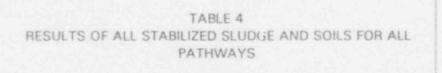
3

2.77E-11 2.82E-11 5.53E-11 8.81E-04 2.49E-03 7.27E-04 7.90E-03 9.89E-03 1.24E-01 2.42E-01

TOTAL



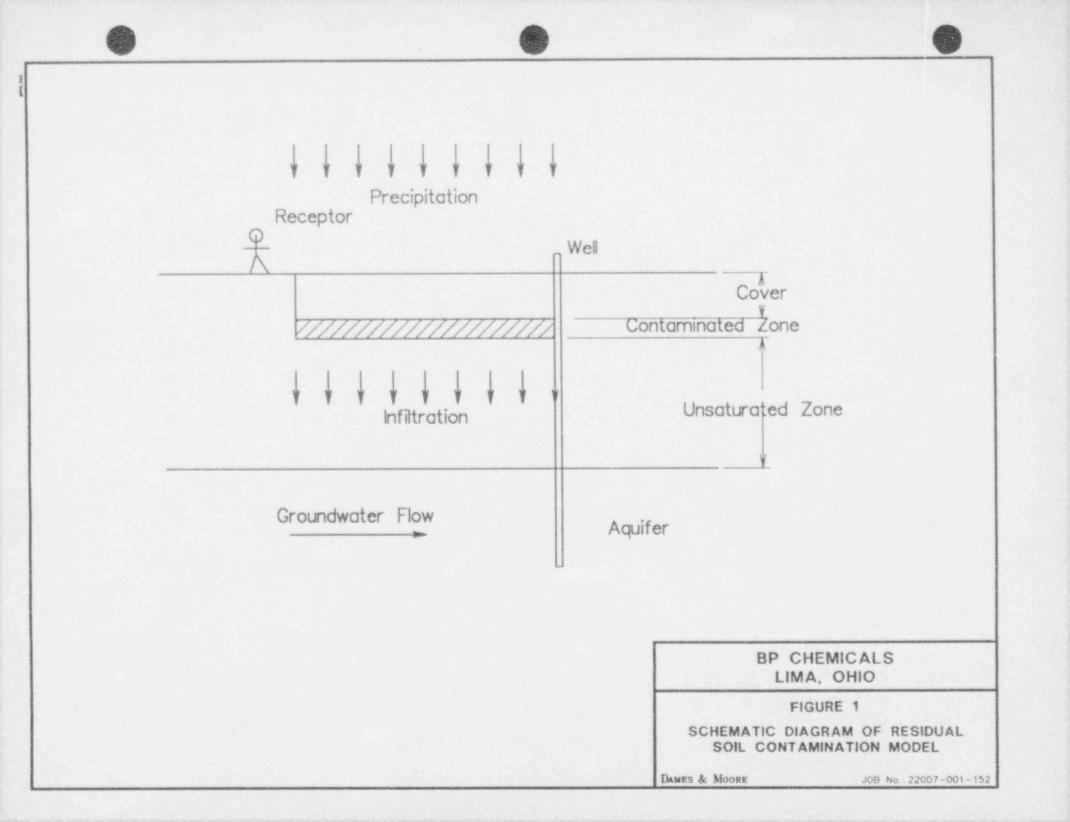


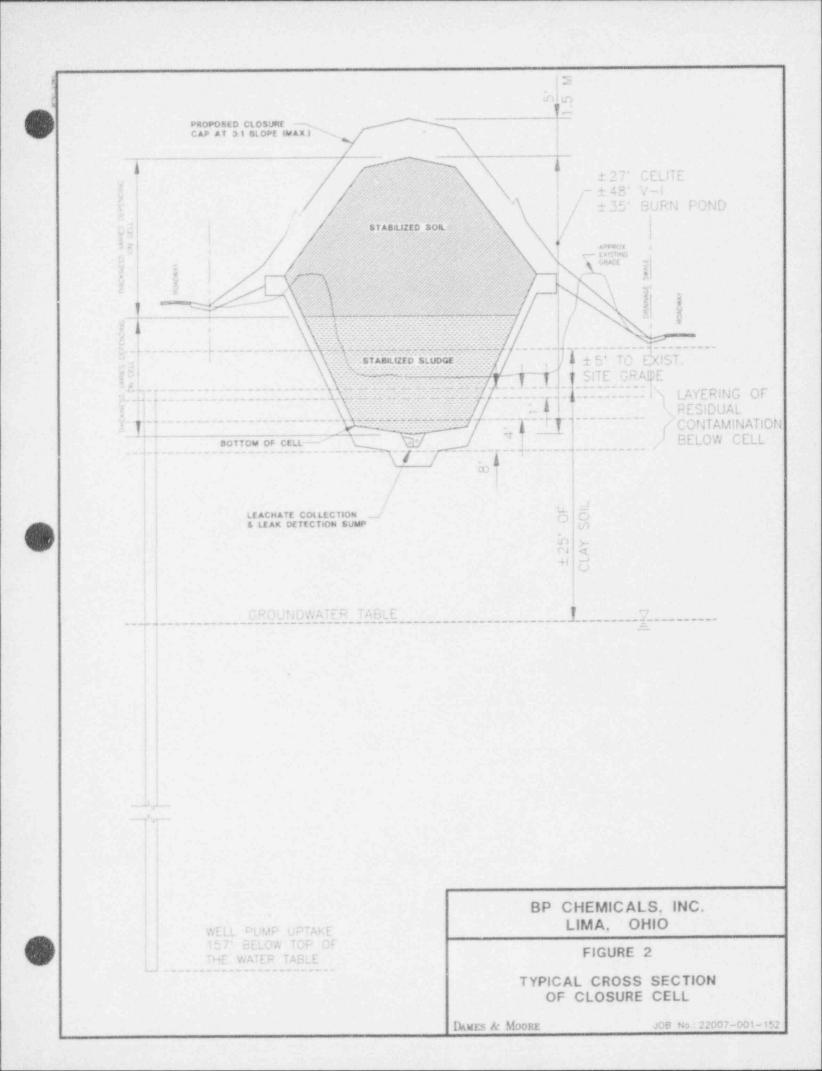


Total Uranium (U-234, U-235 and U-238) (mrem/year)

YEARS									
0	1	10	100	200	400	500	600	800	1000

TOTAL	2.77E-11	2.82E-11	6.40E-11	2.02E-02	5.06E-02	1.12E-01	1.53E-01	1.84E-01	5.52E-01	5.56E-01
MILK	0	0	0	3.47E-04	8.56E-04	1.87E-03	1.88E-03	2.21E-03	1.86E-01	4.88E-03
MEAT	0	0	0	9.07E-05	2.31E-04	5.88E-04	8.45E-04	7.78E-04	1.46E-03	1.92E-03
PLANT	0	0	0	1.37E-03	3.44E-03	7.91E-03	1.08E-02	9.67E-03	1.74E-02	2.22E-02
RADON	0	0	0	1.13E-10	8.54E-10	1.06E-08	3.90E-08	4.84E-07	2.86E-07	7.68E-07
FISH	0	0	0	4.99E-04	1.40E-03	4.06E-03	6.10E-03	7.39E-03	1.10E-02	1.48E-02
DEPENDENT WATER	- 0	0	0	1.79E-02	4.47E-02	9.74E-02	1.33E-01	1.64E-01	2.26E-01	2.89E-01
WATER										
SOIL	0	0	0	0	0	0	0	0	0	0
MILK	0	0	0	0	0	0	0	0	2.61E-06	5.19E-03
MEAT	0	0	0	0	0	0	0	0	1.32E-03	2.63E-03
PLANT	0	0	. 0	0	0	0	0	0	1.09E-01	2.16E-01
RADON	0	1.29E-13	3.15E-11	2.25E-08	1.83E-07	1.59E-06	3.26E-06	5.72E-06	1.41E-05	2.90E-05
DUST	0	0	0	0	0	0	0	0	0	0
INDEPENDENT GROUND	2.77E-11	2.81E-11	3.25E-11	1.36E-10	6.70E-10	1.62E-08	7.98E-08	3.93E-07	9.51E-06	2.30E-04
WATER										





Appendix A

Detailed Input Data for the RESRAD Code

APPENDIX A

DETAILED INPUT DATA FOR THE RESRAD CODE

The following is a synopsis of the site specific data inputs used in RESRAD for the BP Chemicals, Inc., Lima, Ohio site.

The data used in RESRAD are derived from the materials available at the time of the code runs. Where data were not available for specific inputs, a conservative number was used to get the maximum output from RESRAD. In this fashion, the maximum exposure rates would be obtained.



RESRAD Version

Contaminated Zone Area (m²)

Thickness (m)

_ength Parallel to Aquifer (m)

Radiation Dose Limit

Times for Calculations

Principal Radionuclides

CLOSURE CELL

5.03

13,828 m²

Total area encompassing the V-1, Celite and Burn Cells

1.62-meters. Thickness of Burn Pond stabilized sludge in the closure cell

1.95-meters. Thickness of stabilized Deepwell, Celite, and V-1 stabilized sludge in closure cell

2.7-meters. Thickness of soils in the closure cell

266 m

Longest dimension parallel to bedrock aquifer. From Project Drawing.

10 mrem/yr

Comparison number 25 mrem/yr is an EPA limit for exposure to public after release

40 CFR 191.03

1 Year 10 Years 100 Years 200 Years 400 Years 500 Years 500 Years 800 Years 1,000 Years U-238 U-235

U-234



Stabilized sludge (Burn Sludge) 120.5 pCi/g - U-238 3.0 E-01 pCi/g - U-235 6.0 E-04 pCi/g - U-234

Stabilized sludge (Deepwell, Celite & V-1 Sludge)

39.5 pCi/g- U-238 9.9 E-02 pCi/g - U-235 2.0 E-04 pCi/g - U-234

Stabilized soil

9.1 pCi/g - U-238 2.3 E-02 pCi/g - U-235 4.6 E-05 pCi/g - U-234

Isotopic activities based upon ratios given on Table 2-1 of the DOE Health Physics Manual for Good Practices for Uranium Facilities

1.5 m RCRA design closure cell cap

1.73 g/cm3

1.05 E-03 m/yr

1.75 g/cm³ Density of stabilized sludges

2.08 g/cm³ Density of stabilized soils

0.001 m/yr for the stabilized sludges

0.42

Table 2.1.4.1 from Mercer, Rao, Thomas, and Ross, 1982. (See Reference section of this report). This is the average porosity given for clay soil

Totai Depleted Uranium Activity (pCi/g)



Cover Depth (m)

Density of Cover Material (g/cm³)

Cover Erosion Rate (m/yr)

Contaminated Zone Density (g/cm3)

Contaminated Zone Erosion Rate (m/yr)

Contaminated Zone Total Porosity

Col

Contaminated Zone Effective Porosity

Contaminated Zone Hydraulic Conductivity (m/yr)

Contaminated Zone "B" Parameter

Evapotranspiration Coefficient

Precipitation (m/yr)

Irrigation Rate (m/yr)

CLOSURE CELL

0.06

Table 2.1.6.1 from Mercer, Rao, Thomas, and Ross, 1982. (See Reference section of this report)

This is the average value for specific yield of clay which is assumed to equal to effective porosity and the waste is assumed to have clay type properties (conservative)

0.06

Table 2.1.6.1 from Mercer, Rao, Thomas, and Ross, 1982. (See Reference section of this report)

This is the average value for specific yield of clay which is assumed to equal to effective porosity and the waste is assumed to have clay type properties (conservative)

0.03 m/yr

Taken from the Bowser-Morner study done on the samples of clay soil from the site (pp. 1-11, Appendix 2, of the Project Closure Plan). Waste is assumed to resemble clay soils

10.40

Highest value of Table E.2 in the RESRAD Manual. This value is the closest to the subsurface soil being evaluated

0.01

RESRAD default value

0.898 m/yr

Published data obtained from National Weather Service

0.2 m/yr

RESRAD default





Irrigation Mode

Runoff Coefficient

Water Shed Area (m²)

Saturated Zone (Aquifer) Density (g/m³)

Saturated Zone Total Porosity

Saturated Zone Effective Porosity

Saturated Zone Hydraulic Conductivity (m/yr)

Saturated Zone Hydraulic Gradient (m/m)

Distance from Surface to Water Table (m)

CLOSURE CELL

0

Overhead for the area. No artificial irrigation used in this area for farms

0.6

Appendix E of RESRAD manual

 $1.0 \text{ E} + 06 \text{ m}^2$

RESRAD default

1.6 g/cm3

RESRAD default

0.42

Table 2.1.4.1 from Mercer, Rao, Thomas, and Ross, 1982 (See References section of this report). This is the average porosity given for clay soil

0.06

Table 2.1.6.1 from Mercer, Rao, Thomas, and Ross, 1982. (See Reference section of this report)

This is the average value for specific yield for clay soils, where specific yield is assumed to be equal to effective porosity

0.16 m/yr

From Section E of the RCRA, Part "B", Permit Application (pp E-8)

0.02 m/m

RESRAD default

7.0 m

Total depth from the base of the cell to the groundwater table



Water Table Drop Rate (m/yr)

Well Pump Uptake Depth (below H_2O Table) (m)

Nondispersion Model Used

of Unsaturated Zones

Zone 1 Thickness (m)

Zone 1 Soil Density (g/cm³)

Zone 1 Total Porosity

Zone 1 Effective Porosity

Zone 1 b Parameter

Zone 1 Hydraulic Conductivity (m/yr)

CLOSURE CELL

0 m/yr

Actually has risen over the last 20 years. From the Partition Narrative in the RCRA Part "A" Permit Application, pp 5-8

47.76 m

Top elevation of Lockport Dolomite Bedrock formation, of which the source aquifer is located; pump is now at 250' below-grad, however assume pump is turned off and the elevation of water table raises to the top of the bedrock

0

1

7.0 m

Uncontaminated-unsaturated zone thickness

1.60 g/cm3

Uncompacted clay density

0.42

Table 2.1.4.1 from Mercer, Rao, Thomas, and Ross, 1982, (see Reference section of this report)

0.06

Table 2.1.6.1 from Mercer, Rao, Thomas, and Ross, 1982, (see Reference section of this report)

10.40

RESRAD, Appendix F, Table E-2, pp 170

0.03 m/yr

Bowser-Morner Geological/Hydrogeological Study, Appendix 1, pp 6-15 of the project Closure Plan

0

CLOSURE CELL

Distribution Coefficients for U-234

Contaminated Zone (cm³/g)

Unsaturated Zone 1 (cm3/g)

Unsaturated Zone 2 (cm3/g)

Saturation Zone (cm³/g)

Leach Rates (/yr)

4400 (cm3/g)

RESRAD, Appendix E, Table E-5, pp 174, for uranium, pH = 6.5

 $10 (cm^3/g)$

 $10 (cm^3/g)$

50 (cm³/g)

Default values

0 (/yr)

Distribution Coefficients for U-235

Contaminated Zone (cm³/g)

Unsaturated Zone 1 (cm3/g)

Unsaturated Zone 2 (cm³/g)

Saturation Zone (cm³/g)

Leach Rates (/yr)

4400 (cm³/g)

RESRAD, Appendix E, Table E-5, pp 174, for uranium, pH = 6.5

 $10 (cm^3/g)$

10 (cm³/g)

50 (cm³/g)

Default values

0 (/yr)





Distribution Coefficients for U-238

Contaminated Zone (cm³/g)

Unsaturated Zone 1 (cm³/g)

Unsaturated Zone 2 (cm³/g)

Saturation Zone (cm³/g)

Leach Rates (/yr)

4400 (cm³/g)

RESRAD, Appendix E, Table E-5, pp 174. For uranium, pH = 6.5

 $10 (cm^3/g)$

 $10 (cm^3/g)$

50 (cm³/g)

Default values

0 (/yr)



Distribution Coefficients for Ac-227

Contaminated Zone (cm3/g)

Unsaturated Zone 1 (cm³/g)

Unsaturated Zone 2 (cm3/g)

Saturation Zone (cm³/g)

Leach Rates (/yr).

20 (cm³/g) RESRAD Default 20 (cm³/g) 20 (cm³/g) RESRAD Default 20 (cm3/g) RESRAD Default values

0 (/yr)





Distribution Coefficients for Pb-210

Contaminated Zone (cm3/g)

Unsaturated Zone 1 (cm³/g) Unsaturated Zone 2 (cm³/g)

Saturation Zone (cm³/g)

Leach Rates (/yr)

100 (cm³/g) RESRAD Default 100 (cm³/g) 100 (cm³/g) RESRAD Default 10,000 (cm3/g) RESRAD Default values 0 (/yr)



Distribution Coefficients for Pa-231

Contaminated Zone (cm3/g)

Unsaturated Zone 1 (cm³/g) Unsaturated Zone 2 (cm³/g)

Saturation Zone (cm³/g)

Leach Rates (/yr)

50 (cm³/g) RESRAD Default 50 (cm³/g) 50 (cm³/g) RESRAD Default 50 (cm³/g) Default values

0 (/yr)

Distribution Coefficients for Th-230

Contaminated Zone (cm3/g)

Unsaturated Zone 1 (cm³/g)

Unsaturated Zone 2 (cm³/g)

Saturation Zone (cm3/g)

Leach Rates (/yr)

160,000 (cm³/g) RESRAD Detault 160,000 (cm³/g) 160,000 (cm³/g) RESRAD Default 60,000 (cm³/g) Default values 0 (/yr)







Distribution Coefficients for Ra-226

Contaminated Zone (cm³/g)

Unsaturated Zone 1 (cm³/g) Unsaturated Zone 2 (cm³/g)

Saturation Zone (cm³/g)

Leach Rates (/yr)

Inhalation Rate (m³/yr)

Mass Loading for Inhaled Dust

Occupancy and Shielding Factor

Occupancy Factor - Inhalation

Shape Factor - External Gamma

Mixing Height for Dust (m)

70 (cm³/g) RESRAD Default 70 (cm³/g) 70 (cm³/g) RESRAD Default 100 (cm³/g) Default values 0 (/yr) RESRAD calculates the leach rates based upon the distribution coefficients of the contaminated zone 8,400 (m³/yr) RESRAD default

CLOSURE CELL

6e-1

RESRAD default, pp 72

0.45

RESRAD default, pp 72

1

RESRAD defauit, pp 72

3 m

RESRAD default, pp 72





Consumption

Fruits, Veggies, Grains1 (kg/yr)

Leafy Veggies (kg/yr)

Milk (L/yr)

Meat and Poultry (kg/yr)

Fish¹ (kg/yr)

Other Aquatic¹ (kg/yr)

Drinking H₂O¹ (L/yr)

Fraction H₀O from Site

Fraction Aquatic Foods

160 kg/yr National avg 14 kg/yr National avg 92 L/yr National avg 63 kg/yr National avg 5.4 kg/yr National avg 0.9 kg/yr National avg 510 L/yr National average 1

CLOSURE CELL

All drinking water taken from a well on site

0.5

National avg, RESRAD pp 72

Fraction of aquatic foods taken from a pond on site





Livestock

Fodder Meat (kg/day) Milk (kg/day)

Water Intake Meat (L/day) Milk (L/day)

Foliar Deposition g/m3

Depth of Soil Mixing Layer

Drinking Water Fraction for Groundwater

Livestock Water Fraction for Groundwater

Irrigation Water Fraction for Groundwater

68 kg/day 55 kg/day

National avg

50 L/day 160 L/day

National avg

0.0001 g/m³

RESRAD default

0.15 m

1

Fraction of drinking water taken from groundwater on site

1

Fraction of drinking water taken from groundwater on site

1

Fraction of groundwater used for irrigation on site



CLOSURE CELL

APPENDIX C

CLOSURE COST ESTIMATE

		TABLE 1	4.1-1			
	CONTINGENT	CIOCIDE	COCT DOTTM	ATTE CITMMAD	v	
	CONTINGENT	CHOSORE	COSI ESIIM	ALE SUPPAR	1	
	ITEM	UNIT	QUANTITY	UNIT	COSTS	SUBTOTALS
	na para mandra da far da su su da far ann an an air air air air ann an	an a		COST	and an easily in the second	
*	SITE PREPARATION					
	CONTRACTOR	ls		\$85,000.00	\$85,000.00	
	MOB/DEMOB	A - 1 - 1		400,000.00	+00,000.00	
	CONSTRUCT DECON.	5.¥.	200.00	\$61.00	\$12,200.00	
	AREA			401.00	T121200.00	
	CONSTRUCT TEMPORARY	1.1.	250.00	\$5.50	\$1,375.00	
	STORMWATER CONTROLS		200.00		41,010.00	
	SUBTOTAL =				No operated without the addition of the control of the second second second second second second second second	\$98,575.0
	STORMWATER COLLECTION					
	STORMWATER COLLECTION					
	SEWER PIPE	1.1.	1000.00	\$30.00	\$30,000.00	
	CATCH BASINS	ea.	6.00	\$1,800.00	\$10,800.00	
	SUBTOTAL =				PARTY BAR WALLEAST BY AN AND AND AND AND	\$40,800.0
	SURVEYING GRID	-				
	SYSTEM AND LIFT	daily	264	\$300.00	\$79,200.00	
	COORDINATES					\$79,200.0
+	DEWATERING					
	PUMP WATER FROM	day	50	\$1,100.00	\$55,000.00	
	PONDS					
	SUBTOTAL					\$55,000.0
	CONSTRUCTION WATER MANA	GEMENT SYST	EM			
			1			
	CLARIFER	ea	1	\$8,000.00	\$8,000.00	
	BAG FILTER	ea	2	\$5,000.00	\$10,000.00	A list and a list of the
	PIPING	ls	1	\$5,000.00	\$5,000.00	
	FRAC TANKS	mo.	5	\$500.00	\$2,500.00	
	OPERATION	ls	1	\$18,000.00	\$18,000.00	
	SUBTOTAL =					\$43,500.0
			and the second s			
ê.	DECON LARGE DEBRIS	1 <u>6</u> .		\$15,000.00	\$15,000.00	
	A the second sec	A strange	1			\$15,000.0
	EXCAVATE CONTAMINATED S	DIL & STOCKPIL	E 19000	\$25.00	\$475,000.00	
	SUBTOTAL =					\$475,000.0

	TABLE	14.1-1			
		1			
CONTINGENT	CLOSURE	COST ESTIM	ATE SUMMAR	Y	
ITEM	UNIT	QUANTITY	UNIT	COSTS	SUBTOTALS
LINER CONSTRUCTION					
V-1 CELL					
LEACHATE DETECTION/COLLEC	TION				
- PIPING	1.f	540	\$6.60	\$3,564.00	
STONE	c.y.	60	\$17.00	\$1,020.00	
FABRIC	s.t.	2960	\$0.50	\$1,480.00	
100 MIL HDPE	s.t.	2310	\$Q.85	\$1,963.50	
- SUMPS	ea.	Ĩ.	\$2,500.00	\$5,000.00	
ALARM	ea.	2	\$2,000.00	\$4,000.00	
PUMP	ea.	2	\$1,000.00	\$2,000.00	
COMPACTED CLAY	c.y.	9600	\$8.00	\$76,800.00	
60 MIL HDPE	s.f.	138000	\$0.60	\$82,800.00	
FABRIC	s.t.	69000	\$0.50	\$34,500.00	
GEONET	s.f.	138000	\$0.52	\$71,760.00	
TYPE D SAND	C.V.	2075	\$6.00	\$12,450.00	
ANCHOR TRENCH	Lt.	1000	\$65.00	\$65,000.00	
	-				1000 007 1
SUBTOTAL =					\$362,337.
BURN POND CELL					
LEACHATE DETECTION/COLLEC	TION				
- PIPING	1.4	460	\$6.60	\$3,036.00	
- STONE	c.y.	60	\$17.00	\$1,020.00	
- FABRIC	s.t.	3070	\$C.50	\$1,535.00	
- 100 MIL HDPE	s.†.	2400	\$0.85	\$2,040.00	
SUMPS	ea.	2	\$2,500.00	\$5,000.00	
- ALARM	ea.	2	\$2,000.00	\$4,000.00	
- PUMP	ea.	2	\$1,000.00	\$2,000.00	
COMPACTED CLAY	c.y.	12350	\$8.00	\$98,800.00	
60 Mit HDPE	s.t.	187740	\$0.60	\$112,644.00	
FABRIC	s.t.	111090	\$0.50	\$55,545.00	
GEONET	s.f.	187740	\$0.52	\$97,624.80	
TYPE D SAND	C.Y.	2840	\$6.00	\$17,040.00	
ANCHOR TRENCH	L.f.	1230	\$65.00	\$79,950.00	
DUDTOTAL				NOTION - REMERLINGING THE PARTY	6480 224
SUBTOTAL =	dimensioners.		and the second s	and a start of the	\$480,234.8





	TABLE]	4.1-1			
 COLUMN TATOTTAND	NOOTE	COOR DONTH	APPO CITAMA D	v	
CONTINGENT C	LOSURE	COST ESTIM	AIE SUMMAR	I	
 ITEM	UNIT	QUANTITY	UNIT	COSTS	SUBTOTALS
 COUTE COLL	And the support of the second s		COST		
CELITE CELL LEACHATE DETECTION/COLLECTI	ON			a second a second	
	1.1	575	\$6.60	\$3,795.00	
- STONE	C.V.	80	\$17.00	\$1,360.00	
	s.f.	2600	\$0.50	\$1,300.00	
	s.f.	2600	\$0.85	\$2,210.00	
		2000	\$2,500.00	\$5,000.00	
	68.	2	\$2,000.00	\$4,000.00	
ALARM	ea.	2	\$1,000.00	\$2,000.00	
- PUMP	68.	4560	\$8.00	\$36,480.00	
COMPACTED CLAY	c.v.	104000	\$0.60	\$62,400.00	
60 MIL HDPE	s.f.	52000	\$0.50	\$26,000.00	
FABRIC	s.f.	104000	\$0.52	\$54,080.00	
GEONET	and the second se	1500	\$6.00	\$9,000.00	
TYPE D SAND	C.Y.	758	\$65.00	\$49,270.00	
ANCHOR TRENCH	1.4.	/00	000.00	945,270.00	
SUBTOTAL =				a most the reservation for the state of the particular state of the	\$256,895.
STORAGE TANK & FOUNDATION	le.	1	\$30,000.00	\$30,000.00	
	85	5	\$3,000.00	\$15,000.00	
PUMP	ea	2	\$1,500.00	\$3,000.00	
FILTER	ea Lf.	1400	\$45.00	\$63,000.00	
PIPING	ea	100	\$125.00	\$12,500.00	
INSTRUMENTATION	éa	15	\$400.00	\$6,000.00	
					\$129,500.
SUBTOTAL =					1120,000.
SUBTOTAL FOR ALL CELLS =			press	\$866,629.80	
DREDGE &/OR EXCAVATE SLUDO	SE TO S/S AR	EA			
· CELITE & DEEPWELL POND	с.у.	6352	\$40.00	\$254,080.00	
+ V-1 CELL	c.y.	9900	\$40.00	\$396,000.00	
- BURN POND	c.y.	14720	\$40.00	\$588,800.00	
SLUDGE PROCESSING					
- CELITE & DEEPWELL POND	c.y.	6352	\$65.00	\$412,880.00	and the second second
- V-1 CELL	C.Y.	9900	\$65.00	\$643,500.00	
- BURN POND	ç.y.	14720	\$65.00	\$956,800.00	
					\$3,252,060.



		TABLE 1	4.1-1			
	CONTINGENT	CLOSURE	COST ESTIM	ATE SUMMAR	Y	
	ITEM	UNIT	QUANTITY	UNIT COST	COSTS	SUBTOTALS
-	TRANS. SLUDGE FROM S/S AI	REA TO CELL				
	- CELITE & DEEPWELL POND	C.V.	12068.80	\$8.00	\$96,550.40	
	- V-1 CELL	c.y.	17820.00	\$8.00	\$142,560.00	
	- BURN POND	с.у.	30912.00	\$8.00	\$247,296.00	
	SUBTOTAL »					\$486,406.4
	TRANSPORT SOIL TO, AND PL	ACE SOIL IN CE	a grade in the second state of the second stat			and the second second
	- CELITE + V-1 CELLS	c.y.	29925	\$25.00	\$748,125.00	
	> DEEPWELL + BURN	c.y.	19000	\$25.00	\$475,000.00	
	SUBTOTAL =					\$1,223,125.0
	CONSTRUCT RCRA COVER					
	V-1 CELL					
	- SUBGRADE PREP.	c.y.	2075	\$6.00	\$12,450.00	
	· COMPACTED CLAY	C.Y.	5550	\$8.00	\$44,400.00	
	- 60 MIL EMB HOPE	s.f.	81200	\$0.75	\$60,900.00	
	- FABRIC	s.f.	81200	\$0.50	\$40,600.00	
	TYPE D SAND	c.y.	2380	\$14.00	\$33,320.00	
	- TYPE E SEL BKFL	с. у ,	2780	\$6.40	\$17,792.00	
	DRAIN PIPE	L.f.	380	\$6.60	\$2,508.00	
	TOPSOIL	c.y.	2120	\$5.40	\$11,448.00	
	GRADING	C. V.	2120	\$3.60	\$7,632.00	
	- SEED & MULCH	acre	.2	\$2,500.00	\$5,000.00	
	SUBTOTAL =					\$236,050.0
	BURN POND CELL					
				20.00	617.040.00	
	- SUBGRADE PREP.	C.Y.	2840	\$5.00	\$17,040.00	
	COMPACTED CLAY	C.y.	5680	\$8.00	\$45,440.00	
	60 MIL EMB HDPE	s.t.	76700	\$0.75	\$38,350.00	
	FABRIC	s.f.	2840	\$14.00	\$39,760.00	
	TYPE D SAND	C.Y.	3780	\$6.40	\$24,192.00	
	TYPE E SEL BKFL	C.Y.	450	\$6.60	\$2,970.00	
	- DRAIN PIPE	1.1.	1900	\$5.40	\$10,250.00	
	- TOPSOIL	C.Y.	1900	\$3.60	\$6,840.00	
	- GRADING - SEED & MI/LCH	c.y. acre	3	\$2,500.00	\$7,500.00	
	DEED B MILLER	MATO .		A RECEIVE		
	SUBTOTAL =				na mana minana minana kaominin' na dia mandritria dia mandritria dia mandritria.	\$249,877.0



		TABLE 1	4.1-1			
		ar o arma				
	CONTINGENT	CLOSURE	COST ESTIM	ATE SUMMAR	Î	
	ITEM	UNIT	QUANTITY	UNIT	COSTS	SUBTOTALS
*****	CELITE CELL			0001	and a state of the	
	The field of the Control of the local second s					
	- SUBGRADE PREP.	g.y.	700	\$6.00	\$4,200.00	
	- COMPACTED CLAY	C.Y.	3732	\$8.00	\$29,856.00	
	- 60 MIL EMB HDPE	s.f.	44000	\$1.00	\$44,000.00	
	FABRIC	s.f.	52000	\$0.75	\$39,000.00	
	TYPE D SAND	c.y.	1600	\$20.00	\$32,000.00	
	- TYPE E SEL BKFL	c.y.	3359	\$6.40	\$21,497.60	
	- DRAIN PIPE	1.f.	400	\$6.60	\$2,640.00	
	TOPSOIL	c.y.	1250	\$5.40	\$6,750.00	
	GRADING	c.y.	1250	\$3.60	\$4,500.00	
	- SEED & MULCH	acre	2	\$2,500.00	\$5,000.00	
	SUBTOTAL =					\$189,443.6
	INTERCEPTOR DITCH					
	V-1 CELL	1.f.	550	\$12.74	\$7,007.00	
	BURN POND CELL	Lf.	770	\$12.74	\$9,809.80	
	CELITE CELL		450	\$12.74	\$5,733.00	
	SUBTOTAL =					\$22,549.8
	BORROW MATERIAL TESTING					
	DENSITY (FIELD)	dav	200	\$160.00	\$32,000.00	
	PROCTOR (LAB)	ea	70	\$120.00	\$8,400.00	
	SIEVES & LIMITS	ea	70	\$90.00	\$6,300.00	
	VOLATILE ORGANICS	ea	70	\$350.00	\$24,500.00	
	TPH	ea	70	\$90.00	\$6,300.00	
	SUBTOTAL =			51494		\$77,500.0
	DEDAME A DILITY TEETING					
	PERMEABILITY TESTING					
	FIELD ASTM D 3385	ea	15	\$500.00	\$7,500.00	
	LAB (FALLING HEAD)	63	2.2	\$500.00	\$11,000.00	
	SUBTOTAL =			arenta	Conductor I Anna Constanti di Contanta da Andre Se	\$18,500.0
	DEALTH & CACETU	Anti	400	\$100.00	\$40,000.00	
	HEALTH & SAFETY MONITORING	day	400	\$100.00	940,000.00	\$40,000.0



		TABLE 1	14.1-1			
	CONTINGENT	CLOSIRE	COST ESTIM	ATE SUMMAR	Y	
	CONTRACTO					
	ITEM	UNIT	QUANTITY	UNIT	COSTS	SUBTOTALS
*	ANALYTICAL WORK	and design to the second spin and the second spin a se				
	\$/\$	68	200	\$1,500.00	\$300,000.00	
	CHEMICAL	69	300	\$1,200.00	\$360,000.00	and the same the same of the same of the
	RADIOLGICAL	ea	700	\$180.00	\$126,000.00	
			have been and the second se			
	SUBTOTAL =					\$786,000.00
					والمراجع وسأرب المحاوم والمحاور والسواب	
*	CERTIFICATION & INSPECTION					
	REPORT	ls,		\$175,000.00	\$175,000.00	
					of ensited but are group with run or all the title op any conversion	\$175,000.00
		and a second second second	here was a second second			
	PROJECT SUBTOTAL =					\$8,792,554.10
<i>A</i> .	CONSTRUCTION & INSPECTION	N	and a second	7.00%	\$615,478.79	
	MANAGEMENT	%	and a surprise of the second se	7.00%	2010,478.79	\$615,478.79
					and a second descent pro-	9010,470.75
-	ENGINEERING DURING	ls.			\$120,000.00	and a second second
	CONSTRUCTION	10.			1120/000.00	\$120,000.00
					IN A WILL DESCRIPTION OF DESCRIPTION OF DESCRIPTION	
	SUBTOTAL =					\$9,528,032.85
	STOLET STIFFE					
	CONTINGENCY	%		20.00%	\$1,905,606.58	
						\$1,905,606.58
EST	IMATED CLOSURE COST		182			\$11,433,639.00







Health and Safety PLAN

BP Chemicals, Inc. Lima, Ohio

• • • • •

Revision 1 December 1993

Prepared by: B. Koh & Associates, Inc.

PROJECT NAME AND SITE LOCATION

BP Chemicals, Inc. Remediation Project Lima, Ohio

APPROVED

BP Chemicals, Inc.

HEALTH, SAFETY AND ENVIRONMENTAL MANAGER

HUGH M. BLYTHE

w1 2/9/94 Signature / Date

RADIATION SAFETY OFFICER

JOSEPH H. MARTZ

Signature / Date

PLANT INDUSTRIAL HYGIENIST

DEBORAH A. REFSON

10 - 3-11-94 Signature / Date



93-001.BP.LL

Revision 1, December 1993

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М	Monitoring for Personal Contamination



1.0 PURPOSE

The purpose of the BP Chemicals. Inc. (hereafter BPCI) Health and Safety Plan and related Appendices is to assign responsibilities, establish personnel protection standards and mandatory safety practices and procedures, and set forth the regulatory requirements for decommissioning and closure operations at BPCI in Lima, Ohio (see Figure 1-1).

The basic radiation control and protection practices to be implemented by BPCI and Contractor personnel during the decommissioning and closure operations are specified in the Radiological Control Plan (Appendix A). Compliance to these practices will ensure that remediation activities will be conducted in a safe and efficient manner.

BPCI is responsible for the use and control of the radioactive materials at the BPCI site in Lima, Ohio throughout the decommissioning and closure efforts. Such activities and tasks will be conducted in accordance with written procedures reviewed and accepted by authorized BPCI management personnel designated herein who are responsible for the work. At no time shall BPCI personnel. Contractor personnel or subcontractor personnel, in any way violate or deviate from the procedures or requirements set forth in this Health and Safety Plan.

1.1 ALARA Program

1.1.1 Policy

It is the policy of BPCI to maintain individual and collective radiation doses below regulatory limits and as low as reasonably achievable (ALARA). As such, all decommissioning and closure operations performed by BPCI, the Contractor and all subcontractors at the BPCI site shall be preplanned in advance and accepted by BPCI. Control of radiation exposure is based on the assumption that any exposure to ionizing radiation involves some risk. However, occupational exposure within regulatory limits represents a very small risk compared to the voluntarily accepted hazards of normal life.

Consistent with Regulatory Guide 8.8. it is the policy of BPCI to place primary emphasis on design and engineering features to maintain exposures ALARA. When practical, design features are selected in lieu of process controls to maintain exposures ALARA.

Contractors and subcontractor organizations are required either to address the BPCI ALARA Policy and Program elements in their implementing plans and procedures, as applicable, or comply directly with the BPCI ALARA Program requirements (see Section 2.0).

A more detailed description of the BPCI ALARA Program is provided in the BPCI Radiological Control Plan (Appendix A).



1.1.2 ALARA Program

The BPCI ALARA program provides:

- A program that integrates management philosophy and regulatory requirements, including specific goals and objectives for implementation.
- An effective measurement system that is used to determine the degree of success achieved by decommissioning and closure activities with regard to the program goals and specific objectives.
- Assurance that the measurement system results are reviewed on a periodic basis and that corrective actions are taken when attainment of the specific objectives appears to be jeopardized.
- The authority for providing procedures and practices by which the specific goals and objectives to be achieved is delegated.
- Assurance that the resources needed to achieve goals and objectives to maintain occupational radiation exposures and radioactive releases ALARA are made available.
- The coordinating effort among the different Contractor and subcontractor organizations for the implementation of ALARA goals.
- Assurance that available data and experience relating to ALARA from similar decommissioning and closure activities is considered.

1.1.3 Responsibilities of All BPCI and BPCI Contractor Personnel

Each BPCI and BPCI Contractor personnel is responsible for:

- Maintaining an awareness of his or her current radiation exposure and exposure limit.
- Maintaining his or her radiation exposure below established limits and not knowingly exceeding administrative exposure guides without proper authorization.
- Taking reasonable care to maintain his or her radiation exposure ALARA through proper use of time, distance and shielding.
- Advising BPCI management and BPCI Contractor management of sources of unnecessary radiation exposure so that such sources can be eliminated or reduced.

1.1.4 ALARA Goals

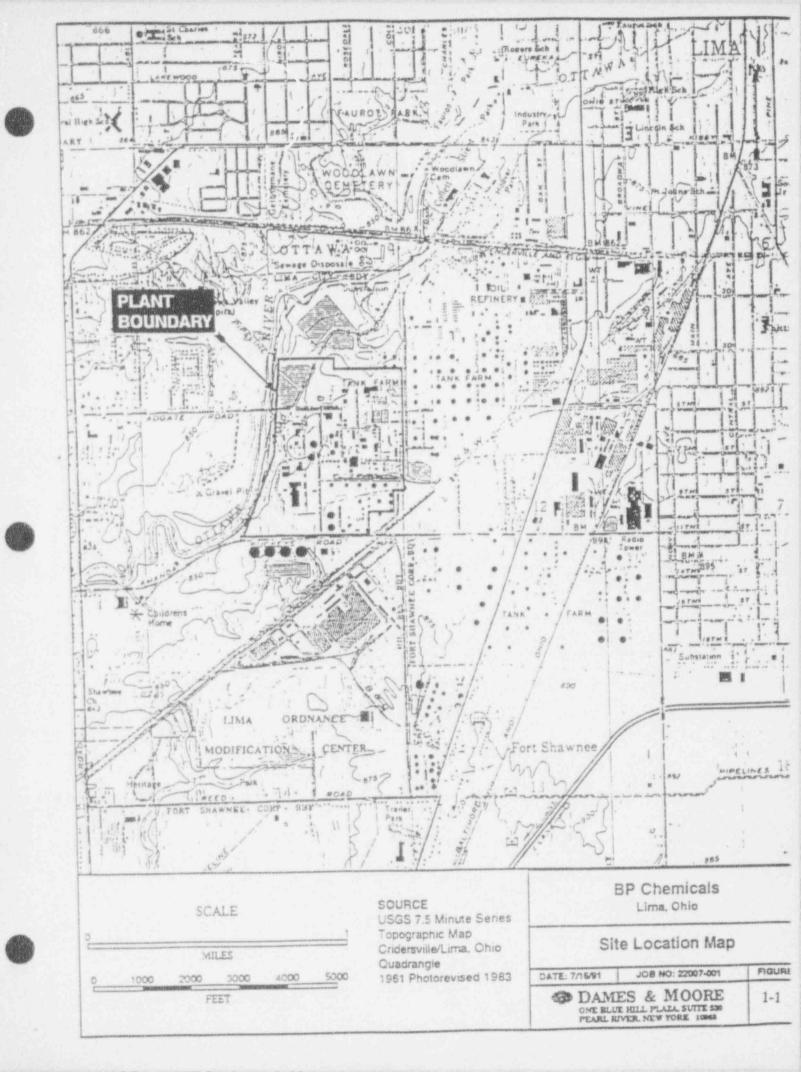
A radiation exposure goals program is established to assist BPCI management and staff in achieving measurable and cost-effective results in maintaining exposures ALARA by:

- Identifying those activities that, because of individual or collective exposures, warrant the most exposure reduction planning and action.
- Involving all BPCI personnel and BPCI Contractor personnel in radiation exposure reduction actions.
- Providing a means of measuring performance of the ALAKA program so that successful techniques can be continued and unsuccessful techniques discarded or changed.

1.1.5 ALARA Review Program

 Review standards should be developed as appropriate and used in evaluating decommissioning ind closure activities to ensure that ALARA considerations are incorporated into future remediation activities.





2.0 APPLICABILITY

The provisions of this Health and Safety Plan and related Appendices are mandatory for all on-site employees engaged in decommissioning and closure operations, and demobilization. This plan has been developed under U.S. Environmental Protection Agency (USEPA) guidelines and complies with applicable safety and health regulations, including OSHA 29 CFR 1910, the recent 29 CFR 1910,120 final rule, and 29 CFR 1926 standards. This plan also complies with the regulations contained in the U.S. Nuclear Regulatory Commission (USNRC) Title 10 CFR 19, the new 10 CFR 20 (May 1991) and applicable USNRC regulatory guides, branch technical positions and guideline documents.

Appendix A of this plan establishes the minimum Radiological Control Program requirements to be complied with by BPCI. Contractor and subcontractor personnel.

At the discretion of BPCI, a Contractor will either:

Prepare his own Health and Safety Plan and Radiological Control Plan (if work involves radioactivity
or exposure to radiation) and related procedures. The Contractor-prepared documents will be
consistent with the requirements specified in the BPCI Health and Safety Plan, Radiological Control
Plan and related procedures. In addition, the Contractor documents must be reviewed and accepted
by BPCI prior to starting field activities.

OF

 Follow the requirements contained in the BPCI Health and Safety Plan, Radiological Control Plan and related procedures. Thus, the Contractor will comply with the BPCI documents directly.

It is also BPCI discretion as to the level of effort or services that BPCI will provide to the Contractor responsible for performing the assigned work. In all cases, however, work performed by BPCI personnel or Contractor personnel will be conducted in compliance with an approved Health and Safety Plan, Radiological Control Plan (when required) and related procedures.

2.1 Review and Approval of the BPCI Health and Safety Plan

Prior to initiation of site activities, the BPCI Health and Safety Plan will be approved by BPCI management as confirmed by the signatures on the cover. This plan will also be reviewed and approved by Ohio EPA and the USNRC. In addition, the Contractor's Health and Safety Plan, Radiological Control Plan, and related implementing procedures will be reviewed and accepted by designated BPCI management personnel as described in Section 2.2 prior to start of work.

In accordance with 10 CFR 20.1101(c), the BPCI radiation protection program contents, as described in this Health and Safety Plan, the Radiological Control Plan and related Appendices, and the implementation of the program will be reviewed on an annual basis.



2.2 Review and Acceptance of Contractor's Plans

2.2.1 BPCI Acceptance of Contractor's Original Documents

When required. BPCI will review for acceptance Contractor procedural documents including the Health and Safety Plan, the Radiological Control Plan, and related procedures for conformance with the requirements of the BPCI Health and Safety Plan and related Appendices, including the BPCI Radiological Control Plan (Appendix A). The procedure for compliance review and acceptance will consist of reviews and sign-offs by assigned qualified BPCI health and safety and radiological safety professionals. The scope of the review will consist of confirming that the plans proposed by the Contractor are consistent with the regulatory requirements and practices set forth herein. The BPCI Construction Manager will sign off the documents to confirm that all reviews have been performed. In addition to the BPCI Construction Manager, the following personnel will be assigned to review and signoff on all Contractor procedural documents:

- BPCI Health and Industrial Hygienist
- BPCI Radiation Safety Officer

The BPCI Construction Manager will be responsible for the distribution of Contractor documents to the reviewing personnel and the resolution of comments received from them. Reviewing personnel comments will be communicated to the affected responsible Contractor through the BPCI Construction Manager. These comments will be satisfactorily addressed by the Contractor to produce a document that is: consistent with the requirements of this Health and Safety Plan; and acceptable for sign-off by the BPCI Construction Manager and other authorized BPCI personnel.

The review and acceptance of Contractor procedural documents will be documented by an acceptance block on the cover page of the document. The acceptance block format (Form 7-1) is contained in Section 7.0.

2.2.2 Revisions to Contractor's Original Documents

If changes are proposed to the Contractor's procedural documents including the Health and Safety Plan, Radiological Control Plan, and related health and safety/radiological control procedures, the proposed page changes will be submitted to the BPCI Construction Manager. To avoid repagination of the original document, the Contractor will use decimal numbering for the additional pages that may be generated by the revisions. For example if two new pages are added following page 18, they would be numbered 18.1 and 18.2. Each revised page will include an acceptance line at the bottom of the page. Proper page revision formatting (Form 7-2) is contained in Section 7.0.

The BPCI Construction Manager will distribute the changes to each of the designated BPCI reviewers. Reviewer comments will be communicated to the responsible Contractor via the BPCI Construction Manager. At the conclusion of the review process, each reviewer will sign the acceptance line and return the page to the BPCI Construction Manager. Upon receipt of all signed off copies the BPCI Construction Manager will sign and date the revised pages to the document (or the entire revised document, if appropriate) and transmit the document(s) via controlled distribution to the Contractor. He will also place the reviewer sign off sheets in the BPCI Project Procedures File.



The Contractor will incorporate the revisions into the original document and maintain the document current at the work location.

2.2.3 Qualifications for Signatory Personnel

In addition to the BPCI Construction Manager, the Contractor's procedural document will be reviewed by the BPCI Radiation Safety Officer and Industrial Hygienist. Contractor procedural documents will be reviewed by the BPCI Radiation Safety Officer (RSO) for compliance related to radiological safety. The BPCI Industrial Hygienist will review the Contractor documents for general health and safety compliance. The qualifications of the reviewers are described below:

2.2.3.1 BPCI Radiation Safety Officer

The Radiation Safety Officer (RSO) shall possess a B.S. in Engineering or Science and have at least four years of applied radiation protection experience. In addition, the RSO shall have successfully completed an Ohmart Technical Training School Radiation Safety Course (or equivalent), including principles and practices of radiation protection, radioactivity measurement and monitoring, mathematics, biological effects of radiation, NRC regulations, waste disposal and emergency procedures.

2.2.3.2 BPCI Industrial Hygienist

The BPCI Plant Industrial Hygienist shall possess a BS degree in engineering or science and have at least four years of experience in applied industrial hygiene or industrial safety.

2.2.4 Authorized Signatory Personnel

Individuals from each category on the following list shall have authority to review and sign off Contractor documents. Following are the names, signatures and initials of each individual:

BPCI Radiation Safety Officers (All Projects)

J.H. Martz (Designee)

Marti IHM

R.J. Ryan (Alternate)

V. Ryan KICK

BPCI Industrial Hygienist (All Projects)

D.A. Refson J. Sidson DAR

BPCI Construction Manager (Mixed Waste Pond Closure Project)

P. C. Campbell la fuer pel

2.3 General Requirements

BPCI Contractor(s) will provide and/or impose the following general health and safety requirements on its employees and all of its subcontractors and their employees. Compliance with these requirements will be verified by BPCI by plan/procedure review prior to and during the course of the work in accordance with Section 2.2 and through audits and surveillances during the course of the work in accordance with Section 5.8.

- a. Personnel working on the site must have had an annual physical (or doctor's waiver for biennial physical), and be certified Fit for Duty, and Fit for Respirator Use, if necessary, by a qualified physician.
- b All employees must have appropriate training (i.e., either a 40-hour or 24-hour OSHA-required (29 CFR 1910.120) Health and Safety course for hazardous waste work or certified equivalent training) and radiation worker training as per Section 2.3.2.
- c. Work will not begin until employees are briefed on the BPCI Health and Safety Plan, have read and understood it, and signed the Plan Acceptance Form (Form 7-3) and the Prenatal Exposure Instructions Form (Form 7-4) in Section 7.0. Any feedback on the Plan from an employee will be recorded on a Plan Feedback Form (Form 7-5).
- d. Field operations must meet applicable safety standards and satisfy BPCI field inspection. Unsafe equipment or operations will necessitate shutting down the job at a cost to the Contractor.

2.3.1 Dosimetry Program

Prior to the start of any work with radioactive materials, the Contractor will prepare, and have accepted by BPCI, a dosimetry program, which is consistent with this Health and Safety Plan, the Radiological Control Plan (Appendix A), 10 CFR 20.1501 and 1502, USNRC Regulatory Guide 10.4, Items 10.1 and 10.4, and the terms of BPCI license with the USNRC. BPCI will review the Contractor dosimetry program to assure compliance with these requirements.

The employee will not begin work until the employee:

- has provided evidence of the physical Fit for Duty and Fit for Respirator Use;
- has successfully passed the Radiation Worker training course (test score of 80% or higher);
- has completed USNRC's Form 4;
- has provided a urine sample (for baseline bioassay); and
- has been assigned appropriate dosimetry in accordance with the approved dosimetry program as specified above.

All employees upon permanent departure from the project will turn in dosimetry and provide a urine sample for closeout bioassay.

2.3.2 Radiation Worker Training

A Radiation Safety Training Course provided by BPCI will consist of classroom and practical training and will be in accordance with 10 CFR Part 19.12 and USNRC Regulatory Guide 10.4 Item 8 and the BPCI Radiological Control Plan (Appendix A). At BPCI's discretion, the Contractor may be authorized to provide the training. Prior to implementation of a Contractor-provided training course, BPCI will review and accept the Contractor's training course content for compliance with the following content requirements (a. through k. below). BPCI will also verify that the Contractor provides qualified instructors, as defined by 10 CFR Part 40.32(b) and USNRC Regulatory Guide 10.4 Item 7, to conduct radiation safety training. The basic training course content requirements include:

- a Basic principles of Radiation Physics.
- b. Biological effects and health risks.
- Exposure and contamination control and limits (including Embryo/Fetus Exposure Regulatory Guide 8.13).
- d. ALARA.
- e. Personnel monitoring and dosimetry (including bioassay).
- f. Postings and signs.
- g. Proper use of protective clothing.
- h Decontamination.
- i. Use of Radiation Work Permits.
- j. Rights and Duties of Radiation Workers (10 CFR 19).
- k. Emergency Procedures.

Each worker's knowledge, competency and understanding of the above listed radiation protection areas will be evaluated. A written "criterion referenced" test will be administered to document adequate understanding of the subjects covered. Satisfactory completion is indicated by a test score of 80% or greater.

2.3.3 Respiratory Protection Program

To the extent practical, the Contractor will implement engineering controls and work practices to maintain employee exposures below permissible exposure limits for substances regulated by 29 CFR Part 1910 and below the occupational dose limits defined in 10 CFR Part 20.1201 and the concentrations specified in Appendix B. Table I, Column 3 of 10 CFR 20.

When engineering controls are not feasible, personal protective equipment will be employed to reduce and maintain employee exposures below applicable limits for the constituents of concern identified at the site. A respiratory protection program in compliance with 10 CFR Part 20.1703, as well as 29 CFR 1910.120 regulations, will be developed and implemented, as required.

The BPCI Radiological Control Plan (Appendix A) contains the minimum requirements for a Respiratory Protection Program.

2.3.4 Worker Qualifications

The Contractor will insist on seeing documentation of both training and a physical including "Fit for Duty" and "Fit for Respirator Use" before allowing a worker to start work on-site. BPCI will audit the Contractor's records to verify compliance.

The BPCI Radiological Control Plan (Appendix A) contains the minimum requirements for worker qualifications.

2.3.5 Contractor's Obligations

If a Contractor chooses not to use the BPCI Health and Safety Plan, the BPCI Radiological Control Plan (Appendix A), and the related health and safety procedures within these plans, he must develop such a document(s) and have the document(s) reviewed and accepted by BPCI prior to starting field activities. The Contractor plan(s)/procedures must be consistent with the requirements specified in the BPCI documents.

The Contractor will provide its subcontractors with a controlled copy of the latest version of each sitespecific Health and Safety Plan, and will also provide subcontractors with site monitoring results as they are obtained in the field (e.g., air quality monitoring, GC data). Subcontractors shall review the information contained in the site-specific Health and Safety Plan and, before commencing field operations, shall communicate to the Contractor any questions regarding the information contained therein, both on factual information presented and its extent. Subcontractors will agree to comply with at least the minimum requirements of the site-specific Health and Safety Plan. The Contractor will be responsible for the health and safety of its own employees. The Contractor agrees to take such additional measures as it deems necessary to at least meet minimum health and safety standards applicable to the services provided if circumstances arise that were unforeseen in the Health and Safety Plan.



The Contractor will, at a minimum, provide safety equipment required in the Health and Safety Plan. When respirators are necessary, the subcontractor will provide a respirator fit test certificate and physician's "fit for respirator use" declaration.

The Contractor agrees to provide BPCI with a completed and signed Contractor/Subcontractor Statement of Compliance (Form 7-6) for all employees used at the site prior to beginning site work (see Section 7.0).

The Contractor agrees to provide BPCI with written acceptance that the information contained in the Health and Safety Plan, when taken in conjunction with Contractor's standard health and safety program and practices is sufficient for subcontractor to perform its operation in a manner consistent with all applicable regulations and the current standard of practice in the industry.

The Contractor will adhere to all applicable procedures for the handling of radioactive materials. Work packages and procedures are to be submitted at least 10 days prior to planned work. The Contractor will also comply with stop work orders issued by the BPCI Site Radiation Safety Officer or his designee.



3.0 SITE DESCRIPTION

3.1 General Information

This Health and Safety Plan provides the radiological, chemical and general safety requirements to be followed during the remediation of the BPCI site. The remediation activities include decontamination of the CAT 21 building, remediation and closure of the corrective action management unit and the remediation and closure of the four surface impoundments. The overall hazard classification assigned to the closure of the surface impoundments is serious. Hazard classification of the other remediation activities will be developed prior to commencement of remediation/decontamination activities (see Section 3.6).

3.2 Site History

BPCI owns and operates an industrial chemicals and integrated nitrogen fertilizer manufacturing complex in Lima, Ohio. The facility has been storing process wastes in four surface impoundments (Deepwell, Burn, Celite and V-1).

All four surface impoundments contain depleted uranium. As a result of previous catalyst manufacturing process which utilized depleted uranium. The Deepwell, Burn and Celite ponds contain EPA listed wastes K011, K013 and K014. The Celite Pond also contains listed U009 waste. The Burn Pond contains listed waste U003 and characteristic waste D003. The V-1 Pond contains characteristic waste D002.

The four surface impoundments, Deepwell, Burn, Celite and V-1, will be closed in accordance with the requirements of Title 40 of Code of Federal Regulation (40 CFR) 265.112 and Ohio Administrative Code (OAC) 3745-66-12, the U.S. Nuclear Regulatory Commission Technical Branch Position published in the Federal Registry Volume 46, Number 205, October 23, 1981, Disposal or On-site Storage of Thorium or Uranium Wastes from Past Operations and 10 CFR 20.2002 (previously 10 CFR 20.302).

Studies have determined that the best method of closure is to consolidate all wastes from the four ponds into as few as two ponds which would be converted to landfills. The liquids from all of the ponds will be pumped and disposed of as hazardous wastes, as appropriate. Sludges from the four ponds will be solidified and stabilized for final disposal in the landfills. The remaining ponds would be decontaminated and released.

3.3 Site Control

BPCI is a limited access installation: access is restricted by fences and manned security gates and only personnel with appropriate identification and training are allowed onto the premises. Therefore, the public is restricted from this site. As plant personnel are on site, provisions to restrict non-essential personnel from site activities will be utilized. As described in the next section, boundaries of site activities will be flagged and nonessential personnel will be restricted from these areas.

3.4 Work Zones

Site activities will be restricted to the facility boundary as shown in Figure 1-1. The Work Zone boundary will be clearly established (e.g., flagging, snow fences, outer security fence, signs) in the immediate area during all closure activities, such as dewatering, excavation and solidification/stabilization of the sludge, liner and cap preparation, etc.)(Figure 3-1).

The work zone shall be further divided into Restricted and Controlled Areas. These areas shall be posted and controlled in accordance with the general requirements outlined in the BPCI Radiological Control Plan (Appendix A) and the procedural requirements specified in Appendix B.

All work zones will be entered in Level C personal protective equipment (PPE) and personal dosimetry. Access and control to work areas shall be maintained via the use of radiation work permits, as outlined in the BPCI Radiological Control Plan (Appendix A) and as specified in Appendix C.

3.5 Facility Description

The hazardous and radiological waste types contained within the four surface impoundments consist of primarily liquids and sludge. The wastes exhibit the following general characteristics:

- Radioactive
- Toxic
- Reactive
- Caustic

There are no unusual site features within the surface impoundment or surrounding areas.

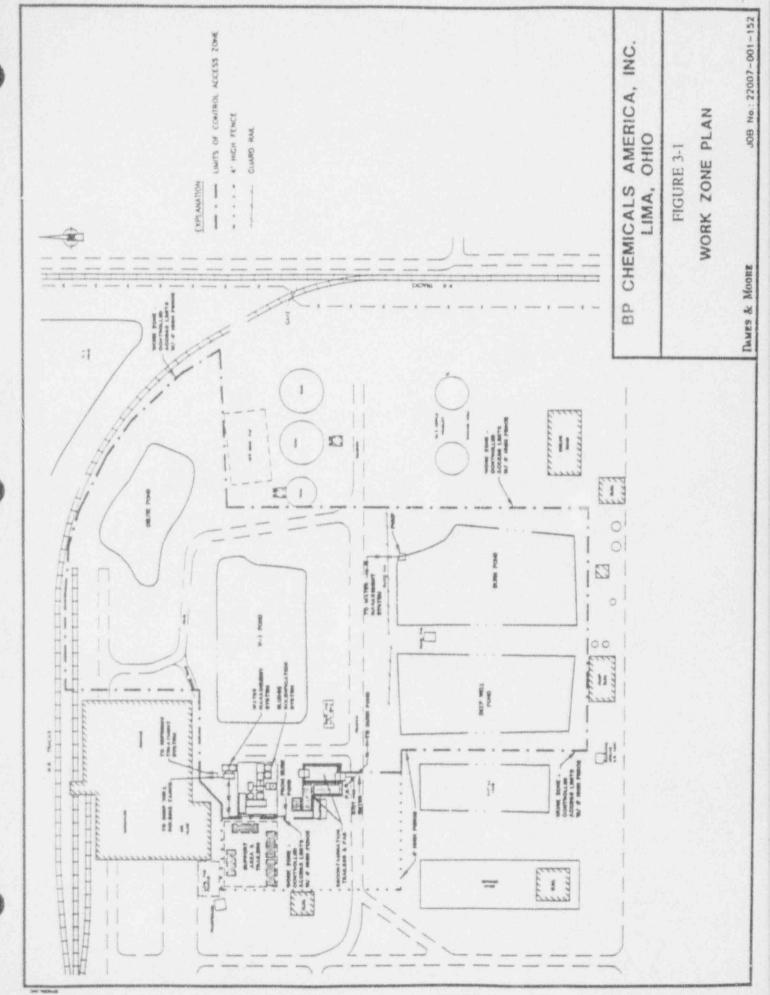
3.6 Hazard Evaluation

As stated in Section 3.2, all of the ponds contain depleted uranium. The Deepwell, Burn and Celite Ponds contain EPA listed wastes K011, K013, and K014. The Celite Pond also contains listed U009. The Burn Pond contains listed waste U003 and characteristic waste D003. The V-1 Pond contains characteristic waste D002. Laboratory analysis of the pond sludges indicated that they contain high levels of total cyanide and moderate levels of various metals and volatile and semi-volatile organic compounds. Exposure limits, recognition qualities, acute effects, and target organs of these contaminants are presented in Tables 1 and 2 in Appendix D.

Standard Safe Work Practices listed in Appendix E must be adhered to at all times.

A health and safety risk analysis for each project task will be prepared in accordance with R Part 1910.120. The analysis includes the physical, chemical and mechanical hazards associated with each task.





4.0 EMERGENCY INFORMATION

4.1 Emergency Planning

Prior to the start of work with radioactive materials, BPCI will contact emergency personnel (e.g., local hospital, ambulance service, local fire department, etc.) to inform them of the nature of the decommissioning and closure activities to be conducted at their site and the health hazards associated with such work. In addition, BPCI will provide radiological emergency kits to the appropriate ambulance service and medical facility. The kit will contain materials to monitor direct radiation exposure, minimize the spread of radioactive materials and monitor for loose contamination.

4.2 Emergency Procedure

If an emergency develops on-site, the procedures as listed in Appendix F should be utilized. Should the situation require outside support services, BPCI will be notified (via Acrylonitrile Room phone number listed below.). BPCI will in turn contact outside support services.

BPCI Radiation Safety Officer or his designee will be continuously available to respond to a radiological emergency, i.e., "on-call." In addition, the Contractor will have a Radiation Safety Officer or his designee at the job site at all times during construction activities.

The Radiation Safety Officer at the site during an emergency that requires outside support services will accompany injured personnel off-site and provide information, as necessary, to emergency support services with regard to radiation safety techniques.

4.3 Emergency Contacts

The BPCI and offsite emergency contacts are listed in Figure 4-1.

4.4 Emergency Route to Hospital

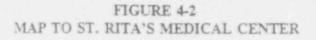
The route to St. Rita's Medical Center is as follows: turn right onto Fort Amanda Road from plant entrance boulevard: proceed north on Fort Amanda Road, which becomes Collett Street, for approximately 1 mile; St. Rita's Medical Center is located on the corner of Market and Collett Streets. The St. Rita's Medical Center address is 730 West Market Street. A map of the specified route is shown on Figure 4-2.

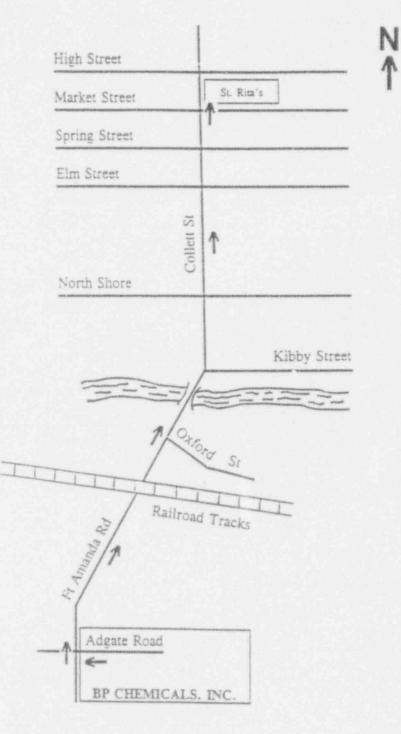


FIGURE 4-1 BPCI AND OFFSITE EMERGENCY CONTACTS

Contact	Person or Agency	Telephone
BPCI Acrylonitrile Control Room	BPCI	(419) 226-1328
BPCI Construction Manager and Emergency Coordinator	Peter J. Campbell	(419) 226-1266 (Plant) (419) 224-6445 (Home)
BPCI Alternate Emergency Coordinator	F. J. Fassel	(419) 226-1242 (Plant) (419) 226-7919 (Home)
BPCI Radiation Safety Officers	J. H. Martz	(419) 226-1241 (Plant) (419) 692-8986 (Home)
	R. J. Ryan	(419) 226-1529 (Plant) (419) 643-3361 (Home)
Police	Allen County Sheriff	911 or (419) 227-3535
Fire	Shawnee Township Fire Department	911 or (419) 991-4055
Hospital	St. Rita's Medical Ctr	(419) 226-9024
Poison Control	St. Rita's Medical Ctr	(419) 226-9024
NRC Region III	Ken Lambert	(708) 829-9853
NRC Headquarters	Sam Nalluswami	(301) 504-2502
Emergency Release Notification	Ohio EPA	(800) 282-9378
National Response Center	USEPA/Coast Guard	(800) 424-8802
BPCI Industrial Hygienist	D. A. Refson	419/226-1243 (Plant) 419/227-7007 (Home)







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5.0 SITE SAFETY WORK PLAN

5.1 Air Monitoring

5.1.1 Monitoring Requirements

5.1.1.1 Chemical

The Contractor Health and Safety Supervisor will conduct air monitoring for the hazards presented in Table 1 of Appendix D. Equipment necessary for monitoring at this site consists of a photoionization detector (PID) (e.g., HNU/Organic Vapor Analyzer), benzene detector tubes and Draeger pumps (with prefilters to filter out non-benzene aromatic compounds), a hydrogen cyanide meter, a particulate monitor, and a combustible gas indicator (CGI). The type of monitoring instruments specified by the hazard and their respective action levels are shown in Table 3 of Appendix D. All ambient measurements taken to evaluate employee exposures must be "downwind" measurements taken in the individual's breathing zone and must be fairly consistent for at least 30 seconds. All monitoring equipment shall be maintained following the procedures outlined in the owner's manual for the specified monitoring equipment.

5.1.1.2 Radiological

In addition, air monitoring will include air sampling for Uranium-238 and its progeny. A weekly 'up wind' background sample and daily 'down wind' sample will be collected through the use of high-volume samplers. Daily samples will be collected using personal air samplers and low volume samplers (<2 CFM) to measure the release of radioactive materials in the work zone. All samples shall be counted for gross alpha and beta activities with equipment sensitive enough to detect 6.0 x 10⁻¹⁴ μ Ci/ml of activity (alpha and beta independently) after correction for background activities. The instrumentation and techniques used to assure that the minimum detectable concentration of airborne radioactivity is below 6.0 x 10⁻¹⁴ μ Ci/ml will be in accordance with the requirements specified in USNRC Regulatory Guide 10.4, Items 10.3 and 10.4 and Report No. 57 from the National Council on Radiation Protection, "Instruments and Monitoring Methods for Radiation Protection." The air sampling information and results of the air samples will be the air sampling documented on Forms 7-7 and 7-8, respectively, as contained in Section 7.0.

For work site samples with activities greater then the above activity arrangements shall be made with an appropriate analytical laboratory to independently verify the activity and isotope(s).

Specific details regarding radiological air monitoring requirements are contained in the BPCI Radiological Control Plan (Appendix A).

5.1.2 Monitoring Schedule

5.1.2.1 Instrument Calibration

All applicable instruments shall be calibrated daily or at intervals according to the manufacturer's instructions. The minimum calibration frequency for all radiation survey equipment will be at intervals not to exceed 7



months or after each repair, whichever is earlier. Readings shall be recorded on the Daily Instrument Calibration Checksheet (Form 7-9) provided in Section 7.0.

5.1.2.2 Background Readings

Before any field activities commence, the background levels of the site will be read and noted on the Air Monitoring Form (Form 7-10, see Section 7.0). Daily background readings shall take place away from areas of potential contamination to obtain accurate results.

Generally, background levels for organic vapors in ambient air should read zero. If background readings indicate higher levels of organic vapors than anticipated, the Contractor Health and Safety Supervisor will determine the source of the readings prior to initiation of on-site activities. This Plan will be amended, as appropriate, to reflect any adjustments necessary as the result of higher than expected background levels.

Background levels for radioactivity in ambient air should be consistent with levels less than 3 x 10^{34} μ Ci/ml for depleted uranium (U^{238}), excluding radon daughters. If background readings indicated higher levels of airborne radioactivity than anticipated, the Contractor Radiation Safety Officer will determine the source of the airborne radioactivity prior to initiation of onsite activities.

5.1.2.3 Air Monitoring Frequency

All site readings may be noted on the Air Monitoring Record Form (Form 7-7, see Section 7.0) along with the date, time, weather conditions, wind direction and speed, if possible, and location where the background level was recorded.

The following frequency should be followed for air monitoring activities as specified for each activity.

Air Monitoring Equipment	Monitoring Frequency (in breathing zone unless indicated otherwise)
Photoionization or Organic Vapor Analyzer	Monitor every 15 minutes
Benzene Detector Tubes and Draeger Pump	When needed as indicated by HNU readings
Hydrogen Cyanide Meter	Continuously
Toxic Dust Meter	Continuously
Combustible Gas Indicator (CGI)	Monitor every 15 minutes at the site of ground-intrusive activities.
Radiological Low volume sampler High volume sampler	Continuously in work zone Continuously at site perimeter

5.2 Levels of Protection

All activities will be initiated in Level C. A minimum of PPE Level D is required for people located on site. The Construction Health and Safety Supervisor may downgrade PPE, as appropriate, if site conditions are amenable. In general, reasons to downgrade PPE include: new information indicating that the situation is less hazardous than originally thought (e.g., measurements on the monitoring equipment are less than the minimum action levels specified in Table 3 of Appendix D over a period of time); a change in site conditions which decreases the hazard; or a change in tasks that will reduce contact or potential contact with hazardous materials. Descriptions of PPE Levels C and D are presented in Table 4 of Appendix D. Personal dosimetry will also be required for all personnel entering a work zone.

5.3 Respiratory Protection

The respiratory program will be in compliance with 10 CFR Part 20.1703, as well as 29 CFR Part 1910 regulations. When respirators are used for the project, the respiratory control factors specified in 10 CFR Part 20.1703(b)(1) and Appendix A of 10 CFR 20 will be used. To the extent possible, the Contractor will implement engineering controls and work practices to maintain employee exposures below permissible exposure limits for substances regulated by 29 CFR Part 1910 and below dose limits defined in 10 CFR 20. When engineering controls are not feasible, personal protective equipment will be employed to reduce and maintain employee exposures below applicable limits for the constituents of concern identified at the site.

Personnel wearing respirators will be required to present proof of respirator fit test, and an annual (or biannual) physical. Respirators belong to, and are only used and maintained by, the individual to whom they have been issued. Every employee who anticipates working on-site must be trained, fit-tested, and declared medically fit to wear respiratory equipment prior to participating in field activities.

All respirators used each day shall be tested for radioactive contamination after each use. This may be accomplished by direct surveying and swipe testing for loose contamination. Contaminated respirators shall be decontaminated immediately and retested, prior to being used again.

Activities will be initiated in Level C. If organic vapors measured in the breathing zone exceed 1 part per million (ppm), use benzene detector tube and Draeger pump. If benzene is detected, evacuate the area for 15 minutes. After 15 minutes, monitor again and if benzene is detected, notify the Contractor Project Manager, the Contractor Health and Safety Supervisor, as well as the BPCI Construction Manager and the BPCI Industrial Hygienist. If hydrogen cyanide is detected, stop work and evacuate the area. Notify the Contractor Project Manager, the Contractor Health and Safety Supervisor, as well as the BPCI Construction Manager and the BPCI Industrial Hygienist. In both of these cases, a reassessment of the situation will be made, including a possible upgrading of respiratory protective equipment. As several of the possible contaminants have poor warning properties, use of an air-purifying respirator may not be appropriate protection for organic vapors. Any reassessment which results in a change in PPE will be reflected in an amendment to this Health and Safety Plan.

All ambient air measurements which are taken to evaluate personnel exposure will be taken within the individual's breathing zone and shall be fairly frequent or constant for a duration of at least 30 seconds.

Detailed requirements for the respiratory protection programs related to radiological constituents are contained in the BPCI Radiological Control Plan (Appendix A).

5.4 Work Limitations

At least two personnel will be in the field at all times. All field personnel will have been declared medically fit for field work, and where respiratory protection is necessary, all personnel will have been properly trained, fit tested and declared fit for respirator use.

5.5 Project Personnel

The responsibilities of the Contractor Construction Manager, the Contractor Construction Health and Safety Supervisor and project personnel are listed in Appendix G and must be adhered to at all times.

5.6 Heat Stress/Cold Stress

If on-site activities are conducted during extreme weather conditions, instructions for minimizing heat stress/cold stress are in Appendix H.

5.7 Fire Protection

Closure activities appear to pose little threat of fire; however, in the event that a fire occurs. Appendix J includes excerpts from BPCI Standard Safe Practice Manual related to fire protection, and location of plant fire hydrants and fire hoses.

5.8 Review and Inspection of Contractor Activities

At least once per week, the Contractor Radiation Safety Officer or his designee will inspect the site for compliance with the requirements of this plan or the Health and Safety Plan submitted by the Contractor. This inspection will include, but not be limited to the following:

- a. all personnel properly wearing and using approved personnel protective equipment and dosimetry:
- b. monitoring equipment properly located and operational;
- c. proper barriers and postings for hazardous and radiological areas:
- d. provision of appropriate safety control and emergency equipment:
- e. general workplace hygiene; and
- conformance of work to approved procedures.

Records of the daily visits will be documented on the Daily Inspection Report Form (Form 7-11) contained in Section 7.0. Any nonconformances shall be assigned a number and immediately brought to the Contractor's attention in writing and recorded on the Nonconformance Log Form (Form 7-12) contained in Section 7.0. The Contractor will implement appropriate corrective action and complete the



Nonconformance Notice and Corrective Action Sheet (Form 7-13) and return it to the BPCI Construction Manager, who will review, verify and approve it and close out the nonconformance.

At random times, no less frequent than once every month the BPCI Radiation Safety Officer or his designee will audit the Contractor's health and safety records to verify the following:

- a. proper training and qualification of all personnel;
- b. worker dose from dosimetry data meets or exceeds ALARA goals;
- c. calibration of monitoring equipment; and
- d. proper monitoring records.

Nonconformances will be managed the same way as was described previously.

5.9 Site Safety Briefings

Site safety briefings will be held by the Contractor Project Manager in coordination with the Contractor Health and Safety Supervisor and the Contractor Radiological Safety Officer. The site safety briefings will be conducted weekly to identify and discuss safety concerns and topics related to the remediation work. The briefings will be attended by all Contractor remediation/construction personnel. The site safety briefings will be documented on Form 7-9 contained in Section 7.0.

5.10 Accidents/Incidents

Accidents, incidents or other related emergencies occurring on the BPCI site during the conduct of the decommissioning and closure operations will be initially reported as specified in Section 4.0 of this Plan. All accidents or incidents will be documented on the Accident Report Form (Form 7-14) contained in Section 7.0.

The Accident Report Form will be completed by the Contractor Project Manager. The Contractor Project Manager is responsible for implementation of the initial corrective action and for follow-up of any corrective action that remains to be taken to close out the accident report.



6.0 DECONTAMINATION

6.1 General

The Contractor will conduct contamination release surveys in accordance with the BPCI Radiological Control Plan (Appendix A) and with the procedures contained in Appendix K. These procedures comply with the requirements of BPCI Source Material License No. SUB-908, i.e., "Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of Licenses for Byproduct, Source or Special Nuclear-Material, May 1987" (Appendix L). The procedures in Appendix K are also in compliance with USNRC Regulatory Guide 10.4, Items 10.3, 10.4 and 11.0.

The project specifications require that the decontamination pad will be equipped with high pressure stream washing and the recirculating water system and treatment plant will be designed for zero discharge. In addition, contaminated clothing, trash, etc., will be packaged by the Contractor in USDOT approved or Owner approved packages and stored in a designated waste storage area. All waste water collected during Division I Work will be temporarily stored in the Burn Pond.

Personnel should follow the decontamination procedures outlined below:

- 1. Locate a decontamination area between the Hot Line (upwind boundary of the Exclusionary Area) and the Clean Area boundary.
- 2. Establish a personal decontamination station (PDS) consisting of a basin with soapy water, a rinse basin with plain water and a can with a plastic bag.
- 3 All personnel leaving the work area shall "frisk" themselves for radioactive contamination prior to performing a chemical decontamination. Procedures for monitoring for personal contamination are contained in Appendix M.
- 4. Wash and rinse boots.
- 5. Remove outside gloves and discard in plastic bag.*
- 6. Remove disposable suit and discard in plastic bag.*
- 7. Upon leaving the contamination area, all personnel will proceed through the appropriate Contamination Reduction Sequence as described above.
- 8. All protection gear should be left on-site during lunch break following decontamination procedures.
- * P. otective clothing, such as boots, splash suits, gloves, face pieces, will be surveyed for radiological contamination. If contaminated, attempts will be made to decontaminate these items to minimize radioactive waste generation, when feasible. Radiologically clean items will be disposed as nonradiological waste.

The maximum decontamination layout for Level C is shown in Figure 6-1, and a description follows.

MAXIMUM MEASURES FOR LEVEL C DECONTAMINATION

Station 1: Segregated Equipment Drop

Station 1a: Final Frisk

Station 2: Boot Cover and Glove Wash

Station 3: Boot Cover and Glove Rinse

Station 4: Tape Removal

Station 5: Boot Cover Removal

Station 6: Outer Glove Removal

Station 7: Suit and Boot Wash

Station 8: Suit and Boot and Glove Rinse

Station 9: Cartridge or Mask Change

Station 10: Safety Boot Removal Deposit equipment used on site (tools, sampling devices and containers, monitoring instruments, radios, clipboards, etc.) on plastic drop cloths or in different plastic-lined containers. Segregation at the drop reduces the probability of cross-contamination. During hot weather operations, a cool-down station may be set up within this area.

 All personnel shall monitor themselves and their equipment for radioactive contamination. This is done prior to chemical decon to minimize the amount of potentially radioactive contaminated waste water produced on site.

 Scrub outer boot covers and gloves with decon solution or detergent and water.

 Rinse off decon solution from Station 2, using as much water as necessary.

- Remove tape around boots and gloves and deposit them in the plastic-lined container.
- Remove boot covers and deposit them in the plastic-lined container.
- Remove outer gloves and deposit them in the plastic-lined container.
- 8. Wash splash suit, gloves, and safety boots. Scrub with long-handled scrub brush and decon solutions.
- Rinse off decon solution using water. Repeat as many times as necessary.
- If worker leaves exclusion zone to change cartridges (or mask), this will be the last step in the decontamination procedure. After worker's cartridges are exchanged, new outer gloves and boot covers donned, and joints taped, worker returns to duty.*
- Remove safety boots and deposit them in the plastic-lined container.*

MAXIMUM MEASURES FOR LEVEL C DECONTAMINATION (continued)

Station 11: Splash Suit Removal

Station 12: Inner Glove Wash

Station 13: Inner Glove Rinse

Station 14: Inner Glove Removal

Station 15: Inner Clothing Removal

Station 16: Face Piece Removal

Station 17: Field Wash

Station 17a: Final Frisk

Station 18: Redress

- 12. With the helper's assistance, remove splash unit. Deposit it in the plastic-lined container.*
- 13. Wash inner gloves with decon solution.
- 14. Rinse inner gloves with water.
- 15. Remove inner gloves and deposit them in the plastic-lined container.*
- 16. Remove clothing soaked with perspiration and place them in the plastic-lined container. Do not wear inner clothing offsite, since there is a possibility that small amounts of contaminants might have been transferred in removing the fully encapsulating suit.*
- 17. Remove face piece. Deposit it in the plastic-lined container. Avoid touching face with fingers.*
- 18. Shower if highly toxic, skin corrosive or skin absorbable materials are known or suspected to be present. Wash hands and face if shower is not available.
- 19. All personnel shall act as a minimum, monitor their face, hands and feet prior to donning street clothes.
- 20. Put on clean clothes.
- * Protective clothing, such as boots, splash suits, gloves, face pieces, will be surveyed for radiological contamination. If contaminated, attempts will be made to decontaminate these items to minimize radioactive waste generation, when feasible. Radiologically clean items will be disposed as nonradiological waste.

6.2 Less Extensive Decontamination

Less extensive procedures for decontamination can be et dished when the type and degree of contamination are known, or when the potential for transfer is judged to be minimal by the Site Safety Coordinator. These procedures generally involve one of two washdowns only.



6.3 Emergency Decontamination

In the event a worker is involved in an accident or impaired, decontamination procedures will be as follows:

- If life-saving procedures are not required, decontaminate the victim as much as possible, and transport to the medical facility for treatment.
- If life-saving procedures are required and the contaminants are extremely hazardous, cover or wrap contaminated areas of the body, perform life-saving procedures, and transport to the medical facility. If the contaminants are not extremely hazardous, life-saving procedures are to be performed, and then transport to the medical facility.

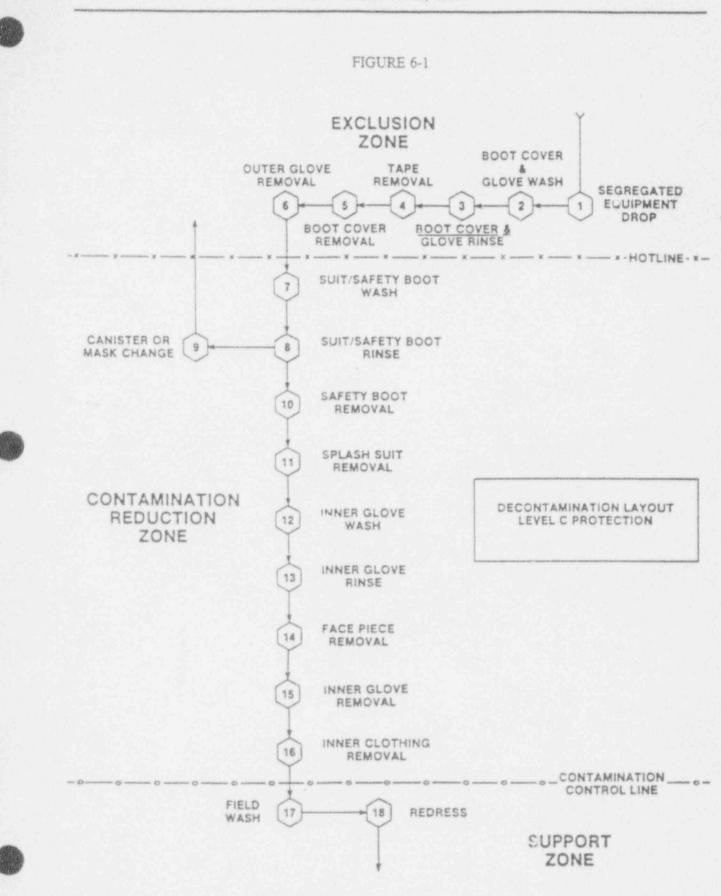
In the event of an accident, monitor the victim for radioactive contamination if conditions and time permits. Decontaminate the victim if conditions and time permits. In the event of a severe accident, notify the receiving medial facility prior to transporting, that the victim is possibly contaminated, and the amount of contamination present.

The BPCI or Contractor Radiation Safety Officer or designee shall accompany the victim and monitor the transporting vehicle, receiving facility and all personnel involved for radioactive contamination.

At any of the aforementioned cases, both transport and emergency room personnel are to be notified regarding both the type and degree of injury, as well as the extent and nature of contamination to the injured party.

6.4 Closure of the Personnel Decontamination Station

All disposable clothing and plastic sheeting used during the operation will be double-bagged, labeled, and contained on-site to await final disposition by BPCI Reusable rubber clothing will be dried and prepared for future use. (If gross contamination has occurred, discard the item.) All wash tubs, pail containers, etc., will be thoroughly washed, rinsed, and dried prior to removal from the site.



6-5

7.0 FORMS

The following forms are used in support of the BPCI Health and Safety Plan.

- Form 7-1 BP Acceptance Block Format
- Form 7-2 Proper Revision Formatting
- Form 7-3 Plan Acceptance Form
- Form 7-4 Prenatal Exposure Instructions Form
- Form 7-5 Plan Feedback Form
- Form 7-6 Contractor/Subcontractor Statement of Compliance
- Form 7-7 Airborne Radioactivity Monitoring Log Form
- Form 7-8 Air Sample Record and Calculation Sheet
- Form 7-9 Daily Instrument Calibration Checksheet
- Form 7-10 Air Monitoring Form
- Form 7-11 Daily Inspection Report Form
- Form 7-12 Nonconformance Log Form
- Form 7-13 Corrective Action Sheet
- Form 7-14 Accident Report Form
- Form 7-15 Site Safety Briefing Form

Airborne Radioactive Material Calculation Sheet and instructions are contained in Appendix I.

The Plan Acceptance Form will be filled out by Contractor employees and by subcontractor employees working on the site. The Plan Feedback Form will be filled out by the Contractor Safety Supervisor and any other on-site employee who wishes to fill one out. The Accident Report Form will be filled out by the Contractor Project Manager in the event that an accident occurs. The Site Safety Briefing Form is filled out by the Contractor Safety Supervisor and signed by all persons who received the site safety briefing.

ALL COMPLETED FORMS WILL BE RETURNED TO THE CONTRACTOR SAFETY SUPERVISOR FOR RETENTION IN PROJECT FILES.





FORM 7-1 BP ACCEPTANCE BLOCK FORMAT

ACCEPTANCE

This document has been reviewed and accepted by BPCI for conformance with the Project Health and Safety Plan Revision 1 dated December 1993 and regulations and guidance documents cited in the Health and Safety Plan as promulgated to the date of the plan. This acceptance does not verify implementation and is not valid without the following signatures:

BPCI Construction Manager (P. C. Campbell)

Date: _______
BPCI Radiation Safety Officer (J.H. Martz or R.J. Ryan)
______ Date: ______

BPCI Industrial Hygienist (D. A. Refson)

Date:



FORM 7-2 PROPER REVISION FORMATTING

Revision -pp-		Date	MM/DD/YY
ACCEPTANCE BY			
Signature:	Date:		





FORM 7-3 PLAN ACCEPTANCE FORM

Instructions

This form is to be completed by each person to work on the subject project work site and returned to the Contractor Safety Supervisor:

Job No.	
Project	
Location	
Date	

I represent that I have read and understand the contents of the above plan and agree to perform my work in accordance with it.

Name (Please Print Clearly or Type)

Signature

Organization

Date



FORM 7-4 PRENATAL EXPOSURE INSTRUCTIONS FORM

I. ______, acknowledge and understand the recommendation of the National Council on Radiation Protection and Measurements to limit radiation exposure to the unborn child to the very lowest practical level, not to exceed 0.5 Rem during the entire period of pregnancy, as contained in "Instructions Concerning Prenatal Radiation Exposure" Regulatory Guide 8.13.

Signed

Printed

Social Security Number

Witness



FORM 7-5 PLAN FEEDBACK FORM

Job No.				

Job Name

Date

Problems with plan requirements:



Unexpected situations encountered:

Recommendations for future revisions:



93-001 BP LL

Revision 1. December 1993

FORM 7-6

CONTRACTOR/SUBCONTRACTOR STATEMENT OF COMPLIANCE

This is to confirm that the employees listed below are qualified by virtue of training and experience to engage in field activities at BPCI in connection with the Contract/Subcontract Agreement between the Contractor and ______, dated ______, 19____. Further, all said employees have been determined to be properly trained and medically fit to perform those field activities prescribed by said contract and to utilize the respiratory protective equipment necessary to perform the job safely in accordance with Title 29 of the Code of Federal Regulation. Parts 1910 and 1926, and any other Federal, state, or local requirements.

Employee Names

I.	.6.
2.	7.
3.	8.
4	9
5	10

Authorized Representative

Printed Name

FORM 7-7 AIRBORNE RADIOACTIVITY MONITORING LOG FORM

Sample #	Date/Time	Location	Results	Tech
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FORM 7-8

AIR SAMPLE RECORD AND CALCULATION SHEET

RWP/RACP No.	Date	Location	RT
Work Evolution During Samp Sample Type: 3" Filte General Area Breathin Air Sampler: Radeco AC Staplex High Volume	nte 4" nr Paper 4" ng Zone Pr Radeco DC	Filter Paper ocess: Mark No. Radeco Goosene	ck 🗆 RASP
Badge No.			
Date Sampler On Date Sampler Off	Time On	Air Flow	
Date Sampler Off	Time Off	Air Flow	LPM L CPM
Total Time (In Minutes) Air Sampler Serial No	Total	Volume	\Box L \Box Ft ³ \Box cc
	MP-210 FIE	LD EVALUATION	
SHOULD BE PER	FORMED IN LO	W BACKGROUND A	REAS (<200 CFM)
Filter Paper: □ < 500 Net C Note: If sample is other than Other Monitoring: □ mI	10 ft3, multiply ne	t CPM contained by [1]	0 sample volume (ft ³) Serial No.
Filter Paper Counting Data	1st Count	2nd Count Cour	<u>it</u>
Counted by: Instrument: Serial Number: Date Counted: Time Counted: Length of Decay (hours): Counting Period (minutes): Gross Counts: Gross Counts: Gross Counts: Gross cpm 2/1: Background cpm: Net cpm 5/0.9: Counter Correction Factor: dpm 7 x 6: Equivalent Air Counted (ft ³): dpm/ft ³ 8/9: μ Ci/cc 10 x 1.59 E-11: MDCR (cpm): MDA (μ Ci/cc) (7 x 11 x 1.59			
Calculations Performed by: Radioisotope Identifications: Reviewed by (signature requi	□ Yes □ N red):		Date

FORM 7-8 (continued) AIR SAMPLE RECORD AND CALCULATION SHEET SUPPLEMENT

ASR No RWP/RACP No				RT	
Work Evolution During Sample	and the second second				
Filter Paper Counting Data	□G <u>Count 1</u>	□P □Y Count 2 Count 3	Count 4	Count 5	<u>Count_6</u>
Counted by:					
Instrument:					
Serial Number:					
Date Counted:					
Time Counted:					
Length of Decay (hours):					
Counting Period (minutes):					
Gross Counts:					
Gross cpm 2/1:					
Background cpm:					
Net cpm 5/0.9					
Counter Correction Factor:					
dpm 7 x 6: Equivalent Air Counted (ft ³):					
dpin/ft ³ 8/9:					
μ Ci/cc 10 x 1.59 E-11:					
MDCR (cpm):					
MDA (µCi/cc) (7 x 11 x 1.59 E-	11):				
Calculations Performed by:					
Radioisotope Identifications: Reviewed by (signature required)	□Yes □♪	to RCF:	Date		

FORM 7-9 DAILY INSTRUMENT CALIBRATION CHECKSHEET

Instrument

Serial #

Date	Ambient Air (yes/no)	Calibration Gas (ppm)	Battery Check (good/bad)	Calibrated by	Remark
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					ONE-YOR INTERVIEW CONTRACTOR



FORM 7-10 AIR MONITORING FORM

General Information

Name(s)	Background Level
Date	Weather Conditions
Time	
Project	
Job No.	
Estimated Wind Direction	
Estimated Wind Speed (i.e., calm,	moderate, strong, etc.)
Location where background level v	was obtained

Equipment Settings

HNU				Explosimeter			
Range			Ali	arm Trigger - '	%LEL		
Span Pot			Alarm Trigger - %02				
Calibration Ga	S		Ca	libration Gas _			
Field Activitie	5						
Field Activitie	s Conducted						
Time	OVA	Explosimeter %LEL %02	Draeger Tube	Radiation Meter	Equipment Units		



FORM 7-11 DAILY INSPECTION REPORT FORM

Activities Observed

Inspection Checklist: All "no" responses must have a nonconformance identified below.

YES	NO	
		Dosimetry and personnel protective equipment being properly worn and used
	10	Monitoring equipment properly located and operational
		Barriers and postings properly erected
		Safety, control and emergency response equipment properly located in work area
		Work play hygiene is adequate
.0	.03	Activities in conformance with approved work procedures

Nonconformatices

Log No.	Description	

Inspected By

Date	Time
Signature	

FORM 7-12 NONCONFORMANCE LOG FORM

Log No.	Date Found	Description	Corrective Action	Date
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Revision 1, December 1993

FORM 7-13 CORRECTIVE ACTION SHEET

Γο	Date	Nonconformance No.
ind required your immed	ntified above and described below iate attention. Please take appro- return it to BPCI Construction M	v were identified on priate action and complete the bottom anager by no later than
Cause of Problem		
Description of Correctiv	e Action Taken	
Submitted by		Date

FORM 7-14 ACCIDENT REPORT FORM

Name C Injured o	r III Employee			
Date of Acc	ident	Time of Accident		xact Location of Accident
Narrative Descript	tion of Accident			
Nature of Illness of	or Injury and Part of	Body Involved		
			The second	ime: 🗆 Yes 🗆 No
Probable Disabilit	y (Check One)			
Fatal	Days Away From Work	Lost Work Day with Days of Restricted Activity	No Lost Work Day	First Aid Only
		Jnit		
Corrective Action		aken (by whom and by	when)	
Nan	ne of Supervisor		Title	
	Signature		Date	

FORM 7-15 SITE SAFETY BRIEFING FORM

Project			
Date	Time	Job No	
Address			
Specific Location			
Type of Work			
	ana kata mana kata kata kata kata kata kata kata k		
	SAFETY TOPICS I	PRESENTED	
Protective Clothing/Equipment			
Chemical Hazards			
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Emergency Procedures			
Hospital/Clinic			
	ATTENDI	EES	
Name (Printed)		Signature	
والمتعاقبة والمتعار والمتعادية والمتكرة			
	and the first of the second second second second second		

Meeting Conducted By:

Name (Printed)

Contractor Safety Supervisor

Contractor Radiological Safety Officer (when applicable)

APPENDIX A

RADIOLOGICAL CONTROL PLAN

Radiological Control Plan

• 0 • 0 •

BP Chemicals, Inc. Lima, Ohio Revision 0 December 1993

> Prepared by: B. Koh & Associates, Inc.

PROJECT NAME AND SITE LOCATION

BP Chemicals, Inc. Remediation Projects Lima, Ohio

APPROVED

BP Chemicals, Inc.

HEALTH, SAFETY AND ENVIRONMENTAL MANAGER

HUGH M. BLYTHE

Augh 11. Blatta, 2.9.94 Signature / Date

RADIATION SAFETY OFFICER

JOSEPH H. MARTZ

H Marth 12-9-94 Signature / Date



93:R-C-PLAN:BP:LL

Revision 0, December 1993

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1.0 DISCLAIMER NOTICE

The radiological control and safety requirements/guidelines contained within this Radiological Control Plan were developed specifically for the BP Chemicals, Inc. (hereafter BPCI) Mixed Waste Pond Closure Project, the Corrective Action Project and the CAT-21 Remediation Project and should not be used on any other project or site without prior approval of the BPCI Radiological Safety Officer.

The BPCI Radiological Control Plan requirements and guidelines are effective only if each worker follows the requirements and guidelines. Intentional disregard by management or workers of the established requirements/guidelines may result in unnecessary exposure or release of radiation or radioactive materials.



2.0 POLICY STATEMENTS

2.1 Health and Safety Policy

It is the policy of the BPCI to provide their employees and require all Contractors and subcontractors to provide their employees with a safe and healthful workplace in accordance with all Federal, State, and Local regulations, as well as BPCI internal procedures. Safety of all employees is a primary consideration in the performance of BPCI activities. Consistent with prudent professional practice, BPCI will identify, evaluate, and correct hazards in BPCI facilities, thereby ensuring that the health, safety, and well-being of all employees are protected.

2.2 ALARA Policy

BPCI is committed to keeping radiation exposure to employees and the general public as low as reasonable achievable (ALARA), commensurate with sound economic and social considerations. BPCI management will demonstrate their commitment by assigning high priority to work plans and procedures that will reasonably reduce personnel and environmental radiation exposures. Therefore, in addition to implementation of the ALARA policy, BPCI will incorporate the ALARA philosophy into applicable operating procedures. Furthermore, BPCI will place primary emphasis on design and engineering features to maintain exposures ALARA. When practical, design features will be selected in lieu of administrative controls to maintain exposures ALARA.

The "As Low As Reasonably Achievable" (ALARA) philosophy is a fundamental objective of all effective radiation protection programs. Reducing individual and collective exposures is desirable. Control of radiation exposure is based on the assumption that any exposure to ionizing radiation involves some risk. However, occupational exposure within regulatory limits represents a very small risk compared to the voluntarily accepted hazards of normal life. This radiation exposure control philosophy has been presumed repeatedly in the guidance provided by such organizations as the National Council of Radiological Protection and Measurements (NCRP), the International Commission of Radiological Protection (ICRP), and the National Academy of Sciences Committee on the Biological Effects of Ionizing Radiation (NAS-BEIR).

Thus, maintaining individual and collective radiation exposures ALARA is a critical element of this Radiological Control Plan which improves other parts of the BPCI radiological protection program through better planning of work, training of workers, and tracking of exposures. Ultimately, these efforts benefit the safety and reliability of the BPCI Remediation Project by improving the quality and the efficiency of work performed.

3.0 PURPOSE, SCOPE, RESPONSIBILITY

3.1 Purpose

This Radiological Control Plan establishes radiation control and protection practices to be implemented by BPCI consistent with Nuclear Regulatory Commission (NRC) standards, and National Council of Radiological Protection and Measurement (NCRP), and International Commission of Radiological Protection (ICRP) recommendations. In addition, this Plan supplements the requirements contained in the BPCI Health and Safety Plan and promulgates the BPCI sitewide procedures for maintaining radiation exposure as low as reasonably achievable (ALARA) and within Federally mandated exposure limits.

3.2 Scope

This Radiological Control Plan has been developed in accordance with the current 10 CFR 19 and the revised 10 CFR 20 (NRC, May 1991) requirements and has been developed and commensurate with the scope and extent of licensed activities and sufficient to ensure compliance with the provisions of 10 CFR 20. Specifically, this Plan provides the radiation protection standards and controls that will be in effect at the BPCI facility during remediation of the surface impoundments, buildings and corrective action management unit(s). Adherence to these controls is the responsibility of each individual as well as members of BPCI line management. Any deviation from this plan requires the written approval of the BPCI Project Director and the Radiation Safe Officer

The major scope of this Plan is to establish the radiological protection practices to be implemented at the BPCI facilities for ensuring control of radioactive materials and radiation exposures to personnel. It is the philosophy of BPCI to maintain radiation exposures to personnel and release of radioactive materials to the environs as low as reasonably achievable (ALARA), and to keep radioactive material contained in the smallest practical volume at all times.

3.3 Responsibilities of Workers

This Plan is available for review to all BPCI. Contractor and subcontractor personnel working at the BPCI facilities. All individuals working or frequenting the radiologically controlled areas of the facilities are responsible for complying with the requirements of this Plan.

All personnel who could potentially come in contact with radioactive materials should understand that a knowledge of standard radiation protection rules and practices is an integral part of their job duties and responsibilities. Each person should be aware that it is their responsibility to minimize their own exposure to radiation and be cognizant of their obligations to BPCI and co-workers for the safe handling of radioactive materials. Each individual working at the BPCI facilities is responsible to perform their job in accordance with plant procedures, job training and in accordance with the principle of maintaining his or her exposures ALARA. Each person who could reasonably be expected to handle radioactive

materials will receive periodic instruction in the general and specific radiological aspects which they may encounter and will be made aware of their responsibility to BPCI the public, and the co-workers for safe handling of radioactive materials.

3.4 Responsibilities of Management

It is the responsibility of BPCI to provide its employees and require all subcontractors to provide their employees with a safe and healthful workplace in accordance with all Federal. State and Local regulations, as well as, BPCI site procedures.

In addition, BPCI Remediation Project management personnel are responsible for:

- (1) Being knowledgeable of the counts of this Plan.
- (2) Ensuring that employees have been fully informed of, and possess a thorough understanding of the sections contained in this Plan which poply to their job assignment.
- (3) Ensuring that all necessary training is scheduled and completed and for maintaining auditable training records which will include any follow-up training and all annual refresher training.
- (4) Reviewing the Radiation Control and Protection Program content contained in this Plan and for reviewing the efficiency of its implementation on an annual basis.
- (5) Maintaining records (provisions of the program, audit and review, sur /eys) related to the Radiation Control and Protection Program.

4.0 PROJECT ORGANIZATION

4.1 Roles, Responsibility and Authority

4.1.1 General

The organizational structure plays a key role in the effectiveness of any Radiological Control and Protection Program. Responsibility, authority and accountability for radiological control and protection must be established within this structure to effectively carry out the objectives of the program. Lines of authority must be organized in such a way that radiological protection and safety has a channel to the top. In addition, top management must be supportive of radiological control and protection efforts.

The BPCI organizational structure depicted in Figure 4-1 has been developed to carry out the objectives of the policy statements presented in Section 2.0. This Figure identifies employee titles and the lines of authority to be used throughout the BPCI remediation projects. The BPCI organizational structure may be reviewed and updated, if necessary, to reflect the current status of site operations.

4.1.2 BP Chemicals, Inc. Organization

4.1.2.1 Health, Safety and Environmental Manager

The Health, Safety, and Environmental Manager (HSEM) is responsible for the management of all remediation projects performed at the BPCI Lima, Ohio facility. These projects include but are not limited to the Mixed Waste Pond Closure Project, CAT-21 Remediation Project and the Corrective Action Project.

In addition, the HSEM has overall responsibility and authority for the development and implementation of the BPCI Radiological Control Plan. The HSEM will work together with specific BPCI Construction Managers and the BPCI Radiation Safety Officer(s) (RSO) to ensure that all radiological protection and control measures are carried out. The HSEM reports directly to the BPCI Plant Manager.

4.1.2.2 Construction Manager

The BPCI Construction Manager (CM) is respond the for the management of his/her respective remediation project (i.e., Mixed Waste Closure Pond Project, CAT-21 Remediation Project, Corrective Action Project). The CM will work together with the BPCI RSO and BPCI Industrial Hygienists and the Contractor Project Manager to ensure that all radiological protection and control measures developed for his/her specific project will be carried out in a safe and efficient manner. The CM reports directly to the BPCI Plant Manager.



4.1.2.3 Radiation Safety Officer

The BPCI Radiation Safety Officer (RSO) is responsible for developing and implementing policies and procedures in accordance with NRC Regulations (Title 10 CFR Parts 19 and 20) and any other applicable requirements/regulations. The RSO has direct recourse to the Health, Safety and Environmental Manager (HSEM) to prevent unsafe practices or to halt an operation which is deemed radiologically unsafe.

The RSO is also responsible to oversee and control the day-to-day radiation protection activities in accordance with the requirements contained in the BPCI Radiological Control Plan. The RSO may delegate day-to-day activities to the Contractor RSO, but is ultimately responsible for the Radiological Control and Protection Program. The RSO reports directly to the HSEM with communications and radiological oversight provided to the CM.

Specific duties of the RSO may include, but are not limited to, the following:

- (1) Provide training to project personnel.
- (2) Verify that site personnel receive (or have received) appropriate radiological training.
- (3) Verify implementation of the Radiological Control Program.
- (4) Provide technical expertise to on-site radiation safety personnel.
- (5) Conduct periodic radiation safety audits at the site.
- (6) Interface between site radiation safety personnel and BPCI management.
- (7) Review surveys conducted during and after the remediation effort.
- (8) Implement additional health and safety requirements as directed by the HSEM or CM.
- (9) Develop and implement radiation control procedures specific to these projects.

Qualifications of the Radiation Safety Officer are:

- (1) A B.S. in Science or Engineering.
- (2) A minimum of 4 years of applied radiation protection experience.
- (3) Previous training consistent with Regulatory Guide 10.4. Item 7, Topics.
- (4) Approved by the BPCI management.
- (5) Authorized by notation in the NRC license.

The Radiation Safety Officers (RSOs) for BPCI are Mr. J. H. Martz (designee) and Mr. R. J. Ryan (alternate). These RSOs were previously approved by the NRC as part of BPCI License No. 5U3-908, Amendment No. 5, dated July 8, 1992.



4.1.2.4 Industrial Hygienist

The BPCI Industrial Hygienist (IH) is responsible for ensuring that general industrial safety and chemical safety requirements, as specified in the BPCI Health and Safety Plan and related procedures, are complied with during conduct of remediation activities. The IH reports directly to the HSEM with communications and industrial hygiene oversight provided to the CM. The IH may delegate day-to-day safety activities to the Contractor Health and Safety Supervisor, but is ultimately responsible for general and chemical safety program, as specified in the Health and Safety Plan.

4.1.2.5 Regulatory Compliance Coordinator

The BPCI Regulatory Compliance Coordinator (RCC) is responsible for identifying, coordinating, and/or resolving and tracking issess involving regulatory agencies (i.e., NRC, Ohio Environmental Protection Agency, Ohio Department of Health) to ensure compliance with applicable federal and state regulations. The RCC reports directly to the HSEM with support provided to the CM.

4.1.2.6 Project and Plant Personnel

All BPCI project and general plant personnel will comply with the requirements of this Radiological Control Plan.

4.1.3 Contractor Organization

At the discretion of BPCI, a remediation contractor may be requested to operate under a variety of contractual arrangements. The alternate arrangements are discussed below.

A Contractor may operate directly under the BPCI Health and Safety Plan, Radiological Control Plan and related procedures, in which case the full services of the BPCI organization will be utilized.

The Contractor may also operate under his own Health and Safety Plan, Radiological Control Plan and related procedures. The Contractor plans and procedures must meet or exceed the requirements specified in the BPCI documents. In this case, the Contractor would provide his own personnel.

A third option is for a Contractor to operate under the BPCI plan, but for the Contractor to provide Health and Safety/Radiological personnel to supplement BPCI personnel.

The typical Contractor personnel and responsibilities are described in the following section.



4.1.3.1 Project Manager

The Contractor Project Manager (PM) is responsible for managing Contractor personnel and other resources necessary to carry out the specific remediation project or activity. The PM will work closely with the Contractor RSO and Health and Safety Supervisor to ensure work being conducted by Contractor personnel is in accordance with either: 1) the requirements specified in the BPCI Health and Safety Plan, Radiological Control Plan and related procedures; or 2) with requirements contained in the Contractor-developed Health and Safety Plan, Radiological Control Plan and related procedures, which are consistent with the BPCI documents. The Contractor PM reports directly to the BPCI CM.

4.1.3.2 Radiation Safety Officer (Optional)

The Contractor Radiation Safety C fficer (RSO) is responsible for the development and implementation of the Contractor Radiological Control Plan and related procedures, when requested by BPCI (see Section 4.1.1). The Contractor RSO is also responsible to oversee and control the day-to-day radiation protection activities in accordance with the requirements contained in the Contractor Radiological Control Plan. In general, the Contractor RSO specific duties are similar to those identified for the BPCI RSO. The Contractor RSO reports directly to the Contractor PM with communications and technical guidance from the BPCI RSO.

4.1.3.3 Radiological Control Technician(s) (Optional)

The Contractor Radiological Controls Technician (RCT) is responsible for adhering to radiological control procedures under the direction of the Contractor RSO.

Specific duties of the RCT include, but are not limited to the following:

- (1) Surveying of areas, materials, equipment and personnel as needed.
- (2) Recording of all survey finding on appropriate forms.
- (3) Report unexpected findings to the project RSO or PM.
- (4) Advise the RSO or PM of any unsafe working conditions at the site.
- (5) Remove employee(s) who have approached the established administrative radiation exposure limits or who have not demonstrated their continuing understanding of, or need for compliance with radiological safety procedures.

4.1.3.4 Health and Safety Supervisor (Optional)

The Contractor Health and Safety Supervisor (HSS) is responsible for developing and implementing the general safety and chemical safety requirements contained in the Contractor Health and Safety Plan and related procedures, when requested by BPCI (see Section 4.1.1). In general, the Contractor HSS is responsible to oversee and control the day-to-day safety activities in accordance with the requirements contained in the Health and Safety Plan. The Contractor HSS reports directly to the Contractor PM with communications and technical direction from the BPCI Industrial Hygienist.

4.1.3.5 Contractor Personnel

All Contractor personnel engaged by the BPCI will comply with the requirements of this Radiological Control Plan.

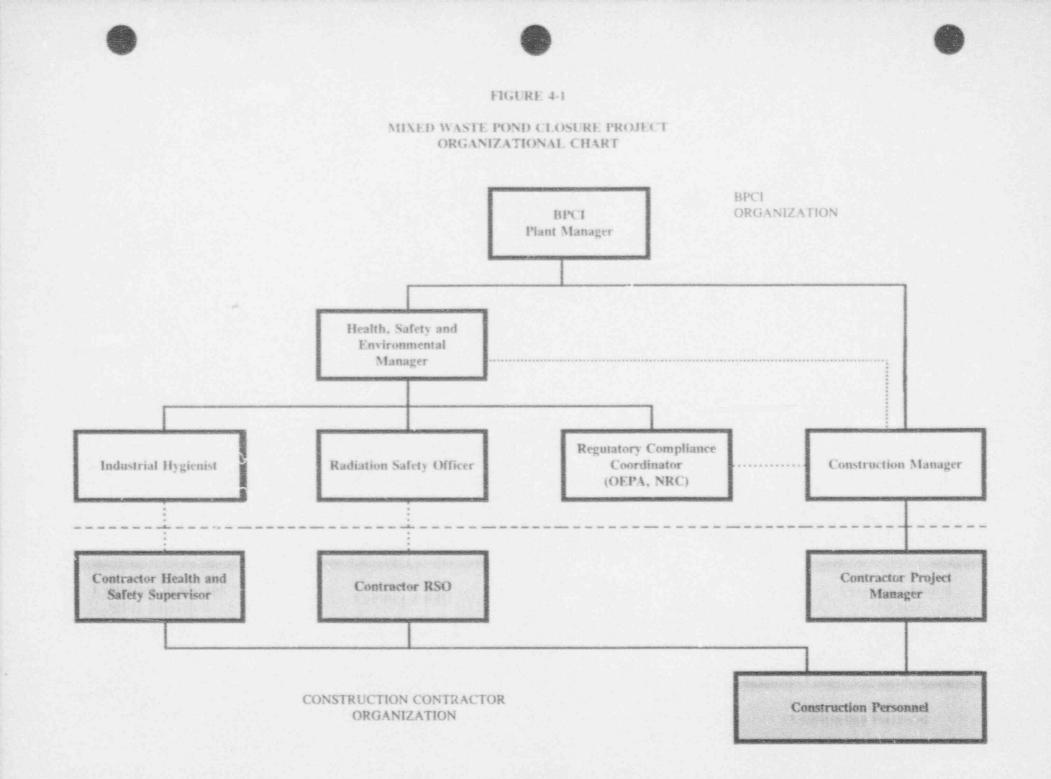
4.2 Stop-Work Authority

The BPCI CM, IH, RSO, RCT, and the Contractor PM, RSO, HSS and RCT have the authority to stop work when a situation is considered to pose an immediate threat to life, health, property or the environment. When an immediate threat does not exist, only the BPCI CM or his designee will have stop-work authority pursuant to the Radiological Control Plan. When it becomes necessary to stop a job due to a safety hazard, conditions will be stabilized immediately so that stopping the job does not in itself present an additional hazard pursuant to the Radiological Control Plan.

Any BPCI or Contractor person found to be wilfully disregarding any provisions of this Radiological Control Plan will be subject to immediate removal from further remediation work by the BPCI CM or his designee.

4.3 Administrative and Field Procedures and Review Requirements

The BPCI Radiological Control Plan establishes the policies and requirements to be followed during the conductance of remediation activities at the BPCI site. However, detailed administrative and field operational procedures which incorporate radiological, industrial and other general safety considerations are required to ensure that the identified policies and requirements are met. Preparation of such procedures minimizes the potential problems encountered during the conduct of activities by requiring explicit planning prior to initiation of the required work. Thus, written procedure(s) is a step-by-step guide for the personnel performing the work or activity. Prior to being issued for use, the procedure will be reviewed and approved by the BPCI CM and the RSO. The approved procedure will be issued, as a restricted document, to ensure that the proper procedure is being used at the work location.



5.0 TRAINING REQUIREMENTS

5.1 Introduction

The purpose of radiation training for the various BPCI remediation activities is to provide qualified personnel to work with the radiation hazard at the site. The training program will be reviewed by BPCI management and kept up to date to reflect changes in the facility and procedures, as applicable.

Training will be required of, but not limited to: all workers involved in day to day remediation operations, project and management personnel who will visit the remediation sites regularly and BPCI and Contractor personnel identified by the CM.

5.2 Site Orientation and Training

Prior to entry into radiologically restricted areas of the BPCI facilities, all personnel will be given a site specific chemical safety and radiological orientation. The objectives of this orientation are to familiarize personnel to:

- Recognize labeled chemicals and radioactive materials, understand the meaning of chemical and radiological warning signs, and be aware of the general hazards associated with chemical and radiological material;
- (2) Understand that, as long as radiological control procedures and limits are followed, harmful effects to personnel or to the environmental from radioactivity at BPCI will be minimized; and
- (3) Recognize and understand the meaning of, and proper response to, emergency signals and use of emergency equipment, such as fire extinguishers, fire hoses and SCBA.

This orientation is required for all personnel visiting or working at the BPCI site including Contractor and subcontractors.

All visitors will be escorted by personnel who are trained as radiation workers and have passed the radiation worker written exam. Visitors will be issued temporary TLDs or self-reading dosimeters by the Radiological Safety Officer or his designee and will be required to wear them whenever they are inside the radiologically controlled work zones.



5.3 Radiation Safety Training

5.3.1 General

A Radiation Safety Training Course provided by BPCI will consist of classroom and practical training and will be in accordance with 10 CFR Part 19.12 and USNRC Regulatory Guide 10.4 Item 8. The Radiation Safety Training will be commensurate with the potential health protection hazards associated with the restricted areas of the mixed waste ponds, corrective action management units, and the CAT-21 buildings.

At the discretion of BPCI, the Contractor may be authorized to provide the training. Prior to implementation of a Contractor-provided training course, BPCI will review and accept the Contractor's training course content for compliance with the following content requirements. BPCI will verify that the General Contractor provides qualified instructors, as defined by 10 CFR Part 40.32(b) and USNRC Regulatory Guide 10.4 Item 7, to conduct radiation safety training.

- (1) Identification and location of licensed radioactive materials and radiological hazards present in the restricted area to be entered by the individual.
- (2) Health protection problems associated with exposure to such radioactive materials or radiation.
- (3) Precautions and procedures to minimize exposures and the spread of contamination (e.g., use of Radiation Work Permits (RWPs), dosimetry, and frisking for personal contamination when leaving a contaminated zone).
- (4) Purposes and functions of protective devices required (if any).
- (5) Applicable NRC regulations to be observed by individuals working in or frequenting restricted areas.
- (6) Terms and conditions of BPCI license applicable to employees working in or frequenting restricted areas.
- (7) Standard operating and emergency procedures to be followed by individuals working in or frequenting restricted areas.
- (8) Responsibility of individuals to report promptly to BP Chemicals, Inc. management unsafe acts or conditions observed in restricted areas that may lead to or cause a violation of NRC regulations or unnecessary exposure to radioactive materials or radiation.
- (9) Rights of employees to receive radiation exposure reports upon request (10 CFR 19.13).
- (10) For persons who actually work with radioactive material, instructions for the safe use of radioactive material.

5.3.2 Basic Radiation Safety Training

Personnel who will require routine unescorted site access (radiation workers) will receive basic Radiation Safety Training.

The basic Radiation Safety Training will include the following specific topics:

- (1) Basic Fundamentals of Radiation.
- (2) Biological Effects of Radiation.
- (3) Risk of Low-Level Occupational Exposures to Radiation.
- (4) Basic Radiation Protection, Exposure and Contamination Control Concepts.
- (5) BPCI Radiation Protection Policies and Procedures.
- (6) Employee and Management Responsibilities for Radiation Safety.
- (7) ALARA.
- (8) Signs and Postings.
- (9) Personnel Monitoring and Dosimetry (including Bioassay).
- (10) Proper Use of Protective Clothing and Frisking Techniques.
- (11) Decontamination.
- (12) Use of Radiation Work Permits (RWPs).
- (13) Prenatal Exposure (Regulatory Guide 8.13).
- (14) Contents of 10 CFR 19: Notices, Instructions and Reports to Workers.
- (15) Emergency Procedures.

At the conclusion of the training, each worker's knowledge, competency and understanding of the above listed radiation protection areas will be evaluated. A written test will be administered to a summer an adequate understanding of the subjects covered. Satisfactory completion is indicated by a test score of 80 percent or greater.



Prior to being allowed unescorted worker access to the site and issuance of a TLD, all personnel will be required to pass (80%) a written exam demonstrating a basic knowledge of radiation worker training and provide evidence of a recent medical examination as described in Section 14.9.

5.4 Other Training

All personnel working on the various remediation projects will require BPCI Contractor and project site specific training. In addition, all personnel working within identified hazardous waste zones will be required to have 40-Hour Hazardous Waste Site Training (OSHA Standard 29 CFR 1910.120(e)).

5.5 Refresher Training

Personnel who will require routine unescorted site access will receive refresher training annually of the following:

- (1) Review of initial Radiation Worker Training subjects;
- (2) Site specific training requirements;
- (3) Any critique of incidents that have occurred in the past year that can serve as training examples of related work; and
- (4) Any other relevant topics.

5.6 Training Verification and Documentation

All persons working on-site will have evidence of initial training and pertinent refresher training as required by Sections 5.3 and 5.5 (e.g., training certificates, letter of certification, etc.) prior to being permitted to perform work involving a potential for exposure to radiation or health hazards. In addition, all site personnel will be required to sign a statement documenting that they have received site-specific training and that they understand the potential site hazards along with the necessary control measures to reduce and/or eliminate those hazards.

All training documentation, including the content of Site-Specific Training, test results, attendance sheets, any other subsequent training (e.g., periodic safety meetings, specific task safety training, etc.), and personnel training files will be maintained on site as part of the Project Procedures Files and available for inspection.

5.7 Employee Access to Information

All pertinent information concerning the health and safety of on-site workers will be conveyed initially via site-specific training. Subsequently, documents such as this Radiological Control Plan, Material Safety Data Sheets (MSDS), and regulatory standards, will either be provided to employees or be made available to them upon request. In addition, any new information concerning safety or health conditions associated with this project will be conveyed to project personnel.

Furthermore, in accordance with 10 CFR 19, current copies of the following documents will be made available for examination by all employees:

- 10 CFR 19 and 20 standards and regulations
- BPCI license, license conditions, and documents incorporated into the license by reference and amendments thereto.
- Operating procedures applicable to remediation activities.
- Any notice of violation involving radiological working conditions, proposed imposition of civil penalty, and any response from BPCI

A notice which describes the documents and states where the documents are available for review will be posted in conspicuous locations throughout the work area.

6.0 ENVIRONMENTAL MONITORING

6.1 Introduction

Remediation operations will be controlled such that no member of the general public will exceed the revised USNRC 10 CFR 20 non-occupational limit of 100 mRem/year. Operations will be conducted such that minimal releases to the environment of airborne and liquid radioactivity will occur. The concentration limits for depleted uranium (U²³⁸) are taken from 10 CFR 20, Appendix B, Table 2, Columns 1 and 2 and are presented here with the BPCI Administrative Limits.

	10 CI	FR 20	BP Adminis	trative Limit
Isotope	Air (µCi/ml)	Water (µCi/ml)	Air (µCi/ml)	Water (µCi/ml)
U ²³⁸	6.0 E-14	3.0 E-7	3.0 E-14	3.0 E-8

In any event, exposure to the public, due to direct, inhalation and ingestion exposures of radioactive materials from the BPCI remediation activities will be limited to 100 mRem in any year. Sampling for airborne and liquid radioactive materials will be performed in accordance with Sections 6.2.2 and 6.2.3 of the Radiation Control Plan and/or the direction of the RSO.

6.2 Monitoring

To ensure that the nonoccupational dose to the public is met, monitoring of the environment around the perimeter of the work site will be performed. Monitoring will consist of the three potential pathways of exposure to the public. The pathways consist of direct exposure to radiation, inhalation and ingestion of radioactive material from the BPCI remediation activities.

6.2.1 Direct Exposure

Direct exposures will be monitored with environmental area Thermoluminescent Dosimeters (TLDs). The TLDs will be placed at strategic locations along the site perimeter. The TLD's will be changed quarterly and analyzed and evaluated by a dosimeter processor that holds current dosimetry accreditation from National Voluntary Laboratory Accreditation Program (NAVLAP) of the National Institute of Standards and Technology. Additionally, during the remediation activities, a TLD(s) will be established at a background location(s) that is not influenced by the radioactively contaminated site. All TLD results will be maintained on an NRC Form 5 (or equivalent).

In addition to the placement of TLD's along the site perimeter, exposure rate measurements will be taken periodically as part of the general site radiation survey program. These measurements will be performed with calibrated instruments, qualified personnel and in accordance with approved procedures.

6.2.2 Airborne Radioactive Materials

Airborne materials are included in the environmental monitoring program to determine possible inhalation exposures to radioactive materials by the public. During remediation operations involving potentially or known radioactive materials, air samples will be collected around the perimeter of the surface impoundments, solid waste management unit(s) and buildings using low volume or variable rate air samplers. The collection and analysis of the air samplers will be performed with qualified personnel, in accordance with approved procedures and with calibrated equipment as described in Section 13.0. The minimum detectable activity of the air sample and counter combination must be able to detect is <3.0 E-14 μ Ci/ml.

Air sampler(s) will be positioned downwind at the site perimeter to collect air that may contain radioactive material during the remediation activities (i.e., downwind of sludge removal, solidification and placement operations).

In addition, air sampler(s) will be located upwind from the site to collect air that will be used to determine background levels.

If any sample result is greater than the BPCI limit then the RSO and CM will be notified. If the sample results are greater than the NRC 10 CFR 20, Appendix B, Table 2 limit for U^{208} , an evaluation will be performed to determine proper corrective action.

6.2.3 Liquid Radioactive Materials

Liquid radioactive materials generated as a result of remediation activities will be collected and analyzed to determine that the material is within the limits established by BPCI and the NRC 10 CFR 20, Appendix B, Table 2 limit for U²³⁸ The sample collection and analysis will be performed with qualified personnel in accordance with approved procedures and calibrated equipment/instrumentation.

If the initial sample result is greater than the BPCI administrative limit, then the BPCI CM and RSO will be advised. If sample results are greater than the NRC 10 CFR 20, Appendix B, Table 2 limits for U²³⁸, an evaluation will be performed to determine proper corrective action and disposition of the liquid.



6.3 Actions

If any environmental pathway exposure exceeds the BPCI administrative limits, then remediation operations will be reviewed to determine the cause of increased pathway exposure and the effect of the exposure on the public and the environment.

Additional measures will be initiated to reduce the exposure pathway and operations can continue with the concurrence of the CM and RSO.



7.9 IDENTIFICATION AND MONITORING OF CONTROLLED AREAS

7.1 Introduction

To aid in the control of radiation exposure and limit the spread of radioactive material, a system of identifying radiologically controlled areas will be implemented by BPCI

The BPCI site will be divided into three distinct areas for radiation exposure control. These areas are unrestricted, controlled and restricted areas. Figure 7-1 depicts the restricted, controlled and unrestricted areas within the site.

Restricted Area means any area access to which is controlled by BPCI for purposes of protection of individuals against undue risks from exposure to radiation and radioactive materials. "Restricted area" shall not include any areas used as residential quarters, although a separate room or rooms in a residential building may be set apart as a restricted area. Within the restricted areas, different zones will be designated to aid in radiation exposure control and control of the radioactive materials present.

Unrestricted Area means any area access to which is neither limited nor controlled by BPCI for purposes of protection of individuals from exposure to radiation and radioactive materials.

Controlled Area means an area, outside a restricted area, but inside the site boundary, access to which can be limited by BPCI for any reason.

In all cases, the radiologically controlled areas will be delineated with distinctive barrier tape or rope and signs. The signs will have the radiation symbol and appropriate wording to warn workers of the potential hazard. A description of the radiation symbol and sign can be found in USNRC Regulatory Guide 8.1 and ANSI Standard N2.1-1969.

All radiological posting will be done by or at the direction of Radiological Control personnel. Movement, removal or defacing of posted radiation warning signs, tags or boundary markers by personnel other than radiological personnel or without their approval may be cause for disciplinary action.

Restricted areas and specific zones within the restricted area will be posted with the appropriate signs, such that posting is readily identifiable from ordinary avenues of approach.

7.2 Radioactive Materials Area

A *Radioactive Materials Area* is an area that contains radioactive materials in amounts exceeding 10 times the 10 CFR 20, Appendix C. Each Radioactive Materials Area (RMA) must be posted with signs meeting applicable standards, including the radiation symbol, and the words "CAUTION - RADIOAC-TIVE MATERIALS AREA" or "DANGER - RADIOACTIVE MATERIALS."





7.3 Radiation Area

Radiation Area means any area, accessible to personnel, in which radiation levels could result in an individual receiving a dose equivalent in excess of 5 mRem in 1 hour at 30 centimeters from the radiation soul ze or from any surface that the radiation penetrates.

Entrance to Radiation Areas will be conspicuously posted with "CAUTION - RADIATION AREA" signs.

7.4 Contaminated Area

A contamination area is an area which contains radioactive material which can spread. The amount of contamination is measured in disintegrations per minute per 100 cm². Contamination above the lowest limits in Table 7-1 will constitute a contamination area. The area will be isolated and posted. The posting will read "CAUTION - CONTAMINATED AREA".

7.5 Airborne Radioactivity

Areas accessible to personnel, such as a room, enclosure, or area will be posted as *Airborne Radioactivity Areas* if airborne radioactivity composed wholly or partly of licensed material exists in concentrations:

(1) In excess of the derived air concentrations (DACs) specified in Appendix B of 10 CFR 20.

(2) To such a degree that an individual present in an area without respiratory protective equipment could exceed, during the hours an individual is present in a week, an intake of 0.6 percent of the annual limit on intake (ALI) or 12 DAC hours.

Each Airborne Radioactivity Area must be posted with signs meeting applicable standards, including the radiation symbol, and the words "CAUTION - AIRBORNE RADIOACTIVITY AREA".

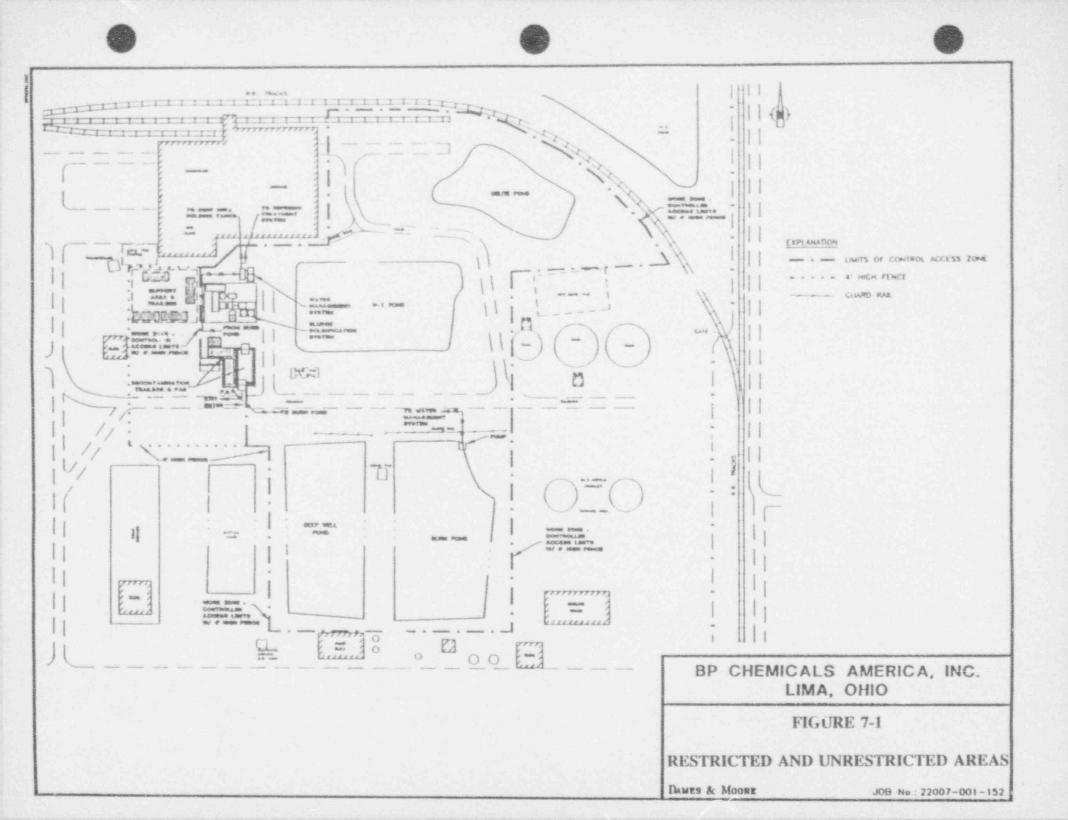
Additional instruments or requirements such as "RWP required"," TLD required," "Contact Health Physics Prior to Entry," as appropriate may be attached to each of the above specified postings.

TABLE 7-1 RADIOLOGICAL CONTAMINATION LIMITS AND SELECTION OF PERSONNEL PROTECTIVE EQUIPMENT

PPE	DIRECT RADIATION LEVELS	LOOSE SURFACE CONTAMINATION	AIRBORNE
None	< 0.01 mR/hr	< 1,000 dpm/100 cm ² β - γ < 20 dpm/100 cm ² α soil contamination of ≤ 35 pCi/gm depleted uranium	<2.0E-12 µCi/ml depleted uranium
TLD	>0.01 mR/hr above background	<pre>< 1,000 dpm/100 cm² β-γ</pre> < 20 dpm/100 cm ² α soil contamination of \leq 35pCi/gm depleted uranium	
TLD, shoe covers, gloves coveralls and head covering	>0.01 mR/hr above background	$\geq 1,000 \text{ dpm}/100 \text{ cm}^2 \beta -\gamma$ $\geq 20 \text{ dpm}/100 \text{ cm}^2 \alpha \text{ to}$ $10,000 \text{ dpm}/100 \text{ cm}^2 \beta -\gamma$ $200 \text{ dpm}/100 \text{ cm}^2 \alpha \text{ or soil}$ contamination of > 35 pCi/gm depleted uranium	≥2.0E-12 µCi/ml depleted uramium
TLD, double shoe, double gloves, coveralls, head covering, hood, half face respirator		> 10,000 dpm/100 cm ² β - γ > 200 dpm 100 cm ² α soil contamination of > 35 pCi/gm depleted uranium	>2.0E-11 μ Ci/ml depleted uranium
TLD, Double shoe covers, Double gloves, double coveralls, head cover, hood, full face respirator		> 100,000 dpm/100cm ² β - γ > 2,000 dpm/100 cm ² α soil contamination of > 35 pCi/gm depleted uranium	>1.0E-10 μCi/ml depleted uranium
TLD, Double shoe covers, Double gloves, double coveralls, head cover, hood, airline respirator or SCBA		soil contamination of >35 pCi/gm depleted uranium	>2.0E-9 μ Ci/ml depleted uranium

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8.0 RADIATION WORK PERMITS

8.1 Introduction

The Radiation Work Permit (RWP) is a administrative tool used to control work occurring inside the radiologically restricted area and to make all of the personnel involved with the work aware of specific hazards and precautions in the specific work area. Additionally, the RWP will instruct the workers as to what protective equipment may be needed and what monitoring will be required.

An RWP will be required for any of the following conditions:

- · Entering a radiation area.
- Entering a contaminated area.
- Entering an airborne radioactivity area.
- Unknown radiological conditions in an area to be entered or equipment to be opened.

8.2 Work Control

All work will be administratively controlled via RWPs. RWPs will be issued daily or weekly, depending on the length of the work task. RWPs will be reviewed daily by the RSO or his designee. The RWP will list the following information:

- (1) Task(s) to be performed.
- (2) Location of task(s).
- (3) Radiological hazards involved with task(s).
- (4) Most recent radiation survey results.
- (5) Required personnel protective equipment.
- (6) Special units restraints or instructions.
- (7) Signature of the RSO or his designee.
- (8) Signatures of the individuals performing the required work

A daily safety meeting will be conducted with all workers to review safety and radiological conditions and/or changes to the RWP, as appropriate.

An RWP will be issued at the start of remediation operations and daily or weekly thereafter. The RWP

will be terminated at the end of 24 hours, 7 days or when conditions change.

The preparation and issuance of RWPs is addressed in BPCI Field Procedure entitled "Radiation Work Permit."



9.0 EXTERNAL RADIATION EXPOSURE LIMITS AND CONTROL

9.1 Introduction

Control of exposure to ionizing radiation is based on the assumption that any dose received as a result of exposure involves some incremental risk; however, exposure within acceptable limits represents a very small increase in risk compared to the normal hazards of life. Therefore, it is the objective of the BPCI Radiological Protection and Control Plan not only to maintain exposures within the limits established by Federal and State law, but also to minimize exposures to individuals, the total work force and the general population in accordance with the as low as reasonably achievable (ALARA) principle.

Remediation operations will be controlled such that no member of the public and no worker will exceed any 10 CFR 20 non occupational and occupational limit (NRC, May 1991) respectively and the total of all workers' exposures will be limited to the lowest reasonably achievable. To ensure worker exposures will be limited to the lowest reasonably achievable, at any time during the remediation efforts the radiation level exceeds 1 mR/hour, remediation work will be immediately stopped. An evaluation of the safety and health effects due to the abnormal radiation level will be performed and documented. Further remediation activities may proceed with the approval of the Project Radiological Safety Officer, after the evaluation is completed.

The USNRC and other appropriate regulatory agencies (Ohio Department of Health, Allen County Department of Health) will be notified within one business day of the exceedance of the action level.

In addition, remediation activities will be controlled such that there will be no release to the environment of airborne radioactivity greater than the concentration limit of 10 CFR 20, Appendix B, Table 2, Column 1 or no release to surrounding water of radioactive liquids greater than 10 CFR 20, Appendix B, Table 2, Column 2 limits.

9.1.1 Control of Personnel Exposure

9.1.1.1 Exposure to Radiation Workers

9.1.1.1.1 Occupational Radiation Exposure Limits

Radiation exposure limits are used for controlling personnel exposure to radiation (excluding medical and dental exposures) to levels which are believed to cause no ill effects even if the employee was exposed to these levels throughout his/her entire working life. These limits are based on those promulgated by Title 10, Code of Federal Regulations, Part 20, "Standards for Protection Against Radiation." Personnel should endeavor to maintain their own exposures as low as reasonably achievable and below these limits.

The occupational exposure limits (10 CFR 20.1201(a)) and the BPCI administrative exposure limits for radiation workers to external radiation are given in Table 9-1. It will be the goal of BPCI to maintain

individual radiation exposure to less than 1 Rem per year.

As stated previously, Table 9-1 lists the BPCI administrative limits for occupational radiation exposure. These limits are less than or equal to those specified in 10 CFR 20. These administrative limits will be the operating limitations for exposure to all personnel. No employee will exceed these limits without receipt of a formal written extension of allowable exposure by the BPCI Radiation Safety Officer (RSO) or his designee.

9.1.1.1.2 Occupational Radiation Exposure Controls

To maintain personnel radiation exposures as low as reasonably achievable (ALARA), BPCI may choose to have more restrictive radiation exposure limits.

The three most important methods to minimize exposure in fulfillment of ALARA objectives are the proper use of time, distance, and shielding. Each of these items is discussed below.

- <u>Time</u>. The less time an individual spends in a radiation area, the less exposure to radiation he/she will receive. To fully utilize the time that is spent in radiation areas, all jobs should be preplanned. Such preplanning should include:
 - (1) Making sure all the tools and equipment required for the job are obtained prior to entering the area.
 - (2) Being familiar with the equipment and work plans prior to entering the area.
 - (3) Knowing the radiation levels as well as component location prior to entering the area.
- <u>Distance</u>. Exposure to radiation can be significantly reduced by keeping as much distance between the individual worker and source as possible.
- <u>Shielding</u>. The third method of controlling/minimizing radiation exposure is by means of shielding. BPCI will utilize shielding, as necessary, to limit exposure to personnel.

9.1.1.1.3 Personnel Monitoring for External Radiation

The purpose of personnel monitoring for external radiation is to provide an indication of the level of external radiation exposure. Occupational exposure limits (10 CFR 20.1201) and the BPCI administrative exposure limits for radiation workers to external radiation are given is Table 9-1.

Upon the initial site visit by each radiation worker, a USNRC Form 4 (or equivalent) will be completed and signed. Exposures to the worker during the course of the remediation activities will be documented IMAGE EVALUATION TEST TARGET (MT-3)

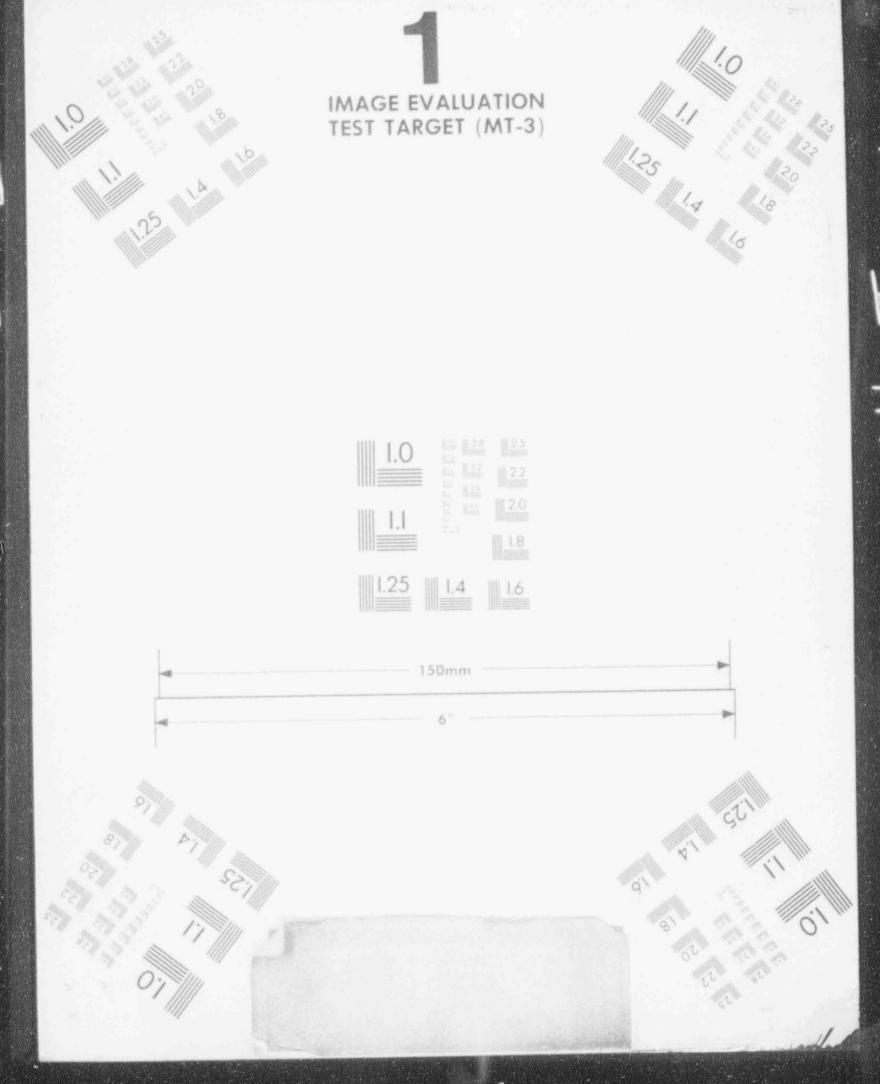




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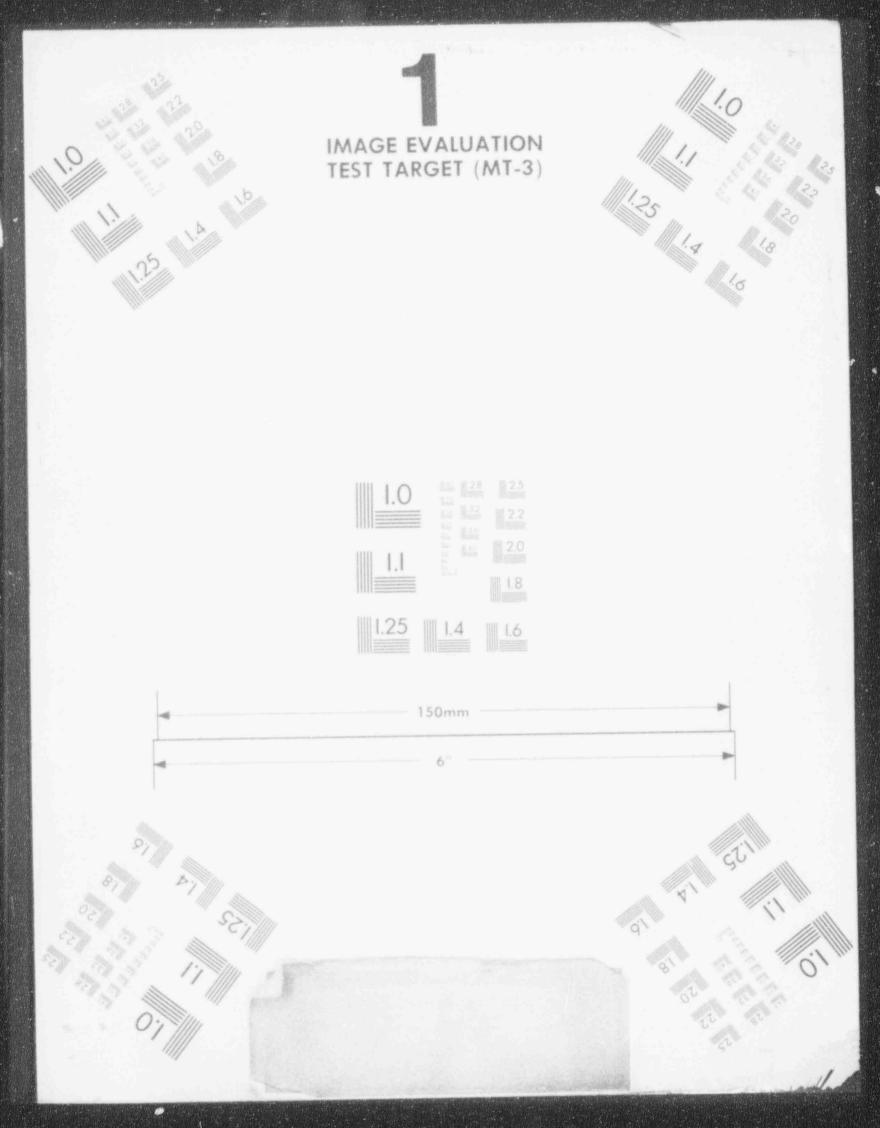


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on a USNRC Form 5 (or equivalent).

9.1.1.2 Exposure to Minors

The annual occupational dose limits for minors specified in 10 CFR 20.1207 is 10 percent of the annual dose limits specified for adult workers.

However, to minimize exposures to minors, individuals under the age of 18 are not permitted to enter any restricted area or any radiation area at the BPCI facilities.

9.1.1.3 Exposure to Unborn Child

Because of the high radiosensitivity of newly formed and fast growing cells, female employees who work in controlled areas and their supervisors will be advised of the National Council on Radiation Protection and Measurement recommendations to keep radiation exposure to an embryo or fetus to the very lowest practical level during the entire gestation period and to limit the dose to the unborn child to a maximum 500 mrem or less during the entire period of pregnancy as specified in 10 CFR 20.1208 (a).

The dose to an embryo will be taken as the sum of the deep dose equivalent to the declared pregnant woman and the dose to the embryo/fetus from radionuclides in the declared pregnant woman.

The BPCI policies regarding exposure to an embryo or fetus are derived from those of Regulatory Guide 8.13 and 8.36 and are very strict in limiting the exposure of fertile females.

These policies are in place to protect the unborn child.

- It is the responsibility of all fertile females on site whose job involves work with radioactive material to declare their pregnancy to their supervisor/manager as soon as it is confirmed.
- Upon declaration of pregnancy, it the responsibility of BPCI management to insure that all proper precautions are taken to minimize exposure to the unborn child of the female employee.

As part of the radiation safety training (and reverification training) and prior to issuance of TLDs, all personnel authorized to receive radiation exposure will be given specific instruction about prenatal exposure risks to a developing embryo and fetus. This instruction will include both orally and in writing, the applicable information contained in the Appendix to U.S. Nuclear Commission Guide 8.13 "Instruction Concerning Precatal Radiation Exposure". All personnel receiving instruction in accordance with the paragraph above will sign the statement contained in the Prenatal Exposure Instructions Form (Figure 9-1) prior to being issued dosimetry.

The signed statements will be kept with the training records and will be retained by BPCI

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9.1.1.4 Exposure to Visitors

BPCI will control the exposure of visitors to its worksites to levels as low as reasonably achievable (ALARA). For exposure control purposes a "visitor" is defined as any person not qualified as a "radiation worker" and who requires access to restricted areas.

Entry by a visitor to a control area will require the following:

- (1) Assignment of a temporary TLD badge or self-reading dosimeter:
- (2) Escort by a qualified radiation worker at all times while in the restricted area
- (3) Documentation of the following information:
 - (a) Name
 - (b) Social Security Number
 - (c) Date of Visit

9.2 Personnel External Exposure Monitoring

9.2.1 Equipment

As stated previously, the purpose of personnel monitoring for external radiation is to provide a indication of the level of external radiation to which an individual has been exposed. Monitoring for external radiation exposure will be accomplished with the use of primary dosimetry and radiation survey dose rate meters. The primary dosimeter for this project will be the thermoluminescent badge (TLD badge) capable of measuring the worker's whole-body exposure.

Other devices that will be available for exposure control are self reading dosimeters and dose rate survey meters. The self reading dosimeters will be used by visitors to the site and as directed by the RSO.

The radiation survey dose rate meter for this project will have a minimum detection rate of 2 μ R/hr, an accuracy of $\pm 10\%$, and a response time of 15 seconds. Radiation and/or contamination instrumentation and specifications are presented in Section 13.0.

9.2.2 Calibration

Portable dose rate survey instrumentation used to evaluate personnel exposure will be calibrated semiannually by a qualified vendor in accordance with ANSI N42.17A-1989 guidance for each type of radiation of concern at the site. Portable instrumentation will be source checked each day the instrument is in use. All calibrations will be performed using standards traceable to the National Institute of Standards and Technology (NIST).

Self reading dosimeters will be tested semi-annually by a qualified vendor in accordance with ANSI N13.5-1972 (R 1989) guidance. TLD badges do not require field calibration, but must meet the performance criteria found in ANSI N13.15-1985.

9.2.3 Survey and Dosimetry Requirements

9.2.3.1 Surveys

Surveys for radiation levels and/or contamination levels will be performed using appropriate portable radiation survey dose rate meters prior to working on known or materials suspected of being contaminated to assess the level of hazards and aid in the establishment of appropriate radiological controls.

These surveys will be performed by qualified individuals using calibrated instruments and in accordance with approved procedures.

9.2.3.2 Dosimetry

Consistent with 10 CFR 20.1502, all personnel who are likely to receive, in one year from sources external to the body, a dose in excess of 10 percent of the limits specified in 10 CFR 20.1201(a) will be monitored by dosimeters. While it is unlikely that any worker will receive a dose in excess of 10 percent of the specified limits, the following personnel will be monitored with dosimeters:

- (1) Personnel entering an area posted as a radiation area.
- (2) Personnel who routinely remain in spaces immediately adjacent to radiation areas. Even though the general area radiation levels in the space are less than one mRem per hour, personnel will be monitored.
- (3) Personnel who directly handle or touch radioactive material, or personnel in a controlled surface contamination area, even though they do not enter a radiation area. However, it is permissible for personnel to handle radiation survey instruments containing check sources without being monitored with dosimeters.

9.2.3.2.1 Thermoluminescent Device (TLD)

BPCI will use TLD badges to measure personnel radiation exposure for permanent record purposes. This TLD measures ionizing radiation by emitting a measurable amount of visible light which is directly proportional to the amount of incident radiation. This TLD measures both beta and gamma exposure. Extremity TLDs will be made available by BPCI if the need arises. Extremity TLDs will be TLD finger rings or TLDs oriented toward the source of radiation as much as practical without causing damage to the devices during use.

The results of the TLD badge measurements are the basis of the legal record of an employee's exposure. Therefore, any deliberate action by an employee which invalidates the TLD measurements is cause for disciplinary action.

An individual's permanent TLD badge will be worn on the front of the body between the waist and neck, facing away from the body. TLD badges are to be placed in the special onsite storage rack when not being used. TLD badges are not to be taken offsite (i.e., home, car).

All personnel required to regularly enter and vork in the radiologically restricted area will be provided with a primary dosimeter (TLD). This dosimeter will be worn daily throughout the duration of the project. Dosimetry will be analyzed quarterly or at the time of employee termination (whichever is earlier) to determine radiation exposure of the individual. Visitors will be assigned a temporary dosimeter (TLD) or a self-reading dosimeter (SRD).

9.2.3.2.1.1 Issuance

Workers will not be issued a TLD until the worker has:

- Provided evidence of the physical fit for duty and fit for respirator use (when required)
- Successfully passed the Radiation Workers Training course (test score of 80% or higher)
- Completed NRC Form 4
- Provided a urine sample/for baseline bioassay

All employees upon permanent departure from the project will turn in dosimetry and provide a urine sample for closeout bioassay.



9.2.3.2.1.2 Loss or Damage of TLDs

Each instance of a lost or damaged personnel TLD will be reported promptly to radiological control personnel.

Individuals who lose or damage their TLD while in a restricted area will immediately exit the area and report the condition to the RSO or his designee. The individual will be restricted from entering restricted areas until an exposure estimate has been completed and a new TLD issued.

9.2.3.2.1.3 Estimate of Dose

All exposures indicated by the TLD will be considered to have been received by the individual unless it can be clearly demonstrated to be erroneous.

If an exposure measurement result from a TLD is lost or proven erroneous, an estimate of the dose received by the individual during the period in question will be established by the RSO or his designee and documented as part of the employee's exposure record.

Estimates of dose received will consider at least the following:

- (1) Dose rates in the individual's work area.
- (2) Actions taken by the individual during the time for which dose information is desired. This review should include consideration of work position, time in restricted areas, etc.
- (3) Doses received by other personnel doing similar work in the area.

9.2.3.2.1.4 Wearing TLDs

The wearing of TLDs will be strictly enforced. TLDs will be worn on the front of the body between the waist and neck, facing away from the body. Any deliberate action by an employee which invalidates the TLD measurements is cause for disciplinary action.

9.2.3.2.1.5 Tracking Radiation Exposure

Prior to personnel performing work at the mixed waste ponds, correction action management units, or CAT-21 building, NRC Form 4. "Occupational External Radiation Exposure History," will be completed to determine personnel lifetime exposure. NRC Form 5, "Current Occupational External Radiation Exposure," will be completed to determine personnel exposure for the current year.

9.2.3.2.2 Self-Reading Pocket Dosimeters

Self-reading pocket dosimeters (SRPD) may be issued to individuals who enter controlled areas. These dosimeters, if used, will be utilized as required and will be returned to the RSO or his designee for processing. If the SRPD is worn with a TLD, the SRPD will be worn next to the permanent TLD.

Pocket dosimeters, whether low or high range types, will be read by the wearer prior to entering radiation or high radiation areas and periodically thereafter to control his own radiation exposure while in these areas. To prevent offscale reading, low range dosimeters will be recharged whenever the reading exceeds 150 mRem.

9.2.4 Analysis

Dosimetry will be provided, processed and evaluated by an offsite dosimetry processor that:

- Holds current personnel dosimetry accreditation from the National Voluntary Laboratory Accreditation Program (NAVLAP) of the National Institute of Standards and Technology (NIST); and
- (2) Approved for the type of radiation (gamma and high energy beta from depleted uranium) that most closely approximates the type of radiation for which the individual wearing the dosimeter is monitored.

Dosimeters will be processed on a quarterly basis or at the time of employee termination, whichever is earlier.

9.2.5 Recordkeeping

9.2.5.1 Dosimetry

When self reading dosimeters are used, the daily exposure will be recorded and tracked on a separate form for visitors and as a portion of the radiation work permit for workers. Copies of TLD results (NRC Form 5) as they relate to a named employee will be maintained on site and available for inspection. Personnel monitoring reports will be maintained with guidance from USNRC Regulatory Guide 8.7, Rev. 1, 1992.

Copies of individual exposure results (NRC Form 5) will be transmitted to each employee at the end of each year. Copies of NRC Form 4 (see Section 9.1.1.1) and Form 5 for individual workers will be maintained as part of the BPCI Project Procedure Files for the duration of the remediation project and until termination of the license.

9.2.5.2 Radiation and Contamination Surveys

Records of radiation and contamination surveys will include:

- (1) Date and time of survey.
- (2) Type(s) of instrument(s) used and their calibration information.
- (3) Sketch and description of survey area.
- (4) Contact and general exposure rates.
- (5) Location of any boundaries and step-off pads.
- (6) Name of survey performing individual and reviewing supervision.

A form that includes the information presented above will be developed for this project.

Records of all surveys will be maintained by BPCI for the duration of the remediation projects and until termination of the license.



FIGURE 9-1 PRENATAL EXPOSURE INSTRUCTIONS FORM

1. ______, acknowledge and understand the recommendation of the National Council on Radiation Protection and Measurements to limit radiation exposure to the unborn child to the very lowest practical level, not to exceed 0.5 Rem during the entire period of pregnancy, as contained in "Instructions Concerning Prenatal Radiation Exposure" Regulatory Guide 8.13.

Signed

Printed

Social Security Number

Witness



TABLE 9-1 RADIATION EXPOSURE LIMITS

WHOLE BODY	OCCUPATIONAL EXPOSURE LIMIT	BP CHEMICALS, INC. ADMINISTRATIVE LIMITS 1 rem/yr	
Total Effective Dose Equivalent	5 rem/yr		
Sum of deep dose equivalent plus committed dose equivalent to any individual organ or tissue	50 rem/yr	5 rem/yr	
Lens of eye, skin and extremities	15 rem/yr	1.5 rem/yr	
Shallow dose	50 rem/yr	5 rem/yr	
Minor	10% of occupational dose limits	10% of Administrative Dose Limits However, no minors are permitted to enter a restricted area	
Embryo/fetus	0.5 rem/gestation period	0.5 rem/gestation period	
General public	0.1 rem/yr	0.1 rem/yr	



10.0 INTERNAL RADIATION LIMITS AND EXPOSURE CONTROL

10.1 Introduction

It is the policy of BPCI to maintain the internal exposure of radioactive materials to ALARA. The use of engineering controls to the maximum extent possible will be employed. If engineering controls are not adequate, as demonstrated by work area air sampling, then respiratory protection will be considered to control internal exposures to radioactive materials. The effectiveness of the internal exposure control program will be confirmed through the use of air sampling surveys and bioassay (see Section 14.4).

Remediation operations will be controlled such that no member of the public and no worker will exceed any 10 CFR 20 (NRC, May 1991) nonoccupational and occupational limit, respectively, and the total of all workers' internal exposures will be limited to the lowest reasonably achievable.

10.2 Engineering Controls

Engineering controls will be utilized to the maximum extent possible to control the production of dusts during the remediation project. Engineering controls may be, but are not limited to using tarps or coverings, water misting or dust control additives.

10.3 Monitoring of Airborne Radioactivity

To demonstrate compliance with the limits specified in 10 CFR 20, Appendix B. Table 1, air sampling of the work areas will be performed daily during excavation, transfer or hauling solidification and placement activities. The frequency and location of sampling equipment will be dictated by the remediation activities that occur each day. An adequate number of samples will be collected to be representative of the air in the work area.

Representative samples will be collected daily in the general work areas, at the breathing zone (within 18") of workers and downwind of the work area at the restricted area boundary. If work involves the use of heavy equipment air samples will be collected in the operator's cabs daily or as directed by the RSO. Work area air sample volumes will be a minimum of 36 cubic feet and collected using high volume, low volume or lapel air samplers as directed by the RSO or designee.

If work involves activities outside the operator cab or when deemed appropriate by the RSO or designee, representative samples will be collected daily in the general work area as close to the workers as practical.

If air sampling determines the possibility of an airborne release, then the RSO or designee will evaluate the possibility of an uptake. Evaluation will include, but not be limited to nasal smears and bioassay methods to determine exposures due to an uptake of U²³⁸.

To demonstrate compliance with the limits specified in 10 CFR 20, Appendix B, Table 2, site perimeter air samples will be collected and analyzed daily during excavation, transfer or hauling solidification and placement operations. The sampler(s) will be positioned at appropriate locations downwind of the site



to collect potential releases from the site.

One background sample will be collected daily from the upwind location to the remediation site. At a minimum, one sample will be collected downwind to the remediation site. The site perimeter air samplers will collect a minimum of 36 cubic feet using a low volume sampler. Downwind perimeter air samples will be collected during periods of remediation activities to verify that quantities of depleted uranium (U²³⁸) above the established limits in 10 CFR 20, Appendix B, Table 2, Column 1 are not released from the site.

Air sample collection and analysis will be performed with qualified personnel using calibrated equipment/instrumentation and in accordance with approved procedures.

10.4 Equipment

Air sampling equipment will be calibrated in accordance with ANSI N13.1-1969 (R/1982) within six months of the start of the project and every six months thereafter. Flow rates for the air samplers will be variable from 0.5 to 20 CFM. The analysis of air samples will be performed with equipment capable of a minimum detectable activity of < 2.0 x E-12 μ Ci/ml. The analysis equipment will be calibrated in accordance with ANSI N42.17A-1989 guidance.

10.5 Analysis

Results of air samples will be compared with the limits given in Table 10-1. If the air sample results are above 10% of 2.0 E-11 μ Ci/ml (2.0 E-12 μ Ci/ml) for U²³⁸, then the RSO or CM will be notified.

10.6 Respiratory Protective Equipment (RPE)

10.6.1 Selection

To maintain the internal exposure of radioactive materials to ALARA, engineering controls will be used to the maximum extent possible. If engineering controls are not adequate, as demonstrated by work area air sampling, then respiratory protection will be considered to control internal exposures to radioactive materials.

All respiratory protective equipment (RPE) will be recommended by the RSO or his designee prior to the initiation of each new task or operation.

RPE will always be selected on the basis of hazard or presumed hazard. Whenever the degree of hazard can not be determined prior to task initiation, a conservative approach for protecting personnel will be assumed.

Respiratory equipment may be used to limit the potential for intake of radioactive materials. Protection factors as specified in 10 CFR 20. Appendix A will not be applied and potential exposures will be based upon measured volumes of contamination in the air. If BPCI determines a need to take credit for the use

of respiratory protection equipment (apply protection factors), it will notify Region III of the NRC in writing 30 days prior to using respiratory protection equipment for that purpose.

10.6.2 Use

Consistent with the applicable portion of 10 CFR 20.1703, the following requirements will apply to the use of RPE at this project:

- RPE will only be used by those persons who have been examined by a licensed physician and found medically qualified to wear the prescribed equipment.
- (2) Project personnel will use the prescribed RPE in accordance with their training and the requirements of the work permit.
- (3) Only equipment recommended by the RSO will be permitted.
- (4) Only equipment that has been selected, maintained, and inspected prior to commencement of work will be permitted.
- (5) Personnel will only be permitted to use equipment for which they have been adequately trained and fitted.
- (6) Only equipment that has been properly fitted in accordance with the acceptable methods contained in NUREG-0041 will be permitted for use.
- (7) Only equipment that has been adequately decontaminated will be permitted to be reused.
- (8) Only approved RPE will be allowed for use during the remediation project.
- (9) Only NIOSH and MSHA-approved respiratory equipment will be used.
- (10) Communications (voice, visual, or signal line) will be maintained between all individuals present. Planning will be such that one individual, unaffected by any likely incident, will have the necessary resources to assist the others in case of any emergency.
- (11) Respiratory protective equipment will not be worn when conditions exist that prevent a good face-to-facepiece seal.
- (12) Cartridges and filters used in conjunction with air-purifying respirators will be changed daily, or upon increased breathing resistance; whichever comes first.
- (13) No contact lenses will be permitted when wearing respiratory protection.

Additional requirements may be identified as work progresses.

10.6.3 Maintenance and Repair

All RPE will be maintained and repaired in accordance with the manufacturer's recommendations, using only manufacturer-approved replacement parts, by personnel who are knowledgeable in the maintenance/repair procedure to be performed. Some procedures may be performed by the user while other procedures must be performed by the manufacturer, or an authorized service center. The following subsections describe the maintenance procedures anticipated for this project.

10.6.3.1 Maintenance/Repair by the User

All personnel who have been issued RPE will be responsible for:

- (1) Daily cleaning or disposal of assigned equipment.
- (2) Cartridge/filter replacement.
- (3) Proper storage of assigned equipment.
- (4) Possession of assigned equipment.
- (5) Requesting maintenance/repair as needed.
- (6) Proper use/handling.
- (7) Breathing-air replenishment.
- (8) Periodic frisking for radioactive contamination.

10.6.3.2 Survey of Cleaned RPE

All RPE coming into contact with the skin will be surveyed for radioactive contamination prior to use by qualified Radiological Control personnel.

10.6.3.3 Maintenance/Repair by the Manufacturer

All equipment that cannot be maintained, serviced, or repaired by the user will be sent to the manufacturer or authorized service center for service. Some of the procedures that are not anticipated to be handled in-house include:

- (1) High-pressure regulator maintenance/repair.
- (2) Cylinder maintenance/repair.
- (3) High-pressure hose maintenance/repair.

Prior to returning RPE to a manufacturer for repair, the equipment will be surveyed for radioactive contamination, decontaminated if necessary, and resurveyed for unrestricted release.

10.6.3.4 Inspection

All RPE will be inspected prior to each use and during cleanings/reassembly. In the case of respiratory protection, the content of inspections will be as prescribed by the manufacturer. In addition, all respirators will be periodically monitored for radioactive contamination. If airborne radioactivity is indicated by the airborne sampling program (Section 10.3), then respirators will be monitored for radioactive contamination after each use. This will be accomplished by direct surveying and swipe testing for loose contamination. Contaminated respirators will be decontaminated immediately and retested, prior to being used again. Decontamination will be in accordance with contamination limits presented in Table 7-1.

10.7 Training and Instructions

As part of the radiation worker training, individuals will be instructed in the proper donning and doffing of respirators. They will also be fit tested and instructed on the proper field test to be used to insure an adequate fit.

In addition, individuals will be instructed on the proper maintenance and cleaning of respirator.

The worker will also be advised that the worker may leave the work area any time for relief from respirator use in the event of respirator failure, physical/psychological distress or other emergency situations.

10.8 Bioassay

While it is not expected that internal exposures due to inhalation or ingestion (uptake) of U²³⁸ would exceed the limits specified in 10 CFR 20, Appendix B, Table 2, Columns 1, 2 and 3, bioassay methodology will be implemented to demonstrate compliance. A bioassay program will be developed and implemented consistent with the applicable portions of Regulatory Guide 8.9.

10.8.1 In-Vitro Bioassay

Urine samples will be collected from each radiation worker prior to start of work to establish a baseline measurement of radioactive material (if any) within the individual body. A second urine sample will be collected from each worker a the time of termination to demonstrate compliance with the specified limits and to ensure that any unknown intakes are quantified. A urine sample will also be collected any time there is a suspect ingestion or inhalation of contaminated material.

10.8.2 In-Vivo Bioassay

In-vivo (lung/whole body) counting will be performed by a qualified vendor or facility, if urinalysis is not possible or sufficient.

Results of each worker pre employment and past employment bioassays will be maintained as part of the BPCI Project procedure files and will be available for the worker to review.

10.8.3 Special Internal Dosimetry Evaluation

Personnel who are involved in radiological work will have internal dosimetry evaluations when internal contamination is confirmed or suspected, in accordance with the following criteria:

A urinalysis or lung count will be required in the following circumstances:

- Whenever personnel are exposed to airborne radioactivity above the limits in 10 CFR 20, Appendix B.
- (2) Whenever personnel are exposed to high airborne concentrations exceeding protection provided by respiratory equipment being worn.
- (3) Whenever nasal swabs or personnel frisking indicates detectable counts of alpha or betagamma activity above established limits.
- (4) Whenever the Radiation Safety Officer or his designee feels that internal monitoring is needed.

When in-vivo examinations are required as a result of internal contamination, the involved personnel will be transported directly to the whole body counter facility as soon as practicable after the incident. Additionally, in-vitro fecal sampling may be required if the urinalysis or in-vivo examination indicates internal contamination.

10.8.4 Dose Commitment

When an internal deposition is detected, the employee's committed effective dose equivalent (CEDE) will be estimated by methods using metabolic modeling consistent with reports 26, 30 and 54 of the International Commission on Radiological Protection (ICRP) and Regulatory Guide 8.9. The calculated CEDE will be reported to the employee and will become a part of his/her exposure history file (NRC Form 5).



10.9 Work Restriction

An employee may have his radiation work activities altered or limited as a result of:

- (1) Approaching the control levels specified in Section 9.1.1 and 10.1.
- (2) Unknown exposure status.
- (3) Increased potential for internal deposition, such as an open skin break.
- (4) Repeated violations of radiological or general safety requirements.

The RSO or his designee is responsible for implementing work restrictions, when necessary. The employee's supervisor will be notified in writing that a work restriction has been imposed within hours of determining the need for a restriction. Copies of work restrictions will be maintained in the employee's dosimetry record.

No person will exceed the administrative control levels of Section 9.1 without prior written approval of the RSO or his designee.

An employee whose exposure status is unknown (e.g., lost dosimeter) will not enter a controlled area until his/her current exposure status is determined by the RSO or his designee.

When an employee has an internal deposition of a radioisotope induced for medical diagnostic purposes, he/she will be restricted from wearing a TLD until the medical isotope is eliminated from the body. This is done to avoid including exposure from the medical isotope to that exposure received from this contact with radioactive material.

Employees who work with radioactive materials will report any skin breaks which they may have to their immediate supervisor and radiological controls personnel. Skin breaks include unhealed wounds, open cracks from chapping, injuries such as lacerations, abrasions, punctures, and blisters or burns. A clearly open wound will be sufficient reason to prohibit entry to a controlled area, irrespective of protective clothing or medical dressings.

Safeguards will be maintained by supervision to minimize the likelihood of accidental introduction of radioactive materials beneath the skin. If the skin is broken while working with radioactive materials, the employee will immediately report to his immediate supervisor who will have the skin break surveyed by Radiological Control personnel. The RSO or his designee will determine if additional follow-up action is required.

Contaminated personnel will be decontaminated in accordance with the approved procedures listed in Table 11-2.

TABLE 10-1 AIR MONITORING/SAMPLING ACTION LEVELS

TYPE OF MEASUREMENT	READING	ACTION
TLD - Personnel	> 50 mrem/qtr.	 Investigate exposure source(s), evaluate tasks/operations involving potential for exposure, establish ALARA controls to reduce exposures as appropriate. Notify BPCI CM and RSO
TLD - Project Site Perimeter	2 times background	 Determine source and evaluate impact on public. Notify BPCI CM and RSO.
Work Area Air Samples for Particulate Radioactivity	2.0E-12 μCi/ml U ²³⁸	 Investigate additional engineering methods to reduce exposure to airborne materials. Notify Contractor Project Manager. Notify BPCI CM and RSO. Increase frequency of work site air sampling
Work Area Air Samples for Particulate Radioactivity	0.10 to 0.25 of 2.0E-11 μCi/mL U ²³⁸	 Investigate the need for respiratory protection Notify BPCI CM and RSO Notify Contractor Project Manager
Perimeter sampling for Particulate Radioactivity	> 0.5 of 6.0E-14 μ Ci/ml U ²³⁸	 Notify BPCI CM and RSO Evaluate controls of off-site emissions and modify as appropriate.

11.0 CONTAMINATION CONTROL

11.1 Introduction

Control of radioactive materials is needed to minimize the spread of contamination. When radioactive contamination is spread, the potential for an individuals exposure to radiation will increase. In the event that radioactive contamination is spread, then decontamination efforts will be implemented.

Decontamination may be required whenever personnel and equipment exit potentially or known contaminated areas of the project site. Proper decontamination will be necessary to minimize the potential for transfer of contaminants to previously unaffected areas, and for personal protection. The subsections below present the personal and equipment decontamination requirements applicable to this project.

11.2 Contamination Control

To the maximum extent possible, all radioactive contamination will be kept to a minimum. Spills of radioactive materials will be isolated and cleaned up as quickly as possible. All equipment and personnel exiting the radiologically restricted area will be monitored for contamination. Limits for amination and associated personnel protective equipment are given in Table 7-1. Contamination limits for surfaces and equipment to be released for unrestricted use are presented in Table 11-1.

11.3 Equipment Decontamination

11.3.1 General

All equipment used on site will be thoroughly decontaminated prior to being cleared for release from the project site. This requirement will apply to all equipment, including (but not limited to) the following:

- (1) Vehicles and heavy equipment.
- (2) Contaminated materials transport equipment (conveyors, hoppers, piping, containers, etc.).
- (3) Air monitoring instruments.
- (4) Sampling apparatuses.
- (5) Hand tools.

The degree of decontamination necessary will vary on the type of equipment involved, and on its uses relative to the amount of contamination that may have occurred.

11.3.2 Requirements

Small items of equipment (i.e., hand-held items such as hand tools and air monitoring instruments) will

be taken to the personnel decontamination area and decontaminated by the user(s) upon entry into the Personal Decontamination Pad. Larger items such as vehicles will be taken to the Equipment Decontamination Pad.

Small items will be protected from contacting contamination to the extent possible through practices such as bagging instruments or taping (if applicable/possible), and avoidance of setting items on potentiallycontaminated surfaces. Decontamination of small items will typically involve a soap and water wash and a clean water rinse, followed by instrument frisking/screening.

Exceptions to these requirements may include:

- (1) Items made of absorbent materials (i.e., wooden handles on tools, etc.) may be discarded and not subjected to decontamination efforts after reasonable effort is made to decontaminate. Absorbent materials in the contamination area should be kept to a minimum.
- (2) Items that require special decontamination procedures, such as samples and/or sampling apparatus.

Large items of equipment (i.e., site vehicles, bulldozers, backhoes, etc.) will undergo decontamination at the Equipment Decontamination Pad. The procedures utilized at this location will include high-pressure steam cleaning of all exterior surfaces. Pre- and post-instrument screening/frisking will be performed to identify potential "hot" spots from a radiological standpoint. These measurements will be taken on both exterior and accessible interior surfaces.

Additional guidance regarding personnel decontamination is contained in Section 6.0 of the BPCI Health and Safety Plan.

11.3.3 Contaminated Release Limits

See Table 11-1 for guidance of contamination limits.

11.4 Personnel Decontamination

11.4.1 General

It is not expected that personnel exiting the radiological control zones will be contaminated after removal of the outer layer of protective clothing. However, if personnel are determined to be contaminated then personnel decontamination procedures will be performed. (See Table 11-2)

The only exception to this requirement would be in the event of an extreme emergency when the urgency of the situation outweighs the need for decontamination. An example of this is a medical emergency where medical attention requires priority treatment.



11.4.2 Procedures

Personnel decontamination protocol will be comprised of removing items of personal protective equipment and clothing (tyvek and outer boots), followed by surveying for radioactive contamination. Radiological survey instrumentation and specifications are presented in Section 13.0. Personnel contaminated above the limits specified in Table 11-1 will be decontaminated using the procedures specified in Table 11-2.

All personnel will receive training in proper decontamination procedures and sequences as part of the sitespecific training for this project.

11.4.3 Facilities

Personal decontamination facilities will consist of as a minimum, a bermed area lined with plastic. The decontamination facility will have provisions for containers containing soapy water, rinse water and receptacles for waste, water and trash. All materials will be tested for radioactive contamination prior to release from the decontamination facility.

11.5 Reuse of Personal Protective Equipment (PPE)

Reuse of items of personal protective equipment (PPE) will be permitted, provided that such items are successfully decontaminated, and that they satisfactorily pass the instrument screening/frisking process. Examples of PPE items that may be reused include:

(1) Hardhats,

- (2) Respirators (exception: air-purifying respirator cartridges).
- (3) Work boots.
- (4) Boot covers.
- (5) Eye and face protection.
- (6) Ear protection (exception: disposable ear plugs).
- (7) Cloth coveralls and/or Tyvek.

(8) Work gloves.

Items that cannot be properly decontaminated will be handled as waste products, containerized, and will remain BPCI property and disposed of in accordance with BPCI requirements for disposal of radioactive waste.



11.6 Confiscation of Contaminated Articles

All site personnel will be made aware, as part of site-specific training that any item brought on site may be confiscated if it becomes radioactively contaminated and cannot be successfully decontaminated. In this regard, site personnel will be informed that personal articles should not be brought on site.

11.7 PPE Requirements for Decontamination Areas

Personnel working in decontamination areas during decontamination operations will need to utilize items of PPE to protect themselves from the contaminants that may be present on the surfaces that are being decontaminated. PPE requirements for personnel working in the personnel decontaminated. For those workers assigned to the equipment decontamination pad, an increased potential for contact with liquids exists due to the use of a high-pressure steam generator. Therefore, minimum PPE requirements for workers in this area will typically involve:

(1) Hooded coveralls, made of moisture-repellant material or rain suits.

(2) Full-face shield.

(3) Boot covers.

(4) Moisture-resistant gloves.

These PPE requirements may be modified based on project site conditions including the use of full-face air-purifying respirators as conditions warrant.

11.8 Personal Hygiene

Due to the nature of operations and contaminants involved at this site, practicing sound personal hygiene will be emphasized to all site workers both initially during site training, and on an on-going basis.

Eating, drinking, chewing gum or tobacco, and smoking will be prohibited in the contaminated or potentially contaminated areas or where the possibility for the transfer of contamination exists.

11.9 Personal Contamination (Frisking and Decontamination)

As part of Radiation Worker Training, all personnel will be instructed in the proper method of removing outer clothing/tyveks and boot covers and monitoring for personal contamination as part of the formal radiation safety training program. Friskers (personal contamination monitors) will be available at each exit from a controlled area. Instructions will be provided at each personal frisking station. Instrumentation/specification of instruments used to monitor for personal contamination are presented in Section 13.0.

In the event that personnel contamination is suspected or found, the RSO or designee will be notified and appropriate action as directed by the RSO be taken. Table 11-1 gives contamination levels for personnel contamination. Table 11-2 provides guidance for skin decontamination methods.

11.10 Waste Minimization

As a result of carrying out the remediation activities at the BPCI sites, radioactive waste in the form of protective clothing, rags, gloves, wipes, tools and equipment will be generated.

It is BPCI policy to minimize the amount of radioactive waste to the extent practical. To achieve this objective, the following guidance is offered:

- Radwaste receptacles are for contaminated trash only. Do not throw clean trash into these containers.
- Take only the amount of material (bags, wipes, rags, etc.) that you need to perform the immediate job. Avoid taking bulk volumes of material into the contaminated area.
- · Bag or tape tools or equipment to minimize the potential for the article to become contaminated.
- Reuse to the extent possible tools and equipment that is already contaminated. Reuse of contaminated tools and equipment will reduce the amount of radioactive material contaminated.
- All tools and equipment removed from contaminated areas must be surveyed by Radiological Control
 personnel prior to removal to determine if they are contaminated. Contaminated tools and equipment
 should be stored for future use and contaminated trash should be disposed of as radwaste. Tools,
 equipment, and trash that are frisked "clean" may be stored or discarded as everyday nonradioactive
 material.
- If cleaning solutions are to be used for decontamination purposes, make sure that the solution is not
 a hazardous chemical that will generate a "mixed waste" if it becomes contaminated with
 radioactivity and has been declared waste. A water based decontamination solution is the preferred
 option.





TABLE 11-1 RADIOACTIVE CONTAMINATION LIMITS

ITEM	USNRC REGULATORY GUIDANCE*				
	AVERAGE ACTIVITY	MAXIMUM ACTIVITY	REMOVABLE ACTIVITY		
Materials and Equipment*	5,000 dpm/100 cm ² α , β - γ	15,000 dpm/100 cm ² α , β - γ	1,000 dpm/100 cm ² α , β - γ		
Personnel	200 dpm β-γ 20 dpm α				

* Contamination limits for materials and equipment specified in "Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of License for Byproduct, Source, or Special Nuclear Materials" (NRC, August 1987).

TABLE 11-2 TABLE OF SKIN DECONTAMINATION METHODS

METHOD	ADMINISTRATING PERSON	EFFECTIVE FOR	DAY, TRUCTIONS		
Masking Tape	RC Technician	Visible Particulate	Apply tape to skin by light patting. Remove carefully.		
Waterless Hand Cleaner	RC Technician	All Skin Contamination	Apply to affected area and allow it to melt onto skin. Remove with cotton or soft disposable towel.		
Soap and Tepid Water	RC Technician	All Skin Contamination	Wash area with low alkaline, non-abrasive soap and tepid water. Repeat until further attempts do not reduce the level. A surgical hand brush may be used with moderate pressure.		
Cornmeal Detergent Paste	RC Technician	All Skin Contamination	Mix cornmeal and powder detergent in equal parts with enough water to form a paste. Put onto affected area for five (5) minutes. Remove with cotton or disposable towel. Rinse skin.		
Shampoo RC Technician		Hair Contamination	Wash hair and rinse. Repeat as necessary. Remove any hair that cannot be decontaminated. DO NOT SHAVE HAIR. Cut hair as close to the skin as possible with scissors.		
Nose Blowing	Individual	Nasal Contamination	Blow nose into a rag, tissue, kim wipe, etc. Monitor tissue after attempt. Stop when no increase in activity is noted.		

METHOD	ADMINISTRATING PERSON	EFFECTIVE FOR	INSTRUCTIONS	
Titanium Dioxide Paste	Medical Personnel	Fission Product Contamination	Form a paste of Titanium Dioxide powder and water. Apply small amounts of water to paste to keep it moist whole massaging it onto area. Continue massage for five (5) minutes. Remove paste with cotton. Rinse thoroughly with lukewarm water followed by a wash with soap and water.	
EDTA Cream	Medical Personnel	Fission Product Contamination	Mix a cream consisting of 1% EDTA, 3% powdered detergent, 8% Carboxy-Methyl-Cellulose, and 8% distilled water. Scrub area with cream. Remove with cotton.	
Potassium	Medical	Alpha	Mix an equal volume of a saturated solution of Potassium Permanganate (6.4 grams) KMnO ₄ /100 ml water) with 1% Sulfuric Acid solution (0.2N). Pour this solution over WET contaminated areas. Rub lightly for several minutes with surgical hand brush. Rinse with tepid water to remove the resulting brown stain. Pour a freshly prepared 5% Sodium Bisulfite solution (10 g NaHSO ₃ /200 ml water). Rinse with tepid water and scrub lightly for several minutes. This procedure may be repeated several times without harm. Limit washing to 2 minutes each.	

TABLE 11-2 (continued) TABLE OF SKIN DECONTAMINATION METHODS

"Note: Do not use EDTA on halogens such as $I^{\rm D1}$ contamination



12.0 RADIATION SURVEYS

12.1 Introduction

In order to adequately determine the extent of the radiation hazard for the BPCI Remediation Project routine and non-routine radiation surveys will be performed. These surveys will consist of direct radiation surveys, total and loose contamination surveys and airborne radiation surveys. Specific procedures will be developed to perform each of the surveys needed to provide adequate information to determine the true extent of the radiation hazard at the BPCI remediation site. The routine and non-routine radiation surveys will be performed by qualified individuals using calibrated equipment/instruments and in accordance with approved procedures.

Specific procedures will be developed to perform each of the surveys needed to provide adequate information to determine the true extent of the radiation hazard at the BPCI remediation site and to minimize personnel exposure to as low as reasonably achievable (ALARA). The routine and nonroutine radiation surveys will be performed by qualified individuals using calibrated equipment/instruments and in accordance with approved procedures.

The radiation survey program is designed to provide the following:

- (1) Provide a means for analyzing trends of the site radiological conditions.
- (2) Informs the workers of existing radiological hazards at the site and in their work area.
- (3) Verifies that the radioactive material is being adequately controlled and not spreading to uncontrolled areas.
- (4) Verifies the effectiveness of contamination controls.
- (5) Verifies the effectiveness of engineering controls and/or respiratory protection.

12.2 General Requirements and Standards

- Surveys will only be conducted by individuals specifically trained in the use of radiation monitoring equipment.
- (2) Surveys are classified as routine and non-routine surveys. Routine surveys are surveys performed on a regular basis while non-routine surveys are performed as necessary to support remediation activities. A schedule of routine surveys will be developed by the RSO.
- (3) Surveys will be performed with instruments calibrated for the type and energy of the radiation being monitored.
- (4) A sufficient number of survey points will be taken in order to adequately assess the radiological status of the area being surveyed.

- (5) Radiological postings and other control measures should be reviewed for adequacy following surveying. The posting will be updated as needed or at the direction of the RSO.
- (6) All radiological surveys will be recorded on standard forms. The forms will contain spaces for the following information:
- (7) Date and time.
- (8) Name of survey and surveyor.
- (9) Space for sketches or drawings of material or areas to be surveyed.
- (10) Space for survey results.
- (11) Space for the instrument(s) being used, serial numbers, calibration date(s), background(s) and efficiencies.

Continuation sheets can be used to complete survey information, however continuation sheets will contain enough information to tie it to the cover sheet.

12.3 Radiation Surveys

Radiation surveys shall be performed at predetermined points in active work areas and adjacent areas whenever operations are performed that have the potential for changing radiation or contamination levels.

12.3.1 Survey Frequencies

Radiation surveys are performed as necessary to ensure personnel do not exceed radiation exposure limits and to meet requirements for posting radiation areas. These surveys are performed to determine whether abnormal radiation levels exist and to determine the extent and magnitude of radiation levels. The following surveys will be the minimum performed.

12.3.1.1 Facilities Containing Radioactive Material

Radiation surveys will be performed to control radiation exposure whenever operations are performed that might be expected to change existing radiation levels. Examples of such operations include accumulation of waste and relocation of highly radioactive materials.

Temporary boundaries (e.g., rope boundaries) of radiation areas will be surveyed weekly to ensure controlled areas do not extend beyond posted boundaries.

Gamma surveys and contamination control surveys will be performed at least weekly in occupied posted radiation areas, in all occupied areas of radiological facilities, and in radioactive material short-term storage areas. Long-term storage areas will be surveyed at least monthly.



Other surveys will be performed as necessary to control personnel exposure to gamma, beta and alpha radiation.

12.3.1.2 During Casualties

Radiation surveys will be performed as necessary to access the extent and magnitude of a radiation condition in the event of an accident which might cause abnormal radiation levels.

12.3.1.3 Records

Records of radiation surveys will be retained until the end of the job and submitted to BPCI. The survey information will be recorded on a standard form, if specified, or on locally prepared forms which contain at least the following information:

- Date and time of survey.
- Reason for survey and type of radiation measured (e.g., weekly gamma).
- Type and identifying number of instruments used.
- Instrument calibration due dates.
- Location (will be shown on a survey map or listed in a table).
- Radiation level measured.
- Remarks.
- Signature of surveyor.
- Signature of persons reviewing results (e.g., RSO or his designee).



12.3.2 Safety Precautions

The following safety precautions will be observed by personnel using portable radiation monitoring equipment.

- (1) Only personnel trained in the use of portable radiation monitoring equipment will be allowed to use this equipment. As a minimum, training will consist of a lecture on the use of the instrument, the meaning of its measurements, a demonstration of its proper handling, and a period of supervised use.
- (2) Damage to or loss of radioactive source can result in spreading, inhaling, or ingesting contamination. Therefore, radioactive sources require careful handling and accountability control. If a source is lost, immediate steps will be taken to recover the source and minimize radiation exposure to or contamination of personnel as a result of the lost source.
- (3) Except for sources which are permanently attached to monitoring instruments, check sources which are not in use will be kept in a locked cabinet. The number of keys will be kept at a minimum. Combination locks are permitted and, when used, the number of personnel having the combination will be kept to a minimum.

12.3.3 Calibration and Maintenar 1 of Survey Instruments

Radiological control supervisory personnel will ensure that the appropriate survey instruments are available, functional, and calibrated using accepted standards for performing radiation surveys.

The types and uses of specific radiation monitoring devices recommended for use are listed in Section 13.2.

12.4 Airborne Radioactivity Surveys

Airborne radioactivity surveys (monitoring/sampling) provide assurance that airborne radioactivity is adequately controlled. The airborne survey consists of drawing a known volume of air through a 0.5 micron, 47 mm diameter (or equivalent) air filter and analyzing the air filter for appropriate radionuclides. Additionally, the airborne survey can act as a guide in the selection of the appropriate respiratory protection equipment. Airborne radioactivity monitoring/sampling will be conducted on a daily or weekly basis, depending on the need.

12.5 Final Verification Survey

Final verification surveys of the surface impoundments, buildings, and solid waste management unit(s) and other related areas will be conducted consistent with the Draft NUREG/CR 5849, Manual for Conducting Radiological Surveys in Support of License Termination (NRC, June 1992).



13.0 INSTRUMENTATION

13.1 Introduction

Direct radiation and contamination monitoring using portable or laboratory measurements will be performed using instrumentation and techniques necessary to detect 200 dpm/probe area (15 cm²) total and 100 dpm/100 cm² removable beta/gamma contamination. Instruments will be calibrated with radiation sources traceable to the National Institute of Standards and Technology (NIST) and having consistent energy spectrum with the radionuclides being measured. If alpha contamination is suspected, appropriate surveys and/or laboratory measurements capable of detecting 20 dpm/100 cm² removable alpha activity will be performed.

13.2 Equipment Specifications

Portable Contamination Monitor (Beta/Gamma)

Range		0 TO 500,000 counts per minute
Accuracy		$\pm 10\%$ of reading between 10% and 100% of full scale on any range
Response Time		- 20 seconds (slow response)
Instrument	× .	Ludlum model 3 with Ludlum model 44-9 probe (or equivalent)

Direct R e ation Exposure Meter (Beta/Gamma)

Range	4	0 TO 5 R/hr auto scaling
Accuracy		$\pm 10\%$ of reading between 10% and 100% of full scale on any range
Response Time		2 to 8 seconds (slow response)
Energy Spectrum	181	beta above 100 KeV and gamma above 15 KeV
Instrument	$\mathcal{T}_{\mathcal{T}}$	Victorian 450 (or equivalent)

Portab's Alpha Survey Monitor

Range -	0 TO COO sounts per minute
Accuracy	\pm \pm reading between 10% and 100% of full scale on any range
Response Time	- 5 seconds (slow response)
Efficiency for Pu239	- 16%
Instrument -	Ludlum Model 3 with Ludlum 43-1 zinc sulfide probe (or equivalent)



Direct Radiation Micro R Meter (Gamma)

Range	0 TO 5,000 micro R/hr scales
Accuracy	- $\pm 10\%$ of reading between 10% and 100% of full scale on any range
Response Time	- 15 seconds (slow response)
Energy Response	1 to 1 energy response above 80 Kev
Instrument	Victorian 450 P (or equivalent)

Scaler (Alpha and Beta/Gamma)

Range		0 TO 500,000 counts
Accuracy		$\pm 10\%$ of reading between 10% and 100% of full scale on any range
Response Time		- 2 to 8 seconds (slow response)
Energy Response	.*.	1 to 1 energy response above 80 Kev
Instrument	1	Ludlum 2200 singular channel analyzer (or equivalent)

Air Samplers

Flow Rate	19	0.5 to 20 cubic feet per minute
Instrument	с. ж.	Radeco 809V variable flow rate air sampler (or equivalent)

Dosimetry

Personnel Dosimetry, Reco	rd -	Landauer TLD Equipment (or equivalent)
Personnel Dosimetry, Self-I	Reading -	Atomic Products #019-100, 200 (or

The above identified radiation survey instruments will be calibrated every 6 months.

Instrument calibration records and daily source check records will be maintained by the RSO and available at the site field office for inspection.



14.0 MEDICAL SURVEILLANCE

14.1 Introduction

This section describes the medical surveillance program applicable to personnel who will work within the radiologically controlled areas at the BPCI site. The purpose of the medical surveillance program is to determine site personnel fitness for duty. The data obtained from the medical surveillance program, in conjunction with information generated via employee exposure monitoring, will be utilized to evaluate the health status of site personnel.

The BPCI Medical Surveillance Program consists of the following elements:

- (1) Administration of the program by BPCI
- (2) Initial, annual and termination medical examinations for all personnel engaged in field work.
- (3) A standard protocol for medical examinations, modified as necessary to reflect site-specific concerns not addressed by the standard protocol.
- (4) Maintenance and retention of medical records.

14.2 Medical Examinations

The BPCI Medical Surveillance Program requires that all personnel engaged in field work involving potential exposure to health, safety, and/or radiological hazards participate in the program. An initial examination is performed on the employee prior to assignment to field work. At least annually, thereafter, the employee is provided with an additional examination. All BPCI employees assigned to remediation projects will be active participants in the medical surveillance program. All project personnel will have had a medical examination meeting the requirements of the program within the past 12 months.

BPCI Contractors and subcontractors must demonstrate that their employees are participants in a medical surveillance program that is at least as comprehensive as the BPCI program by providing BPCI with a written description of their program and the name and telephone number of their examining physician or medical consultant. The BPCI Construction Manager (CM) may contact the subcontractor's physician or medical consultant to discuss the specifics of this project and the content of the subcontractors program.



14.3 Physician's Written Opinion

Physicians performing examinations of BPCI employees are provided with the following information:

- (1) A description of the employee's duties as they relate to the employee's exposures.
- (2) The employee's exposure levels or anticipated exposure levels.
- (3) A description of any personal protective equipment to be used, including the potential use of airsupplied or negative pressure, air-purifying respirators.
- (4) Any information from previous medical examinations in the possession of BPCI or the Contractor which is not readily available to the examining physician.

This information, and the results of the examination, are used as the basis of the physician's written opinion regarding the medical status of the employee.

Upon completion of an initial or annual medical examination of a BPCI Contractor employee, the examining physician is required to provide medical clearance prior to the employee engaging in on-site work activities.

14.4 Recordkeeping

The clinics or physicians utilized by BPCI to perform medical examinations will maintain records of all examinations. BPCI will maintain a medical surveillance file on all current BPCI employees as well as terminated BPCI employees. Contractor medical surveillance files will be maintained by the Contractor until turnover to BPCI at the close of the remediation projects.

15.0 RECORDS AND REPORTS

15.1 General

All records and reports related to the Radiation Control and Protection Program will be maintained by BPCI until the remediation projects are complete and the NRC terminates the BPCI license. Employee exposure records will be retained by BPCI indefinitely.

15.2 Exposure Records and Reports

The RSO will assure that records are maintained to permit a ready accounting of an employee's accumulated radiation exposure. This occupational exposure record will include:

- (1) Any known prior employment occupational exposure history (NRC Form 4 or equivalent).
- (2) External and internal exposure received occupationally, including that received at other installations (NRC Form 5 or equivalent).
- (3) Special dose evaluations and work restrictions.
- (4) Reports of unusual exposure, such as overexposure or incidents with potential for internal disposition. The incident forms will be supplied by BPCI.

Each employee will be informed of the results of all record dosimetry evaluations. Each employee will be provided a copy of his/her occupational exposure at the end of each year.

15.3 Forms and Records

Specific forms or records will be developed for the following items:

- (1) Direct and contamination surveys.
- (2) Personnel contamination survey.
- (3) Airborne survey (monitoring/sampling) calculation data sheets.
- (4) Daily instrument operational check and calibration sheets.
- (5) Daily report of work and surveys completed.
- (6) Radiation Work Permits.
- (7) NRC Form 4 or equivalent and Form 5(or equivalent will be used to track individual worker exposure).

(8) Self Reading dosimeter usage.

15.4 Record Maintenance

BPCI will maintain records consistent with 10 CFR 19 and 20 requirements as applicable and will make such records available to individual workers for inspection. The following is a general listing of the records that will be maintained by BPCI for the remediation projects.

- (1) The provisions of the Radiation Protection and Control Program.
- (2) Audits and other reviews of the Radiation Protection and Control Program content and implementations.
- (3) Results of surveys and calibrations required by 10 CFR 20.1501 and 10 CFR 20.1906(b).
- (4) Records of the results of surveys to determine the dose from external sources and used, in the absence of or in combination with individual monitoring data, in the assessment of individual dose equivalents.
- (5) Records of the results of measurements and calculations used to determine individual intakes of radioactive material and used in the assessment of internal dose.
- (6) Records showing the results of air sampling, surveys, and bioussays.
- (7) Records of the results of measurements and calculations used to evaluate the release of radioactive effluents to the environment.
- (8) Records of doses received by all individuals for whom monitoring was required pursuant to 10 CFR 20.1502. These records must include, when applicable:
 - (a) The deep-dose equivalent to the whole body, eye dose equivalent, shallow-dose equivalent to the skin, and shallow-dose equivalent to the extremities;
 - (b) The estimated intake or body burden of radionuclides:
 - (c) The committed effective dose equivalent assigned to the intake or body burden or radionuclides;
 - (d) The specific information used to calculate the committed effective dose equivalent pursuant to 10 CFR 20.1204(c);
 - (e) The total effective dose equivalent when required by 10 CFR 20.1202; and
 - (f) The total of the deep-dose equivalent and the committed dose to the organ receiving the highest total dose.
- (9) BPCI will maintain the records specified on NRC Form 5, in accordance with the instructions for

.

NRC Form 5, or in clear and legible records containing all the information required by NRC Form 5.

- (10) Records sufficient to demonstrate compliance with the dose limit for individual members of the public.
- (11) Records of the disposal of licensed materials made under 10 CFR 20.2002 and 10 CFR 20.2003.
- (12) BPCI will maintain the records of dose to an embryo/fetus with the records of dose to the declared pregnant woman.
- (13) Records sufficient to demonstrate compliance with the dose limit for individual members of the public.
- (14) Records of the disposal of licensed materials made under 10 CFR 20.2002.
- (15) Incident reports, as required by 10 CFR 20, Subpart M.

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16.0 EMERGENCY ACTIONS

Accidents, industrial events, and medical emergencies that occur at the BPCI remediation sites will be handled in accordance with the procedures specified in BPCI Health and Safety Plan (Section 4.0 and Appendices F and J).

All accidents and medical emergencies that occur on the BPCI site will be reported to the CM, in accordance with the Emergency Contact List contained in Section 4.0 (Figure 4-1) of the Health and Safety Plan.

Onsite first aid emergency response will be supported by the local (Newburgh Heights) emergency response (fire and medical) organizations. Radiation awareness training will be provided to transport and treatment personnel.

The emergency response protocol for various accidents and emergencies are summarized in the subsequent sections. BPCI will notify the NRC of any accident or emergency consistent with the applicable requirements in 10 CFR 20.2202.

16.1 Accidental Spillage of Radioactive Materials

Should radioactive or contaminated materials be accidentally released from their container, the following actions should be taken. BPCI and Contractor personnel are to follow the instructions below which have been developed using the SWIMS acronym:

- S = Stop the spill
- W = Warn other personnel
- I = Isolate the spill area
- M = Minimize personnel exposure
- S = Secure the appropriate equipment

Stop the spill. If the spill has occurred from a source which may or is continuing to add material to the spill, take such measures as necessary to stop the spill, such as closing a valve or blocking the path of the fluid with absorbent material. A balance of risk to the individual must be weighed for potential personnel risk in these actions versus the potential safety and economic cost if limited actions are taken. If mechanical action is needed, such as closing a valve or disabling a pump, knowledge of the effect on the total system or machinery involved is required prior to such actions.

<u>Warn other personnel</u>. Others in the immediate area and those entering the area must be told of the event to enable all personnel to take the appropriate response actions. Health physics personnel must be notified as soon as possible.

Isolate the spill area. Nonvital personnel will be kept out of the immediate vicinity, if necessary, by having someone posted at the entrance to the area. Personnel who have been contaminated will remain in the immediate vicinity to prevent the spread of contaminants until health physics personnel release them. An exception to this is when the ambient radiation levels are high or of a traumatic injury requiring leaving the area has occurred.



Minimize personnel exposure. The event may include both a radiological and a chemical hazard. Personnel will remain in the immediate vicinity until health physics personnel arrive both to assist in spill control and to be available for surveying of exposed individuals. The nature of the spill, both chemical and radiological, and the need to monitor the spill will dictate how close personnel should remain.

Secure the appropriate equipment. Ventilation or other operating equipment may be selected for shutdown due to the nature of the spill and to prevent further occurrence. Knowledge of the system and equipment involved is necessary prior to taking such action.

16.2 Fire in a Restricted Area

Areas will be evacuated by all nonemergency personnel when a fire, heavy smoke, or similar fumes occur in a controlled area. Health physics, operational and/or fire response personnel will be immediately notified. This is true for all fire events, including those where personnel in the immediate vicinity have extinguished a minor event, such as a wastebasket fire.

- When possible, the fire will be extinguished by personnel in the immediate vicinity rather than allowing it to grow into larger proportions while designated personnel are on their way.
- If a fire cannot be rapidly extinguished, the local fire department will be summoned for fire detail:
 - fire detail will wear self-contained respiratory equipment, protective clothing, and any other items deemed necessary by the lead health physics individual
 - the primary function of the fire detail will be to evacuate personnel from the fire area
 - the secondary function of the fire detail will be to save equipment and property without endangering their own or other lives
 - the tertiary function of the fire detail is to minimize the spread of contamination outside the controlled area
- Fire extinguishing agents, such as CO₂, foam, or dry chemicals, are preferred as this minimizes the volume of potentially contaminated liquids.
- All firefighting personnel will be surveyed prior to exiting the event area except for those in need
 of immediate medical assistance outside the controlled area. Minimization of the spread of
 contamination will be kept in mind at all times.

16.3 Contaminated Injury

Medical emergencies or accidents can be divided into two categories. The first category is nonlife threatening and the second being considered as life threatening.

16.3.1 Nonlife Threatening Incidents

Nonthreatening medical emergency victims will be given first aid on the BPCI site. Prior to the victims leaving the site the victim will be monitored for radioactive contamination. If the individual is contaminated decontamination procedures will be followed unless it is determined that the emergency is life threatening.

Specific emergency actions include:

- Wash minor wounds immediately under running water, spreading the edges of the gash. If at all
 practical, collect and retain cotton sponges, fluids, etc., for analyses.
- Report all radiation accidents involving personnel wounds, ingestion or inhalation to the RSO or his designee as soon as possible.
- Call, at once, a physician qualified to treat radiation injuries and to collect additional bioassay samples.
- Permit no person involved in a radiation injury to return to work without the approval of the attending physician and the RSO or his designee.
- Prepare a complete history of the accident and subsequent activity related thereto for the RSO or his designee.

16.3.2 Life Threatening Incidents

In the event that a life threatening accident or injury occurs, the victims life takes prominence over any radiation or contamination controls at the BPCI site. The victim will be treated and transported to St. Rita's Medical Center in Lima, Ohio, as soon as possible. Attempts will be made to minimize the spread of contamination and the Medical Center will be notified of the potentially radioactively contaminated victim being transported to the facility.

In emergency situations where an individual is seriously injured in a contaminated area, the first priority is to treat the injury.

Other actions include:

- · Contact the RSO or his designee.
- Call or have someone call an ambulance.
- Notify the nearest hospital qualified to treat contaminated injuries that a potentially contaminated injured person would soon arrive.

The RSO or his designee equipped with appropriate survey instruments will accompany the contaminated, injured individual to the Medical Center.



Once at the hospital, the RSO or his designee will survey the emergency transport vehicle and paramedic crew. The RSO or his designee will support the medical staff treating the patient regarding survey results, accident history, etc.

No contaminated injured individual may return to work without written approval of the attending physician and the RSO or his designee.

16.3.3 Medical Facility and Transportation

Arrangements will be made with St. Rita's Medical Center and the local emergency response and transportation services to transport, receive and treat potentially contaminated injury victims. If requested, training will be provided to the Medical Center and ambulance transportation organizations personnel for the treatment of radioactively contaminated victims.

Additionally, emergency kits will be available to minimize the spread of radioactive contamination and collect radioactive wastes in the Medical Center and the ambulance service.

16.4 High Airborne Radioactivity

Particulate radioactivity above $2x10^{-11} \mu Ci/ml$ alpha (based on insoluble U^{238}) in occupied radiological areas:

NOTE: High airborne contamination is not expected in ground moving tasks. However, cutting, grinding or burning of other material may be performed in containment, thus warranting these precautions.

Immediate Action: Notify RSO or his designee.

- Evacuate personnel from affected areas. Don respiratory equipment for personnel who must return to the affected area.
- (2) Verify that the high airborne results (i.e., from air sampling or elevated instrument readings) are correct.
- (3) Stop operations which might be causing high airborne radioactivity until adequate control of airborne radioactivity is established.
- (4) Secure air moving equipment (e.g., fans, window air conditioners, and unit heaters) in the affected spaces.
- (5) Determine the extent of the airborne radioactivity by sampling the affected area and adjacent areas which might be affected using portable air samplers.



16.4.1 Supplementary Action

- (1) Attempt to identify the radionuclide causing the airborne radioactivity. For example, by promptly measuring the sample for alpha radioactivity and determining the half life.
- (2) Measure and control surface contamination in areas affected by high airborne radioactivity.
- (3) Perform alpha and beta/gamma surveys of ventilation filters and ducts and measure surface contamination in the vicinity of the ventilation exhaust discharge point.
- (4) When resuming operations, take a portable air sample to verify that the cause of high airborne radioactivity is corrected.
- (5) Check personnel exposed to high particulate radioactivity for internal radioactivity.

16.4.2 Special Emergency Signals

The manufacturing of chemicals at the BPCI Lima. Ohio site poses additional hazards to the worker performing remediation work. Individuals will be instructed on the alarms and evacuation system implemented by BPCI as part of their radiation worker training.

16.4.3 Follow-up Action

A report of any incident involving high airborne radioactivity, other than fallout or natural background, in areas occupied by personnel not wearing or wearing inappropriate respiratory equipment, will be sent to BPCI. The report will include results of internal monitoring and be submitted within ten working days.

16.5 Loss of Radioactive Material

If radioactive material is lost, the following procedures will be followed:

- BPCI or BPCI Contractor personnel will immediately conduct a search. The primary reason for this
 is to ascertain that no persons will receive inadvertent internal or external exposure from the
 material.
- If the material cannot be located before the end of the work day, BPCI will prepare an incident report in accordance with 10 CFR 20.2201 and notify the NRC, as appropriate.

16.6 Follow-up Reporting of All Accidents and Incidents

Follow-up will be performed on all accident and incident that occur on the BPCI site. Reporting will be made to the BPCI Construction Manager and the BPCI Safety Department. Follow-up reports will



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contain the following information:

- · Brief description of the accident or incident.
- · Cause of the accident or incident.
- Immediate corrective action.
- · Action to be taken to prevent recurrence.
- · Schedule or date when actions will be completed.
- Training (if required).
- List of participants.



APPENDIX B

ESTABLISHING AND POSTING RADIOGICALLY CONTROLLED AREAS

APPENDIX B

ESTABLISHING AND POSTING RADIOLOGICALLY CONTROLLED AREAS

1.0 PURPOSE

The purpose of this procedure is to describe the minimum criteria used in establishing radiologically controlled areas and to describe the method by which these areas shall be posted.

2.0 APPLICABILITY/SCOPE

This procedure is applicable to all radiation workers.

3.0 DEFINITIONS

The definitions provided in 10 CFR Part 20 for area designations are provided below.

- 3.1 Controlled Area means an area, outside of a restricted area but inside the site boundary, access to which can be limited by the licensee for any reason.
- 3.2 Radiation Area means any area, accessible to personnel, in which there exists radiation, originating in whole or in part within licensed material, at such levels that a major portion of the body could receive in any one hour a dose in excess of 5 millirems, or in any 5 consecutive days, a dose in excess of 100 millirems.
- 3.3 Airborne Radioactivity Area means any room, enclosure, or operating area in which airborne radioactive materials, composed wholly or partly of licensed material, exists in concentrations:
 - In excess of the amounts specified in Appendix B, Table
 I, Column 1 of 10 CFR 20; or
 - Which, averaged over the number of hours in ony week during which individuals are in the area, exceed 25 percent of the amounts specified in Appendix B, Table I, Column 1 of 10 CFR Part 20.
- 3.4 Contaminated Area any area contaminated with loose surface radioactive contamination above 1,000 DPM/100 cm² for betagamma or 20 DPM/100 cm² for alpha. Step off pads are considered be radiologically clean and an integral part of the area boundary.

- 3.5 Radioactive materials Area any area or room in which licensed material is used or stored and which contains any radioactive material in an amount exceeding 10 times the quantity of such material specified in Appendix C of 10 CFR 20.
- 3.6 Hot Spot a point or small area where a dose rate reading taken on contact with the surface in question would meet the following criteria:
- 3.6.1 For gamma radiation Those areas not posted in accordance with Paragraph 3.3 shall be posted with hot spot markers if there are radiation measurements greater than 100 mrem/hr at contact with any radiation source.
- 3.6.2 For beta radiation the dose rate reading is equal to or greater than (4) four times the general area dose rate reading and is equal to or greater than 200 mrad/hr.
- 4.0 POLICY

None

5.0 PREREQUISITES

None

6.0 PRECAUTIONS

None

- 7.0 PROCEDURE
- 7.1 Rad Con Technician (RCT):
- 7.1.1 Designate and post radiologically controlled areas in accordance with guidelines contained in Table 1.
- 7.1.2 Adjust posting as necessary whenever operations performed in the radiologically controlled area changes the radiological status or whenever surveys indicate reposting is required.
- 7.1.3 Inform the Project Superintendent of any changes in postings.



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- 7.2 Areas of specific concern that are located within a posted area may require additional posting. These areas should be posted with sign(s) bearing the radiation caution symbol and stating the appropriate requirements (examples: Keep Out, Respiratory Protection required, TLD Required, etc.) or any additional information to aid individuals to minimize exposure to radiation or radioactive material.
- 7.3 Normally inaccessible areas, such as overheads, which may have radiation measurements resulting in the need for control as high radiation areas, will be posted with cautionary signs at appropriate access points.
- 7.3.1 These signs will require notification of Radiological Controls prior to working in such areas.
- 7.3.2 If these areas become accessible, they will be managed in accordance with Paragraph 3.3.
- 8.0 RESPONSIBILITIES

Responsibilities are as set forth in Section 7.0 of this procedure.

- 9.0 REFERENCES
- 9.1 Title 10 Code of Federal Regulations Part 20.
- 10.0 ATTACHMENTS
- 10.1 Attachment 1, Table 1, Area Designations and Posting Requirements.

ATTACHMENT 1

TABLE 1

AREA DESIGNATIONS AND POSTING GUIDELINES

Area Designations	Area Definitions	Posting Regulations	Sign Inserts*
Radiation Area	Definition 3.2	Caution-Radiation Area	 Radiation Area RWP Required for Entry Personal Docimetry Required
Airborne Radioactivity Area	Definition 3.4	Caution-Airborne Radioactivity Area	 Airborne Radioactivity Area RWP Required for Entry Personal dosimetry required
Contamination Area	Definition 3.5	Caution-Contamination Arci**	 Contamination Area RWP Required for Entry Personal dosimetry required
Radioactive Materiala Area	Definition 3.7	Caution-Radioactive Materials	 Radioactive Material personal dosimetry required
Hot Spot	Definition 3.8	Hot Spot	1. None

* This column describes the minimum identification requirements for signs posted to identify singular situations. Additional inserts may be used to provide information or impose additional restrictions as necessary by the SSO. Single signs may be used to identify multiple situations (i.e., a high rediation and contaminated area) as long as the minimum required inserts for both situations are used.

NOTE: Duplicate posting is not required if the outer boundary of the area has the appropriate posting.

** In addition to these posting requirements, entrances to contaminated areas must be identified with Step Off Pads.

APPENDIX C

RADIATION WORK PERMIT (RWP) PROCEDURE

APPENDIX C

RADIATION WORK PERMIT

1.0 PURPOSE

The purpose of this procedure is to set forth the requirement for the preparation and use of the Radiation Work Permit (RWP).

2.0 APPLICABILITY/SCOPE

The procedure is applicable to all personnel involved in preparation and use of RWP's.

3.0 DEFINITIONS

RWP - an administrative method of controlling personnel access to RWP required areas for the purpose of minimizing internal and external radiological hazards, maintaining the total dose equivalent as low as reasonably acnievable (ALARA) and working with maximum radiological safety.

4.0 POLICY

Not Applicable

5.0 PREREQUISITES

None

6.0 PRECAUTIONS

None

- 7.0 PROCEDURE
- 7.1 General Requirements
- 7.1.1 An RWP is required for any of the following conditions:
 - 1. Entering a radiation area
 - 2. Entering a contaminated area
 - 3. Entering an airborne radioactivity area
 - Unknown radiological conditions in an area to be entered or equipment to be opened.

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- 7.1.2 Entry may be made into an RWP Area without an RWP in the event that safety of personnel or equipment is endangered. The entry will be made with a Radiological Control Technician (RCT) and/or a dose rate monitoring device if the situation/time permits. following such an entry, an RWP will be executed by Radiological Controls to document the entry.
- 7.1.3 RWP Classifications
- 7.1.3.1 Job specific RWP's are normally prepared with current radiological survey data. Job Specific RWP's may be prepared without current radiological survey data and may authorize planned work to be performed when:
 - a. Job involving entry into numerous locations and/or areas not immediately accessible where acquiring all survey data prior to RWP issue is not practical, or dose to RCT can be minimized by having radiological working conditions checked just prior to commencement of work activities; and,
 - b. A qualified RCT provides continuous coverage until survey is performed and the workers are made aware of the radiological conditions. The survey must be documented following the entry and attached to the RWP.
 - c. These RWP's shall be authorized by the Project Superintendent or his designee.
- 7.1.3.2 Standing RWP's are RWP's issued for routine repetitive duties such as inspections, surveillances, and others as determined by Radiological Controls. All Standing RWP's must be approved by the Project Superintendent or his designee. Other tasks may be performed using a Standing RWP if all the following conditions are met:
 - a. No contamination present or potentially contaminated area.
 - b. Task is of short duration.
 - c. Task is not expected to cause any significant changes in static radiological conditions of areas.
 - d. Approval of Project Superintendent or his designee.
- 7.1.4 Individual(s) entering "RWP" areas must be qualified Radiation Workers or be escorted buy a qualified Radiation Worker. The escort shall be responsible to ensure the individual(s) copies with proper radiological work

practices. Authorization for entry for the individual to be escorted is required in writing, prior to signing on the RWP. This authorization must be from the Project Superintendent, or his designee.

- 7.1.5 If RWP termination is greater than 24 hours following insure, the On-site Safety Officer (OSSO) shall review the adequacy of working RWP's on a daily basis. (RWP's which were not signed out during the 24 hour period or which have been place on "hold" status need not receive this review). The review shall include, as minimum:
 - 1. BP Chemicals Facility
 - 2. Job Status
 - 3. Recent survey/air sample results
 - 4. Impact of above items on the RWP, the date of review and the reviewer's signature shall be documented on the RWP or RWP Continuation Sheet. This is not applicable to Standing RWP's.

7.2 Initiation of RWP's

- 7.2.1 The site supervisor or his designee will initiate the RWP.
- 7.2.2 The Radiological Controls Technician (RCT) initiating the RWP completes the following (Refer to Attachment 10.1):

<u>Block No. 3</u>: Work Description - provide sufficient detail for Radiological Controls personnel to understand the scope of the task. If additional space is needed, an RWP Continuation Sheet (Attachment 10.2) may be used but is not mandatory.

Block No. 4: Priority Code - N/A

Block No. 5: RWP Start Date - the date work should start.

NOTE: May be left blank as directed by Radiological Controls, to be filled in prior to work.

Block No. 8: Job Location (be specific).

<u>Block No. 16</u>: Requested By - RCT prints and signs name in space provided; include date submitted to Radiological Controls.

7.2.3 After completing the applicable portions of the RWP, it is taken to the OSSO or his designee and discussed. All supporting documentation should be included.

7.3 Preparation of RWP's

- 7.3.1 The OSSO or his designee shall review the initiated RWP and all supporting documentation for completeness and adequacy.
- 7.3.2 The qualified Radiological Controls Technician preparing the RWP completes the following (not necessarily in sequence):

<u>Block No. 2</u>: RWP Number and Type of RWP assign next sequential RWP number, type of RWP, and complete the RWP log entry (Attachment 10.4).

Block No. 6: RWP Expiration Date - may be for the duration of the job, to a maximum of one month.

Block No. 7: Job Category - Enter appropriate code as determined by job description and location.

<u>Block No. 9</u>: Radiological Data - Enter the most recent survey data appropriate to the job location/scope. If radiological conditions significantly change, updated survey information shall be included either in Block No. 9 or Block No. 15 (Special Precautions). Survey serial numbers shall be recorded for both original and updated survey data.

- a. All Contaminated and/or Airborne Radioactivity Areas require air samples to be taken, unless exempted by the Project Superintendent.
- b. Standing RWP's are written for areas with historically well known radiological conditions; therefore, survey data greater than two days old may be used to prepare the RWP.
- c. Surveys used to prepare Job Specific RWP's must have been obtained within the previous two days except as specified by Paragraph 7.1.3.1.

Required Available Exposure enter the available individual radiation exposure required for entry on the Radiation Work Permit. This value is determined by one of three methods as follows:

- a. The OSSO Review The Project Superintendent must calculate the maximum exposed individual.
 - NOTE: This is performed primarily when individual exposures approach the administrative limits set forth elsewhere in these procedures.

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- b. If a OSSO Review is not performed for the job, the RCT should determine the required available dose. One suggested method is to multiply the general area radiation reading from Block 9 by 3 (based on a maximum 3 hour expected stay time) or use 100 mrem, which ever is greater.
- c. For Standing RWP's the Required Available Exposure will not be less than 100 mrem.

The Quarterly Exposure Available must be equal to or greater than the Required Available Exposure value in Block 9 prior to entering the RWP area. The Project Superintendent must ensure that the person is issued an alarming SRD or is aware of his exposure limit prior to authorizing the entry this authorization must be documented in the SHSO Log.

Block No. 14: Protective Fauipment Required

- a. Dosimetry
- b. Monitoring Mark the appropriate monitoring requirements based on work area radiological conditions, job scope, and applicable procedures. Periodically during the job, the radiological conditions involved in the job should be evaluated by radiological surveys.
 - If the RWP is being prepared for entry into a dose rate instrument, alarming SRD with preset alarm setpoint, or Radiological Controls Coverage is required.
 - 2. When satisfying High Radiation Area monitoring requirements, if an alarming SRD fails or alarms, personnel shall immediately exit the High Radiation Area, unless the Project Superintendent determines exit is not required based on ALARA considerations.
- c. Protective Clothing
 - For guidance on selection of Protective Clothing refer to Reference 9.6.
- d. Other Mark items which are appropriate for task to be performed.

Block No. 15: Special Precautions

- a. To be used for whatever additional instructions Radiological Controls deems necessary to ensure that the RWP task is performed in a radiologically safe manner.
- b. If additional space is need use an RWP Continuation Sheet (Attachment 10.2). Mark "See Continuation Sheet" box.

Block No. 16: Radiological Controls Technician prints and signs the "Prepared by" space. Include the date the RWP was prepared.

- 7.3.3 The Project Superintendent shall review the RWP and indicated approval for issuance by printing, signing and dating the "Radiological Controls approval" space in Block No. 16. Any changes to an approved RWP must be authorized in writing on all official copies by the Project Superintendent.
- 7.3.4 Use of RWP Copies
- 7.3.4.1 The white copy (record copy) of the RWP and any attached documents shall be kept in the active RWP binder/file.
- 7.3.4.2 All other official copies shall be distributed/used as directed by the Project Superintendent.
- 7.4 RWP Entrance and Exit
- 7.4.1 After reading the RWP the worker shall complete RWP Attachment Sheet (Attachment 10.3) as follows:
- 7.4.1.1 Name, SSN, Signature, and Date Signature signifies understanding of the radiological conditions and requirement specified.
- 7.4.1.2 Workers will enter the initial (SRD) self reading pocket dosimeter reading in the "SRD IN" column. Upon exit from the RWP Area, workers will log their final reading in the "SRD OUT" column.
 - NOTE: SRD's should not read greater than half scale prior to entry. If this should occur, see Radiological Controls personnel.
- 7.4.1.3 Comments to be used for respiratory equipment deficiencies, dosimeter serial numbers, or other appropriate remarks by Radiation Worker or RCT.

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- 7.4.1.4 Completion of the RWP Attachment Sheet entries for Standing RWP's is only necessary once/month when the new Standing RWP is issued.
- 7.5 Termination of RWP's
- 7.5.1 RWP's shall be terminated for the following conditions:
 - 1. Work in the RCA is complete.
 - 2. The expiration date is past.
 - Work done on RWP is not being performed in accordance with instructions on the RWP. (The RWP may be placed on "hold" in lieu of termination).
 - 4. Radiological conditions have degraded significantly from the conditions for which the RWP was written.
- 7.5.2 Terminate the RWP by printing, signing and dating the space provided in Block No. 16. Also, enter the expiration date in the RWP Log.
- 7.5.3 Upon termination of the RWP, the white copies of the RWP, Continuation Sheets, and all Attachment Sheets are to be retained in Radiological Controls files.
- 8.0 RESPONSIBILITIES
- 8.1 Responsibilities are as stated in Section 7.0.
- 9.0 REFERENCES
- 9.1 Surface Contamination Surveys.
- 9.2 Radiological Surveys
- 9.3 Establishing and Posting Areas in the Radiologically Controlled Area (RCA).
- 9.4 Use of Anti-Contamination Clothing.

9.5 10 CFR 20.





APPENDIX D

FIGURES AND TABLES















TABLE 1 EXPOSURE LIMITS AND RECOGNITION QUALITIES

Compound	OSHA Exposure Standard	IDLH Levei	Oder	Odor Warning Concentration (ppm)	LEL (Percent)	LEL (Percent)	Photolonization M Ionization Potentiai (eV)	leter Information Lamp (eV)
Aresenic	10 ug/m ³¹	100 ug/m ³ *	None	N/A	Nonflammable	Nonflammable	N/A	N/A
Barlum	0.5 mg/m3	1100 mg/m3***	Variable	Variable				***
Cadmium	5 ug/m3 0.6 mg/m3**	50 mg/m3	Variable	Variable	ins .			
Chromium	1.0 mg/m3	N/A	Variable	Variable			100-01	
Lead	0.05 mg/m3	100 mg/m3	None	N/A	Incombustible	incombustible	N/A	N/A
Mercury	0.05 mg/m3* 0.1 mg/m3**	28 mg/m3	Odorless		-		-	-
Sliver	0.1 mg/m3	N/A	Variable	Variabie				***
Cyanide	4.7 ppm (15 minuto)	50 mg/m3	faint almond		N/A	N/A	-	-
Benzene	1 ppm 5 ppm (13 minute)	1000 ppm Ca	Aromatic	4.68	1.3	7.1	9.25	10.2
Toluene	100 ppm 150 ppm (15 minute)	2000 ppm	Benzone- Iike	0.17-40	1.3	7.1	9.82	10.2
Bromo- Mothane	5 ppm*	2000 spm Ca	caloroform- ilke	>20 "practically no odor"	13.5	14.5	10.54	
Methylene Chloride	500 ppm 1000 ppm **	5000 ppm	sweet	25-3±0 *can adapt to odor*			I	***
1,1,1-Trl- chlorethane	350 ppm	1000 ppm	sweet	20-400	7	16		***
Tetrachlor- ethylene	25 ppm* 200 ppm**	C.i	ether or chleroform	4.68-50	Incombustible	Incombustible	9.32	
Ammonia (NH ₃)	35 ppm (15 minute)	500 ppm	pungent Irritating	0.32-55	15	28	10.18	10.2



TABLE 1 (CONTINUED) EXPOSURE LIMITS AND RECOGNITION QUALITIES

				Odor			Photoionization N	leter Information
Compound	OSHA Exposure Standard	IDLH Level	Odor	Warning Concentration (ppm)	LEL (Percent)	LEL (Percent)	lonization Potential (eV)	Lamp (eV)
MEK	200 ppm	3000 ppm	Mint-like	4.8-25	2	10	9.48	
Ethyl benzene	100 ppm	2000 ppm	Aromatic odor	0.25-200	1	6.7	8.76	10.2
Trich) cethy	50 ppm* 200 ppm** (15 minute)	1000 ppm	Solvent	21.4-400	12.5	90	9.45	10.2
Selenitm	0.2 mg/m ³	N/A	Odorless	N/A	Nonflæmmable	Nonflammable	N/A	N/A
Acetonitrite	40 ppm 60 ppm (15 minute)	4000 ppm	Ether-like	40	4.4	16	12.22	
Acrylonitrile	2 ppm 10 ppm** (15 minute)	500 ppm Ca	Pungent	19-100	3	17	10.91	
Cresol	5 ppm	250 ppm	sweet tar	variable		-	8.93	
Pyridine	5 ppm	3500 ppm	sickening	0.012-5	1.8	12.4	9.27	
Acetone	750 ppm*	20,000 ppm	mint	100	2.6	12.8	9.69	

Source: Occupational Health Services, HAZARDLINE, 1987 and 1988, and HNu Systems, inc. Instruction Manual, 1986.

Notes:

Ca - Known to be a carcinogen.

* • American Conference of Governmental Industrial Hyglenists

** . Celling value-concentration that should not be exceeded during any part of the working exposure.

*** - National Institute of Occupational Safety and Health Standard

N/A - Not applicable.

--- No information found.

Depieted Uranism	Loose Surface Contamination Rate	Fixed Contamination Rate	Direct Exposure mRem/hr	Detection Instrumentation Instrument*
Alpha	20 ccpm	1000	44-65 brake	Ludium Model 3 with Model
Beta	100 ccpm	1000	451-9 Probe	Ludium Model 3 with Model
Gamma			0.5	Ludium Model 19 µR mete

* Equivalent Instruments of different manufacturers may be used.





TABLE 2

ACUTE AND CHRONIC EFFECTS AND FIRST ATD TREATMENT

	Compound Routes of Entry	Eye Irritant	Acute Effects	Chronic Effects
Arsenic	inhalation Skin absorption Skin and/or eye contact Ingestion	Yes	Dermatitis	Liver, kidneys, skin, lungs, lymphatic system, potential human carcinogen
Berium	inhalation Ingestion Skin and/or eye contact	Yes	Muscle spesms, skin burns, slow pulse	Heart, CNS, skin, respiratory system, eyes
Cedmium	Inhalation Ingestion		Cough, tightness in chest, muscle aches, nausea	Respiratory system, kidneys, prostate, blood, potential human carcinogen
Chromium	Inhalation Ingestion		Histologic fibrosis of lungs; chromium (VI) carcinogen	Respiratory system
Lead	Inhalation Ingestion Skin and/or eye contact		Lessitude, insomnia, eye grounds, malnutrition, constipation, abdominal pain, gingival lead lime	GI tract, CNS, kidneys, blood, gingival tissue
Mercury	Inhalation Skin absorption Skin and/or eye contect	Yes	Cough, tremor, insomnia, headache, fatigue, salivation, eye and skin irritant	Skin, respiratory system, CNS, kidneys, eyes
Silver	Inhalation Ingestion Skin and/or eye contect	Yes	Nose, skin, and throat irritant, skin ulceration, blue-grey eyes	Nasal septum, skin, eyes
Cyanide	Inhalation Skin absorption Ingestion Skin and/or eye contact	Yes	Asphyxia and death, weakness, headache, confusion, nausea, vomiting, eye and skin irritant, gasping, toxicity due to dermai absorption.	CVS, CNS, liver, kidneys, skin
Benzene	Inhalation Ingestion Skin absorption Skin and/or eye contact	Yes	lrritates nose, respiratory system, giddy, headache, nausea, staggered gait	Blood, CNS, skin, bone marrow, eyes, respiratory system, leukemia

TABLE 2 (CONTINUED)

ACUTE AND CHRONIC EFFECTS AND FIRST AID TREATMENT

Compound	i Routes of Entry	Eye Irritent	Acute Effects	Chronic Effects
Toluene	Inhalation Skin absorption Ingestion Skin and/or eye contact	tes.	fatigue, confusion, euphoria, dizziness, headache, dilated pupils, insomnia, dermatitis, muscle fatigue	CNS, liver, kidneys, skin
Bromomethene	Inhaletion Skin absorption Ingestion Skin and/or eye contact	Yes	Headache, vertigo, nausea, vomiting, hand tremor, convulsions, eyes and skin irritant	CNS, respiratory system, skin, eyes, pot. hum. CAY
Methylene Chloride	Inhalation Ingestion Skin and/or eye contact	Yes	Fatigue, weakness, sleepiness, lightheadedness, limbs numb, tingle, nausra, vertige, worsen angina	Skin, CVS, eyes, CNS
1,1,1- trichlorcettane	Inhalation Ingestion Skin and/or eye contact	Yes	Headache, lassitude, CNS depression, poor equilibrium, dermatitis	Skin, CNS, CVS, eyes
tetrachloroethylene	Inhalation Ingestion Skin and/or eye contact	Yes	Headache, vertigo, visual disturbances, tremors, nausea, vomiting, dermatitis	Respiratory system heart, liver, kidneys, CNS, skin, potential human carcinogen
MEK	Inhalation Ingestion Skin and/or eye contact	Yes	Irritates nose, headache, dizziness, vomiting	CN5, lungs
Ethylbenzene	Inhalation Ingestion Skin and/or eye contact	Yes	Eye irritant, headache, dermatitis, coma	Eyes, upper respiratory system, skin, CNS
Trichloroethylene	Inhalation Ingestion Skin and/or eye contact	Yes	Neadache, vertigo, visual disturbances, tremors, nausea, vomiting, dermatitis	Respiratory system, heart, liver, kidneys, CNS, skin, potential human carcinogen

TABLE 2 (CONTINUED)

ACUTE AND CHRONIC EFFECTS AND FIRST ALD TREATMENT

Compound	Routes of Entry	Eye Irritant	Acute Effects	Chronic Effects
Selenium	Inhalation Skin Absorption Ingestion Skin and/or eye contact	Yes	Eyes, nose, throat irritant, disturbs vision, headache, chill, fever, bronchitis, metal taste, garlic breath, dermatitis, blurred ision	Upper respiratory system, eyes, skin, liver kidneys, blood
Acetonitrile	Inhalation Skin Absorption Ingestion Skin and/or eye contact	Yes	Asphyxia, nausea, vomiting, chest pain, weakness, stupor, convulsions, eye irritant	Kidneys, liver, CVS, CNS, lungs, skin, eyes
Acrylonitrile	Inhalation Ingestion Skin and/or eye contact	Yes	Asphyxia, eye irritant, headache, sneezing, nausea, vomiting, weakness, dermafitis, toxicity due to dermal absorption.	CVS, liver, kidneys, CNS, skin and brain tumor, lung and bowel cancer
Cresol	Inhalation Skin Absorption Ingestion Skin and/or eye contact	Yes	CNS effects, confusion, depression, respiratory failure, weak pulse, skin and eye burns, dermatitis	CNS, respiratory system, liver, kidneys, skin, eyes
Pyridine	Inhalation Skin Absorption Ingestion Skin and/or eye contact	Yes	Headache, nei Jousness, insomnia, frequent urination, dermatitis	CNS, liver, kidneys, gastrointestinal tract
Acetone	Inhalation Ingestion Skin and/or eye contact	Yes	Eyes, nose, throat irritant, headache, dizziness, dermatitis	Respiratory system, skin
Depleted Uranium*	Inhalation Ingestion Direct Exposure	No	> 450 Rem exposure-nausea, diarrhea, loss of hair, fever, 50% die within 60 days without medical treatment	Delayed cancer (may occur), genetic effects, reduced life expectancy
emmon i e	inhelation ingestion skin and/or eye contact	Yes	eye, nose, throat irritant; dyspnea; bronchospasm; chest pain; pulmonary edema; pink frothy sputum; skin burna; reticulation	Respiratory system; eyes

* Uranium is a heavy metal, the toxicity risk is higher than the radiological risks.







TABLE 3

Hazard Monitoring Methods, Action Levels, and Protective Measures

Hazard	Monitoring Method	Action Level	Monitoring Schedule	Protective Measures
Organic Vapors	HNU with 10.2 probe or greater eV probe	<1 ppm above back- ground in the site- workers' breathing zone	Continuing working and monitoring	Level C
			Use Draeger pump and detector tubes; if no benzene is detected, continue working and monitoring	Level C
		2 10 ppm above back- ground in the site workers' breathing tone and sustained for 1 minute	Stop work and leave area; contact PM and OSC; a reassessment of site conditions (including PPE) will be conducted	EVACUATE AREA
Benzene	Benzene detector tubes	Any concentration in site workers' breath- ing zone	Stop work and leave area for 15 min- utes; monitor again; if any concentra- tion detected, contact PM and OSC; a reassessment of site conditions (including PPE) will be conducted	EVACUATE AREA
Cyanide	Hydrogen Cyanide Meter	Any concentration in site workers' breath- ing zone	Stop work and leave area for 15 min- utes; monitor again; if any concentra- tion detected, contact PM and DSC; a reassessment of site conditions (including PPE) will be conducted	EVACUATE AREA
Toxic Dust	Particulate Monitor	>5mg/må	Stop work and leave area for 15 minute monitor again; if >5 mg/m3, evacuate a contact PM and OSC; a reassessment of conditions may be necessary.	nd
Explosion	CGI	0-10% LEL	Continue investigation	
		>10% LEL	Continue monitoring with caution as higher levels are Encountered. Revoke Hot Work Permit. Stop all "hot work" in progress.	
		225% LEL	Explosion Hazard - withdraw from area immediately	

TABLE 4

PROTECTIVE EQUIPMENT FOR ON-SITE ACTIVITIES

Activity	Level	Protective Equipment
All Activities	с	Half face air purifying respirator ¹ , chemical resistant clothing, inner & outer chemical resistant gloves, safety boots, hard hat
		Note: hearing protection may also be needed on a case-by-case basis.
People located on-site	D	Work clothes or coveralls, safety glasses or goggles, hard hat, chemical resistant gloves
		Note: face shield and/or hearing protection may also be needed on a case-

by-case basis.

The General Contractor's respiratory program will be in compliance with 10 CFR Part 20, as well as 29 CFR Part 1910 regulations. To the extent possible, the General Contractor will implement engineering controls and work practices to maintain employee exposures to or below permissible exposure limits for substances regulated by 29 CFR Part 1910 and to or below dose limits defined in 10 CFR Part 20.103(b), Appendix B, Table I, Column I. When engineering controls are not feasible, personal protective equipment will be employed to reduce and maintain employee exposures below applicable limits for the constituents of concern identified at the site.

APPENDIX E

STANDARD SAFE WORK PRACTICES

APPENDIX E STANDARD SAFE WORK PRACTICES

I. GENERAL

- Eating, drinking, chewing gum or tobacco and smoking are prohibited in the contaminated or potentially contaminated are or where the possibility for the transfer of contamination exists.
 - 2. Avoid contact with potentially contaminated substances. Do not walk through puddles, pools, mud, etc. Avoid, whenever possible, kneeling on the ground, leaning or sitting on equipment or ground. Do not place monitoring equipment on potentially contaminated surface (i.e., ground, etc.).
 - Prevent, to the extent possible, spillage. In the event that a spillage occurs, contain liquid, if possible.
 - 4. Prevent splashing of contaminated materials.
 - 5. All field crew members shall make use of their senses (all senses) to alert them to potentially dangerous situations in which they should not become involved (i.e., presence of strong, irritating or nauseating odors).
 - Field crew members shall be familiar with the physical characteristics of investigations, including:
 - Wind direction in relation to ground zero area;
 - Accessibility to associates, equipment, vehicles;
 - o Communications;
 - Hot zone (areas of know or suspected contamination);
 - o Site access; and
 - o Nearest water sources.
 - 7. The number of personnel and equipment in the contaminated area should be minimized, but



only to the extent consistent with work force requirements of safe site operation.

- All wastes generated during Contractor and/or subcontractor activities at the site will be disposed of as directed by the PM.
- All electrical equipment should be connected to ground fault interrupting circuits (GFIC).
- II. DRILLING AND SAMPLING PROCEDURES

For all drilling and sampling activities, the following standard safety procedures shall be employed.

- All drilling and sampling equipment shall be cleaned before proceeding to the site.
- At the drilling for sampling site, sampling equipment shall be cleaned after each use.
- Work in "cleaner" areas should be conducted first where practical.
- The minimum number of personnel necessary to achieve the objectives shall be within 25 feet of the drilling or sampling activity.
- If emergency and back-up subcontracted personnel are at the site, they should remain 25 feet from the drilling or sampling activity, where practical.
- 6. Exclusion zones will be established within designated hot lines. Delineation of a hot line will reflect the interface between areas at or below a predetermined threshold contaminant concentration, based on available data including the results of monitoring and chemical analyses, information from site personel regarding historical site activities, and general observations. This determination will be made by the PM in conjunction with the OSSO and site personnel.
- III. BOAT SAFETY PRACTICE (LAGOON SAMPLING)
 - Two persons will man he sampling boat and an on-shore supervisor will be present at all times.

- All field personnel shall wear life preservers.
- The on-shore supervisor should be equipped with in-plant communication in case an accident requiring emergency services occurs.
- In-plant safety and medical personnel should have complete notification of the boat sampling schedule and locations.
- A tow line will be attached to the boat and maintained on land at all times if practicable.
- Boarding and unloading the sampling boat will be conducted from a dry and stable location if practicable, without necessitating contact by personnel with the contaminated wastewater.
- Personnel shall position themselves accordingly in the boat to maintain a stable condition at all times (counter balancing bow and stern or port starboard).
- Sampling equipment should be drained thoroughly before being brought into the boat.
- 9. If sampling equipment falls into the water, do not make any attempt to retrieve it.
- IV. DRILLING IN A LANDFILL
 - Specific monitoring methods and protective equipment indicated in Tables 3 and 4 should be utilized. Monitoring with detector tubes for H₂S, HCN and vinyl chloride shall be carried out. Monitoring for exposure to CH₄ shall be conducted as well.
 - 2. Establish a clean area just outside of the landfill consisting of decontamination area and backup support health and safety and firefighting equipment (fire extinguishers). This will be continuously monitored by the OSSO who will have visual contact with personnel in the landfill in protection Level B gear in case of an emergency.
 - 3. Prior to the start of drilling a probe within the landfill, a protective steel sheeting or

blasting mat, about 20 feet by 10 feet will be placed over the area to be probed. The probe will be drilled through a hole cut in the center of the sheeting.

 Appropriate emergency and backup subcontractor personnel should remain 25 feet from the drilling or sampling activity where practical.

V. CONFINED SPACE ENTRY

All personnel will treat Contined Space Entry as a special hazard. All tanks, similar vessels and partially or entirely closed spaces shall be regarded as being potentially dangerous.

Before entering a confined space, the OSSO must see that the following is adhered to:

- All mechanical apparatus such as agitators and pumps within the confined space, which if activated could injury the workers, are locked out.
- 2. The atmosphere within the confined space is tested for oxygen (O_2) deficiency, flammable gas or vapor, LEL, and any applicable toxic gases or vapors, and the test results recorded. Atmospheric testing must be performed at least every 12 hours. The area will be continuously vented to dissipate any vapors or gases (five air changes are required). The percent O_2 , LEL and toxic vapor concentration (if applicable) will be redetermined and recorded and upon reaching safe levels, as indicated on the meter, the space may be entered. The area shall be continuously, positively (blow air in) ventilated prior to and during entry. The following equipment will be used in lieu of standard equipment.
 - A. Flashlights, lanterns or alternating current (AC) or direct current (DC) electric powered lighting which is approved for Class 1, Division 1, Group C or D Atmosphere (explosion-proof).
 - B. Hand tools constructed of non-sparking metal alloys.
 - C. Ground fault circuit interrupters (GFI's) must be used on all electrically operated hand tools and lighting used in a confined space. The GFI's will be physically located outside the confined space.

- Workers are provided and required to use protective equipment as follows:
 - A. For worker entering confined space:
 - gloves
 - rubber steel-toes boots
 - impermeable coveralls
 - safety harness with attached lifeline
 - escape packs
 - hard hat with safety glasses
 - self-contained breathing apparatus with a full-face mask
 - B. For trained attendant observing operation:
 - hard hat
 - safety glasses or goggles
 - gloves
 - boots and safety shoes
 - impermeable coveralls
 - immediate access to self-contained breathing apparatus with full-face mask
 - immediate access to safety harness and lifeline
 - two-way radio for summoning assistance and emergency communication
- 4. A trained attendant must be stationed outside the opening of any permit-required confined space in which personnel are working. The attendant must continuously monitor the inside and outside conditions of the space and have means to summon the rescue teamshould it be needed.
- 5. Duties of entrants and attendants

Entrants:

- Must be familiar with the kinds of hazards they might be exposed to during entry and understand the consequences of those exposures.
- b. Must know the signs and symptoms of potential exposures.
- c. Must sign Permit when entering and log times.
- d. Must understand the use, selection and limitations of all personal protective equipment required on the Permit.
- e. Perform only work as indicated by the Permit System.

- f. Must follow communication techniques listed on the Permit that ensure continuous contact with the attendant.
- g. Must understand, if applicable, the operation of personnel and area continuous monitoring devices.
- h. Must notify the attendance if you initiate an evacuation.
- i. Must evacuate the space:
 - 1. When ordered by the attendant.
 - 2. If an emergency alarm (other than testing) sounds.
 - 3. If they believe they are in danger.
 - 4. If there is a loss of contact with the attendant.

Attendant:

- a. Must review possible hazards in the space and the symptoms of exposure to those hazards with the person signing the Permit.
- Is responsible for all work grous entering his/her assigned entry way and must ensure all entrants sign the posted permit.
- c. Must keep an accurate count of all entrants.
- d. Maintains continuous contact (visual, verbal or radio) with all persons working in the Confined Space. Rescue help will be summoned if contact with the entrants is lost and cannot be guickly restored.
- e. Must continuously monitor inside and outside conditions for hazards and keep all unauthorized personnel out of the area.
- f. Performs no duties that might interfere with the primary monitoring duties.
- g. Must remain on duty at all times outside the Confined Space for the duration of the entry or during a rescue attempt until relieved.

- h. Must order an evacuation if:
 - Any condition not allowed by the Permit occurs, such as hot work, solvent usage or unauthorized work practices or procedures.
 - 2. Behavioral changes in entrant such as euphoria or giddiness, which might result from oxygen deficiency or excessive exposure to some gases or vapors.
 - 3. Detects situations outside the space that could endanger those inside, such as a spill or vehicle idling near the ventilation intake.
 - 4. For any reason the attendant has to leave his station and a relief attendant is not available.
 - 5. The BP Chemical Emergency Alarm sounds.
- i. Must be aware of the method used to summon rescue personnel and be familiar with the following emergency rescue section.
- Must return Entry Permit to issuant when work is completed and report any hazards confronted or created during the entry.

Emergency Rescue

- a. If an entrant needs rescued, the attendant must never enter the space, but should get immediate help.
- All Confined Space Rescues will be performed by the Shawnee Fire Department Emergency Rescue Team.
 Rescue is initiated by notifying BP Lima Chemicals by phone (226-1329) or Shawnee Fire Department by telephone (991-4055).
- c. A BP Chemicals Team Leader must be notified immediately.
- d. When Shawnee Emergency Rescue team responds to an inplant rescue emergency, all hazards of the particular space must be communicated prior to entry. This may be accomplished by use of an MSDS, process P&I drawings, and any other applicable information.

- e. Once the Rescue Team has been summoned, the attendant should:
 - Make sure stand-by rescue equipment (i.e., lights, O₂ resuscitators, ropes, etc.) is ready or enroute.
 - 2. Start emergency ventilation (i.e., air hoses).
 - 3. Stay in communication with entrants.
 - 4. Monitor the situation and be ready to give rescuers such informa ion as:
 - a. How many victims.
 - b. Struct iral hazards.
 - c. Chemicals types and concentrations.
 - d. Victim status (alert or unconscious)

6. Training

Entrants, Attendants and individuals responsible for authorizing permits must be trained in their responsibilities outlined in this procedure. Permitted Confined Spaces will be spot checked periodically to ascertain compliance to these requirements.

7. Employees are not permitted to enter a confined space in which levels in excess of acceptable standards (see exposure standard in Health and Safety Plant) are present.

8. Air supply lines are inspected for leaks or cracks which could result in breakage during use. Face mask respirators are checked for proper flow rate. Two-way radios are tested to assure proper working order and reception of signal transmitted. Safety harnesses and eye liner are checked for proper integrity.

9. The permit should also contained the following information:

- a. Location where the entry is to be performed
- b. Date permit is written
- c. Purpose for entry brief description of work to be done
- d. Other permits required
- e. Attendant/entrant communication identify the type of communication to be used between the attendance and
- List types of personal protective equipment required for safe entry
- g. Signature of the qualified person conducting the atmospheric tests

- Time of test h.
- Test results 1.
- Name of person(s) entering the confined space Name of attendant j.
- k.



APPENDIX F

CONTACTS AND PROCEDURES

APPENDIX F

CONTACTS AND PROCEDURES

I. CONTACTS

Should any situation of unplanned occurrence require outside of support services, the appropriate contacts should be made. The list of appropriate contacts is listed in Section 4 of the Health & Safety Plan.

II. PROCEDURES

In the event that an emergency develops on-site, the procedures delineated herein are to be immediately followed. Emergency conditions are considered to exist if:

- Any member of the field crew is involved in an accident or experiences any adverse effects or symptoms of exposure while on-site; or
- A condition is discovered that suggests the existence of a situation more hazardous than anticipated.

The following emergency procedures should be followed:

- A. Personnel on-site should use the "buddy system" (pairs). Buddies should pre-arrange hand signals or other means of emergency signals for communication in case of lack of radics or radio breakdown (see the following item).
 - Hand gripping throat: out of air, can't breathe
 - Grip partner's wrist or place both hands around waist: leave the area immediately, no debate
 - o Hands on top of head: need assistance
 - Thumbs up: Okay, I'm all right, I understand
 - o Thumbs down: No, negative

B. Site work area entrance and exit routes should MAR:91:002:001.BP -1be planned, and emergency escape routes delineated by the OSSO.

C. Visual contact should be maintained between "pairs" on-site with the team remaining in close proximity in order to assist each other in case of emergencies.

D. In the event that any member of the field crew experiences any adverse effects of symptoms or exposure while on-site, the entire field crew should immediately halt work and act accordingly to the instructions provided by the OSSO.

- E. Wind indicators visible to all on-site personnel should be provided by the PM to indicate possible routes for upwind escape.
- F. The discovery of any condition that would suggest the existence of a situation more hazardous than anticipated should result in the evacuation of the field team and reevaluation of the hazard and the level of protection required.
- G. In the event that an accident occurs, the PM is to complete and Accident Report Form for submittal to the Office Safety Coordinator (OSC), who will forward a copy to the RHSM and the FWHSD. The OSC should assure that the follow-up action is taken to correct the situation that caused the accident.
- H. In the event that an accident occurs, the PM is to complete an Accident Report Form for submittal to the OSC.

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APPENDIX G

RESPONSIBILITIES

APPENDIX G

RESPONSIBILITIES

1.0 PROJECT MANAGER

The Project Manager (PM) shall direct on-site investigations and operational efforts. The PM, assisted by the On-Site Safety Officer (SSO), has primary responsibility for:

- Making certain that appropriate personnel protective equipment and monitoring equipment is available and properly utilized by all on-site personnel.
- Making certain that personnel receive this plan and are aware of the provisions of this plan, are instructed in the work practices necessary to ensure safety, and are familiar with planned procedures for dealing with emergencies.
- 3. Making certain all field personnel have had appropriate OSHA Health and Safety Training.
- Making certain that personnel are aware of the potential hazards associated with the site operations.
- Monitoring the safety performance of all personnel to ensure that the required work practices are employed.
- Correcting any work practices or conditions that may result in injury or exposure to hazardous substances.
- Preparing any accident/incident reports (see attached Accident Report Form) and routine job exposure record.q.
- 8. Assuring the completion of Plan Acceptance and Feedback Forms attached hereto.

2.0 ON-SITE SAFETY OFFICER

The On-Site Safety Officer (SSO) shall:

 Implement project Health & Safety Plans and report to the Site Safety Coordinator and the PM for action if any deviations from the anticipated conditions described in the plan and has the authorization to stop work at any time.

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- Calibrate all monitoring equipment (except radiation detection equipment) on a daily basis and record results on the attached sheets (see Section 7.0 - Daily Instrument Calibration Check Sheet and Daily Radiation Instrument Operability Check Sheet).
- Making certain that all monitoring equipment is operating correctly according to manufacturer's instructions and provide maintenance if it is not.
- 4. Confirm that personnel working on-site have the proper medical surveillance program and Health & Safety training which qualifies them to work at a hazardous waste site. Also be responsible for identifying all WMS site personnel with special medical problems (i.e., allergies).

3.0 PROJECT PERSONNEL

Project personnel involved in on-site investigations and operations are responsible for:

- Taking all reasonable precautions to prevent injury to themselves and to their fellow employees.
- Performing only those tasks that they believe they can do safely, and immediately reporting any accidents and/or unsafe conditions to the SSO.
- 3. Notifying the PM and 0550 of any special medical problems (i.e., allergies) and making certain that all on-site personnel are aware of any such problems.

APPENDIX H

HEAT STRESS/COLD STRESS

APPENDIX H HEAT STRESS/COLD STRESS

HEAT STRESS

If site work is to be conducted during the summer or in other hot environments, heat stress is a concern in the health and safety of personnel. For workers wearing permeable clothing, follow recommendations for monitoring requirements and suggested work/rest schedules in the current American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limits Values for Heat Stress. For workers wearing semipermeable or impermeable clothing, the ACGIH standard cannot be used. For these situations, workers should be monitored when the temperature in the work area is above 70°F (21°C).

To monitor the worker, measure:

- Heart rate. Count the radial pulse during a 30-second period as early as possible in the rest period.
 - If the heart rate exceeds 110 beats per minute at the beginning of the rest period, shorten the next work cycle by one-third and keep the rest period the same.
 - If the heart rate still exceeds 110 beats per minute at the next rest period, shorten the following work cycle by one-third.
- Oral temperature. Use a clinical thermometer (3 minutes under the tongue) or similar device to measure the oral temperature at the end of the work period (before drinking).
 - If oral temperature exceeds 99.6°F (37°C), shorten the next work cycle by one-third without changing the rest period.
 - If oral temperature still exceeds 99.6°F (37.6°C) at the beginning of the next rest period, shorten the following work cycle by one-third.
 - Do not permit a worker to wear a semipermeable or impermeable garment when his/her oral temperature exceeds 100.6°F (38.1°C).
- Body water loss, if possible. Measure weight on a scale accurate to ±0.25 lb at the beginning and end of each work day to see if enough fluids are being taken to prevent dehydration. Weights should be taken while the employee wears similar clothing or, ideally, is nude. The body water loss should not exceed 1.5 percent total body weight loss in a work day.

Initially, the frequency of physiological monitoring depends on the air temperature adjusted for solar radiation and the level of physical work (see following Table) The length of the work cycle will be governed by the frequency of the required physiological monitoring.

> SUGGESTED FREQUENCY OF PHYSIOLOGICAL MONITORING FOR FIT AND ACCLIMATIZED WORKERS

Temperature	Normal Work Ensemble	<u>Impermeable</u> Ensemble
90°F (32.2°C)	After each 45	After each 15
or above	minutes of work	minutes of work
87.5°-90.0°F	After each 60	After each 30
(30.8°-32.2°C)	minutes of work	minutes of work
82.5°-87.5°F	After each 90	After each 60
(28.1°-30.8°C)	minutes of work	minutes of work
77.5°-82.5°F	After each 120	After each 90
(25.3°-28.1°C)	minutes of work	minutes of work
72.5°-77.5°F	After each 150	After each 120
(22.5°-25.3°C)	minutes of work	minutes of work

* Calculate the adjusted air temperature (ta adj) by using this equation: ta adj °F = ta °F + (13 x % sunshine). Measure air temperature (ta) with a standard mercury-in-glass thermometer, with the bulb shielded from radiant heat. Estimate percent sunshine by judging what percent time the sun is not covered by clouds that are thick enough to produce a shadow (100 percent sunshine - no cloud cover and a sharp, distinct shadow; 0 percent sunshine- no shadows).

If workers are not monitored for heat stress, work activities in hot environments can result in dehydration, heat exhaustion, heat stress or even heat stroke.

Signs and Symptoms of Heat Stress

- Heat rash may result from continuous exposure to heat or humid air.
 - muscle spasms

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- pain in the hands, feet and abdomen
- Heat exhaustion occurs from increased stress on various body organs including inadequate blood circulation due to cardiovascular insufficiency or dehydration. Signs and symptoms include:

- pain, cool, moist skin
- heavy sweating
- dizziness
- nausea
- fainting
- Heat stroke is the most serious form of heat stress.
 Temperature regulation fails and the body temperature rises to critical levels. Immediate action must be taken to cool the body before serious injury and death occur. Competent medical help must be obtained. Signs and symptoms are:
 - red, hot, usually dry skin
 - lack of or reduced perspiration
 - nausea
 - dizziness and confusion
 - strong, rapid pulse
 - coma

COLD STRESS

Frost Bite

Frostbite is an injury resulting from exposure to cold. The extremities of the body (fingers, toes) are most often affected. The signs of frostbite are:

- o Skin turns white or grayish-yellow.
- Pain is sometimes felt early, but subsides later. Often there is no pain.
- o The affected part feels intensely cold and numb.

Hypothermia

If site work is to be conducted during the winter, cold stress is a concern in the health and safety of the personnel. Additional insulated clothing will be provided to field personnel. Of special note for cold stress on this site is the wearing of tyvek suits. Disposable clothing does not breath; therefore, perspiration is not provided with a means of evaporation. During strenuous physical activity, an employee's cloths can become wet. Wet cloths combined with cold temperatures can lead to hypothermia. If the air temperature is less than 40°F and an employee becomes wet, the employee must change to dry clothes. The on-site heated trailer facility or a personnel vehicle may be utilized as a change area.

Hypothermia is characterized by shivering, numbness, drowsiness muscular weakness and a low internal body temperature when the body feels war externally. This can lead to unconsciousness and death. In either case (frostbite or hypothermia), seek immediate medical attention.

To prevent these effects from occurring, persons working in cold environments should wear adequate clothing and reduce the time spent in the cold area.



APPENDIX I

AIR SAMPLING, FIELD EVALUATION AND SAMPLING ASSESSMENT OF RADIOACTIVE PARTICULATES PROCEDURE

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APPENDIX I

AIR SAMPLING, FIELD EVALUATION AND SAMPLE ASSESSMENT OF RADIOACTIVE PARTICULATES

1.0 PURPOSES

- 1.1 This procedure describes the practices for the sampling and assessment of airborne particulate radioactivity.
- 1.1.1 Field evaluation is described for particulates.
- 2.0 PREREQUISITES, PRECAUTIONS AND LIMITATIONS
- 2.1 If the air sample is obtained for a specific work task, record the RWP number of RCM Form 7.1, the Air Sample Record (ASR).
- 2.2 If the air sample is obtained as part of an area radiation or contamination survey, record the air sample number of the survey record used for that survey.
- 2.3 All instruments and equipment shall be checked in accordance with the applicable Radcon Instrument Procedure (RIP).
- 2.4 Use filter paper specified by On-site Safety officer.
- 2.5 Exercise care to avoid damage to and/or contamination of the air sample and/or filter paper.
- 2.6 All air samples (filter paper, iodine cartridge) are to be field evaluated, when practicable, with an HP-210 probe or equivalent to determine if it is necessary to initiate radiological protective actions. The background count rate should be less than 300 cpm to enable a reasonably sensitive evaluation. Abnormal conditions are to be reported to SSO as soon as practicable. Refer to Step 3.4.
- 2.7 The contribution from short-lived radon daughters must be considered for immediate sample counting. Activity from these daughter products will be negligible at approximately four hours after obtaining the sample.
- 2.8 SSO may request an isotopic evaluation of the sample.
- 2.9 When reading a rotometer scale, estimate the flow rate accurately as possible.
- 3.0 PROCEDURE

- 3.1 Preparation
- 3.1.1 Obtain a copy of Form 7.1.
- 3.1.2 Record as much of the information requested as possible, prior to sampling.
- 3.1.2.1 If the air sample is obtained for a specific work task, record is sufficient detail the job location and work activity performed during the sampling period.
- 3.1.2.2 Any required air sampling information recorded in the field (for example, on a field worksheet) may be transcribed to the ASR later.
- 3.1.3 Check the appropriate sample type on the ASR.
- 3.1.3.1 Collect "General Area" samples approximately five feet above the floor.
- 3.1.3.2 Collect "Process Samples" in close proximity to equipment or system suspected of being a source of airborne radioactivity. The sample may be withdrawn from a system.
- 3.1.3.3 Collect "Breathing Zone" (BZ), samples in the individual's breathing zone (approximately 8-10 inches from the face). Preferably, these samples are obtained with an air sampler capable of sampling a volume of at least 10 ft2 of air while the individual is in the sampling area. This enables an acceptable sample minimum detectable activity to be obtained on a gross activity detector (e.g., MS-3, SAX-2) or equivalent. If necessary, a low flowrate, battery-operated personnel sampler is available for use. Record the name and badge number of the user along with all other required data on the ASR.
- 3.1.4 Record the name, badge number, department or company, respirator device code (if applicable), and exposure period or respirator use period for all personnel to whom the ASR will be credited.
- 3.1.5 Take all necessary equipment to the air sampling site.
- 3.1.5.1 Air sampler with compatible sample head.
- 3.1.5.1.1 The following table lists portable air samplers and their normal use:



Air Sampler

Radeco AC

Radeco DC

Radeco Gooseneck

RASP Pump

Staplex High Volume

Long Term Samples

to 9999 Min.)

Grab Samples (up to

Emergency Grab Samples

Grab Samples or Long Term

Samples (Timer Records up

approx. 30 min.)

Volume Environmental or Other High Volume Samples

Normal Use

Battery Operated Personal Breathing Zone Personal Air Sampler Samples

3.1.5.2 Filter papers

- 3.1.5.2.1 Ensure that the filter paper is properly positioned in the sample head and is not damaged. A small mark may be placed on the edge of the filter paper to indicate the air inlet side.
- 3.1.5.3 Three prong to three prong twist lock electrical adapter plug (applicable for only AC powered samplers).
- 3.1.5.4 Sample containers
- 3.1.5.5 Labels and marking pens
- 3.1.5.6 Timing device
- 3.1.6 Carts containing this equipment may be used as necessary. Cart standby locations are designated by Radcon supervision. DC samplers require a 12V DC battery for operation.
- 3.2 Obtaining Air Samples
- 3.2.1 Particulate Sampling
- 3.2.1.1 Position or hold the air sampler such that the intake does not touch or come close to potentially contaminated or contaminated surfaces.
- 3.2.1.2 Plug the AC powered air sampler into a convenient outlet or, if utilizing a DC powered air sampler, connect the battery clips to their respective battery terminals.



- 3.2.1.2.1 The black cable is negative and shall be connected to the negative battery terminal. The red cable is positive and shall be connected to the positive battery terminal.
- 3.2.1.3 Turn the air sampler on and record the data and time.
- 3.2.1.4 Record the flow of the fixed speed air sampler. It utilizing a variable speed sampler, adjust the flowrate until the desired flowrate is obtained (1-3 cfm), and record the flowrate.
- 3.2.1.4.1 The flowrate is read at the centerline of the rotometer float.
- 3.2.1.5 When practicable, allow the air sampler to run for a sufficient length of time to enable a minimum sample volume of 10 cubic feet (ft³). For example, an air sampler running at 2 cubic feet per minute (cfm) takes 5 minutes to obtain a volume of 10 ft².
- 3.2.1.6 Turn the air sampler off and record the date, time and flowrate.
- CAUTION: During Step 3.2.1.7, exercise care to avoid cross contamination of the filter paper or holder.
- 3.2.1.7 Remove the filter paper from the sample holder (handle it by the edge). Place the filter paper in a suitable sample container. Identify the container with the sample information (e.g., date, time, location, initials and ASR number).
- 3.2.1.8 Calculate the average air flow from the following formula:

air flow at start + air flow at end = average air flow

- 3.2.1.9 Multiply the average air flow by the sampling time in minutes and record the total volume sampled.
- 3.2.1.10 Perform field evaluation of the sample, step 3.3, when practicable.
- 3.3 Field Evaluation
- 3.3.1 This evaluation, when practicable, should be performed as soon as practicable for filter paper.
- 3.3.2 Using an RM-14 or equivalent, with an HP-210 probe, or equivalent, determine the background radiation level in counts per minute (Spm).

- 3.3.2.1 The background level should be at low as possible (<300 cpm).
- 3.3.3 Place the HP-210 probe approximately 1/2 inch above the sample. Ensure that the RESPONSE control on the RM-14 is set for the slowest response. This is necessary to maintain an adequate sensitivity.
- 3.3.4 Turn the instrument selector switch to a range which results in a reading on the scale (preferably the upper half of the scale).
- 3.3.5 Wait approximately 30 seconds and determine the net count rate for the filter paper and iodine cartridge. Check the approximate boxes on RCM Form 7.1 at "HP-210 FIELD EVALUATION."
- 3.3.5.1 If the >500 NET CPM box for filter paper is checked, notify Radcon supervision. This notification is necessary to determine if there is a need for immediate corrective actions (e.g., evacuation, isolation of a system or area, closing an open system, donning respiratory protection, etc.).
- 3.3.5.1.1 Refer to Table 3.7.3.4 for additional guidance.
- 3.3.5.2 If the <500 NET CPM box for filter paper or the <150 NET CPM for iodine is checked, evaluations are required to determine if actions are required to minimize personnel exposure to airborne radioactivity, (e.g., engineering controls, reevaluation of respiratory protection requirements, possible evacuation, etc.) (Ref. 5.3).
- 3.3.5.2.1 Refer to Table 3.7.3.4 for additional guidance. Consult Radcon supervision for assistance.
- 3.3.6 All samples shall be retained for additional counting.
- 3.4 Sample Assessment
- 3.4.1 Filter paper
- 3.4.1.1 Prior to counting on the MS-3 or equivalent, record on the ASR, under "FILTER PAPER COUNTING DATA," the date and time (at the start of the count), and the length of time between sampling and counting.
- 3.4.1.1.1 Use the mean time of the sampling period to calculate the decay time.
- 3.4.1.1.2 If a 4 inch diameter filter paper is used with the Staplex high volume air sampler, trace the outline of a 2-inch circle on the center of the paper and cut out the traced circle on a board the outer portion of the paper and count

the center portion. The sample volume must be adjusted to the filter paper surface area being counted. The filter paper surface area is now 1/3 of the original active area; therefore, the sample volume must be divided by 3 and recorded on the ASR as the "EQUIVALENT AIR COUNTED."

- 3.4.1.2 Count the sample on the MS-3 or equivalent except as described below. Samples are normally counted for 5 or 10 minutes. Record all required data on the ASR.
- 3.4.1.2.1 Air samples with a total air volume insufficient to provide a minimum detectable activity (MDA) of less than (<)3.0E-10 microcuries per cubic centimeter (μ Ci/cc), should be initially counted on the ND-6650 or equivalent to eliminate the need to recount based on a high sample MDA on the MS-3.
 - 3.4.1.2.2 Based on results of the field evaluation, SSO may require the cutting of a 2 inch diameter filter paper for counting. The sample volume must be adjusted to the filter paper surface area being counted. For example, if only 1/3 of the filter paper surface area is counted, the sample volume must be divided by 3 and recorded on the ASR as the "EQUIVALENT AIR COUNTED."
- 3.4.1.3 Perform calculations indicated on RCA Form 7.1 to determine the concentration of activity in $\mu Ci/cc$.
- 3.4.1.4 If the activity is equal to or greater than (\geq) 3.0E-10 μ Ci/cc notify SSO.
- 3.4.1.4.1 If the recount of the sample is requested, the counts should be performed within 4 hours after sampling in order to facilitate evaluation of short-lived isotopes. Recounts may be documented on RCM Form 7.1, Section 1.
- 3.4.1.5 The sample shall be retained for isotopic analysis if deemed necessary by SSO. SSO should attempt to determine the principal radioisotopes of the sample and initiate corrective and/or protective actions. If the isotopic analysis falls to identify any isotopes, the activity may be due to radon daughters.
- 3.4.1.6 The sample shall be retained for an alpha count if deemed necessary by OSSO.
- 3.4.1.6.1 Alpha counting is to be performed on the SAC-4 or equivalent.
- 3.4.1.6.1.1 Record all data on RCA Form 7.1 or RCA Form 7.1 Section 1.



- 3.4.1.6.2 When a sample is retained for an alpha count, the filter paper should be stored in a suitable sample container (e.g., plastic petri dish) to minimize sample loss due to sample transfer. Notify Radcon supervision of the sample results and for guidance on sample recounts.
- 3.4.1.6.2.1 The original plastic bag should be retained as it may contain a small part of the sample.
- 4.0 RECORDS AND FORMS
- 4.1 Form 7.1, Air Sample Record
- 4.2 Form 7.1, Section 1, Air Sample Record Supplement
- 5.0 <u>REFERENCES</u>
- 5.1 "Air Sampling Media," ND1HPS:013

TABLE 3.7.3.4

-Notify SSO (Ref. 5.3). -Notify SSO.

- -Suggest respiratory devices be worn.
- -Suggest confirmation of results via isotopic analysis.
- -Notify SSO (Ref. 5.3). -Respiratory devices should be worn.
- -Personnel in area assigned MPChours, if applicable.
- -Steps should be taken to minimize exposure.
- -Confirm area posted as "Caution Airborne Radioactivity Area" and correct, if necessary.
- -Suggest confirmation of results via isotopic analysis.

-Notify SSO (Ref. 5.3) -Consider the evacuation for the area or donning of respiratory devices, if available.

- -Personnel in area assigned MPChours, if applicable.
- -Steps should be taken to minimize exposure.
- -Confirm area posted as "Caution Airborne Radioactivity Area" and correct, if necessary. -Confirm results via isotopic
- analysis.
- -If result is from a Field Evaluation, check the possible need for sample volume correction.

* Based on Co-60 or I-131 ** 500 net cpm (particulate) or 150 net cpm (I-131) as measured by an HP-14 or equivalent, with an HP-210 probe.

 $\geq 3 \times 10^{-10}$ and $< 1 \times 10^{-9}$ $\geq 1 \times 10^{-9}$ and $> 2.25 \times 10^{-9}$

 $\geq 2.25 \times 10^{-9}$ and $< 9 \times 10^{-9}$

29 × 10.9**

RCM FORM 7.1

AIR SAMPLE RECORD

RWP/RACP NO .: DATE:

LOCATION: RT:

WORK EVOLUTION DURING SAMPLE:

SAMPLE TYPE: 0 3*FILTER PAPER 0 4*FILTER PAPER o GENERAL AREA O BREATHING ZONE O PROCESS: MARK NO: AIR SAMPLER: ORADECO AC O RADECO DC O RADECO GOOSENECK ORASP OSTAPLEX HIGH VOLUME O AMS-2 O AMS-8 O MSA LAPEL:WORN ST: BADGE NO:

DATE SAMPLER ON: _____ TIME ON: _____ AIR FLOW: ______ DATE SAMPLER OFF: ____ TIME OFF: ____ AIR FLOW: _____OLPM oCFM TOTAL TIME (IN MINUTES: ____ AVG AIR FLOW: ____ AIR SAMPLER SERIAL NO: _____ TOTAL VOLUME: _____OL OFT' O CC

> MP-210 FIELD EVALUATION SHOULD BE PERFORMED IN LOW BACKGROUND AREAS (< 200 CPM)

FILTER PAPER o < 500 NET CPM

0 > 500 NET CPM

NOTE: IF SAMPLE IS OTHER THAN 10 FT', MULTIPLY NET CPM CONTAINED BY [10 SAMPLE VOLUME (FT')]

OTHER MONITORING: o mR/hr o mrem/hr INSTRUMENT: SERIAL NO .:

FILTER PAPER COUNTING DATA

BY 1st COUNT 2nd COUNT COUNT

COUNTED BY: INSTRUMENT: SERIAL NUMBER: DATE COUNTED: TIME COUNTED: LENGTH OF DECAY (hours): COUNTING PERIOD (minutes): GROSS COUNTS: GROSS cpm 2/1: BACKGROUND cpm: NET cpm 5/0.9: COUNTER CORRECTION FACTOR: dpm 7 x 6: EQUIVALENT AIR COUNTED (ft3) dpm/ft³ 8/9 µCi/cc 10 x 1.59E-11 MDCR (cpm) MDA (µCi/cc) (7 x 11 x 1.59.E-11)

CALCULATIONS PERFORMED BY: RADIOISOTOPE IDENTIFICATIONS of YES of NO RCF:

REVIEWED BY (signature Required):





AIR SAMPLE RECORD SUPPLEMENT

ASR NO:

RWP/RACP NO: DATE: LOCATION: RT:

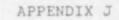
WORK EVOLUTION DURING SAMPLE:

FILTER PAPER COUNTING DATA COUNT 1 COUNT 2 COUNT 3 COUNT 4 COUNT 5 COUNT 6

COUNTED BY: INSTRUMENT: SERIAL NUMBERS: DATA COUNTED: TIME COUNTED: LENGTH OF DECAY (hours) COUNTING PERIOD (minutes) GROSS COUNTS GROSS cpm 2 / 1 BACKGROUND cpm NET cpm 3 - 4 CORRECTED cpm 5/0.9 COUNTER CORRECTION FACTOR dom 7x6 EQUIVALENT AIR COUNTED (ft3) dpm/ft³ 8 / 9 µCi/cc 10 x 1.59E-11 MDCR (cpm) MDA (µCi/cc) (7 x 11 x 1.59E-11)-9 CALCULATIONS PERFORMED BY: RADIOISOTOPE IDENTIFICATION DYES DNO RCF:

REVIEWED BY (Signature Required):

DATE:



FIRE PREVENTION AND CONTROL

BP Chemicals Lima/Standard Practice

Procedure Name:

Fire Prevention and Control

Effective Date: Review Due: Copy Number:	07/01/93 July 1994 	Unit: Section:	Lima Plant All	Procedure Number: Revision Number: Page:	L-SP-S-4001 0 1 of 5
Copy Number:	f_				

RFC Leader Signature (led Review of this procedure):

Changes made vs. Last issue: None

Submitted By:

J. H. Martz Safety Systems Coordinator

Issued By:

J. W. Walpole Plant Manager

(Date) (Signature) 9 30 193 (Date)

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Scope 1.0

It is the responsibility of every employee, contractor and visitor of BP Lima Chemicals to ensure that the company's policies regarding fire prevention are followed. Compliance with these guidelines will assist in minimizing the potential for fire in the plant.

Cross Referenced Procedures 1.1

BP Lima Chemicals Employee Safety Ru'as Booklet

Departments Affected 1.2

This procedure is applicable to all employees, contractors or visitors which enter the BP Lima Chemicals Facility.

Distribution List 1.3

Same as Safety Procedures Summary, L-SP-G-0000, Section 1.3, Distribution List.

(Current Safety Standard Practices are available for viewing on the computer system.)

Initiatives List 14

This policy is applicable to the following initiatives:

OSHA PSM Regulation CMA Responsible Care Standard ISRS Safety System

Responsibility 2.0

Owner of this SP is the Safety Systems Coordinator. It is the responsibility of the HSE Dept. to effectively administrate this policy as issued by the BP Lima Chemicals Plant Manager. This responsibility includes providing assistance and advice to operating and maintenance personnel to effectively and safely comply with the fire prevention and control policy.

Policy 3.0

- General Rules of Prevention 31
 - It will be the responsibility of every Team Leader to see that the 1. company's policy in regard to fire prevention is carried out in his respective unit.

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- 2. Engine oil should be drained into containers provided or empty oil drums and discarded in accordance with appropriate regulations. Never drain oil onto the ground or under engines, motor bases, etc.
- All areas subject to oil spillage, such as under motor bases, mechanic's workshop, etc., should be checked daily and washed clean with water as required.
- 4. Waste, such as sacks, used oil filters, soft rope, rags, etc., should not be allowed to accumulate. Whenever possible, this debris should be disposed of immediately after use. Oil soaked rags should be kept in covered containers until disposed of.
- 5. No smoking is permitted within the plant except in designated areas. All employees shall observe the no smoking areas and warn visitors of the smoking restrictions. Failure to abide can result in disciplinary action and denial of admittance to the area.
- Never use gasoline or other flammable liquids as a cleaning agent.
- 3.2 Fire and Emergency Alarms
 - 1. All occupants of the BP Lima Chemicals facility should familiarize themselves with emergency procedures in their respective areas so that they know what to do when an alarm sounds.
 - All possible exits, exit access routes and exit discharge routes shall be kept unobstructed to allow safe and smooth evacuation in the event of an emergency.
 - Know the location of fire alarm stations.
 - 4. Know the location and how to use and/or operate the fire extinguisher.
 - 5. Automatic sprinkler system will maintain a clearance of thirty-six (36) inches between the sprinkler head and any stored material or other item in the path of sprinkler discharge.
- 3.3 Classification of Fires

Fires are classified into three (3) categories:

Class "A" Fires

Ordinary combustible material, such as wood, paper, cloth, where the cooling effect of quantities of water is most effective in reducing the temperature of the burning material below the ignition temperature.

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Class "B* Fires		liquide such as of	eum products or othe I. grease, gasoline, v thering effect of dry o	vnera ine
Class "C* Fire	S	conductivity of the	I equipment where the extinguishing media er, soda acid or foam uld not be used on C	a is of first h type
Class of Fire		Extin	guisher to Use	
Class "A" Wood, paper,	rags, etc.		surized water hemical	
Class "B" Oil, grease, g all other flam	asoline an mable liqui	d Haloi	hemical n 1211	
Class "C" Electrical			on Dioxide (CO ₂) n 1211	•

- 3.4 Control of Fires
 - 1. To create fire, three (3) components are necessary:
 - A. Fuel
 - B. Oxygen (air)
 - C. Heat

Eliminate any of these and you eliminate the fire. Thus, most fires are fought by eliminating the fuel source by the most readily available means, such as closing valves, diverting flow, etc.; eliminating or reducing the air supply by use of a cover, a blanketing chemical, or an encompassing inert gas; or reducing the heat below the ignition point by cooling with chemicals or water.

- A continuous training program is necessary to ensure that all operating personnel know how to operate all fire fighting equipment and the type of equipment appropriate for the class of fire.
- Periodic fire drills should be held so that all regular operating personnel will be knowledgeable of the procedure to follow in the event of a fire.

 It is most important that all fire fighting equipment be kept in its designated location so that it can be located immediately in an emergency.





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5. All fire fighting equipment should be checked weekly or monthly depending on regulatory requirements to assure it is operable.

APPENDIX K

CONTAMINATION RELEASE SURVEY PROCEDURES

BP CHEMICAL LIMA OHIO PROJECT

Tide: Contamination Release Surveys

Number:	Revision: 0	Effective Date:	Approval	
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			Radiation Safety Officer	Date

1.0 PURPOSE

This procedure establishes requirements for the contamination monitoring of equipment and materials being released for use or disposal outside the Radiological Control Area (RCA).

2.0 APPLICABILITY

This procedure for contamination detection is applicable to material and equipment being released as not contaminated after the potential exposure to contamination.

3.0 REFERENCES

NOTE: Applicable operating procedures for radiation detection instruments will be referenced in this section upon determination of specific make and models to be used.

- 3.1 10 CFR 20, Standards for Protection Against Radiation
- 3.2 Regulatory Guide 10.4, Guide for the Preparation of Applications for Licenses to Process Source Material (Including Items: 10.3, Surveys and Monitoring; and 10.4, Radiation Detection Instrument and Instrument Calibration)
- 3.3 NUREG/CR2082 (ORNL/HASRD-95), Monitoring for Compliance With Decommissioning Termination Survey Criteria
- 3.4 Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of Licenses for Byproduct, Source, or Special Nuclear Material, November 1976
- 3.5 INPO 88-010, Guidelines for Radiological Protection at Nuclear Power Stations

4.0 REQUIREMENTS

4.1 Personnel Requirements

- 4.1.1 A Senior Health Physics (HP) Technician
- 4.1.2 A Junior HP Technician under instruction of a Senior HP Technician

4.2 Material and Equipment

- 4.2.1 Thin window Geiger Mueller (GM) detector count rate instrument
- 4.2.2 Portable alpha count rate instrument
- 4.2.3 Analytical equipment for counting smears

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4.2.4 Smears

4.2.5 Survey Maps

5.0 PRECAUTIONS/LIMITATIONS

5.1 Precautions

- 5.1.1 Contact of an instrument probe with the surface being surveyed can damage or contaminate the probe.
- 5.1.2 Contaminated counting areas can cause cross-contamination of sample material, resulting in inaccurate results. Check counting areas for contamination frequently and decontaminate, if necessary.

5.2 Limitations

- 5.2.1 Counting of smears or direct frisking using a GM pancake probe for releasing material must be performed in a background of 300 counts per minute (cpm), or less.
- 5.2.2 Direct frisking only determines the presence of contamination. Smears must be used to determine if it is fixed or removable.
- 5.2.3 Determination of alpha contamination levels by the use of a beta-gamma survey instrument may only be allowed when an equivalence has been established between the uranium contamination concentration and the beta-gamma count rate. Such an equivalence must be documented and approved by the HP Supervisor.

6.0 PREREQUISITES

Appropriate instrument checks have been performed:

- · Battery check has been performed
- Calibration is current
- · Daily source check has been performed

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7.0 INSTRUCTIONS

Instructions are contained in this section for releasing material and equipment from two types of areas: posted contaminated areas, and posted RCAs. The extent of the survey required to be performed is commensurate with the potential for contamination being present. Subsection 7.1, Release From Contaminated Areas, provides instructions for the performance and documentation of a detailed internal and external survey for alpha, beta, and gamma contamination. Subsection 7.2, Release From RCAs, provides instructions for the performance of a secondary survey to ensure no contamination is released from the work site.

NOTE: Material and equipment with potentially contaminated internal surfaces (e.g., pipes, hoses, ducts, and drums) are to be surveyed in accordance with Subsection 7.1.

7.1 Release From Contaminated Areas

When releasing equipment and material from posted contaminated areas, both internal and external surfaces shall be surveyed. Pipes, hoses and ducts shall have internal contamination measured at accessible ends and traps. Any pipe, hose, or duct of a diameter that is unable to be surveyed shall be treated as contaminated.

NOTE: For the purpesses of this section, contamination levels should be recorded as dpm/100 cm². Results of smears taken on objects with a surface area of less than 100 cm² (e.g., screw driver) should be recorded as dpm/object.

- 7.1.1 Determine average beta-gamma and alpha contamination levels.
 - a. Perform live direct readings over a surface area of approximately one square meter (e.g. four at the corners and one in the middle). Survey suspect areas such as a truck's floor board or the tracks of a back hoe.
 - For objects of greater surface area than one square meter, all surfaces that have been in contact with known or suspected contaminated surfaces shall be surveyed. Approximately one third of other surface areas shall be surveyed.
 - For objects of less surface area, the average should be derived for each such object.
 - Document area surveyed and average beta-gamma and alpha contamination levels on a Release Survey Record (Attachment 1).

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7.1.2 Determine the maximum beta-gamma and alpha contamination levels.

- a.. Perform a direct frisk of the areas surveyed in Step 7.1.1.
- Document maximum beta-gamma and alpha contamination levels on Attachment 1.
- 7.1.3 Determine the removable beta-gamma and alpha contamination levels.
 - a. Perform a smear over the areas where the maximum contamination levels were detected in Step 7.1.2.
 - Document maximum beta-gamma and alpha contamination levels on Attachment 1.
- 7.1.4 Any equipment or material having contamination levels equal to or greater than the following shall be treated as contaminated and not released for unconditional use:
 - a. Average Contamination: 5000 dpm a/100 cm² 5000 dpm By/100 cm²
 - b. <u>Maximum</u> Contamination: 15000 dpm α/100 cm² 15000 dpm βy/100 cm²
 - c. <u>Removable</u> Contamination: 1000 dpm cv/100 cm² 1000 dpm By/100 cm²

7.2 Release From RCAs

Material being released from an RCA shall be surveyed to ensure no contamination is inadvertently released from the work area. Such surveys are not required to be documented; however, detection of any contamination greater than the release criteria shall result in the performance of a documented survey.

- 7.2.1 Determine the maximum beta-gamma and alpha contamination levels. Survey suspect areas such as a truck's floor board or the tracks of a back hoe.
- 7.2.2 Determine the removable beta-gamma and alpha contamination levels.
- 7.2.3 Any equipment or material having contamination levels equal to or greater than the appropriate levels specified in Step 7.1.4 shall be treated as contaminated and not released for unconditional use.

7.3 Release Survey Records

- 7.3.1 The following minimum data shall be recorded for all surveys:
 - a. Description of material or equipment
 - b. Surfaces surveyed (a sketch of the item with survey points designated)
 - c. Average, maximum, and removable contamination levels
 - d. Name of surveyor and date of survey

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	 e. Survey instrument type, model number, f. Equivalency between uranium contamin beta-gamma count rate (if used) 	, and calibration date nation concentration and the					
7.	3.2 All Survey Records shall be turned over to I BP Chemical's requirements at close of pro-	BP Chemical in accordan ject.	ce with				

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APPENDIX L

GUIDELINES FOR DECONTAMINATION OF FACILITIES AND EQUIPMENT PRIOR TO RELEASE FOR UNRESTRICTED USE OR TERMINATION OF LICENSES FOR BYPRODUCT, SOURCE, OR SPECIAL NUCLEAR MATERIAL

APPENDIX L

GUIDELINES FOR DECONTAMINATION OF FACILITIES AND EQUIPMENT PRIOR TO RELEASE FOR UNRESTRICTED USE OR TERMINATION OF LICENSES FOR BYPRODUCT, SOURCE, OR SPECIAL NUCLEAR MATERIAL

The instructions in this guide, in conjunction with Table 1, specify the radionuclides and radiation exposure rate limits which should be used in decontamination and survey of surfaces or premises and equipment prior to abandonment or release for unrestricted use. The limits in Table 1 do not apply to premises, equipment, or scrap containing induced radioactivity for which the radiological considerations pertinent to their use may be different. The release of such facilities or items from regulatory control is considered on a case-by-case basis.

- 1. The licensee shall make a reasonable effort to eliminate residual contamination.
- 2. Radioactivity on equipment or surfaces shall not be covered by paint, plating, or other covering material unless contamination levels, as determined by a survey and documented, are below the limits specified in Table 1 prior to the application of the covering. A reasonable effort must be made to minimize the contamination prior to use of any covering.
- 3. The radioactivity on the interior surfaces of pipes, drain lines, or ductwork shall be determined by making measurements at all traps, and other appropriate access points, provided that contamination at there locations is likely to be 'epresentative of contamination on the interior of the pipes, drain lines, or ductwork. Surfaces of premises, equipment, or scrap which are likely to be contaminated but are of such size, construction, or location as to make the surface inaccessible for purposes of measurement shall be presumed to be contaminated in excess of the limits.
- 4. Upon request, the Commission may authorize a licensee to relinquish possession or control of premises, equipment, or scrap having surfaces contaminated with materials in excess of the limits specified. This may include, but would not be limited to, special circumstances such as razing of buildings, transfer to premises to another organization continuing with radioactive materials, or conversation of facilities to a long-term storage or standby statue. Such request must:





- a. Provide detailed, specific information describing the premises, equipment or scrap, radioactive contaminants, and the nature, extent, and degree of residual surface contamination.
- b. Provide a detailed health and safety analysis which reflects that the residual amounts of materials on surface areas, together with other considerations such as prospective use of the premises, equipment, or scrap, are unlikely to result in an unreasonable risk to the health and safety of the public.
- 5. Prior to release of premises for unrestricted use, the licensee shall make a comprehensive radiation survey which establishes that contamination is within the limits specified in Table 1. A copy of the survey report shall be filed with the Division of Fuel Cycle, Medical, Academic, and Commercial Use Safety, U. S. Nuclear Regulatory Commission, Washington, DC 20555, and also the Administrator of the NRC Regional Office having jurisdiction. The report should be filed at least 30 days prior to the planned date of abandonment. The survey report shall:
 - a. Identify the premises.
 - b. Show that reasonable effort has been made to eliminate residual contamination.
 - c. Describe the scope of the survey and general procedures followed.
 - d. State the findings of the survey in units specified in the instruction.

Following review of the report, the NRC will consider visiting the facilities to confirm the survey.





		TA	BLE 1			
ACCEPTABL	E	SURFACE	CONT	AMINA	TION	LEVELS

U-nat, U-235, U-238, and associated decay products	5,000 dpm a/100 cm ²	15,000 dpm a/100 cm²	1,000 dpm a/100 cm ²
Transuranics, Ra-226, Ra-228, Ra-230, Th-228, Pa-231, I-227, I-125, I-129	100 dpm/100 cm ²	300 dpm/100 cm ²	20 dpm/100 cm ²
Th-nat, Th-232, Sr-90, Ra-223, Ra-224, U-232, I-126, I-131, I- 133	1000 dpm/100 cm²	3000 dpm/100 cm ²	200 dpm/100 cm ²
beta-gamma emitters (nuclides with decay modes other than alpha emission or spontaneous emission) except Sr-90 and			
others noted above	5000 dpm by/100 cm ²	15,000 dpm by/100 cm ²	1000 dpm by/100 cm ²

There surface contamination by both alpha- and beta-gamma-emitting nuclides exists, the limits established for alpha- and beta-gamma-emitting nuclides should apply independently.

As used in this table, dpm (disintegrations per minute) means the rate of emission by radioactive material as determined by correcting the amounts per minute observed by an appropriate detector for background, efficiency, and geometric factors associated with the instrumentation.

Measurements of average contaminant should not be averaged over more than 1 square meter. For objects of less surface area, the average should be derived for each such object.

The maximum contamination level applies to an area of not more than 100 cm².

The amount of removable radioactive material per 100 cm² of surface area should be determined by wiping that area with dry filter of soft absorbent paper, applying moderate pressure, and assessing the amount of radioactive material on the wipe with an appropriate instrument of known efficiency. When removable contamination on objects of less surface area is determined, the pertinent levels should be reduced proportionally and the entire surface should be wiped.

The average and maximum radiation levels associated with surface contamination resulting from beta-gamma emitters should not exceed 0.2 mrad/hr at 1 cm and 1.0 mrad/hr at 1 cm, respectively, measured through not more than 7 milligrams per square centimeter of total absorber.

APPENDIX M MONITORING FOR PERSONAL CONTAMINATION

APPENDIX M

MONITORING FOR PERSONAL CONTAMINATION

1.0 PURPOSE

- 1.1 This procedure describes personnel contamination monitoring and describes actions to be taken upon detecting contamination during frisking.
- 2.0 APPLICABILITY, SCOPE
- 2.1 This procedure applies to all personnel working within the Radiologically Controlled Area (RCA).
- 3.0 DEFINITIONS
- 3.1 Contaminated Individual The term assigned to an individual who is found to be externally contaminated as indicated by a pancake probe frisk of >100 net cpm, B-r or >20 net cpm.
- 3.2 Whole Body Frisk The term assigned to the personnel survey technique used to qualitatively and quantitatively establish the presence of external personnel contamination. A whole body frisk is a complete frisk of the individual with a pancake type survey instrument.
- 4.0 POLICY

None

5.0 PREREQUISITES

None

6.0 PRECAUTIONS

None

- 7.0 PROCEDURE
- 7.1 Radiological Control Technicians will conspicuously place monitoring equipment at strategic locations adjacent to Radiologically Controlled Areas.

NOTE:

This equipment can be, but is not limited to, friskers, portable survey meters and portal monitors. The location of this equipment will vary depending upon radiological conditions and the potential for radioactive contamination. All personnel will use these instruments as they are encountered.

- 7.1.1 It is the responsibility of all individuals to perform a complete Whole Body Frisk in accordance with this procedure when leaving a posted contamination area or whenever directed to do so by Radiological Controls personnel.
- 7.1.2 Whole Body Frisk using the pancake type (Geiger Mueller Tube) probe or alpha scintillation probe as directed by the SSO.
- 7.1.2.1 Upon leaving a contamination control point, proceed to the nearest frisking unit. Ensure the frisker is set on the lowest scale and the background is less than 300 cpm. If you are not sure about the setting or the background reading is questionable, notify Radiological Controls personnel for assistance. Do not touch the instrument until your hands are properly frisked.
- 7.1.2.2 Conduct whole body frisk in accordance with Table 2, "Frisking Instructions and Sequence".
 - NOTE: A proper whole body frisk should take 2-3 minutes. If for any reason a whole body frisk cannot be performed on an individual prior to exiting a Radiologically Controlled Area, that individual shall be considered potentially contaminated until frisking is accomplished.
- 7.1.2.3 While performing the frisk, pay particular attention to facial areas (nostrils, mouth, feet) and contact points (elbows, hips, knees, feet) by pausing at these areas. If you cannot reach all portions of your body ask a fellow worker or Radiological Controls Technician for assistance (ensure the individual frisks his hands prior to touching the probe).
- 7.1.2.4 If the alarm sounds, remain at that point and notify Radiological Controls. If necessary, have another worker notify Radiological Controls.
- 7.1.3 It is the responsibility of Radiological Controls personnel to evaluate personnel frisking operations to ensure established frisking techniques are followed. This responsibility may include:
- 7.1.3.1 Periodically observing personnel frisking operations to ensure compliance with the frisking procedure.
- 7.1.3.2 Perform spot check frisks of individuals. Direct individuals to re-perform improper frisks.
- 7.1.3.3 Periodically check the settings of friskers.

- 7.1.3.4 Assure whole body frisks are conducted in an area where background is less than 300 cpm.
- 7.1.3.5 Assure that frisking station is set up as close to the step-off pad or control point as possible.
- 7.2 Response of Radiological Controls personnel to monitor alarms.
- 7.2.1 Upon notification by a radiation worker that an alarm has sounded, frisk/re-frisk the individual, paying particular attention to the areas in which the instrument has indicated contamination present.
- 7.2.2 If the alarm is valid, measure the contamination as follows:
- 7.2.2.1 Using a frisker, measure the activity and note the approximate area(s) and location(s) of the contamination.
 - NOTE: Ensure that all frisk survey results are logged in net CPM (NCPM) unless otherwise specified and the time of each survey is included on the skin contamination report.
- 7.2.3 When personnel clothing contamination > 100 cpm above background is detected, complete the applicable sections of the Clothing Contamination Report (Form 1). Document the circumstances, decon method, survey results, and disposition of the clothing determined to be contaminated.
- 7.2.4 When skin contamination > 100 cpm above background is detected, complete the applicable sections of the personnel Skin Contamination Report Form (Form 2) and initiate decontamination as follows:
- 7.2.4.1 Table 1 describes basic personnel decontamination methods which may be used if a simple water flush, such as a shower, is not successful in removing the contamination. Other methods may be approved on a case basis by the SSO. These methods are not to be considered as applicable for the decontamination of severely insured or internally-contaminated workers. These workers shall be decontaminated under the direction of qualified medical personnel.

- 7.2.4.2 The decontamination of workers shall be accomplished in progressive steps beginning with a water flush, with an evaluation performed after each step. No decontamination shall be taken to the point of skin abrasion. If skin reddening appears as a result of decontamination efforts, notify the Project Superintendent for evaluation.
- 7.2.4.3 Decontamination of the ears, eyes, and mouth should be limited to water rinses conducted by the individual, for example, while showering. Nasal irrigation should only be used if blowing the nose is not effective and shall only be done by gualified medical personnel.
- 7.2.4.4 Decontamination of minor wounds shall be limits to flushes with water only. Refer further decontamination to qualified medical personnel.
- 7.2.4.5 The psychological well-being of the contaminated worker should always be considered. The unusual nature of ionizing radiation may create apprehension, and occasionally unreasonable tear may accompany contamination. Every effort to reassure the worker and to allay his fears should be made.
- 7.2.4.6 As a guideline, all attempts should be made to reduce levels to less than 100 cpm. If this level cannot be obtained, the SSO or his designed shall be notified.
- 7.2.5 Question the individual to decermine when the contamination may have been received and initiate controls to prevent further contamination until corrective actions have been determined and initiated.
- 7.3 After deconcomination the worker shall report to the SSO with the Skin Contamination Report. Review the results of decontamination report and Bio Assay Results (if applicable) with the SSO and sign the Skin Contamination Report.
 - NOTE: Where inhalation, ingestion, or absorption through the skin is suspected, the worker will provide a urine sample as required by the Project Superintendent.

7.4 The SSO shall review the incident to determine the cause of the decontamination and provide recommendations to prevent recurrence.

- NOTE: Notification of SSO is not necessary if contamination levels are less than 5,000 dpm and there is no personal injury associated with the contamination. For any other incidents, the OSSO is to use his own discretion if notification of the above is necessary.
- 7.5 The SSO shall review the Skin Contamination Report and attach comments if necessary.
- 7.6 The Project Superintendent shall evaluate the Skin Contamination Report and calculate a skin dose using MIRD/11, ORNL/5000 or equivalent methods. (Use 10 cm2 as the minimum area to calculate a skin dose from the contamination.)
- 8.0 RESPONSIBILITIES
- 8.1 Project Superintendent shall:
- 8.1.1 Review all Personnel Skin Contamination Reports.
- 8.1.2 Review all instances where skin contamination levels cannot be reduced to less than 100 cpm.
- 8.1.3 Perform skin dose calculations for all skin contaminations.
- 8.1.4 Review all Personnel Contamination Reports.
- 8.2 Radiological Controls Technicians shall:
- 8.2.1 Evaluate personnel frisking operations.
- 8.2.2 Provide required information for personnel contamination reports.
- 8.2.3 Perform personnel decontamination in accordance with Paragraph 7.2.3 and Table 1.
- 8.3 All site Personnel shall frisk in accordance with Paragraph 7.1.2.
- 9.0 REFERENCES
- 9.1 Establishing and Posting Radiologically Controlled Areas.
- 9.2 Radiological Surveys
- 9.3 Radiation Protection Policy
- 9.4 MIRD 11

9.5 ORNL 5000

10.0 ATTACHMENTS

10.1 Table 1 Table of Skin Decontamination Methods

- 10.2 Table 2 Frisking Instructions and Sequences
- 10.3 Form 3 Clothing Contamination Report (Example)
- 10.4 Form 4 Personnel Contamination Report Form





TABLE 1

TABLE OF SKIN DECONTAMINATION METHODS

Method	Administrating Person	Effective for	Instructions
Masking Tape	RC Technician	Visible Particulate	Apply tape to skin by light patting. Remove carefully.
Waterless Hand Cleaner	RC Technician	All Skin Contamination	Apply to affected area and allow it to melt onto skin. Remove with cotton or soft disposable towel.
Soap and Tepid Water	RC Technician	All Skin Contamination	Wash area with low alkaline, non-abrasive soap and tepid water. Repeat until further attempts do not reduce the level. A surgical hand brush may be used with moderate pressure.
Commeal Detergent Paste	RC Technician	All Skin Contamination	Mix commeal and powder detergent in equal parts with enough water to form a paste. Put onto affected area for five (5) minutes. Remove with cotton or disposable towel. Rinse skin.
Shampoo	RC Technician	Hair Contamination	Wash hair and rinse. Repeat a necessary. Remove any hair that cannot be decontaminated. DO NOT SHAVE HAIR. Cu hair as close to the skin as possible with scissors.







Table 1 (Con't)

Nose Blowing Blow nose into a rag, tissue, Individual Nasal Contamination kim wipe, etc. Monitor tissue after attempt. Stop when no increase in activity is noted. Titanium Dioxide Paste Medical Personnel Fission Product Contamination Form a paste of Titanium Dioxide powder and water. Apply small amounts of water to paste to keep it moist while massaging it onto area. Continue massage for five (5) minutes. Remove paste with cotton. Rinse thoroughly with lukewarm water followed by a wash with soap and water. EDTA Cream* Medical Personnel Fission Produce Contamination Mix a cream consisting of 1% EDTA, 3% powered detergent, 8% Carboxy-Methyl-Cellulose, and 8% distilled water. Scrub area with cream. Remove with cotton.





Table 1 (Con't)

Potassium

Medical

Alpha

saturated solution of Potassium Permanganate (6.4 grams) (KMn04/100 ml water) with 1% Sulfuric Acid solution (0.2N). Pour this solution over WET contaminated areas. Rub lightly for several minutes with surgical hand brush. Rinse with tepid water to remove the resulting brown stain. Pour a freshly prepared 5% Sodium Bisulfite solution (10g NaHS03/200 ml water). Rinse with tepid water and scrub lightly for several minutes. This procedure may be repeated several times without harm. Limit washing to two minutes each.

Mix an equal volume of a

* NOTE: Do not use EDTA on Halogens such as I-131 contamination.

TABLE 2

FRISKING INSTRUCTIONS AND SEQUENCES

IMPORTANT

- A. Verify frisker is on X1 scale.
- B. Hold probe approximately 1/2" from surface being surveyed and move probes slowly (2-3 inches/second).
- C. If background count increases to greater than 100 counts above background, remain in area and notify Radiological Controls Technician.
- D. A minimum two-minute frisk is required.

PERFORM SURVEY AS FOLLOWS:

- 1. Survey hands before picking up probe.
- 2. Depress button on timer to start.
- 3. Proceed to survey in following order:
 - a. Head (pause at mouth and nose; if wearing hard hat, remove it, frisk inside and out, then frisk head).
 - b. Neck and shoulders.
 - c. Arms (pause at each elbow).
 - d. Chest and abdomen, including TLD and pocket dosimeter.
 - e. Back, hips and seat of pants.
 - f. Legs (pause at each knee).
 - g. Shoe tops.
 - h. Shoe bottoms (pause at sole and heel). If exiting from RCA, step across line into uncontrolled area as the bottom of each foot is completed.
- Timer will sound buzzer at each of two minutes. Complete frisking carefully, return probe to holder, recheck each hand, then leave area.

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APPENDIX E

PROJECT QUALITY ASSURANCE AND QUALITY CONTROL PLAN

1.0 INTRODUCTION

- 2.0 SOIL SAMPLING QUALITY ASSURANCE PROJECT PLAN
- 3.0 GROUNDWATER MONITORING QUALITY ASSURANCE PROJECT PLAN
- 4.0 SOLIDIFICATION/STABILIZATION
- 5.0 COMPACTED CLAY LAYERS
- 6.0 GEOMEMBRANE LINER INSTALLATION
- 7.0 LEAK DETECTION AND LEACHATE COLLECTION SYSTEMS
- 8.0 FINAL COVER SYSTEMS
- 9.0 DOCUMENTATION
- 10.0 LABORATORY GA/GC PLAN

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1.0 INTRODUCTION



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1.0 INTRODUCTION

1.1 GENERAL

The purpose of this Quality Assurance/Quality Control (QA/QC) Plan is to provide QA and QC procedures for activities associated with the closure of four surface impoundments at BP Chemicals, Inc. (BP) in Lima, Ohio. This QA/QC Plan is to be used in conjunction with the "Closure Plan - Mixed Waste Pond Closure Project," BP Chemicals, Lima, Ohio (June 12, 1991).

The contents of this document include the following:

- Quality Assurance Project Plan for Soil Sampling (Section 2);
- Quality Assurance Project Plan for Groundwater Monitoring (Section 3);
- QA procedures for Sludge stabilization/solidification (Section 4);
- QA procedures for construction of the closure cell components (Sections 5-8);
- Documentation protocols (Section 9).

The term quality control is defined as a system to measure and/or regulate the properties or characteristics of an item or service to assure that a defined set of standards are met. The term quality assurance is defined as a method or an organized system in which managing personnel can monitor activities to assure that the quality control program is properly implemented and that quality standards are met.

1.2 CONSTRUCTION QUALITY ASSURANCE ORGANIZATION

The construction quality quality assurance organization for the project is illustrated on Figure 1-1. Construction quality assurance will be provided by the inspection personnel of BP Chemical's construction department with direction from the Engineer in conjuction with the closure certification process. The BP personnel assigned to this project as inspectors will be qualified by training and experienced to inspect this type of work. The Engineer or the Engineer's designated representative will provide project specific training for BP Chemical inspection personnel prior to or during the startup of each quality related aspect of the project. During critical phases of the project the Engineer of his designated representative will be on the site on a fulltime basis. The BP inspector will complete the various checklists needed to document quality of the construction performed. These forms are provided in this document.

The BP inspection personnel will have stop work authority in the event that a quality related deficiency will be covered or otherwise built into the project.

The Engineer's designated representative will be an employee of the Engineer's firm who possesses the training and experience necessary to review the aspect of the work he is at the site to observe. The designated representative will be working under the responsible charge of the Engineer. In addition to training BP inspection personnel, the Engineer or his designated representative will review the inspection work of the BP personnel assigned to the project and assure that corrective action is taken if necessary.

All construction documentation prepared by BP inspection personnel will be reviewed and approved by the Engineer or his designated representative.



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1.3 PROJECT MEETINGS

1.3.1 Pre Construction Meeting

Prior to the start of construction a meeting will be held to work out operational details. A portion of this meeting will be devoted to Quality Assurance issues. This agenda will include:

Assuring that all parties have appropriate quality assurance documents and are aware of the quality assurance protocols for the project.

Reviewing responsibilities and lines of authority for each organization involved in the project.

Reviewing documentation, reporting and document handling protocols.

Reviewing protocols for managing and documenting deficiencies, repairs and corrective action.

1.3.2 Daily Progress Meetings

Each day, there will be a daily progress meeting to discuss ongoing and planned activities. The lead BP inspector will participate in this meeting as follows:

Identify the contractor's work plans for the day to assure that adequate inspection coverage will be available.

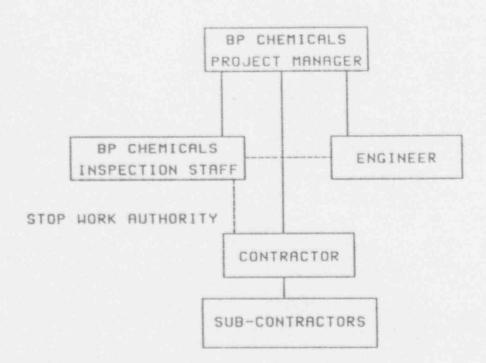
Review previous days activities and close out deficiencies previously identified.

Review contractor's planned work activities for the next five days forward to arrange for adequate inspection staff.





FIGURE 1-1 -- PROJECT QUALITY ASSURANCE ORGANIZATION









2.0 QUALITY ASSURANCE PROJECT PLAN

SOIL SAMPLING

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2.0 SOIL SAMPLING QUALITY ASSURANCE PROJECT PLAN

2.1 INTRODUCTION

This Quality Assurance Project Plan (QAPjP) presents the policies, organization, objectives, functional activities, and specific quality assurance (QA) and quality control (QC) activities to ensure that data of known quality is generated in the conduct of soil sampling and analyses for the Mixed Waste Pond Closure Project at the BP Chemical, Inc. Lima, Ohio facility. The QAPjP is intended to ensure that all technical data generated are sufficiently accurate, precise and representative to support the intended use of the data.

QC consists of a system of checks on field sampling and laboratory analysis (through the use of field blanks, duplicates, documentation of all sample movement, chain of custody records, etc.) to provide supporting information on the quality of the methods employed and on the data. QA consists of overview checking to certify that the QC procedures have been properly implemented to produce accurate data. QA is in general a supervisory function. All QA/QC procedures will accord with applicable technical standards, government regulations and guidelines, and specific project goals and requirements. This QAPjP is prepared in accordance with all OEPA and USEPA guidance documents and incorporates relevant provisions of HASL-300.

The QAPjP presents QA/QC provisions applicable to the following activities:

- · Sample collection, control, chain-of-custody, and analysis;
- Document control;
- · General laboratory instrumentation, analysis, and control; and
- · Review of project reports.

Specific laboratory QA, instrumentation and control protocols are found in the Laboratory's Quality Assurance Project Plan (LQAPiP) which is incorporated into this document by reference.

2.2 PROJECT DESCRIPTION

Soil sampling will be conducted as part of a mixed waste pond closure project at BP Chemical, Inc.'s Lima facility. Four surface impoundments at the facility – Burn, Deepwell, Celite and V-1 impoundments-- will be closed. Specific closure activities are described in detail in BP Chemical's "Closure Plan, Mixed Waste Pond Closure Project, BP Chemicals, Inc., Lima, Ohio, June 12, 1991."

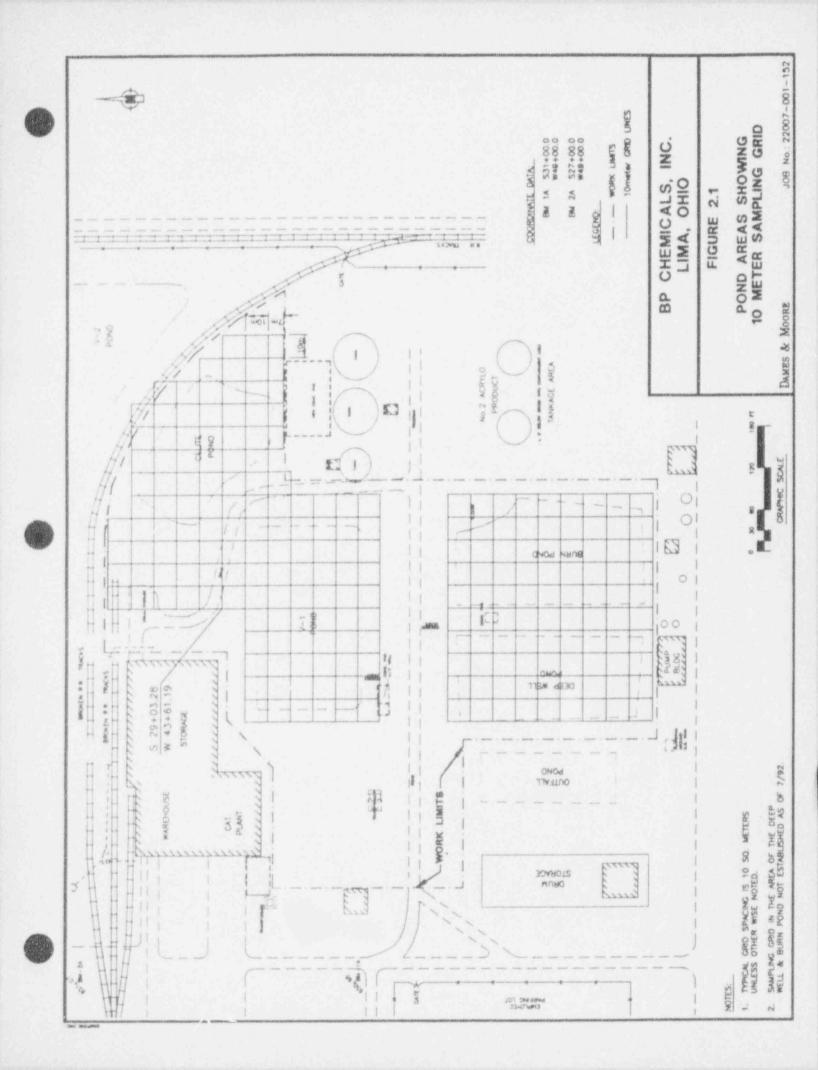
2.2.1 SITE DESCRIPTION

The four surface impoundments to be closed are located on BP Chemical property in Lima. Ohio and are shown on Figure 2-1. Descriptions of the impoundments can be found in the Closure Plan referenced above.

2.2.2 SITE BACKGROUND

Until mid-1988, the Burn, Deepwell, and Celite Ponds managed acrylonitrile acetonitrile and catalyst-process waste waters which resulted in pond sludges containing the EPA-listed wastes K011, K013, and K014, as well as low levels of depleted uranium. The V-1 Pond was used to manage caustic waste waters and was found to contain low levels of depleted uranium. The sludges in all four ponds are classified as radioactive mixed waste.

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As described in the Closure Plan, the sludges in the four surface impoundments will be excavated and treated, and the underlying soils will be sampled and analyzed for target parameters (discussed in Section 2.2.3). In order to minimize the post-closure footprint of the ponds, the sludges and contaminated soils from the four ponds will be consolidated into two ponds.

The closure cells will be located in the area now occupied by the Celite and V-1 ponds. Excavation of the soil in the Celite and V-1 ponds will be conducted until contaminated soil is removed. If this is not practical, a risk assessment will be performed to determine if constituents in the soil may be safely left in place. A risk assessment will determine if leaving the soils in place represents a potential threat to human health and the environment. The risk assessment will be performed in accordance with OEPA's "Closure Plan Review Guidance." The excavation will be kept open until such time as OEPA has reviewed the findings of the risk assessment. Due to the possible presence of radioactive constituents in the soil, Oak Ridge Associated Universities must conduct a survey of the pond bottoms to determine if they are suitable for license termination and unrestricted release.

The Deepwell and Burn ponds will be clean closed, if clean closure is found to be technically feasible. Feasibility will be determined after sludge removal, when it is possible to sample the underlying soil. The objective of clean closure of the Burn and Deepwell ponds is to remove contaminated soils until the concentrations of all of the hazardous constituents in the ponds are below acceptable "clean levels" (i.e. either background levels or method detection limits as defined in the Closure Plan). Similar to the Celite and V-1 ponds, Oak Ridge Associated Universities must conduct a survey of the pond bottoms to determine if they are suitable for license termination and unrestricted release.

This risk assessment will be prepared following receipt of the analytical results so that the potential risks associated with the constituents may be estimated individually and in combination. However, the framework for the assessment will be prepared in advance. This schedule will prevent delay of closure activities.

The excavated sludges will be stabilized with cement admixtures before being placed in the closure cells to provide stability and to bind up the contaminants. The stabilization will be done in a temporary processing plant constructed on-site and will be in accordance with laboratory-tested solidification agents-sludge mix design specifications.

Liquids removed from the ponds during closure operations will be disposed of as hazardous waste in accordance with currently permitted practices at the BP Chemicals, Inc. facility.

The closure cells will be constructed in accordance with the requirements of RCRA section 3004(o). The cells will have a dual liner system, a leachate collection system, and a leak detection system below the stabilized sludges and contaminated soil. The cells will be covered with a cap that conforms to RCRA requirements and includes drainage layers, a compacted clay barrier layer, and synthetic membrane liners. Storm water control will be provided during closure operations and the closure period.

Because depleted uranium (U^{200}) has a very long half-life, a pathway analysis was performed. The analysis assumed that institutional control of the site had ceased, the stability and recognizability of the waste form was lost, and all barriers constructed above and below the sludges had disintegrated. The results of this analysis indicated that the dose that would be received by the hypothetical maximally exposed individual, an intruder, would be a fraction of normal background exposure in the area.

After closure is completed, the closure cells will be monitored and maintained, as required, by BP Chemicals, Inc. The closure cell design is such that active maintenance will not be required. Post-closure monitoring will consist of groundwater monitoring, which has already been instituted for the area beneath and around the ponds. The groundwater monitoring program currently in place at BP consists of two upgradient wells and nine downgradient wells. The wells screen the uppermost aquifer in the bedrock and range in depth from 51.3 ft. to 72.1 ft. There will also be periodic inspections of various design features of the closed facility.

2.2.3 TESTING AND SAMPLING

In order to estimate the extent of the contamination in the soil in the four impoundment areas, soil sampling and analyses will be performed. Samples will be taken of the soil using split spoon samplers from each impoundment area after the sludges have been removed, and the underlying clay has been exposed. The excavated area will be surveyed for radiological contamination, and the samples will be screened in the field for organic contamination. The specific sequence and procedures followed are summarized in Section 2.5 "Sampling Procedures" below, and in detail in the Closure Plan.

Samples will be analyzed for the following parameters:

- Volatile organics acetone, acetonitrile, acrylonitrile, trichloroethylene, 1,1-dichloroethane, vinyl chloride, 1,1-dichloroethylene, methyl ethyl ketone, tetrachloroethylene, 1,1,1-trichloroethane and bromomethane;
- · Semi-volatile organics methyl naphthalene and pyridine;
- RCRA total metals arsenic, barium, cadmium, chromium, lead, mercury, selenium, and silver;
- · Cyanide; and
- Radioactivity (U²³⁸).

The analytical results of this effort will be compared to "clean" soil levels as specified in the project Closure Plan (concentration limits and/or as estimated through a health based risk assessment). If the results indicate higher concentrations then those established for the clean levels then additional samples below the 2-foot interval will be taken in the respective areas. Additional samples will be obtained and analyzed in this manner until acceptable contaminant concentration levels are reached. Refer to Section 2.5.1 "Sampling Protocols" for more detailed information on the sampling procedures.

Numerous quality assurance checks will be performed on the sample analysis. They involve the preparation of field and laboratory blanks and duplicates. The specific frequency of blanks and duplicate sample analysis varies from one in ten, to one in twenty, depending on the parameter and method.

It is anticipated that the sampling and analytical work for this project will take from eight to sixteen weeks spread out over three to six months. This timing depends on the timing of the completion of the waste excavation effort preceding it.

2.2.4 PROJECT SCHEDULE

A detailed project schedule is included in the Closure Plan.

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2.3 PROJECT ORGANIZATION AND RESPONSIBILITY

This QAPjP provides for designated QA personnel to review products and provide guidance on QA matters. This QAPjP also outlines the approach to be followed to ensure that products of sufficient quality are obtained. Figure 2-2 illustrates the QA program organization. This structure will provide for direct and constant operational responsibility, clear lines of authority, and the integration of QA activities. The various QA functions are explained below.

2.3.1 PROJECT DIRECTOR

The project director will have overall responsibility for ensuring that the project meets BP's objectives and quality standards. In addition, he will be responsible for technical quality control and project oversight, and will provide the project manager with access to BP management.

2.3.2 PROJECT MANAGER

The project manager will be responsible for implementing the project and will have the authority to commit the resources necessary to meet project objectives and requirements. The project manager's primary function is to ensure that technical, financial, and scheduling objectives are achieved successfully. The project manager will report directly to BP Project Director, and will provide the major point of contact and control for matters concerning the project. The project manager will:

- · Define project objectives and develop a detailed work plan and schedule;
- Establish project policy and procedures to address the specific needs of the project as a whole, as well as the objectives of each task;
- Acquire and apply technical and corporate resources as needed to ensure performance schedule constraints;
- Orient all team leaders and support staff concerning the project's special considerations;
- · Monitor and direct the team leaders;
- Develop and meet ongoing project and/or task staffing requirements, including mechanisms to review and evaluate each task product;
- · Review the work performed on each task to ensure its quality, responsiveness, and timeliness;
- Review and analyze overall task performance with respect to planned requirements and authorizations;
- · Approve all external reports (deliverables) before their submission to BP;
- Ultimately be responsible for the preparation and quality of interim and final reports; and
- · Represent the project team at meetings and publy carings.



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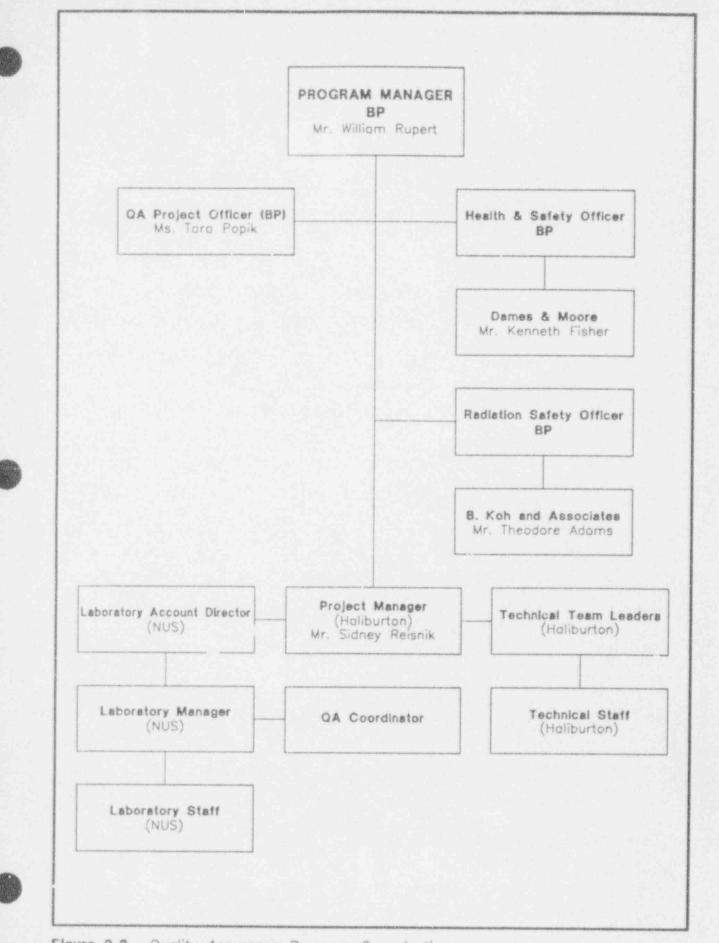


Figure 2-2 Quality Assurance Program Organization

2.3.3 TEAM LEADERS

The project manager will be supported by a team leader or leaders who will be responsible for leading and coordinating the day-to-day activities of the various resource specialists under their supervision. The team leader is a highly experienced environmental professional who will report directly to the project manager. Specific team ' responsibilities include:

- Provide of day-to-day coordination with the project manager on technical issues in specific areas of expertise;
- Development and implementation of team-related work plans, assurance of schedule compliance, and adherence to management-developed study requirements;
- Coordination and it of team staff;
- · Implementation of QC for technical data provided by the team staff;
- · Adherence to work schedules provided by the project manager;
- * Authorship, review, and approval of text and graphics required for team efforts;
- · Coordination of technical efforts of subcontractors assisting the team;
- Identification of p. ins at the team level, discussion of resolutions with the project manager, and
 provision of communication between team and upper management; and
- · Participation in preparation of the final report.

2.3.4 TECHNICAL STAFF

The technical staff (team members) for this project will be drawn from corporate resources. The technical team staff will be utilized to gather and analyze data, and to prepare various task reports and support materials. All of the designated technical team members will be experienced professionals who possess the degree of specialization and technical competence required to effectively and efficiently perform the required work.

2.3.5 QA PROJECT OFFICER

The QA project officer will be responsible for maintaining QA for the BP pond closure project. Specific functions and duties include:

- · Providing an external, and thereby independent, QA function;
- Coordinating with BP officers, the project manager, contractor laboratory management and staff to
 ensure that QA objectives appropriate to the project are set, and that personnel are aware of these
 objectives;
- Coordinating with laboratory management and personnel to ensure that QC procedures appropriate to demonstrating data validity and sufficient to meet QA objectives are developed and in place;



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- Coordinating with laboratory QA personnel to ensure that QC procedures are followed and documented;
- · Requiring and/or reviewing actions taken in the event of QC failures; and
- Reporting non-conformance with QC criteria or QA objectives, including an assessment of the impact on data quality or project objectives, to the project manager.

2.3.6 LABORATORY ACCOUNT EXECUTIVE

The laboratory director will be responsible for all analytical work and will work in conjunction with the QA unit. He will maintain liaison with the QA officer regarding QA and custody requirements. Specific duties include:

- Maintaining indexed master copies of all laboratory project records and final reports, listing for each
 project the equipment used, instrument methods, nature of project, date project was initiated, current
 status, name of sponsor, name of project manager, and status of final report;
- · Maintaining copies of the methods and safety manual;
- Maintaining written status reports on the project, noting any problems, recommendations, and corrective actions taken; and
- · Requiring that all final reports be reviewed for accuracy.

2.3.7 LABORATORY MANAGER

The laboratory manager will maintain liaison with the laboratory director regarding QA elements of specific sample analyses tasks. He will report to the laboratory director and work in conjunction with the QA unit. Specific duties include:

- · Developing the project-specific protocols in coordination with the laboratory director;
- · Ensuring that personnel clearly understand their required tasks;
- · Ensuring that the study is carried out in accordance with the protocol;
- · Ensuring that all project QA/QC methods are followed;
- · Ensuring that all data generated during a project are accurately recorded and verified;
- Ensuring that any problems reported during the monitoring of a project by the QA unit are reported to the QA director and that corrective actions are taken and documented; and
- Ensuring that the study protocol, as well as the final report and all the supporting raw data, are transferred to suitable archives upon completion of the study.



2.3.8 QA COORDINATOR

The Laboratory QA officer will be responsible for overseeing the QA program within the laboratory and for maintaining all QC documentation. He will report directly to the laboratory director. Specific duties include:

- · Conducting independent QA review of laboratory data:
- · Reviewing all QC procedures, documentation, and corrective actions;
- · Reporting QA/QC problems to laboratory and corporate management;
- · Maintaining standard operating procedures and laboratory QA/QC manual; and
- · Conducting internal laboratory performance audits.

2.3.9 LABORATORY STAFF

Each member of the laboratory staff will perform an assigned QA or analytical function that is pertinent to and within the scope of his or her knowledge, experience, training, and aptitude. An individual will be assigned the responsibility for checking, reviewing, or otherwise verifying that a sample analysis activity has been correctly performed.

2.3.10 LABORATORY FACILITIES

The laboratory will have capabilities to handle mixed waste and will be staffed by full-time scientists and technicians.

All laboratory work will be performed in accordance with applicable guidelines established by the NRC, OEPA, and USEPA. When approved protocols do not exist, the laboratory staff will develop and validate appropriate analytical methods. In addition, QA and QC programs will be maintained for the instruments and the analytical procedures used. Refer to the Project Laboratory QAPjP for a listing and description of these procedures.

The laboratory will be equipped with state-of-the-art instrumentation for the analyses of soil samples. There will be sufficient back-up instrumentation to prevent exceeding sample holding times in the event of instrumentation failure.

The laboratory will be fully equipped for analysis of all types of water and soil samples for chemical contaminants and general characterization. Proven and approved analytical techniques will be used, backed by a rigorous system of QC and QA checks to ensure reliable and defensible data.

Organic analysis will be accomplished by GC and/or GC/MS. For the extraction of samples, the laboratory will utilize separatory funnel and sonication methods routinely and Soxhlet and continuous extraction methods when necessary.



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The laboratory may use two types of instruments for analysis of metals in various matrices: AAS and ICP. The various AAS techniques include application of flame, furnace, cold vapor, and hydride generation procedures. During sample preparation and analysis, laboratory staff should be especially careful to avoid the matrix interference effects to which the analysis of solid samples (soil, sediment, and sludge) for trace metals is particularly susceptible. Check standards (either USEPA-provided or National Technical Institute of Standards [NTIS]-traceable) will be used with each set of prepared samples.

Other instruments in the laboratory should include a total organic carbon analyzer, specific ion electrodes (fluoride, cyanide, nitrate, ammonia), spectrophotometers and basic items such as pH and conductivity meters. Other equipment necessary for analyses as required by this QAPjP will be available within the laboratory as applicable.

2.4 QA OBJECTIVES FOR MEASUREMENT DATA

The characteristics of major importance for the assessment of generated data are accuracy, precision, completeness, representativeness, and comparability. These characteristics are defined below.

2.4.1 ACCURACY

Accuracy is the digree of agreement of a measurement or average of measurements with an accepted reference or "true" value and is a measure of bias in the system.

Analytical accuracy may be expressed as the percent recovery of an analyte which has been added to the environmental sample at a known concentration before analysis. The equation used to calculate percent recovery is found in Section 2.13.1.1.

Accuracy of a particular analysis is measured by assessing its performance with "known" samples. These "knowns" can take the form of EPA or NTIS traceable standards (usually spiked into a pure water matrix), or laboratory prepared solutions of target analytes into a pure water of sample matrix; or (in the case of GC or GC/MS analyses) solutions of surrogate compounds which can be spiked into every sample and are designed to mimic the behavior of target analytes without interfering with their determination. In each case the recovery of the analyte is measured as a percentage, corrected for analytes known to be present in the original sample if necessary, as in the case of a matrix spike analysis. For EPA or NTIS supplied known solutions, this recovery is compared to the published data that accompany the solution. For prepared solutions and surrogate compounds, the recovery is compared to EPA-developed data or laboratory-specific control limits as available. Refer to the Laboratory QAPjP for procedures and data used in surrogate compound recovery comparisons.

If recoveries do not meet required criteria, then the analytical data for the batch (or, in the case of surrogate compounds, for the individual sample) are considered potentially inaccurate. The analyst or his supervisor must initiate an investigation of the cause of the problem and take corrective action. This can include re-calibration of the instrument, reanalysis of the QC sample, reanalysis of the samples in the batch, or flagging the data as suspect if the problems cannot be resolved. As a rule, analyses are not corrected for recovery of matrix spike or surrogate compounds.

The accuracy of simple, yet fundamental field analysis is difficult to assess quantitatively. Sampling accuracy can be maximized, however, by adoption and adherence to a strict QA program. Specifically, all procedures will be documented as standard protocol and all equipment and instrumentation will be properly calibrated and

well maintained. Trip blanks, ambient condition blanks (field blanks) and equipment decontamination washes will be associated with all field samples in order to assess representativeness and potential cross contamination. In addition to equipment operation and standard operating procedures, a high level of accuracy will be maintained by thorough and frequent review of field procedures. In this manner, any deficiencies will be quickly documented and corrected.

2.4.2 PRECISION

Precision is defined as the degree of mutual agreement among multiple measures of the same condition under similar circumstances. However, one must differentiate between analytical precision and total system precision. Analytical precision may entail an examination of the agreement of multiple points in a calibration curve (linearity). This is measured either as a correlation coefficient and as percent relative standard deviation (%RSD). Specific acceptance criteria can be found in the Laboratory QAPjP under "Calibration".

Precision, as a measure of the reproducibility of an analytical result, is assessed through the use of duplicate sample analyses or matrix spike duplicate analyses. A relative percent difference (RPD) is calculated and the RPD must be less than a method specific value for the results to be considered precise. Specific acceptance criteria can be found in the Laboratory QAPjP.

Total system precision is assessed through the review of field duplicate data. RPDs are calculated and the results compared to the following control limits: for water samples RPD <50%, for solids samples RPD <100%. If these criteria are met the data are considered to be reasonably representative of actual field conditions.

2.4.3 COMPLETENESS

Completeness is a measure of the amount of valid data obtained from a measurement system compared to the amount expected to be obtained under correct normal conditions. Completeness is expressed as the percentage of valid data obtained from a measurement system.

Field sampling conditions are often unpredictable and non-uniform. However, the objective of the field sampling program is to obtain samples for analyses required at each individual site, provide sufficient sample material to complete those analyses, and to produce QC samples that represent all possible contamination situations, i.e., contamination during sample collection, transportation and storage.

The overall data quality objective for completeness during this investigation is 95 percent because all data points are considered critical to this investigation.

2.4.4 REPRESENTATIVENESS

Representativeness expresses the degree to which data accurately and precisely represent a characteristic of a population, parameter variations at a sampling point, a process condition, or an environmental condition.

The characteristic of representativeness is not quantifiable. Subjective factors to be taken into account are as follows:

• The degree of homogeneity of a site;



- · The degree of homogeneity of a sample taken from one point in a site; and
- * The available information on which a sampling pizn is based.

To maximize representativeness of results, sampling techniques and sample locations will be carefully chosen so that they provide laboratory samples representative of the site and the specific area. Within the laboratory, precautions at a taken to extract from the sample bottle an aliquot representative of the whole sample. This includes premixing the sample and discarding pebbles from soil samples.

2.4.5 COMPARABILITY

Comparability expresses the confidence with which one data set can be compared to another. Comparability is assured through the consistent use of sampling and analytical standard operating procedures and the consistent use of units of measure throughout the sampling and analysis program.

2.4.6 GOALS

The quality control samples that will be collected in the field are as follows: one duplicate sample per day or for every 20 samples for organic, uranium, pH and cyanide analysis (or for every 10 samples analyzed for metals), whichever is greater; one equipment blank per day and when moving from area of high contaminant concentration to an area of low concentration; one trip blank per day (for organics only); and one field (ambient) blank sample per day or for every 20 samples, whichever is greater. Numerical goals for QA objectives for the soil sampling program are listed in Table 2-1. Sample results will be reported on a dry weight basis, along with moisture content of the sample.

Target values for method detection limits are included in Section 2.8, Analytical Procedures. Note that tabulated values are not always attainable. Instances may arise where high sample concentrations, nonhomogeneity of samples, or matrix interferences preclude achievement of target detection limits or other quality control criteria. In such instances the contractor will report reasons for deviations from these detection limits or noncompliance with quality control criteria. If method detection limits need to be defined, they will be done so in accordance with Section 2.8.

2.5 SAMPLING PROCEDURES

Because mixed waste contaminants may be present, the soil in the four ponds will be sampled and analyzed for both radiological and chemical parameters. The Burn and Deepwell Ponds are planned for clean closure and are therefore subject to the clean closure standards for both radiological and chemical parameters. The soil in the Celite and V-1 Ponds must meet the criteria for clean closure for radiological parameters before liner systems are installed; however, chemical contaminants that exceed clean closure standards may be left in place providing that they would not affect groundwater quality.

present

The sequence of sampling events is tabulated below. Sampling for chemical contamination will proceed the radiological sampling. However, as required by the Contractors Health, Safety and Radiation Control Plan, a gamma survey will be performed before and during the chemical sampling effort. Each event is described in detail in the following discussion.



TABLE 2-1

PROJECT PRECISION, ACCURACY AND COMPLETENESS GOALS

Method	Analyte	Precision (%RPD)	Accuracy (% LCS Rec)	Completeness (% Valid Data)
EPA 3050 and 6010/7000 series	Total Metals	25%	**	95%
SW-846, 8240/8030 8270	Volatile Organics: Semi-volatile Organics	30%	**	95%
ORAU Procedures; Section 16 (or equal)	Radioactivity	30%	**	95%
CLP SOW IMP 02.1	Total Cyanide	30%	••	95%

RPD = Relative percent difference

LCS Rec = Laboratory control standard recovery ** = 70 - 130% unless control limits specified in Table 1-9

SAMPLING EVENTS

SAMPLING EVENT	DESCRIPTION	EXCAVATION	
Chemical Sampling	Two 2 ft. split-spoon samples collected from every other 10m x 10m grid intersection	14m radial area around identified chemical hot spot is excavated	
Phase I Radiological	Walkover gamma survey	Areas with elevated readings are identified (i.e. above background). Phase II ceases when sampling shows levels lower than three times the guidance value of 35 pCi/g (105 pCi/g)	
Phase II Radiological	Sampling (to depth of 6 in.) and analysis for U-238 at hot spots identified in Phase I	7m radial area around identified radiological hot spots are excavated	
Phase III Radiological	Systematic sampling-5 samples (to a depth of 6 in.) collected from within each $10m \times 10m$ grid etc.	Excavation in areas where appropriate; re-sampling,	
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2.5.1 SAMPLING PROTOCOLS

2.5.1.1 Chemical Soil Sampling

To identify and define the horizontal extent of the chemical contamination, the chemical sampling plan will be a systematic plan conducted on the 10m x 10m grid system. Sample locations will be on every other grid intersection or 20m apart. Samples will also be collected from all areas that a visual inspection of the pond bottom suggests may contain contamination.

Figure 2-1 shows the 10m x 10m grid overlay for each pond. It is estimated that the following number of samples will be collected from each pond:

Pond	Approximate Number of Samples
Burn Pond	15
Deepwell	15
Celite	18
V-1	15

To identify and define the vertical extent of the chemical contamination samples will initially be collected to a depth of 4 feet in 2-foot intervals using 2-inch or 3-inch diameter, stainless steel core sampler. Each 2-foot core sample will be separated into two 1-foot samples that will be placed in glass sample containers. The two 1-foot samples from the top 2 feet of soil will initially be sent to the laboratory for analysis. The remaining samples (samples collected at depths from 2 to 4 feet) will be properly labeled and preserved. It is anticipated that the surface where the sampling is conducted may be smeared with small amounts of waste sludge deposited by the wheels or tracks of equipment. Consequently, the top 1 inch of the surface will be scraped prior to sampling in order to prevent false positive test results. Smears and tracks will be identified visually and removed after the underlying soil is determined to be representative of target values.

To identify samples with high levels of contamination in the field, the first sample jar filled at a sample location will be screened with an on-site gas chromatograph. The results will be noted and recorded in the field log book.

The soil samples will be analyzed for the following indicator parameters: volatile organics, semi-volatile organics, total cyanide, RCRA total metals and radiological parameters (see Table 2-2). Holding times will be measured from the date of collection.

If laboratory analysis of the first set of samples (i.e. samples from 0-1 feet and 1-2 feet) show the concentrations of indicator parameters in excess of "clean levels," the results may be reevaluated using a health risk assessment model to determine whether the existing levels present a health risk. If the risk assessment model determines that there is no health risk posed by the levels of contaminants in place, clean closure activities will be considered complete. If the results of the risk assessment model determine that the levels of contaminants are unacceptable, the second set of samples (i.e., the 2-4 foot depth samples already collected) will be analyzed by the laboratory. The process (i.e., laboratory analysis and risk assessment) will be repeated for this second set of samples. If it is determined that levels of contaminants are unacceptable in the last set of samples, it will be necessary to excavate the hot spot(s) (described below) and to re-sample.



TABLE 2-2

METHODS, SAMPLES CONTAINERS, PRESERVATION METHODS AND HOLDING TIMES FOR RADIOLOGICAL AND CHEMICAL SOIL ANALYSIS

Analyte	Method [*]	Estimated Method Detection Limit (mg/kg) ^b	Preservation/ Holding Time	Container
total cyanide	9010	0.5	4°C/14 days	4 oz. plastic or glass jar
organics				
acetonitrile	8240B	0.1	4°C/14 days	4 oz. wide-mouth
acrylonitrile	8030A	0.09		glass bottle, Teflon-
1,1,1-trichloroethane	8240	5		lined cap
methyl ethyl ketone	8240	100		
acetone	8240	100		
1,1-dichloroethylene	8240	5		
pyridine	8270	5		
methyl naphthalene	8270	10		
trichloroethylene	8240	50		
bromomethane	8240	10		
tetrachloroethylene	8240	5		
1.1-dichlorethane	8240	5		
vinyl chloride	8240	10		
Total Metals	3050 and			
arsenic	7060A	2	4° C/6 months	8 oz. wide-mouth
barium	6010A	40	4° C/6 months	glass or plastic
cadmium	6010A	1.1.1.1.1.1.1.1.1.1	4° C/6 months	bottle
chromium	6010A	2	4° C/6 months	
lead	7421	1	4° C/6 months	
mercury	7470A	2	4° C/28 days	
selenium	7740	1	4° C/6 months	
silver	6010A	2	4° C/6 months	
Uranium-238;	ORAU	*:	none	l kg plastic bottle
Radium-226;	Procedures			
	Sections 5,			
	15 and 16			

⁴ Analysis methods (except those for radioactivity) are from U.S. EPA's SW-846, <u>Test Methods of Evaluating</u> Solid Waste, Third Edition, November 1990.

^b Elevated detection limits may result from matrix interferences.

^c Lower level detection limits are background levels and are site specific.

Soil removal will be done in the hot spot areas to the depths identified by the analysis of the first 4 feet of soil. The size of the hot spot is calculated according to EPA's "Methods for Evaluating the Attainment of Cleanup Standards - Volume 1: Soils and Sludges."

The hot spot calculations depend on three parameters. Two of the parameters are chosen and fixed and the third is determined by the choice of the first two factors. The three parameters are:

- · grid pattern and spacing;
- · hot spot shape and size; and
- · false positive rate.

A 20m grid spacing (determined as described above) and a 5% false positive rate (i.e. chance of missing a hot spot if a hot spot is present) are the two fixed factors. If it is assumed that the hot spot is circular, the hot spot area is calculated to have a radius of 14m.

After the hot spot area(s) are excavated, another round of samples will be collected. This additional sampling will consist of one 2-foot split spoon collected at each sampling location. The sampling points will be located on the original 10m x 10m grid; however, the sample locations will be shifted 10m down and 10m over from the original locations (i.e. the samples will be taken diagonally across from the locations of the first two sets of samples).

Once the chemical sampling analysis results are below chemical clean level standards or the risk assessment model determines the levels to be safe, the area will be considered suitable for clean closure.

2.5.1.2 Radiological Soil Sampling

Sampling methods to be utilized are taken from <u>Laboratory Procedures Manual for the Environmental Survey</u> and <u>Site Assessment Program</u>, latest Edition, C.F. Weaver, M.J. Lauderman, and S. Shanmugan, for Oak Ridge Associated Universities, Oak Ridge, Tennessee (ORAU); and <u>Manual for Conducting Radiological</u> Surveys in Support of License Termination, J.D. Berger, 1992 (NUREG/CR-5849).

Radiological soil sampling will be carried out in three phases: Phase I will consist of a radiological soil survey and identification of hot spot areas; Phase II will consist of soil sampling and radiological analysis for tranum 238 (112) and excavation, as necessary; and Phase III will involve the collection of final clearance samples. The radiological sampling plan will be a systematic sampling plan conducted on a 10m x 10m grid system.

Phase I of the radiological sampling plan will consist of a walkover gamma survey (i.e. over the entire surface area). The gamma survey will be performed with an appropriately shielded, $2^* \times 2^*$, sodium iodine (NaI) detector with an accompanying ratemeter (e.g., Eberline ESP-2 with SPA scintillation probe or equivalent) to locate elevated readings (i.e. readings above background). The results will be logged on a survey map containing the 10m x 10m grid lines so that exact locations of elevated readings can be properly documented. At this time, areas exhibiting elevated readings (i.e. "hot spots") will be identified.



Phase II will consist of selected surface soil sampling. Grab samples of approximately 1 kg (i.e. within 6 inches of the surface) will be collected from those areas that showed elevated readings identified during the Phase I radiological survey. In the absence of hot spots, one sample may be collected from within each grid area.

Results of these laboratory measurements will identify soil contaminated with greater than 35 pCi/gm of depleted uranium, the recommended maximum concentration for unrestricted release permitted under disposal option 1 (as defined in the Nuclear Regulatory Commission's document, "SECY 81-576").

A 7-meter radial area around these contaminated spots (i.e., hot spots) will be excavated before Phase III begins. The methodology to derive the 7-meter radial hot spot area is presented in the EPA publication, "Methods for Evaluating the Attainment of Clean-up Standards - Volume 1: Soils and Solid Media," (PB89-234959). Hot spot calculations depend on three parameters. Two of the parameters are chosen and fixed and the third is determined by the choice of the first two factors. The three parameters are:

- grid spacing (G);
- hot spot shape and size (L represents the radius for a circular hot spot); and
- false positive rate (∞).

The two fixed factors are the grid spacing and the false positive rate (i.e., chance of missing a hot spot if a hot spot is present). Table A.11 (PB89 - 234959), provides a tabulation of false positive rates for elliptical shaped hot spots based on:

- 1. grid pattern (square or triangular).
- 2. L/G; the ratio of the longer diameter of the elliptical shaped hot spot (L) to the grid spacing (G).
- 3. ES; the elliptical shape factor, defined as S/L the ratio of the shorter diameter (S) to the longer diameter (L) of the elliptical shaped hot spot.

Using:

- 1. square grid pattern
- 2. S = L for a circle, therefore ES = 1.0
- 3. a false positive rate of 5 % (0.05), when compared to the values for these rates given in the table it is very close to 0 % (0.00).

Gives an estimated L/G ratio of 0.7, and since:

G = 10 then L = 0.7 (10) = 7 meters

From Table A.11, using a false positive rate of 5 percent and a square grid pattern with 10-meter spacing result in a hot spot with a radius of 7 meters.

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To confirm that the hot spot material was contained within and removed from the excavated area, a minimum of four soil samples will be collected from within the excavation. Typically, one sample will be taken from the location of the original sample (center of the hot spot), and three will be taken at a radius of 3 to 4-meters from the original location. The samples will also be located so as to be equidistant from each other (plus or minus 2-feet). For sufficiently large hot spots where the excavation area is larger than defined by a 7-meter radius circle, the confirmation samples will be taken at the nodes created from overlaying a 5 by 5-meter grid on the original area.

Soil samples will be analyzed for depleted uranium using methods outlined in the Laboratory Procedures Manual for the ORAU Environmental Survey and Site Assessment Program, Latest Edition: Sections 5 and 16. Approximately 10% of the samples will be collected as quality assurance/quality control (QA/QC) samples. Several of these samples will also be submitted to an independent radiological laboratory to develop correlations between gamma spectroscopy analysis, laboratory gamma spectroscopy cross check results, and radiochemical isotopic uranium analysis.

Remediation of the hot spot areas will continue until all the soil sample results are less than three times the guidance value of 35 pCi/gm (105 pCi/gm). Once this has been achieved, then Phase III Radiological sampling activities will commence.

The results of the hot spet evaluation and remediation will be included in the report submitted to the Nuclear Regulatory Commission outlining the results of the project sampling effort. The report will include sample locations, results, and quantities of material removed.

Phase III will consist of a systematic sampling design for surface soils at the site and will follow clearance sampling/analysis and excavation to remove any chemical contamination.

As specified in the NRC Technical Branch Position, SECY 81, Disposal or On-Site Storage of Thorium or Uranium Wastes from Past Operations, the concentrations of remaining materials shall be sufficiently low so that no individual may receive an external dose in excess of 10 micro-roentgens per hour ($10 \ \mu$ R/hr). To assure that this criteria is satisfied. Phase III will include a gamma exposure rate survey which will be performed in each 10m x 10m grid. The Gamma exposure rates will be measured at 1-meter above the ground surface using a portable rate meter with a gamma scintillation detector (NaI) cross-calibrated with a pressurized ionization chamber. Five measurements will be taken from within each 10m x 10m grid block.

Following a final walkover gamma survey, five surface soil samples of approximately 1 kg (2.54 pounds) each will be collected (within 0.15 m or 6° of the surface) from each 10m x 10m grid square. If no elevated readings are identified within a grid square during the walkover gamma surface survey, surface soil samples will be collected near the corners and the center of each grid. If elevated readings are detected, then a sample of the soil from the area of elevated reading will be collected as part of the five samples per grid area. Samples will be collected using trowels, spoons, or shallow cores (0.6*) and placed into plastic bags that will be appropriately labeled. Proper decontamination practices will be employed to prevent cross contamination of samples (e.g., sampling gloves will be disposed of after the collection of each sample).

The areas of elevated activity used in the evaluation will be defined from four or more soil samples taken from locations surrounding the sample location which exhibited the elevated result. The samples will be taken from locations that are in a rectangular pattern, and will be at a distance no greater than $\frac{1}{2}\sqrt{A}$, where:



 $A = 100 \left(\frac{elevated \ activity \ value}{(35 \ pCi/gm)^2} \right)^2$

If the sample results for a grid fail the test of significance, (calculation 8-13 of Draft NUREG/CR-5849 described below), then further remediation sampling, and evaluation will occur in the area of elevated activity. If the sample results pass the test of significance, then remediation work in the area tested will stop.

2.5.1.3 Evaluation of Phase III Radiological Sample Results

Evaluation of the soil sampling program results will be performed in accordance with Draft NUREG/CR-5849 as follows:

- Section 8.5.2, Comparison with Guideline Values, Elevated Areas of Activity, Calculation 8-10
- Section 8.5.4, Calculating Average Levels, Calculation 8-11
- Section 8.5.5, Comparisons, Calculations 8-12 and 8-13



All of the soil sample results will be compared to the guideline value of 35 pCi/gm. Any sample results exceeding the guideline value by three times (105 pCi/gm) will be treated as a hot spot and result in further remediation sampling and evaluation. Once all of the sample results are below three times the guideline value, then the results of the soil samples collected from each 10m x 10m grid will be tested for statistical significance (per Chapter 8, Sections 8.5.2 and 8.5.5 of Draft NUREG/CR-5849) and compared to the guideline value of 35 pCi/gm.

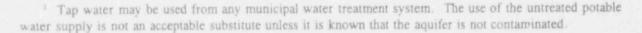
2.5.2 SAMPLE HANDLING

The sample containers, preservation methods, and holding times required for the soil samples are listed in Table 2-2.

2.5.3 EQUIPMENT DECONTAMINATION PROCEDURES

Sampling equipment must be cleaned prior to reuse. The following is the accepted procedure for decontaminating sampling equipment used to collect samples to be evaluated for chemical contamination.

- scrub with tap water¹ and non-phosphate detergent;
- rinse with tap water;
- rinse with 10% HNO₃.



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- rinse with deionized water;
- rinse with hexane;
- rinse with methanol;
- rinse with deionized water (demonstrated analyte-free water);
- air dry; and
- · wrap in aluminum foil.

The following is the accepted procedure for decontaminating sampling equipment used to collect samples to be evaluated for Radiological Contamination:

- scrub with tap water and non-phosphate detergent;
- · rinse with tap water:
- rinse with 10% HNO;;
- rinse with deionized water;
- air dry; and
- wrap in aluminum foil.

2.6 SAMPLE CUSTODY FOR SOIL SAMPLES

2.6.1 FIELD OPERATIONS

This section describes standard operating procedures for sample identification and chain-of-custody to be utilized for all field activities. The purpose of these procedures is to ensure that the quality of the samples is maintained during their collection, transportation, storage and analysis. All chain-of-custody requirements comply with standard operating procedures indicated in USEPA sample-handling protocol.

Sample identification documents must be carefully prepared so that sample identification and chain-of-custody can be maintained and sample disposition controlled. Sample identification documents include:

- Daily logs;
- Sample label;
- Custody seals; and
- Chain-of-custody records.



2.6.1.1 Daily Logs

Daily logs and data forms are necessary to provide sufficient data and observations to enable participants to reconstruct events that occurred during the project. All daily logs will be kept in a bound notebook and consecutively numbered. All entries will be made in waterproof ink, dated, and signed. Sampling data will be recorded in the sampling record. Corrections will be made according to the procedures given at the end of this section.

The Site Log is the responsibility of the site team leader and will include a complete summary of the day's activities at the site.

The sampling record will include:

- Name of person making entry (signature).
- · Names of samplers/title.
- · Levels of personnel protection:
 - Level of protection originally used;
 - Changes in protection, if required; and
 - Reasons for changes.
- · Documentation on samples taken, including:
 - Sampling location and depth station numbers;
 - Sampling date and time, sampling personnel;
 - Type of sample (grab, composite, etc.);
 - Sample matrix; and
 - Preservation.
- · On-site measurement data.
- · Field observations and remarks.
- · Weather conditions, wind direction, etc.
- · Unusual circumstances or difficulties.
- · Initials of person recording the information.

2.6.1.2 Sample Identification

A field coding system will be used to identify each sample obtained during the sampling program. This coding system will provide a tracking record to allow retrieval of information about a particular sample and assure that each sample is properly identified.

Each sample is to be identified by a unique code which will indicate the sample number, sample type, sample point and sequence number. An example of the sample identification code is as follows:

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Sample Identification Code X-YY-(B'-C')-BB

where X is the first letter of the pond name, YY represents sample location as related to the grid system, (B'-C') is the depth below the surface, AAAA represents the analytical parameter, and BB represents sample type (where appropriate).

The pond names represented above by X may be one of the following:

B - Burn Pond C - Celite Pond V - V-1 Pond D - Deepwell Pond

The sequence number YY is used in conjunction with the pond identifier to describe sample location according to the grid (e.g., 7L, 10H, etc).

The analytical parameter codes, AAAA, that may be used are as follows:

VOA - volatile organic analytes SVOA - semi-volatile organic analytes MET - metals CYN - cyanide U238 - uranium-238 R226 - radium-226

Sample type letter-designations that may be used are as follows:

TB - trip blank FB - field blank EB - equipment blank DUP - duplicate sample

Field duplicate samples will have their own sequential numbering system for the YY designator that does not correspond to the site grids (i.e., the first DUP will be 01, second 02, etc.). The corresponding sample member or I.D. will be recorded in the field log book, and this information will not be communicated to the laboratory.

2.6.1.3 Sample Containerization and Labeling

Each sample will be labeled, preserved (as required) and sealed immediately after collection. To minimize handling of sample containers, labels will be filled out prior to sample collection. The sample label will be filled out using waterproof ink and will be firmly affixed to the sample containers. The sample label will give the following information:



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- · Name of sampler,
- · Date and time of collection,
- Sample number, and
- · Analysis required.

2.6.1.4 Field Custody Procedures

The primary objective of the chain-of-custody procedures is to provide an accurate written or computerized record that can be used to trace the possession and handling of a sample from collection to completion of all required analyses. A sample is in custody if it is:

- · In someone's physical possession;
- · In someone's view;
- · Locked up; or
- · Kept in a secured area that is restricted to authorized personnel.

Appropriate field custody procedures include the following:

- · As few persons as possible should handle samples.
- Sample bottles will be obtained precleaned by the laboratory or an approved retail source. Coolers
 or boxes containing cleaned bottles should be sealed with a custody tape seal during transport to the
 field or while in storage prior to use.
- The sample collector is personally responsible for the care and custody of samples collected until they are transferred to another person or dispatched properly under chain-of-custody rules.
- * The sample collector will record sample data in the field log book.
- The site team leader will determine whether proper custody procedures were followed during the field work and decide if additional samples are required.

2.6.1.5 Custody Seals

Custody seals are pre-printed adhesive-backed seals with security slots designed to break if the seals are disturbed. Sample shipping containers (coolers, cardboard boxes, etc., as appropriate) are sealed in as many places as necessary to ensure security. Seals must be signed and dated before use.

2.6.1.6 Chain-of-Custody Record

The chain-of-custody record must be fully completed at least in duplicate by the field technician who has been designated by the project manager as responsible for sample shipment to the appropriate laboratory for analysis. In addition, if samples are known to require rapid turnaround in the laboratory because of project time constraints or analytical concerns (e.g., extraction time or sample retention period limitations, etc.), the person completing the chain-of-custody record should note these constraints in the "Remarks" section of the custody record.

2.6.1.7 Transfer of Custody and Shipment

- The coolers in which the samples are packed must be accompanied by a chain-of-custody record. When transferring samples, the individuals relinquishing and receiving them must sign, date, and note the time on the chain-of-custody record. This record documents sample custody transfer.
- Samples must be dispatched to the laboratory for analysis with a separate chain-of-custody record accompanying each shipment. Shipping containers must be sealed with custody seals for shipment to the laboratory. The method of shipment, name of courier, and other pertinent information are entered in the "Remarks" section of the chain-of-custody record.
- All shipments must be accompanied by the chain-of-custody record identifying their contents. The
 original record accompanies the shipment. The other copies are distributed appropriately to the site
 team leader and project manager.
- If sent by mail, the package is registered with return receipt requested. If sent by common carrier, a bill of lading is used. Freight bills, Postal Service receipts, and bills of lading are retained as part of the permanent documentation. Samples will not be shipped on Friday to insure that there is no chance of samples being held in-route over a weekend.

2.6.1.8 Corrections to Documentation

Notebook:

As with any data logbooks, no pages will be removed for any reason. If corrections are nece these must be made by drawing a single line through the original entry (so that the original entry still be read) and writing the corrected entry alongside. The correction must be initialed and dated. Most corrected errors will require a footnote explaining the correction.

Sampling Forms and Sampling Record:

As previously stated, all sample identification tags, chain-of-kustody records, and other forms must be written in waterproof ink. None of these documents are to be destroyed or thrown away, even if they are illegible or contain inaccuracies that require a replacement document.

If an error is made on a document assigned to one individual, that individual may make corrections simply by crossing a line through the error and entering the corrected information. The incorrect information should not be obliterated. Any subsequent error discovered on a document should be corrected by the person who made the entry. All corrections must be initialed and dated.



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2.6.2 SAMPLE HANDLING, PACKAGING, AND SHIPPING

The transportation and handling of samples must be accomplished in a manner that not only protects the integrity of the sample, but also prevents any detrimental effects due to the possible hazardous nature of samples. Regulations for packaging, marking, labeling, and shipping hazardous materials are promulgated by the United States Department of Transportation (DOT) in 49 CFR 171 through 177.

All chain-of-custody requirements must comply with standard operating procedures in the USEPA sample handling protocol.

2.6.2.1 Sample Packaging

Samples must be packaged carefully to avoid breakage or contamination and must be shipped to the laboratory at proper temperatures. The following sample packaging requirements will be followed:

- · Sample bottle lids must never be mixed. All sample lids must stay with the original containers.
- The sample volume level can be marked by placing the top of the label at the appropriate sample height, or with a grease pencil. This procedure will help the laboratory to determine if any leakage occurred during shipment. The label should not cover any bottle preparation QA/QC lot numbers.
- Shipping coolers must be partially filled with packing materials and ice when required, to prevent the bottles from moving during shipment.
- The sample bottles must be placed in the cooler in such a way as to ensure that they do not touch one another.
- When the environmental samples are to be cooled, the use of "blue ice" or some other artificial icing
 material is preferred. If necessary, ice may be used, provided that it is placed in plastic bags. Ice
 is not to be used as a substitute for packing materials.
- Any remaining space in the cooler should be filled with inert packing material. Under no circumstances should material such as sawdust, sand, etc., be used.
- A duplicate custody record must be placed in a plastic bag and taped to the bottom of the cooler lid. Custody seals are affixed to the sample cooler.

2.6.2.2 Shipping Containers

Environmental samples will be properly packaged and labeled for transport and dispatched to the laboratory. A separate chain-of-custody record must be prepared for each container. The following requirements for shipping containers will be followed.

Shipping containers are to be custody sealed for shipment as appropriate. The container custody seal will consist of filament tape wrapped around the package at least twice and custody seals affixed in such a way that access to the container can be gained only by cutting the filament tape and breaking a seal.

Field personnel will make arrangements for transportation of samples to the laboratory. When custody is relinquished to a shipper, field personnel will telephone the laboratory custodian to inform him of the expected time of arrival of the sample shipment and to advise him of any time constraints on sample analysis. Samples will be retained by the laboratory for 30 days after the final report is submitted.

2.6.2.3 Marking and Labeling

- · Use abbreviations only where specified.
- The words "This End Up" or "This Side Up" must be clearly printed on the top of the outer package. Upward pointing arrows should be placed on the sides of the package. The words "Laboratory Samples" should also be printed on the top of the package.
- After a sample container has been sealed, two chain-of-custody seals will be placed on the container, one on the front and one on the back. The seals are protected from accidental damage by placing strapping tape over them.
- In addition, the coolers must also be labeled and placarded in accordance with DOT regulations if the samples to be shipped represent a medium and high hazard.

2.6.3 LABORATORY OPERATIONS

A designated sample custodian accepts custody of the shipped samples and verifies that the sample identification number matches that on the chain-of-custody (c-o-c) record. Pertinent information as to shipment, pickup, and courier is entered in the "Remarks" section. The custodian then enters the sample identification number and other information into the laboratory sample tracking system. The custodian will then place each sample in the proper secure storage area. When samples are requested by a technician for sample preparation and/or analysis, the custodian will relinquish the samples to the technician using proper logging out procedures. Upon return of the samples, proper logging in procedures will be followed, and the custodian will return the samples to the proper secure storage area.

Upon receipt at the laboratory, the custodian must check that custody seals on boxes are intact. Strapping tape should be placed over the seals to ensure that seals are not accidentally broken during shipment.

2.7 CALIBRATION PROCEDURES AND FREQUENCY FOR INSTRUMENTATION

All instruments and equipment used during laboratory analysis will be operated, calibrated, and maintained according to the manufacturer's guidelines and recommendations as well as criteria set forth in the Laboratory QAPjP. Operation, calibration, and maintenance will be performed by personnel properly trained in these procedures. Documentation of all routine and special maintenance and calibration information will be maintained as outlined in the Laboratory QAPjP and will be available on request.

2.8 ANALYTICAL PROCEDURES

Analytical methods to be utilized for the sampling tasks are referenced in the USEPA document, <u>Test Methods</u> for Evaluating Solid Waste (Physical/Chemical Methods), SW-846, Revised November 1990.

The detection limits and quality control criteria for the analytical program are contained in the Laboratory QAPjP referenced above. Instances may arise where high sample concentrations, non-homogeneity of samples, or matrix interferences preclude achieving the detection limits of associated quality control criteria. In such instances, the reasons for deviations from these detection limits or noncompliance with quality control criteria will be reported, and the method detection limits must be established as specified by the procedures for each parameter (i.e. using a multiplier). If no specific method (or multiplier) is provided, then the laboratory is to submit to BP Chemical's QA project officer for review the lowest obtainable instrument detection limits (IDL's) which will be used as MDL's.

Methodology references contain specific QC criteria associated with the particular methods. These specific requirements include calibration, tuning, and QC samples and are described in detail within the methods. Daily performance tests and demonstration of precision and accuracy are required.

2.9 DATA REDUCTION, VALIDATION, AND REPORTING

QA/QC requirements will be strictly adhered to during sampling and analytical work. All data generated will be reviewed by comparing and interpreting results from chromatograms (responses, stability of retention times), accuracy (mean percent recovery of spiked samples), and precision (reproducibility of results). Refer to the Laboratory QAPjP for a detailed discussion of QA/QC protocol. Data will be reported on a dry weight basis, along with the moisture content of the sample.

All calculations and data manipulations will be included in the appropriate methodology references. Control charts and calibration curves will be used to review the data and identify outlying results. Prior to the submission of the report to the client, all data will be evaluated for precision, accuracy, and completeness. Sections 2.4, 2.8, and 2.13 of this document include some of the QC criteria to be utilized in the data validation process.

Data storage and documentation will be maintained using logbooks and data sheets that will be kept on file. Analytical and field QC will be documented and included in the report. The central file will be maintained for the sampling and analytical effort for a period of five years after the final report is issued.

Complete evaluation of the analytical data requires that the data be reported completely and correctly. An independent data review will be performed as outlined in the Laboratory QAPjP. The following information is required for complete evaluation of the analytical data and will be reported separately:

- · Dates the samples were collected in the field;
- · Extraction and analysis dates for all the samples;
- · Applicable holding times for each analysis; and
- · Analysis dates for laboratory QC samples.

Reports will be reviewed by the laboratory supervisor, the QA officer, laboratory manager and/or director, and the project manager. Analytical reports will contain a data table including results; supporting QC information will also be provided. Raw data will be available for later inspection, if results, and maintained in the control iob file.

2.10 INTERNAL QUALITY CONTROL CHECKS

QC data are necessary to determine precision and accuracy and to demonstrate the absence of interferences and/or contamination of glassware and reagents. Laboratory-based QC will consist of calibration verifications, replicates, spikes, and blanks. Field duplicates and field blanks will be analyzed by the laboratory as samples and will not necessarily be identified to the laboratory as duplicates or blanks.

Calculations will be performed for recoveries and standard deviations along with review of retention times, response factors, chromatograms, calibration, tuning, and all other QC information generated. All QC data, including split samples, will be documented. QC records will be retained and results reported with sample data.

2.10.1 BLANK SAMPLES

Blank samples are analyzed in order to assess possible contamination from the field and/or laboratory so that corrective measures may be taken, if necessary. Blank samples are discussed in the following sub-sections: Field Blanks and Laboratory Blanks.

2.10.1.1 Field Blanks

Various types of blanks are used to check the cleanliness of field handling methods. The following types of blanks may be used: the trip blank, the routine field blank and the field equipment blank. They are analyzed in the laboratory as samples, and their purpose is to assess the sampling and transport procedures as possible sources of sample contamination. Field staff may add blanks if field circumstances are such that they consider normal procedures are not sufficient to prevent or control sample contamination, or at the direction of the project manager. Rigorous documentation of all blanks in the site logbooks is mandatory.

- Trip Blanks are similar to routine field blanks with the exception that they are not exposed to field conditions. Their analytical results give the overall level of contamination from everything except ambient field conditions. Each trip blank will be prepared by filling a 40-ml vial with deionized water prior to the sampling trip, transported to the site, handled like a sample, and returned to the laboratory for analysis without being opened in the field.
- Field Equipment Blanks are blank samples (sometimes called transfer blanks or equipment blanks) designed to demonstrate that sampling equipment has been properly prepared and cleaned before field use, and that cleaning procedures between samples are sufficient to minimize cross contamination.

2.10.1.2 Laboratory Blanks

In addition to field blank samples, three types of blanks routinely analyzed in the laboratory are calibration blanks, method blanks, and reagent blanks. Method blanks and reagent blanks are used to assess laboratory procedures as possible sources of sample contamination.

 Method Blanks are laboratory blanks that correspond to the first step in sample preparation and as such, provide a check on contamination resulting from sample preparation and measurement activities. Method blanks for water and soil samples consist of deionized water and are subjected to the entire sample procedure as appropriate for the analytical method being utilized.



- Reagent/Solvent Blanks are closely related to method blanks, but they do not incorporate all sample
 preparation materials and analytical reagents in one sample. When a method blank reveals
 significant contamination, one or more reagent blanks are prepared and analyzed to identify the
 source of contamination. These reagent blanks are then subjected to the entire sample procedure as
 appropriate for the analytical method being utilized.
- Calibration blanks are employed to verify that the instrument's zero setting has not drifted such that low levels of analytes might be subject to false positives or false negatives.

2.10.2 FIELD DUPLICATES

Field duplicate samples consist of a set of two samples collected independently at a sampling location during a single sampling event. In some instances the field duplicate can be a blind duplicate, i.e., indistinguishable from other analytical samples so that personnel performing the analyses are not able to determine which samples are field duplicates. Field duplicates are designed to assess the consistency of the overall sampling and analytical system.

2.10.3 LABORATORY REPLICATES

Laboratory replicate samples are aliquots of a single sample that is split on arrival at the laboratory or upon analysis. Laboratory replicate samples may be made if no field duplicate samples are provided by the field sampling team; however, their purposes are not always interchangeable. Significant differences between laboratory replicate samples are generally due to analytical technique, whereas significant differences in field duplicate samples may be due to a variety of reasons.

2.10.4 CALIBRATION STANDARDS

A calibration standard is prepared in the laboratory by dissolving a known amount of a pure compound in an appropriate matrix. The final concentration calculated from the known quantities is the true value of the standard. The results obtained from these standards are used to generate a standard curve and thereby quantitate the compound in the environmental sample. A minimum of three calibration standards will be used to generate a standard curve for all analyses.

2.10.5 CHECK STANDARD

A check standard can be prepared in the same manner as a calibration standard or it may be obtained from USEPA. The final concentration calculated from the known quantities is the "true" value of the standard. The important difference in a check standard is that it is not carried through the same process used for the environmental samples, but is analyzed without digestion or extraction. A check standard result is used to validate an existing concentration calibration standard file or calibration curve. The check standard can provide information on the accuracy of the instrumental analytical method independent of various sample matrices.



2.10.6 SPIKE SAMPLE

A sample spike is prepared by adding to an environmental sample (before extraction or digestion), a known amount of pure compound of the same type that is to be assayed for in the environmental sample. These spikes simulate the background and interferences found in the actual samples and the calculated percent recovery of the spike is taken as a measure of the accuracy of the total analytical method. When there is no change in volume due to the spike, it is calculated as follows:

$$\%R = \frac{100 (O-X)}{T}$$

Where: % R = Percent recovery;

O = Measured value of analyte;

X = Measured value of analyte concentration in the sample before the spike is added; and

T = Quantity of added spike.

Tolerance limits for acceptable percent recovery are established in the methodology references and presented in Section 2.10 of this document.

2.10.7 INTERNAL STANDARD

An internal standard is prepared by adding a known amount of pure compound to the environmental sample; the compound selected is not one expected to be found in the sample, but is similar in nature to the compound of interest. Internal standards are added to the environmental sample just prior to analysis. (Note: Internal standards and surrogate spikes are different compounds. The internal standard is for quantification purposes using the relative response factor; surrogate spikes indicate the percent recovery and, therefore, the efficiency of the methodology.)

2.10.8 MATRIX SPIKE/DUPLICATE

Aliquots are made in the laboratory of the same sample and each aliquot is treated exactly the same throughout the analytical method. Spikes are added at approximately 10 times the method detection limit. The relative percent difference (RPD) between the values of the matrix spike and matrix spike duplicate, as calculated below, is taken as a measure of the precision of the analytical method:

$$RPD = \frac{(D_1 - D_2)}{(D_1 + D_2) / 2} \times 100$$

Where: RPD = Relative percent difference;

D₁ = First sample value; and

D₂ = Second sample value (duplicate).

In general, the tolerance limit for RPDs between laboratory duplicates should not exceed 20% for validation in homogeneous inorganic samples. Refer to Section 2.8 for criteria on RPDs.

2.10.9 QUALITY CONTROL CHECK SAMPLES

Inorganic and organic control check samples will be provided by BP and are to be used as a means of evaluating analytical techniques of the analyst.

2.10.10 LABORATORY CONTROL STANDARDS

Laboratory Control Standards (LCS) are aliquots of organic-free or deionized water to which known amounts of analyte have been added. They are subjected to the sample preparation extraction procedure and analyzed as samples. The stock solutions used for LCS are purchased or prepared independently of calibration standards. The LCS recovery tests the function of analytical methods or equipment and are described in more detail in the Laboratory OAPiP.

2.10.11 CONTROL LIMITS

Minimal control limits for each analytical method have been established by the U.S.EPA (SW-846, Third Edition). Refer to the Laboratory QAPjP for the internal quality control procedures for each analytical method to be used for this project.

2.11 PERFORMANCE AND SYSTEM AUDITS

The Project QA/QC Supervisor assigned to the project will conduct periodic audits of the operations at the site to ensure that work is being performed in accordance with the work plan and associated standard operating practice. A checklist appropriate to the activities scheduled during the audit will be used. The audit will cover, but not necessarily be limited to, such areas as:

- · Conformance to standard operating procedures;
- · Completeness and accuracy of documentation;
- · Chain-of-custody procedures;
- · Compliance with the Health and Safety Plan; and
- · Construction specifications.

BP, or its appointed representative, may choose to audit the laboratory. These audits may take the form of Performance Evaluation samples or on-site inspections of the laboratory. Performance evaluation samples may be either blind samples or know to the laboratory. Reasonable notice will be provided if the audit is to include an on-site inspection of the laboratory.

2.12 PREVENTIVE MAINTENANCE

All laboratory and field instruments and equipment used for sample analysis will be maintained and serviced only by qualified personnel. All repairs, adjustments, and calibrations will be documented in an appropriate logbook or data sheet that will be kept on file. A stock of spare parts and consumables for all analytical equipment will be maintained. In addition, a sufficient redundancy of equipment items to allow for a reasonable level of equipment failure should also be maintained.

2.13 PROCEDURES USED TO ASSESS DATA PRECISION, ACCURACY, AND COMPLETENESS

Performance of the following calculations will be documented and included in the QC section.

2.13.1 FORMULAS

2.13.1.1 Accuracy

Accuracy is the difference between an average value and the "true" value when the latter is known or assumed. The term "accuracy" is normally used interchangeably with "percent recovery," and describes either recovery of a known amount of analyte (spike) added to a sample of known value, or recovery of a synthetic standard of known value.

% Recovery (spike) =
$$\frac{SSR - SR}{SA} \times 100$$

Where: SSR = Spike sample results

SR = Sample result

SA = Spike added

$$\& Recovery (standard) = \frac{Observed Value}{True Value} \times 100$$

Note: The units for the concentrations of spikes, samples, and observed and true values vary based on the analysis. However, they are typically $\mu g/L$ or mg/L for water samples and $\mu g/kg$ or mg/kg for soil samples.

Average: The average (or arithmetic mean) of a set of "N" values is the sum of the values divided by "N":

$$X = \frac{\sum_{i=1}^{N} X_i}{N}$$

2.13.1.2 Precision

Relative to the data from a single test procedure, precision is the degree of mutual agreement among individual measurements made under prescribed conditions. An estimate of standard deviation is normally used to describe the precision of a method.

Standard Deviation Estimate: Standard deviation estimate is the most widely used measure to describe the dispersion of a set of data.

Normally, X + SD will include 68%, and X + 2SD will include about 95%, of the data from a study.

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$$(SD) = \frac{\sum_{i=1}^{N} (\bar{X}_i - \bar{X})^2}{N - 1}$$

Relative Standard Deviation (RSD): The estimate of precision of a series of replicate measurements will usually be expressed as the relative standard deviation (RSD):

$$RSD = \frac{SD}{\overline{X}} \times 100$$

Relative Percent Difference (RPD): A measure of the difference between two samples assumed to be identical through dividing (splitting) an original sample, analyzing each portion, identifying the values of the first replicate (X_1) and that of the second replicate (X_2) , and dividing the difference by the mean (X) of X_1 and X_2 .

$$RPD = \frac{X_1 - X_2}{X} \times 100$$

2.13.1.3 Completeness

Completeness is a measure of the amount of valid data obtained from a measurement system compared to the total amount expected to be obtained under normal conditions. The goal of is to achieve 100% completeness, however, a 95% completeness figure is usually required for a particular analysis and overall project objective.

Completeness for each parameter is calculated as:

 $Completeness = \frac{Number of accepted analyses}{Number of requested analyses} \times 100$

2.13.2 CONTROL LIMITS

Control limits are developed by the laboratory based on historical data. Refer to the Laboratory QAPjP for the project control limits.

2.14 CORRECTIVE ACTION

Corrective actions can be initiated as a result of performance and system audits, laboratory and inter-field comparison studies, data validation, and/or a QA program audit. They may also be required as a result of a request from BP. Success or failure of BP-requested corrective actions will be reported to BP with an estimate of the effect on data quality, if any.

Corrective actions may include altering procedures in the field, conducting subsequent audits, or modifying laboratory protocol. Time and type of corrective action, if needed, will depend on the severity of the problem and relative overall project importance. The project manager is responsible for initiating corrective action and the laboratory manager/director or the team leader is responsible for its implementation.

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Precision and accuracy will be regularly tracked by the analytical staff to determine unacceptable results and to evaluate and implement corrective actions. Precision and accuracy criteria for all analyses are listed in Section 2.4 of this QAPjP. Laboratory supervisors and QA/QC staff will evaluate analytical data against the accompanying quality control data for validity. Corrective actions may include, but are not limited to, re-calibration of instruments using freshly prepared calibration standards; replacement of lots of solvent or other reagents that give unacceptable blank values; additional training of laboratory personnel; or reassignment, if necessary. Corrective actions in many cases may have to be defined as the need arises.

If substantial corrective action is required or if serious QA problems are encountered, BP will be notified by phone and in writing as soon as possible. All corrective action will be implemented and documented after notification of BP.

2.15 QUALITY ASSURANCE REPORTS

Upon completion of a project sampling effort, analytical and QC data will be included in a comprehensive report that summarizes the work and provides a data evaluation. A discussion of the validity of the results in the context of QA/QC procedures will be made, as well as a summation of all QA/QC activity.

Serious analytical problems will be reported to BP. Time and type of corrective action, if needed, will depend on the severity of the problem and relative overall project importance. Arective actions may include altering procedures in the field, conducting an audit, or modifying laboratory action. All corrective action will be implemented after notification of BP.





3.0 GROUNDWATER MONITORING

QUALITY ASSURANCE PROJECT PLAN



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3.0 QUALITY ASSURANCE PROJECT PLAN

3.1 INTRODUCTION

This Quality Assurance Project Plan (QAPjP) presents the policies, organization, objectives, functional activities, and specific quality assurance (QA) and quality control (QC) activities to ensure the validity of data generated in the conduct of post-closure groundwater sampling for the mixed waste pond closure project at the BP Chemical, Inc. Lima, Ohio facility. The purpose of the QAPjP is to ensure that all technical data generated are accurate and representative in order to withstand regulatory agency scrutiny.

QC consists of a system of checks on field sampling and laboratory analysis (through the use of field blanks, duplicates, documentation of all sample movement, chain of custody records, etc.) to provide supporting information on the quality of the methods employed and on the data. QA consists of overview checking to certify that the QC procedures have been properly implemented to produce accurate data. QA is in general a supervisory function. All QA/QC procedures will be in accordance with applicable professional technical standards, government regulations and guidelines, and specific project goals and requirements. This QAPjP is "repared in accordance with all OEPA and USEPA guidance documents.

The QAPJP incorporates the following activities:

- Sample collection, control, chain-of-custody, and analysis;
- o Document control;
- o Laboratory instrumentation, analysis, and control; and
- o Review of project reports.

Analytical samples will be collected in the field utilizing the procedures described herein and sent to an appropriately certified laboratory for analysis. Duplicates, replicates, and spiked samples will be used to develop estimates of the quality of the analytical data. Equipment used to take field measurements will be maintained and calibrated in accordance with established procedures. Records of calibration and maintenance will be kept by assigned personnel. Field testing and data acquisition will be performed following strict guidelines as described herein.

Document control procedures will be used to coordinate the distribution, coding, storage, retrieval, and review of all data collected during all sampling tasks.

3.2 PROJECT DESCRIPTION

This QAPjP pertains to the sampling of groundwater in the uppermost aquifer underlying the facility to be conducted during post-closure for the mixed waste pond closure project at BP Chemical, Inc.'s Lima facility. All closure and post-closure activities are described in detail in BP Chemical's "Closure Plan, Mixed Waste Pond Closure Project, BP Chemicals, Inc., Lima, Ohio, June 12, 1991."

The groundwater monitoring system consists of two upgradient wells and nine downgradient wells. Five of the downgradient wells are located immediately adjacent to the Celite and V-1 ponds which will be closed permanently and four of the downgradient wells are located adjacent to the Burn and Deepwell ponds which will be clean closed.

3-1

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3.2.1 SITE DESCRIPTION

The location of the monitoring wells to be sampled are located on BP Chemical property in Lima, Ohio and are shown in Figure 3-1.

3.2.2 SITE BACKGROUND

Until mud-1988, the Burn, Deepwell, and Celite Ponds managed acrylonitrile, acetonitrile and catalystprocess waste waters which resulted in pond sludges containing the EPA-listed wastes K011, K013, and K014, as well as low levels of depleted uranium. The V-1 Pond was used to manage caustic waste waters and was found to contain low levels of depleted uranium. The sludges in all four ponds are classified as radioactive

As described in the Closure Plan, the sludges in the four surface impoundments will be excavated and treated, and the underlying soils will be sampled and analyzed for target parameters (discussed in Section 3.2.3). In order to minimize the post-closure footprint of the ponds, the sludges from the four ponds will be consolidated into two ponds.

The closure cells will be located in the area now occupied by the Celite and V-1 ponds. Excavation of the soil in the Celite and V-1 ponds will be conducted until contaminated soil is removed. If this is not practical, a risk assessment will be performed to determine if constituents in the soil may be safely left in place. The risk assessment will determine if leaving the soils in place represents a potential threat to human health and the environment. The risk assessment will be performed in accordance with OEPA's "Closure Plan Review Guidance.* The excavation will be kept open until such time as OEPA has reviewed the findings of the risk assessment. Due to the possible presence of radioactive constituents in the soil. Oak Ridge Associated Universities must conduct a survey of the pond bottoms to determine if they are suitable for license termination and unrestricted release.

The Deepwell and Burn ponds will be clean closed, if clean closure is found to be technically feasible. Feasibility will be determined after sludge removal, when it is possible to sample the underlying soil. The objective of clean closure of the Burn and Deepwell ponds is to remove contaminated soils until the concentrations of all of the hazardous constituents in the ponds are below acceptable "clean levels" (i.e. either

In the event that further excavation and removal of contaminated soils from the Burn and Deepwell ponds is not practical, an assessment of the potential risk of not removing the additional soil will be performed. The risk assessment will determine if leaving the soils in place represents a potential threat to human health and the environment. The risk assessment will be performed in accordance with OEPA's *Closure Plan Review Guidance". The excavation will be kept open until such time as OEPA has reviewed the findings of the risk assessment. Similar to the Celite and V-1 ponds, Oak Ridge Associated Universities must conduct a survey of the pond bottoms to determine if they are suitable for license termination and unrestricted release.

This risk assessment will be prepared following receipt of the analytical results so that the potential risks associated with the constituents may be estimated individually and in combination. However, the framework for the assessment will be prepared in advance. This schedule will prevent delay of closure activities.

The excavated sludges will be stabilized with cement admixtures before being placed in the closure cells to provide stability and to bind up the contaminants. The stabilization will be done in a temporary processing plant constructed on-site and will be in accordance with laboratory-tested solidification agents-sludge mix design

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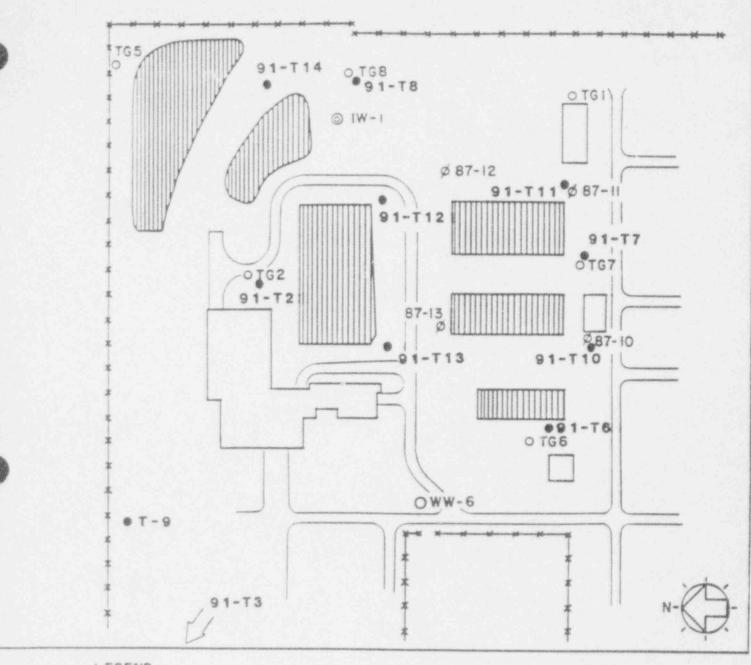
In the event that further excavation and removal of contaminated soils from the Burn and Deepwell ponds is not practical, an assessment of the potential risk of not removing the additional soil will be performed. The risk assessment will determine if leaving the soils in place represents a potential threat to human health and the environment. The risk assessment will be performed in accordance with OEPA's "Closure Plan Review Guidance". The excavation will be kept open until such time as OEPA has reviewed the findings of the risk assessment. Similar to the Celite and V-1 ponds, Oak Ridge Associated Universities must conduct a survey of the pond bottoms to determine if they are suitable for license termination and unrestricted release.

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LEGEND

- O INJECTION WELL
- MONITOR WELL
- O TEST HOLE / WELL
- O WATER WELL
- Ø PLUGGED WELL

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FIGURE 3-1: LOCATION OF EXISTING MONITORING WELLS

Liquids removed from the ponds during closure operations will be disposed of as hazardous waste in accordance with currently permitted practices at the BP Chemicals, Inc. facility.

Because depleted uranium (U^{238}) has a very long half-life, a pathway analysis was performed. The analysis assumed that institutional control of the site had ceased, the stability and recognizability of the waste form was lost, and all barriers constructed above and below the sludges had disintegrated. The results of this analysis indicated that the dose that would be received by the hypothetical maximally exposed individual, an intruder, would be a fraction of normal background exposure in the area.

After closure is completed, the closure cells will be monitored and maintained, as required, by BP Chemicals, Inc. The closure design is such that active maintenance will not be required. Post-closure monitoring will consist of groundwater monitoring, which has already been instituted for the area beneath and around the ponds. The groundwater monitoring program currently in place at BP consists of two upgradient wells and nine downgradient wells. The wells screen the uppermost aquifer in the bedrock and range in depth from 51.3 ft. to 72.1 ft. There will also be periodic inspections of various design features of the closed facility.

3.2.3 TESTING AND SAMPLING

3.2.3.1 Target Compounds

The groundwater from the wells will be analyzed for one year, to re-establish background water quality, for the following parameters:

acetonitrile	endrin
acrylonstrile	lindane
ammonia	methoxychlor
arsenic	toxaphene
banum	2.4-D
cadmium	2.4.5-TP Silvex
chromium	radium
cyanide	gross alpha
fluoride	gross beta
lead	coliform bacteria
mercury	turbidity
nitrate	selenium
silver	sulfide
chloride	iron
manganese	phenols
sodium	sulfate
pН	specific conductance
total organic carbon	total organic halogen
	acrylonitrile ammonia arsenic barium cadmium chromium cyanide fluoride lead mercury nitrate silver chloride manganese sodium

During the first year, four replicate measurements of Group III parameters will be obtained for the upgradient wells. Group I parameters will not be sampled during subsequent years sampling; Group II parameters will be sampled annually and Group III parameters will be taken semi-annually. Four replicate measurements will be taken of all wells during subsequent years and used for statistical comparison.

3.2.4 PROJECT SCOPE AND OBJECTIVES



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The scope of this study is to sample and analyze groundwater in the uppermost aquifer underlying the facility as a check on the integrity of the closure cells.

The objective of this project is to obtain high quality, well documented data to withstand regulatory agency scrutiny.

3.2.5 PROJECT SCHEDULE

The implementation of the groundwater monitoring program is outlined in the schedule shown on Table 3-1.

3.3 PROJECT ORGANIZATION AND RESPONSIBILITY

This QAPjP provides for designated QA personnel to review products and provide guidance on QA matters. This QAPjP also outlines the approach to be followed to ensure that products of sufficient quality are obtained. Figure 3-2 illustrates the QA program organization. This structure will provide for direct and constant operational responsibility, clear lines of authority, and the integration of QA activities. The various QA functions are explained below.

Project Director

The project director will have overall responsibility for ensuring that the project meets BP's objectives and quality standards. In addition, he will be responsible for technical quality control and project oversight, and will provide the project manager with access to BP management.

Project Manager

The project manager will be responsible for implementing the project and will have the authority to commit the resources necessary to meet project objectives and requirements. The project manager's primary function is to ensure that technical, financial, and scheduling objectives are achieved successfully. The project manager will report directly to BP Program Manager, and will provide the major point of contact and control for matters concerning the project. The project manager will:

- o Define project objectives and develop a detailed work plan and schedule;
- Establish project policy and procedures to address the specific needs of the project as a whole, as well as the objectives of each task;
- Acquire and apply technical and corporate resources as needed to ensure performance schedule constraints;
- o Orient all team leaders and support staff concerning the project's special considerations;
- Monitor and direct the team leaders;
- Develop and meet ongoing project and/or task staffing requirements, including mechanisms to review and evaluate each task product;



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TABLE 3-1: PROJECT IMPLEMENTATION SCHEDULE

	1991 1992	1993
Task	Mar. Apr. May Jun. Jul. Aug. Sep. Oct. Nov. Dec. Jan. Feb. Mar. Apr. May Jun. Jul. Aug. Sep. Oct. Nov. D	ec. Jan.
Initial Sampling	x	
first Year Monitoring (Reestablish Background Data)	xx	
Perform Statistical Analysis of Background Data and Report Results		
First Semi-Annual Sampling (Group III)	a x	
Statistical Comparison of Semi-Annual Sampling with Background Data		
First Annual Sampling (Groups II & III)		x
Statistical Comparison of Annual Sampling with Background Data		

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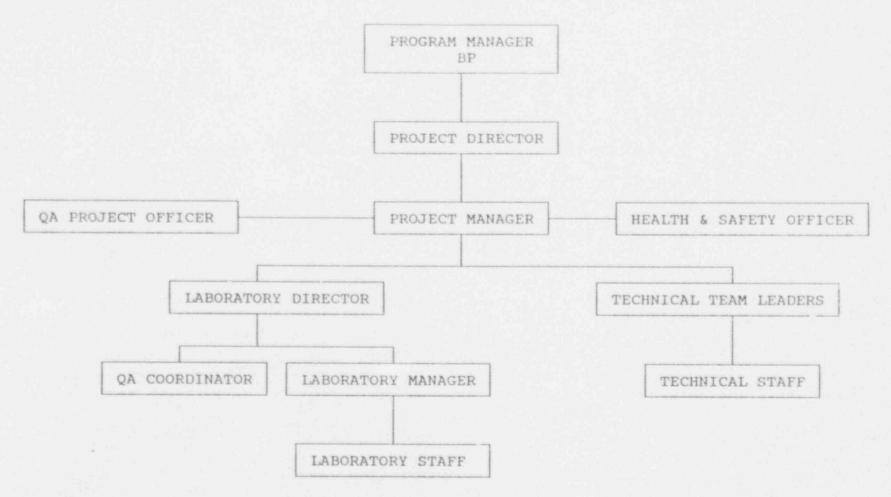






QUALITY ASSURANCE PROGRAM ORGANIZATION

FIGURE 3-2



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- o Review the work performed on each task to ensure its quality, responsiveness, and timeliness:
- Review and analyze overall task performance with respect to planned requirements and authorizations;
- Approve all external reports (deliverables) before their submission to BP;
- o Ultimately be responsible for the preparation and quality of interim and final reports; and
- Represent the project team at meetings and public hearings.

Team Leaders

The project manager will be supported by a team leader or leaders who will be responsible for leading and coordinating the day-to-day activities of the various resource specialists under their supervision. The team leader is a highly experienced environmental professional who will report directly to the project manager. Specific team leader responsibilities include:

- Provision of day-to-day coordination with the project manager on technical issues in specific areas of expertise;
- Development and implementation of team-related work plans, assurance of schedule compliance, and adherence to management-developed study requirements;
- Coordination and management of team staff;
- o Implementation of QC for technical data provided by the team staff;
- Adherence to work schedules provided by the project manager;
- Authorship, review, and approval of text and graphics required for team efforts;
- o Coordination of technical efforts of subcontractors assisting the team;
- Identification of problems at the team level, discussion of resolutions with the project manager, and provision of communication between team and upper management; and
- Participation in preparation of the final report.

Technical Staff

The technical staff (team members) for this project will be drawn from corporate resources. The technical team staff will be utilized to gather and analyze data, and to prepare various task reports and support materials. All of the designated technical team members will be experienced professionals who possess the degree of specialization and technical competence required to effectively and efficiently perform the required work.

QA Project Officer

The QA project officer will be responsible for maintaining QA for the BP pond closure project. Specific functions and duties include:

- o Providing an external, and thereby independent. QA function:
- Coordinating with BP officers, the project manager, contractor laboratory management and staff to
 ensure that QA objectives appropriate to the project are set, and that personnel are aware of these
 objectives;
- Coordinating with laboratory management and personnel to ensure that QC procedures appropriate to demonstrating data validity sufficient to meet QA objectives are developed and in place;
- Coordinating with laboratory QA personnel to ensure that QC procedures are followed and documented;
- Requiring and/or reviewing actions taken in the event of QC failures; and
- Reporting non-conformance with QC criteria or QA objectives, including an assessment of the impact on data quality or project objectives, to the project manager.

Laboratory Director

The laboratory director will be responsible for all analytical work and will work in conjunction with the QA unit. He will maintain liaison with the QA officer regarding QA and custody requirements. Specific duties include:

- Maintaining indexed master copies of all laboratory project records and final reports, listing for each project the equipment used, instrument methods, nature of project, date project was initiated, current status, name of sponsor, name of project manager, and status of final report;
- Maintaining copies of the methods and safety manual;
- Maintaining written status reports on the project, noting any problems, recommendations, and corrective actions taken; and
- Requiring that all final reports be reviewed for accuracy.

Laboratory Manager

The laboratory manager will maintain liaison with the laboratory director regarding QA elements of specific sample analyses tasks. He will report to the laboratory director and work in conjunction with the QA unit. Specific duties include:

- o Developing the project-specific protocols in coordination with the laboratory director;
- Ensuring that personnel clearly understand their required tasks;
- o Ensuring that the study is carried out in accordance with the protocol;
- Ensuring that all project QA/QC methods are followed;



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- o Ensuring that all data generated during a project are accurately recorded and verified;
- Ensuring that any problems reported during the monitoring of a project by the QA unit are reported to the QA director and that corrective actions are taken and documented; and
- Ensuring that the study protocol, as well as the final report and all the supporting raw data, are transferred to suitable archives upon completion of the study.

QA Coordinator

The Laboratory QA officer will be responsible for overseeing the QA program within the laboratory and for maintaining all QC documentation. He will report directly to the laboratory director. Specific duties include:

- o Conducting independent QA review of laboratory data;
- Reviewing all QC procedures, documentation, and corrective actions;
- Reporting QA/QC problems to laboratory and corporate management;
- Maintaining standard operating procedures and laboratory QA/QC manual; and
- Conducting internal laboratory performance audits.

Laboratory Staff

Each member of the laboratory staff will perform an assigned QA or analytical function that is pertinent to and within the scope of his or her knowledge, experience, training, and aptitude. An individual will be assigned the responsibility for checking, reviewing, or otherwise verifying that a sample analysis activity has been correctly performed.

Laboratory Facilities

All laboratory work will be performed in accordance with applicable guidelines established by OEPA and USEPA. In addition, QA and QC programs will be maintained for the instruments and the analytical procedures used.

The laboratory will be equipped with state-of-the-art instrumentation for the analyses of water samples. There will be sufficient back-up instrumentation to prevent exceeding sample holding times in the event of instrumentation failure.

The laboratory will be fully equipped for analysis of all types of water samples for chemical contaminants and general characterization. Proven and approved analytical techniques will be used, backed by a rigorous system of QC and QA checks to ensure reliable and defensible data.

Organic analysis will be accomplished by LC, GC and/or GC/MS. For the extraction of samples, the laboratory will utilize separatory funnel and sonication methods routinely and Soxhlet and continuous extraction methods when necessary.

The laboratory may use two types of instruments for analysis of metals in various matrices: AAS and ICAP. The various AAS techniques include application of flame, furnace, cold vapor, and hydride generation procedures.



Other instruments in the laborato, y should include a total organic carbon analyzer; ion exchange chromatography; specific ion electrodes (fluoride, cyanide, nitrate, ammonia); spectrophotometers; and basic items such as pH and conductivity meters.

3.4 QA OBJECTIVES FOR MEASUREMENT DATA

All measurements will be made to ensure that analytical results are representative of the media and conditions measured. Unless otherwise specified, all data will be calculated and reported in units consistent with other organizations reporting similar data to allow comparability of data bases among organizations. Data will be reported in $\mu g/L$ and mg/L for aqueous samples, or otherwise as applicable.

The characteristics of major importance for the assessment of generated data are accuracy, precision, completeness, representativeness, and comparability. These characteristics are defined below.

3.4.1 DEFINITIONS

The characteristics of major importance for the assessment of generated data are accuracy, precision, completeness, representativeness, and comparability. These characteristics are defined below.

3.4.1.1 Accuracy

Accuracy is the degree of agreement of a measurement or average of measurements with an accepted reference or "true" value and is a measure of bias in the system.

Analytical accuracy may be expressed as the percent recovery of an analyte which has been added to the environmental sample at a known concentration before analysis. For example, accuracy can be determined from the results of matrix spike analyses performed at the rate of one set every 20 samples or one per batch. The equation used to calculate percent recovery is found in Section 3.13.1.2.

Accuracy of a particular analysis is measured by assessing its performance with "known" samples. These "knowns" can take the form of EPA or NTIS traceable standards (usually spiked into a pure water matrix), or laboratory prepared solutions of target analytes into a pure water or sample matrix; or (in the case of GC or GC/MS analyses) solutions of surrogate compounds which can be spiked into every sample and are designed to mimic the behavior of target analytes without interfering with their determination. In each case the recovery of the analyte is measured as a percentage, corrected for analytes known to be present in the original sample if necessary, as in the case of a matrix spike analysis. For EPA or NTIS supplied known solutions, this recovery is compared to the published data that accompany the solution. For prepared solutions, the recovery is compared to EPA-developed data or historical data as available. For surrogate compounds, recoveries are compared to USEPA CLP acceptable recovery tables.

If recoveries do not meet required criteria, then the analytical data for the batch (or, in the case of surrogate compounds, for the individual sample) are considered potentially inaccurate. The analyst or his supervisor must initiate an investigation of the cause of the problem and take corrective action. This can include re-calibration of the instrument, reanalysis of the QC sample, reanalysis of the samples in the batch, or flagging the data as suspect if the problems cannot be resolved. For highly contaminated samples, recovery of matrix spike may depend on sample homogeneity. As a rule, analyses are not corrected for recovery of matrix spike or surrogate compounds.

The accuracy of simple, yet fundamental field analysis is difficult to assess quantitatively. Sampling accuracy can be maximized, however, by adoption and adherence to a strict QA program. Specifically, all procedures will be documented as standard protocol and all equipment and instrumentation will be properly calibrated and well maintained. Trip blanks, ambient condition blanks (field blanks) and equipment



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decontamination washes will be included in all sample batches to ensure all samples represent the particular site from which they were taken and to assess the potential for cross-contamination that may have occurred. In addition to equipment operation and standard operating procedures, a high level of accuracy will be maintained by thorough and frequent review of field procedures. In this manner, any deficiencies will be quickly documented and corrected.

3.4.1.2 Precision

Precision is the degree of mutual agreement among individual measurements of a given parameter. The closer the numerical values of the measurements, the more precise the measurement. The measure used to estimate the precision if a method is the standard error of the estimates for the least square regression line if "measured" versus "target" calculations. The primary role of this application is to characterize the precision of any analytical method under specified conditions. This allows the immediate comparison of precision of different results produced by the same method.

Analytical precision for a single analyte is expressed as a percentage of the difference between duplicate samples and matrix spike duplicates for a given analyte. Relative percent difference is calculated as shown in Section 3.13.1.2.

Precision will be determined through the use of matrix spike duplicates for the analytical work performed. The laboratory will select one sample in 20 (or one per batch) and split the sample into three aliquots. The first aliquot will be analyzed routinely for the parameters of interest, while the other two aliquots will be spiked with known quantities of the parameters of interest prior to analysis. The relative percent difference (RPD) will be calculated and used as an indication of the precision for the analyses performed.

3.4.1.3 Completeness

Completeness is a measure of the amount of valid data obtained from a measurement system compared to the amount expected to be obtained under correct normal conditions. Completeness is expressed as the percentage of valid data obtained from a measurement system. For data to be considered valid, it must meet all the acceptance criteria including accuracy and precision, as well as any other criteria specified by the analytical method used.

Field sampling conditions are often unpredictable and non-uniform. However, the objective of the field sampling program is to obtain samples for analyses required at each individual site, provide sufficient sample material to complete those analyses, and to produce QC samples that represent all possible contamination situations, i.e., contamination during sample collection, transportation and storage.

The overall data quality objective for completeness during this investigation is 100 percent because all data points are considered critical to this investigation.

Samples for which data points fail accuracy, precision, interference, or contamination data quality objectives, will be reanalyzed until the data quality objectives are met. Sufficient sample volume will be collected to ensure that re-analysis can occur as needed.

3.4.1.4 Representativeness

Representativeness expresses the degree to which data accurately and precisely represent a characteristic of a population, parameter variations at a sampling point, a process condition, or an environmental condition.

The characteristic of representativeness is not quantifiable. Subjective factors to be taken into account are as follows:

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- The degree of homogeneity of a site;
- The degree of homogeneity of a sample taken from one point in a site; and
- The available information on which a sampling plan is based.

To maximize representativeness of results, sampling techniques and sample locations will be carefully chosen so that they provide laboratory samples representative of the site and the specific area. Within the laboratory, precautions are taken to extract from the sample bottle an aliquot representative of the whole sample. This includes premixing the sample and discarding pebbles from soil samples.

3.4.1.5 Comparability

Comparability expresses the confidence with which one data set can be compared to another.

3.4.2 GOALS

QA goals provide the mechanism for ongoing control and evaluation of measurement data quality throughout the course of the project and will ultimately be used to define data quality for the various measurement parameters. The QA/QC effort will focus on controlling measurement error within the limits established and will ultimately provide a database for estimating the actual uncertainty in the measurement data.

Target values for detection limit, percent spike recovery and percent "true" value of known check standards, and RPD of duplicates/replicates are included in Section 3.8, Analytical Procedures. Note that tabulated values are not always attainable. Instances may arise where high sample concentrations, nonhomogeneity of samples, or matrix interferences preclude achievement of target detection limit, or other quality control criteria. In such instances the contractor will report reasons for deviations from these detection limits or noncompliance with quality control criteria.

Table 3-2 lists the quality control samples that will be collected in the field. Numerical goals for QA objectives are listed in Tables 3-3 and 3-4.

3.5 SAMPLING PROCEDURES

3.5.1 Sampling Protocol

Measurement of Water Level and Well Volume

The depth to water will be measured in all wells before any purging at the site begins. These should be measured within a 2-hour period to insure that water levels used to determine direction of groundwater flow are not affected by dynamics in the bedrock aquifer. The water level measurement will be made with a calibrated electric tape to the nearest 0.01 foot. The end of the tape will be weighted with a stainless steel rod. The electric tape and attached weight will be thoroughly rinsed three times with commencial distilled water after each well measurement and allowed to air-dry completely before use. Measurements will be taken with a Solinst electric tape dedicated to the monitor wells.

The top of the 2-inch casing inside the guard pipe will be always used as the reference measuring point. These measurements will be recorded on a purge volume calculation sheet (discussed in Section 3.6.1.2) and compared to previous measurements for abnormalities.







TABLE 3-2 NUMBER OF GA/OC SAMPLES

Analysis	Duplicate/Replicate	Irip Blank	Equipment Blank
VoC	one duplicate/event	one per day/cooler	none (if using dedicated equipment, otherwise 1/event)
phenols	one duplicate/event	na	none (if using dedicated equipment, otherwise 1/event)
ТОХ	four replicates/event	na	none (if using dedicated equipment, otherwise 1/event)
pesticides, herbicides	one duplicate/event	na	none (if using dedicated equipment, otherwise 1/event)
coliform bacteria	one duplicate/event	na	<pre>none (if using dedicated equipment, otherwise 1/event)</pre>
cyanide	one duplicate/event	na	none (if using dedicated equipment, otherwise 1/event)
radiological	one duplicate/event	na	none (if using dedicated equipment, otherwise 1/event)
amponía, nitrate	one duplicate/event	na	none (if using dedicated equipment, otherwise 1/event)
TOC	four rep'icates	na	none (if using dedicated equipment, otherwise 1/event)
fluoride, chloride, turbidity, sulfate	one duplicate/event	na	none (if using dedicated equipement, otherwise 1/event)
metals	one duplicate/event	na	none (if using dedicated equipment, otherwise 1/event)

Note: p8 - 4 replicates conductivity - 4 replicates

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TABLE 3-3

FIELD MEASUREMENTS, INSTRUMENT CALIBRATION PROCEDURES AND PRECISION

Field Measurement	Instrument	Calibration Procedure	Precision
Water pH	pH Meter	pH 4.0 Buffer Solutions	±0.1 pH unit
Water Level Survey	Electric tape	NA	0.1 ft
Specific Conductance	Conductivity Meter	KCl Reference Solution	S = ±50 umhos/cm every 4 hours
Water Temperature (Surface)	Mercury Thermometer	Reference to Mercury	0.1°C





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Chemical Constituent	U.S. EPA Approved Method*	Precision (% MDD)	Accuracy (% (CS #EC)	Completernes (X Valid Data
Acetonitrile	8240	202		900
Acrylonitrile	8240	401	80 - 120%	350
Annonia	5-350.1	202		150
Arsenic	7060	202		100
Barium	6010	40%	. ik	430
Cadmium	7151	105		100
Chronium	7190	207	5	420
Cyanide	9010	207		170
Fluoride	5-340.2	40%		430
Lead	7421	404	80 - 120%	190
Veroury	7470	207	1	350
Witrate	9200	401	80 - 120%	150
Selenium	7740	40%	4	150
Silver	7760	202	1	150
Endrin	8080	40%	80 - 120%	150
L'indane	8080	40%	4	450
Methoxychlor	8080	202		150
Toxaphene	8080	205		350
2,4-0	8080	X07	3	200
2.4-5-TP Silver	8080	202	x	150
Radium	9315	¥0%	4	055
Gross Alpha	9310	40%	2	150
Gross Beta	9310	107	5	420
Coliform Bacteria	9131	40%	1	150
Turbidity	5-180.1	¥03	80 - 120%	256
Chloride	9252	202	1	06%
Iron	7380	XU7	¥021 - 18	OKA
Manganese	7460	107		*CX
Phenol s	9066	202		40A
Sodium	6010	202		404 926
Sulfate	9038	202	80 - 120%	254
Hd	0705	40%	80 - 1201	051
Specific Conductance	9050	40%	1	100
Total Organic Carbon	9060	202	80 - 120%	150
Total Organic Malogen	0206	202	80 - 120X	95%

RPD - Relative Percent Difference LCS Rec - Laboratory Control Standard

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Dedicated pumps have been installed with their intakes set several inches above the bottom of the wells in order to obtain a sufficient amount of water sample. These pumps are too wide to allow the total depth of the well to be sounded. In the event that fines from the aquifer accumulate at the bottom of the well and clog the pump intake, or if the pump and tubing are removed for repair, the dedicated equipment will be placed in a large polyethylene bag and the total depth will be measured by sounding with a decontaminated electric tape. The total depth will be measured from the top of the well casing and compared with the original total depth listed on the purge volume calculation sheet. If a significant amount of fines have accumulated in the well, they will be removed with a decontaminated bailer before re-installation of the pump.

Purging Static Water

Dedicated positive-gas-displacement bladder pumps ("Well Wizards") will be installed in all of the shallow bedrock wells. Due to the use of a gasoline-powered engine, precautions will be necessary to prevent contamination of equipment and samples. The engine and gasoline container will be segregated from other equipment during transport. Engineer exhaust will be directed away and downwind from the well. Work gloves will be worn when fueling or adjusting the engine and will be removed before handling sampling equipment and containers. Latex surgical gloves will be used to handle sample containers.

Pressure hoses will be connected in-line from the oil-less compressor to the control box, then to the well head nipple. Maximum purge rate will typically be 0.6 gal/min after adjusting controls for pump pressurization and vent cycles. The discharge tube will run to a five gallon bucket to measure the volumes purged and the actual purge volume will be recorded on the field data sheet. The filled bucket will be poured onto the ground at least 10 feet away and downslope from the well. Fluid appearance and odor will also be noted.

Sample Collection

Three field measurements will be made at each sample point after purging: pH, specific conductance and temperature. A separate bottle or beaker will be used to contain the water during measurement or to decant the sample into the instrument reservoir. These bottles may be reused, but will be thoroughly rinsed with distilled water and allowed to dry completely after each use, then rinsed thoroughly with sample water before use. Duplicate field measurements will be taken periodically to insure consistency of data and instrument reliability. Four replicate measurements of pH and specific conductance will be taken in accordance with the prescribed sampling schedule.

Pumping rates will be reduced to less than 100 ml per minute before collecting samples to preclude aeration, splashing and over-filling of bottles. Sample bottles will be filled directly from the discharge tube with minimal air contact and without allowing the sampling equipment or fingers to contact the inside of the bottles. Caps will be kept in hand while filling bottles. Sample containers will be filled in the same sequence for every well, in the following order: VOC, phenols, TOX, pesticides, herbicides, colliform bacteria, cyanide, radiological, ammonia, nitrate, TOC, fluoride, chloride, turbidity, sulfate and metals. The unfiltered metal samples will be collected before the filtered materials so that no containers will be filled after the disposable in-line filter is used.

3.5.2 Sample Handling

Sample containers and preservation methods are presented in Table 3-5.









TABLE 3-5: GROUNDWATER SAMPLE CONTAINER INFORMATION

Containers - Preservatives	Analysis	Group #	No. of Containers Per Well lst fear Upgradient (2 Wells)	No. of Containers Per Well 1st Tear-Downgradient (9 Wells + Duplicate)	Total No. of Containers Ist Year (All Wells)	Total No. of Containers Semi-annual (All Wells)	lotal No. of Containers Annual (All Welts)
GLASS:							
40 mi viais	VOC	1	3	3	6 + 30 = 36		
4 oz. amber - H2SO4	phenois	п	1		2 * 10 = 12		1 × 12 = 12
- 240 mL amber	TOK	111	8 (TOX replicates)	2	16 + 20 = 36	2 x 4 x 12 = 96 (incl. replic.)	2 x 4 x 12 = 96 (incl. replic.)
	pesticides, herbloides	1	1		2 + 10 = 12		
POLYETHYLENE:							
sterilized-unpres.	coliform bacteria	1	1	1	2 + 10 = 12		
4 oz NeOH	:yanide	1	1	1	2 * 10 = 12		
1 Gal - HNO3 /	adiological	1	1	1	2 + 10 = 12		
	mmonia, nitrate, DC	1, 1, 11	4 (TOC replicates)	1	8 * 10 = 18	4 x 12 = 48 (incl. replic.)	4 x 12 = 48 (incl. replic.)
	louride, chloride, urbidity, sulfate	t, 1, ft, 11	١	1	2 * 10 = 12	1 x 12 = 12 (turbidity only)	1 * 12 = 12
1 Ot MNO3 #	ætals	1, 11	2 (filtered function)	2 (filtered & unfilt.)	4 * 20 = 24		1 × 12 = 12

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3.6 SAMPLE CUSTODY

3.6.1 Field Operations

This section describes standard operating procedures for sample identification and chain-of-custody to be utilized for all field activities. The purpose of these procedures is to ensure that the quality of the samples is maintained during their collection, transportation, and storage through analysis. All chain-of-custody requirements comply with standard operating procedures indicated in USEPA sample-handling protocol.

Sample identification documents must be carefully prepared so that sample identification and chain-ofcustody can be maintained and sample disposition controlled. Sample identification documents include:

- o Daily logs;
- Purging and sample record;
- Sample Analysis Request Sheets;
- o Sample label;
- o Custody seals; and
- Chain-of-custody records.

3.6.1.1 Daily Logs

Daily logs and data forms are necessary to provide sufficient data and observations to enable participants to reconstruct events that occurred during the project. All daily logs will be kept in a bound notebook and consecutively numbered. All entries will be made in waterproof ink, dated, and signed. Sampling data will be recorded in the sampling record. Corrections will be made according to the procedures given at the end of this section.

The Site Log is the responsibility of the site team leader and will include a complete summary of the day's activity at the site.

The sampling record will include:

- Name of person making entry (signature).
- Names of samplers/title.
 - Levels of personnel protection:
 - Level of protection originally used:
 - Changes in protection, if required; and
 - Reasons for changes.
- Documentation on samples taken, including:
 - Sampling location and depth station numbers;
 - Sampling date and time, sampling personnel;
 - Type of sample (grab, composite, etc.);
 - Sample matrix; and
 - Preservation.
- o On-site measurement data.
- Field observations and remarks.
- Weather conditions, wind direction, etc.
- o Unusual circumstances or difficulties.
- o Initials of person recording the information.



3.6.1.2 Purging and Sample Record

As previously stated, three field measurements will be made at each sample point: pH, specific conductance, and temperature. The results from these measurements, in addition to a water level measurement, will be recorded on a purging and sample record which is included in Appendix A of the "Groundwater Monitoring Plan". Any problems encountered during sampling, such as equipment malfunction, unusual well response to pumping, etc., will be noted directly on the field forms.

A purge volume calculation sheet, contained in Appendix A of the "Groundwater Monitoring Plan", will be used to calculate and record the purge volumes required for each well. Depth to water will be subtracted from the total well depth listed on the sheet, and the result multiplied by the conversion factor for well casing size to obtain the gallons of water in the well. At least three well volumes are purged unless the well is pumped dry. In that case, which is not anticipated, the well will be allowed to recover up to 24 hours before sampling.

3.6.1.3 Sample Analysis Request Sheet

A sample analysis request sheet will accompany each sample and will be filled out at the time of sample filtration and preservation. On the sheet, the number of sample containers and any preservatives will be noted, along with the analyses to be performed. The sheet also lists the site name, sample identified, company name, name of sample collector, and data nd time of sample collection. A space on the lab sheet is provided for any unusual circumstances of which the lab should be advised.

3.6.1.4 Sample Identification

A field coding system will be used to identify each sample obtained during the sampling program. This coding system will provide a tracking record to allow retrieval of information about a particular sample and assure that each sample is properly identified.

3.6.1.5 Sample Labels

Each sample will be labeled, chemically preserved and sealed immediately after collection. To minimize handling of sample containers, labels will be filled out prior to sample collection. The sample label will be filled out using waterproof ink and will be firmly affixed to the sample containers. The sample label will give the following information:

- o Site I.D.
- o Sampling Point
- o Date/Time
- o Sampler
- Type of Preservation
- o Analysis parameters

3.6.1.6 Field Custody Procedures

The primary objective of the chain-of-custody procedures is to provide an accurate written or computerized record that can be used to trace the possession and handling of a sample from collection to completion of all required analyses. A sample is in custody if it is:

- o In someone's physic... possession;
- o In someone's view:
- o Locked up; or

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Kept in a secured area that is restricted to authorized personnel.

Appropriate field custody procedures include the following:

- As few persons as possible should handle samples.
- Sample bottles will be obtained precleaned by the laboratory or an approved retail source. Coolers or boxes containing cleaned bottles should be sealed with a custody tape seal during transport to the field or while in storage prior to use.
- The sample collector is personally responsible for the care and custody of samples collected until they are transferred to another person or dispatched properly under chain-of-custody rules.
- o The sample collector will record sample data in the field log book.
- The site team leader will determine whether proper custody procedures were followed during the field work and decide if additional samples are required.

3.6.1.7 Custody Seals

Custody seals are preprinted adhesive-backed seals with security slots designed to break if the seals are disturbed. Sample shipping containers (coolers, cardboard boxes, etc., as appropriate) are sealed in as many places as necessary to ensure security. Seals must be signed and dated before use.

3.6.1.8 Chain-of-Custody Record

The chain-of-custody record must be fully completed at least in duplicate by the field technician who has been designated by the project manager as responsible for sample shipment to the appropriate laboratory for analysis. In addition, if samples are known to require rapid turnaround in the laboratory because of project time constraints or analytical concerns (e.g., extraction time or sample retention period limitations, etc.), the person completing the chain-of-custody record should note these constraints in the "Remarks" section of the custody record.

3.6.1.9 Transfer of Custody and Shipment

- The coolers in which the samples are packed must be accompanied by a chain-of-custody record. When transferring samples, the individuals relinquishing and receiving them must sign, date, and note the time on the chain-of-custody record This record documents sample custody transfer.
- o Samples must be dispatched to the laboratory for analysis with a separate chain-of-custody record accompanying each shipment. Shipping containers must be sealed with custody seals for shipment to the laboratory. The method of shipment, name of courier, and other pertinent information are entered in the "Remarks" section of the chain-of-custody record.
- All shipments must be accompanied by the chain-of-custody record identifying their contents. The
 original record accompanies the shipment. The other copies are distributed appropriately to the site
 team leader and project manager.
- o If sent by mail, the package is registered with return receipt requested. If sent by common carrier, a bill of lading is used. Freight bills, Postal Service receipts, and bills of lading are retained as part of the permanent documentation. Samples will not be shipped on Friday to insure that there is no chance of samples being held in-route over a weekend.



3.6.1.10 Corrections to Documentation

Notebook

As with any data logbooks, no pages will be removed for any reason. If corrections are necessary, these must be made by drawing a single line through the original entry (so that the original entry can still be read) and writing the corrected entry alongside. The correction must be initialed and dated. Most corrected errors will require a footnote explaining the correction.

Sampling Forms and Sampling Record

As previously stated, all sample identification tags, chain-of- custody records, and other forms must be written in waterproof ink. None of these documents are to be destroyed or thrown away, even if they are illegible or contain inaccuracies that require a replacement document.

If an error is made on a document assigned to one individual, that individual may make corrections simply by crossing a line through the error and entering the corrected information. The incorrect information should not be obliterated. Any subsequent error discovered on a document should be corrected by the person who made the entry. All corrections must be initialed and dated.

3.6.2 LABORATORY OPERATIONS

A designated sample custodian accepts custody of the shipped samples and verifies that the sample identification number matches that on the chain-of-custody (c-o-c) record. Pertinent information as to shipment, pickup, and courier is entered in the "Remarks" section. The custodian then enters the sample identification number and other information into the laboratory sample tracking system. The custodian will then place each sample in the proper secure storage area. When samples are requested by a technician for sample preparation and/or analysis, the custodian will relinquish the samples to the technician using proper logging out procedures. Upon return of the samples, proper logging in procedures will be followed, and the custodian will return the samples to the proper secure storage area.

Upon receipt at the laboratory, the custodian must check that custody seals on boxes are intact. Strapping tape should be placed over the seals to ensure that seals are not accidentally broken during shipment.

3.6.3 SAMPLE HANDLING, PACKAGING, AND SHIPPING

The transportation and handling of samples must be accomplished in a manner that not only protects the integrity of the sample, but also prevents any detrimental effects due to the possible hazardous nature of samples. Regulations for packaging, marking, labeling, and shipping hazardous materials are promulgated by the United States Department of Transportation (DOT) in 49 CFR 171 through 177.

All chain-of-custody requirements must comply with standard operating procedures in the USEPA sample handling protocol.

Prepared samples sent to contract laboratories will be packaged in Multi-Purpose Bio-Mailers (Fisher Catalogue No. 110676-19, Dry Ice-Styrene Container Mailer) of equivalent shipment. U-tec freezer packs (Fisher Catalogue No. 03-528-1) or equivalent are pre-chilled and packaged with samples in each mailer. Vermiculite or equivalent inert material will be used to fill the void spaces and stabilize bottles in the shipping container. Mailers will be sent out by UPS Overnight freight service which picks up daily at the facility. Samples will not be shipped on Friday to insure that there is no chance of samples being held in-route over a weekend.



Shipping Containers

Shipping containers are to be custody-sealed for shipment as appropriate. The container custody seal will consist of filament tape wrapped around the package at least twice and custody seals affixed in such a way that access to the container can be gained only by cutting the filament tape and breaking a seal.

Field personnel will make arrangements for transportation of samples to the laboratory. When custody is relinquished to a shipper, field personnel will telephone the laboratory custodian to inform him of the expected time of arrival of the sample shipment and to advise him of any time constraints on sample analysis. Samples will be retained by the laboratory for 30 days after the final report is submitted.

Marking and Labeling

- o Use abbreviations only where specified.
- o The words "This End Up" or "This Side Up" must be clearly printed on the top of the outer package. Upward pointing arrows should be placed on the sides of the package. The words "Laboratory Samples" should also be printed on the top of the package.
- After a sample container has been sealed, two chain-of-curtory seal, will be placed on the container, one on the front and one on the back. The seals are protected from accidental damage by placing strapping tape over them.
- In addition, the coolers must also be labeled and placarded in accordance with DOT regulations if shipping medium and high hazard samples.

3.7 CALIBRATION PRO RES AND FREQUENCY

All instruments and equipment used during sampling and laboratory analysis will be operated, calibrated, and maintained according to the manufacturer's guidelines and recommendations as well as criteria set forth in the applicable analytical methodology references. Operation, calibration, and maintenance will be performed by personnel properly trained in these procedures. Documentation of all routine and special maintenance and calibration information will be maintained in an appropriate logbook or reference file, and will be available on request.

The following sections include brief descriptions of calibration procedures for major laboratory instruments which are to be used for analysis (unless equivalent instruments are substituted). It is understood that all procedures are applicable to equivalent instruments, with the appropriate changes, if these equivalent instruments are substituted for those named below.

Laboratory capabilities will be initially demonstrated for instrument and reagent/standards performance as well as accuracy and precision of analytical methodology. Brief descriptions of calibration procedures for major instrument types follow. Again, equivalent procedures will be used if equivalent instruments are substituted. Table 3-6 summarizes equipment calibration procedures, including calibration frequency, that may be used for sample analysis.



TABLE 3-6 SUMMARY OF CALIBRATION REQUIREMENTS

Instrument/Equipment to be Calibrated	Group	Calibration Technique	Calibration Frequency	Acceptance Limits
Gas Chromatograph/ Mass Spectrometer	GC/MS	Initial 3 or 5-point standard curve Calibration Check Standard/Continuing Calibration Standard	Daily and/or as needed daily	350 ≤20% D ≤20%
Gas Chromatograph	GE	For CLP Testing Establish linearity, breakdown and retention time windows, run daily quantitation standards	Linearity standard every 72 hours, calibration standards at the beginning, end, and every 10 samples, breakdown standard every ten samples	RSD 510% % Breakdown <20% Calibration standard RF <15% of initial Run for quantitation and <20% for confirmation run
		For Non-CLP Testing Initial 3 point standard curve Continuing Calibration Standard	Daily and/or as needed daily	RSD <10% RSD <15%
Total Organic Carbon	Gen. Chem.	Calibration with three single injections of a KMP standard	Deily	110% of true value
Total Organic Halogen	Gen. Chem.	Calibration with three single injections of a TOX standard Method blanks in duplicate	Deily	±5% of true value blank average <1.0 ur
pH Meter	Gen. Chem.	Bracket pH value using commercially prepared buffers	Daily	±0.05 units
Conductivity Meter	Gen. Chem.	Calibration with a single KCl reference solution	Daily	EPA reference solution observed. True value *25%
Infrared Spectrophotometer	Gen. Chem.	Standard curve generated using 5 concentrations of std. using a 1 cm cell and 3 concentrations of std. using a 2 cm cell	Daily	Coefficient of correlation must be greater than 0.95
TV, VIS	Gen. Chem.	Standard curve generated from 5 standards and a blank	Daily	Coefficient of correlation must be greater than 0.95
Technicon Auto- Anəlyzer	Gen. Chem.	Standard curve generated using 4 or more standards and a blank (method specific)	Deily	Coefficient of correlation must be greater than 0.95

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TABLE 3-6 (Continued) SUMMARY OF CALIBRATION REGUIREMENTS

Instrument/Equipment to be Calibrated	Group	Calibration Technique	Calibration Frequency	Acceptance Limits
inductively Coupled Plasma Spectrophotometer	Metals	Profile spectrometer. Calibration with a single standard and blank	Daily	s10% of true value
		Calibration verification	Every 10 samples	±10% of true value

Independent check sample

Every 10 samples ±10% of true value

3.7.1 FIELD INSTRUMENTATION

Photoionizer

Static or dynamic gas generation systems can be utilized for calibration of the instrument. A number of such systems for generating test atmospheres for various gases have been described by G.O. Nelson in "Controlled Test Atmospheres." Ann Arbor Science Publishers, Ann Arbor, Michigan (1971).

The most convenient packages for calibration are the non-toxic analyzed gas mixtures available from the manufacturer in pressurized containers.

A rapid procedure for calibration involves bringing the probe and readout in close proximity to the calibration gas, cracking the valve on the tank and checking the instrument reading. This provides a useful spot check for the instrument.

The recommended and most accurate procedure for calibration of the instrument from a pressurized container is to connect one side of a "T" to the pressurized container of calibration gas, another side of the "T" to a rotameter, and the third side of the "T" directly to the 8-inch extension to the photoionization probe. The valve of the pressurized container is cracked until a slight flow is indicated on the rotameter. The instrument draws in the volume of sample required for detection, and the flow in the rotameter indicates an excess of sample. The span pot is adjusted so that the instrument is reading the exact value of the calibration gas. (If the instrument span setting is changed, the instrument should be turned back to the standby position and the electronic zero should be readjusted, if necessary.)

Calibration with toxic gases should be performed in a hood since the photoionization detector is a nondestructive analyzer. The calibration gas should be prepared in the same matrix (air, nitrogen, hydrogen, etc.) in which it is to be measured, otherwise an inaccurate reading may be obtained. The increased response which is seen in oxygen free gases can be attributed to a reduction in the quenching of ions by oxygen (actually O_2) and is typical of any ionization detector. The quenching effect of oxygen is constant from about 10% O_2 to very high levels.

If a gas standard prepared in nitrogen is to be used for measurements in air, fill a 0.5- or 1-liter bag with the standard, then add 50 or 100 cc of pure oxygen to bring the level to 10-12%. Any error between this value and 20% oxygen is quite small. If the sample to be measured is in nitrogen, standards should be prepared in nitrogen.

Conductance, Temperature, and pH Tester

Temperature and conductance instruments are factory calibrated. Temperature accuracy can be checked against an NTIS certified thermometer prior to field use, if necessary. Conductance accuracy may be checked with a solution of known conductance and recalibration can be instituted, as necessary.

To recalibrate conductance add standard solution to cup, discard, and refill. Repeat procedure until the digital display indicates the same value twice in a row. Adjust the potentiometer until the display indicates the known value of conductance.

To standardize the pH electrode and meter, place the pH electrode in the 7.0 buffer bottle. Adjust the *ZERO* potentiometer on the tester so that the display indicates 7.00.

Then place the pH electrode in the 4.0 or 10.0 buffer bottle (depending on where you expect the actual measurement to be). Adjust the "SLOPE" potentiometer on the tester so that the display indicates the value of the buffer chosen. Measure the pH using the third buffer. Record the results in the notebook.



Note: There is interaction between the "ZERO" and "SLOPE" adjustments, so the procedure should be repeated several times.

Do not subject the pH electrode to freezing temperatures.

Rinse the electrode in distilled water when going from one buffer to another. When not in use the cap should be kept on the electrode. Keeping the cotton in the cap moist will keep the electrode ready to use. Moisten the cotton frequently (once a week, usually).

3.7.2 LABORATORY INSTRUMENTATION

Laboratory capabilities will be initially demonstrated for instrument and reagent/standards performance as well as accuracy and precision of analytical methodology. Brief descriptions of calibration procedures for major instrument types follow. Again, equivalent procedures will be used if equivalent instruments are substituted.

Gas Chromatography/Mass Spectrometry

All GC/MS instruments have been calibrated at five different concentration levels for analytes of interest, using the procedures outlined in SW-846, Test Methods for Evaluating Solid Waste, Third Edition, revised November, 1986. Compounds selected as System Performance Check Compounds (SPCCs) must show a minimum mean response factor (specified) for the initial calibration to be considered valid. Compounds selected as Calibration Check Compounds (CCCs) must show a Relative Standard Deviation (RSD) for response factors less than a specified amount for the calibration to be considered valid. This calibration can be utilized as long as it can be demonstrated to remain valid. On a daily basis, the instrument is hardware-tuned using either bromofluorobenzene (BFB) for volatile analytes, or decafluorotriphenyl-phosphine (DFTPP) for semi-volatile analytes. Mass spectral peaks must conform both in mass numbers and relative intensity to USEPA's requirements before analysis can proceed.

Following a successful tune, the initial five-point calibration is verified by a single mid-range standard. SPCCs and CCCs are used to check response factors for adequacy and consistency against required limits before analytes can proceed.

A successful calibration verification is followed by a method blank analysis. All target analytes (with the exception of common laboratory solvents) must be below target detection limit before analysis can proceed.

Plasma Emission Spectrophotometry

The calibration is set using a high range standard (typically 1,000 ppb) for all target analytes at the start of an analytical run. Standards at (typically) 500 ppb are run to check linearity within specified limits for each element. If found necessary, a high level check standard (typically 10,000 ppb) will be run to verify high range linearity.

Atomic Absorption Spectrophotometry

The AAS unit is typically calibrated at three points for furnace metals. A linearity of 0.995 or better confirms calibration. A check standard (USEPA-supplied or traceable) is used to verify calibration and must read within the USEPA specified limits before the instrument is used for analysis. All furnace metal samples are injected twice and spiked infurnace (typically at the 25-ppb level) to check for matrix effects. Samples showing matrix depression of signal are diluted to remove matrix effects.

TOX Analysis

The MCI TOX 10 Analyzer is calibrated daily by utilizing a 500 ppb halogen standard (pentachlorophenol). The percent recovery of the standard must be within the range of 95-105%. Each sample is analyzed in duplicate. One spike sample, spiked with 25 ppb of the halogen standard, is analyzed for every ten samples. The relative percent difference between duplicates must not exceed 20%; spike recovery must be in the range of 80-120%. The detection limit for the MCI TOX 10 Analyzer is 15 μ g/L.

Metals by ICP

A calibration curve of three standards is run daily, prior to the analysis of the samples. The calibration curve must have a correlation coefficient of 0.995 or greater. Afterwards, a single standard is run every ten samples. The apparent concentration of this standard must lie within 10 percent of the true concentration. Standards are prepared by diluting commercially available solutions. The concentrations of the commercial standards are checked quarterly against an EPA or NTIS check solution.

Colorimetric Analysis

Cyanide falls into this category. A calibration curve of at least three standards is prepared daily. The correlation coefficient of the curve must be 0.995 or greater.

3.8 ANALYTICAL PROCEDURES

Presented herein are the detection limits and quality control criteria for the analytical program. However, instances may arise where high sample concentrations, non-homogeneity of samples, or matrix interferences preclude achieving the detection limits of associated quality control criteria. In such instances, the reasons for deviations from these detection limits or noncompliance with quality control criteria will be reported.

3.8.1 ANALYTICAL PROCEDURES AND QA OBJECTIVES TABLE

Table 3-7 lists all analyses expected to be performed by the laboratory for this project. For each analysis, we list:

- Parameter name;
- Reference and method numbers;
- A brief description of the method;
- The matrix applicable to that method; and
- The detection limit.

Methodology references contain specific QC criteria associated with the particular methods. These specific requirements include calibration, tuning, and QC samples and are described in detail within the methods. Daily performance tests and demonstration of precision and accuracy are required.

3.9 DATA REDUCTION, VALIDATION, AND REPORTING

QA/QC requirements will be strictly adhered to during sampling and analytical work. All data generated will be reviewed by comparing and interpreting results from chromatograms (responses, stability of retention times), accuracy (mean percent recovery of spiked samples), and precision (reproducibility of results). Refer to Section 3.10 for detailed discussion of QA/QC protocol.



TABLE 3-7 ANALYTICAL DETECTION LIMITS AND METHODS

METHOD DETECTION LIMITS

	U.S. EPA			HETHOR DETECT	INA CINITA
Chemical Constituent	Approved Method*	Matrix (S/W)	Brief Description of Method	Water (µg/l	Soil (mg/kg)
Acetonitrile	8240	s/W	Purge and Trap, GC/MS	300	400
Acrylonitrile	8240	S/W	Purge end Trap, GC/MS	300	400
Ammonia	5-350.1	u	Titration	200	
Arsenic	7060	S/W	Furnace AA	5	500
Barium	6010	S/W	ICP	10	500
Cadmium	7131	S/W	ICP	10	500
Chromium	7190	S/W	1CP	20	1000
Cyanide	9010	S/W	Spectrophometric	5	0.05
Fluoride	5-340.2	u	Calorimetric	100	
Lead	7421	S/W	Furnace AA	50	2500
Mercury	7470	S/W	Cold Vapor - Liquid	5	250
Nitrate	9200		Spectrophotometer	100	
Selenium	7740	5/W	Furnace AA	5	500
Silver	7760	5/14	TCP	10	500
Endrin	8080	u	GC	0.1	0.2
Lindane	8080	u	GC	0.5	0.1
Methoxychior	8080	u	GC	0.5	1
Toxaphene	8080		GC	1	2
2,4-D	8080		GC	.5	.1
2,4-5-TP Silver	8080	u	GC	.5	.1
Radium	9315	U			
Gross Alpha	9310	u u	이번 부장에 가지 않는 것 같아요. 바다		
Gross Beta	9310	W		영국의 영국의 영국 문국에	**
Coliform Bacteria	9131			1	
Turbidity	5-180.1	W		**	
Chloride	9252		Titrimetric, Mercuric Nitrate	2000	
Iron	7380	¥	ICP	50	2500
Manganese	7460	w	Direct Aspiration, AA	10	500
Phenols	9066		Calorimetric	10	1
Sodium	6010	u .	ICP	5000	
Sulfate	9038	W	Turbidimetric	2000**	
рH	9040	u.	Electrometric		
Specific Conductance	9050	u u	Wheatstone Bridge		
Total Organic Carbon	9060	W	Infrared or Flame Ionization	1000	
Total Organic	9020	u	Carbon adsorption,		
Halogen			microcoulometric-titration	10	
			detector		

* SW-846, third edition, November 1986 ** Practical Quantification Limit

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All calculations and data manipulations are included in the appropriate methodology references. Control charts and calibration curves will be used to review the data and identify outlying results. Prior to the submission of the report to the client, all data will be evaluated for precision, accuracy, and completeness. Sections 3.4, 3.8, and 3.13 of this document include some of the QC criteria to be utilized in the data validation process.

Data storage and documentation will be maintained using logbooks and data sheets that will be kept on file. Analytical and field QC will be documented and included in the report. The central file will be maintained for the sampling and analytical effort for a period of five years after the final report is issued.

Complete evaluation of the analytical data requires that the data be reported completely and correctly. The following information is required for complete evaluation of the analytical data and will be reported separately:

- Dates the samples were collected in the field;
- Extraction and analysis dates for all the samples;
- Applicable holding times for each analysis; and
- Analysis dates for laboratory QC samples.

Reports will be reviewed by the laboratory supervisor, the QA officer, laboratory manager and/or director, and the project manager. Analytical reports will contain a data tabulation including results and supporting QC information will be provided. Raw data will be available for later inspection, if required, and maintained in the control job file.

3.10 INTERNAL QUALITY CONTROL CHECKS



QC data are necessary to determine precision and accuracy and to demonstrate the absence of interferences and/or contamination of glass-ware and reagents. Laboratory based QC will comprise at least 10% of each data set generated and will consist of standards, replicates, spikes, and blanks. Depending upon the particular method used, QC may be more rigorous, but at a minimum, one spike or replicate per 10 samples and one method blank per 20 samples or run, whichever is greater, will be utilized for every analytical run. Field duplicates and field blanks will be analyzed by the laboratory as samples and will not necessarily be identified to the laboratory as duplicates or blanks. For each matrix, field duplicates will be provided at a rate of one per 20 samples collected. Field blanks, routine field, and rinseate blanks will be provided at a rate of one per 20 samples collected for each parameter group, whichever is greater. Trip blanks will be provided at a rate of one per day and will be analyzed for volatile components only.

Calculations will be performed for recoveries and standard deviations along with review of retention times, response factors, chromatograms, calibration, tuning, and all other QC information generated. All QC data, including split samples, will be documented in the site logbook. QC records will be retained and results reported with sample data.

3.10.1 BLANK SAMPLES

Blank samples are analyzed in order to assess possible contamination from the field and/or laboratory so that corrective measures may be taken, if necessary. Blank samples are discussed in the following sub-sections: Field Blanks and Laboratory Blanks.

3.10.1.1 Field Blanks

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Various types of blanks are used to check the cleanliness of field handling methods. The following types of blanks may be used: the trip blank, the routine field blank, the field equipment blank. They are analyzed in the laboratory as samples, and their purpose in to assess the sampling and transport procedures as possible sources

of sample contamination. Field staff may add blanks if field circumstances are such that they consider normal procedures are not sufficient to prevent or control sample contamination, or at the direction of the project manager. Rigorous documentation of all blanks in the site logbooks is mandatory.

- Routine Field Blanks or bottle blanks are blank samples prepared in the field to access ambient field conditions. They will be prepared by filing empty sample containers with deionized water and any necessary preservatives. They will be handled like a sample and shipped to the laboratory for analysis.
- Trip Blanks are similar to routine field blanks with the exception that they are not exposed to field conditions. Their analytical results give the overall level of contamination from everything except ambient field conditions. One trip blank will be collected with every batch of water samples for volatile organic analysis. Each trip blank will be prepared by filling a 40-ml vial with deionized water prior to the sampling trip, transported to the site, handled like a sample, and returned to the laboratory for analysis without being opened in the field.
- Field Equipment Blanks are blank samples (sometimes called transfer blanks or rinseate blanks) designed to demonstrate that sampling equipment has been properly prepared and cleaned before field use, and that cleaning procedures between samples are sufficient to minimize cross contamination. If a sampling team is familiar with a particular site, they may be able to predict which areas or samples are likely to have the highest concentration of contaminants. Unless other constraints apply, these samples should be taken last to avoid excessive contamination of sampling equipment.

3.10.1.2 Laboratory Blanks

In addition to field blank samples, three types of blanks routinely analyzed in the laboratory are calibration blanks, method blanks, and reagent blanks. Method blanks and reagent blanks are used to assess laboratory procedures as possible sources of sample contamination. Calibration blanks establish the analytical baseline against which all other blanks are measured.

- Method Blanks are laboratory blanks that correspond to the first step in sample preparation and as such, provide a check on contamination resulting from sample preparation and measurement activities. Method blanks for water and soil samples consist of deionized water which is subjected to the entire sample procedure as appropriate for the analytical method being utilized.
- Reagent/Solvent Blanks are closely related to method blanks, but they do not incorporate all sample preparation materials and analytical reagents in one sample. When a method blank reveals significant contamination, one or more reagent blanks are prepared and analyzed to identify the source of contamination. These reagent blanks are then subjected to the entire sample procedure as appropriate for the analytical method being utilized.
- Calibration Blanks consist of pure reagent matrix and are used to zero an instrument's response to the level of analytes in the pure reagent matrix. They do not provide a direct indication of the types, sources, or levels of contamination, but they establish the analytical baseline.

3.10.2 FIELD DUPLICATES

Field duplicate samples consist of a set of two samples collected independently at a sampling location during a single sampling event. In some instances the field duplicate can be a blind duplicate, i.e., indistinguishable from other analytical samples so that personnel performing the analyses are not able to determine which samples are field duplicates. Field duplicates are designed to assess the consistency of the overall sampling and analytical system.



3.10.3 LABORATORY REPLICATES

Laboratory replicate samples are aliquots of a single sample that is split on arrival at the laboratory or upon analysis. Laboratory replicate samples may be made if no field duplicate samples are provided by the field sampling team; however, their purposes are not always interchangeable. Significant differences between laboratory replicate samples are generally due to analytical technique, whereas significant differences in field duplicate samples may be due to a variety of reasons.

3.10.4 CALIBRATION STANDARDS

A calibration standard is prepared in the laboratory by dissolving a known amount of a pure compound in an appropriate matrix. The final concentration calculated from the known quantities is the true value of the standard. The results obtained from these standards are used to generate a standard curve and thereby quantitate the compound in the environmental sample. A minimum of three calibration standards will be used to generate a standard curve for all analyses.

3.10.5 CHECK STANDARD

A check standard is prepared in the same manner as a calibration standard or may be obtained from USEPA. The final concentration calculated from the known quantities is the "true" value of the standard. The important difference in a check standard is that it is not carried through the same process used for the environmental samples, but is analyzed without digestion or extraction. A check standard result is used to validate an existing concentration calibration standard file or calibration curve. The check standard can provide information on the accuracy of the instrumental analytical method independent of various sample matrices.

3.10.6 SPIKE SAMPLE

A sample spike is prepared by adding to an environmental sample (before extraction or digestion), a known amount of pure compound of the same type that is to be assayed for in the environmental sample. These spikes simulate the background and interferences found in the actual samples and the calculated percent recovery of the spike is taken as a measure of the accuracy of the total analytical method. When there is no change in volume due to the spike, it is calculated as follows:

$$\% R = \frac{100 (0-X)}{T}$$

Where:

%R = Percent recovery;

0 = Measured value of analyte;

X = Measured value of analyte concentration in the sample before the spike is added; and

T = Quantity of added spike.

Tolerance limits for acceptable percent recovery are established in the methodology references and presented in Section 3.10 of this document.

3.10.7 INTERNAL STANDARD

An internal standard is prepared by adding a known amount of pure compound to the environmental sample; the compound selected is not one expected to be found in the sample, but is similar in nature to the compound of interest. Internal standards are added to the environmental sample just prior to analysis. (Note: Internal standards and surrogate spikes are different compounds. The internal standard is for quantification purposes using the relative response factor; surrogate spikes indicate the percent recovery and, therefore, the efficiency of the methodology.)

3.10.8 MATRIX SPIKE/DUPLICATE

Aliquots are made in the laboratory of the same sample and each aliquot is treated exactly the same throughout the analytical method. Spikes are added at approximately 10 times the method detection limit. The relative percent difference (RPD) between the values of the matrix spike and matrix spike duplicate, as calculated below, is taken as a measure of the precision of the analytical method:

 $\begin{array}{l} \text{RPD} = (\underline{D}_1 - \underline{D}_2) \ \text{x} \ 100 \\ (D_1 + D_2)/2 \end{array}$

Where: RPD = Relative percent difference;

D₁ = First sample value; and

D₂ = Second sample value (duplicate).

In general, the tolerance limit for RPDs between laboratory duplicates should not exceed 20% for validation in homogeneous samples. Refer to Section 3.8 for criteria on RPDs. Acceptable RPDs may vary depending on actual levels.

3.10.9 QUALITY CONTROL CHECK SAMPLES

Inorganic and organic control check samples are available from USEPA free of charge and are used as a means of evaluating analytical techniques of the analyst.

3.10.10 LABORATORY CONTROL STANDARDS

Laboratory Control Standards (LCS) are aliquots of organic-free or deionize water to which known amounts of analyte have been added. They are subjected to the sample preparation extraction procedure and analyzed as samples. The stock solutions used for LCS are purchased or prepared independently of calibration standards. The LCS recovery tests the function of analytical methods or equipment.

LCS are prepared and analyzed on a daily basis and at a frequency of one per ten samples if more than ten samples are run in a given bunch.

The laboratory computer generates a call for LCS every ten samples logged in for a particular determination. The true value and recovered concentration are archived and retrievable for statistical analysis. Laboratory control limits are calculated when 20 data points become available. Specific laboratory control procedures are as follows:





Volatile Organics

For every ten samples analyzed, a method blank, a duplicate, and a spike are included as part of the analytical batch. A surrogate and an internal standard are added to each sample in order to monitor purging efficiency and instrument operation.

Metal Analysis

Most metal analyses are done by one of two techniques: graphite furnace atomic absorption, spectrophotometry or inductively coupled argon plasma emission spectrophotometry (ICP). All sample digestions follow EPA or Standard Methods prescribed procedures. One daily method blank for every ten samples is run for each element. One duplicate and one spiked sample are analyzed for every ten samples.

When the concentration of the metal is being determined exceeds the highest standard, the sample is diluted so it falls within the range of calibration. AS daily laboratory control standard is run for all metals. The accuracy of the analysis of metals in soil is checked annually by analyzing a NTIS reference material such as SRM No. 1646, an estuarine sediment.

Colorimetric, Titrimetric, Gravimetric, Ion Chromatograph, and Potentiometric Analyses

Chemical analyses which fall into these categories must be analyzed along with at least one method blank per every ten samples. Sample duplicates and sample spikes are also prepared and analyzed every ten samples.

Control standards or materials, currently used by the laboratory are either prepared in-house from high purity starting materials or are purchased as standard concentrates. The laboratory also uses comparability spikes made from EPA WP and WS series standards. The best laboratory control standards are those materials traceable to EPA or NTIS.

3.10.11 CONTROL LIMITS

Minimal control limits for each analytical method have been established by the U.S.EPA (SW-846, Third Edition). Table 3-8 presents a summary of the internal quality control procedures for each analytical method to be used for this project.

3.11 PERFORMANCE AND SYSTEM AUDITS

Performance and system audits include careful evaluation of both field and laboratory QC. System audits are performed on a regularly scheduled basis during the lifetime of the project to determine the accuracy of the measurement systems.

System audits will be performed through duplicate sampling in the field and issuing the laboratory blind samples. Split samples may be provided and will be documented. Blind samples will be analyzed by the laboratory utilizing appropriate analytical methodology and results reported with sample data.

Laboratory audits are of two types-external and internal. External audits are carried out by such certifying agencies as USEPA, the American Industrial Hygiene Association, and major industrial clients. These external audits are specific to the needs of the individual agency or client, but all include reviews of analytical capabilities and procedures; chain-of-custody procedures; documentation control; quality control and quality assurance; and laboratory organization. All include analysis of blind samples for performance evaluation. They are, therefore, a vital and objective element of the laboratory QA program.



TABLE 3-8

SUMMARY OF INTERNAL QUALITY CONTROL PROCEDURES

Analytical Metho	d <u>Parameter</u>	Quality Control Check	Frequency	Acceptance Criteria	Corrective Action
		FL.D QUALITY CONTROL			
5-350.1	Ammonia	Duplicate	One every 20 field	Within 10%	Same
5-340.2	Fluoride		samples		
9200	Nitrate	Equipment blank	One per sampling equipment every 20	No compounds should be detected	Same
5-180.1	Turbidity		field samples		
9252	Chloride	LAB QUALITY CONTROL			
9066	Phenols	Calibration curve (4 pt)	Each batch	0.995 > Correlation	Recalibrate
9038	Sulfate	Midpoint standard	Every 10 samples	Within 20% of expected value	Reanalyze blank or qualify results
		FIELD QUALITY CONTROL			
8080	Pesticides/ Herbicides	Duplicate	one every 20 field samples	within 10%	Review analysis and sampling methodology to determine if additional samples should be collected or qualify the results
		Equipment blank	one per sampling equipment every 20 field samples	no compounds should be detected	Review analysis and sampling methodology to determine if additional samples should be collected or qualify the results
		LAB QUALITY CONTROL			
		Instrument Performance - 3.0 point celibration curve	every 72 hours	DDT retention time >12 min; total breakdown of DDT is ≤20%	Rerun or qualify results
		calibration blank	one every 20 samples	nothing detected	Reanalyze or qualify results
		midpoint standard	one every 10 samples	< 10% relative standard deviation	Reanalyze or qualify results

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8 Internal audits of laboratory functional groups take place at regular intervals. A QA officer will audit a laboratory by reviewing the analytical logbooks for the period since the previous audit and preparing a report to laboratory management listing discrepancies from acceptable procedures. Follow-up action by management may include sample reanalysis; an amended report to a client if necessary; and retraining of offenders.

The project manager and QA officer will create a schedule and institute a program for regular system and performance audits. Field and laboratory audits will be performed during the project sampling and analytical activities. The field audits will be performed by the health and safety officer and the laboratory audits by the corporate QA officer.

3.12 PREVENTIVE MAINTENANCE

All laboratory and field instruments and equipment used for sample analysis will be maintained under service agreements with the manufacturers and will be serviced and maintained only by qualified personnel. All repairs, adjustments, and calibrations will be documented in an appropriate logbook or data sheet that will be kept on file.

A stock of spare parts and consumables for all analytical equipment will be maintained. In addition, a sufficient redundancy of equipment items to allow for a reasonable level of equipment failure should also be maintained.

3.13 PROCEDURES USED TO ASSESS DATA PRECISION, ACCURACY, AND COMPLETENESS

Performance of the following calculations will be documented and included in the QC section.

3.13.1 FORMULAS

3.13.1.1 Accuracy

Accuracy is the difference between an average value and the "true" value when the latter is known or assumed. The term "accuracy" is normally used interchangeably with "percent recovery," and describes either recovery of a known amount of analyte (spike) added to a sample of known value, or recovery of a synthetic standard of known value.

% Recovery = $100 \times SSR - SR$ (spike) SA

Where: SSR = Spike sample results;

SR = Sample result; and

SA = Spike added.

%Recovery = 100 x <u>Observed Value</u> (standard) True Value

NOTE: The units for the concentrations of spikes, samples, and observed and true values vary based on the analysis. However, they are typically $\mu g/L$ or mg/L for water samples and $\mu g/kg$ or mg/kg for soil samples.

Average

The average (or arithmetic mean) of a set of "N" values is the sum of the values divided by "N":

$$\begin{array}{c} N \\ \Sigma & Xi \\ X = L \\ N \end{array} = 1$$

3.13.1.2 Precision

Relative to the data from a single test procedure, precision is the degree of mutual agreement among individual measurements made under prescribed conditions. An estimate of standard deviation is normally used to describe the precision of a method.

Standard Deviation Estimate: Standard deviation estimate is the most widely used measure to describe the dispersion of a set of data.

Normally, X + SD will include 68%, and X + 2SD will include about 95%, of the data from a study.

$$(SD) = \sum_{i=1}^{N} \frac{(X - X)^2}{N + 1}$$

Relative Standard Deviation (RSD): The estimate of precision of a series of replicate measurements will usually be expressed as the relative standard deviation (RSD):

$$\begin{array}{rcl} \text{RSD} &= & \underline{\text{SD x 100\%}} \\ & X \end{array}$$

Relative Percent Difference (RPD): A measure of the difference between two samples assumed to be identical through dividing (splitting) an original sample, analyzing each portion, identifying the values of the first replicate (X_1) and that of the second replicate (X_2) , and dividing the difference by the mean (X) of X_1 and X_2 .

$$\operatorname{RPD} = \frac{X_1 - X_2}{X} \times 100$$

3.13.1.3 Completeness

Completeness is a measure of the amount of valid data obtained from a measurement system compared to the total amount expected to be obtained under normal conditions. The goal of is to achieve 100% completeness, however, a 95% completeness figure is usually required for a particular analysis and overall project objective.

Completeness for each parameter is calculated as:

3.13.2 CONTROL LIMITS

Control limits are developed by the laboratory based on historical data. Prior to awarding a contract to perform the analysis for the project, the laboratory will submit laboratory control limits based on historical data to the QA Project Officer.

3.14 CORRECTIVE ACTION

Corrective actions can be initiated as a result of performance and system audits, laboratory and interfield comparison studies, data validation, and/or a QA program audit. They may also be required as a result of a request from BP. All corrective action necessary to resolve an analytical problem's will be taken. Success or failure of BP-requested corrective actions will be reported to BP with an estimate of effect on data quality, if any.

Corrective actions may include altering procedures in the field, conducting subsequent audits, or modifying laboratory protocol. Time and type of corrective action, if needed, will depend on the severity of the problem and relative overall project importance. The project manager is responsible for initiating corrective action and the laboratory manager/director or the team leader is responsible for its implementation.

Precision and accuracy will be regularly tracked by the analytical staff to determine unacceptable results and to evaluate and implement corrective actions. Precision and accuracy criteria for all analyses are listed in Section 3.4 of this QAPjP, and laboratory supervisors and QA/QC staff will evaluate analytical data against the accompanying quality control data for validity. Corrective actions may include, but are not limited to, recalibration of instruments using freshly prepared calibration standards; replacement of lots of solvent or other reagents that give unacceptable blank values; additional training of laboratory personnel; or reassignment, if necessary. Corrective actions in many cases may have to be defined as the need arises.

If substantial corrective action is required or if serious QA problems are encountered, BP will be notified by phone and in writing as soon as possible. All corrective action will be implemented and documented after notification of BP.

3.15 QUALITY ASSURANCE REPORTS

Upon completion of a project sampling effort, analytical and QC data will be included in a comprehensive report that summarizes the work and provides a data evaluation. A discussion of the validity of the results in the context of QA/QC procedures will be made, as well as a summation of all QA/QC activity.

Serious analytical problems will be reported to BP. Time and type of corrective action, if needed, will depend on the severity of the problem and relative overall project importance. Corrective actions may include altering procedures in the field, conducting an audit, or modifying laboratory protocol. All corrective action will be implemented after notification of BP.





4.0 SOLIDIFICATION/STABILIZATION



In order to be considered suitable for disposal, the stabilized sludge must meet performance standards for enconfined compressive strength (50 psi or greater within 28 days determined by ASTM D 2166), permeability (less than 10-6 cm/sec determined by SW-846 Method 9100), and leachability of hazardous constituents (standard varies with constituent).

The treated sludge must be tested in the field to ensure that it meets the performance standards listed above. It was determined that the treated sludge would be tested for only one of the performance parameters based on the assumption that all the standards would be satisfied if one standard is met.

Compressive strength was chosen to be the parameter representative of the performance of the stabilized sludge.

As previously stated, the treated sludge must exhibit a 28-day compressive strength of at least 50 psi. A field test that is indicative of compressive strength is the pocket penetrometer test. A pocket penetrometer test will be performed on representative composite simples obtained from every 8- or 10-hour shift at intervals of two days, five days, ten days, fifteen days, two days, and twenty-eight days. As soon as a penetrometer reading equivalent to 50 psi compressive strength and attained, testing will stop.

In order for pocket penetrometer reading e used as indicators of compressive strength, correlations between the two values must be established in the laboratory stabilization/solidification study ready be used. The 48-hour penetrometer test result obtained in the laboratory for each sludge binder mixture is presented in the following table:

POND	48-HOUR SET STRENGTHS
Celite	505
Burn	600
V-1	760
Deepwell	505

Six cylinders of the sludge binder mixture will be cast every ten shifts and compressive strength will be measured at the intervals cited above (i.e., two days, five days, ten days, fifteen days, twenty days, and twenty-eight days). A correlation factor will be developed by comparing the compressive strength results to the pocket penetrometer readings obtained at the same time interval.

Copies of all stabilization/solidification quality control test results will be sent to OEPA on a weekly basis.

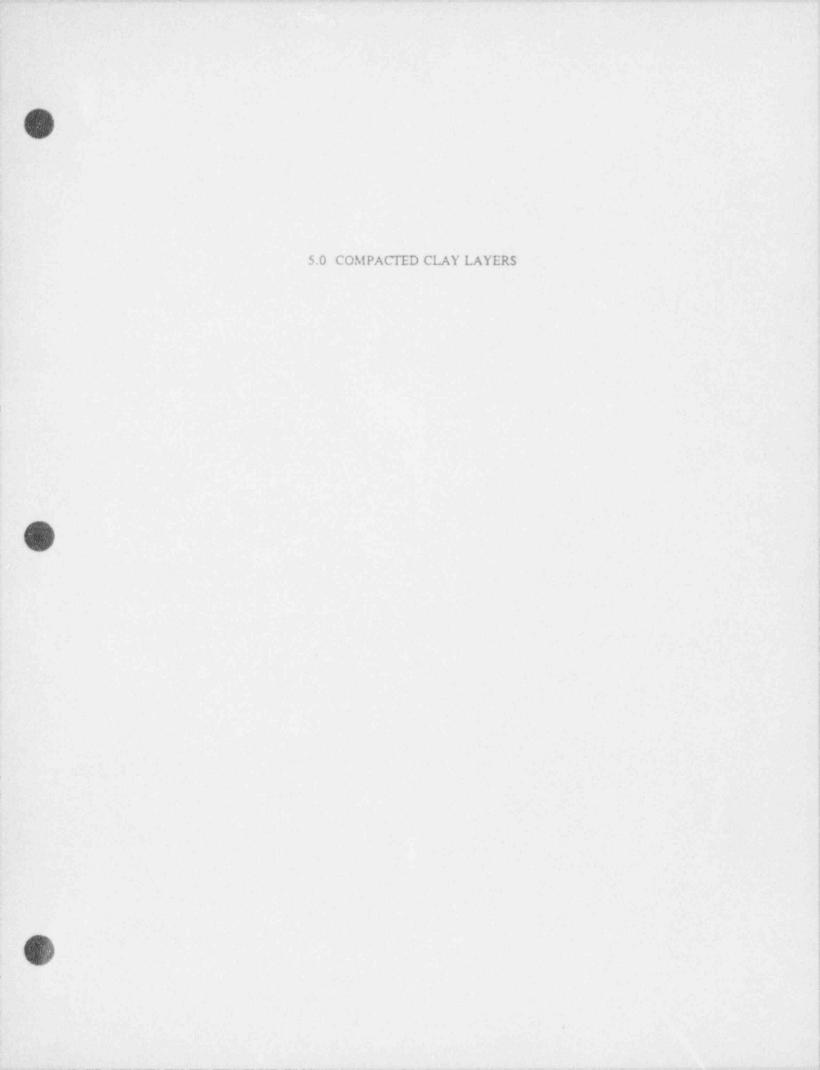


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5.0 COMPACTED CLAY LAYERS

5.1 INTRODUCTION

This section addresses the quality assurance for the installation of compacted clay layers used in the containment of liquids and solids. Inspection and documentation activities will be performed by a BP inspector. Engineer or his designated representative will visit site at least once per week to verify that proper QA procedures are being followed.

5.2 PRECONSTRUCTION

5.2.1 MATERIALS

Verify on the basis of test data that all proposed materials have all of the characteristics listed below to be acceptable for use as compacted clay on this project. Complete borrow source checklist (Form 5-1 in Appendix A).

- a. Are from approved borrow sources or from required project excavation.
- b. Classified according to ASTM D 2487 as CL or CH.
- c. Contain at least 60-percent fines (minus No. 200 sieve size).
- d. Have a liquid limit greater than 25 percent and a plasticity index greater than 10 but less than 40.
- e. Enve no more than 10 percent gravel-size particles, with a maximum particle size of less than 2 inches.
- f. Are free of organic matter and debris and are not contaminated.
- g. Can be prepared so as to have a maximum nominal clod size of 2 inches before placement for compaction.
- h. Are within the specified moisture range to allow adequate compaction.
- i. Have a hydraulic conductivity of 1.0 x 10⁻⁷ cm/sec or less per EPA Method SW 846, (Falling Head Method) when compacted to optimum moisture and density.

5.2.2 SOURCE INSPECTION

Inspect source to verify sufficient quantity. Soil that displays characteristics that vary from the previously tested and accepted soil are not acceptable for use as compacted clay.

5.2.3 SOURCE IDENTIFICATION

Assign a source identification number consisting of the material type as set forth in the specifications and a sequential number (i.e., B-3). This number should be used on all records regarding the material.



5.3 CONSTRUCTION

5.3.1 COMPACTED CLAY LAYER IDENTIFICATION

A compacted clay layer is constructed of material acceptable for use as compacted clay as previously described in this section. The compacted clay layers exist in all locations noted as "compacted clay" on the drawings for this project. Specifically, they are located in both the liner system and the cover system.

Each lift is to be designated by the coordinates of the corners of the lift and the elevation of the top and bottom. These data are to be provided by the contractor using appropriate surveying techniques.

5.3.2 COMPACTED CLAY LAYER PLACEMENT

Immediately prior to installation of the designed compacted clay layer, observe the supporting surface. Where soft, unstable or otherwise unsuitable material is encountered at supporting surface, after approval by the owner, or his designated representative, corrective measures as directed by the engineer will be taken. The integrity of the underlying materials is the responsibility of the contractor and are to be verified by the inspector.

5.3.3 CONSTRUCTION OBSERVATION

5.3.3.1 Layer Placement

Throughout construction of the compacted clay layer, observe the layer materials to ensure and document the items listed below are performed by the contractor. Complete lift checklist (Form 5-2 in Appendix A) on each lift. For continuous fill operation, a separate checklist must be prepared for each lift.

- a. Adequate scarification of the surface of the previous lift.
- b. Removal of roots, rocks, rubbish, or off-spec soil from the layer material.
- Identification of changes in soil characteristics necessitating additional laboratory testing or a change in construction specifications.
- d. Adequate spreading of layer material to obtain complete coverage and the specified loose lift thickness.
- e. Adequate clod size reduction of layer material to no more than 2 inches.
- Adequate spreading and incorporation of water to obtain full penetration through clods and uniform distribution of the specified water content.
- g. Adjustment of water content by adding water or working with disks and harrows.
- h. Prevention of significant water loss and desiccation cracking before and after compaction.

5.3.3.2 Layer Compaction

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Throughout construction of the compacted clay layer, observe the compaction process to ensure and document the items listed below are performed. Complete lift checklist (Form 5-2 in Appendix A) daily for work performed on each lift.

a. Uniformity of coverage by compaction equipment, especially at compacted fill edges, in equipment turnaround areas, and at the tops and bottoms of slopes.

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- b. Consistent achievement of the specified soil density, water content, and permeability throughout each completed lift based on test data furnished by contractor's testing agency.
- c. Repair of penetrations or holes resulting from the use of density or moisture probes.
- d. Adequate tying together of replaced and undisturbed sections of the layer.
- e. Use of methods sufficient to tie liner lifts together.
- f. Timely placement of protective covers to prevent desiccation of layer material, between the installation of lifts or after completion of the layer.
- g. Prevention of accidental damage of installed portions of the layer by equipment traffic.

5.3.3.3 In-Situ Testing

Verify that in-situ testing is performed in accordance with specifications and that test results are in the acceptable range.

5.4 POSTCONSTRUCTION

When final lift is placed, inspector will have contractor provide final surveyed location and elevation of surface and verify that surface is at paper location and is free of cracks and surface drainage.

As construction proceeds, all field logs and contractor submittals will be reviewed by the engineer, or his designated representative, to assure the quality control program is properly implemented. A copy of each document will be made and kept on file until the project is complete. Upon completion, all files will be stored in the company's archives for the duration of the warranty. The originals will be forwarded to BP Chemicals.





6.0 GEOMEMBRANE LINER INSTALLATION



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6.0 GEOMEMBRANE LINER INSTALLATION

6.1 INTRODUCTION

This section addresses the QA/QC for the installation of High Density Polyethylene (HDPE) geomembrane used in the containment of liquids and solids.

6.2 QUALITY CONTROL

6.2.1 MATERIALS

6.2.1.1 Resin

A first quality resin will be used in the manufacture of the geomembrane. The resin will be designed and manufactured specifically for the intended purpose. The resin will meet the specifications presented in the following table. All test results must be recorded on Form No. 1 contained in Appendix A or on other forms approved for the project.

SPECIFICATION	TEST METHOD	TESTING FREQUENCY	STANDARD
specific gravity melt index low temperature brittleness	ASTM D792 ASTM D1238 ASTM 746 Procedure B	1/batch 1/batch 1/batch	0.93 0.3g/10 min -112° F

6.2.1.2 HDPE Geomembrane Material

The geomembrane material to be used shall be of HDPE and 60-mil or 100-mil in thickness. The geomembrane sheet manufacturer shall ensure that the geomembrane used for the project is of high quality by subjecting the geomembrane to performance tests at regular intervals. The table below lists the appropriate tests, test methods, frequency of testing, and minimum standards. All test results must be recorded on Form No. 2 contained in Appendix A or on other forms approved for the project.

SPECIFICATION	TESTING FREQUENCY	MINIMUM STANDARD	MINIMUM <u>STANDARD</u>
Thickness (ASTM D 1593)	Min. 25/roll	60 mils	100 mils
Minimum tensile properties (ASTM D 638) Tensile strength at break Tensile strength at yield Elongation at break Elongation at yield	1/10,000 S.F.	240 lbs/in 140 lbs/in 700% 13%	400 lbs/in 240 lbs/in 700 % 13 %
Dimensional stability (ASTM D 1204)	1/day	± 2%	± 2%



Maximum carbon black content (ASTM D 1603)	1/day	2.5%	2.5%
Environmental stress cracking (mm) (ASTM D 1693)	1/week	1500 hrs	1500 hrs
Puncture resistance (FTMS 101C-2065)	1/10,000 S.F.	80 lbs	130 lbs

6.2.1.3 Welding Materials

All welding material shall be of a type recommended and supplied by the manufacturer and shall be delivered in the original sealed containers each with an indelible label bearing the brand name, manufacturer's mark number, and directions for use.

The welding equipment shall be capable of continuously monitoring and controlling the temperature of the zone of contact where the machine is actually fusing the lining material so as to ensure that changes in environmental conditions will not affect the integrity of the weld.

All clamps, clips, bolts, nuts, and other fasteners used to secure the liner around each appurtenance shall have a life span equal to or exceeding the liner or those recommended for use by the manufacturer.

6.2.2 GEOMEMBRANE INSTALLATION

6.2.2.1 Panel Identification

A panel is the unit area of geomembrane which is to be sealed in the field; i.e., a field panel is a roll or a portion of roll cut in the field. At the time of installation, the Contractor Supervisor will assign an "identification code" (number or letter-number) to each field panel consistent with the layout drawings. The field panel identification code shall be as simple and logical as possible.

1.2.2.2 Geomembrane Placement

Immediately prior to installation of the designed geomembrane liner, the clay surface shall be observed by the Contractor and Engineer. The decision to repair cracks, if any, shall be made by BP Chemicals or their representative. The subgrade shall be walked by Contractor and BP Chemicals or their representative for joint approval. The Contractor or Subcontractor performing liner installation will sign acceptance of the surface condition of the subgrade. The integrity of the underlying soils is the responsibility of the Contractor.

6.2.3 GEOMEMBRANE WELDING

Welding is not to be conducted during any precipitation, in the presence of excessive moisture (e.g., fog, dew), in an area of ponded water, or in the presence of excessive wind without the use of wind barriers. Welding is to be conducted with ambient temperatures between 34°F and 105°F. Welding may be performed at temperatures below 34°F if the ambient temperature above the liner is artificially heated, provided the liner is not damaged.

Prior to welding seams the weld type, welding machine number, and the welders name are to be recorded in daily logs. The welder is to identify on the daily logs if the weld is original or a repair (see Form No. 2 in Appendix B).







6.2.4 FIELD TESTING

6.2.4.1 Start-Up Testing

A test strip per welding machine will be made at the start of each welding period. A welding period is defined as, at a minimum, a four hour period of welding operations. This typically corresponds to the morning and attennoon. The test strip will be 4 feet in length by 2 feet in width with the seam centered lengthwise. The test strip will be cut in half with regards to length. One half will be given to the client and the other half will be tested in peel. The sample will have three 6-inch by 1-inch coupons cut from it. Test description is as follows:

Peel Test

The overlapped portion of the coupon will be pulled 180 degrees from the top portion of the coupon. The coupon will be pulled using a tensiometer. A pass is defined as film tearing bond (i.e. sheet material tears with no damage to the weld). A failure is defined as the seam peeling.

6.2.4.2 Non-Destructive Seam Continuity Testing

All field seams will be tested over their entire length using vacuum test methods, air pressure testing or other approved methods. The purpose of the nondestructive tests is to ensure the continuity of the seam. All field seam testing is to be carried out as work progresses and is not to be left to the end of all the field seaming. Vacuum testing and air pressure testing equipment and procedures are presented in the following sections.

6.2.4.2.1 Vacuum Testing

Equipment

- A vacuum box assembly consisting of a rigid housing, a transparent viewing window, a soft neoprene gasket attached to the bottom, prot hole or valve assembly, and a gauge to indicate chamber vacuum;
- o A steel vacuum tank and pump assembly equipped with a pressure controller and pipe connections;
- A rubber pressure/vacuum hose with fittings and connections;
- A bucket and wide brush or spray assembly;
- A soapy solution;

Procedure

- Energize the vacuum pump and reduce the tank pressure to approximately 5 psi (10 inches of Hg.) gauge;
- Wet a strip of geomembrane approximately 12 inches by 48 inches (0.3 m i.y 1.2 m) with the soapy solution;
- o Place the box over the wetted area;
- Close the bleed valve and open the vacuum valve;
- Ensure that a leak tight seal is created;



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- For a period of approximately 5 to 10 seconds, examine the geomembrane through the viewing window for the presence of soap bubbles;
- o If no bubble appears after 10 to 15 seconds, close the vacuum valve and open the bleed valve, move the box over the next adjoining area with a minimum 4 inches (75 mm) overlap, and repeat the process;
- o All areas where soap bubbles appear shall be marked and repaired:
- Vacuum tests are to be recorded on daily field reports.

6.2.4.2.2 Air Pressure Testing (Double Fusion Seam)

Equipment

- An air pump (manual or motor driven) equipped with pressure gauge capable of generating and sustaining a pressure between 25 and 30 psi (160 and 200 kPa);
- A rubber hose with fittings and connections;
- o A sharp hollow needle, or other approved pressure feed device.

Procedure

- Seal both ends of the seam to be tested;
- o Insert needle or other approved pressure feed device into the tunnel created by the fusion weld;
- Energize the air pump to a pressure between 25 and 30 psi (160 and 200 kPa), close valve, and sustain pressure for approximately two initiates;
- o If loss of pressure exceeds 2 psi (15 kPa), or does not stabilize, locate faulty area and repair;
- Remove needle or other approved pressure feed device and seal;
- o Record air pressure test results on daily field reports.

6.2.4.3 Destructive Testing

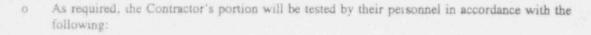
At a minimum of every 500 linear feet of field seam, destructive seam testing is to be completed. Testing procedures for the destructive testing methods are as follows:

- o A test strip, 54 inches in length by 12 inches in width, will be removed.
- Three 6-inch by 1-inch samples will be tested in peel with a manual tensiometer immediately (see Form No. 2 in Appendix B).
- The Contractor will keep 12 inches, give the QA/QC Engineer 12 inches for 3rd party testing and give BP Chemicals 12 inches to store in their archives.

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Seam strength ASTM D3083 100% of sheet yield strength

Peel adhesion ASTM D413 Film tearing bond

- o 50 coupons, 6 inches by 1-inch per sample are to be tested (see Table 1 in Appendix C).
- All areas that have been destructively tested will be repaired with patches and welded by the extrusion method and vacuum tested (See Form No. 3 in Appendix B).

6.2.5 REPAIR

6.2.5.1 Identification

All welded areas and non-welded areas will be visually inspected for irregularities, blisters, abnormalities, defects, etc. The project supervisor will locate and record the location of all damages (see Form No. 3 in Appendix B).

6.2.5.2 Verification

All repairs will be made as follows:

- Prior to repairs, a test strip will be made and tested as in Section 6.2.4.
- All damages will be repaired by the extrusion welding method.
- All patches will be nondestructively tested.
- All repairs will be recorded and located on the as-built drawings (see Form No. 3 in Appendix B).

6.2.6 GENERAL PROCEDURES

Transportation: All geomembrane rolls will be packaged and shipped under the manufacturer's supervision. Care will be taken to avoid damage of the rolls.

Delivery: No geomembrane rolls will be shipped until all required submittals have been received by the client. To avoid damage all rolls will be unloaded using nylon straps and proper equipment, such as forklifts, front end loaders, etc.

On-Site Storage: All geomembrane rolls will be stored in a staging area protected from grease, dirt, punctures, moisture, mechanical abrasions and heat.

On-Site Handling: All geomembrane rolls will be transported form the staging area to the construction area using nylon straps and proper equipment, such as forklifts, front end loaders, etc.

Anchor Trench: The anchor trench will be excavated to the lines and grades shown in the design drawings. Excavation will not exceed the amount to be lined in two (2) days. The anchor trench will be compacted as per the technical specification.

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Bolting: All bolting will be done as per details in the design drawings. All batten strips will be visually inspected to assure compression of the neoprene gasketing. All batten strips will be tapped in the ceuter between two bolts, with a ballpeen hammer. A high pitched ringing sound indicates proper pressure between the strip and the gasket. A low pitched sound indicates a lack of pressure between the strip and the gasket. All anchor bolts are to be re-checked for tightness using a standard ratchet assembly.

Layout Drawings: Layout drawings will be made and submitted to the client prior to start-up of construction. All layout drawings will be strictly adhered to. No changes will be made unless agreed to by the client.

Panel Placement:

- The equipment used in handling the geomembrane shall not cause any damage to the geomembrane.
- The equipment used in handling the geomembrane shall not damage the sub-base.
- Persons working on the geomembrane shall not smoke, wear damaging shoes or involve themselves in activities that may damage the geomembrane.
- All edges of the geomenibrane will be properly weighted to avoid uplift due to wind.
- Traffic across the geomembrane will be minimized. All areas exposed to traffic will be protected by a minimum one (1) foot of soil cover.
- All damages will be recorded and located on the as-built drawings.
- All damages will be repaired in accordance with the quality assurance/quality control specification.
- Geomembrane panels will not be placed in excessive winds.

6.2.7 FIELD WELDING

6.2.7.1 General Conditions

In general, seams should be oriented parallel to the line of maximum slope; i.e., oriented along, not across, the slope. In corners and odd-shaped geometric locations, the number of seams should be minimized. No horizontal seam should be less than 5 feet (1.5 m) from the toe of the slope or areas of potential stress concentrations unless otherwise authorized.

All seams will have a seam number that corresponds with the panel numbers. Seam numbers will be derived from the combination of the two panel numbers that are to be welded together.

All seams will have minimum overlap of 4 inches (100 mm) for fusion welding and 3 inches (75 mm) for extrusion welding.

All seams will be free of dirt, moisture, grease or any foreign substance.

All seams that are to be extrusion-welded will be cleaned of oxidation. This will be done by using a hand grinder with 80-grit sanding discs. Care will be taken as not to damage the geomembrane.

"Fishmouths" or wrinkles at the seam overlaps shall be cut along the ridge of the wrinkle in order to achieve a flat overlap. The cut "fishmouths" or wrinkles shall be seamed and any portion where the overlap is inadequate shall then be patched with an oval or round patch of the same geomembrane extending a minimum of 6 inches beyond the cut in all directions.

If an extrusion welder is stopped for longer than one minute, it will be purged to remove heat-degraded extrudate.

All fusion welded seams must extend to the outside edge of panels.

All fusion welded "T" seams (i.e. the result of geomembrane panels placed perpendicular to each other) will be double welded. The extrusion process will be used for the second weld.

All extrudate rod will be free of dirt, dry and protected from damage.

6.2.7.2 Welding Equipment

All welding machines will undergo a regular maintenance program. If the project exceeds three months in length, welding machines are to be sent back to the shop for maintenance. All welding machines will be accompanied by parts for repairs on site. All project are to be equipped with an extra welding machine in case of a major breakdown.

Extrusion Process: All extruders will be equipped with temperature gauges at the barrel and the nozzle. These temperature gauges will be monitored hourly to assure the proper temperatures are maintained. All extruders will be equipped with a pre-heat assembly. The pre-heat assembly will be equipped with a temperature gauge. The pre-heat assembly will be monitored with the extrusion process.

Fusion Process: The apparatus will be an automated vehicular-mounted device. All fusion welders will be equipped with a temperature gauge at the wedge. The temperature will be monitored hourly to assure the proper temperature is maintained.

Hot Air Process: The apparatus will be an automated vehicular-mounted device. All hot air welders will be equipped with a temperature gauge with the capability to monitor the temperature of the air. The temperature will be monitored hourly to assure the proper temperature is maintained.

Electric generators: All generators will be placed on a smooth base to avoid damage to the geomembrane. The generator will have a minimum wattage of 10kw per welder.

The electric cable used to operate the welding machines will be no longer than 150 feet and be of no. 10 gauge.

There will be at least one spare welding machine for every three (3) welding crews.

6.2.8 GEOMEMBRANE ACCEPTANCE

At various stages of the project the Contractor will submit to the client the following information:

- Qualifications
- Resumes of key personnel
- Manufacturer's resin certification
- Mill Certificates for manufacture of membranes
- Daily checklists

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- Records of field welding
- Damage and repairs report
- Field weld samples and start up test samples
- Daily Field Reports
- Subgrade acceptance forms
- Contractor's warranty
- As-built drawings outlining
 - o Panel layout
 - o Seam layout
 - o Location of repairs

6.3 QUALITY ASSURANCE

6.3.1 SUBMITTALS FROM RESIN AND GEOMEMBRANE MANUFACTURER

All project specific information regarding the properties of the resin and geomembrane sheets will be reviewed by the project manager or the designated representative. The resin geomembrane manufacturers must submit sampling procedures, sampling frequency, testing methods and test results. Any materials not conforming to the specifications will be rejected. All acceptable results will be forwarded to the client and a copy held on file until the completion of the project. Upon completion of the project, the file will be stored in the company's archives for the duration of the warranty.

6.3.1.1 Requirements of Resin Suppliers and Membrane Manufacturers

Prior to Bid, the Manufacturer shall supply the following to the Contractor:

- A list of at least 15 projects totaling a minimum of 10 million square feet.
- Copy of the quality control program for membrane manufacture.
- Information of daily production capacity.
- Certification that the material to be manufactured will meet the specifications.

After Contract Award, the Manufacturer shall supply the following to the Contractor:

- Submittals from resin supplier reporting results of required testing (see Section 6.2.1).
- Production date of resin.
- Statement that no reclaimed polymer was added to resin.
- Submittals from geomembrane manufacturer reporting results of required testing (see Section 6.2.1.2).

6.3.2 FIELD LOGS AND DOCUMENTATION

Daily field logs will be kept by the Contractor Supervisor. All daily logs will be submitted to the Engineer or representative at the beginning of each week. The logs will be reviewed by the managing personnel to follow the day's events. (production, meetings, unique problems, etc.) (see Appendix B).

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As production advances, all documents in Appendix B will be completed. All documents will be reviewed by the project manager or the designated representative to assure the quality control program is properly implemented. A copy of each document will be made and kept on file until the project is complete. Upon completion all files will be stored in the company's archives for the duration of the warranty. The originals will be forwarded to the client.

6.3.3 REQUIREMENTS FOR FIELD PERSONNEL

All field supervisors will have a minimum of five (5) years experience as a supervisor in various fields of construction.

A welder will be classified as a Master Welder only after he/she has successfully welded a minimum of five (5) million square feet of geomembrane.

All apprentice welders will undergo the following training before being allowed to weld on site:

- A series of lectures on the importance of quality.
- A series of lectures an the different types of welding techniques.
- Successfully weld several thousand square feet of geomembrane.

6.4 GENERAL PROCEDURES

Layout Drawing:

Prior to start up of construction, a plan drawing will be prepared. The drawing will outline the following:

- Panel layout
- Seam Layout
- Details of anchor trench and drilling and bolting to structures and pipe.

Pre-Bid Submittals

Prior to submitting proposal, Contractor will supply the following:

- Qualifications
- Personnel Resumes
- Project List Outlining
 - o Project location
 - o Client referral
 - o Type of material
 - o Application
- Sample warranty
- Welding and testing description



Post-Bid Submittals

After award of the contract, Contractor will supply the following:

- Quality Control/Quality Assurance Manual
- layout drawings as outlined above
- Manufacturer's submittal.
- Subgrade acceptance certification

Pre-Construction Meeting

Prior to start-up of construction, a meeting will be held at the site or at a location decided by the client. At a minimum, the meeting will be attended by a Contractor representative, the design engineer, the quality control/quality assurance engineer and a representative of the client. The purpose of the meeting is to:

- Review responsibilities
- Review authorities
- Establish proper communications
- Review time schedule
- Review methods of operations
- Present and review geomembrane layout drawings

1. 4

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7.0 LEAK DETECTION AND LEACHATE COLLECTION SYSTEM

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7.0 LEAK DETECTION AND LEACHATE COLLECTION SYSTEM

7.1 INTRODUCTION

This section addresses the quality assurance for the installation of the leak detection and leachate collection systems used in the containment of liquids and solids.

7.2 PRECONSTRUCTION

7.2.1 MATERIALS

Verify that the contractor has submitted the items listed below.

- Manufacturer's certificates for the geosynthetic materials in accordance with project specifications, and as listed below in this section.
- b. Product data on pipe underdrains and accessories in accordance with project specifications, and as listed below in this section.
- c. Borrow material test reports in accordance with project specifications, and as listed in Section 5.0 "Compacted Clay Layers," of this document.

7.2.1.1 HDPE Geomembrane

Verify for the underlying geomembrane material, that documentation of satisfactory installation is complete in accordance with the requirements presented in Section 6.0 "Geomembrane Liner Installation" of this document.

7.2.1.2 Geonet

Designate locations on rolls from which samples are to be taken. Verify on the basis of test data furnished by contractor that the geonet material is first quality high density polyethylene (HDPE) resin and at a minimum has the properties listed below. Complete geonet material checklist (Form 7-1 in Appendix A) for each batch of material furnished.

	SPECIFICATION	STANDARD	TESTING FREQUENCY
4,1	Melt Index (ASTM D 1238)	1.1 g/10 min	1/batch of resin
2	Density (ASTM D 1505)	0/93 g/cc	1/batch of resin
	Carbon Black Content (%) (ASTM D 1603)	2 to 3%	1/batch of resin
	Standard Crush Strength (min) (ASTM D 1621)	7000 psf	1/batch of resin
5.	Transmissivity (ASTM D 4716-87) ¹	10 gal/min/ft (see note 2) 5 gal/min/ft (see note 3)	1/10,000 ft ²

Drainage gradient of 0.02 to 0.25, pressure of 10,000 psf, and seating time of 15 min.

² HDPE above and below.

³ HDPE below and geotextile and soil above.

Review placement diagram furnished by contractor and approve or comment on it.

7.2.1.3 Geotextile

Designate location on rolls from which samples are to be taken. Verify on the basis of test data that the geotextile material is made of polypropylene and has the properties listed below. The geotextile material used between the protective sand layer and the geonet shall be of the woven type. Geotextile used as a separator between soil layers is to be of the nonwoven type. Complete geotextile material checklist (Form 7-2 or 7-3 in Appendix A) for each batch furnished.

	SPECIFICATION	STANDA Non Woven	<u>ARD</u> Woven	TESTING FREQUENCY
1.	Mass per unit area (min) (ASTM D 3776)	8 oz/yd²	8 oz/yd²	1/10,000 ft ²
2.	Permeability (ASTM D 4491)	1.6 to 1.9 sec-1	NR	1/10,000 ft ²
3.	Puncture (min) (ASTM D 3787)	100 lbs	1500 lbs	1/:0,000 ft ²
4.	Mullen Burst (min) (ASTM D 3786)	245 psi	1100 psi	1/10,000 ft ²
5.	Trapezoid Tear Strength (min) (ASTM D 4533)	95 Ibs	190 lb	1/10,000 ft ²
6.	Grab Tensile/Elongation (ASTM D 4632)	203 to 225 lbs/50%	400/25 %	1/Roll
7.	Wide Width Strip (ASTM D 4595)	105 lb/in	290 lb/in	1/10,000 ft²
8.	UV Resistance (500 hrs) (ASTM D 4355)	>80% strength retained	>85% strength retained	1/Resin Batch
9.	Flow Rate (ASTM D 4991)	NR	50 gpm/ft ²	
10.	Apparent Opening Size (ASTM D 4751)	NR	40 sieve	

Review placement diagram furnished by contractor and approve or comment on it.

7.2.1.4 Pipe

Verify that the pipe material delivered is in accordance with project specifications. Verify that the pipe fittings and appurtenances are of the same material and are designed for the tubing furnished.

7.2.1.5 Backfill

Verify on the basis of test data furnished by contractor that the delivered backfill materials for pipe trenches and sumps are in accordance with project specifications and drawings.

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7.3 CONSTRUCTION

7.3.1 GEONET

Verify that the following are complied with during installation. Complete installation checklist. Panel number should be taken from approved placement drawing. Number rolls sequentially from anchor trench. Complete no less than one checklist per shift.

- a. HDPE liner below is clean, undamaged and straight.
- b. Geonets are handled in such a manner as to ensure they are not damaged in any way.
- c. On slopes, geonets are anchored in the anchor trench; then rolled down the slope in such a manner as to continually keep the material in tension.
- d. In the presence of wind, the materials are weighted with sandbags until final covers are installed.
- e. Care is taken to assure that any underlying layers are not damaged during placement.
- Care is taken to assure that stones, mud, and dirt are not entrapped in the geonet during placement and seaming operations.
- g. Geonets are butt joined or lapped, and that nylon cable ties are applied to the net edge at 5-foot intervals along the edge.
- h. On slopes, the ends overlap 2-feet and two rows of cable ties are applied.
- 1. On bottoms, the ends overlap a minimum of 2-inches and one row of three cable ties are applied.
- Material is placed in accordance with approved placement diagram.
- 7.3.2 GEOTEXTILE

Verify that the following are complied with during installation. Complete installation checklist. Panel number should be taken from approved placement drawing. Number rolls sequentially from anchor trench. Complete no less than one checklist per shift.

- For geotextile placed over geonet, make sure geonet is undamaged and free of dirt or other obstructions which could block drainage.
- b. Geotextile is handled in such a meoner as to ensure it is not damaged in any way.
- c. On slopes, geotextiles are anchored su the anchor trench; then rolled down the slope in such a manner as to continually keep the material in tension.
- d. In the presence of wind, the materials are weighted with sandbags until final covers are installed.
- e. Care is taken to assure that any underlying layers are not damaged during placement.
- Care is taken to assure that stones, mud, and dirt are not entrapped in the geotextile during placement and seaming operations.



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- g. Geotextiles are installed per manufacturer's recommendation for this type of installation or use.
- h. If sewing is required, the thread is a material with chemical resistance similar to the geotextile, and as recommended by the manufacturer.
- 1. Material is placed in accordance with approved placement diagram.

7.3.3 PIPE TRENCHES AND SUMPS

Verify that the following are complied with during construction. Complete installation checklist. Each pipe section recorded should be a continuous unit. Station from lowest end of pipe.

- a. The geomembrane and geonet materials on which the trenches are installed are undamaged and clean.
- b. Pipe is placed on the bedding material (Type G-Rounded Stone) to the established line and grade.
- c. Pipe is lain with the perforations at the lower quarter points of the section.
- d. Jointing of pipe and closure of upstream ends is made with the specified couplings and end caps; and, that the downstream end of the pipe shaft is connected to the drainage structures by methods recommended by the manufacturer.
- e. The pipe is bedded in and the trench is backfilled with Type G-Rounded Stone to the specified depth, care is taken to avoid damage or displacement of the pipe, the geotextile is folded into place and lapped as shown on the construction drawings, and excess fabric is trimmed and removed.
- Slopes, widths, depths, and other dimensions of the system are in accordance with project plans and specifications.
- g. Backfill is placed in such a manner as to prevent accidental damage to the geosynthetic materials or mixing of the backfill materials.
- h. Check each section for straightness by lamping before proceeding with the next section.
- i. Backfilling of the leachate collection system is completed by placing Type D-Sand above the woven geotextile as shown on the construction drawings.

7.4 POST CONSTRUCTION

7.4.1 SURFACE PROTECTION

Following construction verify that contractor has taken adequate precautions to observe that dust does not accumulate on surface of geotextiles or geonets.

7.4.2 TESTING

After installation is complete pour water in from all sides of liner at crest of slope and verify return in sump and proper operation of leak detection system.



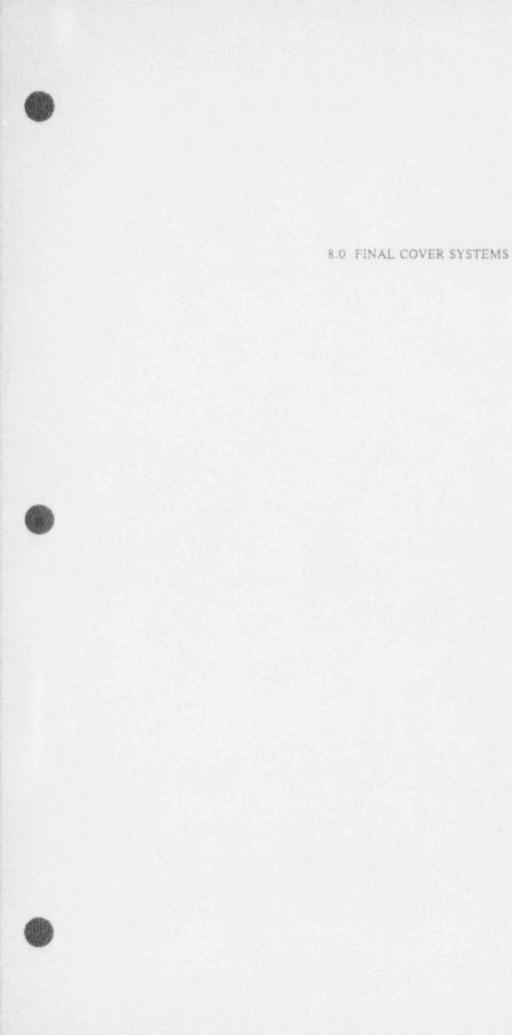


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8.0 FINAL COVER SYSTEMS

8.1 INTRODUCTION

This section addresses the quality assurance for the installation of the final cover system. This section will provide assurance that all layers of the final cover are uniform and damage-free and that the materials and construction of each layer are as outlined in the design specifications.

Various components of the final cover system are addressed in previous sections of this document. These sections are referenced where appropriate.

8.2 PRECONSTRUCTION

8.2.1 MATERIALS

8.2.1.1 Contractor Submittals

Verify that the contractor has submitted the items listed below.

- Manufacturer's certificates for the geosynthetic materials in accordance with project specifications, and as listed in section 7.0 of this document.
- b. Borrow material test reports and/or manufacturer's certificates for the clay, Type D sand, Type E select backfill, topsoil, fertilizer, lime, seed, mulch, and geotextile netting in accordance with project specifications.

8.2.1.2 Compacted Clay Layer

Verify that the material to be used for the compacted clay layer conforms to the specification requirements in accordance with the procedures in Section 5.0 of this document.

8.2.1.3 HDPE Geomembrane

Verify that the geomembrane material to be used conforms to the specification requirements in accordance with the procedures in Section 6.0 of this document.

8.2.1.4 Drainage Layer of Type D Sand

8.2.1.4.1 Type D Sand

Verify on the basis of test data that the Type D sand is in accordance with project specifications. Complete backfill material checklist (Form 8-1 in Appendix A).

8.2.1.5 Geotextile

Verify that the geotextile conforms to the specifications in accordance with the criteria specified in Section 7.0 of this document.

8.2.1.6 Type E Select Backfill

Verify on the basis of test data that the Type E Select Backfill is a granular material, maximum particle size of

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3 inches graded from coarse to fine, conforming to classification A-1, A-2-4, A-2-5 or a sandy or gravely clay conforming to classification A-2-6 or A-6 with the exception that the plasticity index will not exceed 20. Complete backfill material checklist (Form 8-1 in Appendix A).

8.2.1.7 Topsoil Cover

Verify on the basis of test data that the topsoil material has the characteristics listed below. Complete backfill material checklist (Form 8-1 in Appendix A).

- a. Is free of roots, rocks larger than 1/2" in diameter, subsoil, debris, large weeds and foreign matter.
- b. Has an acidity range (pH) of 5.5 to 7.5.
- Contains a minimum of a 4 percent and a maximum of 25 percent inorganic matter.

8.2.1.8 Topsoil Seeding

8.2.1.8.1 Fertilizer

Verify that the fertilizer used for the cover is 20-15-15 analysis in the spring or 10-20-20 analysis in the fall.

8.2.1.8.2 Lime

Verify that the lime to be used to achieve correct pH consists of agricultural or dolomite ground limestone or pelletized limestone with a total neutralizing potential (TNP) of 90+. In no circumstances will hydrated, calcined lime or limestone sludges may be substituted for agricultural or dolomitic lime.

Verify that the quantity of lime to be used on the topsoil cover is determined by tests that are conducted on the topsoil after the topsoil has been placed.

8.2.1.8.3 Seed

Verify that the standard permanent cover mixture of seeding for the cover in the fall consists of timothy, wheat, alsike clover and red clover in the relative amounts shown below. A fall temporary cover mixture is provided to allow for erosion protection if the permanent cover cannot be established. A spring permanent cover mixture is provided is provided if spring seeding is required at the site.





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1 PLS = pure live seed. Note: Use only a high-purity seed with high germination percentage. *And appropriate rhizobium inoculant.

8.2.1.8.4 Mulch

Verify that materials for mulching are straw or hay, and they are reasonably free of weed seed and such foreign matter as may detract from their effectiveness as a mulch or injuries to desired plant growth.

8.2.1.8.5 Geotextile Netting

Verify that geotextile netting is AMXCO erosion control netting manufactured by the American Excelsior Company in Arlington, Texas.

8.2.2 FIELD OBSERVATION

8.2.2.1 Foundation

Verify that inspection has been performed of all foundation surfaces (solidified sludge or compacted

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contaminated soil) to ensure they have been constructed to meet or exceed the specified design. To minimize the potential for future differential settlement or subsidence and resultant final cover system damage, inspect the supporting surface with the contractor and engineer in order to identify areas that require corrective measures prior to the installation of the clay liner. A surface area that exhibits variations greater than 6 inches will be considered in need of corrective action. Corrective action will consist of filling these depressions with compacted clay material to obtain a smooth surface.



8.3 CONSTRUCTION

8.3.1 COMPACTED CLAY LAYER INSTALLATION

Inspect the installation of the compacted clay layer in accordance with the requirements of Section 5.0 of this document.

8.3.1.1 HDPE Membrane

Verify that the HDPE membrane is installed as specified in accordance with procedures in Section 6.0 of this document.

8.3.1.2 Drainage Layer of Type D Sand or a Geonet

8.3.1.2.1 Type D Sand

Verify that the Type D sand is placed on the geosynthetic membrane as shown on the construction drawings and in accordance with project specifications following the compaction procedures in Section 5.0 of this document.

8.3.1.3 Geotextile

Verify that the geotextile is installed as specified in Section 7.0 of this document.

8.3.1.4 Type E Select Backfill

Verify that the Type E Select Backfill is placed on the geotextile as shown on the construction drawings and in accordance with project specifications following the compaction procedures in Section 5.0 of this document. Pay careful attention to avoidance of overcompaction.

8.3.1.5 Topsoil Cover

Verify that the topsoil is disced with ordinary field-finishing implements such as a tandem spring rake or tandem disc harrow provided the equipment can mix at a consistent 5 or 6 inch depth; mixing is done when clean fill exhibits a dry or semi-dry consistency; and mixing is not attempted immediately following rainfall, to avoid incomplete mixing of the cover soil material.

8.3.1.6 Topsoil Seeding

8.3.1.6.1 Fertilizer

Verify that application of the fertilizer over the area is done at a rate of 300 pounds per acre of 20-15-15 analysis (spring application) or 10-20-20 analysis (fall application) fertilizer. This is the equivalent of 6.9 pounds of fertilizer per 1,000 sq.ft. The fertilizer can be applied from a spreader (hopper) of broadcast as long as a uniform application rate can be maintained.

8.3.1.6.2 Lime

Verify that lime is applied to the topsoil cover in quantities as determined by testing the topsoil; and, the lime is spread prior to seeding the soil cover, during the active growing season, and during dry weather.



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8.3.1.6.3 Seed

Verify that seed is spread from a broadcast spreader or hydroseeder as required.

8.3.1.6.4 Mulch

Verify that within 24 hours after seeding, the vegetative mulching material is evenly placed over all seeded areas at the rate of approximately 3,100 pounds (1.55 tons) per acre for straw, or 2.3 tons per acre for hay. This is the equivalent of 71 pounds of straw per 1,000 sq ft or 106 pounds of hay per 1,000 sq ft.

8.3.1.6.5 Geotextile Netting

Verify that seeded and mulched areas susceptible to storm erosion forces and out slopes having slope gradients equal to or steeper than 4:1 (H:V) are covered with geotextile netting of a polypropylene type (3/4 to 1/2 inch mesh weave); and, the seccing and mulching is completed within 24 hours of the final grading. If conditions warrant a longer period, verify that a geotextile netting is placed immediately, over the entire cover areas, to protect the soil, seed, and mulch. The netting is placed over the mulch or soil and fastened to the ground with 8-inch wire staples (available through the netting supplier) affixed at 2-foot intervals along the netting rolls

Verify that once prepared with netting, reseeded areas are protected from any vehicular traffic which could destroy or degrade the protection provided by the geotextile netting.

8.3.1.7 Watering

Verify that after completion of installation of fertilizer, seed, lime, mulch and erosion control netting, the newly seeded area are watered in accordance with the items listed below.

- a. Watering of the seeded area is accomplished using either canvas "soaker" hoses laid in parallel across the seeded area and connected to a source of potable water, or the flat ribbon "spray" hoses connected to a source of potable water.
- b. The site is watered sufficiently to provide at least 1-1/2 inches of water per week during the first three weeks of cover vegetation establishment.
- c. An estimate of the amount of water delivered to the seeded area is obtained by placing several plastic rain gauges (to collect water) on the seeded portion of the site.
- d. Care is taken during watering to prevent complete soil saturation. Generally, more frequent watering of short time duration is more successful that prolonged watering periods.
- e. Watering from mud-day to late afternoon is avoided to prevent scorching of germinated seedings.

8.3.2 FIELD OBSERVATION

Throughout construction of the system, observe the system installation to ensure the items listed below are performed.

- Slopes, widths, depths and other dimensions of the system are in accordance with project plans and specifications.
- b. The application process is uniform.

- . Type E Select Backfill and topsoil are not overly compacted.
- d. Throughout construction of the compacted clay layer, requirements specified in Section 5.0 of this document are followed.

8.4 POSTCONSTRUCTION

Conduct a visual check of the completed cover to ensure that it meets the specified design. Verify that slopes are surveyed and any unusual depressions are noted and corrected.

Continue inspection of the cover until it has been ascertained that a vegetation cover has been reasonably well established. Verify that grass and ground cover is inspected once a month by a qualified specialist during the first 4 to 6 months following germination; and, at that time, a final check of the cover is made to ensure that it is as specified.





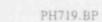
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9.0 DOCUMENTATION

9.1 INTRODUCTION

This section addresses the documentation requirements of the QA/QC plan for the Mixed Waste Pond Closure Project.

9.2 DAILY RECORDKEEPING

9.2.1 DAILY FIELD LOGS

Daily field logs shall be kept by each of the contractor supervisors as well as the engineer or his designated representative and the BP project inspector. The logs will include information to document the day's events (production, meetings, unique problems, etc.). Copies of the contractor daily logs will be submitted to the BP project inspector and engineer, or his designated representative, on Monday of each week.

9.2.2 DAILY SUMMARY REPORTS

Daily summary reports shall be completed by the engineer, or his designated representative. The reports will summarize the information contained in the field logs and checklists to characterize each day's events (production, meetings, unique problems, etc.). All daily field reports shall be submitted to management personnel as they are completed.

The daily summary reports shall be written on Form 9-1 in Appendix A; or, an approved equivalent which provides blanks and/or space for the following:

- o Unique identifying sheet number for cross-referencing and document control.
- o Date, project name, location, and other identification that may be useful.
- o Data or weather conditions (temperature, cloudiness, wind, etc.).
- o Reports on any meetings held and their results.
- Unit processes and locations of construction underway during the time-frame of the daily summary report.
- o Equipment and personnel being worked in each unit process, including subcontractors.
- o Descriptions of areas or units of work being inspected and documented.
- Descriptions of off-site materials received, including any quality verification (vendor certification) documentation.
- o Calibrations, or re-calibrations, of test equipment, including actions taken as a result of re-calibration.
- Decisions made regarding approval of units of material or of work, and/or corrective actions to be taken in instances of substandard quality.
- Unique identifying sheet numbers of inspection data sheets and/or problem reporting and corrective measures reports used to substantiate the decisions described in the preceding item.



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o Signature of the engineer, or his designated representative (author).

9.2.3 INSPECTION DATA SHEETS

All observations, and field and/or laboratory tests, by the contractor's approved testing agency or the BP Inspector, shall be recorded on an inspection data sheet. All inspection data sheets shall be submitted to the BP Inspector. The inspection data sheets will either be forms contained in this document or a separately prepared document which contains at least the following information:

- o Unique identifying sheet number for cross-referencing and document control.
- o Description or title of the inspection activity.
- o Location of the impection activity or location from which the sample increment was obtained.
- Type of inspection activity; procedure used (reference to standard method when appropriate).
- Recorded observation or test data, with all necessary calculations.
- Results of the inspection activity; comparison with specifications.
- Personnel involved in the inspection activity.

The inspection data sheet will include a signature block for the following:

- Signature of the appropriate inspection personnel who performed the inspection or observation.
- Signature of the contractor management confirming knowledge of the inspection data sheet contents.
- o Signature of the engineer.

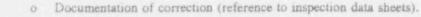
9.2.4 PROBLEM IDENTIFICATION AND CORRECTIVE MEASURES REPORTS

A problem is defined herein as material or workmanship that does not meet the specified design. Problem Identification and Corrective Measures Reports shall be cross-referenced to specific inspection data sheets where the problem was identified. All Problem Identification and Corrective Measures Reports shall be submitted to the engineer, or his designated representative, at the time of observation or inspection. The Problem Identification and Corrective Measures Reports will include the following information:

- o Unique identifying sheet number for cross-referencing and document control.
- o Detailed description of the problem.
- o Location of the problem.
- o Probable cause.

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- o How and when the problem was located (reference to inspection data sheets).
- o Estimation of how long problem has existed.
- o Suggested corrective measure(s).



- o Final results.
- o Suggested methods to prevent similar problems.

The report will contain a signature block for the following:

- o Signature of the appropriate inspection personnel who performed the inspection or observation.
- Signature of the contractor management confirming knowledge of the Problem Identification and Corrective Measures Report contents.
- o Signature of the engineer.

9.3 ACCEPTANCE OF COMPLETED COMPONENTS

All daily summary reports, inspection data sheets, problem identification and corrective measures reports, and other relevant documentation shall be reviewed by the engineer, or his designated representative. The documentation shall be evaluated and analyzed for internal consistency and for consistency with similar work. Review of these documents shall be timely in order to permit errors, inconsistencies, and other problems to be detected and corrected as they occur, when corrective measures are easiest.

The above information shall be assembled and summarized into periodic Acceptance Reports. The Acceptance Reports shall indicate that the materials and construction processes comply with the specific design. These materials shall be included in project records and submitted to the owner.

9.4 FINAL DOCUMENTATION

At the completion of the project, the owner will submit a final report to OEPA. This report will include all of the daily summary reports, inspection data sheets, problem identification and corrective measures reports, acceptance reports, deviation from design and material specifications (with justifying documentation), and asbuilt drawings. This document shall be certified correct and included as part of the closure certification package prepared by the engineer.

9.5 STORAGE OF RECORDS

During construction for the BP Chemicals mixed waste pond closure project, the project records will be kept onsite by the contractor, at another location on the plant property by the owner and at an offsite location by the engineer and in the offices of the Ohio EPA. This includes the project manager's copy of the design criteria, plans, and specifications, the QA/QC plan, and the originals of all the data sheets and reports. The duplicate records kept at various locations will avoid loss of this information if the originals are destroyed.

Once the project is complete, all files will be stored in the company's archives for the duration of the warranty.





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NUS LABORATORY DIVISION OF HALLIBURTON NUS CORPORATION

QUALITY ASSURANCE PROJECT PLAN FOR ANALYSIS OF MIXED WASTE SAMPLES FROM THE POND CLOSURE PROJECT AT BP CHEMICALS, INC. LIMA, OHIO



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NUS LABORATORY DIVISION OF HALLIBURTON NUS CORPORATION

QUALITY ASSURANCE PROJECT PLAN FOR ANALYSIS OF MIXED WASTE SAMPLES FROM THE POND CLOSURE PROJECT AT BP CHEMICALS, INC. LIMA, OHIO

Joanne Simanic Laboratory Director

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Quality Assurance Project Plan Distribution:

Joanne Simanic Laboratory Director, NUS Laboratory

Lisa Manning Quality Assurance Manager, NUS Laboratory

Sandra L. Whitney Project Manager, NUS Laboratory

Charles Kieda Technical Director, NUS Laboratory

Richard Capp Tracey Colbert Jonathan Talbott Group Leaders, NUS Laboratory

Sidney Rasnick Project Manager, HALLIBURTON NUS Corporation

William Rupert Program Manager, BP Chemicals, Inc.

Brtt Quinby Civil Engineer, Dames & Moore

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PROJECT DESCRIPTION

The BP Chemicals Inc., Lima, Ohio facility has four surface impoundments (i.e., ponds) which contain sludges classified as radioactive and hazardous mixed wastes under the Atomic Energy Act of 1957, as amended, and the Resource Conservation and Recovery Act, respectively.

Waste streams from the acrylonitrile manufacturing process fed into the ponds. Until 1971, the acrylonitrile manufacturing process utilized a catalyst which was produced from depleted uranium. This uranium, in the form of uranium oxide is the source of radioactivity in the ponds. Since it is virtually insoluble, all of the radioactivity is contained in the sludge.

The four ponds were permitted under the interim status provisions of RCRA and were listed on BP Chemicals America, Inc. (BPC) 1980 Part A permit application. The ponds were also included in the U.S. Nuclear Regulatory Commission (NRC) license granted to BPC and its predecessor companies for the possession of depleted uranium for use in the catalyst. The ponds and their waste stream sources are as follows:

POND	SOURCE OF INFLUENT
1. Burn Pond	Rainwater, off-specification acetonitrile waste, Barex Plant sludges
2. Deepwell Pond	Acrylonitrile process wastes including bottom stream from waste stripper, bottom stream from acetonitrile column and bottoms from acetonitrile purification column.
3. Celite Pond	Excess waste from Deepwell Pond and spilled acrylonitrile waste.
4. V-1 Pond	Caustic cleaning wastes.

The location of each of the ponds is illustrated in Figure 3-1. Waste streams have been withdrawn from the ponds in accordance with applicable regulations. Wastes are now stored in above-ground tanks prior to disposal. These tanks are permitted in accordance with applicable regulations.

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The Closure Plan for the BPC site has been prepared by Dames & Moore. The objective of the clean closure is to remove contaminated soils until the concentrations of all hazardous constituents in the ponds are below acceptable "clean levels". "Clean levels" are defined as less than or equal to the Method Detection Limit as defined in Section 3.11.2 of the Ohio EPA Closure Plan Review. Section 3.11.2 states that, since a constituent's analytical detection limit in soil is dependent upon the characteristics of the matrix, analytical detection limits must be developed by the analytical laboratory at the time the sample is analyzed using SW-846 methods.

NUS Laboratory has been selected by BPC to provide analytical support for the Closure project. As described in the Closure Plan, the sludges in the four ponds will be excavated and treated, and the underlying soils will be sampled and analyzed for target parameters (Table 3-1). In order to minimize the post-closure footprint of the ponds, the sludges from all four ponds will be consolidated into the Celite and V-1 Ponds.

To estimate the amount of contaminated soil which must be removed from the four ponds, soil sampling and analyses will be performed. Samples will be taken using split spoon samplers from each impoundment area after the sludges have been removed, and the underlying clay has been exposed. The excavated area will be surveyed for radiological contamination and the samples will be screened in the field for organic contamination. On-sight screening (i.e., volatile headspace analysis using an OVA) for acetonitrile will be performed by BP Chemicals, Inc. or contractor personnel. If on-sight screening indicates gross contamination, excavation will continue until "clean levels" are indicated.

The minimum number of 2-foot split spoon samples is estimated to be 63. Each 2-foot sample will be split into 1-foot samples for a total of 126 soil samples. Each soil sample which is sent to NUS Laboratory, Pittsburgh will be analyzed for the parameters listed in Table 3-1. The analytical results of this effort will be compared to "clean" soil levels as specified in the project Closure Plan (concentration limits and/or as estimated through a health based risk assessment). If the results indicate higher concentrations than those established for the clean levels, then additional samples will be taken in the respective areas. Additional samples will be obtained and analyzed until acceptable contaminant concentration levels are reached.

It is anticipated that the sampling and analytical work for this project will take eight to sixteen weeks spread out over three to six months. Timing is dependent in the completion of the waste excavation effort preceding sampling and analysis.

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TABLE 3-1 PARAMETERS FOR SOIL SAMPLES

Uranium-238

Volatile organics -

Acetone Acetonitrile Acrylonitrile Benzene 1,1-Dichloroethylene Methyl ethyl ketone Tetrachloroethylene 1,1,1-Trichloroethane Trichloroethylene Bromomethane 1,1-dichoroethane Vinyl chloride

Semivolatile Organics -

Pyridine Methyl naphthalene

RCRA Total Metals

Arsenic Barium Cadmium Chromium Lead Mercury Selenium Silver

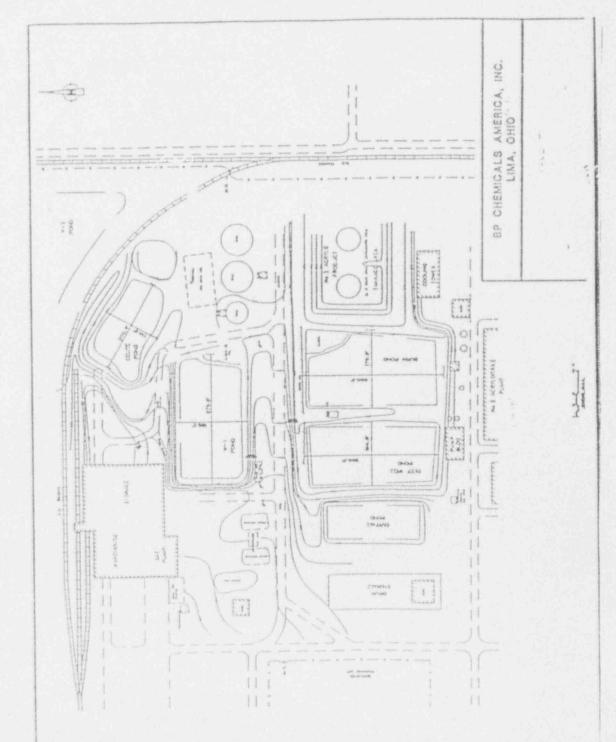
Cyanide



pH

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FIGURE 3-1 BP CHEMICALS, INC. LIMA, OHIO



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PROJECT ORGANIZATION AND RESPONSIBILITY

1.0 PURPOSE AND APPLICABILITY

NUS Laboratory, a division of HALLIBURTON NUS Corporation, is located in Pittsburgh, Pennsylvania. Figure 4-1 presents the laboratory's organizational chart. This section depicts the organizational structure, functional responsibilities, levels of authority, and lines of communication for activities affecting quality within the laboratory.

Discussed below are those individuals who will be directly involved in the analytical support required for the BPC project. These individuals will be responsible for the collection of valid data, as well as the routine assessment of measuring systems for precision and accuracy.

2.0 RESPONSIBILITIES

2.1 QUALITY ASSURANCE DEPARTMENT

- Lisa Manning, Quality Assurance Manager
 NUS Laboratory
 5350 Campbells Run Road
 Pittsburgh, PA 15205
 Phone: 412-747-2501
- Gregory Malzone, Quality Assurance Coordinator NUS Laboratory
 5350 Campbells Run Road
 Pittsburgh, PA 15205
 Phone: 412-747-2551
- Jeff Otte, Quality Assurance Representative NUS Laboratory
 5350 Campbells Run Road
 Pittsburgh, PA 15205
 Phone: 412-747-2542

The quality assurance department is responsible for ensuring that the data produced by the laboratory meets standards set by State and Federal regulations as well as those established by HALLIBURTON NUS

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Corporation and BP Chemicals, Inc. Responsibilities of the Quality Assurance Department include the following:

- Conducting independent QA review of laboratory data
- Reviewing all QC procedures, documentation, and corrective actions
- maintaining standard operating procedures and laboratory QA/QC manual; and
- Conducting internal laboratory performance audits
- Statistically analyze QC results and update control limits, including trend analyses, to determine the ongoing validity of analytical systems

2.2 OPERATIONS DEPARTMENT

2.2.1 Project Manager

Sandra L.Whitney Two Marquis Plaza - Suite 200 5313 Campbells Run Road Pittsburgh, PA 15205 Phone: 412-747-2555

The project manager will be responsible for all analytical work and will work in conjunction with the QA unit. He will maintain liaison with the QA officer regarding QA and custody requirements. Specific duties include:

- Preparing the BP Chemicals, Inc. Pond Closure Project specific workplans required by the scope of the project.
- Reviewing sample log-in for the BP Chemicals, Inc. Pond Closure Project.
- Developing the project-specific protocols in coordination with the laboratory technical director.

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- Compiling and reviewing final reports for accuracy.
- Ensuring that all project QA/QC methods are followed.
- Ensuring that any problems reported during the project are monitored and corrective actions are taken and documented.

2.2.2 Laboratory Group Leaders

- Richard Capp, GC/MS NUS Laboratory
 5350 Campbells Run Road
 Pittsburgh, PA 15205
 Phone: 412-747-2541
- Tracey Colbert, Radiochemistry and Inorganics Chemistry NUS Laboratory
 5350 Campbells Run Road
 Pittsburgh, PA 15205
 Phone: 412-747-2533
- Jonathan Talbott, Metals NUS Laboratory
 5350 Campbells Run Road Pittsburgh, PA 15205
 Phone: 412-747-2534

Laboratory Group Leaders are responsible for data production activities within their assigned groups. Assistant Group Leaders may assist the Group leader in the supervision of analysis and data review and approval. Laboratory Group Leaders are responsible for the following activities related to the BP Chemicals, Inc. Pond Closure Project:

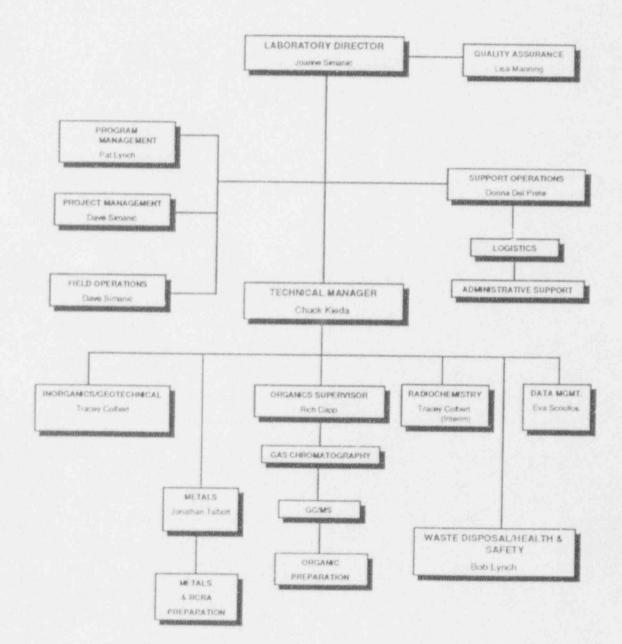
- Receive and distribute assignments, scheduling analyses in a timely manner to meet holding times and sample turnaround schedules.
- Review and approve data, evaluating it for completeness, accuracy, and compliance with stated QA/QC objectives prior to entry into the Laboratory Information Management System (LIMS) and prior to issuance of final reports.

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Perform technical reviews of analytical procedures and ensure compliance with required quality control standards.

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FIGURE 4-1 ORGANIZATIONAL CHART



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QUALITY ASSURANCE OBJECTIVES FOR DATA MEASUREMENT

1.0 PURPOSE AND APPLICABILITY

Data quality is defined by the EPA in terms of precision, accuracy, completeness, representativeness, and comparability. This section of the QA Plan defines NUS Laboratory's data quality objectives (DQOs) for each parameter required for the BP Chemicals, Inc. Pond Closure Project with respect to specifications set forth by the Ohio EPA.

2.0 PROCEDURE

2.1 PRECISION

Precision is a measure of the reproducibility of a set of measurements made under a given set of conditions. The precision of laboratory data is measured through the analysis of samples (or matrix spikes) in duplicate. Precision is quantified as the range or relative percent difference (RPD) of the duplicate measurements. Range is generally used to express the precision of measurements near the reporting limit, while RPD is used for measurements at higher analyte levels. If one or both measurements are less than the reporting limit, precision is not quantified.

Matrix spikes and matrix spike duplicates are prepared and analyzed 1 in 20 project samples when performing organics analyses.

A duplicate is prepared and analyzed 1 in 20 project samples when analyzing for uranium-238 by gamma spectroscopy.

A duplicate and matrix spike are prepared and analyzed 1 in 10 project samples for metals (i.e., RCRA total metals - arsenic, barium, cadmium, chromium, lead, mercury, selenium, and silver).

A duplicate is analyzed 1 in 20 project samples for pH.

A duplicate and matrix spike are analyzed 1 in 20 project samples when performing CLP cyanide analysis.

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DQOs for precision, which are derived from EPA methods and/or based on statistical evaluation of laboratory data, vary from parameter to parameter. Consult the tables at the end of this section for specific precision DQOs.

2.2 ACCURACY

Accuracy is a measure of the agreement of a measurement and a true or accepted value. It is a description of the bias of the measurement system. Accuracy is measured as percent recovery (or percent error) of standards or matrix spikes. Blanks also provide a measure of accuracy in that they test for systematic bias from trace contaminants in reagents and for random error from random sources of contamination, such as trace contaminants in glassware.

The accuracy of instrumental measurements is measured by the analysis of initial and continuing calibration standard. Consult Table 5-1 for specific DQOs.

The accuracy of sample preparation and analysis is measured by the analysis of a preparation blank, and a lab control standard with batch of samples for radiochemical, metals, and cyanide analysis. A preparation blank and surrogate standards spiked into each sample measure the accuracy of sample preparation and analysis for organic compounds. DQOs for the accuracy of preparation blank data, laboratory control standards and surrogate spike recoveries, which are derived from EPA methods, and/or based on statistical evaluation of laboratory data, vary from parameter to parameter. Consult Table 5-1 for specific DQOs.

The accuracy of the measurement system within randomly selected sample matrices is measured by the analysis of matrix spikes. A matrix spike is prepared and analyzed 1 in 10 project samples for metals. A matrix spike and matrix spike duplicate are prepared and analyzed 1 in 20 project samples for volatile organic compounds. A matrix spike is prepared and analyzed 1 in 20 project samples for cyanide (CLP protocol).

DQOs for the accuracy of matrix spikes, which are derived from EPA methods and/or based on statistical evaluation of laboratory data, vary from parameter to parameter. Consult Table 5-1 for specific matrix spike DQOs. In general, if these DQOs are not met, the associated sample results are

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qualified to indicate the probable presence of a matrix interference.

2.3 REPRESENTATIVENESS

Representativeness is a measure of the degree to which data accurately and precisely represent the sampling point parameters or an environmental condition. Several elements throughout the sampling and sample handling process must be controlled to maximize the representativeness of analytical data. These include the sampling plan, sample collection, sample preservation, and the lapse of time between sampling and the initiation of analysis (i.e., the holding time). Sampling plans, sample collection, sample preservation, and holding times are discussed in Section 6 of this document.

2.4 COMPARABILITY

Comparability is the degree of confidence with which one set of data can be compared to a related set of data. The comparability of NUS Laboratory's data is enhanced by the use of EPA-approved methodology whenever available, participation in internal and external performance evaluation programs, and the periodic analysis of reference materials. In addition, data are expressed using consistent reporting limits in units commonly used in reporting environmental data.

2.5 COMPLETENESS

Completeness is a measure of the amount of valid data (i.e., data that was generated according to appropriate methodology, and meets NUS Laboratory's quality control requirements and holding times) obtained from a measurement system relative to the amount that was expected to be generated under correct normal conditions, NUS Laboratory evaluates completeness through its data quality objectives. (See Table 5-1.)

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TABLE 5-1 DATA QUALITY OBJECTIVES

Calibration/ Quality Control Sample	Frequency	Acceptance Criteria	Corrective Action	Complete- ness
		Volatiles by GC/MS		
BFB Tune	Start of each 12- hour period of analysis	See Appendix A. Section 1, 3.1.2	Make adjustments or repairs as necessary to meet tune	100%
5-Point Initial Calibration	Whenever continu- ing calibration criteria are not met	See Appendix A, Section 1.3.2. Alternatively, since the project specific compound list is limited. SPCC >0.300 and %RSD ≤30.0% for all project specific analytes (acetone, acetonitrile, acrylonitrile, benzene, 1,1-dichloroethtylene, methylethyl ketone, tetrachloroethylene, and 1,1,1-trichloroethane, trichloroethene, 1,1- dichloroethane, vinyl chloride and bromomethane) criteria may be applied.	Make adjustments or repairs as necessary to meet SPCC and CCC criteria	100%



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Calibration/ Quality Control Sample	lity Control		Frequency	Corrective Action	Complete- ness
1-Point Continuing Calibration	Immediately, following each successful tune	See Appendix A, Section 1.3.3. Alternatively, since the project specific compound list is limited, SPCC >0.300 and %D ≤25.0% for all project specific analytes (acetone, acetonitrile, acrylonitrile, benzene, 1.1-dichloroetheyle, methylethyl ketone, tetrachloroethylene, and 1.1.1-trichloroethane, trichloroethane, vinyl chloride and bromomethane) criteria may be applied.	Make adjustments or repairs as necessary to meet SPCC and CCC criteria	100%	
Method Blank	Following each successful initial or continuing cali- bration and before sample analysis	No project specific compouds (acetone, acetonitrile, acrylonitrile, benzene, 1,1- dichloroethylene, methytethyl ketone, tetrachloroethylene, and 1,1,1-trichloroethane, trichloroethene, 1,1- dichloroethane, vinyl chloride and bromomethane) present at or above the reporting limit	Repeat the method blank. Clean the system and/or replace parts until an acceptable blank is obtained	95%	



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Calibration/ Quality Control Sample	Frequency	Acceptance Criteria	Corrective Action	Complete- ness
Standard blank Recovery		Method blanks: LLS TOL-d _B 90-108% R ¹ LLS BFB 84-108% R ¹ LLS 1,2-DCE 92-113% R ¹ MLS TOL-d _B 80-110% R ¹ MLS 1,2-DCE 80-116% R ¹	Check standard and spiking and calibration factor. Acceptable recoveries must be obtained prior to sample analysis.	95%
Trip Blank, field Blank	1 per 20 project samples	No project specific (acetone, acetonitrile, acrylonitrile, benzene, 1,1-dichlorethylene, methylethyl ketone, tetrachloroethylene, and 1,1,1-trichloroethane, trichloroethene, 1,1- dichloroethane, vinyl chloride and bromomethane) present at or above the detection limit	Notify BP Chemicals. Inc. Discuss corrective (i.e., resampling or qualify data) action	95%
Surrogate Standard Recovery (Continued)	Samples and MS/MSDs	Samples, MS/MSD: TOL-d _a 84-138% R BFB 59-113% R 1.2-DCE 70-121% R	Repeat sample analysis once. If recovery remains outside criteria. assume matrix effect	95%²





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Calibration/ Quality Control Sample	Frequency	Acceptance Criteria	Corrective Action	Complete- ness
Matrix Spike/ Matrix Spike Duplicate (MS/MSD)	1 per 20 project samples	acetone $50-150\%$ R ¹ acetonitrile $50-150\%$ R ¹ acrylonitrile $50-150\%$ R ³ benzene $66-142\%$ R ¹ 1,1-dichloroethylene $52-173\%$ R ¹ methylethyl ketone $16-229\%$ R ¹ tetrachloroethylene $66-148\%$ R ¹ 1,1,1-trichloroethane $69-145\%$ R ¹ trichloroethene $62-137\%$ Bromomethane $50-150\%$ 1,1-dichloroethane $50-150\%$ Vinyl chloride $50-150\%$	Qualify sample results	95%
	Gam	ma Spectroscopy (Uranium-	238)	
Calibration	Annually	See Appendix A, Section 2 (Section 3)		100%





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Calibration/ Quality Control Sample	ity Control		Corrective Action	Complete- ness	
Counter Pertormance Check		mance		100%	
Counter Performance Check (Continued)	Daily	See Table 5-2'	FWHM and Peak Channel: Compare the FWHM resolution and the peak control channel with the control limits. If the FWHM exceeds the limit, take the following action:	100%	
			 Verify that the dewar has sufficient liquid nitrogen to cool the detector. 		
			 Verify that the amplifier and ADC settings are correct. 		
			 Verify that pole- zero cancellation is properly adjusted. 		

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Calibration/ Quality Control Sample	Frequency	Acceptance Criteria	Corrective Action	Complete ness
Counter Performance Check (Continued)	Daily	See Table 5-2 ¹	4. If adjustments are made in steps 1 through 3, recount the source and check the peak centroid channel and FWHM.	100%
			5. If the system cannot be returned to within the control limits, refer to the instru- ment manuals to identify further action and deter- mine whether the system must be removed from service.	
Counter Background Check	Daily	See Table 5-2'	Recount the check five times. If all counts are below the upper limit, continue with sample analysis. If not, suspend sample analysis and clean the counting chamber. Obtain acceptable back- grounds before proceeding with sample analysis.	100%
Lab Control Standard	Each batch of up to 20 samples prepared together	75.0-125%' recovery	Recount all samples	95%

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Calibration/ Quality Control Sample	Frequency	Acceptance Criteria	Corrective Action	Complete- ness
Duplicates	One project sample in 20	RPD ≤40%	Recount duplicate. If still out, reprepare and reanalyze duplicates and ¼ of samples in batch.	95%
	A	Metals by ICP		
3 Point Initial Calibration	At the start of each run	r ≥0.995	Check standards. Make adjustments or repairs as necessary to meet criteria.	100%
1-Point Calibration Verification	Immediately after initial calibration	90.0-110% R	Check standards. Make adjustments or repairs as necessary to meet criteria.	100%
Standard at 2 Times the Reporting Limit	Immediately following the initial calibration blank	Result discernable from the blank	Recalibrate	100%
High Standard	Immediately following the standard at 2 times the reporting limit	95.0-105% R	Recalibrate	100%
Interference Check Sample	Beginning and end of each run and every 8 hours of operation	80-120% R	Check interlement correction. Recalibrate and reanalyze all samples run since the last acceptable interference check sample	100%
1-Point Continuing Calibration	After each set of 10 samples and at the end of the run	90.0-110% R	Reject all sample results for the element in question since the last acceptable continuing calibration check. Recalibrate.	100%

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Calibration/ Quality Control Sample	Frequency	Acceptance Criteria	Corrective Action	Complete- ness
Calibration Blank	Following calibra- tion verification and each continuing calibration check	Absolute value of the result less than the reporting limit	Reject all sample results for the element in question since the last accept- able calibration blank. Recalibrate.	100%
Method Blank	1 for each set of up to 20 samples digested	Result less than the reporting limit	Redigest all associ- ated samples with results greater than or equal to the reporting limit and less than 10 times the level in the blank.	95%
Lab Control Standard	1 for each set of up to 20 samples digested together	Ba: 71.0-115% R ¹ Cd: 71.9-105% R ¹ Cr: 64.4-123% R ¹ Ag: 50-150% R ¹	Redigest the associated samples	95%
Duplicates	1 per 10 project samples	Range less than or equal to 4 times the reporting limit for results less than 5 times the reporting limit. RPD less than or equal to 40% for values greater than or equal to the 5 times the reporting limit.	Redigest duplicates and 25% of samples with positive results to spotcheck precision of the batch	95%
Matrix Spikes	1 per 10 project samples	50-150% R	Qualify matrix spike results <75.0% R and >125% R.	Э
		Metals by GFAA		
3-Point Initial Calibration	[Same as ICP]	[Same as ICP]	[Same as ICP]	[Same as ICP]
1-Point Calibration Verification	[Same as ICP]	[Same as ICP]	[Same as ICP]	[Same as ICP]





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Calibration/ Quality Control Sample	Frequency	Acceptance Criteria	Corrective Action	Complete- ness
Reporting Limit Standard	Immediately after the first calibration blank	Result discernable from the blank	Recalibrate	100%
1-Point Continuing Calibration	After each set of 10 samples and at the end of the run	85.0-115% R	Reject all sample results since the last acceptable continuing calibration check. Recalibrate.	95%
Calibration Blank	[Same as ICP	[Same as ICP]	[Same as ICP]	[Same as ICP]
Method Blank	[Same as ICP]	[Same as ICP]	[Same as ICP]	[Same as ICP]
Lab Control Standards	1 for each set of up to 20 samples digested together	As: 59.8-122% R ¹ Se: 50-150% R ¹ Pb: 50-150% R ¹	Redigest the associated samples	95%
Single Spike Analysis	Each field sample not run as a matrix spike	See Appendix A. Sectoin No. 4	Qualify results or perform MSA	100%
Duplicates	[Same as ICP]	[Same as ICP]	[Same as ICP]	[Same as ICP]
Matrix Spikes	[Same as ICP]	[Same as ICP]	[Same as ICP]	[Same as ICP]
		Mercury by CVAA		
5-Point Initial Calibration	At the start of each	r ≥ 0.995	Check standards and analyzer. Redigest the entire batch.	100%
1-Point Calibration Verification	Immediately following initial calibration	80.0-120% R	Check standards and analyzer. Redigest entire batch.	95%



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Calibration/ Quality Control Sample	Frequency	Acceptance Criteria	Corrective Action	Complete- ness
11-Point Continuing Calibration	After each set of 10 samples and at the end of the run	80-120% R	Reject all sample results since the last acceptable continuing calibration.	95%
			Redigest the portion of the batch not successfully run.	
Calibration Blank	[Same as ICP]	[Same as ICP]	[Same as ICP]	[Same as ICP]
Lab Control Standard	1 for each set of up to 10 soil samples	61.3-91.9% R ¹	Redigest the batch.	95%
Duplicates	[Same as ICP]	[Same as ICP]	[Same as ICP]	[Same as ICP]
Matrix Spikes	[Same as ICP]	[Same as ICP]	[Same as ICP]	[Same as ICP]
		Cyanide		
4-Point Initial Calibration	At the start of each run	r ≥ 0.995	Recolor curve. If still nonconforming, re- distill the entire batch	100%
1-Point Calibration Verification	Immediately following initial calibration, after each set of 10 samples, and at the end of the run	85.0-115% R	Recolor. If still nonconforming, reject all sample results since the last accept- able calibration verification.	95%
			Redistill the portion of the batch not successfully run.	

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Calibration/ Quality Control Sample	Frequency	Acceptance Criteria	Corrective Action	Complete ness
Method Blank	1 per 10 samples and at the end of the run	Result less than the reporting limit	Redistill all associated samples with results greater than or equal to the reporting limit and less than 10 times the level in the blank.	95%
Lab Control Standard	1 per 20 soil samples distiiled together	85-115% R	Redistill the associated samples	95%
Duplicates	1 in 20 project samples	[Same as ICP]	Redistill the duplicates and 25% of positive results to spotcheck precision of the batch.	95%
Matrix Spikes	1 per 20 project samples	[Same as ICP]	[Same as ICP]	[Same as ICP]
		pН		
2-Point Calibration	At the start of each run	None	None	None
Calibration Ver* cation	Immediately following initial calibration, after 10 samples, and at the end of the run	Within ±0.1 pH units of true value	Recalibrate and reanalyze all samples run since the last acceptable calibration verification	
Duplicates	1 in 20 project samples	<1% RPD	Rerun the duplicates and 25% of the sample to spotcheck precision in the batch	95%
		Semivolatiles by GC/MS		
DFTPP Tune	Start of each 12- hour period of analysis	See Appendix A. Section 8, 3 1.2	Make adjustments or repairs as necessary to meet tune	100%





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Calibration/ Quality Control Sample	Frequency	Acceptance Criteria	Corrective Action	Complete- ness
5-Point Initial Calibration	Whenever continu- ing calibration criteria are not met	See Appendix A, Section 8, 3.2. Alternatively, since the project specific compound list is limited, SPCC >0.300 and %RSD <30.0% for both target analytes (pyridine and methyl naphthalene) criteria may be applied.	Make adjustments or repairs as necessary to meet SPCC and CCC criteria	100%
1-Point Continuing Calibration	Immediately, following each successful tune	See Appendix A, Section 8, 3.3. Alternatively, since the project specific compound list is limited, SPCC >0.300 and %D ≤25.0% for both target analytes (pyridine and methyl naphthalene) criteria may be applied.	Make adjustments or repairs as necessary to meet SPCC and CCC criteria	100%
Method Blank	Following each successful initial or continuing cali- bration and before sample analysis	No project specific (pyridine and methyl naphthalene) present at or above the reporting limit	Re-extract associated sample with positive results for target analytes	95%
Surrogate Standard Recovery	Each method blank	Method blanks: p-Terphenyl-d14 15-157% Nitrobenzene-d5 13-124% 2-Fluorobiphenyl 17-115%	Check standard and spiking and calibration factor. Acceptable recoveries must be obtained prior to sample analysis.	95%
Surrogate Standard Recovery	Samples and MS/MSDs	Samples, MS/MSD: p-Terphenyl-d14 18-137% Nitrobenzene-d5 23-120% 2-Fluorobiphenyl 30-115%	Repeat sample analysis once. If recovery remains outside criteria, assume matrix effect	95% ²

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Calibration/ Quality Control Sample	Frequency	Acceptance Criteria	Corrective Action	Complete- ness	
Matrix Spike/ 1 per 20 proje Matrix Spike samples Duplicate (MS/MSD)		Pyridine 25-150% R ¹ Methyl naphthalene 25-150% R ¹	Qualify sample results	95%	

Subject to change as statistically-based limits are recalculated over time.

It analysis is repeated and results remain outside limits, or if recovery comes into limits when analysis is repeated and reanalysis is within hold time, data quality objective has been met.

Matrix spike recovery is matrix dependent. Objective cannot be set without knowledge of potential interference in the soils.

Key:

LLS = low level soil MLS = medium level soil SPCC = system performance check compounds CCC = calibration check compounds %RSD = percent relative standard deviation %R = percent recovery BFB = bromotluorobenzene

Key (Continued):

MS/MSD = matrix spike/matrix spike duplicateTol-d_g = Toluene-d_gBFB = Bromofluorobenzene1.2-DCE = 1.2-Dichloroethanecpm = counts per minutedpm = disintegrations per minuteMDA = minimum detectable activityRPD = relative percent differenceFWWM = full width at half maximum.



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TABLE 5-2 PERFORMANCE CHECKS FOR RADIOCHEMISTRY

TABLE 5-2

PERFORMANCE CHECKS FOR RADIOCHEMISTRY

Gamma Detector	Background Checks Total Counts: 1000 Secs	Performance Checks								
		Eu-155-105.3 keV		Eu-154-723.3 keV		Eu-154-1274 keV				
		Peak CIIN	FWHM	Gross Area Counts	Peak CHN	FWHM	Gross Area Counts	Peak CHN	FWHM	Gross Area Counts
PTG #1	777-1031	407.72-	4.03	90941- 97855	2940.45- 2944.45	6.59	21545-22894	5201 84- 5205 84	8.49	19701-20580
Tennelec #2	2744-3408	373.5-379.5	5.71	171245- 178509	2789.82- 2793.82	7.08	37084-3907a	4941.13 1945.13	8.54	35395-36628
Tennelec	2335-2848	185.74- 389.74	4.08	166780- 175450	2773.24-2777.24	6.28	36262-39125	4901 89- 4903 89	7,96	35239-36614

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SAMPLING PROCEDURES

INTRODUCTION

Soil sampling will be conducted as part of the mixed waste pond closure project at BP Chemical, Inc.'s Lima facility. The four surface impoundments (ponds) - Burn, Deepwell, Celite and V-1 will be closed. Specific closure activities are described in detail in BP Chemicals, Inc.'s "Closure Plan, Mixed Waste Pond Closure Project, BP Chemicals, Inc., Lima, Ohio, June 12, 1991." Descriptions of the four surface impoundments is contained in the Closure Plan referenced above. Additional information is contained in the "Quality Assurance Project Plan for the Mixed Waste Pond Closure Project" (QAPjP).

1.0 SAMPLING PROCEDURES

1.1 Since the Burn and Deepwell Ponds are planned for clean closure, these impoundments are subject to clean closure standards (established by the Ohio EPA) for both radiological and chemical parameters.

The soil in the Celite and V-1 Ponds must meet the criteria established for clean closure for radiological parameters before liners are installed. However, chemical contaminants that exceed clean closure standards may be left in place provided that they pose no health risks, as determined by a risk assessment model.

1.2 NUS Laboratory will analyze samples which have been collected and submitted to the laboratory for radiological parameters (gamma spectroscopy, specifically Uranium-238), volatile organic compounds (acetone, acetonitrile, acrylonitrile, benzene, 1,1-dichloroethylene, methylethyl ketone, tetrachloroethylene, 1,1,1-trichloroethane, trichloroethene, 1,1-dichloroethane, vinyl chloride and bromomethane), semivolatile compounds (pyridine and methyl napthalene), cyanide, 8 RCRA metals (arsenic, barium, cadmium, chromium, lead, mercury, selenium, and silver) and pH. Table 6-1 summarizes the clean levels for the required parameters.

1.3 The specific sequence and procedures which will be followed for sampling are described in detail in the Closure Plan referenced above.



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1.3.1 Radiological soil sampling will be carried out in three phases:

Phase I - will consist of a radiological soil survey and excavation, as necessary.

Phase iI - will consist of soil sampling and radiological analysis by NUS Laboratory for Uranium-238 and excavation, as necessary.

Phase III - the collection of final clearance samples and radiological analysis by NUS Laboratory for Uranium-238.

More detail regarding the sampling events is contained in the "Quality Assurance Project Plan for the Mixed Waste Pond Closure Project", Section 2.5.

1.3.2 Chemical soil sampling will be done following completion of radiological sampling. Samples will be collected based on a 10 m x 10 m grid system. Chemical soil sampling is described in detail in the previously mentioned Closure Plan and QAPjP. Initially, samples will be collected to a depth of 4 feet in 2 foot intervals. Each 2 foot core sample will be separated into 2 - 1 foot samples. The two 1-foot samples will initially be sent to NUS Laboratory for analysis. Remaining samples will be labelled and stored.

To ensure that samples with high levels of contamination are not sent to NUS Laboratory, headspace analysis for volatile organic compounds (with an OVA) will be performed at the BP Chemicals, Inc. pond closure site in Lima, Ohio on the first sample jar filled at a sample location. Headspace analysis will involve filling a sample jar 3/4 full with sample, covering with tin foil and capping the jar. The capped headspace screening sample will be shaken and left in the sun for 15 minutes. At the end of the 15 minutes, BP Chemicals, Inc. personnel will shake the sample, remove the cap, raise the tin foil seal and place the tip of the OVA into the jar carefully so as not to clog the OVA with sample matter. A peak reading will be noted as well as a constant reading.

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If the laboratory analysis of the first set of samples (i.e., 0-1 foot and 1-2 feet) indicates that concentrations of contaminants are in excess of "clean levels" (Table 6-1), the results may be re-evaluated using a risk assessment model to determine whether existing levels present a health risk. If the risk assessment model determines that there is no health risk posed by these levels, clean closure activities will be considered complete and NUS Laboratory will not receive additional samples. However, if the results of the risk assessment model determine that the levels of contamination are unacceptable, the second set of samples (i.e., the 2-4 foot depth samples already collected) will be sent to NUS Laboratory for analysis.

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Laboratory analysis and risk assessment, if required will be repeated for the second set of samples. If it is determined that these levels are unacceptable, excavation will be necessary in "hot spots" and resampling will be done. Once the chemical sampling analysis results from NUS Laboratory are below chemical clean levels, or the risk assessment model determines that levels are safe, the area will be considered suitable for clean closure.

2.0 SAMPLE CONTAINER REQUIREMENTS

Sample containers are constructed of glass, as listed on Table 6-2. NUS Laboratory uses only new sample containers.

- Volatile organics vials and bottles are prepared in the following manner:
 - -- Bake vials, bottles, and liners at 180°C.
 - -- Allow vials, bottles, and liners to cool to room temperature in an enclosed environment free of contamination.
 - -- Se I vials with septa (Teflon side down), and cap. Cap bottles.

2.1 SAMPLE PRESERVATION

Sample preservation techniques and holding times are listed in Table 6-2. Holding times are measured from the date and time of sampling.

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2.2 SAMPLE BOTTLE ORDERS

Bottle orders specifying the following information are prepared by the Project Manager on a bottle order form (Figure 6-1). Bottle orders should be placed as far in advance as possible.

- Analysis, matrices, number of samples
- Date required
- Mode of transportation to the site

Bottle orders will be shipped to the BP Chemicals, Inc. Pond Closure Project site in Lima, Ohio. Bottle orders will contain chain-of-custody forms (Figure 6-2), custody seals on the coolers, and trip blanks.

2.3 FIELD QUALITY CONTROL

NUS Laboratory will be provided with the following field Quality Control (QC) samples:

- 1.5.1 Field Duplicates 1 in 10 project samples. These will not necessarily be identified as duplicates.
- 1.5.2 Field Blanks and Equipment Blanks 1 in 20 project samples. Field blanks will not necessarily be identified as blanks. Field blanks are prepared in the field by pouring carbon treated deionized water directly into sample containers. Field blanks are analyzed for all parameters of interest.
- 1.5.3 Trip Blanks 1 per day These will be analyzed only for volatile compounds. Trip blank vials will be prepared at the laboratory and shipped to the BP Chemicals, Inc. pond closure site with bottle orders. Trip blanks ensure that cross contamination of volatile organic compounds (VOCs) during sample shipment has not occurred.

2.4 LABELS

A completed label should be placed on each sample jar prior to sample collection.

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The following information should appear on the label:

- Name of facility (BP Chemicals, Inc., Mixed Waste Pond Closure)
- Date and time of collection (time of collection will coincide with chain-of-custody form)
- Sample identification (name of sample point)
- Sample type (e.g., 0-1 foot, 1-2 foot)
- · Sample matrix

3.0 CHAIN-OF-CUSTODY FORM

A chain-of-custody form (Figure 6-2 or equivalent) should be completed for each sampling event to document sample custody from the time of collection through transfer of custody to the laboratory. At a minimum, the chain-of-custody record must contain the following information.

- Type of sample bottle (e.g., 8 oz. wide mouth, 16 oz. wide mouth)
- Sample identification
- Signature of collector
- Date and time of sample collection
- Signature and inclusive dates and times of possession for each person taking custody of the samples

4.0 SAMPLE DELIVERY TO THE LABORATORY

Samples must be delivered to the laboratory in a manner such that the characteristics of the sample are preserved and analysis can be completed within the holding times. Table 6-2 lists preservative techniques and holding times for the parameter list for BP Chemicals, Inc. Pond Closure Project.

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TABLE 6-1 CLEAN LEVELS FOR SOIL

PARAM	AETER	CLEAN LEVEL
Uranium-238 (Gamma S	pectroscopy)	35 pCi/g
Volatile Organics		*
acetone acetonitrile acrylinitrile benzene 1,1-dichloroethylene methyl ethyl ketone tetrachloroethylene 1,1,1-trichloroethane	1,1-dichloroethane vinyl chloride	
Semivolatile Organics pyridine methyl naphthalene		•
RCRA Metals arsenic barium cadmium chromium lead mercury selenium silver		15.0 mg/kg 125.7 mg/kg 0.8 mg/kg 21.1 mg/kg 21.9 mg/kg 0.1
Cyanide		*
pH		4.7 - 9.0 ¹

* Matrix specific detection limits - to be determined using a "clean" sample.

Defined in Section 3.11.2 of the Ohio EPA Closure Plan Review Guidance Document.

² To be determined prior to sampling via background soil survey.

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TABLE 6-2 CONTAINER PRESERVATION AND HOLDING TIME REQUIREMENTS NON-AQUEOUS SAMPLES

PARAMETER	CONTAINER	PRESERVATIVE	MAXIMUM HOLDING TIME
Uranium-238	Quart - Wide Mouth Glass	None	6 months
Volatile Organics Semivolatile Organics	8 oz. Glass with TLC ¹	Cool, 4°C	Volatiles: 14 days Semivolatiles: Extract within 7 days of collection. Analyze within 40 days of collection.
RCRA Metals	8 oz Glass ^{1, 2}	None	6 months, except Hg - 26 days
Cyanide	8 oz. Glass with TLC ^{1.2}	Cool, 4°C	14 days
рН	8 oz. Glass ^{1, 2}	Cool, 4°C	No specific holding time has been established for soils.

Teflon-lined Cap

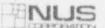
² Metals, cyanide and pH will be analyzed from one 8 oz. glass container. A separate 8 oz. jar will be utilized for the volatile and semivolatile organics.



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FIGURE 6-1 BOTTLE ORDER FORM



5390 CAAMPABLUE PLAY PC) INTERNATION PLAY 10003

LABORATORY SERVICES GROUP 9033 GENERAL AVENUE --CLARTON TR 77038 (7130 -088-1810

F

ANALYTICAL WORK ORDER

14 P.O. HUMBER CLIENT NUMBER v. PRICE CODE PROL NUMBER LC 1 % SPECIAL INSTRUCTIONS 14 T 1 O JOB DESC. WEL /DATE CALL /TIME SHIP BOTTLE ORDER PLASTIC ANDER IT SHEET NEED ORIGINATOR 64 Water Chern. manager (B. 14. INCOMING SAMPLES Matata --------- PL Here Extension HACL Dete Expecte TEST COST TEST mar A red. COST R Nitrogen ----Section De H.50. # 80D marian ale P Cyanica -----N₈ OH Summe mainten all ZHC,H,O, 4 C.O.D. T.O.C. manue & ac. H.50. ----- 4 (M. R Batteria manimum 4 (198) HA, Sola, ParticiaCBwity ----- 1 gal. HINNES, 4 oz, witte mouth S 1500 GLASS ----R ISH & Granas mineman file . arridoer. H,50, amber 2402 -14.50. HORGANIC ORGANIC 1.04 CLWN CS WY. R Vorente Organica West southing was 1403. OSM PR-ACTO EP TOX 10 PP-BH NPIDES A APP NOA -PSB's (4 pit _____ 4 dram ____ 5 dram ____ Otrose Scorete SPECES BAR 1451 Almont B Haterbergerstere Hackground MPDES C HELENCE. CTHS IN DATE SHIPPED T. Hav class VIA PCB-en SALENNE F S. Ruy Phase PCH-stai AN MILL INFORMATION PHOPOSAL NO



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FIGURE 6-2 CHAIN-OF-CUSTODY FORM

MALLIBURTON NUS Environme Corporation and Subsidiaries	US EN	vironi diarie	nes.			lat t	0	CHAIN OF CUSTODY RECORD
			104 M 21			111	//	
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TATION DATE TIME COMP	COMP	0.8 x 3		11ATIOHLOCATION			+	
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LABORATORY SAMPLE CUSTODY

1.0 PURPOSE AND APPLICABILITY

This section outlines the procedures for receipt, log-in, storage and tracking sample received from the BP Chemicals, Inc. Pond Closure Project for analysis at the laboratory. Field duplicates and field blanks will be analyzed by NUS Laboratory as samples and will not necessarily be identified as duplicates or blanks. Field duplicates will be provided at the rate of 1 per 10 samples collected. Field blanks and equipment blanks will be provided at a rate of 1 per 20 samples collected for each parameter group, whichever is greater. Trip blanks will be provided at the rate of one per day and will be analyzed for volatile compounds only.

2.0 PROCEDURE

2.1 SAMPLE RECEIPT AND LOG-IN DURING NORMAL WORKING HOURS

- 2.1.1 All samples are received into the laboratory through sample receiving. When samples are received into the laboratory during normal working hours (i.e., 8:30 a.m. 5:00 p.m., M-F, 8:00 a.m. 12 Noon, Saturday) the sample custodian or a member of the Receiving Department signs and dates the shipping manifest to acknowledge receipt of the sample containers.
- 2.1.2 The Sample Custodian then examines the shipping containers and verifies that the correct number of shipping containers was received by signing and dating the airbill.
- 2.1.3 The Sample Custodian removes the chain-of-custody seal and opens the shipping containers to remove the enclosed sample documents.

Since samples received from the BP Chemicals, Inc. Pond Closure Project will be potentially radioactive, they will be handled as such. Qualified personnel will screen the samples for radioactivity levels using the uR survey meter. Radioactive materials will be

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segregated form non-radioactive samples. The procedure used will be as follows:

- i. Line the lab bench with absorbent paper and wear gloves to handle the samples.
- ii. Verify that the uR survey meter is within calibration, i.e., less than six months have passed from the calibration date. If the calibration date is exceeded, return the meter to the radiation safety officer designee (RSOD). Obtain another meter for sample screening.
- iii. Record the make, model, and calibration date of the meter on the sample survey record.
- iv. Perform a battery check and record the result. If the battery check fails or degrades over time, notify the RSOD.
- v. Turn the scale knob to the lowest scale. Point the meter away from the samples and measure ambient background. Record the value on the survey record.
- vi. Place the front end of the meter in contact with the sample to be measured. Record the sample number and the instrument reading on the survey record.

If the needle goes off-scale, select the next highest scale setting. Repeat until the reading comes on-scale. Record this final measurement on the survey record.

If a sample reads >1 mR/hr, notify the RSOD immediately. (Notify the Radiochemistry Group Leader in his/her absence.) Do not handle the sample further.

If a sample reads >10X background but <1 mR/hr, place a radioactive materials sticker on the sample and move it to a controlled radiological area for storage. The sample will be handled as a radioactive sample; it will be segregated from nonradioactive samples.



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If a sample for radiochemical analysis reads above background but <10X background, label the sample with a colored sticker and write the reading on the sticker. This information will be helpful to radiochemistry lab personnel from an analytical and cross-contamination prevention standpoint.

If radioactive samples are received after hours, or when no member of the Radiochemistry Laboratory is available, the samples will be placed in the radioactive sample staging area designated by the RSOD.

The RSOD will determine the safe handling procedures appropriate to the radioactivity level of the samples described in Appendix B.

2.1.4 The Sample Custodian removes the samples from the shipping container(s) and completes the laboratory sample log-in sheet (Figure 7-1 or equivalent). Analyses requested and sample bottles received are documented using test codes and bottle codes, respectively.

Any anomalies with the sample containers, such as the following, are noted on the laboratory sample log-in sheet and a nonconformance/corrective action record. For example:

- Broken sample container.
- Improper sample container.
- Improperly preserved sample (with respect to temperature preservation).

The Project Manager should be notified immediately if any anomalies are noted. The Project Manager will notify BP Chemicals, Inc. immediately for resolution or clarification of the problem.

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- 2.1.5 The Sample Custodian cross-checks the information on the chainof-custody record, air bill, and sample labels to determine if discrepancies exist. If so, they are noted on the laboratory sample log-in sheet and a nonconformance/corrective action record. When all of the information has been recorded and cross-checked, the Sample Custodian signs and dates the laboratory sample log-in sheet.
- 2.1.6 The Sample Custodian physically applies a laboratory sample number to each bottle. Care must be taken to ensure that the sample number does not interfere with information recorded on the sample label or tag.

The laboratory sample number consists of seven characters, as follows:

P999999 for samples received at the Pittsburgh laboratory

where "999999" is a six-digit number, which increases consecutively with each new sample number.

- 2.1.7 The Sample Custodian signs and dates the chain-of-custody record.
- 2.1.8 The Sample Custodian completes the top portion of a lab tracking record (Figure 7-2).
- 2.1.9 Using the information on the laboratory sample log-in sheet, the Sample Custodian completes sample log-in through the LIMS.
- 2.1.10 Following sample log-in, the laboratory sample log-in sheets, the documents received with each set of samples, and a printout from the LIMS of the information entered at sample log-in are routed to the Project Manager for review. If any of the information entered into the LIMS is incorrect, the Project manager notes the appropriate changes on a speed letter (Figure 7-3) or equivalent. When the changes have been completed, the Project Manager signs and dates the laboratory sample log-in sheet.

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2.2 SAMPLE STORAGE

- 2.2.1 The Sample Custodian places the samples in the appropriate storage area. Samples for volatile organics analysis are segregated from other samples to minimize the opportunity for cross-contamination. Samples requiring preservation to 4°C (volatile organics) are stored in refrigerated storage units. Samples from BP Chemicals, Inc. Pond Closure Project will be maintained in locked storage units.
- 2.2.2 Samples are retained in primary storage until work is completed. Samples are retrieved and stored by Sample Custodians or analysts. Following generation of the report, the Sample Custodian moves the samples to secondary storage. Thirty days thereafter, the unused portions of samples are returned to BP Chemicals, Inc. in accordance with NUS Laboratory's radiation safety procedures.

2.3 SAMPLE ANALYSIS AND DATA ENTRY

- 2.3.1 A work list from the LIMS is printed by each group leader periodically. This list incudes the client i.d. number, NUS Laboratory sample number, date received, preparation method, analytical method, analyte, and client for the selected tests and samples. Following sample log-in, the analyses are available for inclusion on the work list.
- 2.3.2 Samples are received from the appropriate locked storage units by a Sample Custodian or analyst. Samples are signed out on a tracking form which includes the date and time of removal. Raw and prepared samples are returned to the locked storage units.
- 2.3.3 Sample preparation and analysis is documented in bound laboratory notebooks and on preprinted worksheets.
- 2.3.4 During data entry, the book and page number of the analysis log is entered into the LIMS along with the results so that raw data are easily retrievable.

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2.4 PROJECT RECORDS

Client files will contain the following:

- Field chain-of-custody records
- All project-related correspondence (internal and external)
- Laboratory tracking records
- A complete set of deliverables

2.5 DIRECT SAMPLE TRACKING

The National Enforcement Investigations Center (NEIC) of the EPA defines custody of evidence in the following ways:

- It is in your actual possession, or
- It is in your view after being in your physical possession, or
- It is in your possession and then you locked or sealed it to prevent tampering, or
- It is in a secure area.

NUS Laboratory will maintain direct sample tracking showing the transfer of samples from secure, locked sample storage to the secure laboratory area and back to locked storage for this project.

Samples, sample extractions, and sample digestions are stored in locked areas when not in use for sample preparation or analysis. Keys to the locked storage areas are controlled by the Sample Custodian or designated laboratory personnel. The following NUS Laboratory personnel are authorized to access samples in locked storage.

- Project Managers
- · Drivers
- Laboratory Analysts
- Laboratory Assistants
- Laboratory Group Leaders and Assistant Group Leaders
- Laboratory Operations Managers

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- Logistic Support Group leaders
- Quality Assurance Coordinator
- Quality Assurance Representatives
- Sample Custodians

The following steps are taken to document the location of the samples at all times.

- When a sample is to be placed in locked storage following checkin, or a sample extract or a sample digestion is to be placed in storage following sample preparation, the Sample Custodian or analyst obtains a key to the locked storage area and completes the lab tracking record (Figure 7-2). The storage area is unlocked, and the sample or sample preparation is placed in the designated area. The storage unit is locked immediately, and the key is returned.
- When a sample (or its extract or digestion) is to be removed from storage, the Sample Custodian or analyst obtains a key to the storage area, completes the lab tracking record, and unlocks the storage area to permit removal of the sample. The storage area is locked immediately after the removal of the sample, and the key is returned. The analyst is now responsible for the custody of sample.
- When a sample (or its extract or digestion) is to be returned to locked storage, the Sample Custodian or analyst obtains a key to the storage area, signs the lab tracking record, and unlocks the storage area to permit return of the sample. The storage area is locked immediately after return to the sample, and the key is returned.

The laboratory tracking record is placed in the client tile or project file following review by data management personnel.

SA "NPLE LOG-IN SHEET HALLIBURICH MUS LABORATORY SERVICES GROUP

Paga ot

Project Cata Time Sample Receipt Air Big Mo. 16 Coolers Received: No. Coolers Received: No. Coolers Received: No. 16 Cool	Affention: Custody Seals: Yes / No Interlines / Phone: Tes / No Interlines / Phone: Phone: Tes / No Phone: Tes / No Phone: Sample Tegs: Yes / No	Price Discount (*) PO No.: Vendor No.: Work Order Project No! PMS Code: Project No! PMS Code: Project No!	Change Ordert Yes / No Proposal No.: Deletions: Additions:	Sample Identification Date Test Codes [AM/PM] Bothes			Special Pequirements:
		SIC Pace	Anornalios.	Sampl			Speck
		Jeb Ns.	2	Mgiða			
		Client Ma	Condition of Samples Upon Receipt Rest Yes / No Ice Packst Yes / No Containers Intact Yes / No Other:	Leb Sample Number			ionse and and
Clent Report Address	Attantion: CO: Phone:	Log-In Date	Condition of Sample Res: Yes / No Containers Intact Other:	Task No			Special Instructions

FIGURE 7-1 SAMPLE LOG-IN SHEET

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FIGURE 7-2 LABORATORY TRACKING RECORD

	1 1	* * @	age	Time*	
ы. О		Date / Time *	Reluthed to Storage	Date	
143			Relut	θý	
BAGE				Time.	
			Transferred	Date	
S GROUP	oci Name.	ived by	11	E OL	
RECORD	Case No /Project Name SDG Designation:	Samples Received by: . Samples Transferred to:		Time*	
ALCKING AATORY	Case Social Sam	Transferred	Date		
LABORATORY TRACKING RECORD HALLIBURTON NUS LABORATORY SERVICES GROUP			11	10	
LISURTON LABO			orage	Time.	
	Sairipie Conisiners		Remaved from Storage	Date	
	Sainpie		Remov	ke .	
			Lab Sample	(including QC samples)	
	Sample Storage Lotacon Sample Humbers		Containetr	000000	

se military time (i.e. 0145 + 145 a.m.; 1345 + 145 p.m.).

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FIGURE 7-3 SPEED LETTER

SPEED LETTER* 44-902	a santana in kasa na ang s	Wilson	Jone Ship A way atomis
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REPLY	DATE	SIGNED	
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CALIBRATION PROCEDURES, SAMPLE PREPARATION AND ANALYTICAL PROCEDURES, INTERNAL QUALITY CONTROL

1.0 PURPOSE AND APPLICABILITY

This section provides specific calibration procedures, sample preparation and analytical procedures and illustrates internal quality control checks in the form of standard operating procedures (SOPs).

The BP Chemicals, Inc. Mixed Waste Pond Closure Project involves the analysis of soil samples for uranium-238 by gamma spectroscopy, volatile and semivolatile organics (acetone, acetonitrile, acrylonitrile, benzene, 1,1-dichloroethylene, methylethyl ketone, tetrachloroethylene, 1,1,1-trichloroethane, trichloroethene, 1,1-dichloroethene, 1,1-dichloroethane, vinyl chloride, bromomethane, pyridine, and methyl naphthalene), RCRA total metals (arsenic, barium, cadmium, chromium, lead, mercury, selenium, and silver), cyanide, and pH. Appendix A contains all of the applicable SOPs.

2.0 VOLATILE ORGANICS ANALYSIS BY GAS CHROMATOGRAPHY/MASS SPECTROMETRY (GC/MS)

Appendix A, Section 1 contains the SOP for Volatile Organics Analysis by GC/MS.

- A matrix specific detection limit study will be performed for the volatile organic compounds prior to analysis. The procedure is described in Appendix B Section 1.
- Section 3.1 describes instrument setup and tuning. NUS Laboratory employs capillary columns only for analysis. Refer to section 3.1.1 for operating conditions and 3.1.2 for tuning.
- Section 3.2 discusses initial calibration, calculation of relative response factors (RRF) for each compound and calculation of % relative standard deviation (%RSD) or RRF values for each compound.
- Continuing calibration checks and the acceptable criteria are discussed in Section 3.3.



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- Since samples from BP Chemicals, Inc. Mixed Waste Pond Closure Project will be soil matrix, refer to Section 3.5 for the analytical procedure.
- Data reduction is discussed 3.6., 3.8, and 4.0. Since TICs are not required for the BP Chemicals, Inc. Mixed Waste Pond Closure project, those sections which discuss TICs are not applicable.
- Section 5.0 contains quality control requirements.
- Method references are contained in Section 10.0.

3.0 DETERMINATION OF GAMMA-EMITTING RADIONUCLIDES (GAMMA SPECTROSCOPY)

Appendix A, Section 2 contains the SOP for Gamma Spectroscopy.

- Section 3.0 contains routine sample preparation procedures. However, samples for this project will be prepared in accordance with Section 5 of Oak Ridge Associated University's "Laboratory Procedures Manual for the Environmental Survey and Site Assessment Program". Samples will be prepped following Section 2, steps 2.1.1 through 2.1.5. Section 5 is contained in Appendix A, with NUS Laboratory's SOP for Gamma Spectroscopy. Since BP Chemicals, Inc. Mixed Waste Pond Closure samples will be a soil matrix, section 3.2 is applicable. Also contained in Section 3.0 are data acquisition procedures, spectral data reduction technique and calibration method.
- Data collection, reduction and reporting are described in Section 4.0.
- Section 5.0 contains quality control procedures.
- Method references are listed in Sectir: 9.0.

4.0 pH - SOIL/WASTE

Appendix A. Section 3 contains the SOP for determining the pH in soil/waste.

Section 3.0 contains sample preparation procedures.

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- Data collection is described in Section 4.0.
- Section 5.0 contains quality control procedures.
- Section 6.0 describes some of the more common interferences.
- References are listed in Section 10.0.

5.0 GRAPHITE FURNACE ATOMIC ABSORPTION

Appendix A. Section 4 contains the SOP for graphite furnace atomic absorption.

- Arsenic, lead, and selenium will be analyzed for using graphite furnace techniques.
- * A matrix specific detection limit study will be performed for selenium using the procedure outlined in Appendix B, Section 2.
- Section 3.0 describes the preparation of the instrument for analysis.
- Data collection procedures are contained in Section 4.0.
- Section 5.0 contains quality control procedures.
- Section 6.0 discusses interferences encountered using the methodology.
- Section 10.0 lists the method references.

6.0 INDUCTIVELY COUPLED PLASMA - ATOMIC EMISSION SPECTROMETRIC METHOD

Appendix A, Section 5, contains the SOP for inductively coupled plasma - atomic emission spectrometric method.

- Barium, cadmium, chromium, and silver will be analyzed for using inductively coupled plasma.
- Section 2.0 discusses the theory of the methodology.

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- Section 3.0 summarizes the procedure which is followed in analyzing samples.
- Section 4.0 discusses data collection.
- Quality control is summarized in Section 5.0.
- References are listed in Section 10.0.

7.0 MERCURY ANALYSIS IN SOIL/SEDIMENT BY MANUAL COLD VAPOR TECHNIQUE

Appendix A, Section 6 contains the SOP for mercury analysis in soils/sediments using the cold vapor technique.

- Section 3.0 contains sample preparation procedures, calibration sample and standard analysis and data reduction.
- Quality control is summarized in Section 5.0.
- Section 10.0 contains method references.

8.0 CLP CYANIDE

- A matrix specific detection limit study will be performed for CLP cyanide using the procedure described in Appendix B, Section 3.
- Section 3.0 contains sample preparation procedures and standardization procedures for solutions.
- Section 4.0 discusses data collection.
- Quality control is summarized in Section 5.0.
- For the BP Chemicals, Inc. Pond Closure Project, daily calibration will be done. A calibration curve containing 4 data points will be analyzed. In lieu of calculating the correlation coefficient, the calculated RSD must be no greater than 7.5% for the curve to be acceptable.

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9.0 BASE NEUTRAL EXTRACTABLE ORGANICS ANALYSIS BY GAS CHROMATOGRAPHY/MASS SPECTROMETRY

- A matrix specific detection limit study will be performed for pyridine and methyl naphthalene (semivolatile organic compounds) prior to analysis.
 This procedure is described in Appendix B. Section 4.
- Appendix A, Section 8 contains the SOP for base neutral/acid extractable organic compounds.
- Sections 3.1 through 3.5 summarize instrument setup, initial calibration, continuing calibration verification, and sample analysis for target compounds.
- Section 3.7 discusses quantitation of target compounds.
- Quality control is summarized in Section 5.
- Section 10.0 contains method references.

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DATA HANDLING

1.0 PURPOSE AND APPLICABILITY

NUS Laboratory's analytical product includes a complete and accurate written record of sample preparation and analysis, sufficient for third party data validation. This section defines NUS Laboratory procedures for data collection, reduction, entry into the LIMS, validation, and reporting.

All data is collected, reduced, entered, validated, and reported in accordance with this procedure.

2.0 PROCEDURE

- 2.1 DATA COLLECTION
 - 2.1.1 Analytical activities are documented in sufficient detail to allow them to be recreated. This includes the following, at a minimum, for sample preparation and analysis.
 - The analytical activity being performed.

This includes a brief description of the analyte(s) and technique, and the NUS Laboratory SOP number.

- The person(s) performing the activity and the date and time that the activity was initiated.
- Instrument parameters.

This includes instrument identification and settings. (Instrument settings may be referenced to previous documentation of instrument parameters or instrument printouts if available then.)

The analytical sequence (i.e., the chronological order of analysis).

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The following data must be recorded and/or retrievable from an instrument printout (quantitation report, printer tape, etc.) for each sample, standard, and QC check run in the analytical sequence. <u>Units for all variables must be specified</u>, preferably in column headings.

- NUE Laboratory sample number.
- QC sample type identification (prep blank, ms, etc.) if QC sample.
- Dilutions made prior to taking a sample aliquot (actual initial and final volumes, not a ratio).

Sample aliquot/final volume.

Instrument reading.

- Final result to be reported, along with qualifiers where appropriate.
 - Percent recovery, RPD, range, or percent difference of quality control checks.
- The calibration curve from which data are quantified.

This must be identified by instrument and date run, the initial calibration is included in the analytical run.

Notes regarding any anomalies.

For example, change in color, formation of precipitate or difficulties (e.g., instrument malfunction) encountered during analysis.

The notebook identification number on each page.

The method, date, analyst, and instrument must be documented in a laboratory notebook. The remaining

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information must be recorded in the notebook or on preprinted worksheets, or retrievable from instrument output.

2.1.2 Preparation of reagents and standards (calibration, calibration verification, surrogate spike, and matrix spike) is also documented in support of sample analysis in a lab notebook for organic and radiochemistry procedures, respectively.

2.2 DATA REDUCTION

2.2.1 Qualitative Identification

Qualitative identification of organic compounds is performed according to CLP Statement of Work Guidelines which are delineated in Appendix A, Section 1.

Appendix A, Section 2 contains calibration and quality control guidelines for radiochemistry analyses.

2.2.2 Quantitation

The equations used to calculate final results are specified in the appropriate SOP.

- Data reduction for gamma spectroscopy is discussed in Section 4.2 of the SOP (Appendix A, Section 2).
- Volatile organics analysis and the quantitation of target compounds is contained in Section 3.8 of the SOP (Appendix A, Section 1).
- pH determination is discussed in Appendix A. Section.
- Metals by graphite funrace and the quantitation or arsenic lead, and selenium are discussed in Appendix A, Section 4.
- Analysis of metals by ICP is discussed in Appendix A, Section 5 under procedure.

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- Quantitation of mercury is discussed in 3.4 of Section 6, Appendix A.
- Report solid samples (soil/sediment/non-organic wastes) on dry wight basis. Percent moisture/solids will also appear on the report.

2.2.3 Analyst Evaluation

The quality control data for each batch or analytical run are evaluated against acceptance limits. (See Section 5) Whenever a quality control result exceeds acceptance limits, with the exception of matrix spike recoveries, corrective action is required prior to turning in data for the batch or analytical run for independent data review. Corrective actions are documented in the analysis log. When corrective action requires the efforts of someone other than the analyst, or the corrective action will not be completed during the work shift, the analyst completes a nonconformance/corrective action record.

2.3 DATA ENTRY

After data reduction, the analyst enters the following data from the analytical run into the laboratory information management system (LIMS).

- Date and time of analysis (time initiated).
- Analyst.
- Instrument.
- Sample results, including comments/qualifiers.
- QC sample results, including comments/qualifiers.
- Lab notebook reference.

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2.4 DATA VALIDATION AND REPORTING

The data validation and reporting sequence are described below. The independent data and check-out reviews conducted by the operations staff are intended to compliment one another. The independent data review evaluates the results obtained for many samples for one test; check-out evaluates the results for all tests run for one sample. Errors and inconsistencies that are not apparent from the initial review may be evident in the second review.

2.4.1 Independent Data Review

- Following data reduction and before or after data entry, the raw data associated with the analytical run -- analysis log, instrument output (quantitation reports, chromatograms, spectra, strip chart recordings), calibration curves, etc. are forwarded to the Group Leader or his/her designee for independent review and approval. The review encompasses the correctness, acceptability, and completeness of the following elements of data generation and handling. (All elements are not applicable to all tests.)
 - Data entry
 - Instrument tuning
 - Initial calibration
 - Continuing calibration/calibration verification
 - Calibration blanks
 - Method blanks



At least 10% of the samples in the batch will be reviewed. The reviewer initials the specific sample results reviewed. If an error is found, 100% of the samples reported from the batch must then be reviewed.

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- Surrogate or lab control standard recovery
- Qualitative identifications¹
- Quantitation, including units and reportable figures¹
- Precision of duplicates
- Recovery of matrix spikes
 - Holding time
- Data qualifiers/comments

When an unacceptable calibration or quality control check is generated, the data reviewer ensures that appropriate corrective action was taken <u>prior to</u> approving the data. Any defects are corrected. Raw data and data entry are also corrected as necessary. If corrective action cannot be taken, the sample results are qualified appropriately.

- If independent data review is conducted prior to data entry, data entry is verified separately. Any problems with the data must be corrected prior to approval of the data.
- Upon approval of the data, the reviewer initials the lab notebook page(s) or the worksheet, and indicates approval of the data in the LIMS, which allows the data to proceed to check-out.

2.4.2 Sample Check-out

When all of the results for the parameters assigned to a sample have passed independent data review, they are evaluated by the Laboratory Manager or his/her designee during check-out. Errors and inconsistencies that were not evident in the initial review may become apparent when each result is evaluated in light of the results obtained for the other parameters. Specifically, the following are reviewed.

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- Units and reportable figures.
- Reasonableness of results given the available information about the sample.
- Method references.
- QC data completeness.

Any problems with the data must be corrected before the data are approved at check-out.

2.4.3 Report Preparation

- Following check-out, data are available for report preparation through the LIMS. Reports consist of a lab analysis report or a lab analysis report and a quality control report. The lab analysis report contains the following information:
 - Client name and address (including the person to whose attention the report is being sent).
 - NUS Laboratory report number.
 - Report date.
 - NUS Laboratory client number.
 - Identification of the person who reviewed and approved the data at check-out.
 - Date sampled and date of sample receipt for each sample.
 - Determination, result, and units for each radiochemical parameter for each sample.
- The quality control report contains the following information as applicable to the analytes:

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- Supplemental information, including batch number, method reference, date and time of analysis, analyst, and instrument used for radiochemical determinations, and method reference for volatiles.
- Laboratory control sample recoveries.
- Radiochemical method blank results.
- Radiochemical matrix spike and duplicate results.

A copy of the chain-of-custody will also be provided with the final reports.

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LABORATORY QUALITY CONTROL

1.0 PURPOSE AND APPLICABILITY

This procedure provides an overview of procedures used to assess and control analytical processes applicable to the BP Chemicals, Inc. project. Specific information on quality control checks for individual laboratory groups is provided in the SOPs in Appendix A of this Quality Assurance Plan for BP Chemicals, Inc.. Additionally, the blind QC sample program and participation in performance evaluation studies are detailed in Section 11, Performance Audits.

2.0 PROCEDURE

2.1 ACCEPTANCE LIMITS

Acceptance limits for the daily QC program are taken from EPA methods or are established by NUS Laboratory from actual QC data as described in this section. Acceptance limits are calculated and summarized semiannually, at a minimum, and distributed to laboratory operations personnel by the QAD.

2.1.1 Fixed Limits

In general, acceptance limits for GC/MS for tuning, initial and continuing calibration, method blanks, surrogate standards, and precision and accuracy of matrix spikes and duplicates or duplicate matrix spikes are based on acceptance limits established in EPA methods and are detailed in the appendices to this QA Plan.

2.1.2 Variable Limits

Variable limits are based on laboratory-generated data and and updated semi-annually, at a minimum, by the QAD.

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a. Accuracy

- Acceptance limits for percent recovery of lab control standards are calculated from actual QC data. The mean (x) and standard deviation (s) are calculated from the most recently generated percent recovery data. A minimum of 20 values are necessary to establish limits; up to 100 values will be used when available. Outliers, which are excluded from the calculation of acceptance limits, are identified as described in paragraph 3.4.
- Acceptance limits are calculated as follows, where x_i represents the individual values and n is the number of values:

Parameter	Symbol	Formula
Upper Control Limit	UCL	x + 3s
Upper Warning Limit	UWL	x + 2s
Center Line	X	(Sum x _i)/n
Lower Warning Limit	LWL	x - 2s
Lower Control Limit	LCL	x - 3s

- Acceptance limits are tested initially by determining the percentage of points falling in the range of x + 1s. It is expected that approximately 68% of the data will fall within this range. If <50% of the data fall within this range, the limits are suspect and must be verified prior to use.
- b. Precision
 - Acceptance limits for the range or RPD of duplicate analyses are calculated from the standard deviation (s)

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of the most recently generated range or RPD data. A minimum of 20 values are necessary to establish limits; up to 100 values will be used when available. Outliers, which are excluded from the calculation of control limits, are identified as described in paragraph 3.4.

Until sufficient data have been generated to calculate acceptance limits, the following limits will apply:

Range: <2 times the method detection limit

RPD: <20%

Acceptance limits are calculated as follows, where x_i represents the individual values and n is the number of values:

Parameter	Symbol	Formula
Upper Control Limit	UCL	x + 3s
Upper Warning Limit	UWL	x + 2s
Center Line	×	(Sum x _i)/n

For radiochemistry, precision acceptance limits are established for the ranges shown in Table 10-1. Variable limits based on in-house data must not exceed the maximum listed.

c. Acceptance Limit Updates

Acceptance limits will be updated semi-annually at a minimum, when 5 or more new values have been generated. The summary of acceptance limits is revised and distributed to the appropriate lab groups after each update.

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2.2 OUT-OF-CONTROL SITUATIONS

Whenever an out-of-control situation occurs, with the possible exception of matrix spike recoveries (see 3.1.1), corrective action is required prior to continuation of analysis and/or reporting of the data for the entire batch. The corrective action taken for <u>each</u> out of control event must be described in the analysis log. In addition, when corrective action cannot be completed by the analyst within the same work shift, a nonconformance/corrective action record is completed. (See Section 14, Corrective Action.)

2.2.1 Fixed Limits

Analyses are out of control whenever the acceptance limits are exceeded.

2.2.2 Variable Limits

Analyses are out of control whenever any of the following events occur:

- 1 point is outside the control limits
- 2 consecutive points are outside the warning limits
- 7 consecutive points are on one side of the center line
 - 7 consecutive points increase or decrease
- An obvious cyclical pattern is observed in the distribution of points

In order to evaluate the data in this manner, the quality control data will be graphed on control charts or tabulated in chronological order.

2.3 IDENTIFICATION OF OUTLIERS

Outliers, which are excluded from the data used to calculate acceptance limits, are identified as follows (according to the procedure described in ASTM E178-80, Sections 4.1 and 4.2):

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- x, s, and n are those values calculated the last time acceptance limits were updated. (This differs from ASTM E178-80 which uses the values from the data set under evaluation.)
- x, is that value in the <u>current</u> set of data furthest from x. (The current data is the set of data under evaluation.)
- T_{1%} is the T value from Table I in ASTM E178-80 for n at the 1% significance level.
- * If the absolute value of $(x x_t)/s \le T_{1\%}$, x_t is not an outlier. Use this value and all other values in the data set to calculate acceptance limits.
- If the absolute value of $(x x_f)/s > T_{1\%}$, x_f is an outlier. Delete this value from the data set and do not use it to update acceptance limits. Add the next most recent value (if available) to the data set and repeat the test for outliers.

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TABLE 10-1

RADIOCHEMISTRY ACCEPTANCE CRITERIA

Parameter

Level

Maximum Acceptance Criteria⁽¹⁾

Gamma Emitters

<100 pCi/L ≥100 pCi/L Range <10 pCi/L RPD <10%

(1) Adapted from EPA 600/4-81-004, Table 3



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PERFORMANCE EVALUATION AND SYSTEMS AUDITS

1.0 PURPOSE AND APPLICABILITY

Performance evaluation audits test the precision and accuracy of laboratory data through the analysis of reference materials whose true value is unknown to the analyst. NUS Laboratory participates in performance evaluation studies sponsored by the EPA and a variety of certifying and accrediting agencies. NUS Laboratory also conducts an internal Blind Quality Control Sample (BQCS) program to monitor data quality.

1.1 BQCS PROGRAM

NUS Laboratory monitors and controls its analytical processes through daily quality control checks and a blind quality control sample program. The daily quality control (QC) program consists of control samples prepared and inserted into the analytical process by the analyst. These QC checks are advantageous in that the analyst receives feedback on analytical performance as soon as the control sample result is obtained. Should the result indicate a performance problem, corrective action can be taken immediately. However, since the analyst knows the identity of the control sample as well as its true or expected value, the opportunity for bias in the treatment of the QC sample exists. The ongoing, group-wide BQCS program, compliments the daily quality control program. These control samples are either single or double blinds inserted into the analysis process by the quality assurance staff. Thus, the opportunity for analyst bias is reduced or aliminated.

This dual approach to quality control provides the analyst with sufficient information to evaluate the performance of the analytical system in real-time, while providing laboratory management with ongoing, unbiased feedback on laboratory performance.

The BQCS program is also used to develop precision and accuracy data quality objectives and to provide objective evidence of the overall quality of NUS Laboratory data.



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1.2 EXTERNAL PERFORMANCE EVALUATION STUDIES

NUS Laboratory participates in a variety of performance evaluation programs sponsored by the EPA, state regulatory agencies, and other certifying or accrediting agencies. NUS participates in these studies in order to obtain and retain the desired certifications and accreditations.

Systems audits evaluate work group performance against established quality assurance requirements. Waste handling and disposal procedures are also monitored in accordance with this procedure. Work performed under the BP Chemicals, Inc. Quality Assurance Project Plan may be audited at the discretion of the Quality Assurance Coordinator or the Laboratory Manager.

External systems audits are also used as sources of feedback on the quality and performance of the laboratory. Nonconformances identified during external systems audits are documented in the audit report and laboratory response, and corrected in the same manner as internal systems audit findings.

2.0 PROCEDURE

- 2.1 BOCS PROGRAM
 - 2.1.1 Scope of the BQCS Program
 - The BQCS program serves as a check on the effectiveness of the daily quality control program. It is not the primary tool for accepting or rejecting data on a daily basis.

The BQCS program encompasses the analytical procedures run routinely at the laboratory for which reference materials are readily available.

 A schedule for the BQCS program is set annually, at a minimum, by the QAR responsible for the BQCS program. At a minimum, blind QC samples are submitted for analysis quarterly; at most, they are submitted monthly. Additionally,

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primary drinking water parameters for which the labortory holds drinking water certification must be submitted for analysis through the BQCS program quarterly.

2.1.2 Preparation and Distribution of Blind QC Samples

Reference materials and glassware are dedicated to the preparation of the blind samples, and are not used routinely for any other purpose.

The QAR maintains a log of blind sample preparation and distribution, which documents the following:

- Reference material used material, manufacturer, lot number.
- Method of preparation.
- Identification number of each sample.
- Distribution of samples.
- Signature and date.
- In preparing blind samples, the stability of reference materials and the compatibility of different materials must be considered. The accuracy of the results obtained for the blind samples must be a function of sample analysis, not blind sample preparation.
- Blind samples are submitted for analysis through sample login.
- 2.1.3 Evaluation of Blind QC Sample Results
 - The analyst(s), instrument used, and date of analysis are noted by the QAR so that these variables can be considered in the evaluation.

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- Initially, blind sample results are evaluated against the first applicable acceptance criteria from the following list:
 - Acceptance limits provided with the reference material.
 - Acceptance limits listed in the reference method.
 - NUS Laboratory's daily quality control program acceptance limits.
 - The procedure for dealing with out-of-control BQCS results is detailed in Figure 11-1. Out-of-control results will be brought to the Laboratory Group Leader's attention for investigation and correction. using a nonconformance/corrective action record (Figure 14-3), or equivalent. The Group Leader's investigation should address the following points. (This list is not exhaustive, but serves as a starting point.)
 - Check for calculation errors.
 - Check accuracy of calibration standards and procedures.
 - Check the quality control data that was generated with the blind sample -- blanks, calibration checks, surrogate or blank spike recovery, duplicates, matrix spikes -- for anomalies.
 - Evaluate analyst's and/or instrument's performance in general.
 - Rerun the blind QC sample if the holding time has not expired.

The results of the investigation are summarized on the nonconformance/corrective action record and returned to the QAR within ten working days. A log listing the status of the nonconformances is maintained by the QAR.

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 The parameters in question are submitted for blind sample analysis monthly until acceptable results are obtained on two consecutive samples. If analytical problems persist, and out-of-control results are obtained on two consecutive blind samples, the Laboratory Manager is notified and analysis is monitored closely pending correction of the problem. Each batch of samples must contain a blind quality control sample prepared by the local QAR. If unacceptable results are obtained for the blind QC sample, the run is rejected. Close monitoring continues until acceptable results are obtained for three consecutive batches, mat a minimum.

2.2 EXTERNAL PERFORMANCE EVALUATION STUDIES

2.2.1 Scope of the External Performance Evaluation Studies

External PE studies are run at the frequency required to obtain and retain desired certifications, accreditations, and approvals, at r minimum. Additional studies may be run at the discretion of the Laboratory Manager.

For the purposes of this procedure, annual NPDES DMR-QA performance evaluation samples and any other PE samples submitted for analysis by a client are considered to be external PE studies.

2.2.2 Preparation and Reporting of External PE Samples

- The Group Leader, Assistant Group Leader, or an experienced analyst prepares the PE sample for analysis according to the preparation instructions. Samples should be run as soon as possible after opening the PE sample ampoule to minimize sample degradation.
- Following independent data review and approval by the Group Leader or his/her designee, the QAR also reviews the raw data, requests additional analyses if data are suspect, and completes the report form.

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 A second member of the QAD double checks the results reported against the analysis log or LIMS printout to ensure that there have not been any transcription errors. The completed report form is then submitted to the appropriate agency.

2.2.3 Evaluation of the External PE Sample Results

- Upon receipt of the external evaluation report from the EPA or other agency, the QAR notes the analyst, instrument used, and date of analysis for each result so that these variables can be considered in the evaluation.
- Out-of-control results are brought to the Laboratory Group Leader's attention for investigation and correction, using a nonconformance/corrective action record (Figure 14-3), or equivalent. As with the investigation of blind QC sample failures, the Group Leader's investigation should address the following points. (This list is not exhaustive, but serves as a starting point.)
 - Check for calculation errors.
 - Check accuracy of calibration standards and procedures.
 - Check the quality control data that was generated with the blind sample -- blanks, calibration checks, surrogate or blank spike recovery, duplicates, matrix spikes -- for anomalies.
 - Evaluate analyst's and/or instrument's performance in general.
 - Rerun the blind QC sample if the holding time has not expired.

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The results of the investigation are summarized on the nonconformance/corrective action record and returned to the QAR within ten working days.

The parameters in question are submitted for blind sample analysis monthly until acceptable results are obtained on two consecutive samples. If analytical problems persist, and out of control results are obtained on two consecutive blind samples, the Laboratory Manager is notified and analysis is monitored closely pending correction of the problem. Each batch of samples must contain a blind quality control sample prepared by the local QAR. If unacceptable results are obtained for the blind QC sample, the run is rejected. Close monitoring continues until acceptable results are obtained for three consecutive batches, at a minimum.

2.3 PERFORMANCE EVALUATION AUDIT SUMMARY

The local QAR summarizes blind QC sample and external PE sample results for inclusion in periodic reports to management and discussion at monthly quality control meetings.

2.4 INTERNAL SYSTEMS AUDITS

2.4.1 The Quality Assurance Coordinator schedules internal systems audits so that all work groups and major laboratory programs are audited each year. Audit assignments are distributed within the QAD. Operations personnel may also function as auditors providing they are given training and are independent of the work being audited. See Figure 11-2 for an example schedule.

A laboratory profile (see Table 11-1) is performed annually for each major laboratory work group, in accordance with the audit schedule. For each quarter in which a profile is not performed, a quarterly report (see Table 11-2) is prepared. The profiles and quarterly reports satisfy internal systems audit requirements and serve as the basis for determining group leader performance with respect to the quality assurance program each quarter.

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- 2.4.2 The auditor prepares and audit plan for each lab profile. The auditor may use discretion in preparing the plan based on his/her prior knowledge of the work group's performance. All of the topics listed in Table 11-1 need not be ac'dressed in each lab profile. The audit plan is reviewed by a certified lead auditor prior to audit conduct. The audit plan must be retrievable for a period of two years.
- 2.4.3 The auditor conducts the audit according to the plan. The auditor's notes must include specifics regarding personnel interviewed or observed, and documents reviewed. Audit notes must be retrievable for a period of two years.
- 2.4.4 The scope and findings of the audit are summarized in a profile report. The report is reviewed by a certified lead auditor. Following this, the report is reviewed with the responsible group leader(s). The group leader must acknowledge each area requiring corrective action by initialing the portion of the report identifying the need for corrective action and providing a date by which the action will be completed. Discussion between the auditor and the group leader is encouraged. The report will be revised based on clarifications provided by the group leader at the auditor's discretion. The group leader may attach additional comments as an addendum to the report if he/she so desired.
- 2.4.5 The profile and guarterly reports are distributed as follows:

Lab Manager Quality Assurance Coordinator Applicable Group Leader(s) Applicable Assistant Group Leader(s) Quality Assurance Files

2.4.6 The auditor will follow up on the implementation of corrective actions required as a result of a laboratory profile in the quarterly reports until each issued is closed. An Audit Findings Follow-up Form (Figure 14-5) will be used to document follow-up.

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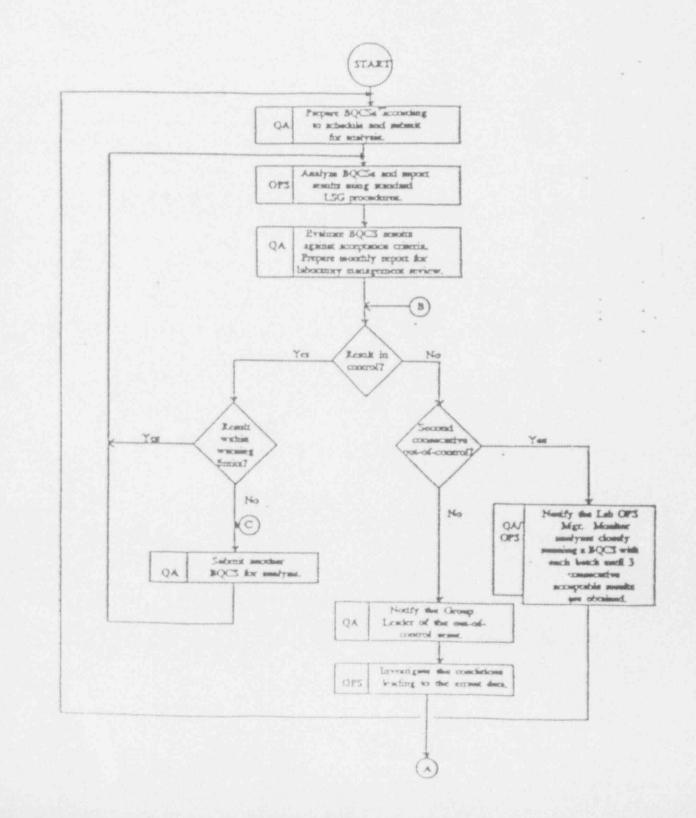
At the Quality Assurance Department's discretion, a quality notice (Figure 14-6) may be used to track resolution of complex or chronic nonconformances.

2.5 EXTERNAL SYSTEMS AUDITS

- 2.5.1 The QAD serves as the interface between the laboratory and the client and regulatory agency representatives performing systems audits of NUS Laboratory. Upon notification of intent to audit by a client or regulatory agency, the QAD notifies laboratory personnel of the audit.
- 2.5.2 The QAD participates in the audit; additional NUS Laboratory personnel are called upon as necessary.
- 2.5.3 The QAD provides a written summary of the results of each audit to NUS Laboratory management including strengths and deficiencies identified by the auditors.
- 2.5.4 The QAD, in consultation with appropriate management personnel, responds to external audit findings. Corrective actions are tracked through Audit Findings Follow-up Form. A Quality Notice may be opened for findings at QAD discretion.

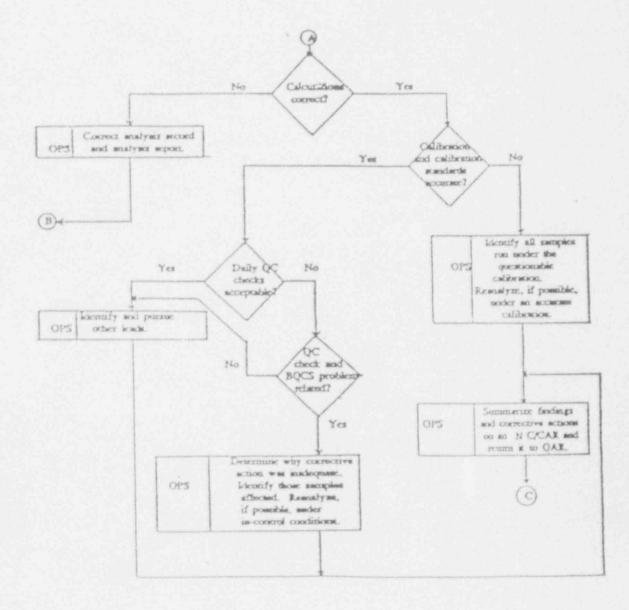
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FIGURE 11-1



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FIGURE 11-1 (CONTINUED)

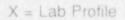


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FIGURE 11-2

LABORATORY PROFILE SCHEDULE (EXAMPLE) HALLIBURTON NUS LABORATORY SERVICES GROUP PROGRAM MONITORING SCHEDULE (EXAMPLE)

Program Element	Jan	Feb	Mar	Apr	Мау	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Metals	X		Q			Q			Q			Q
Bioassay		Х	Q			Q			Q			Q
GC/MS			X			Q			Q			Q
Inorgan- ics/RCRA			Q	Х		Q			Q			Q
GC			Q		х	Q			Q			Q
Logistic Support						×						
Project Manage- ment							×					
QA-19								X				
CHP							i din .		Х			
LWD-1										Х		
QA-20											X	
6				6.5								



Q = Quarterly Report



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TABLE 11-1

LABORATORY PROFILE CONTENTS

1.0 COVER PAGE

Prepare a cover page that lists the following:

- · Work group audited
- Auditor's signature
- Dates of the audit
- Group Leader's signature

2.0 EXECUTIVE SUMMARY

2.1 Areas of Improvement

List areas of improvement since the last report.

2.2 Areas of Concern

List areas of concern from this audit.

3.0 CONTROL CHARTING/NONCONFORMANCE RESOLUTION

3.1 Control Charts

From periodic review of control charts, discuss the status of the following since the last report:

- Maintenance of control charts
- Response to out-of-control events
- Trends apparent from the chart

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TABLE 11-1 LABORATORY PROFILE CONTENTS (CONTINUED)

3.2 Nonconformance Resolution

From periodic review of nonconformance/corrective action records, discuss the status of the following since the last report:

- Maintenance of the records
- Response to nonconformance (i.e., for appropriateness and timeliness)
- Trends apparent from the records (including a Pareto chart of nor-conformance frequencies)

4.0 PERFORMANCE AUDITS

6.

- 4.1 Performance Audit Results
 - Summarize results (i.e., percent and number of results passing) for internal external performance audit samples for which evaluations were received since the last report.
 - Discuss favorable and unfavorable trends apparent from the results.

4.2 Performance Audit Findings

List the following for each performance failure open in last report and opened since the last report:

- Parameter and technique used for analysis
- Outcome of investigation
- Status; if open, list actions required to close

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TABLE 11-1 LABORATORY PROFILE CONTENTS (CONTINUED)

5.0 SYSTEMS AUDITS

5.1 System Audit Repults

List audite that the lat was involved in since the last report.

5.2 Systems Audit Findings

List the following for each issued identified in a systems audit (i.e., external audit finding, observation, and recommendation) open in the last report and opened since the last report:

- Problem or concern
- Actions taken since the last report
- · Status; if open, list actions required to close

6.0 Dr SSESSMENT AND METHOD REVIEW

Identify two tests performed by the lab that warrant additional attention. (Should there be no tests to concern, select two at random from the price book.) The performance of these methods is audited against the NUS Laboratory method. Verify that the lab is using the current NUS Laboratory method. (If an NUS Laboratory method has not been prepared, audit against the reference method.)

Select a recent run for each of these tests that has passed independent review. Select last sample in each run. For the test/sample combination identified, review and evaluate therefollowing:

- 6.1 Project Plan (where applicable)
 - Familiarize yourself with the project requirements for the samples identified.





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TABLE 11-1 LABORATORY PROFILE CONTENTS (CONTINUED)

- Verify that the lab is working from the current revision of the plan.
- 6.2 Sample Log-in and Lab Tracking Records
 - Review the sample log-in sheet, field chain-of-custody record, pH check log, and related correspondence for the samples identified.

Evaluate the records for completeness, legibility, and proper resolution of nonconformances.

Review lab tracking records (where applicable).

Evaluate the records for completeness and legibility for the samples and tests identified.

6.3 Sample Preparation Data

· Review the sample preparation data (where applicable).

Evaluate for the following:

- completeness
- legibility
- standards traceability (including documentation of source and preparation, proper storage, and proper frequency of preparation)
- conformance to QC program (including calibrations)
- independent review and approval
- accuracy of data entry into the LIMS

6.4 Sample Analysis Data

Review the sample analysis data.

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TABLE 11-1 LABORATORY PROFILE CONTENTS (CONTINUED)

Evaluate the following:

- completeness
- legibility
- standards traceability (including documentation of source and preparation, proper storage, and proper frequency of preparation)
- conformance to QC program (including calibrations)
- independent review and approval
- accuracy of data entry into the LIMS
- appropriateness of report comments (i.e., comments in the LIMS)

7.0 LABORATORY MAINTENANCE

7.1 Housekeeping and Safety

Evaluate housekeeping and safety (i.e., personnel protection practices) in the lab area.

7.2 Preventive Maintenance

- Review calibration stickers for currency.
- List overdue preventive maintenance activities.
- Ensure that periodic calibration of active equipment in the lab is current.
- Verify that the equipment list is up to date.
- 7.3 Temperature and Maintenance Logs

Review temperature and maintenance logs.

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TABLE 11-2

QUARTERLY LABORATORY REPORTS

1.0 COVER PAGE

Prepare a cover page that lists the following:

- Work group
- Preparer's signature
- Date prepared

2.0 EXECUTIVE SUMMARY

2.1 Areas of Improvement

List areas of improvement since the last report.

2.2 Areas of Concern

List areas of concern from this audit.

3.0 CONTROL CHARTING/NONCONFORMANCE RESOLUTION

3.1 Control Charts

From periodic review of control charts, discuss the status of the following since the last report:

- Maintenance of control charts
- Response to out-of-control events
- · Trends apparent from the chart

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TABLE 11-2 QUARTERLY LABORATORY REPORTS (CONTINUED)

3.2 Nonconformance Resolution

From periodic review of control charts, discuss the status of the following since the last report:

- · Maintenance of the records
- Response to nonconformances (i.e., for appropriateness and timeliness)
- Trends apparent from the records (including a Pareto chart of nonconformance frequencies)

4.0 PERFORMANCE AUDITS

- 4.1 Performance Audit Results
 - Summarize results (i.e., percent and number of results passing) for internal external performance audit samples for which evaluations were received since the last report.
 - · Discuss favorable and unfavorable trends apparent from the results.

4.2 Performance Audit Findings

List the following for each performance failure open in the last report and opened since the last report:

- Parameter and technique used for analysis
- Outcome of investigation
- · Status: if open, list actions required to close

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TABLE 11-2 QUARTERLY LABORATORY REPORTS (CONTINUED)

5.0 SYSTEMS AUDITS

5.1 Systems Audit Results

List audits that the lab was involved in since the last report.

5.2 Systems Audit Findings

List the following for each issued identified in a systems audit (i.e., external audit finding, observation, and recommendation) open in the last report and opened since the last report:

- Problem or concern
- Actions taken since the last report
- Status; if open, list actions required to close

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PREVENTIVE MAINTENANCE

1.0 PURPOSE AND APPLICABILITY

These requirements have been established to ensure that instruments used for sample analysis function properly and reliably and to minimize prolonged instrument downtime so that regulatory holding times and other sample turnaround commitments can be met.

2.0 PROCEDURE

2.1 INSTRUMENT MAINTENANCE LOGS

- 2.1.1 The performance history of all major laboratory equipment is be documented in instrument maintenance logs. In-house preventive maintenance, trouble-shooting, and corrective maintenance is documented in the log by the NUS Laboratory staff member performing the maintenance. When maintenance is performed by an outside vendor, the NUS Laboratory staff member signing the service report shall also note the service performed in the log. The book and page number of the maintenance log entry is referenced on the service report, and the service report is forwarded to the Instrument Specialist for inclusion in the equipment file.
- 2.1.2 The QAD reviews instrument logs annually, at a minimum. Balance logs are received quarterly.

2.2 TEST EQUIPMENT CALIBRATION

The equipment used to calibrate analytical equipment is NIST certified and/or calibrated periodically against standards having known and valid traceability to recognized standards. Requirements are specified below. Calibration of test equipment is documented in the same fashion as analytical equipment calibrations.

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- 2.2.1 mV standards and 5-1/2-digit voltmeters are calibrated by an outside vendor annually, at a minimum.
- 2.2.2 Glass/mercury thermometers are calibrated against an NISTcertified thermometer annually, at a minimum. A tag identifying the calibration date and correction factor are physically applied to the thermometers.
- 2.2.3 Thermocouples are calibrated against a mV standard and an ice bath annually, at a minimum.
- 2.2.4 Class S weights are used to verify weights maintained at the balances. They are calibrated annually against weights whose calibration is traceable to the NIST.
- 2.2.5 Weights maintained at the balances are calibrated against Class S weights annually, at a minimum.
- 2.2.6 Meters used to measure air uptake of exhaust and fume hood are calibrated annually, at a minimum, by an outside vendor.
- 2.3 PREVENTIVE MAINTENANCE OF ANALYTICAL EQUIPMENT
 - 2.3.1 Preventive maintenance (PM) encompasses a variety of operations: specification checks, calibration, cleaning, lubrication, reconditioning, adjustments, and testing. The purpose of preventive maintenance is two-fold: (1) to minimize the occurrence and severity of catastrophic performance losses that result in prolonged equipment downtime, and (2) to detect and correct more subtle, noncatastrophic performance losses before they have a significant impact on data generation and/or quality.

The time frames specified for preventive maintenance activities are minimum requirements; checks/maintenance may be performed more frequently but not less frequently.

2.3.2 Preventive maintenance requirements for analytical equipment are tabulated in Appendix C to this QA Plan. The QAD issues reminders (Figure 12-1 or equivalent) for PM due monthly or less frequently.



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Reminders are issued to the Group Leader or the Instrument Specialist, as appropriate, approximately six weeks before the PM due date. This will allow sufficient time to schedule the maintenance so that it can be performed prior to the due date with minimal disruption to sample analysis. The Group Leader/Instrument Specialist is responsible for completion of the PM on or before the due date. Performance of the PM may be delegated, but responsibility for its completion rests with the Group Leader/Instrument Specialist.

If the required preventive maintenance cannot be performed on or before the due date, it is the responsibility of the Group Leader/Instrument Specialist to contact the QAD and reach a mutually agreed upon time frame for its completion. Every effort should be made to keep the preventive maintenance program and supporting documentation current and complete, since failure to do so could result in equipment performance loss and/or the equipment becoming inactive.

- 2.3.3 The Group Leader or Instrument Specialist performing the preventive maintenance is responsible for documenting the activity in the maintenance log. Documentation includes the following:
 - Brief description of the PM activity.
 - Identification of any equipment used in calibration or ventication by type, make, model, serial number, date of last calibration, and calibration due date.
 - Signature of the person performing the PM.
 - Date on which the PM was performed.

When periodic maintenance involves calibration or calibration verification, a calibration label (Figure 12-2 or equivalent) is applied to the equipment by the person completing the calibration/verification.

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- 2.3.4 Inactive equipment is labeled with an inactive label (Figure 12-3 or equivalent) and is segregated from active equipment whenever possible. Equipment that is not in conformance with preventive maintenance requirements may be made inactive at the discretion of the QAD.
- 2.3.5 Any change in status, from active to inactive or inactive to active, should be recorded by the Group Leader on a Change of Status Record (CSR, Figure 12-4). The completed CSR should be forwarded to the QAD to update the equipment list, then to the equipment file.

2.4 REQUESTING IN-HOUSE SERVICE

- 2.4.1 While preventive maintenance reduces the number and severity of equipment malfunctions, it will not eliminate all malfunctions. Whenever the expertise of the Instrument Specialist is required to trouble-shoot and/or repair equipment, the Group Leader completes a Service Request Form (Figure 12-5). The form serves three purposes: (1) it informs the Instrument Specialist of problems, (2) it helps the Instrument Specialist prioritize his/her work, and (3) it provides a history of the problems encountered by individual instruments and classes of instruments. (This form is also used to schedule in-house maintenance for the facility.)
- 2.4.2 The requester completes Part I of the form <u>and</u> notes the request for service in the instrument log. The requester should describe the problem on the form as completely as possible. This allows the Instrument Specialist to evaluate and correct the problem in the most efficient manner. Priority codes are as follows:
 - Priority 1 Immediate repair required. Downtime will have a major impact on overall laboratory performance. Repair to be completed as soon as possible (i.e., within 1 workin) day or less if parts/service are available).

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- Priority 2 Service to be performed within 1 to 5 working days. Limited impact on overall laboratory operations, but significant impact on 1 or more groups. Extended downtime may cause significant problems.
- Priority 3 Service to be performed on a scheduled basis. Order of service performed is based on order in which requests are received. Generally service will be performed within 10 to 30 working days. Priority 3 is appropriate when an operable backup system is available.
- Priority 4 Service to be performed on inactive equipment or low priority maintenance. Service should be performed within S0 days, even if an outside vendor must be used.
- 2.4.3 Following servicing, the Instrument Specialist completes Part II of the form. The original form is forwarded to the equipment file and a copy is forwarded to the requester.

2.5 MAJOR EQUIPMENT LIST

- 2.5.1 All major laboratory equipment is catalogued on a Major Equipment List. The list identifies equipment by type, make, model, and serial number. The list also identifies the year in which the equipment was obtained, the laboratory to which it is assigned, its calibration status, and the frequency of calibration as applicable to the equipment type. The list is updated by the QAD as equipment is put into or taken out of service.
- 2.5.2 Equipment that contains radioactive isotopes is listed on the primary equipment list and on an auxiliary Radioactive Instrument/Article Inventory. The Radioactive Instrument/Article Inventory identifies the type of equipment, its make, model, and serial number, the nuclide and its action, and the Group Leader responsible for the equipment.
- 2.5.3 Equipment cannot be moved, modified, or discarded without approval of the responsible Group Leader.



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2.6 NEW EQUIPMENT

- 2.6.1 Newly acquired equipment must be integrated into the QA program prior to its use in sample analysis. In order to do this efficiently, the Instrument Specialist, Group Leader, and QAD must work together.
- 2.6.2 When new equipment has been received, the Group Leader works with the Instrument Specialist and QAD to develop a set of preventive maintenance checks and quality control checks for the equipment, if not already established. Additionally, the Group Leader and the QAD determines if any preliminary studies should be performed, such as a detection limit study and/or a demonstration of performance. It is important to include any preliminary studies and demonstrations of equipment performance, such as first chromatograms or raw data, etc., in the equipment file, as this will be valuable for later diagnostics.

NOTE: For new types of equipment, the choice of preventive maintenance and quality control checks is discussed with all fixed-base laboratories so that requirements are consistent between the facilities.

- 2.6.3 After successful calibration and completion of any required studies, the Group Leader completes a CSR, indicating that the equipment is active. The record lists the performance studies completed and references the location of the documentation of the studies. The equipment may then be used in sample analysis. The CSR is forwarded to the QAD, who updates the equipment list. The CSR is then forwarded to the equipment file.
- 2.6.4 Instrument manuals supplied by the manufacturer are maintained by the Group Leader for reference.

2.7 CRITICAL SPARE PARTS LIST

Each laboratory retains a critical spare parts inventory and a spare parts inventory list. The spare parts listed are those which, in the best judgment of the Group Leader, Instrument Specialist and LSG management, can best decrease downtime and increase data acquisition efficiency most



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economically. A critical spare parts list is included in the equipment file and upuated as necessary. A recommended critical spare parts list for each instrument group is included in the appendix to this procedure.





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PREVENTIVE MAINTENANCE REMINDER

ISSUED TO:

DATE:

SERVICE REQUIRED

INSTRUMENT:

(Make/Model/Serial No.)

PM TO BE PERFORMED:

DUE DATE:

SERVICE COMPLETED

BY:_____

DATE:

DOCUMENTED:

(Maintenance Log Book and Page Number)

RETURN COMPLETED REMINDER TO QAC



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EQUIPMENT:

CALIBRATED DATE:

VERIFIED DATE:

DUE DATE:



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INACTIVE EQUIPMENT

EQUIPMENT:

DATE: INACTIVATED:

INITIALS:

DATE ACTIVATED:

INITIALS:

Return completed label to QAD following equipment activation



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CHANGE OF STATUS RECORD

TYPE:	MODEL:
MANUFACTUREF:	SERIAL NO.:
This piece of equipment became:	on
Active/Inactive	Date

List the events leading to the change of status along with any other pertinent information below.

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SERVICE REQUEST FORM

PART I - SERVICE REQUIRED

INSTRUMENT OR FACILITY SYSTEM: MAKE MODEL SERIAL NO.

DESCRIPTION OF PROBLEM (Include date and time first occurred):

PRIORITY CODE (1.4) (See back of form):

REQUESTER: DATE:

PART II - SERVICE PERFORMED

FAULT CONDITION DIAGNOSIS:

CORRECTIVE ACTION:

SERVICED BY:

DATE:

DISTRIBUTION: Equipment file (original) Requester



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DATA QUALITY ASSESSMENT PROCEDURES

Procedures for the routine assessment of precision and accuracy through the analysis of quality control checks are described elsewhere in this Quality Assurance Project Plan for BP Chemicals, Inc., Mixed Waste Pond Closure.

- Section 8 Discusses the specific SOPs (contained in Appendix A), including calibration procedures, sample preparation, and analytical procedures.
- Section 10 Contains an overview of the internal quality control program.

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CORRECTIVE ACTION

1.0 PURPOSE AND APPLICABILITY

This procedure describes the mechanisms by which corrective actions for nonconformances detected through routine sampling and laboratory operations, performance audits, or systems audits are identified and closed. This procedure is applicable to all NUS Laboratory operations. It interfaces directly with the following procedures contained in the Quality Assurance Project Plan for BP Chemicals, Inc..

- Section No. 7, Documentation and Chain-of-Custody
- Section No. 10, Internal Quality Control
- Section No. 9, Data Reduction, Validation, and Reporting
- Section No. 11, Performance and Systems Audits

The nonconformance/corrective action record described in this procedure is a tool by which problems and their consequences, and corrective action measures and their outcomes are documented and communicated.

2.0 PROCEDURE

2.1 CORRECTIVE ACTIONS FOR NONCONFORMANCES IDENTIFIED DURING ROUTINE LABORATORY OPERATIONS

Nonconformances can occur at any time during routine laboratory operations - during sample bottle preparation, sample receipt, sample analysis, data reduction, and reporting. When a nonconformance is immediately correctable (i.e., fully correctable by the person identifying the nonconformance within the same work shift), corrective action need only be documented through the records routinely generated for that activity. However, when corrective action cannot be completed by the person identifying the nonconformance within the same work shift, a nonconformance/corrective action (NC/CA) record, Figure 14-1 for Sample Control or Figure 14-2 for Sample Analysis is completed.

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Performance audits evaluate the end product of a process or series of processes. If the and product is acceptable, the process is assumed to be acceptable. However, if the end product is unacceptable, the process must be examined thoroughly to determine the cause(s) of the failure and correct them. A nonconformance/corrective action record is opened for each performance evaluation sample failure to document the failure and track investigation and correction of the problem.

2.1.1 Sample Control Nonconformances

- a. Sample control NC/CA records are used to document and track resolution of the following nonconformances:
 - Chain of custody
 - Broken sample container
 - Incompatible sample container or cap
 - Incorrect sample pH
 - Incorrect temperature preservation
 - Headspace in VOA vials or TOX bottles (aqueous samples)
 - Missed hold time
 - Insufficient information available to log-in samples
- b. Sample control NC/CA records are prenumbered as follows:

SC-XX-YYYY

Where XX is the last two digits of the year and YYYY is a consecutive number starting with 0001. The records are maintained in a 3-ring binder in sample receiving. Completed records are periodically forwarded to the QA files.

- c. When a sample control nonconformance occurs, the person identifying the nonconformance:
 - Completes Section 1 of the next available, sequentially numbered record.

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- Records the NC/CA number on the sample log-in sheet under "Anomalies," if the nonconformance is identified during sample receipt inspection.
- iii. Forwards the original to the project manager for the job, retains a copy in the binder, and copies anyone else who should be informed of the problem.

NOTE: "Corrective measures" in section 1 is completed by whomever takes corrective steps -- the originator, Project Manager, or someone else.

The Project Manager:

- Completes Section 2 of the NC/CA record and contacts the client when appropriate. If the client is contacted (e.g., to discuss whether or not resampling will be performed) the specific person contacted, and the date are documented on the record.
 - NOTE: If there is any problem with sample integrity (e.g., preservation, sample container, hold time, chain-of-custody) the client must be contacted to allow him/her to decide appropriate corrective action.
- i. Initiates any corrective actions.
- iii. Once the problem is resolved to the client's satisfaction (or to the extent possible), the Project Manager:
 - i. Returns the original form to the binder; the copy is discarded.
 - Provides a copy of the record to anyone else who should be informed of the nonconformance and its resolution.

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 QAD reviews open NC/CA records and tallies nonconformances during periodic inspection of logistic support and customer services work groups, and completes Section 3 of the <u>original</u> record.

2.1.2 Sample Analysis Nonconformances

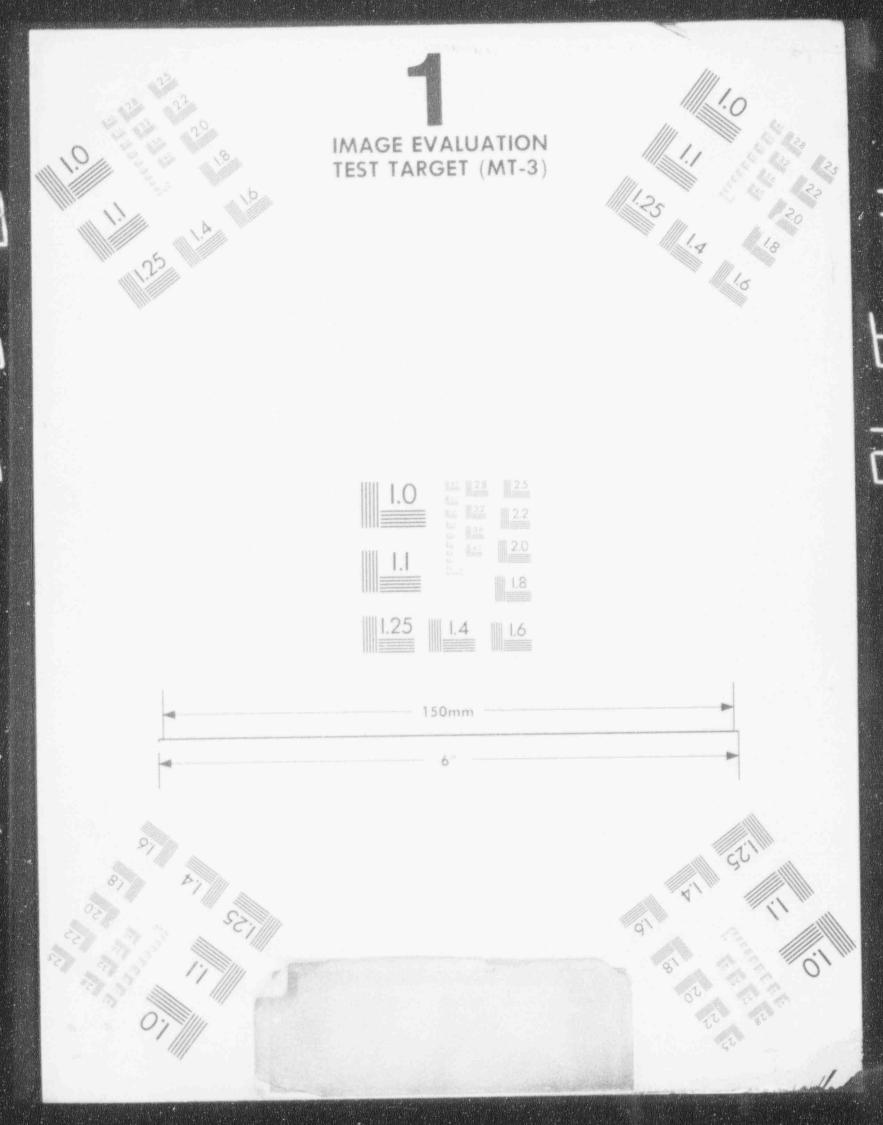
- Sample analysis NC/CA records are used to document and track resolution of the following nonconformances:
 - Failure to perform the required quality control checks
 - Failure to meet calibration or quality control criteria
 - NOTE: This includes any out of control occurrence on control charts. Cross reference the NC/CA number on the control chart to enhance traceability of corrective action.
 - Error in data reduction or reporting.
 - Unusual sample response during analysis that is likely to adversely affect the results or precludes completion of analysis.
- b. Sample analysis NC/CA records are prenumbered as follows:

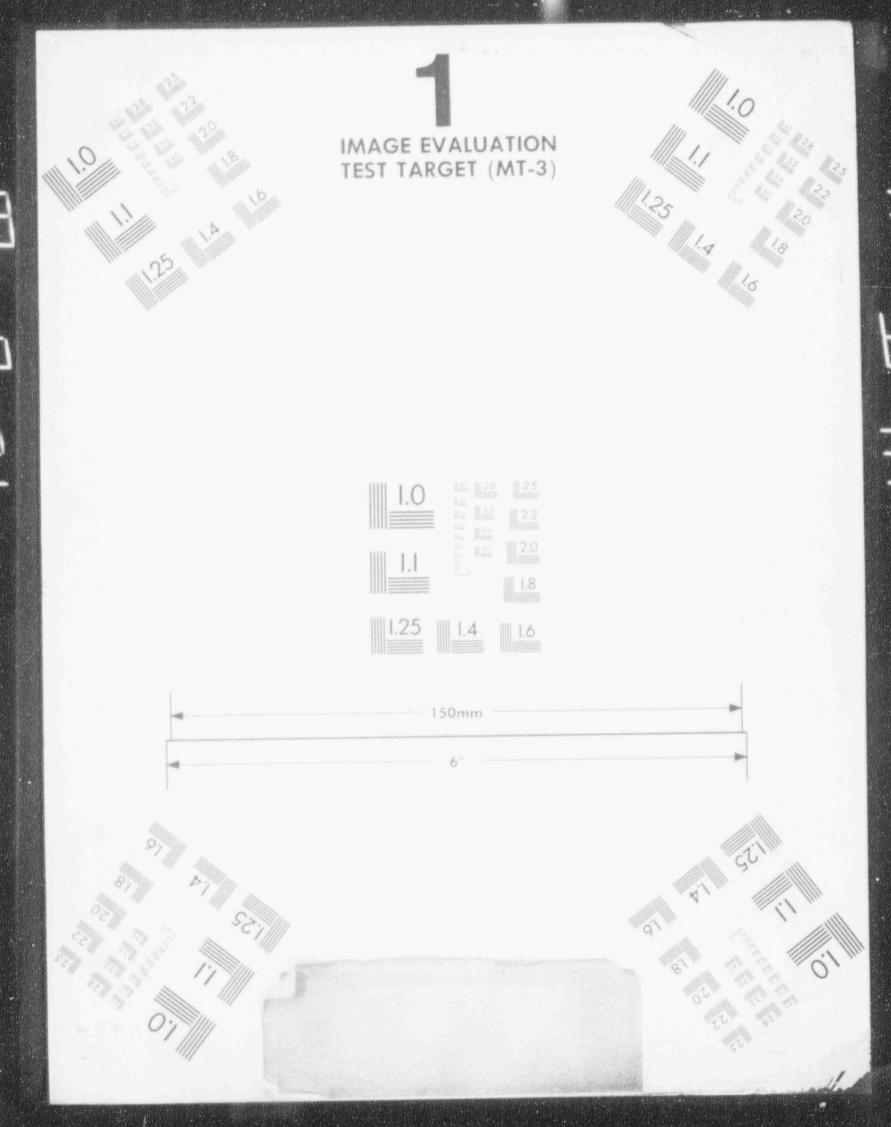
SA - Z - XX - XXXX

Where Z is the department code of the analysis laboratory (as opposed to the sample preparation laboratory), XX is the last two digits of the year, and YYYY is a sequential number starting with 0001.

The forms are maintained in a 3-ring binder in the analysis lab.

c. When a sample analysis nonconformance occurs, the person identifying the nonconformance:







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- i. Completes Section 1 of the next available, sequer tially numbered record from his/her work group.
 - NOTE: 'Corrective measures' in section 1 is completed by whomever takes corrective steps--the originator, another analyst, or someone else.
 - Forwards the record to the Group Leader of the work group that will take the corrective action, and places a copy in the binder. (If corrective action will be taken in the originator's work group, the original can remain in the binder.)
- iii. References the NC/CA number in the raw data and on the proper control chart.

The Group Leader (or designee):

- . Reviews corrective actions, and concurs or requests further actions.
- ii. Ensures that the action is implemented.
- ii. Completes Section 2 of the NC/CA record.

Upon resolution of the problem, the Group leader:

- Returns the NC/CA record to the binder; the copy is discarded.
- Forwards a copy of the NC/CA record to the Project Manager if the nonconformance cannot be fully rectified (e.g., prep or analysis hold time violated, reanalysis cannot be performed, turnaround time requirement cannot be met).

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d. QAD reviews open NC/CA records and tallies nonconformances during periodic inspection of each work group, and completes Section 3 of <u>original</u> record.

2.1.3 Performance Evaluation (PE) Nonconformances

C. .

- a. Performance sample NC/CA records are used to document and track resolution of performance evaluation failures.
- Performance evaluation NC/CA records are prenumbered as follows:

PE - Z - XX - YYYY

Where Z, XX, and YYYY are as defined above in 3.1.2b.

QAD initiates a record for each internal or external PE failure by completing Section 1 of the next available, sequentially numbered record.

He/she forwards the original to the appropriate Group Leader and retains a copy in the binder.

Group Leader determines root cause and corrective action, completes Section 2 of the record, and returns the record to the QAD within the specified timeframe.

QAD reviews response, accepts the response if complete or requests further investigation. Once the response is accepted, the QAD files original and discards copy in binder.

QAD reviews open records and tallies root causes during periodic inspection of each work group, and completes Section 3 of <u>original</u> record.

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2.1.4 NC/CA Trends

In quarterly reports and lab profiles the QAD discusses favorable and unfavorable trends evident from the nonconformances and corrective actions reported.

2.2 CORRECTIVE ACTIONS FOR SYSTEMS AUDIT FINDINGS

2.2.1 Internal Systems Audits

Findings identified through internal systems audits are documented in the lab profile report. During the report review meeting, the Group Leader is asked to acknowledge the need for corrective action and to provide a corrective action commitment date. (See Figure 14-4.) Root cause and specific corrective measures are discussed during the meeting.

The QA Coordinator or Representative opens a follow-up form (Figure 14-5) for each finding. The form is filed with the profile report. During subsequent follow-up, the QA Coordinator or QA Representative (QAC/QAR) documents the status of corrective actions in section two.

- If the corrective measures taken were effective, the finding is closed in section three and a copy of the closed form is forwarded to the Group Leader.
- If corrective actions have been ineffective or have not been taken, this is noted on the form. The Group Leader must provide a corrective action plan by completing the back of the form. Failure to take effective action thereafter results in the opening of a quality notice.

Open findings are also discussed in the quarterly QA report to management.

A quality notice (QN, Figure 14-6) is opened for chronic nonconformances. The QA Representative adds the notice to the QN log, completes the front of the form, and discusses the nature of

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the problem with the Lab Manager. The Lab Manager documents his/her concurrence with the need for corrective measures at the bottom of the page. The QAC/QAR then reviews the notice with the Group Leader, who must document root cause, corrective actions, preclusive actions, and completion dates within three working days. Corrective actions must be completed as soon as possible. The notice is filed with the profile report and included in QAD follow-up.

2.2.2 External Systems Audits

The QAC/QAR assigned to the audit and the Laboratory Manager review each audit summary and, once received, the audit report. They determine who within LSG will be tasked with responding to each finding and recommendation, and with directing corrective actions. The QAC/QAR coordinates preparation of the formal audit response and opens a follow up form (Figure 14-5) for each finding or recommendation to track corrective action. The QAC/QAR then follows-up on corrective actions as described for internal audits in section 3.2.1 above.

The status of the audit response and corrective actions are discussed in the quarterly QA report to management.

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Figure 14-1

NC/CA I SC-92-

and the charge for share of a	RE CTIVE ACTION RECORD - SAMPLE CONTROL
SECTION 1 : ORIGINATOR	Date/Time:
Sample Number(s):	
Client:	
Indicate the nonconforming	g condition(s):
Corrective reasures :	
Reported by:	Date:
RETAIN COPT IN SCICA LO	TO ACCOUNT ELECUTIVE / PROJECT MANAGER G BOOK · REFERENCE NC/CA & ON LOG-IN SHEET
	SOOR " REFERENCE NC/CA & ON LOG-IN SHEET
SECTION 2 : ACCOUNT EXEC.	/ PROJECT NANAGER
Comments or recommendation	ns:
Date correction	ve action completed:
Approved by:	
RETURN ORIG:	INAL TO LOGISTICS NC/CA LOG BOOK
FORWARD COPIES, AS AN	PPROPRIATE, TO :
FORWARD COPIES, AS AN SECTION 1 : QA DEPARTMENT	Corrective action
TORRARD COPIES, AS A	PPROPRIATE, TO :
TORRARD COPIES, AS A	Corrective action
SECTION 3 : QA DEPARTMENT	Corrective action
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Figure 14-2

NC/CA 1 5A-A-92-

	REANCE/CORRECTIVE ACTION 1	
SECTION 1 : ORIG	Date/Time	
malyst:	Instrument:	Sample 1:
		Client:
Test:	Prep Analyst:	Prep Date:
Todicare the non	conforming condition(s):	
LUGILACE CAE NON	month of many months and a second s	
Corrective measu	Ies :	
		*
Reported by:	and the second state of the se	Date:
		-
FORWARD ORIGI	NAL TO GROUP LEADER RESPO RETAIN COPY IN NC/CA	NSIELE FOR CORRECTIVE ACTION LOG BOOK
and in page of the second second second second second	NAL TO GROUP LEADER RESPO RETAIN COPY IN NC/CA	LOG BOOK
SECTION 2 : GROU	RETAIN COPY IN NC/CA	LOG BOOK
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SECTION 2 : GROU	RETAIN COPY IN NC/CA	LOG BOOK
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SECTION 2 : GROU Conments or reco Date Approved by: RETURN ORI FORM SECTION 3 : QA	RETAIN COPY IN NC/CA	LOG BOOK
SECTION 2 : GROU Conments or reco Date Approved by: RETURN ORI FORM SECTION 3 : QA	RETAIN COPY IN NC/CA	LOG BOOK

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Figure 14-3

NC/CA / PE-G-92-

Halliburton MUS Environmental NONCONFORMANCE/CORRECTI	Corporation - Laboratory Services Group VE ACTION RECORD - PE/BQCS FAILURE
SECTION 1 : QA DEPARTMENT	Data/Time:
Analyst:	
Department:	
Test:	
Prep Date:	
Sample Number(s):	
Reported Value:	
Acceptance Range:	
Reported by:	
FORWARD ORIGINAL TO GROUP LE	Date: ADER RESPONSIBLE FOR CORRECTIVE ACTION IN QA NC/CA LOG BOOK
Please investigate the cause(s and corrective actions below Findings and root cause:) of this failure. Report your findings . Return this form to QA Department.
Corrective measures:	
Reported by:	Date:
RETURN ORIG	INAL TO QA DEPARTMENT
SECTION 3 : QA DEPARTMENT	Corrective action
Coments:	satisfactory?YesNo
NC/CA closed by:	Date:

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Figure 14-4

AUDIT FINDINGS: SYSTERS

INTERNAL/QNE

90-098 (CLOSED); No standards, tracers or client samples were received in 1991 that exceeded 10% of the NRC license limit. This quality notice was generated in response to the receipt of the Sirrine samples in 1987.

90-099 (CLOSED): A Radioactive Material Request Fore was completed and submitted to the RSO for review and approval for low-level calibration standards and tracers on may 31, 1991. "

90-100 -35ED): The Po-ZiO button source has sufficient activity to x rul as a GPC performance check for gross alpha/beta analyses. However, the next source shall be Th-230 source that has a sufficiently long half-life.

90-104 (CLOSED): The gamma spec pole-zero opticalizations were performed by the RSD on November 27, 1990 for systems 1 and 2 and January 25, 1991 for system 3. The next annual calibrations and pole-zero settings are avaiting the move to the newly remodeledcounting room set for January 1991. The optimalizations are recorded in the maintenance logs, 92-88 p. 80 and 291-90 p. 12.

90-105 (OPEN): The control charting for the various systems performance checks vas reviewed. However, some of the systems check charts reviewed lacked necessary information and overlapping limits made them difficult to discern. See the control chart review section of this report.

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90-106 (CLOSED): Control charting of jampa spec systems background and performance checks have been performed since the systems went on-line in February 1991. The proper CC checks were worked out with the QAD for K-40 and mixed jampa multing radionuclide determination analyses.

90-107 (CLOSED): Gamma spec QC checks were arranged with the QAD prior to the start-up of the ENSR/ERN K-40 analyses in February 1991. QC data is subelited to the QAD for evaluation and statistical calculation of control limits. For soil samples, an aqueous method blank and LCS are prepared and counted. For mixed radionuclide work, an ENSL-LV Gamma in Water Cross-Check Study shall be analyzed as an LCS.

91-009 (OPEN): Training records remain incomplete and unrevised.

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Figure 14-5

AUDIT FINDINGS FOLLOW UP

	HALL	IBURTON NUS ENVIRONMENTAL CORPORATION LAB SERVICES GROUP
		AUDIT FINDINGS FOLLOW-UP REPORT
SECTION		Auditor completes for findings not dealt with via a quality notice at the time the audit report is finalized.
Audit:		Date:
Finding	l:	
Group	Leader:	Corrective Action Commitment Date:
SECTI		Auditor completes during follow-up activities. Group Leader mus acknowledge overdue corrective action by initialing and dating the auditor's notation below and providing a corrective action plan on the back of this form.
DATE	INITIALS	CORRECTIVE ACTION STATUS
	1	
Sector of a local party		
	1	
n		
SECTION		Auditor completes upon closure
SEC TR		Auditor completes upon closure Oate



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DATE	INITIALS	CORRECTIVE ACTION	COMPLETION
-			
			and a second
			and a second
			a select for the second second second
	· · · · · · · · · · · · · · · · · · ·		

Figure 14-5 (Continued)



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Figure 14-6

ELALLIUURTON NUS	QN NO:	Activity/Program/Project	
Laboratory Services Group	Response Assigned Ta:		Oue Oate:

Requirement(s):

See Attactment

 \square

Condition Observed/Rationale:

See Attactimient

Reported by:	O are:
Management Concurrence:	Date:



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Figure 14-6 (Continued)

RESPONSE: Complete Each Rem

1. Findings of root cause investigation:

2. Plans for corrective action, immediate and long term to preclude recurrence:

3. Scheduled date(s) for corrective action completion:

Response submitted by:	Date:	
QUALITY ASSURANCE DEPAR	ITMENTAL REVIEW	
Corrective Action Disposition:		
	See Attactionen:	
Corrective Actions Ventiled and ON Closed by:	Date	

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QUALITY ASSURANCE REPORTS TO MANAGEMENT

1.0 PURPOSE AND APPLICABILITY

This procedure defines vehicles for the discussion of quality assurance issues among mid-level group management and reporting of the Quality Assurance Department's activities and concerns to upper-level management.

2.0 PROCEDURE

2.1 MONTHLY QUALITY CONTROL MEETINGS

Once each calendar month, the QAD meets with Managers and Group Leaders from Operations, CSD, and Logistic Support to discuss relevant quality issues, including findings from systems and performance monitoring. The QC Meeting will be supplemental to, not in lieu of, the Quality Improvement Process (QIP). The QAD is responsible for setting the meeting agenda and communicating the minutes of the meeting to meeting participants and group management.

Part of the monthly agenda will consist of a round table discussion of factors affecting quality from the perspective of each Manager and Group Leader.

2.2 QUALITY ASSURANCE REPORTS

At the close of each calendar quarter, the QARs prepare a quarterly assessment of quality assurance performance within each work group for the QAC. The QAC then prepares and submits a report to management summarizing QA performance for all laboratory operations. The report shall summarize the following information:

- Performance Audits
 - A summary of the results and acceptability of performance evaluation sample results submitted by the QAD or by outside evaluators.

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- Open performance evaluation issues.
- System Audits
 - A listing of internal systems audits performed, and points identified in the executive summary.
 - A listing of external systems audits conducted including a summary of any nonconformances found.
 - Open systems audit issues.
 - Other Critical Issues

A discussion of significant issues from the QC meetings, control chart review, NC/CA record review, SOP preparation, or other activities.

The QAC also prepares an annual summary of QA activities for each calendar year.

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VOLATILE ORGANICS ANALYSIS BY GAS CHROMATOGRAPHY/MASS SPECTROMETRY

1.0 SCOPE AND APPLICATION

This method covers the determination of priority pollutant and US EPA CLP target compound list (TCL) purgeable organics in water, sediment, soil and waste. Reporting limits are listed in Table 1. Other compounds suitable for purge and trap techniques and GC/MS detection may be determined by this method. Calibration protocols for such compounds will be specified in a project-specific plan.

2.0 SUMMARY OF METHOD

Water Samples

An inert gas is bubbled through a volume of sample contained in a specifically designed purging chamber at ambient temperature. The purgeables are efficiently transferred from the aqueous phase to the vapor phase. The vapor is swept through a sorbent column where the purgeables are trapped. After purging is completed, the sorbent column is heated and backflushed with inert gas to desorb the purgeables onto a gas chromatographic column. The gas chromatograph is temperature-programmed to separate the purgeables, which are then detected with a mass spectrometer operating in the Electron Ionization (El) mode.

Sediment/Soil Samples

Low Level

An inert gas is bubbled through a sample/water mixture held at 40°C in a specially designed purging chamber. The purgeables are efficiently transferred from the aqueous phase to the vapor phase. The vapor is swept through a sorbent column where the purgeables are trapped. After purging is completed, the sorbent column is heated and backflushed with inert gas to desorb the purgeables onto a gas

Approvals:

7/30/92 "And Chmen Lab Operations Manager Date PAL.

Quality Assurance Coordinator

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chromatographic column. The gas chromatograph is temperatureprogrammed to separate the purgeables, which are then detected with a mass spectrometer.

Medium Level

A measured amount (usually 4 g) of soil is extracted with 10 mL methanol. A portion (usually 100 μ L) of the methanol extract is diluted to 5 mL with reagent water. At this point the sample is processed in the same manner as described above for water samples.

3.0 PROCEDURE

3.1 Instrument Set-up and Tuning

- 3.1.1 Perform instrument set-up as described below for packed or capillary column operation.
 - Set the GC/MS operating conditions for packed column operation as follows:

Parameter	Operating Condition
Column Type	Packed with 1% SP-1000 on Carbopack B (60/80 mesh)
Column Specifications	6' by 2 mm ID, 1/4 inch OD glass
Flow Rate/Gas	30 ml/min./Helium
Column Temperature	Isothermal at 45°C for 3 minutes, increase to 200°C at 8°C/min., hold for 15 minutes
Electron Energy	70 volts (nominal)
Mass Range	35-260 daltons
Scan Time	Approximately 3 seconds/scan (at least 5 scans per peak, but not to exceed 7 seconds per scan)
Note: dalton = amu	

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Set the GC/MS operating conditions for capillary column operation as follows:

Parameter	Operating Condition
Column Type	Capillary
Column Specifications	105 m or 60 m, 0.53 mm l.D., 3.0 μ m film thickness
Flow Rate/Gas	6 ml/min.(approx.)
Column Temperature	105 m: 40°C (1 min) to 165°C at 5°C/min, 165°C to 230°C at 20°C/min.
	60 m: 10°C (1 min) to 130°C at 8°C/min, 130°C to 230°C at 20°C/min.
	Cryogenic cooling using liquid N ₂ is required whenever using the 60 m capillary column.
Тгар	Minimum length - 25 cm. Should contain 15 cm of Tenax 60/80 mesh and 8 cm of silica gel 35/60 mesh or equivalent phase.
Tune the instrument as fo	llows:

a. Manually inject 50 ng of BFB and check that the GC/MS system meets the standard mass spectral ion abundance criteria listed below:

3.1.2

Mass	BFB Ion/Abundance Criteria	
50	15.0 - 40.0 percent of mass 95	
75	30.0 - 60.0 percent of mass 95	
95	Base peak, 100 percent relative abundance	
96	5.0 - 9.0 percent of mass 95	

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173	Less than 2.0 percent of mass 174
174	Greater than 50.0 percent of mass 95
175	5.0 - 9.0 percent of mass 174
176	Greater than 95.0 but less than 101.0 percent of mass 174
177	5.0 - 9.0 percent of mass 176

- b. Retune the system if criteria are not met. Do not proceed with analysis until a successful tune is performed.
- c. Repeat the BFB calibration every 12 hours of operation or whenever corrective actions are taken that change or affect the tuning criteria (e.g., on source cleaning or repair). The 12-hour period begins with the BFB injection.

3.2 Initial Calibration

- 3.2.1 Prepare a 5-point initial calibration curve as follows. Perform separate initial calibrations for waters (ambient temperature purge), low level soils (40°C purge) and medium level soils (ambient temperature purge with methanol added).
 - a. Assemble the purge and trap device. Condition the trap initially according to manufacturer's instructions. Prior to daily use, condition the trap for 10 minutes by backflushing at 180°C with the column at 220°C.
 - b. Fill a 16-mL screw cap autosampler vial with 10 mL reagent water for the "W/S" autosamplers and 15 mL reagent water for the "W" unit.
 - c. Spike target analyte calibration standards into the vial and cap immediately. Spike to achieve standard solutions at 20, 50, 100, 150 and 200 μ g/L. For medium level soil calibrations, add 100 μ L methanol.
 - d. Load the autosampler with the appropriate internal standard/surrogate spiking solution. The 125 μ g/mL solution is used for systems C and D; the 250 μ g/mL solution is used for system E. (The difference is due to the internal standard sample loop in each system.) The auto sampler will spike each standard, sample and blank with the

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solution (2.0 μL for systems C and D; 1.0 μL for system E).

- e. Connect the purge and trap device to a gas chromatograph. The gas chromatograph must be operated using the parameters listed in step 3.1.1.
- f. Purge the standard for 11.0 ± 0.1 minutes at ambient temperature for waters and medium level soils, and at 40°C for low level soils.
- g. Adjust the device to the desorb mode and begin the GC/MS analysis. Concurrently, introduce the trapped materials to the gas chromatographic column by rapidly heating the trap to 180°C while backflushing the trap with an inert gas at 20 60 mL/min for 4 minutes.
- h. Desorb for four minutes. Recondition the trap by turning it to the bake mode. Allow the trap to bake at 220°C for 11.0 minutes. Turn off the trap. When cool, the trap is ready for the next standard.
- 3.2.2 Tabulate the area response of the compound characteristic ions against concentration for each compound and internal standard. Calculate relative response factor (RRF) for each compound using the following equation:

$$RRF = \underline{Ax} \times \underline{Cis}$$

where Ax = Area of the characteristic ion for the compound to be measured

- Ais = Area of the characteristic ion for the specified internal standard (see Table 2)
- Cis = Concentration of the internal standard
- Cx = Concentration of compound to be measured
- 3.2.3 Calculate the average Relative Response Factor (RRF_{ave}) for each compound. The RRF_{ave} of the five system performance check compounds (SPCC) listed below must be at least 0.300, with the exception of 0.250 for bromoform.

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SPCC

Chloromethane 1,1-Dichloroethane Bromoform 1,1,2,2-Tetrachloroethane Chlorobenzene

3.2.4 Calculate the % relative standard deviation (% RSD) of RRF values for each compound. The maximum acceptable % RSD for the calibration check compounds (CCC) listed below is 30%.

Vinyl chloride 1,1-Dichloroethene Chloroform 1,2-Dichloropropane Toluene Ethylbenzene

The % RSD is calculated as follows:

% RSD = <u>Standard Deviation</u> x 100 Mean

3.2.5 Once the criteria for initial calibration have been met, report the RRF_{ave} and % RSD for all compounds.

If the SPCC and CCC criteria are not met, evaluate the system and take corrective measures before proceeding with method blank or sample analysis.

3.3 Continuing Calibration

- 3.3.1 Analyze a 50 µg/L calibration standard containing all target compounds every 12 hours immediately following a successful tune.
- 3.3.2 Perform a system performance check as described in step 3.2.3. If SPCC criteria are not met, take corrective actions to isolate and correct the problems before continuing with analysis.

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3.3.3 Perform a continuing calibration check to verify the validity of the initial calibration by calculating the % difference of the RRF for each CCC as follows:

% Difference = $\frac{RRF_{ave} - RRF_{c}}{RRF_{ave}} \times 100$

where $RRF_{ave} =$ average response factor from initial calibration.

RRF_e = response factor from current continuing calibration standard

Proceed as indicated below after calculating the % difference:

- If the % difference for each CCC is < 25.0%, assume the initial calibration is valid and continue analysis.
- b. If the % difference for any CCC is > 25.0%, take corrective action.
- c. If the source of the problem cannot be determined, generate a new five-point initial calibration curve. The calibration criteria must be met before analysis can continue.

difference is $\leq 25.0\%$ and minimum response factor is ≥ 0.300 for each target analyte.

Note: If continuing calibration is being performed for a limited set of compounds (e.g., BTEX) sample analysis may proceed as long as %

- 3.4 Water Sample Analysis
 - 3.4.1 Repeat step 3.2.1 using 10 or 15 mL of sample in place of the calibration standard.
 - 3.4.2 If any compound in the sample exceeds linear calibration range, clean the system by analysis of method blanks until a blank free of interferents is obtained. Reanalyze the sample at a dilution at which no target compound is saturated. Adjust the final volume of this dilution to 5.0 mL with reagent water.
 - 3.4.3 Tabulate the retention time and EICP area for each internal standard against that of the most recent 12-hour continuing calibration standard.

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If the following criteria are not met, reanalyze the sample:

- a. The retention time for each internal standard must not change by more than 30 seconds from the latest 12-hour continuing calibration standard.
- b. The extracted ion current profile (EICP) area for the quantitation ion for each internal standard must not change by more than a factor of two (-50% to +100%) from that of the latest 12-hour continuing calibration standard.

3.4.4 Calculate the surrogate spike recoveries as follows:

Percent Surrogate Recovery = $\frac{\Omega d}{\Omega a} \times 100$

where Qd = quantity determined by analysis Qa = quantity added to sample

The surrogate spike recoveries must be within the limits listed in the Quality Control File - GC/MS. Acceptable recovery in the method blank must be obtained prior to analyzing the samples. If recovery of a surrogate is cutside acceptance limits for a sample, the sample must be reanalyzed.

3.5 Soil/Sediment/Waste Sample Analysis

- Note: Determine the method to use as follows or alternatively, screen all soil/sediments by the medium level protocol:
 - Analyze the sample as a medium level soil/sediment if solvent vapor or oily material is observed.
 - Analyze the sample as a low level soil/sediment if solvent vapor is not observed.
- 3.5.1 Analyze low level soil/sediment/waste samples as follows:
 - a. Do not discard any supernatant liquid. Mix the contents of the sample container with a metal spatula.
 - Tare a 40-mL VOA vial and weigh 5.0 gm of sample into it. Record the amount in the vial.

Note: If peaks are saturated from the analysis of a 5.0 gm sample, analyze a smaller sample

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aliquot to prevent saturation. However, the smallest sample aliquot permitted is 1.0 gm. If less than 1.0 gm is needed, the medium level method must be used.

- c. Add 5.0 mL of reagent water and 5.0 µL of the surrogate/internal standard spiking solution to the vial.
- d. Connect the 40-mL VOA vial to the purge and trap system. Heat the sample to 40° C \pm 1°C and proceed with the analysis as described in steps 3.2.1d-g.

Evaluate internal standard responses and retention times and surrogate spike recoveries as described in Sections 3.4.3 and 3.4.4.

- 3.5.2 Analyze medium level soil/sediment/waste samples as follows:
 - a. Do not discard any supernatant liquid. Mix the contents of the sample container with a metal spatula.
 - b. Tare a 40-mL VOA vial and weigh 4.0 gm into it. Record the amount in the vial.
 - c. Quickly add 9.0 mL of methanol followed by 1.0 mL of surrogate spiking solution to the vial, cap, and shake for 2 minutes.

Note: Perform these additions rapidly to avoid loss of volatiles.

- d. Allow the extract to settle for 2 minutes (approx.) and remove 1-2 mL of the methanol solution to a 2-mL screw cap vial with a teflon-lined septa. Label with "MLS" and sample number. Use on the same day.
- e. Add 100 µL of the methanol extract and 5.0 µL of internal standard spiking solution to 4.9 mL of reagent water. Inject the water/methanol sample into the purging chamber and proceed with the analysis as described in steps 3.2.1d-g.

Evaluate internal standard responses and retention times and surrogate spike recoveries as described in Sections 3.4.3 and 3.4.4.

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3.6 Identification of Target Compounds

- 3.6.1 Identify volatile target compounds by comparison of the sample and standard mass spectra generated during a 12-hour period.
- 3.6.2 Positively identify a compound by meeting the following criteria:
 - a. The relative retention time (RRT) of the sample component is within \pm 0.06 RRT units of the standard component.
 - b. All ions present in the standard mass spectrum at a relative intensity greater than 10% (most abundant ion in the spectrum equals 100%) must be present in the sample spectrum.
 - c. The relative intensities of ions specified in the above paragraph must agree within \pm 20% absolute intensity between the standard and sample spectra.
 - d. lons greater than 10% in the sample spectrum but not present in the standard spectrum must be considered and accounted for by the analyst making the comparison. When GC/MS computer data enhancement programs are used to obtain the sample component spectrum, both the enhanced and the raw spectra must be evaluated. The verification process should favor false negatives.

3.7 Identification of Non-TCL Tentatively Identified Compounds (TICs)

- Note: TICs will be evaluated upon client request. This section of the procedure is, therefore, optional. Consult the worklist to determine if TICs are to be reported for a given sample.
- 3.7.1 Perform a maximum of ten library searches for non-TCL sample components of greatest apparent concentration relative to the nearest internal standard free of interferences.
 - Note: Components with peak areas less than 10% of the nearest internal standard do not require library searches.
- 3.7.2 Use the following guidelines in making tentative identifications:
 - Relative intensities of major ions in the reference spectrum (ions greater than 10% of the most abundant ion) should be present in the sample spectrum.

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b. The relative intensities of the major ions should agree within \pm 20% absolute intensity.

Example: For an ion with an abundance of 50% of the standard spectrum, the corresponding sample ion abundance must be between 30% and 70%.

- Molecular ions present in the reference spectrum should be present in the sample spectrum.
- d. lons present in the sample spectrum but not in the reference spectrum should be reviewed for possible background contamination or the presence of coeluting compounds.
- e. lons present in the reference spectrum but not in the sample spectrum should be reviewed for possible subtraction from the sample spectrum because of background contamination or coeluting compounds. Data system library reduction programs can sometimes create these discrepancies.
- 3.7.3 If, in the opinion of the mass spectral specialist, no valid tentative identification can be made, the compound should be reported as "unknown". The mass spectral specialist should give additional classification of the unknown compound, if possible (i.e., unknown aromatic, unknown hydrocarbon, unknown acid type, unknown chlorinated compound). If probable molecular weights can be distinguished, include them.

3.8 Quantitation of Target Compounds

- 3.8.1 Quantify target components identified by the internal standard method. The internal standard nearest the retention time of a given analyte is used for quantitation (see Table 2).
- 3.8.2 The relative response factor (RRF) from the daily standard analysis is used to calculate the concentration in the sample. Use the response factor as determined in step 3.2.2 and the following equations:
 - Note: Since o- and p-xylene overlap on the packed column, the xylenes must be quantitated as m-xylene. Likewise, since m- and p-xylenes coelute on the capillary column, the xylenes must be reported as oxylene. The concentration of all xylene isomers must

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be added together and the result reported as total xylenes.

a. Water samples

Concentration (in μ g/L) = $\frac{(A_{\star})(I_{\bullet})}{(A_{\star})(RF)(V_{\bullet})}$

where $A_x =$ Area of the characteristic ion for the compound to be measured

- A_a = Area of the characteristic ion for the specified internal standard
- I, = Amount of internal standard added in ng
- V_o = Volume of water purged in mL (take into account any dilutions)

b. Medium level sediment/soil samples

Concentration (in $\mu g/kg$) = $\frac{(A_{\star})(I_{\star})(V_{\star})}{(A_{\star})(FF)(V_{\star})(W_{\star})}$

c. Low level sediment/soil samples

Concentration (in $\mu g/kg$) = $\frac{(A_s)(1_e)}{(A_b)(RF)(W_s)}$

where

 A_{x} , I_{s} , A_{is} = same as above

- V_t = Volume of total extract in μ L (use 10,000 μ /L or a factor of this when dilutions are made)
- $V_i = Volume of extract added in \mu L for purging$
- W_e = Wet weight of sample purged in gm

3.9 Quantitation of Non-Target Tentatively Identified Compounds (TICs)

3.9.1 An estimated concentration for non-target components tentatively identified shall be quantified by the internal standard method. For quantification, use the nearest internal standard free of interferences.



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3.9.2 The formula for calculating concentrations is the same as in Section 3.8. Use total area counts from the Reconstructed Ion Chromatograms (RICs) for both the compound to be measured and the internal standard. Assume a response factor (RF) of 1. Qualify the value from this quantitation as estimated. Calculate the estimated concentration for all tentatively identified compounds as well as those identified as unknowns.

4.0 DATA COLLECTION

Document all data in a bound lab notebook for each set of analyses performed. Entries must be made at the time of analysis. Examples of appropriate forms for data collection (i.e., assignment sheets and injection log) are shown on Figures 1-3.

Data collection should include the following:

- method code and brief description (e.g., GC/MS LLW).
- instrument parameters.
- date and time of BFB injection, and analyst(s) signature(s).
- LSG sample number and aliquot, and data system filename. Identify any lab quality control samples (method blanks, MS/MSDs, LCSs).
- spikes added, to include the spiking solution identification number and the volume of spike added.

5.0 QUALITY CONTROL

5.1 Method Blank Analysis

Run a method blank analysis every 12 hours immediately following a successful initial or continuing calibration.

Low Level Water (LLW)

Analyze an aliquot of reagent water according to the procedure described in Section 3.2.

Low Level Soil (LLS)

Analyze 5.0 mL of reagent water according to the procedure described in Section 3.2.

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Medium Level Soil (MLS)

Analyze 4.9 mL of reagent water and 100 μ L of methanol according to the procedure described in Section 3.2.

Evaluation Criteria

A method blank must not contain more than five times the reporting limit of the following common laboratory solvents: methylene chloride, acetone and 2-butanone.

Evaluate internal standard response and retention times and surrogate spike recoveries as described in Sections 3.4.3 and 3.4.4. These criteria must be met prior to proceeding with sample analysis.

5.2 Matrix Spike/Matrix Spike Duplicate Analysis (MS/MSD)

Prepare and analyze an MS/MSD with every twenty samples of similar matrix and concentration.

- For LLW and LLS samples, take two additional aliquots of the selected sample(s), spiked with 10 μ L of the matrix spiking solution, and perform VOA analysis.
- For MLS samples, take two additional aliquots spiked with 8 mL of methanol and 1 mL of MLS Matrix Spiking Solution and perform VOA analysis.
- When a sample requiring dilution has been chosen as the MS/MSD, the MS/MSD must be analyzed at the same dilution as the unspiked sample.

Calculate percent recovery as follows:

Percent Recovery =
$$\frac{SSR - SR}{SA} \times 100$$

where SSR = Spiked Sample Result SR = Sample Result SA = Spike Added

Calculate the relative % difference (RPD) as follows:

$$\begin{array}{l} \text{RPD} = \underline{2(D_1 - D_2)} \times 100 \\ (D_1 + D_2) \end{array}$$



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where $D_1 = MS$ Result $D_2 = MSD$ Result

Advisory MS/MSD percent recovery and RPD limits are listed in the quality control test file. Since these limits are for advisory purposes only, they should not be used to determine if sample reanalysis is required.

6.0 INTERFERENCES

- 6.1 Impurities in the purge gas, organic compounds out-gassing from the plumbing ahead of the trap, and solvent vapors in the laboratory account for the majority of contamination problems. The analytical system must be demonstrated to be free from contamination under the conditions of the analysis by running laboratory method blanks. Use TFE-tubing and TFE-thread sealants. Avoid using flow controllers with rubber components in the purging device.
- C. < Samples can be contaminated by diffusion of volatile organics (particularly fluorocarbons and methylene chloride) through the septum seal during storage and handling.
- 6.3 Contamination by carry-over can occur whenever high level and low level samples are sequentially analyzed. To reduce carry over, the purging device and sampling syringe must be rinsed with reagent water between sample analyses. Whenever an unusually concentrated sample is encountered, it should be followed by an analysis of reagent water to check for cross-contamination.
- 6.4 For samples containing large amounts of water-soluble materials, suspended solids, high boiling compounds or high purgeable levels, it may be necessary to flush the purging device with a detergent solution, rinse it with distilled water, and dry it in a 105°C oven between analyses. The trap and other parts of the system are also subject to contamination; frequent bakeout and purging of the entire system may be required.

7.0 SAFETY PRECAUTIONS

- 7.1 Wear a lab coat and safety glasses with side shields at all times while performing this procedure. Wear gloves to avoid skin contact with acids, bases, organic solvents and possible toxicants used as reagents or contained in the samples for analysis.
 - 7.1.1 Should skin or eye contact occur, flush the exposed area(s) with large amounts of water and seek immediate medical attention.

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- 7.1.2 <u>Never pipet materials by mouth.</u> Use a rubber bulb or other approved suction device to transfer materials by pipet.
- 7.2 Handle and store all reagents in accordance with the precautions listed on the material safety data sheets (MSDS).
 - 7.2.1 Consult the MSDS for each reagent listed in this procedure before use. The MSDS will provide pertinent information on toxicity, safety precautions and storage conditions.
 - 7.2.2 <u>Always</u> consult the label on the reagent bottle for up-to-date information on safety precautions during handling, preferred storage conditions and expiration data.
 - 7.2.3 Label all flasks, vials, etc., with the intended contents prior to filling. Follow established laboratory procedure in completing and affixing labeling information to equipment.
- 7.3 Avoid breathing solvent and standard solution vapors. If overexposure to vapors should occur, seek fresh air and immediate medical attention.
- 7.4 Handle all glass equipment with care, particularly during assembly and disassembly.
- 7.5 Avoid contact with hot GC parts (e.g., injection ports or transfer lines).
- 7.6 Vent GC/MS mechanical pump exhaust to the outside.
- 8.0 APPA A S AND MATERIALS
 - 8.1 View syringes: 5-µL and larger, 0.006 inch ID needle.
 - 8.2 <u>Syringe valve</u>: Two-way valve with Luer-lock ends (3-inch), if applicable to the purging device.
 - 8.3 Syringe: 5.0-mL, gas tight with shut-off valve.
 - 8.4 Balance:
 - 8.4.1 Analytical: Capable of weighing to 0.0001 g.
 - 8.4.2 Top loading: Capable of weighing to 0.1 g.
 - 8.5 VOA vials: 40-mL, screw cap with teflon liner.
 - 8.6 Flasks: Class A, volumetric with ground glass stoppers.

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- 8.7 <u>GC column</u>: 6 feet long x 0.1 inch ID glass, packed with 1% SP-1000 on Carbopack B (60/80 mesh), or equivalent.
- 8.8 Purge and trap device: TEKMAR/LSC-2, Tekmar Model 4000/ALS or equivalent.
- 8.9 <u>Gas Chromatograph/Mass Spectrometer (GC/MS)</u>: Finnigan 4023/9610, Finnigan Incos 50B or equivalent
- 8.10 <u>GC/MS Data System</u>: Finnigan MAT-1 Incos or equivalent. System
- 8.11 <u>Autosampler</u>: Dynatech PTA 30W or PTA 30W/S or equivalent. Calibrate the sample loop of each unit following installation.
- 8.12 <u>Autosampler Vials</u>: 16-mL capacity glass, screwtop vial with teflon-
- 8.13 Dynatech Autosampler Soil Vial: 30-mL (approx.) capacity with fritted

9.0 REAGENTS

- 9.1 <u>Reagent water</u>: Deionized water passed through an activated carbon column.
- 9.2 Sodium thiosulfate: Granular, ACS grade.
- 9.3 Methanol: Pesticide quality or equivalent.
- 9.4 <u>Stock standard solutions</u>: Prepare from pure standard materials or purchase commercially; prepare stock standard solutions in methanol using assayed liquids or gases as appropriate. See LSG Method No. AP-005.
- 9.5 <u>Calibration Standards</u>: Prepare calibration standards for each priority pollutant and TCL compound at five concentration levels from stock solutions: 20, 50, 100, 150, and 200 µg/L. Alternatively, varying these concentrations.
- 9.6 <u>Surrogate, Internal and Matrix Spiking Standard Solutions</u>: Prepare the

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9.6.1 Medium Level Soil (MLS) Surrogate Spiking Solution - Prepare a solution containing the following compounds in methanol.

Toluene-d _e	25 µg/mL	
4-Bromofluorobenzene	25 µg/mL	
1,2-Dichloroethane-d	25 µg/mL	1

9.6.2 MLS Internal Standard Spiking Solution - Prepare a solution containing the following compounds in methanol.

Bromochloromethane	50 µg/mL
1,4-Difluorobenzene	$50 \mu g/mL$
Chlorobenzene-d _s	$50 \mu g/mL$

- 9.6.3 LLW/LLS Surrogate/Internal Standard Spiking Solution Prepare solutions containing surrogate and internal standards at a concentration of 125 and 250 µg/mL of each compound in methanol.
- 9.6.4 4-Bromofluorobenzene (BFB) Standard Prepare a 50 µg/mL solution of BFB in methanol.
- 9.6.5 Matrix Spiking Solution Prepare a solution containing the following compounds in methanol.

5 µg/mL
$5 \mu g/mL$
3- 3- 2-

10.0 REFERENCES

- 10.1 U.S. EPA SW-846, "Test Methods for Evaluating Solid Waste, Physical/Chemical Methods," Volume IB, 1986; Method 8240.
- 10.2 40 CFR Part 136, "Guidelines Establishing Test Procedures for the Analysis of Pollutants Under the Clean Water Act; Final Rule and Interim Final Rule and Proposed Rule," October 26, 1984, Method 624.
- 10.3 U.S. EPA Contract Laboratory Program, "Statement of Work for Organic Analysis, Multi-Media, Multi-Concentration", 2/88, revised 9/88.

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Table 1

Volatile TCL Compounds and Reporting Limits

Parameter	LLW/LLS (µg/l)/(µg/kg)	MLS (µg/kg)
Chloromethane	10	1200
Bromomethane	10	1200
Vinyl chloride	10	1200
Chloroethane	10	1200
Methylene chloride	5	620
Trichlorofluoromethane	5	620
Acetone	10	1200
Carbon disulfide	5	620
1,1-Dichloroethene	5	620
1,1-Dichloroethane	5	620
cis-1,2-Dichloroethene1	5	620
trans-1,2-Dichloroethene ¹	5	620
Chloroform	5	620
1,2-Dichloroethane	5	620
2-Butanone	10	1200
1,1,1-Trichloroethane	5	620
Carbon tetrachloride	5	620
Vinyl acetate	10	1200
Bromodichloromethane	5	620
1,2-Dichloropropane	5	620
cis-1,3-Dichloropropene	5	620
Trichloroethene	5	620
Dibromochloromethane	5	620
1,1,2-Trichloroethane	5	620
Benzene	5	620
trans-1,3-Dichloropropene	5	620
2-Chloroethylvinylether	10	1200
Bromoform	5	620
4-Methyl-2-pentanone	10	1200
2-Hexanone	10	1200
Tetrachloroethene	5	620
Toluene	5	620

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Table 1

Volatile TCL Compounds and Reporting Limits (Continued)

Parameter	LLW/LLS _(µg/l)/(µg/kg)_	MLS <u>(µg/kg)</u>
1,1,2,2-Tetrachloroethane	5	520
Chlorobenzene	5	620
Ethylbenzene	5	620
Styrene	5	620
Xylenes (total)	5	620



Note: cis- and trans-1,2-Dichloroethene are routinely reported as total 1,2-Dichloroethene unless the isomers are specifically requested.

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Table 2

Volatile Internal Standards with Corresponding Priority Pollutant and TCL Analytes Assigned to Quantitation

Bromochloromethane

Chloromethane Bromomethane Vinyl chloride Chloroethane Methylene chloride Trichlorofluoromethane Acetone Carbon disulfide 1.1-Dichloroethene 1,1-Dichloroethane cis-1,2-Dichloroethene Chloroform 1.2-Dichloroethane 2-Butanone trans-1.2-Dichloroethene 1.2-Dichloroethane-d, (surr) 1,4-Difluorobenzene

1,1,1-Trichloroethane Carbon tetrachloride Vinyl acetate Bromodichlorornethane 1,2-Dichloropropane trans-1,3-Dichloropropene Trichloroethene Dibromochloromethane 1,1,2-Trichloroethane Benzene cis-1,3-Dichloropropene 2-Chloroethylvinylether Bromoform

Chlorobenzene-de

2-Hexanone 4-Methyl-2-pentanone Tetrachloroethene 1,1,2,2-Tetrachloroethane Toluene Chlorobenzene Ethylbenzene Styrene Xylenes (total) 4-Bromofluorobenzene (surr) Toluene-d₈ (surr)

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GCHES Assignment Sheet (29-Jul-92 Samples 206415 - 206416)

Date entered and init.: Due Dete: -Approved and init.: Sample: <u>P206416</u> Tent: <u>OVPPW</u> Type: <u>OFIG</u> Analysis Mumber: <u>2</u> Anis. Eef. Mumber: Dilution Run File Log Page Anist/Processor(Estat) Analysis audicer: g Anis. Eef. Budder: Analysi (Edg0) Budder: Dete Analysis Instrument: GCMS Book: Page: Eagle Description: <u>\$/\$ MAUSOLEM BUMP / ZNE ERT</u> -Received Original (vol/wrt): _____ 17-801-92 Final (vol): _____ fime Sampled: Client: BLANK BANNLE #: Prep Neth: DO Anis Neth: 020wE-CASE ID: Not Available SDG: Not Available

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COMMENTS:

P206416 TYPE C

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GCMS Assignment Sheet (29-Jul-92 Samples 206415 - 206416)

And a second design and a	Approved and init:
Sampie: <u>P206116</u> Test: <u>OV2</u> Type: <u>ORIG</u> Anslysis Bumber: <u>6</u> Anle. Ref. Bumber: Ansiyst (Empd) Bumber:	Bun File Bilution Log Page Anlat/Processor(Eap)
Date Analyzed:	
instrument: GCMS Page:	
Sample Description: 5/6 RAUSOLEUM SLDEP / ZHE EXT Client:	Time Sampled: Received Original (vol/wt): 17-AL-92 Final (vol): RUB SATCH #: Prap Reth: G0 Ania Reth: OVGASEARCH
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SAMPLE PREPARATION AND DATA ACQUISITION

FOR GAMMA SPECTROSCOPY

1.0 SCOPE AND APPLICATION

This method is applicable to anything that contains or is a gamma-emitting radionuclide. The method can be applied to soil, water, air filters, etc. providing the sample can be condensed or reduced in size such that it can be placed in a calibrated geometry for counting.

2.0 SUMMARY OF METHOD

Solid samples are mixed as well as possible in their as-received containers. Liquid samples are shaken immediately before being transferred to the counting container. No other sample processing is done except to transfer to a suitable container (or plate) for counting.

A portion of the as-received sample is placed in a container such as a widemouth poly-bottle or marinelli beaker for which a calibration exists. An intrinsic germanium detector, interfaced with a 8192-channel multichannel analyzer, is used to obtain the gamma spectrum. This spectrum is transferred to a computer, which processes the data using the computer program GDR. The GDR program contains gamma-ray libraries and detector efficiencies that permit identification and quantification of gamma-emitting radionuclides. These data are then corrected for room background.

3.0 PROCEDURE

Note: Do not apply bias across the detector unless it has been sufficiently cooled to liquid nitrogen temperatures. An overnight cooling time is recommended.

Approvals:

Job Operations Manager Date PAL

11/12/92

Quality Assyrand Coordinator

Date

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3.1 Water Sample Preparation

- 3.1.1 Measure 0.5, 1.0 or 2.0 L of a sample and transfer into a marinelli beaker of comparable size. Aliquot depends on sample available, but 1.0 or 2.0 L is preferable.
- 3.1.2 Place a lid on the marinelli beaker and seal it with Parafilm or tape.
- 3.1.3 Record the sample number on the lid and record the sample number and volume in the gamma spec log book.
- 3.1.4 Transfer the marinelli beaker to the counting room for analysis.

3.2 Soil or Sludge Sample Preparation

- 3.2.1 Measure an aliquot of oven-dried (103°C), well-mixed sample into a tared 250-mL wide mouth poly-bottle. Fill the bottle to either 4.5 cm (half-full) or 9.0 cm (full) depending on the volume of sample available.
- 3.2.2 Cap the bottle and seal with Parafilm or tape.
- 3.2.3 Weigh the filled sample bottle.
- 3.2.4 Record the weight of the sample and the sample number on the bottle and in the gamma spec log book.
- 3.2.5 Transfer the sample to the counting room for analysis.
- Note: Solid samples should be compacted as well as possible to eliminate channels and air pockets. Place a plastic bag over the detector end cap when counting samples known to contain levels of radioactivity above background levels.

3.3 Data Acquisition

- 3.3.1 Record the MCA number, and count date and time in the gamma spec log book.
- 3.3.2 Place the samples in the appropriate detector cavities and close the shield lids.
- 3.3.3 Preset the appropriate counting times using the "F3" key. Liquid samples are typically counted for 500 minutes (30,000 sec) and solid samples are typically counted for 100 minutes (6000 sec). Counting times may be lengthened or shortened

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depending on required minimum detectable activities (MDA). Exit the preset mode by striking the "esc" key. Preset time must be entered in seconds.

- 3.3.4 Erase any previous spectra on the screen by striking the "F2" and "control" keys simultaneously. (Be sure previous spectra have been stored prior to erasing.)
- 3.3.5 Acquire the sample spectra by striking the "F1" key.
- 3.3.6 Save the acquired spectra individually. This is accomplished by moving the highlight to the desired window utilizing the left and right arrow keys. Strike the "enter" key to zoom in on the highlighted window. Strike the "F7" key and type in the filename for the spectrum.

The filename has the following format:

A:XYZZZZZZ.SPM

where

- X = the MCA number.
- Y = A,B,C, etc. indicating the first count, second count, etc. for the sample.
- ZZZZZZ = the unique Halliburton NUS number assigned to the sample.
- Note: A: will save the spectrum to a floppy disk in the A drive. Be sure to have a formatted disk in this drive. Repeat for each detector on which a spectrum has been acquired.
- 3.3.7 Detectors may be operated independently by following steps 3.3.1 through 3.3.5 while in the zoomed mode.
- 3.4 Spectral Data Reduction
 - 3.4.1 Exit the MIS software by pressing the "ALT" "Q" keys, then moving the highlighted area to "exit to DOS" using the down arrow key. Press the "return" key.
 - 3.4.2 Access the GDR reduction software by typing at the "c:\GDR>" prompt:

"GDRMA\N GDRIVERX.DAT"

where X = the mea number on which the spectrum has been acquired.



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- 3.4.3 Select the appropriate menu item by pressing the corresponding "F" key. Menu items may also be selected by using the up or down arrow keys to move the highlighted area to the desired menu item and pressing the "return" key.
- 3.4.4 Verify the reduction parameters by selecting "F8", Modify Setup Parameters. Acceptable volume units are L (liters), mL (milliliters), g (grams) or filter. If L (liters) is used, the entry for "Vol. Mult Factor to mL:" must be 1.0 E + 3. "Activity units" will usually be pCi (picocuries). When this is the case, "Mult. Factor to μ Ci:" must be 1.0 E + 6. Use the space bar to move the highlight from item to item. Use the "enter" key to charge an entry.
- 3.4.5 Press the "S" key to save any changes to the setup parameters and return to the main menu.
- 3.4.6 Press the "F1" key from the main menu. Press the "F2" key from the Spectrum Select Menu. When prompted, type in the filename under which the desired spectrum has been stored. Be sure to include the ".SPM" extension. Press the return key to finalize the spectrum selection.
- 3.4.7 Enter the spectrum data as the system prompts for it. Data that will be requested are:

MCA COUNT START date and time - entered as (mo-da-yr and hr:mn) : [default]

SAMPLING START date and time - entered as (mo-da-yr and hr:mn) : [default]

SAMPLING STOP date and time - entered as (mo-da-yr and hr:mn) : [default]

SAMPLING VOLUME - entered as a number [default]

SAMPLE UNITS - entered as an abbreviation for sample volume unit [default]

SAMPLE ID - entered as name: up to 40 alphanumeric characters (default)

Sampling start and stop times usually will be the same. The correct time to enter is the time of sampling or the point in time to which data is to be decay-corrected.



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The sample ID field will be printed in the header of the report. This information should include client, sample number, and raw data log book and page numbers. Press the "return" key after each entry.

- 3.4.8 Press the "F1" key to select the appropriate calibration data from file. A detector file will be displayed. Verify that this is the file for the detector on which the spectrum has been acquired. If it is not, type in the correct file. Press the "return" key.
- 3.4.9 Press the "F1" key to select the appropriate efficiency calibration data from file. An efficiency file will be displayed. Verify that this is the appropriate file corresponding to the detector and geometry for which the spectrum has been acquired. If it is not, type in the correct file. Press the "return" key.
- 3.4.10 Press the "F4" key from the main menu, which will now be displayed, to initiate the peak search. Press the "return" key. Press the "F2" key to send the peak search results to the printer. This will automatically send the activity report to the printer as well. Press the "F4" key to generate the activity report.
- 3.4.11 Press the "F10" key to save the results. Use the filename for which the spectrum was saved along with the ".RES" extension. Press the "return" key.
- 3.4.12 Press the "F7" key to save the spectrum into a file. Use the filename for the spectrum along with a ".SPC" extension. Press the "return" key.

3.4.13 Repeat steps 3.4.2 - 3.4.12 for each spectrum.

- 3.5 Calibration
 - Note: Calibration is performed on each spectrometer system annually, at a minimum, on each geometry in which measurements will be made. The energy range of the mixed nuclide standard is 59.54 keV to 1836 keV. Spectra are analyzed from 50 keV to 2000 keV.
 - 3.5.1 Prepare a standard in the desired geometry using a NISTtraceable mixed nuclide gamma standard. Be sure the standard is thoroughly mixed with the sample matrix. Appropriate

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geometries include marinelli beakers filled with reagent water, poly-bottles filled with Ottawa sand, planchets and air filters.

For aqueous sample geometries, pipet an aliquot of mixed nuclide standard directly into a known volume of acidified reagent water. For solid sample geometries, pipet the aqueous standard onto Ottawa sand and dry under an infrared lamp. Volatile nuclides such as Hg-203 must be deleted from the acquired system.

- 3.5.2 Acquire and save a spectrum following steps 3.3.2 3.3.6.
- 3.5.3 Analyze the spectrum following steps 3.4.1 3.4.10.
- 3.5.4 Press the "F6" key from the GDR main menu to initiate the calibration routine. Press the "F2" key to send the calibration data to the printer.
- 3.5.5 Enter the appropriate information into the system as it prompts for it. This information will be grams of standard used in calibration source and tolerance for match (use 2.0 keV).
- 3.5.6 Press the "F3" key from the calibration menu. Enter a description of the geometry when the system prompts for it. Up to 20 characters may be used.
- 3.5.7 Press the "F3" key from the Efficiency Calibration menu to use the results of the peak search. A list of calibration pairs will be displayed. Press any key to return to the menu.
- 3.5.8 Press the "F4" key to view a log/log plot of the calibration. Verify that the curve is a reasonable fit of the data points.
- 3.5.9 Press the "F5" key to proceed with the calibration. Press the "F1" key for exponential fit. A second view of the curve will be displayed. Verify that the curve is a reasonable fit of the data points. Press any key to return to the menu.
- 3.5.10 Press the "F1" key to store the results of the calibration only if the curve is a reasonable fit of the data pairs. Press the "F2" key and repeat the calibration process if the fit is not reasonable.

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3.5.11 Store the efficiency file using the format:

e fXXYY.eff

where XX = the detector number YY = a geometry description (e.g., 1LM is a 1-L marinelli beaker).

Record the efficiency filename, geometry, detector number and date generated in the gamma spec maintenance log.

3.5.12 Follow the above procedure for energy versus channel and full width/half maximum versus energy calibrations.

4.0 DATA HANDLING

4.1 Data Collection

Document the data in a bound lab notebook for each set of analyses performed. Entries must be made at the time of analysis and include the following (see Figure 1):

- description of activity being documented (e.g., "Gamma Spec Analysis") and LSG procedure being followed (e.g., LSG Method No.: GSPEC, rev. 0).
- date and time analysis started and completed, and analyst(s) signature(s).
- count length.
- LSG sample number and sample aliquot. Identify any lab quality control samples (method blanks, MS/MSDs, LCSs).
- spikes added, to include the spiking solution identification number and the volume of spike added.
- 4.2 Data Reduction and Reporting for Gamma Spec

Using the GDR Nuclide Activity Summary, report gamma spectroscopy scan data as follows.

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Report each nuclide that the data system has identified and quantified to two significant figures along with the counting uncertainty rounded to two significant figures (see Figure 2) with the following provisos:

Report only those nuclides positively identified and quantified by the GDR program.

In evaluating the identifications made by the software, consider the following:

- Agreement of results for multiple photon peaks of a given nuclide.
- Possible identifications of any unidentified peaks.
- Possibility that identified nuclides may actually be low abundance peaks of other nuclides found in the sample that have not been included in the libraries.

Document and support changes to automated nuclide identifications on the instrument printout.

If the counting uncertainty is less than 10 percent of the reported activity, round the uncertainty up to 10% of the activity value. Do not report a lower order of magnitude (decimal place) in the uncertainty than will be reported in the activity.

Examples:

176 + 32 pCi/L is reported as 180 + 30

176 + 9 pCi/L is reported as 180 + 20

- If the counting uncertainty is greater than the reported activity, do not report the nuclide as found (see Figure 3).
 - If no nuclides are identified by the data system, report "NND" in the results column of the LIMS data entry screen and "NND = No nuclides detected" in the Comments field of the data entry screen.

4.3 Data Reduction and Reporting for Specific Target Nuclides

If a specific nuclide is listed as an analyte in the LIMS and it was identified and quantified by the data system, report it as described above. If the specific nuclide is not identified and quantified by the data

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system, report the minimum detectable activity (MDA) for those nuclides as calculated by the data system. Report MDA values to one significant figure. (See Figure 3.)

Qualify results for soil samples as follows: "Samples were oven-dried at 103°C prior to analysis. Nuclides volatile at this temperature are, therefore, excluded from analysis."

5.0 QUALITY CONTROL

- 5.1 Sample Quality Control
 - 5.1.1 Prepare a blank, a lab control standard, and a duplicate and matrix spike for each batch of up to twenty like samples.
 - 5.1.2 Blanks and lab control samples are prepared using Ottawa sand for solid matrices and reagent water for aqueous matrices.
 - 5...3 Matrix spikes are not required for solid samples.
 - 5.1.4 Cs-137 and Co-60 are the nuclides spiked into laboratory control standards and matrix spikes.

5.2 Instrument Quality Control

- 5.2.1 Count a background check for 1000 seconds on each detector each day it is in use. Record results in the performance log and plot the results on a control chart.
- 5.2.2 Count a 30,000 second blank monthly, at a minimum, for each matrix analyzed to be used for background correction.
- 5.2.3 Count a europium check source for 1000 sec on each detector each day the detector is in use. Monitor the 105, 723 and 1274 keV peaks. Record in the maintenance log the fwhm, peak channel and gross peak counts. Plot on a control chart the peak channel and gross peak counts.

6.0 INTERFERENCES

- 6.1 Essentially all interferences are eliminated in this method due to the high resolving abilities of the intrinsic germanium detector.
- 6.2 Naturally occurring radionuclides found in building components may result in the occurrence of peaks not truly in the sample. These are corrected for during the data reduction process.

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7.0 SAFETY PRECAUTIONS

- 7.1 Wear a lab coat and safety glasses with side shields at all times while performing this procedure. Wear gloves to avoid skin contact with radionuclides, acids, bases, organic solvents and possible toxicants used as reagents or contained in the samples for analysis.
 - 7.1.1 Should skin or eye contact occur, flush the exposed area(s) with large amounts of water and seek immediate medical attention.
 - 7.1.2 <u>Never pipet materials by mouth.</u> Use a rubber bulb or other approved suction device to transfer materials by pipet.
- 7.2 Handle and store all reagents in accordance with the precautions listed on the material safety data sheets (MSDS).
 - 7.2.1 Consult the MSDS for each reagent listed in this procedure before use. The MSDS will provide pertinent information on toxicity, safety precautions and storage conditions.
 - 7.2.2 <u>Always</u> consult the label on the reagent bottle for up-to-date information on safety precautions during handling, preferred storage conditions and expiration data.
 - 7.2.3 Label all flasks, vials, etc., with the intended contents prior to filling. Follow established laboratory procedure in completing and affixing labeling information to equipment.
- 7.3 Avoid breathing solvent and standard solution vapors. If overexposure to vapors should occur, seek fresh air and immediate medical attention.
- 7.4 Handle all glass equipment with care, particularly during assembly and disassembly.

8.0 APPARATUS AND MATERIALS

- 8.1 Marinelli beakers: 0.5-, 1.0- and 2.0-L.
- 8.2 Graduated cylinders: 0.5-, 1.0- and 2.0-L.
- 8.3 Poly-bottles: 250-mL, wide mouth bottles.
- 8.4 Spatula.
- 8.5 Parafilm or Teflon tape.
- 8.6 Analytical balance.

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- 8.7 High purity germanium detector with shield.
- 8.8 Spectroscopy amplifier.
- 8.9 High voltage supply.
- 8.10 Multichannel analyzer: 8192 channels.
- 8.11 Computer with printer.
- 8.12 Computer software: PCA/MIS and GDR.
- 8.13 Floppy disks.
- 9.0 REFERENCES
 - 9.1 GDR Software Oparating Instructions Quantum Technologies Inc.
 - 9.2 MIS Multiple Input System Operating Instructions Tennelec/Nucleus Inc.
 - 9.3 "Gamma Spectroscopy", Environmental Survey Manual, U.S. Dept. of Energy.

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Auantum fechnology GOR_C Nuclide Activity Summary 105404. book 339-91 pg 44 Eff.= 1/14.29e-001*En1-1.35e+000 + 1.23e+002*En18.99e-0011 07-01-92 11:00 FINAL ACTIVITY REPORT Energy Conc +- 1.95sigma Halflife Peaks (sev) (pCi/Liter) (hrs) Found Nuclice B 1-226 180 186.20 1.55e+002 +-1.692+002 1.40e+007 1.of 1 Cr-51 (90) Sr-85 (20) Cs-184 (80) 320.08 < 8.60e+001 513.39 < 1.78e+001 569.31 < 7.87e+001 MDA 1.56e+003 MDA 1.81e+004 MDA 661.65 % 1.4le+001 2.64e+005 MOA 7.50e+003 MDA 4,620+004 MOA. HINKNOWN PEAKS Energy contents of the C.L. Phy. Fwem Det IKey) Land Containty Counts Counts (rev Comma/sec Containty Counts Counts (rev Comma/sec

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pH - SOIL/WASTE

1.0 SCOPE AND APPLICATION

This method is used for electrometrically measuring pH in soils.

2.0 SUMMARY OF METHOD

The pH of a solution refers to its hydrogen ion activity. The pH value is expressed as the logarithm of the reciprocal of the hydrogen ion activity in moles per liter at a given temperature. The practical pH scale extends from 0 (very acidic) to 14 (very basic) with 7 corresponding to neutrality at 25°C.

The soil sample is mixed with reagent water or a calcium chloride solution, depending if the soil is considered noncalcareous or calcareous, respectively. The soil suspension is stirred periodically over a 30-minute period and then left undisturbed for 1 hour so the soil settles. The pH of the supernatant solution is measured with a pH meter using a combination electrode.

3.0 PROCEDURE

3.1 Calibration of pH Meter

- Prepare and maintain the pH meter according to the 3.1.1 manufacturer's instructions.
- 3.1.2 Calibrate the instrument/electrode system at pH 7 and 4 using buffer solutions. Repeat adjustments on successive portions of the two buffer solutions until readings for both are within 0.05 pH of the buffer solution value.
- 3.1.3 Verify the accuracy of the calibration by measuring a pH 10 buffer. Recalibrate if it reads outside the range of 9.90-10.10.
- Note: Samples must be analyzed as soon as possible following collection. Assume all soils are noncalcareous unless specifically noted by the client

Approvals:

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Coordinator



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or Project Manager. Assume that solidified samples (i.e., crushed concrete) are calcareous.

Use a meter with automatic temperature compensation.

- 3.2 Sample Preparation and pH Measurement of Noncalcareous Soils
 - 3.2.1 Add 20.0 g of soil and 20.0 mL of reagent water to a 50-mL beaker. Stir the suspension with a glass rod several times over a 30-minute period.
 - 3.2.2 Allow the soil suspension to settle for approximately 1 hour.
 - 3.2.3 Immerse the electrode just deep enough into the supernatant solution to cover the sensing elements. Allow the meter to stabilize. Record the meter reading and remove the electrode from the solution.
 - 3.2.4 Rinse the electrode with reagent water thoroughly and gently blot dry between samples.
- 3.3 Sample Preparation and pH Measurement of Calcareous Soils
 - 3.3.1 Add 10.0 g of soil and 20.0 mL of 0.01 M CaCl₂ solution to a 50-mL beaker. Stir the suspension with a glass rod several times over a 30-minute period.
 - 3.3.2 Allow the soil suspension to settle for approximately 1 hour.
 - 3.3.3 Immerse the electrode just deep enough into the supernatant solution to cover the sensing elements. Allow the meter to stabilize. Record the meter reading and remove the electrode from the solution.
 - 3.3.4 Rinse the electrode with reagent water thoroughly and gently blot dry between samples.

4.0 DATA COLLECTION

Document the following information in a bound lab notebook for each set of pH measurements performed. Entries must be made at the time of method performance. Data entry should include the following (see Figure 1):

method number (pH-S) and brief description (pH - Soil/Waste).

 date and time performed and analyst(s) signature(s) and employee number(s).

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- instrument used for measurements (e.g., Accumet 925).
- buffer standards used in calibration and quality control, by standard identification number and/or manufacturer and lot number.
- LSG sample number and aliquot. Identify any quality control samples (i.e., duplicates or daily standards).
- suspension solution used reagent water or CaCl₂ solution.

5.0 QUALITY CONTROL

5.1 CALIBRATION

Calibrate the instrument using buffer solutions of pH 7 and 4. Measure a buffer solution of pH 10 to check the calibration and recalibrate if the meter reads outside of \pm 0.10 pH units of the buffer.

Analyze a daily standard to check the calibration before sample analysis begins as described below in Section 5.2. Recalibrate the instrument system if this initial daily standard does not pass the statistical evaluation criteria in the "Quality Control Test File - Wet Chemistry."

5.2 DAILY STANDARDS

Daily standards must be measured at a frequency of 1 per 10 samples, and at the start and end of the run.

A daily standard consists of a buffer solution standard not used to initially calibrate the meter/electrode unit.

Daily standard results are evaluated using the acceptance criteria in the "Quality Control Test File - Wet Chemistry". If a result fails, reanalyze all of the samples run since the last conforming daily standard.

5.3 DUPLICATES

Measure a duplicate for 1 in 10 samples daily. The duplicate analysis consists of a second aliquot of a sample processed in the same manner as the original aliquot.

Limits for precision are listed in the "Quality Control File - Wet Chemistry". Reanalyze the duplicate sample when precision is unacceptable and spotcheck 25% of the positive results. Rerun all samples and report recheck results if spotchecks do not duplicate original results within the quality control file limits.

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6.0 INTERFERENCES

- 6.1 The glass electrode, in general, is not subject to solution interferences from color, turbidity, colloidal matter, oxidants, reductants or high salinity.
- 6.2 Sudium error at pH >10 is minimized by using a low-sodium-error electrode.
- 6.3 Coatings of oil material or particulate matter can impair electrode response. Remove these coatings by gentle wiping or detergent washing, followed by rinsing with reagent water. An additional treatment with dilute HCI solution (1:9, v/v) may be necessary to completely remove the film.
- 6.4 Temperature effects on the electrometric determination of pH arise from two sources. The first is caused by the change in electrode output at various temperatures and is eliminated by using a meter with automatic temperature compensation or by control ling the temperature of the measured solutions. The second source is due to changes in the sample as the temperature changes. This error is sample-dependent and cannot be controlled.

7.0 SAFETY PRECAUTIONS

- 7.1 Wear a lab coat and safety glasses with side shields at all times while performing this procedure. Wear gloves to avoid skin contact with acids, bases, organic solvents and possible toxicants used as reagents or contained in the samples for analysis.
 - 7.1.1 Should skin or eye contact occur, flush the exposed area(s) with large amounts of water and seek immediate medical attention.
 - 7.1.2 <u>Never pipet materials by mouth.</u> Use a rubber bulb or other approved suction device to transfer materials by pipet.
 - 7.1.3 Wear a dust mask or work in a hood as necessary to prevent exposure to dusts from solid samples.
- 7.2 Handle and store all reagents in accordance with the precautions listed on the material safety data sheets (MSDS).
 - 7.2.1 Consult the MSDS for each reagent listed in this procedure before use. The MSDS wi'l provide pertinent information on toxicity, safety precautions and storage conditions.



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- 7.2.2 <u>Always</u> consult the label on the reagent bottle for up-to-date information on safety precautions during handling, preferred storage conditions and expiration data.
- 7.2.3 Label all flasks, vials, etc., with the intended contents prior to filling. Follow established laboratory procedure in completing and affixing labeling information to equipment.
- 7.3 Handle all glass equipment with care.

8.0 APPARATUS AND MATERIALS

- 8.1 <u>pH Meter</u>: Meter with readout to at least 0.01 pH units and with automatic temperature compensation (Accumet 925 or equivalent).
- 8.2 <u>Electrodes</u>: Combination-type incorporating both measuring and reference functions.
- 8.3 Beakers: 50-mL capacity.
- 8.4 Flasks: 1- and 2-L volumetric flasks.

9.0 REAGENTS

- 9.1 Reagent water: Deionized water.
- 9.2 <u>Secondary Standard Buffers</u>: Commercially available solutions that have been validated by comparison with NIST standards are recommended for routine use. Alternatively, the buffers may be prepared in the laboratory from NIST salts.
- 9.3 <u>Silver Nitrate Standard (0.1 N)</u>: Dissolve 1.6987 g AgNO₃ in reagent water and dilute to volume in a 1-L flask. Mix thoroughly. Standardize the AgNO₃ solution as described in LSG Method N. ober 1145.
- 9.4 Potassium Dichromate Indicator (5%): Dissolve 50 g K₂CrO₄ in a small amount of reagent water. Add AgNO₃ solution until a definite red precipitate is formed. Let stand 12 hours, filter and dilute to 1 liter with reagent water. Prepare fresh annually.
- 9.5 Calcium Chloride Solutions:
 - 9.5.1 Calcium Chloride Stock Solution (0.072 M) Dissolve 21.18 g of CaCl₂•2H₂O in reagent water in a 2-L flask. Cool the solution, dilute to volume with reagent water and mix well.

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Standardize the solution by adding 1.0 mL of 5% K_2CrO_4 to a 25.0 mL aliquot of the solution and titrate to the endpoint with standard 0.1 N AgNO₃.

Calculate the volume needed to prepare a 0.01 M CaCl₂ using the following equations:

 $N_{ceclr} = N AgNO_3 \times Vol AgNO_3 (from titn.) 25 mL$

 Vol_{caClz} (in mL) = <u>0.01 M (1800 mL)</u> N_{CaClz} (from above calc.)

9.5.2 Calcium Chloride Solution (0.01 M) - Dilute the volume of CaCl₂ calculated above to 1.8 liters with reagent water. Check and adjust the pH to a range of 5-6.5 by adding Ca(OH)₂ or HCl.

As a check on the preparation of this solution, measure its electrical conductivity. The specific conductivity should be $2320 \pm 80 \ \mu mohs/cm$ at 25°C.

10.0 REFERENCES

U.S. EPA SW-846, "Laboratory Manual, Physical/Chemical Methods," Volume IC, 1986; Method 9045.

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Sample	Climt	ANG KAL	Int pH .	H	
ICV (10.00 pH)		100	9.96	9.90 = 9967.	Keigwery
204899 (10.0004)	-	100	9.76	996 = 99.69.	Lewy
205/58	ASE, Inc.	100	8.53	8.5	
205155		/00	7.49	7.5	Batch 11280
205448	XYZ, Inc.	100	7.63	7.4	105205197
205453		100	9.03	9.9 SRNG	a 0. las
205453 Dup	1111	100	9.08	7.1	
COV, (2.00, H)		100	7.00	7.00 = 100%	Burry
Sample	Gient	Aliquet	Instudy	AH	
2.04441	Bacterto	100-+100	8.09	P.I	Both 11281
204442		mi dagz	7.65	7.6	405 205 973
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GRAFHITE FURNACE ATOMIC ABSORPTION

1.0 SCOPE AND APPLICATION

Metals in solution are readily determined by atomic absorption spectroscopy. As opposed to conventional flame analysis, a greater percentage of available analyte atoms are vaporized and dissociated for absorption when the furnace technique is used. Additional advantages of this technique include the use of smaller sample volumes and the detection of lower concentrations of elements.

This method is applicable to a large number of metals in drinking, surface, and saline waters and domestic and industrial wastes (see Table 1 for analytes and reporting limits). Drinking water free of particulate matter is analyzed directly. Ground water, other aqueous samples, TCLP and EP extracts, industrial wastes, soils, sludges, sediments and other solid wastes require digestion prior to analysis.

Detailed instrument operating instructions are provided in the manufactuers' operator manuals.

2.0 SUMMARY OF METHOD

A small aliquot of a sample is placed into the graphite tube in the furnace. The sample is then treated thermally. First, a low current heats the tube to evaporate the sample to dryness. Then at a higher temperature to destroy organic matter and volatilize other matrix components. Finally, the tube is heated to incandescence which, in an inert atmosphere, atomizes the element being determined, forming a ground-state vapor. Radiation from a hollow cathode lamp or electrodeless discharge lamp, characteristic of the metal analyte, passes through the ground-state vapor. A photoelectric detector measures the intensity of transmitted radiation which decreases in proportion to the concentration of metal analyte in the sample.

Approvals:

aboratory Manager Date

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Quality Assarate Coordinator

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3.0 GRAPHITE FURNACE PROCEDURE

- 3.1 Prepare the instrument as follows:
 - 3.1.1 Turn on instrument.
 - 3.1.2 Select the proper lamp for the analysis from Table 2A/B, depending on the instrument in use. Allow the lamp to warm up for a minimum of 5 minutes (30 minutes if using an electrodeless discharge lamp).
 - 3.1.3 Call up program and select analyte. Adjust the monochromator slit width and wavelength, and the lamp current on the PE 3030. This is done automatically on the PE 5100. See Table 2A/B for specifications.
 - 3.1.4 Align the furnace and lamp to maximize system sensitivity.
 - 3.1.5 Select both the proper inert gas flow and the correct temperature program from Table 3A/B, depending on the instrument in use.
 - 3.1.6 Check the graphite tube for signs of corrosion and/or flaking. If these signs are present, replace tube as follows:
 - Note: It is good practice to replace the tube every day of analysis.
 - a. Press the FURNACE button on the Perkin-Elmer HGA-600. This will open the furnace chamber.
 - b. Remove old graphite tube.
 - c. Clean the furnace area, including the two windows, with a cotton swab and isopropal alcohol.
 - d. Load a platform into a new tube; load the new tube into the furnace; press FURNACE and the chamber will close.
 - e. Clean the pyrolytic graphite tube before use with five to ten high-temperature burns.
- 3.2 Refer to Table 4 for standard concentrations, matrix modifiers, and calibration type for the element of interest.

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- 3.3 Prepare autosampler as follows:
 - 3.3.1 Pipette samples into autosampler cups. Add matrix modifiers, if necessary.
 - 3.3.2 Load cups into autosampler tray. Verify autosampler loading as described in NUS Laboratory Procedure AP-013.
- 3.4 Perform the analytical sequence as listed in Table 5. Perform a minimum of two replicate firings for standardization, QC and sample analyses. Report the average result of the multiple firings. Ouality control criteria are specified in Section 6.
- 3.5 When analyte concentration exceeds the concentration of the high standard, reanalyze the sample after appropriate dilution. Prepare sample dilutions with reagent water acidified with 1 mL of HNO₃ per 100 mL. Use the least dilution necessary to bring the analyte within the upper two thirds of the analytical range.
 - Note: Samples being analyzed for Sb must be diluted with reagent water acidified with 1 mL of HNO₃ and 5 mL HCl per 100 mL.
- 3.6 When a low-level sample is run immediately after a very high concentration sample, particularly for refractory metals, be aware of the possibility of carryover contamination. Recheck low-level positive results, as necessary, to ensure the absence of carryover.
- 3.7 Shut down instrument after the completion of sample analysis as follows:
 - 3.6.1 Turn off lamp energy.

3.6.2 Turn off instrument.

Leave the inert gases on unless the instrument is being shut down for an extended period of time.

- 3.7 Calculate sample results as follows:
 - 3.7.1 Read the metal value in mg/L (i.e., the average of the two firings) directly from the instrument printout.
 - 3.7.2 For aqueous samples report metal concentrations in mg/L using the following equation:

 $Metal_{imp/ij} = A \times \frac{FV}{IV}$

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- Where: A = metal in mg/L of sample digestate from calibrationcurve
 - FV = final volume of dilution (=1 if no dilution)
 - IV = initial volume of sample (=1 if no dilution)
- 3.7.3 For solid samples report metal concentrations as mg/kg, wet or dry weight, using the equation(s) below:
 - a. Solid samples wet weight:

$$Metal_{(mg/kg wel)} = \frac{A \times V}{W}$$

- Where: A = metal in mg/L of sample digestate from calibration curve
 - V = final volume of sample digestate in mL
 - W = wet weight of sample in grams
- b. Solid samples dry weight:

$$Metal_{(mg/kg dry)} = Metal_{(mg/kg wet)} \times \frac{100}{\% \text{ solids}}$$

4.0 DATA COLLECTION

Document all data in a bound lab notebook and on the printed worklist for each set of analyses performed. Entries must be made at the time of analysis.

4.1 BOUND LABORATORY NOTEBOOK (see Figure 1)

Document the following:

- brief description of test and analyte.
- instrument number (e.g., PE 5100) and operating conditions such as wavelength, lamp serial number, background correction and integration time.
- temperature program information such as step number, temperature, ramp time (sec) and hold time (sec).
- standard reference number.
- matrix modifier, if any.
- sample aliquot.

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- LSG sample numbers with appropriate dilutions, spikes and comments, if any. Identify any lab quality control samples (method blanks, duplicates, MS/MSDs, LCSs, etc.).
- date/time analysis started and analyst(s) signature(s).

4.2 PRINTED WORKSHEET (see Figure 2)

Document the following:

- date/time analysis started and analyst(s) employee number(s).
- instrument number and run file.
- sample cup numbers and results, with units, taken from computer printout (see Figure 3).
- book and page reference to data in bound lab notebook.

5.0 QUALITY CONTROL

5.1 INSTRUMENT CONTROL CHECKS

5.1.1 Initial Calibration Verification (ICV)

Verify and document the accuracy of the initial calibration by running an initial calibration verification standard, independent of the calibration standard, immediately after instrument calibration.

When measurements exceed the control limits of 90-110%, terminate analysis and correct the problem which may be due to instrument set-up or function and/or accuracy of the standard materials. Recalibrate the instrument and verify the calibration before proceeding with the analysis sequence.

5.1.2 Initial Calibration Blank (ICB)

Analyze an initial calibration blank immediately after the ICV.

If the absolute value of the blank result exceeds the reporting limit, terminate analysis, correct the problem, recalibrate, and verify the calibration.

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5.1.3 Reporting Limit Standard

Analyze a standard at the reporting limit, following the ICB, to verify that the instrument has adequate sensitivity. The response for this standard must be discernible from the ICB.

5.1.4 Continuing Calibration Verification (CCV)

Aanalyze a mid-range standard for continuing calibration verification, after each set of 10 analyses and at the end of each run, to ensure calibration accuracy during each run.

Recovery limits for CCV are 85.0-115% for routine analysis samples and 90.0-110% for NPDWR compliance monitoring and New Jersey samples. If CCV acceptance limits are not met, terminate analysis, correct the problem, recalibrate, and verify the calibration. Reanalyze all field and quality control samples run since the last acceptable ICV or CCV standard.

5.1.5 Continuing Calibration Blank (CCB)

Analyze a calibration blank after each CCV standard.

If the absolute value of the blank result exceeds the reporting limit, terminate analysis, correct the problem, recalibrate, and verify the calibration. Reanalyze all field and quality control samples analyzed since the last acceptable calibration blank.

5.1.6 Single Spike Analysis

Perform a single, post-digestion, spike analysis on each field sample that is not being run as a pre-digestion matrix spike, to check for sample matrix interferences.

Spike post-digestion spikes at a concentration equal to the midpoint of the graphite furnace calibration curve for each element. Analyze the spike immediately following the original sample analysis.

Depending on the original sample result, follow a or b to evaluate the single spike results:

- The original sample yields a result less than two times the reporting limit;
 - If analytical spike recovery is forty percent or greater, report the unspiked sample result.

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- If analytical spike recovery is less than forty percent, dilute the sample five fold. Repeat both the unspiked and spiked analyses on the diluted aliquot.
 - If recovery of the analytical spike in the diluted aliquot is greater than or equal to forty percent, report the result, corrected for the dilution.
 - If analytical spike recovery is again less than forty percent, report the result, corrected for dilution, and flag the data with the following comment:

Recovery of the graphite furnace analytical spike was less than forty percent, indicating the presence of a matrix interference. The result is therefore estimated because of the presence of this interference.

- Note: For the analysis of lead and selenium on drinking water samples, recovery of the analytical spike must be 85-115%. Recovery outside this range requires analysis by method of standard additions as outlined in Section 5.5.
- b. The original sample result is greater than or equal to two times the routine reporting limit:
 - If recovery of the analytical spike is 85-115%, report the unspiked sample result.
 - If recovery of the analytical spike is not 85-115%, dilute the sample by a factor of 2 to 5, and analyze by method of standard additions as outlined in Section 5.5.

5.2 SAMPLE PREPARATION CONTROL CHECKS

5.2.1 Preparation Blank (PB) Analysis

A provaration blank, consisting of reagent water processed through sample preparation, is prepared and analyzed with each batch of up to 20 samples digested at the same time.

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Evaluate the preparation blank results as follows:

- a. If the concentration of the blank is less than or equal to the routine reporting limit, the blank is acceptable.
- b. If any analyte concentration in the blank is above the routine reporting limit, all samples associated with the blank with the analyte's concentration less than 10x the blank concentration and above the routine reporting limit, must be redigested and reanalyzed for that analyte. Do not correct the sample concentration for the blank value.
- c. If the concentration of the blank is below the negative routine reporting limit, troubleshoot the instrument.

5.2.2 Laboratory Control Sample (LCS) Analysis

A laboratory control sample analysis measures the accuracy of laboratory processing over time. A laboratory control sample is prepared and analyzed for all target analytes for each matrix (water or solid/waste) with each batch of up to 20 samples digested together.

The aqueous LCS spiking solution is be independent (i.e., from a different lot) from the calibration standards.

The solid/waste LCS is a solid reference material. If an analyte of interest is not present in a reference material, spike the analyte into the LCS from a source independent of the calibration standards.

If the percent recovery for an LCS falls outside the control limits established in the "Quality Control Test File - Metals," redigest and reanalyze the samples associated with that LCS for the analyte(s) in question.

5.2.3 Pre-digestion Spike Sample Analysis

The spike sample analysis provides information about the effect of the sample matrix on the digestion and measurement procedures. Perform at least one spike sample analysis for every batch of 10 samples digested at the same time. Add the spike before digestion, prior to the addition of other reagents.

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Calculate individual component percent recoveries (%R) as follows:

% Recovery = $\frac{(SSR - SR)}{SA} \times 100$

- Where: SSR = Spiked Sample Result SR = Sample Result SA = Spike Added
- Note: When the sample concentration is less than the reporting limit, use SR = 0 for purposes of calculating % Recovery.

If the spike recovery is not within the limits of 75-125%, qualify the data for that sample as follows:

This sample was analyzed as a matrix spike. Recovery of the spike was [fill in the recovery] indicating the presence of a matrix interference.

When the sample concentration exceeds the spike concentration by a factor of four or more, flag the data as follows:

Sample concentration greater than four times spike concentration. Disregard matrix spike recovery value.

5.2.4 Duplicate Sample Analysis

The duplicate sample analysis provides information about the reproducibility of graphite furnace results. One duplicate sample is prepared and analyzed for every set of up to 10 samples digested at the same time.

For results less than 5 times the instrument detection limit (IDL), the range of the duplicate must be ≤ 2 times the IDL. If one result is above 5 x IDL and the other is below, use the ± 2 x IDL criteria.

When both results are > 5 time the IDL, calculate the relative percent difference (RPD) as follows:

$$\frac{RPD}{(S+D)/2} = \frac{|S-D|}{(S+D)/2} \times 100$$

Where: *RPD* = Relative Percent Difference *S* = First Sample Value (original)



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D = Second Sample Value (duplicate)

Limits for RPD are listed in the "Quality Control Test File - Metals."

When precision (range or RPD) is unacceptable, reanalyze the duplicate sample. If it remains nonconforming, redigest and reanalyze 25% of the positive results. If reanalysis results do not duplicate original results, redigest and reanalyze all samples and report the reanalysis results.

5.3 INSTRUMENT DETECTION LIMIT (IDL) DETERMINATION

Determine instrument detection limits for each instrument used, at least quarterly (every 3 calendar months) for CLP TAL analytes and biennially for non-TAL analytes. The IDLs must be less than or equal to the reporting limits.

Determine the Instrument Detection Limits in mg/L as follows:

- Prepare a standard solution of each analyte in reagent water at a concentration 3-5x the manufacturer's suggested IDL initially, then 3-5x the detection limit thereafter.
- Perform seven consecutive measurements of the standard on three nonconsecutive days.

Perform each measurement as if it were a separate analytical sample followed by a rinse and/or any other procedure normally performed between analysis of separate samples.

Calculate the standard deviation (SD) for each set of seven measurements.

- Average the standard deviation values.
- Calculate the IDL (mg/L) by multiplying the average SD by 3.

If the instrument is adjusted in anyway that may affect the IDL, redetermine the IDL.

5.4 DILUTION ANALYSIS

Perform dilution analysis, if necessary, to identify matrix interference, as follows:

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- 5.4.1 Withdraw two equal aliquots from the sample. To one of the aliquots, add a known amount of analyte and dilute both aliquots to the same predetermined volume.
 - The dilution volume should be based on the analysis of the undiluted sample. Preferably, the dilution should be 1:4, while keeping in mind that the diluted value should be at least 5 times the instrument detection limit.
 - Under no circumstances should the dilution be less than 1:1.
- 5.4.2 Analyze the diluted aliquots.
- 5.4.3 Compare the unspiked results, multiplied by the dilution factor, to the original determination.

Agreement of the results within 10% indicates the absence of interference. Comparison of the actual signal from the spike with the expected response from the analyte in an aqueous standard should help confirm the finding from the dilution analysis.

5.5 METHOD OF STANDARD ADDITIONS

When requested or as indicated in Section 6.1.6 above, the method of standard additions (MSA) is used to compensate for matrix effects. MSA involves the analysis of an unspiked aliquot of sample and three additional aliquots spiked at varying levels. The unspiked sample result must be at least 5 times the reporting limit, whenever possible. All of the spiked aliquots must be within the linear range.

The method of standard additions is performed as follows:

- 5.5.1 Keep dilutions at a minimum. Larger or successive dilutions may be required if severe matrix interference is encountered (i.e., very low or no spike recovery).
- 5.5.2 Begin MSA by preparing and analyzing one unspiked (0 ADD) aliquot.
- 5.5.3 Based on the 0 ADD result, determine the appropriate spiking levels:

a. 0 ADD result \geq 10 x RL:

Prepare three additional spikes at approximately 50%, 100% and 150% of the concentration of the unspiked (0

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ADD) aliquot. Maintain the volume of sample and final volume in the 0 ADD aliquot throughout all spikes.

Calculate the x-intercept, slope, and correlation coefficient of the best fit line using a calculator having these statistical capabilities. If the correlation coefficient of the MSA is greater than or equal to 0.995, calculate the final result by multiplying the absolute value of the x-intercept by the dilution factor. If the correlation coefficient is less than 0.995, repeate the MSA once, employing additional dilution if deemed necessary. If the correlation coefficient on the second MSA is again less than 0.995, calculate a result from the MSA with the better correlation, and flag the data as follows:

Result was obtained by method of standard addition, A linear correlation could not be established. Matrix interference is suspected. This should be considered when evaluating the data.

b. $RL \leq 0$ ADD result < 10 x RL:

Prepare three additional spikes at 5, 10 and 15 times the detection limit, whenever linear range permits. Maintain the volume of sample and final volume in the 0 ADD aliquot throughout all spikes.

Calculate the x-intercept, slope, and correlation coefficient of the best fit line using a calculator having these statistical capabilities. If the correlation coefficient of the MSA is greater than or equal to 0.995, calculate the final result by multiplying the absolute value of the x-intercept by the dilution factor. If the correlation coefficient is less than 0.995, repeat the MSA once. If the correlation coefficient on the second MSA is again less than 0.995, calculate a result from the MSA with the better correlation, and flag the data with the note described in step a, above.

c. 0 ADD result < RL:

Prepare two additional spikes at 5 and 10 times the detection limit, whenever linear range permits. Maintain the volume of sample and final volume in the 0 ADD aliquot throughout all spikes.

If recovery of either spike is <40%, prepare the 0 ADD aliquot and two additional spikes, employing an additional

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5 or 10 fold dilution. If recovery is still <40%, report the result of the largest dilution. Flag the data with the following:

Result was obtained by method of standard addition. Although the reported result is below the detection limit, spike recovery was less than 40% - matrix interference is suspected. This should be considered when evaluating the data.

6.0 INTERFERENCES

6.1 Though the problem of oxide formation is greatly reduced with furnace procedures because atomization occurs in an inert atmosphere, the technique is still subject to chemical interferences. The composition of the sample matrix can have a major offect on the analysis. It is those effects which must be determined and taken into consideration in the analysis of each different matrix encountered.

To verify the absence of matrix or chemical interference, post-digestion spiking is used. Treat samples that indicate the presence of interference in one or more of the following ways:

- Analyze the sample by the method of standard additions.
- Successively dilute and analyze the samples to eliminate interferences.
- Modify the sample matrix either to remove interferences or to stabilize the analyte. Addition of ammonium nitrate removes alkali chlorides; addition of ammonium phosphate retains cadmium. Mixing hydrogen with the inert purge gas aids in molecular dissociation through chemical reduction.
- 6.2 Gases generated in the furnace during atomization may have molecular absorption bands encompassing the analytical wavelength. Zeeman background correction is employed. Background correction may also compensate for nonspecific broad-band absorption interference.
- 6.3 Interference from a smoke-producing sample matrix can be reduced by extending the charring time at a higher temperature or utilizing an ashing cycle in the presence of air. Use care to prevent loss of the analyte.
- 6.4 Oxidize samples containing large amounts of organic materials by conventional acid digestion before analyzing in the furnace to minimize broad-bank absorption.

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- 6.5 Anion interference studies in the graphite furnace indicate that, under conditions other than isothermal, the nitrate anion is preferred. Therefore, nitric acid is preferable for any digestion or solubilization step. Minimize the amount of other acids used in addition to HNO₃, particularly hydrochloric and, to a lesser extent, sulfuric and phosphoric acids. The exception here is Sb analysis, which requires digestions and dilutions with HCI.
- 6.6 Carbide formation resulting from the chemical environment of the furnace has been observed. Reduce carbide formation and increase sensitivity with the use of pyrolytically coated graphite.
- 6.7 Spectral interference can occur when an absorbing wavelength of an element present in the sample but not being determined falls within the width of the absorption line of the element of interest. The results of the determination will then be erroneously high, due to the contribution of the interfering element to the atomic absorption signal.

Interference can also occur when resonant energy from another element in a multielement lamp, or from a metal impurity in the lamp cathode, falls within the bandpass of the slit setting when that other metal is present in the sample. Reduce this type of interference by narrowing the slit width.

- 6.8 Contamination of the sample can be a major source of error because of the extreme sensitivities achieved with the furnace. The following precautions are necessary to reduce contamination interference:
 - Keep the sample preparation work area scrupulously clean.
 - Clean all glassware as directed in the glassware cleaning procedure, AP-018.
 - Soak pipet tips suspected of contamination with 1:5 HNO₃ and rinse thoroughly with tap and reagent water.
 - Note: Pipet tips are a frequent source of contamination. The use of a better grade of pipet tip can greatly reduce this problem.
 - Give close attention to reagent blank results.
 - Clean the pyrolytic graphite tube before use with five to ten high-temperature burns.
- 6.9 Memory effects occur when the analyte is not totally volatized during atomization. This condition depends on several factors: volatility of the

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element and its chemical form, whether pyrolytic graphite is used, the rate of atomization, and furnace design. Clean the tube by operating the furnace at full power for the required time period, as needed, at regular intervals during analysis.

7.0 SAFETY PRECAUTIONS

- 7.1 Wear a lab coat and safety glasses with side shields at all times while performing this procedure. Wear gloves to avoid skin contact with acids, bases, organic solvents and possible toxicants used as reagents or contained in the samples for analysis.
 - 7.1.1 Should skin or eye contact occur, flush the exposed area(s) with large amounts of water and seek immediate medical attention.
 - 7.1.2 <u>Never</u> pipet materials by mouth. Use a rubber bulb or other approved suction device to transfer materials by pipet.
- 7.2 Handle and store all reagents in accordance with the precautions listed on the material safety data sheets (MSDS).
 - 7.2.1 Consult the MSDS for each reagent listed in this procedure before use. The MSDS will provide pertinent information on toxicity, safety precautions and storage conditions.
 - 7.2.2 <u>Always</u> consult the label on the reagent bottle for up-to-date information on safety precautions during handling, preferred storage conditions and expiration data.
 - 7.2.3 Label all flasks, vials, etc., with the intended contents prior to filling. Follow established laboratory procedure in completing and affixing labeling information to equipment.
- 7.3 Avoid breathing solvent and standard solution vapors. If overexposure to vapors should occur, seek fresh air and immediate medical attention.
- 7.4 Handle all glass equipment with care.

8.0 APPARATUS AND MATERIALS

- 8.1 <u>Atomic absorption spectrometer</u>: Perkin-Elmer 3030, Perkin-Elmer 5100, or equivalent.
- 8.2 Graphite furnace: Perkin-Elmer HGA-600, or equivalent.
- 8.3 Autosampler: Perkin-Elmer AS-60, or equivalent.

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- 8.4 <u>Electrodeless discharge lamps</u>: Single element lamps used for As, Se, and Pb analyses.
- 8.5 Hollow cathode lamps: Single element lamps.
- 8.6 <u>Pipets</u>: Microliter with disposable tips. Sizes can range from 5 to 1000 μL as required.
 - Note: Pipet tips should be checked as a possible source, of contamination prior to their use.
- 8.7 <u>Pressure-reducing valves</u>: The supplies of fuel and oxidant should be maintained at pressures somewhat higher than the controlled operating pressure of the instrument by suitable valves.
- 8.8 Conical sample cups: clear polystyrene, unsterile.
- 8.9 Glassware: class A volumetric flasks and class A volumetric pipets.

9.0 REACTINTS

- 9.1 <u>Reagent water</u>: Deionized water passed through a mixed bed resin column. Use reagent water for the preparation of all reagents and calibration standards and as dilution water.
- 9.2 <u>Nitric acid (HNO₃, 1:1)</u>: Use trace metals grade acid certified for AA use. Prepare a 1:1 dilution with reagent water by adding the concentrated acid to an equal volume of water.
- 9.3 <u>Hydrochloric acid (HCl, 1:1)</u>: Use trace metals grade acid certified for AA use. Prepare a 1:1 dilution with reagent water by adding the concentrated acid to an equal volume of water.
- 9.4 Hydrogen peroxide (H₂O₂, 30%): Use ACS grade, 30% solution.
- 9.5 Argon gas: Use prepurified grade.
- 9.6 <u>Stock standard metal solutions</u>: Ricca Chemical Co. certified 1000 ±5 ppm, or equivalent.
- 9.7 <u>Calibration and detection limit standards</u>: See Table 4 for standards concentrations.

Standard solutions are acidified as follows:

As/Se in 1% HNO₃ and 2% H₂O₃.

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- Sb in 5% HNO₃ and 2.5% HCl for soils.
 Sb in 1% HNO₃ and 5% HCl for waters.
- All other analytes in 1% HNO₃.
- 9.8 <u>Calibration blank/dilution water</u>: reagent water acidified to specifications listed in Section 10.7, above.

10.0 REFERENCES

- 10.1 U.S. EPA. "Methods for Chemical Analysis of Water and Wastes," EPA-600/4-79-020, revised March, 1983. 200-series Methods.
- 10.2 U.S. EPA. "Test Methods for Evaluating Solid Waste-Physical/Chemical Methods," SW-846, 1986. 7000-series Methods.
- 10.3 American Public Health Association. <u>Standard Methods for the Examination of Water and Wastewater</u>, 17th Edition, 1989. Method 3113-B.

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TABLE 1

GRAPHITE FURNACE ATOMIC ABSORPTION REPORTING LIMITS

Metal	Reporting (mg/L)	g Limit (mg/kg)
Aluminum Antimony Arsenic Beryllium Cadmium Chromium Chromium Copper Iron Lead Molybdenum Selenium Silver Thallium Tin Vanadium	0.003 0.01 0.003 0.0005 0.0005 0.001 0.002 0.002 0.002 0.002 0.002 0.002 0.002 0.002 0.004 0.0005 0.001 0.005 0.004	0.3 1 0.3 0.05 0.05 0.1 0.2 0.2 0.2 0.2 0.2 0.2 0.2 0.2

TABLE 2A

GRAPHITE FURNACE ATOMIC ABSORPTION PERKIN-ELMER 3030 OPERATING CONDITIONS

Element	User	Wavelength	Slit	Lamp	Time (sec)	Graphite	Autosampler	Rollover
	Program Name/#	(nm)	(nm)	Type/ Current'	Integration	Display	Tube Type ²	Volume (µL)	Absorbance
Aluminum	AL	309.3	0.7	HC/25	3	3	PG	20	1.000
Antimony	SB	217.6	0,2	HC/20	5	5	PG	10	3.000
Arsenic	AS	193.7	0.7	EDL/8	5	5	PG	30	1.000
Beryllium	BE	234.9	0.7	HC/30	5	5	PG	20	1.00
Cadmium	CD .	228.8	0.7	HC/4	7	7	PG	10	1.00
Chromlum	CR	357.9	0.7	HC/25	4	5	PG	15	1.30
Copper	- CU	324.7	0.7	HC/15	4	4	PG	20	1.00
lion	FE	248.3	0.2	HC/30	4	6	PG	20	1.00
Lead	PB	283.3	0.7	EDL/10	4	5	PG	20	1.00
Molybdenum	MO	313.3	0.7	HC/30	12	4	PU	10	2.00
Selenium	Se	196.0	0.7	EDL/6	- 4	4	PG	30	1.00
Silver	ÅĜ	328.1	0.7	HC/10	5	5	PG	20	1.00
Thallium	TL	276.8	0.7	HC/20	5	4	PG	25	1.50
Vanadium	V	318.4	0.7	HC/30	5	5	PU	15	1.00

TABLE 2A

Method No.: Revision: Effective Date: Page:

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TABLE 2A GRAPHITE FURNACE ATOMIC ABSORPTION PERKIN-ELMER 3030 OPERATING CONDITIONS PAGE 2 Lamp type - HC = Hollow cathode; EDL = Electrodeless Discharge Lamp Current -

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grooved; NPU = P.G = Pyrocoated, grooved; P.U = Pyrocoated, ungrooved; NPG = Non-pyrocoated, Non-pyrocoated, ungrooved Graphite tube type -

NOTE. The following operating conditions apply to all of the above elements

Gas type - Argon, 53 psi at regulator signal Processing - Peak Area Analysis Mode - Zeeman Furnace Cooling Method - Tap water or Recirculator, if available Replicates - 2 Screen Format - Basic data Screen Format - Basic data Statistics - Average, standard deviation and coefficient of variation Frint - Main values Main and supplemental data (calibration only)

TABLE 2A (CONT'D)

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TABLE 28

GRAPHITE FURNACE ATOMIC ABSORPTION PERKIN-ELMER 5100 OPERATING CONDITIONS

Element	User Program	Wavelength	Silt	Lamp	Time (s	sec)	Graphite	Autosampler	Rollover
	Name/#	(nm)	(nm)	Type/ Current'	Integration	Display	Tube Type ²	Volume (µL)	Absorbance
Aluminum	ALDL	309.3	0.7	/25	5	5	PG	20	
Antimony	SBOL	217.6	0.2	HC/20	5	5	PG	10	3.000
Arsenic	ASCL	193.7	0.7	EDL/6	5	5	PG	30	1.00
Beryllium	BEDL	234.9	0.7	HC/30	5	5	PG	15	1.00
Cadmium	CDDL	228.8	0.7	HC/4	5	5	PG	10	1.00
Chromium	CADL	357.9	0.7	HC/25	4	5	PG	20	1.30
Copper	CUDL	324.7	0.7	HC/15	5	5	PG	15	1.00
Iron	FEDL	248.3	0.2	HC/30	5	5	PG	20	1.00
Lead	PBDL	283.3	0.7	EDL/7.5	4	5	PG	20	1.40
Selenium	SEDL	196.0	2.00	EDL/4	7	7	PG	30	1.40
Silver	AGDL	328.1	9.7	HC/10	5	7	PG	20	
Thallium	TLDL	276.8	0.7	HC/20	5	7	PG	20	1.00
l'in	SNDL	286.3	0.7	HC/30	5		NPU	40	1.50

TABLE 2B

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TABLE 2B GRAPHITE FURNACE ATOMIC ABSORPTION PERKIN-ELMER 5100 OPERATING CONDITIONS PAGE 2

- Lamp type HC = Hollow cathode, EDL = Electrodeless Discharge Lamp Current -
- PG = Pyrocoated, grooved; PU = Pyrocoated, ungrooved; NPG = Non-pyrocoated, grooved; NPU = Non-pyrocoated, ungrooved Graphite tube type --14

NOTE: The following operating conditions apply to all of the above elements:

Gas type - Argon, 53 psi at regulator Signal Processing - Peak Area Analysis Mode - Zeeman Furnace Cooling Method - Tap water Replicates - 2 Screen Forma - Basic data Supplemental data (calibration only) Statistics - Average, standard deviation and coefficient of variation Blank, Standard, Sample Units - mg/L Print - Main values Main and supplemental data (calibration only) Save All Data - Yes

TABLE 2B (CONT'D)

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TABLE 3A

GRAPHITE FURNACE ATOMIC ABSORPTION PERKIN-ELMER 3030 TEMPERATURE PROGRAM'

-		Furnace	Time	(sec)	Internal	Gas Type	
Element	Step	Temperature (°C)	Ramp	Hold	Gas Flow	(N or A)	Read
Aluminum	1	200	30	20	300	À	
	2	1100	10	20	300	A	
	3	20	1	1	300	A	
	4	2500	0	3	a	A	
	5	2700	1	2	300	A	
	6	20	1	1	300	A	
Antimony	1	170	10	30	300	A	
	2	1100	5	20	300	A	
	3	20	1	5	300	A	
	4	2500	0	5	20	A	
and the second secon	5	2700	1	5	300	A	
Arsenic	1	150	10	30	300	A	
	2	1100	10	20	300	A	
	3	20	1	5	300	A	

TABLE 3A

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TABLE 3A GRAPHITE FURNACE ATOMIC ABSORPTION PERKIN-ELMER 3030 TEMPERATURE PROGRAM' PAGE 2

Element	-	Furnace	Time	(sec)	Internal	Gas Type	
Creineur	Step	Temperature (°C)	Ramp	Hold	Gas Flow	(N or A)	Read
Arsenic (Continued)	4	2400	0	5	0	A	
	5	2500	2	3	.300	A	
Beryllium	1	150	25	25	300	A	
	2	900	30	30	300	A	
	3	20	1	5	300	A	
	4	2500	0	4	0	A	
	5	2600	1	5	300	A	
Cadmium	1	160	5	30	300	A	
	2	700	5	20	300	A	
	З	20	1	5	300	A	
	4	1600	0	7	50	A	
	5	2400	1	3	300	A	
Chromium	1	150	5	30	300	A	
	2	1000	5	30	300	A	

TABLE 3A (CONT'D)

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TABLE 3A	GRAPHITE FURNACE ATOMIC ABSORPTION PERKIN-ELMER 3030 TEMPERATURE PROGRAM

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Flamant	2404	Furnace	Time	Time (sec)	Internal	Gas Type	
	date	remperature (``C)	Ramp	Hold	Gas Flow	(N or A)	Read
Chromium (Continued)	(*)	20	4	9	300	A	
	4	2500	0	4	100	A	
	u)	2700	61	0	300	4	
Cepper	+	150	10	20	300	A	
	OI.	1000	10	20	300	A	
	0	20	1	w	300	A	
	*1	2500	0	4	0	4	
	ŝ	2600	2	4	SOD	(<	
Iron	-	80	5	0	200	ξ <	
	.eu	250	30	30	300	c 4	
	eŋ.	1000	30	30	300	A	
	4	20	-	2	300	4	
	so.	2400	0	4	20	A	
	9	2700	64	3	300	. <	

TABLE 3A (CONT'D)

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TABLE 3A	GRAPHITE FURMACE ATOMIC ABSORPTION PERKIN-ELMER 3030 TEMPERATURE PROGRAM PAGE 4

Flamant	Chan	Furnace	Time	Time (sec)	Internal	Gas Type	
V - 113-11-11-11-11-11-11-11-11-11-11-11-11-	date	remperature (°C)	Ramp	Hold	Gas Flow	(N or A)	Read
Iron (Continued)	5	20	2	01	300	4	
Lead	-	170	10	30	300	4	
	2	900	w)	30	300	A	
	0	20	-	so.	300	A	
	4	1800	0	4	0	A	
	-10	2400	.02	0	300	A	
Molybdenum	**	160	20	20	300	×	
	2	1100	10	20	300	4	
	0	20		10	300	A	
	-1	2700	0	21	0	A	
	1.	2800	2	22	300	A	
	60	20		22	300	4	
	7	2800	CV.	5	300 -	A	
Selenium	**	150	10	40	200		

TABLE 3A (CONT'D)

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TABLE 3A GRAPHITE FURNACE ATOMIC ABSORPTION PERKIN-ELMER 3030 TEMPERATURE PROGRAM' PAGE 5

flamon.	1	Furnace	Time	Time (sec)	Internal	Gas Type	
VIDINA	date	remperature (°C)	Ramp	Hold	Gas Flow	(N or A)	Read
Selenium (Continued)	Cu.	1100	10	20	300	A	
	0	20	1	52	300	A	
	4	2200	0	4	0	A	
	s	2500	2	Ð	300	4	
Silver	+	200	10	30	300	×	
	ea	700	10	30	300	A	
	63	20	-	ŝ	300	×	
	4	2100	0	so.	0	A	
	ŝ	2500	-	cu	300	A	
Thallum	1	170	10	30	300	A	
	101	300	40	10	300	V	
	e	20	-	5	300	A	
	4	1400	0	w	0	A	
	423	2500	0	e	200	V	State of State of State

TABLE 3A (CONT'D)

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TABLE 3A GRAPHITE FURNACE ATOMIC ABSORPTION PERKIN-ELMER 3030 TEMPERATURE PROGRAM' PAGE 6

Element	Cian .	Furnace	Time	(sec)	Internal	Gas Type	
Elenient.	Step	Temperature (°C)	Ramp	Hold	Gas Flow	(N or A)	Read
Vanadium	1	150	20	20	300	A	
	2	1100	10	20	300	A	
	3	20	2	5	300	A	
	4	2700	0	5	0	A	
	5	2700	1	5	300	Δ	

Temperature program may require minute, daily modifications depending upon room temperature, atmospheric conditions, etc.

TABLE 3A (CONT'D)

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Florence	Change of	Furnace	Time	Time (sec)	Internal	Gas Type	
VIDUDUS	dato	l'emperature (`U)	Ramp	Hold	Gas Flow	(N or A)	Read
Aluminum	-	150	10	40	300	×	
	8	1100	10	30	300	A	
	0	20	<i>p</i>	υ	300	A	
	4	2500	0	LO LO	0	A	
	12	2600	-	LD.	300	A	
Antimony		170	ŝ	40	300	×	
	64	006	1	30	300	A	
	.02	20	-	9	300	×	
	4	2500	0	ۍ ا	20	A	
	<u>ن</u>	2600	-	50	300	Å	
Arsenic	-	170	20	30	300	×	
	<u>e</u> 4	600	10	30	300	X	
	0	20	-	w	300	A	
	4	2300	0	5	0	4	

TABLE 3B

PERKIN-ELMER \$100 TEMPERATURE PROGRAM

TABLE 3B

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		Furnace	Time	Time (sec)	Internal	Gas Type	
Inement	deto	i emperature (°C)	Ramp	Hold	Gas Flow	(N or A)	Read
Arsenic (Continued)	4D	2500	-	5	300	A	
Berylijum		170	10	30	300	A	
	01	900	15	30	300	A	
	0	20	1	S	300	A	
	4	260.0	0	43	40	4	
	10	2650	+	w	300	A	
Cadmum	-	170	ŝ	30	300	•4	
	CV.	500	40	30	300	A	
	0	20		40	300	A	
	4	1600	0	4/2	30	A	
	ŝ	2600	Ŧ	63	300	×	
Chromium	4	170	10	30	300	<	
	¢4	006	ŝ	25	300	A	
	.09	20	-	63	300	×	

TABLE 3B (CONT'D)

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Flamons	Ci an	Furnace	Time	Time (sec)	Internal	Gas Type	
111 Di Tratini	date	i emperature (°C)	Ramp	Hold	Gas Flow	(N or A)	Read
Chromium (Continued)	4	2650	0	4	80	A .	
	5	2600	2	0	300	A	
Copper	-	170	10	30	300	A	
	5	800	1	30	300	A	
	0	20	-	S	300	A	
	4	2500	0	50	0	A	
	0	2630	+	10	300	A	
Iron		120	-	50	300	A	
	cu	1400	-	30	300	A	
	Ø	20		15	300	A	
	4	2400	0	2	20	A	
	s	2600		u)	300	A	
Lead	1	150	10	40	300	¥	
	2	900	5	30	300	Ą	

TABLE 38 (CONT'D)

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TABLE 3B GRAPHITE FURNACE ATOMIC ABSORPTION PERKIN-ELMER 5100 TEMPERATURE PROGRAM' PAGE 3

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Element	Cton	Furnace	Time	Time (sec)	Internal	Gas Type	
	And A	(n_) empadenar	Ramp	Hold	Gas Flow	(N or A)	Read
Lead (Continued)	0	20	****	9	300	4	
	4	1600	0	4	0	4	
	ιņ	2500		3	300	0	
Selenium		170	10	30	300	V	
	ę.	600	un	20	300	4	
	g	20	-	w)	300	<	
	4	2100	0	P.	C		
	3/3	2800	-	4.0	000	¢ •	
Silver		120	-	30	000	K .	
	61	800	-	30	2006	< <	
	(1)	20	+	Q.	300	4	
	4	2100	0	10	0	4	
	u)	2600	-	10	300	<	
Thallum	4.4	150	2.2	00		c .	

TABLE 3B (CONT'D)



TABLE 38 GRAPHITE FURNACE ATOMIC ABSORPTION PERKIN-ELMER 5100 TEMPERATURE PROGRAM

		-	
	-490		b:
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TABLE 38 GRAPHITE FURNACE ATOMIC ABSORPTION PERKIN-ELMER 5100 TEMPERATURE PROGRAM' PAGE 5

Element		Furnace	Time	Time (sec)	Internal	Gas Type	
CICLINE	daio	lemperature (°C)	Ramp	Hold	Gas Flow	(N or A)	Read
Thailium (Continued)	2	300	5	10	300	A	
	0	20		3	005	4	
	4	1400	0	5	0	×	
	ŝ	2500	-	4	300	A	
Tin	**	150	10	40	300	A	
	2	1100	15	15	300	A	
	-07	20	-	15	300	A	
	17	2500	0	22	0	A	ŀ
	so.	2500	1	40	300	A	
	9	20	-	50	300	4	

Temperature program may require minute, daily modifications depending upon room temperature, atmospheric conditions, etc.

TABLE 3B (CONT'D)

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Nonfinear

Calibration Type Nonknear Nonlinear Noninear Nonlinear Nonlinear 1000 µL blank, standard, sample plus 100 µL matrix modifier Sample Preparation Matrix Modifier Preparation Weigh 24, 78 g Ni(NO₃)₂ and dilute to 500 mL with delonized H₅O Matrix McOHler 0, 0 025, 0.050, 0.075 0, 0 005, 0 0075, 0.01 (PE 3030) Standard Concentration (mg/L) 0, 0.01, 0.025, 0.04 0.001,0025.004 (PE 5100) 0, 0 01, 0 02, 0 03 (PE 3030) 0, 0 01, 0 02, 0 03 (PE 5100) Element Molybdenum' Selenium Thalium Silver

TABLE 4

PE 2030 model anly.

0, 0,010, 0.025, 0.040

Vanadium'

10

PE 5100 model only 14

TABLE 4 GRAPHITE FURNACE ATOMIC ABSORPTION PERKIN-ELMER 3030 AND 5100 CAUBRATION CONDITONS PAGE 2



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Element	Standard Concentration (mg/L)	Matrix Nodilier	Matrix Modifler Preparation	Sample Preparation	Calibration Type
Molybdenum'	0. 0.025. 0.050. 0.075		Non-Section of the section of the se	and the second se	A function of the second se
Selenum	0, 0.01, 0.025, 0.04	Ni(NO ₃) ₂	Weigh 24.78 g Ni(NO ₃) ₂ and dilute to 500 mi, with delonized H ₂ O	1000 µL blank, standard, sampie plus 100 µL metrix	Nonlinear
Silver	0. 0.005, 0.0075, 0.01 (PE 3030)	4.44			Noninear
	0, 0.01, 0.025, 0.04 (PE 5100)	1	-	Annual	Nonlinear
Thailium	0, 0.01, 0.02, 0.03 (PE 3030)	1	-	Natara A	Noninear
	0, 0.01, 0.025, 0.04 (PE 5100)	-			Nonlinear
tin ^a	0. 0.1, 0.15, 0.20	and a second			
Vanadium'	0, 0.025, 0.05, 0.075			4 - 3 - 4 - 4 - 4 - 4 - 4 - 4 - 4 - 4 -	Nonsnear

TABLE 4 (CONT'D'

PE 3030 model only

PE 5100 model anly. - 94

TABLE 4 GRAPHITE FURNACE ATOMIC ABSORPTION PERKIN-ELMER 3030 AND \$100 CALIBRATION CONDITONS PAGE 2

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TABLE 5

GFAA ANALYSIS SEQUENCE

Run # Sample	

Key

Instrument warmup and stabilization

Initial calibration:	1	CB	CB = calibration blank
	2	S1	S1 = low conc. calibration standard
	3	S2	S2 = middle conc. calibration standard
	4	S3	S3 = high conc. calibration standard
Initial QC checks:	5	ICV	ICV = initial calibration verification
	6	ICB	ICB = initial calibration blank
	7	RLS	RLS = reporting limit standard
Sample analysis:	8 9 10 11 12 13 14 15 16 17	SX SX SX SX SX SX SX SX SX SX	SX = digestate; includes field samples, duplicates, matrix spikes, prep blanks, lab control standards. All field samples, except those run as duplicate/matrix spike, must be single-spiked.
QC checks:	18	CCV	CCV = continuing calibration verification
	19	CCB	CCB = continuing calibration blank

Repeat sample analysis and continuing calibration cycle until all samples are analyzed.

Final QC checks: n = 1 CCV n = 1 ast sequence number in run n = CCB

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FIGURE 1

Routino Cuby 6MA 121 Siavi Tine 219 P381-92 ITTA TEMPERATURE PROCINAM Coment Contranting Instrument P\$5700 (20) TEP TEMP. RAMP HOLD NO CO (SEC) (SEC) V. avelong h25.2.2 nm Standard Reference[]147 92001 176 Matrix Modifier (1997) Background Carrection 2 Matrix Modifier (1997) Background Carrection 2 Modifier Reference (1997) Integration Time (1998) Integration Time (1998) Integration Time (1998) 10 30 15 25 1 5 -lan Contractionation Massi: California Verification; Standard Source 200002 (floct 1998 1975) Standard Source 2000-3 Standard Standard Source 2000-3 Standard St monthe Road SO) Runkile 30106CK Analytical spike prosented by address covered of a este o simple solution to availed to a spike All Stundards and bus proved someters contain 100 all of 4 Blust 2014 1000 - 20 Stage () 1 Spike Com thenk 20 57596 4 76 1 91501 2 001 3 005 004 ILV. Thur the RECORDA PB 1992415502 13 22H16A Radia disath usure Valas

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FIGURE 2

Ca. G. 15502

UCHITSH(T) January DG, 1995 Flame/Graphite furnace

A/19	algues thing	FILM DISECTION	, Line Level 1	6rg			BATCH 35562			
1999/3 221165 221166 221166 221166 225505 227506	ORTG DUP PS ORTG LCSR	0.1895	16-DEC- 16-DEC- 16-DEC- 16-DEC- 06-JAH-	92 18 DEC- 92 18 DEC- 92 18 DEC- 93 DA JAN 93 DA JAN	MI Oute 92 05 JAN 02 1 92 05 JAN 02 1 92 05 JAN 92 1 92 05 JAN 92 1 92 05 JAN 92 1 93 0 JAN 92 1 91 1 1 1	Onwrez Dowrez Onwrez Grai Onw	Actor Actro24 - Actro24 - Actro24 - Actro24 - Actro24 - Actro24 - Actro24 -	Sample OLD ASHFILL ACU ASHFILL MEW ASHFILL NEW ASHFILL Leb Constrot Method Bland	CELL CELL CELL Sample	
					SAMPLE INSTRUC	TIONS				
	Analysia			Scare						
Set.	DATE	Instrument	Art 8.5	11me	Rias Fille			Conversit s		
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FIGURE 3

ID 1CV5/1000X5/100	Seq. No. 000	05 A/S Pos.: 1	Date: 01/06/93
Neplicate 1 Concentration (mg/L))		Time: 22:06	
Seplicate 2 Conceptration (ng/L		Time: 22:00	
Seats to be (net/to)		55: 0.00006	RSD(%): 0.23
10.103	Seq. No.: 00	006 Ann 1997 2	Date: 01/06/93
September 1 Souther tration (merk -1)	0 0004	Time: 22114	
Neplicate 2 Concentration (mg/L):		Time: 21/1-	
Fean Conc (ng/L)		SD: 0.00025	R5U(%): 109.01
15 DL 0.001	Beg. No. 1 00	1007 A.E.S.L. 3	Date: 01/06/93
Seplicate 1 Concentration (ce/b)		Tine: 22.17	
Seplicate 2 Concentration (ma/L 1		Time: 22.17	
Yean Come (mert 1)	0.0009	5D: D.22 28	350(%): 8.93
15 222206 PB	Teg. No.: 0	0008 A/C Pos. 4	Date: 01/06/93
Seplicate 1 Concentration (mg/L)	0.0003	Time S1.01	
Availate 2 Concentration (SR/P		Time: 11 44	
			+ (C+(U)) 28.88
110 131545 100	Sec No. 1		
And a te 1 Concentration stder			
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			263.e W173673

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INDUCTIVELY COUPLED PLASMA-ATOMIC EMISSION SPECTROMETRIC METHOD

1.0 SCOPE AND APPLICATION

Inductively coupled plasma atomic emission spectroscopy (ICP) is used to determine elements, primarily metals, in solution. Groundwaters, surface waters, effluents, leachates, soil/sediment, or waste can be analyzed using ICP following suitable digestion to solubilize the analytes.

This method is used for the simultaneous multielement determination of trace elements in solution. The basis of the method is the measurement of atomic emission by an optical spectroscopic technique.

Table 1 lists analytes and their corresponding wavelengths. Instrument detection limits, as obtained from the periodic detection limit studies, are updated and published in memo form each quarter.

Detailed instrument operating instructions are provided in the manufacturers' operator manuals.

2.0 SUMMARY OF METHOD

Samples are nebulized and the aerosol is transported to the plasma torch for excitation. Characteristic atomic line emission spectra are produced by a radio-frequency inductively coupled plasma (ICP). The spectra are dispersed by a grating spectrometer and the intensities of the lines are monitored by photomultiplier tubes. The photocurrents from the photomultiplier tubes are processed and controlled by a computer system.

A background correction technique compensates for variable background contribution to the determination of trace elements. Background is measured adjacent to analyte lines on samples during analysis. The position selected for the background intensity measurement, on either or both sides of the analytical line, is determined by the complexity of the spectrum adjacent to the analyte line. The chosen position must be free of spectral interference and reflect the

Approvals:

PAL

aboratory Manager Date Laboratory Manager

11/20/92

Quality Assurance Coordinator

Date

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same change in background intensity as occurs at the analyte wavelength measured.

Background correction is not required in cases of line broadening where a background correction measurement actually degrades the analytical result. The possibility of additional interferences and tests for their presence must be recognized so appropriate corrections are made.

3.0 PROCEDURE

- 3.1 Instrument Analysis
 - 3.1.1 Set up the instrument with the operating parameters listed in Figure 1. Allow the instrument to become thermally stable before use.
 - Note: This usually requires at least 30 minutes of operation prior to calibration.
 - 3.1.2 Initiate the appropriate operating configuration of the computer.
 - 3.1.3 Perform the analytical sequence as listed in Table 2. Perform a minimum of two replicate exposures for standardization, QC and sample analyses. Report the average result of the multiple exposures. Flush the system with the calibration blank solution for 30 seconds (minimum) between each sample and standard.
 - 3.1.4 Profile and calibrate the instrument on a blank and three standards according to the manufacturer's recommendations using mixed calibration standard solution(s). Include all target analytes in the initial calibration and subsequent instrument QC checks.

Resloping during the run is acceptable if it is immediately preceded and followed by a CCV and CCB.

3.1.5 When an analyte concentration exceeds 100 mg/L or the concentration of the high standard, whichever is higher, reanalyze for that analyte after appropriate dilution. Use the least dilution necessary to bring the analyte within valid analytical range. Report the highest valid value for each analyte as measured from the analyses.

Prepare sample dilutions with reagent water acidified with 2 mL of (1 + 1) HNO₃ and 10 mL HCl per 100 mL.

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Note: I arge negative sample results indicate a sample may need dilution, raising the reporting limit.

3.2 Calculations

- 3.2.1 Read the metal value in mg/L directly from the instrument printout.
- 3.2.2 For aqueous samples report metal concentrations in mg/L using the following equation:

$$Metal_{Imp/L} = A \times \frac{FV}{IV}$$

- where A = metal in mg/L of sample digestate from calibration curve
 - FV = final volume of dilution (=1 if no dilution)
 - IV = initial volume of sample (=1 if no dilution)
- 3.2.3 For solid samples report metal concentrations as mg/kg, wet or dry weight, using the appropriate equation(s) below:
 - a. Solid samples wet weight:

$$Metal_{(mg/kg wet)} = \frac{A \times V}{W}$$

where:

- A = metal in mg/L of sample digestate from calibration curve
- V = final volume of processed sample in mL
- W = wet weight sample in grams
- b. Solid samples dry weight:

$$Metal_{tmg/kg dry} = Metal_{(mg/kg wet)} \times \frac{100}{\% \text{ solids}}$$

4.0 DATA COLLECTION

Document each ICP run in a bound lab notebook for each set of analyses performed. Entrices must be made at the time of analysis. Following data reduction, complete the worksheet. Example logbook and worksheet entries are shown on Figures 2 and 3, respectively.

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Data collection should include the following:

- brief description of analysis (e.g., ICP Analysis).
- date and time analysis started and analyst(s) signature(s).
- LSG sample number and sample aliquot. Identify any lab quality control samples (method blanks, MS/MSDs, LCSs).
- spikes added, to include the spiking solution identification number and the volume of spike added for post-digestion spikes.

5.0 QUALITY CONTROL

5.1 Instrument Control Checks

5.1.1 Initial Calibration Verification (ICV):

Immediately after instrument calibration, verify and document the accuracy of the initial calibration for every analyte by running an Initial Calibration Verification (ICV) standard at each wavelength used for analysis. This standard is independent of the calibration standards.

When measurements exceed the control limits of 90-110%, terminate analysis, correct the problem, recalibrate the instrument, and reverify the calibration before proceeding with the analysis sequence.

5.1.2 ICP Interference Check Sample (ICS) Analysis

Refer to Table 3. To verify interelement and background correction factors, analyze and report the results for the ICP Interference Check Samples at the beginning and end of each analysis run and every 8 hours of operation, whichever is more frequent.

The Interference Check Samples consist of two solutions: Solution A and Solution AB. Solution A consists of the interferents and Solution AB consists of the analytes mixed with the interferents. An ICS analysis consists of analyzing both solutions consecutively, starting with Solution A, for all wavelengths used for each analyte reported by ICP.

Results for the ICP analyses of Solution AB during the analytical runs must fall within the control limit of $\pm 20\%$ of the true value for the analytes included in the Interference Check Samples.

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If not, terminate the analysis, correct the problem, recalibrate the instrument, and reanalyze the samples since the last good ICS.

5.1.3 Initial Calibration Blank (ICB):

Analyze a calibration blank at each wavelength used for analysis immediately after the ICV.

If the absolute value of the blank result exceeds the reporting limit, terminate analysis, correct the problem, and recalibrate and verify the calibration. Reanalyze all samples and quality control checks analyzed since the last acceptable calibration blank.

5.1.4 High Standard:

Before beginning the sample run, reanalyze the highest mixed calibration standard for each analyte as if it were a sample. Recovery must be 95.0-105%. If recovery exceeds the control limit, terminate analysis, correct the problem, recalibrate and reverify the calibration.

Low Level Standard:

To verify linearity near the reporting limit for ICP analysis, analyze an ICP standard for all metals at two times the reporting limit from Table 1 at the beginning of each sample analysis run. The response for this standard must be discernible from the ICB.

5.1.5 Continuing Calibration Verification (CCV):

To ensure calibration accuracy during each run, analyze a midrange standard for continuing calibration verification. Analyze at a frequency of 10% and report it for every wavelength used for the analysis of each analyte.

If the deviation of the continuing calibration verification is greater than the control limits of 90-110%, terminate analysis, correct the problem, recalibrate the instrument and reverify the calibration. Reanalyze all samples and quality control checks run since the last good calibration verification for the affected analytes.

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5.1.6 Continuing Calibration Blank (CCB):

Analyze a calibration blank at each wavelength used for analysis after each continuing calibration verification standard.

If the absolute value of the blank result exceeds the reporting limit, terminate analysis, correct the problem, and recalibrate and verify the calibration. Reanalyze all samples and quality control checks analyzed since the last acceptable calibration blank.

5.2 Sample Preparation Checks

5.2.1 Preparation Blank (PB) Analysis:

A preparation blank, consisting of reagent water processed through sample preparation, is prepared and analyzed with each batch of up to 20 samples digested at the same time.

Evaluate the preparation blank results as follows:

- a. If the absolute value of the concentration of the blank is less than or equal to the routine reporting limit, no correction of sample results is performed.
- b. If any analyte concentration in the blank is above the routine reporting limit, the lowest concentration of that analyte in the associated samples must be 10x the blank concentration.

Otherwise, all samples associated with the blank with the analyte's concentration less than 10x the blank concentration and above the routine reporting limit, must be redigested and reanalyzed for that analyte (except for an identified aqueous soil field blank). The sample concentration is not to be corrected for the blank value.

- c. If the concentration of the blank is below the negative routine reporting limit, then all samples reported below 10x reporting limit associated with the blank must be redigested and reanalyzed.
- 5.2.2 Laboratory Control Sample (LCS) Analysis:

A laboratory control sample (LCS) is prepared and analyzed for all target analytes for each matrix (water or solid/waste) with each batch of up to 20 samples digested together.

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The aqueous LCS solution must be independent (i.e., from a different lot) from the calibration standards. Prepare and analyze one aqueous LCS for every batch of 20 samples digested at the same time.

Prepare and analyze one solid LCS, using each of the procedures applied to solid samples, for every batch of 20 samples digested at the same time. If an analyte of interest is not present in a reference material, spike the analyte into the LCS.

If the percent recovery for an LCS falls outside the control limits established in the "Quality Control Test File - Metals," redigest and reanalyze the samples associated with that LCS for the analyte(s) in question.

5.2.3 Spike Sample Analysis:

The spike sample analysis provides information about the effect of the sample matrix on the digestion and measurement procedures. Add the spike before digestion prior to the addition of other reagents. Perform at least one spike sample analysis for every batch of 10 samples digested at the same time.

Refer to Table 4 for the analyte spiking levels.

If the spike recovery is not within the limits of 75-125%, qualify the data for that sample as follows:

This sample was analyzed as a matrix spike. Recovery of the spike was outside the established acceptance limits. However, the preparation blank and laboratory control sample were found to be in control, indicating the presence of a matrix interference.

Calculate individual component percent recoveries (%R) as follows:

% Recovery = $\frac{(SSR - SR)}{SA} \times 100$

where SSR = Spiked Sample Result SR = Sample Result SA = Spike Added

Note:

When the sample concentration is less than the reporting limit, use SR = 0 for purposes of calculating % Recovery.

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When the sample concentration exceeds the spike concentration by a factor of four or more, the data is flagged and noted as follows:

Sample concentration greater than four times spike concentration.

5.2.4 Duplicate Sample Analysis:

Prepare and analyze one duplicate sample for every batch of 10 samples digested at the same time.

Use a control limit of $\pm 2 \times IDL$ for results less than five times the IDL. If one result is above 5 x IDL and the other is below, use the $\pm 2 \times IDL$ criteria.

Calculate the relative percent difference (RPD) when both results are $>5 \times IDL$ as follows:

$$RPD = \frac{|S - D|}{(S + D)/2} \times 100$$

where RPD = Relative Percent Difference

S = First Sample Value (original)

D = Second Sample Value (duplicate)

Limits for precision are listed in the "Quality Control Test File - Metals."

For aqueous samples: When precision is unacceptable, reanalyze the duplicate sample. If it remains nonconforming, redigest and reanalyze 25% of the positive results. If reanalysis results do not duplicate original results, redigest and reanalyze all samples and report the reanalysis results.

For soil/sediment samples: Corrective action is not required when the precision on soil samples is outside control limits.

5.3 Instrument Detection Limit (IDL) Determination

Determine instrument detection limits for each instrument used, at least quarterly (every 3 calendar months) for CLP TAL analytes and biennially for non-TAL analytes. The IDLs must meet the reporting limits.



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Determine the Instrument Detection Limits in μ g/L as follows:

- Prepare a standard solution of each analyte in reagent water at a concentration 3-5x the manufacturer's suggested IDL initially, then 3-5x the reporting limit thereafter.
- Perform seven consecutive measurements of the standard on three nonconsecutive days.

Perform each measurement as if it were a separate analytical sample followed by a rinse and/or any other procedure normally performed between analysis of separate samples.

Calculate the standard deviation for each set of seven measurements.

- Average the standard deviation values.
- Calculate the IDL (μ g/L) by multiplying the average SD by 3.

Determine and report IDLs for each wavelength used in the analysis of the samples.

If the instrument is adjusted in anyway that may affect the IDL, redetermine the IDL.

5.4 Interelement Corrections for ICP

Determine ICP interelement correction factors for TAL and non-TAL analytes annually, at a minimum. Determine correction factors for spectral interference due to AI, Ca, Fe, and Mg for all ICP instruments at all wavelengths used for each reported analyte. Report correction factors for spectral interference due to analytes other than AI, Ca, Fe, and Mg if they were applied.

If the instrument was adjusted in anyway that may affect the ICP interelement correction factors, redetermine the factors.

5.5 Linear Range Analysis (LRA)

Analyze a linear range verification check standard quarterly (every 3 calendar months) for each TAL element and biennially for each non-TAL element.

The analytically determined concentration of this standard must be within $\pm 5\%$ of the true value. This concentration is the upper limit of the ICP linear range.

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6.0 INTERFERENCES

- 6.1 Spectral interferences can be categorized as 1) overlap of a spectral line from another element, 2) unresolved overlap of molecular band spectra, 3) background contribution from continuous or recombination phenomena, and 4) background contribution from stray light from the line emission of high concentration elements.
- 6.2 Physical interferences are generally associated with the sample nebulization and transport processes. Change in viscosity and surface tension can cause significant inaccuracies especially in samples which may contain high dissolved solids and/or acid concentrations. A peristaltic pump may lessen these interferences. If these types of interferences are operative, reduce them by sample dilution and/or utilization of standard addition techniques.

High dissolved solids can cause salt buildup at the tip of the nebulizer. This affects aerosol flow rate causing instrumental drift. Wetting the argon prior to nebulization, the use of a up washer, or sample dilution can control this problem. Control of the argon flow by the use of mass flow controllers improves instrument performance.

6.3 Chemical interferences are characterized by molecular compound formation, ionization effects and solute vaporization effects. They can be minimized by careful selection of operating conditions (i.e., incident power, observation position, etc.), buffering the sample, matrix matching and standard addition procedures. These types of interferences can be highly dependent on matrix type and the specific analyte.

7.0 SAFETY PRECAUTIONS

- 7.1 The toxicity or carcinogenicity of each reagent used in this method has not been precisely defined; however, each chemical compound should be treated as a potential health hazard.
- 7.2 Wear a lab coat and safety glasses with side shields at all times while performing this procedure. Wear gloves to avoid skin contact with acids, bases, organic solvents and possible toxicants used as reagents or contained in the samples for analysis.
 - 7.2.1 Should skin or eye contact occur, flush the exposed area(s) with large amounts of water and seek immediate medical attention.
 - 7.2.2 <u>Never</u> pipet materials by mouth. Use a rubber bulb or other approved suction device to transfer materials by pipet.

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- 7.3 Handle and store all reagents in accordance with the precautions listed on the material safety data sheets (MSDS).
 - 7.3.1 Consult the MSDS for each reagent listed in this procedure before use. The MSDS will provide pertinent information on toxicity, safety precautions and storage conditions.
 - 7.3.2 <u>Always</u> consult the label on the reagent bottle for up-to-date information on safety precautions during handling, preferred storage conditions and expiration data.
 - 7.3.3 Label all flasks, vials, etc., with the intended contents prior to filling. Follow established laboratory procedure in completing and affixing labeling information to equipment.
- 7.4 Avoid breathing solvent and standard solution vapors. If overexposure to vapors should occur, seek fresh air and immediate medical attention.
- 7.5 Handle all glass equipment with care.

8.0 APPARATUS AND MATERIALS

- 8.1 Inductively Coupled Plasma-Atomic Emission Spectrometer:
 - 8.1.1 ARL Model 3560 simultaneous computer-controlled inductively coupled plasma - atomic emission spectrometer with background correction.
 - 8.1.2 Radio frequency generator.
- 8.2 Argon gas: welding grade or better.

9.0 REAGENTS

- 9.1 <u>Reagent water</u>: Deionized water passed through a Barnstead Ultrapure Mixed Bed Cartridge or equivalent.
- 9.2 Acids: Ultra-high purity grade or equivalent.
 - 9.2.1 Hydrochloric acid concentrated (s.g. = 1.19).
 - 9.2.2 Hydrochloric acid (1 + 1) Add 500 mL conc. HCI to 400 mL reagent water and dilute to volume with reagent water in a 1-L volumetric flask.
 - 9.2.3 Nitric acid concentrated (s.g. = 1.41).

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- 9.2.4 Nitric acid (1+1) Add 500 mL conc. HNO₃ to 400 mL reagent water and dilute to volume with reagent water in a 1-L volumetric flask.
- 9.3 <u>Stock standards</u>: Purchased commercially and certified by the manufacturer.
- 9.4 <u>Mixed calibration standard solutions</u>: Prepare mixed calibration standard solutions by combining appropriate volumes of the stock solutions in volumetric flasks. Add 2 mL of (1 + 1) HNO₃ and 10 mL of (1 + 1) HCl and dilute to 100 mL with reagent water. Follow LSG Procedure AP-006, Preparation of Inorganic Chemistry Standards.
- 9.5 <u>Calibration blank</u>: Prepare by diluting 2 mL of (1 + 1) HNO₃ and 10 mL of (1 + 1) HCl to 100 mL with reagent water. Prepare a sufficient quantity to flush the system between standards and samples.
- 9.6 <u>Continuing calibration verification (CCV) standard</u>: Prepare by combining compatible elements at a concentration equivalent to the mid-points of their respective calibration curves.
- 9.7 Interference check sample (ICS): Laboratory-prepared or obtained from EPA, if available.

If true values for analytes contained in the ICS are not supplied with the ICS, determine the mean by initially analyzing the ICS at least five times repetitively for the particular analytes. Perform this mean determination during an analytical run where the results for the previously supplied EPA ICS met all recovery specifications. Additionally, use the result of this initial mean determination as the true value for the lifetime of that solution (i.e., until the solution is exhausted).

If the ICP Interference Check Sample is not available commercially, prepare independent ICP Check Samples with interferent and analyte concentrations at the levels specified in Table 3 - Interferent and Analyte Elemental Concentrations Used for ICP Interference Check Sample. Establish the mean value and standard deviation by initially analyzing the Check Samples at least five times repetitively for each parameter on Table 3. Results must fall within the control limit of $\pm 20\%$ of the established mean value. Report the mean and standard deviation in the raw data.

Prepare the initial calibration verification (ICV) in the same acid matrix as the calibration standards and in accordance with the instructions provided by the supplier. This standard is independent of the calibration standards.

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10.0 REFERENCES

- 10.1 "Methods for Chemical Analyses of Water and Wastes," U.S. EPA, Method 200.7, 1979, Revised March 1983.
- 10.2 "Test Methods for Evaluating Solid Waste Physical/Chemical Methods," U.S. EPA SW-846, Method 6010, September 1986.
- 10.3 Documentation Instrument 3560-5571 (2 volumes).
- 10.4 Plasma Vision Software Guide.

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WAVELENGTHS AND REPORTING LIMITS

Element	Wavelength, nm	Reporting Limits $\mu g/L^{(1)}$	
Aluminum	308.220	100	and the set
Antimony	206.840	200	
Arsenic	193.700	100	
Barium	455.400	5	
Beryllium	313.040	5	
Boron	249.770	50	
Cadmium	226.500	5	
Calcium	317.930	100	
Chromium	267.720	10	
Cobalt	228.620	10	
Copper	324.750	10	
Iron	259.940	20	
Lead	220.350	50	
Lithium	670.780	5	
Magnesium	279.080	50	
Manganese	257.610	5	
Molybdenum	202.030	50	
Nickel	231.600	20	
Potassium	766.490	200	
Selenium	203.980	100	
Silicon	251.610	50	
Silver	328.070	10	
Sodium	589.000	100	
Strontium	407.770	10	
Thallium	190.860	100	
Tin	189.990	100	
Titanium	337.280	10	
Tungsten	239.710	100	
Vanadium	292.400	10	





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TABLE 1 (CONT'D)

WAVELENGTHS AND REPORTING LIMITS

Element	Wavelength, nm	Reporting Limits $\mu g/L^{(1)}$	
Zinc	213.860	10	
Zirconium	343.820	10	

 Instrument detection limits (IDLs) are determined periodically and are published in memo form. Reporting limits are ≥ the IDLs.

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ICP ANALYSIS SEQUENCE

	Run No.	Sample	Кеу
Instrument warmu	up and sta	bilization	
Initial calibration:	1	СВ	CB = calibration blank
	2	S1	S1 = low conc. calibration standard
	3	S2	S2 = middle conc. calibration standard
	4	S3	S3 = high conc. calibration standard
Initial QC checks:	5	ICV	ICV = initial calibration verification
	6	ICS A	ICS A = interference check sample analytes only
	7	ICS AB	ICS AB = interference check sample analytes and interferents
	8	ICB	ICB = initial calibration blank
	9	S3	
	10	LLS	LLS = low level standard
Sample analysis:	11	SX1	SX = digestate; includes field samples, duplicates, matrix spikes, prep blanks, lab control standards
	12	SX2	
	13	SX3	
	14	SX4	
	15	SX5	
	16	SX6	
	17	SX7	
	18	SX8	
	19	SX9	
	20	SX10	
Continuing			
QC checks:	21	CCV	CCV = continuing calibration verification
	22	CCB	CCB = continuing calibration blank

Repeat sample analysis and continuing calibration cycle until all samples are analyzed.

Final QC checks:		ICS A ICS AB	
	n-1	and the second	
	n	CCV	n = last sequence number in run

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INTERFERENT AND ANALYTE ELEMENTAL CONCENTRATIONS USED FOR ICP INTERFERENCE CHECK SAMPLE

(mg/L)	Interferents	(mg/L)
1.0	Al	500
0.5		500
0.5		200
1.0		500
0.5		
0.5		
0.5		
0.5		
1.0		
	1.0 0.5 0.5 1.0 0.5 0.5 0.5	1.0 Al 0.5 Ca 0.5 Fe 1.0 Mg 0.5 0.5 0.5 0.5 0.5 1.0 1.0 1.0 0.5 0.5

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Element	Water/Soil (ug/L)
Aluminum	2,000
Antimony	5,000
Arsenic	5,000
Barium	2,000
Beryllium	50
Boron	5,000
Cadmium	50
Calcium	10,000
Chromium	200
Cobalt	500
Copper	250
Iron	1,000
Lead	500
Lithium	200
Magnesium	5,000
Manganese	500
Molybdenum	2,000
Nickel	500
Potassium	5,000
Selenium	5,000
Silicon	5,000
Silver	50
Sodium	10,000
Strontium	2,000
Thallium	10,000
Tin	2,000
Titanium	5,000
Tungsten	5,000
Vanadium	2,000
Zinc	500
Zirconium	5,000

SPIKING LEVELS FOR SPIKE SAMPLE ANALYSIS BY ICP

The levels shown indicate concentrations in the final digestate of the spiked sample (100 mL final volume).

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2 (15)	Nr 27	+-+-
B TIZSA	K (b)	+++
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MERCURY ANALYSIS IN SOIL/SEDIMENT BY MANUAL COLD VAPOR TECHNIQUE

1.0 SCOPE AND APPLICATION

This procedure measures total mercury (organic and inorganic) in soils, sediments, bottom deposits and sludge-type materials. The range of the method is 0.2 to 5 μ g/g. The range may be extended above or below the normal range by increasing or decreasing sample size or through instrument control.

The procedure is written for the Perkin-Elmer and Bacharach/Coleman MAS Mercury Analyzers and utilizes software developed by LSG for data reduction.

2.0 SUMMARY OF METHOD

A weighed portion of the sample is digested with aqua regia, potassium permanganate, and heat. Mercury in the digested sample is then measured by the conventional cold vapor technique.

3.0 PROCEDURE

3.1 Sample Handling and Preservation

- 3.1.1 Because of the extreme sensitivity of the analytical procedure and the omnipresence of mercury, take care to avoid extraneous contamination. Wash glassware carefully.
- 3.1.2 Refrigerate solid samples at 4°C (±2°C) upon receipt until analysis.
- 3.1.3 Analyze the sample without drying.

Approvals: Chuck Unvalle for 10/30/92 Laboratory Manager Date PAL Joanne Simaure

Dea Morin

10/30/95

Quality Assurance Coordinator

Date

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3.2 Calibration and Sample Analysis

- 3.2.1 Prepare the standards, samples, and quality control checks as shown in Table 1. Quality control checks are also described in section 5.0.
 - Initial Calibration: Transfer 0.0, 2.0, 5.0, and 10.0 mL aliquots of a 0.01 µg/mL mercury standard and 2.0, 5.0, and 10.0 mL aliquots of a 0.1 µg/mL mercury standard to a series of 300 mL BOD bottles. Add enough reagent water to each bottle to make a total volume of approximately 10 mL.
 - Continuing Calibration Blanks (CCB): Transfer 10 mL of reagent water to a BOD bottle for each blank.
 - c. Initial Calibration Verification (ICV) Standard: Transfer a known volume of an independent standard containing 0.05 to 1.0 μg Hg to a BOD bottle. Dilute to 10 mL with reagent water.
 - d. Continuing Calibration Verification (CCV) Standards: Transfer a known volume of the 0.1 μg/mL mercury working standard containing 0.05 to 1.0 μg Hg to a BOD bottle for each standard. Dilute to 10 mL with reagent water.
 - e. Laboratory Control Standard (LCS): Weigh a 0.2 g portion of solid reference material, or appropriate aliquot to bring within linear range, to the nearest 0.0001 g and quantitatively transfer it to the bottom of a BOD bottle.
 - f. Each sample: Weigh a representative 0.2 g portion of wet sample to the nearest 0.0001 g and quantitatively transfer it to the bottom of a BOD bottle. (Use a smaller aliquot if a 0.2 g aliquot exceeds the linear range of the analyzer.)
 - g. Duplicate: Weigh a second 0.2 g aliquot of 1 in 10 samples being prepared together and quantitatively transfer it to the bottom of BOD bottle.

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- h. Matrix Spike: Weigh a third 0.2 g aliquot of each sample selected for duplicate analysis and quantitatively transfer it to the bottom of a BOD bottle. Add 2.0 mL of the 0.1 μg/mL mercury working standard to bottle.
- 3.2.2 Add 5 mL of aqua regia to each bottle and swirl. Heat samples for 2 minutes in a water bath maintained at 95°C. Remove the samples from the water bath and cool.
- 3.2.3 Add 50 mL reagent water and 15 mL of KMnO₄ solution to each bottle. Observe the samples for several minutes. If the purple color fades, add additional KMnO₄ solution or dry KMnO₄ reagent. Continue additions until the purple color remains for several minutes.
- 3.2.4 Add 8 mL of potassium persulfate solution and return the bottles to the water bath for 30 minutes. Remove the samples from the water bath and cool.
- 3.2.5 Add 50 mL of reagent water to each bottle.
- 3.2.6 An <u>alternate</u> digestion procedure employing an autoclave may also be used. Weigh a representative 0.2 gram portion of wet sample and place it in the bottom of a BOD bottle. Add 5 mL of concentrated H₂S04₄ and 2 mL of concentrated HNO₃ to the 0.2 g of sample. Add 5 mL of saturated KMnO₄ solution and cover the bottle with a piece of aluminum foil. The sample is autoclaved at 121°C and 15 lbs. for 15 minutes.

Cool, make up to a volume of 100 mL with reagent water, and add 6 mL of sodium chloride-hydroxylamine sulfate solution to reduce the excess permanganate.

3.3 Perkin-Elmer and Bacharach/Coleman MAS50B - Instrument Setup

3.3.1 Mechanical Meter Zero - With the power switch OFF, make sure that the meter pointer indicates exactly 0 microgram (100% T). If it does not, adjust the meter mechanical zero adjust screw with a screwdriver to bring the meter pointer to 0- microgram (100% T).

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- 3.3.2 Although the Analyzer has been adjusted at the factory, it might become necessary to adjust it if any of the following conditions apply:
 - the mercury lamp has been replaced.
 - the optical filter has been replaced (should be performed ONLY by a qualified service engineer or technician).
 - when readings with standard samples constantly deviate more than five percent of full scale in one direction.

Consult the Instrument Manual:

- Calibration at 9.0 µg with a liquid sample, and
- Calibration at 1.0 μg with a liquid sample.
- 3.3.3 Plug the line cord into the power receptacle. Turn the POWER and PUMP switch ON and make sure that the pilot light glows.
- 3.3.4 Let the analyzer warm up at least 15 minutes.
- 3.3.5 Turn the MEMORY switch OFF, the METER switch to %T, and CLOSE the shutter.
- 3.3.6 Turn the 0% T knob to adjust the meter pointer to approximately 0%T.
- 3.3.7 OPEN the shutter. Turn the 100%T knob to adjust the meter pointer to exactly 100%T. Return to 0%T by closing the shutter, and set 0%T exactly using the 0%T knob. Recheck 100%T and adjust if needed. Repeat for 0%T.
 - NOTE: If deviation is noted when opening and closing the shutter, it indicates insufficient warm up time for lamp.
 - If 0%T to 100%T cannot be achieved, Hg lamp may require adjustment or cell windows may require replacement.

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- 3.3.8 Open the shutter. Turn the METER switch to the X5 position. Fine adjust for 100%T with the 100%T knob.
- 3.3.9 Select the MEMORY function desired, ON or OFF. Select the %T scale.

3.4 Sample and Standard Analysis

Perform the following steps for one bottle at a time. Analyze samples in the sequence shown on Table 1.

3.4.1 Under an operating fume hood, add 6 mL of sodium chloridehydroxylamine sulfate solution to each bottle to reduce the excess permanganate.

NOTE: This step may release toxic chlorine gas.

3.4.2 When the solution has decolorized, wait 30 seconds, then add 5 mL of stannous sulfate solution and <u>immediately</u> attach the bottle to the aeration tube.

Stannous chloride volatilizes the mercury. It is, therefore, essential that this step is performed very rapidly.

- 3.4.3 Observe the transmittance reading decrease on the meter to a minimum point.
- 3.4.4 When the reading levels off (at approximately 1 minute), record the reading in the analysis log.
- 3.4.5 Open the by pass valve and continue aeration until transmittance returns to its minimum value.
- 3.4.6 Close the by pass valve, remove the stopper and frit from the bottle and rinse them with reagent water. Continue aeration.

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3.5 Data Reduction

- 3.5.1 Enter mercury standard concentrations and corresponding percent transmittance values into the mercury software program using the Initial Data Entry Option of the Main Menu.
- 3.5.2 After all standard points have been entered save the data using the SAVE DATA TO DISK option.
- 3.5.3 Print the calibration data (standard concentration, absorbance) using the PRINT DATA option.
- 3.5.4 Calculate the correlation coefficient of the calibration curve using the RUN CORRELATION PROGRAM option. The correlation coefficient must be ≥0.995.
- 3.5.5 Calculate sample concentrations in mg/L from the calibration curve using the RUN CORRELATION PROGRAM option. Calculate final results using the following formula:

mg/kg Hg = mg/L Hg (from curve) $\times \frac{0.1 L}{Sample Aliquot (g) Volume} \times \frac{1000 g}{kg}$

3.5.6 Plot the calibration curve using the RUN PLOT PROGRAM option.

4.0 DATA COLLECTION

Document all phases of sample analysis as shown in Figures 1 through 4: standards preparation, run log, standard curve, and worksheet, respectively.

5.0 QUALITY CONTROL

5.1 Instrument Calibration

Calibrate the analyzer each time a set of samples is run using the solutions described in 3.2.1a. If the correlation coefficient is <0.995, the standard curve is invalid. All associated samples must be prepared again with another standard curve.



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5.2 Initial Calibration Verification (ICV)

Immediately after initial calibration, verify the accuracy of the initial calibration by the analysis of an Initial Calibration Verification Solution. This standard is independent of the calibration standards. When measurements exceed the control limits of 80-120%, terminate analysis, correct the problem, reprepare samples, and repeat calibration.

5.3 Continuing Calibration Verification (CCV)

To ensure calibration accuracy during each analysis run, use a standard for continuing calibration verification and analyze at a frequency of 10%. The standard must also be analyzed after the last sample of the run.

If the deviation of the continuing calibration verification is greater than the control limit of 80-120%, stop analysis, correct the problem, reprepare standards and all samples run since the last acceptable calibration verification.

5.4 Initial Calibration Blank (ICB) and Continuing Calibration Blank (CCB)

Analyze a calibration blank immediately after every initial and continuing calibration verification, at a frequency of 10%. Analyze the blank at the beginning of the run and after the last CCV run after the last sample. If the absolute value of the blank result exceeds the reporting limit, repeat the analysis of all samples run in the batch with results \geq reporting limit and <10x the level in the blank.

5.5 Laboratory Control Sample (LCS)

In addition to these quality control requirements, analyze a solid LCS. Prepare and analyze one solid LCS for each batch of up to twenty solid samples digested together.

Recovery limits for the LCS are listed in the Quality Control Test File -Metals. If the results for the solid LCS fall outside the control limits, terminate the analyses, correct the problem, and reanalyze the samples associated with that LCS.

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5.6 Spike Sample Analysis

Add a 2 µg/L spike to one in ten samples at the start of analysis (i.e., prior to the addition of other reagents).

If the spike recovery is not at or within the limits of 75-125%, qualify the data for that sample. An exception to this rule is made in situations where the sample concentration exceeds the spike concentration by a factor of four or more. In such an event, the data shall be reported unflagged even if the percent recovery does not meet the 75-125% recovery criteria.

Percent recovery (%R) is calculated as follows:

Where.

SSR = Spiked Sample Result SR = Sample Result SA = Spike Added

When sample concentration is less than the reporting limit, use SR = 0 for purposes of calculating % Recovery.

5.7 Duplicate Sample Analysis

Analyze one duplicate sample for every ten samples digested together. Calculate the relative percent difference (RPD) as follows:

$$\mathsf{RPD} = \frac{|\mathsf{S} - \mathsf{D}|}{(\mathsf{S} + \mathsf{D})/2} \times 100$$

Where,

RPD = Relative Percent Difference

S = First Sample Value (original)

D = Second Sample Value (duplicate)

Limits for precision are listed in the "Quality Control Test File - Metals." Qualify the associate sample results when precision is unacceptable.

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5.8 Instrument Detection Limit (IDL) Determination

Determine the instrument detection limits for each instrument used at least quarterly (every 3 calendar months), and verify that they meet the reporting limit.

Determine the Instrument Detection Limits by multiplying by 3, the average of the standard deviations obtained in three nonconsecutive days from the analysis of a standard solution (the analyte in reagent water) at a concentration 3x-5x the instrument manufacturer's suggested IDL, with seven consecutive measurements per day.

6.0 INTERFERENCES

The same types of interferences that may occur in water samples are also possible with sediments, i.e., sulfides, high copper, high chlorides, etc. (See LSG Procedure HG-W.)

Samples containing high concentrations of oxidizable organic materials, as evidenced by high chemical oxygen demand values, may not be completely oxidized by this procedure. When this occurs, the recovery of organic mercury will be low. The problem can be eliminated by reducing the weight of the original sample or by increasing the amount of potassium persulfate (and consequently stannous chloride) used in the digestion.

7.0 SAFETY PRECAUTIONS

- 7.1 Wear a lab coat and safety glasses with side shields at all times while performing this procedure. Wear gloves to avoid skin contact with acids, bases, organic solvents and possible toxicants used as reagents or contained in the samples for analysis.
 - 7.1.1 Should skin or eye contact occur, flush the exposed area(s) with large amounts of water and seek immediate medical attention.
 - 7.1.2 <u>Never pipet materials by mouth.</u> Use a rubber bulb or other approved suction device to transfer materials by pipet.



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7.1.3 Avoid breathing solvent and standard solution vapors. If overexposure to vapors should occur, seek fresh air and immediate medical attention.

Because of the toxic nature of mercury vapors, take precautions as necessary to avoid its inhalation.

- 7.2 Handle and store all reagents in accordance with the precautions listed on the material safety data sheets (MSDS).
 - 7.2.1 Consult the MSDS for each reagent listed in this procedure before use. The MSDS will provide pertinent information on toxicity, safety precautions and storage conditions.
 - 7.2.2 <u>Always</u> consult the label on the reagent bottle for up-to-date information on safety precautions during handling, preferred storage conditions and expiration data.
 - 7.2.3 Label all flasks, vials, etc., with the intended contents prior to filling. Follow established laboratory procedure in completing and affixing labeling information to equipment.
- 7.3 Handle all glass equipment with care.

8.0 APPARATUS AND MATERIALS

- 8.1 Perkin-Elmer 50B or Bacharach/Coleman MAS 50B Mercury Analyzer.
- 8.2 Software program for calculation of mercury results.

9.0 REAGENTS

- 9.1 Reagent water: Deionized water.
- 9.2 <u>Aqua regia</u>: Prepare immediately before use by <u>carefully</u> adding three volumes of concentrated HCI to one volume of concentrated HNO₂.
- 9.3 Sulfuric acid (0.5 N): Cilute 14.0 mL of concentrated sulfuric acid to 1 liter.

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- 9.4 <u>Stannous sulfate</u>: Add 25 g stannous sulfate to 250 mL of 0.5 N sulfuric acid. This mixture is a suspension and should be stirred continuously during use. A 10% solution of stannous chloride can be substituted for stannous sulfate.
- 9.5 Sodium chloride-hydroxylamine sulfate solution: Dissolve 12 g of sodium chloride and 12 g of hydroxylamine sulfate in reagent water and dilute to 100 mL. Hydroxylamine hydrochloride may be used in place of hydroxylamine sulfate.
- 9.6 Potassium permanganate, mercury-free, 5% solution (w/v): Dissolve 5 g of potassium permanganate in 100 mL of reagent water.
- 9.7 <u>Mercury stock solution</u>: Dissolve 0.1354 g of mercuric chloride in 75 mL of reagent water. Add 10 mL of concentrated nitric acid and adjust the volume to 100.0 mL (1.0 mL 1.0 mg Hg). Alternatively, stock standard may be purchased.
- 9.8 Mercury working standard: Make successive dilutions of the stock mercury solution to obtain a working standard containing 0.10 μg/mL. This working standard and the dilution of the stock mercury solutions must be prepared fresh daily. Maintain acidity of the working standard at 0.15% nitric acid by adding nitric acid to the volumetric flask, as needed, before adding the aliquot of standard.
- 9.9 <u>Potassium Persulfate, 5% solution, (w/v)</u>: Dissolve 5 g of potassium persulfate in 100 mL of reagent water.

10.0 REFERENCES

- 10.1 US EPA, "Methods for Chemical Analyses of Water and Wastes," Method 245.1, 1979 (revised March, 1983).
- 10.2 US EPA, SW-846, "Test Methods for Evaluating Solid Waste Physical/ Chemical Methods," 1986, Method 7471.

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TABLE 1 ANALYTICAL SEQUENCE

Sequence	Sample, Standard, QC Check	<u>Sequence</u>	Sample, Standard, QC Check
1.	Initial Calibration Blank	25.	SX 11 DUP
2.	0.0005 mg/L Initial	26.	SX 11 MS
	Calibration Standard	27.	SX 12
3.	0.0010 mg/L Initial	28.	SX 13
	Calibration Standard	29.	SX 14
4.	0.0020 mg/L Initial	30.	SX 15
	Calibration Standard	31.	SX 16
5.	0.0050 mg/L Initial		
	Calibration Standard	32.	SX 17
6.	0.0100 mg/L Initial	33.	SX 18
	Calibration Standard	34.	SX 19
7.	Initial Calibration	35.	SX 20
	Verification		
8.	Continuing Calibration		Repeat 9 through 35 until
	Blank (CCB)		all SX aliquoted
9.	Lab Control Standard		
10.	SX 1	n-1	CCV
11.	SX 1 DUP	n	CCB
12.	SX 1 MS		
13.	SX 2		
14.	SX 3		
15.	SX 4		
16.	SX 5		
17.	SX 6		
18.	SX 7		
19.	SX 8		
20.	SX 9		
21.	SX 10		
22.	Continuing Calibration Verification (CCV)		
23.	CCB		
24.	SX 11		

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FIGURE 1 STANDARD PREPARATION LOG

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Standards										
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			- G G B							1.11
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K: SPEX W	IP 15			icatio		By		10/2 J¢D	6/92	, 105
k : SPEX W Concen	IP 15 tration	2: 5.1		icatio		By		10/2 J¢D	6/92	, 105
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FIGURE 2 MERCURY ANALYSIS LOG

TITLE /	M= J	AHGS				PR	OJECT					110
Mercury	in	Spil	hir	CVA	۵		BOOK	NO. PJ	10-92			
Mercury Work conunde	d hom	Page			1.1.1					1	DUPL	ICATE
Instrum	ent :	MAS	50B			I	nitial	Calibo	ation	Vent	icat	ion
Run Star	AT.	me:	103	0	1.1.1			Refei				
Waypler	ig th	1 2	537	nm			Sour	ce:	SPEX	WP		
Filenam	re. 1:	hat	2102	6			Lot	No.:	3-97	AS		
Calibrati					rence :			Value.			IL	
						C		uing C				cat
0.00	OS N	19/1 :	4.	260-	92-18			Refere				
		14:						ce:			Contraction of the local distribution of the	
		9/1:						No. :				
		9/1 :						Value			4	
0.010					92-18	M		Spike				e
Water ba						50		12.01				
					ma 90			ef. 2-				
		Time	13.3	D Te	mp 9:	50 1		ERA		the second s		
	0 11			-	1.0 -					_		
Sample					1. 1a 1			iomon	ents			
ŢŨ	ID	192	(mL)			mgl			-			
Blank	A	1			100.0			1.1.		11		
5-0.0005	B				96.5							6. 1
5-0.0010	C				93.5							
5-0.0020	P				85.0							
5-0.0050	E				68.0							
5-0.0100	F	11			48.0							
Blank	6		100		100.0	10,0002						
TEN	H		5	100	83.0	4.96	97	32R				
ICB /PB	I	0.2000	100		100.0	×0.0002						1
LESR		0.0534			65.5							
214543	K	0.211.3			84.0							
214543 DUP		0.2098			83.0	E. C.						
214543 MS		0.2108			72.0							
214546	W	0.2009			99.0		1	12 12		1 1		1
ccv-1	X		5	100	82.5	5.13	10	12R		1.1		1
CCB-/	Y		100		100.0	10,0000						
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SIGNATURE	ohn	C. 1	Doc							DAJE 0	1261	52
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MERCURY STANDARD CURVE

	Date:	* IT THE REPORT OF A DESIGNATION	
	Analyst:		
Stock Solution - 1000 mg/L Hg	Instrument:		
Manufacturer:	Wavelength:2	53.7 nm	
Lot #:	Digestion: Auto	clave:	
SOLUTION 1 - 10 mg/l Hg	Steam Bath:		
10.0 mL STOCK SOLN plus 5 mL HNO/I Liter	Time On	_ Temp ("C)	
SOLUTION II - 0.1 mg/L Hg	Time	Temp (°C)	
10.0 mL SOLN I plus 5 mL HNO/1 Liter	Time	Temp (°C)	
SOLUTION III - 0.01 mg/L Hg	Time	_ Temp (°C)	
10.0 mL SOLN II plus 0.5 ml. HNOy/100 mL		Temp (°C)	
	Tirne Off	Temp (°C)	

Final Dilution	Final Conc.	Peak Height (T%)	Absorbance
0.0 mL	0.0000 mg/L		
2.0 mL SOLN HI/100 mL	0.002 mg/L		· March 10 Control of
5.0 mL SOLN III/100 mL	0.0005 mg/L		
10.0 mL SOLN UI/100 mL	0.0010 mg/L		
3.0 mL SOLN II/100 mL	0.0030 mg/L		
5.0 mL SOLN 11/100 mL	0.0050 mg/L		
7.0 mL SOLN 11/100 mL	0.0070 mg/L.	The second s	
10.0 mL SOLN 11/100 mL	0.0100 mg/L		
0.0 mL	0.0000 mg/L		

Correlation Coefficient (r)

CALCULATIONS:

Absorbance = $2 - \log(\%T)$

 $mg/L Hg = (Curve Reading) (\frac{100 mL}{Sample Aliquot}) (Dilutions)$

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FIGURE 3 (Continued)

CONCENTRATION ABSORBANCE

4			100.0	-2.175800957218727D-08
		0005	95.5	1,8470740304646770-02
		9010	2.79	2.9188368847956860~02
4	: 0	0020	85.0	7.0581067633069960-02
5	: Ó,	0050	68.0	.1674910920460889
6	: 0	0400	48.0	.2187587507062022

ND.	0	6
MEAN	0.003083	0.100249
MED	0.001500	0,049885
SDEV	0.003826	0.122829

Press space bar to return to menu.

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FIGURE 3 (Continued)

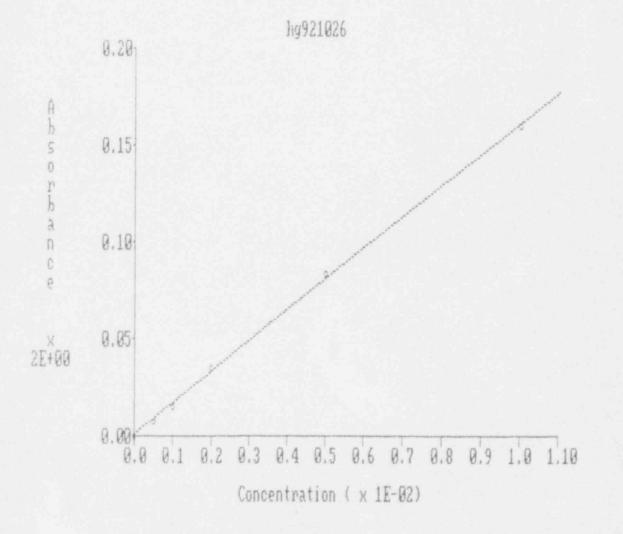
Garren (A. e. 7)			
SAMPL 2		HEDREANCE	20N/201753***GN
81an) ICV IC87FB LC56 214543 214543000F 214543000F 214546 C6V-1 C6F=1	100.0 87.0 100.0 62.5 84.0 87.0 72.0 99.0 82.5 100.0	000000 0.080922 000000 0.183759 0.075721 0.080922 0.142658 0.004365 0.083546 000000	0000758 0.002382 000058 0.005683 0.002320 0.002482 0.002482 0.0004404 0.000058 0.002563 000058





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FIGURE 3 (Continued)



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Analyse:	Mersony, 194	al (Hŋ).				87	VICH 10089				
			Date	Date	Date						
sighte Type	CINE	10	Sampled	Received	licar	2100	ants		Simple D	Pescription	
16543 DUP			21-SEP+97	08-0CT-92			AHGS展。	R	CIN / AS RE	C*D	
14543 (85				08-001-92			ABGSS -		CTW / AS RE		
16543 DR15			-21-SEP-92	08-001-92		0	ANGSR		CIU / AS RE		
14546 0816				08-001-95			AHGSR -		CH / AS REC		
15158 LCSR				20-001-92			AHGS		ab Control		
STSTAR BENK			20-001-92	20-001-92			ANGS		ethod Blank		
				SAM	PLE INSTRUC	TIONS					
214543	LAB TRACKED										
216563	TYPE C										
214546	LAB JRACKED										
214546	1998 C										
						5 S S S					
Arsal ys	115			Start							
tel. Date	1700 F	rument	A11155	T i eve	Run File			Comm	wyst.s		
			30008	1030 h	y921026	. <u>Prin</u> i	t hie : hg	102.6	*****		
			<u> XCO:18</u>	1030 h	y 921020	- <u>Prin</u> i	thie the	102.6			
			<u>20098 - 1</u>	1030 h	y 921021	<u>Prin</u>	the hy	102.6			
			30008	1030 h	y921021	- Prin	t hie : hg	102.6			
1 <u>10/26</u> 2 2 2 2 2			30008	1030 h	у 9.2.10.2.6 Носьк	e Prins Rage		102.6	HSR I Rec	<u>1v/sa</u>	Review
1 <u>10/26</u> 2 2 2 2 2	192 MA	5 508	esuit		Rook		tanar 1			<u>1v/sa</u>	Peview
1 <u>10/26</u> 2 5 3 orpie lare	192 MA	5 50 Å	esuit	<u>18914</u>	Rook	kane	tanar 1	120	HSP I Rec	1¥/5A 0.949	
1 <u>IO/26</u> 2 5 5 monte type riasas our	192 MA	5.50 <i>8</i> Ge	Result 1.18	<u>18914</u>	Rook	kane	tanar 1	120	HSP I Rec		
1 <u>10/246</u> 2 3 4 5 4 4 5 5 4 5 5 5 5 5 5 5 5 5 5 5 5	192 MA	5.908 	sesuls 1,18 2,09	<u>18914</u>	Rook	kane	tanar 1	120	HSP I Rec		
1 <u>10/26</u> 2 3 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5	192 MA	5.908 	8esuit 1.18 2.09 1.1	<u>18914</u>	Rook	kane	tanar 1	120	<u>нія I яес</u> 104	*****	

ADVANCE CHANGE NOTICE (ACN) TO LSG STANDARD OPERATING PROCEDURE

ACN Number: HG-S-0-A

Effective Date: 12/04/92

Applicability:

Page 2, Section 3.2.1.a Page 3, Section 3.2.4

Page 11, Section 9.9

Rationale:

Section 3.2.1.a - Corrects error in standard concentrations.

Section 3.2.4 - Addition of potassium persulfate is necessary to thoroughly break down the organics. Potassium persulfate also drives off chlorine, which also absorbs at 253.7 nm.

Section 9.9 - Instructions for potassium persulfate preparation added in conjunction with its use in Section 3.2.4.

Approvals:

Vaboratory Manager Date

PAL

Taxa 11 Jan

1/25/92

Quality Assurance Coordinator

Date

Method: CLP-CN Revision No: 0 Effective Date: 05/01/93 Page: 1 of 19

TOTAL CYANIDE USING CONTRACT LABORATORY PROGRAM (CLP) METHODS

1.0 SCOPE AND APPLICATION

This method is applicable to the determination of cyanide in drinking, surface and saline waters, domestic and industrial wastes, and in sediments and other solids using USEPA Contract Laboratory (CLP) protocol.

The manual colorimetric procedure is sensitive to approximately 0.01 mg/L. The detection limit for solid samples is dependent on the weight of sample taken for analysis.

2.0 SUMMARY OF METHOD

The cyanide as hydrocyanic acid (HCN) is released from cyanide complexes by means of a reflux-distillation operation and absorbed in a scrubber containing sodium hydroxide solution. The cyanide ion in the absorbing solution is then determined colorimetrically.

In the colorimetric measurement, the cyanide is converted to cyanogen chloride, CNCI, by reaction with chloramine-T at a pH less than 8. After the reaction is complete, color is formed on the addition of pyridine-barbituric acid reagent. The absorbance is read at 578 nm. To obtain colors of comparable intensity, it is essential to have the same salt content in both the sample and the standards.

3.0 PROCEDURE

3.1 SAMPLE HANDLING AND PRESERVATION

- 3.1.1 Oxidizing agents such as chlorine decompose most of the cyanides. Ascorbic acid must be added to samples containing residual chlorine at sampling to eliminate this interferant.
- 3.1.2 Water samples are preserved with 2 mL of 10 N sodium hydroxide per liter of sample (to pH >12) at the time of

Approvals:

Laboratory Manager Date

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4/22/93

Quality Assurance Manager

Method: CLP-CN Revision No: 0 Effective Date: 05/01/93 Page: 2 of 19

collection.

- 3.1.3 Water and solid samples are stored at 4°C prior to analysis.
- 3.1.4 Solid samples are not dried prior to analysis. A separate percent solids determination must be made.
- 3.1.5 Samples must be analyzed within 12 days of receipt.

3.2 STANDARDIZATION OF SOLUTIONS

- 3.2.1 Prepare the standard cyanide solutions I & II, standard silver nitrate solution and chloride standard solution as directed in Section 9.0.
- 3.2.2 Determine the normality of the standard silver nitrate solution, after preparation, as follows:
 - Attach the glass and silver-silver chloride electrodes to a mV meter with an expanded scale.
 - Pipet 10.0 mL of 0.01 N chloride standard (KCI) into a 250-mL beaker and dilute to 100 mL with reagent water.
 - c. Add 2.0 mL concentrated HNO, and a small stir bar.
 - d. Immerse the electrodes <u>slowly</u> and record the initial mV reading.
 - Note: Maintain an even stirring rate. Avoid large air bubbles under the electrodes by adjusting the stir rate or re-immersing the electrodes.
 - e. Add 0.01 N AgNO₃ titrant in small increments using a buret. Record the mV readout after each increment. See Figure 1 for a titration example.

Note: Avoid stopping the titration too early or too few points will be available to draw the line beyond the end-point.

- f. Plot mV vs. mL AgNO₃ to determine the endpoint of the titration. The end-point is the mid-point of the straight line connecting the two parallel lines as indicated in Figure 2.
- g. Repeat Section 3.2.2 step:, b e until the AgNO₃ titration results agree within 1 mL and the mV readings within ±2 units.

Method: CLP-CN Revision No: 0 Effective Date: 05/01/93 Page: 3 of 19

 Calculate the normality (N) of the AgNO₃ standard using the following equation:

 $N = \frac{0.01 \ N \ KCl \ x \ 10 \ mL \ KCl}{mL \ AgNO_3 \ at \ endpoint}$

- 3.2.3 Standardize the potassium cyanide stock monthly as follows:
 - Transfer 50 mL of 250 mg/L KCN stock to a 250-mL Erlenmeyer flask and dilute to 100 mL with 0.04 N NaOH.
 - b. Add 0.5 mL rhodamine indicator.
 - c. Titrate with standard AgNO₃ to the first color change from yellow to salmon pink using a 25-mL buret. Record the buret reading.
 - Repeat Section 3.2.3 steps a c until the titration results agree within 0.5 mL.
 - e. Titrate a blank of 0.04 N NaOH.
 - f. Calculate the cyanide concentration of the KCN stock solution using the following equation:

$$\frac{mg/L \ CN}{50 \ mL \ KCN \ stock} = \frac{(A - B) \ x \ N \ AgNO, \ x \ 0.052 \ x \ 10^6}{50 \ mL \ KCN \ stock}$$

Where: $A = mL AgNO_3$ needed to titrate standard $B = mL AgNO_3$ needed to titrate blank $N AgNO_3 =$ result calculated in Section 3.2.2 step h.

g. Calculate the proper aliquot of KCN stock required to prepare a liter of 2.5 mg/L CN as follows:

 $X = \frac{2.5 \text{ mg/L CN x 1000 mL}}{\text{mg/L CN stock conc.}}$

Where: mg/L CN stock conc. = result calculated in Section 3.2.3 step f.

- 3.3 SAMPLE PREPARATION
 - Note: Test all water samples for sulfide and chlorine interference and pretreat as necessary.

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3.3.1 Test and pretreat for sulfide as follows:

 Moisten a strip of lead acetate test paper with acetic acid (1:9, v/v). Place a drop of sample on the test paper and check for darkening to indicate the presence of sulfide.

If sulfide is absent, proceed directly with Section 3.3.2; if sulfide is present, continue with Section 3.3.1 step b.

- b. Aliquot 25 mL more sample than required for cyanide analysis.
- c. Add a small amount of powdered cadmium carbonate to the sample. Yellow cadmium sulfide will precipitate.
- d. Repeat the lead acetate paper test.
- Repeat the cadmium carbonate addition as necessary until retesting is negative for sulfides.
 - Note: Avoid a large excess of cadmium carbonate and a long contact time in order to minimize a loss by complexation or occlusion of cyanide on the precipitate.
- f. Filter the solution through dry #41 filter paper into a dry beaker. Use the treated sample for analysis.
- 3.3.2 Test and pretreat for chlorine as follows:
 - a. Moisten a strip of potassium iodide-starch test paper with acetic acid (1:9, v/v). Place a drop of fresh sample (i.e., sample not pretreated for sulfide) on the paper and check for bluish darkening to indicate chlorine.

If chlorine is absent, proceed with Section 3.4; if chlorine is present, continue with Section 3.3.2 step b.

- b. Add 0.1 g of sodium arsenite per liter of sample.
- c. Repeat the potassium iodide-starch paper test.
- d. Repeat the sodium arsenite addition as necessary until retesting is negative for chlorine.
- e. Use a suitable aliquot from the pretreated sample for the distillation described in Section 3.4.

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3.4 DISTILLATION

Note: Refer to Figure 3 to assemble the distillation apparatus. Refer to Figure 4 for the distillation/analytical sequence.

3.4.1 Initial Calibration

Distill the following 4 calibration standards and a blank each day that samples are distilled.

- 10.0 mL of 0.5 mg/L CN solution = 5.0 µg CN/250 mL
- 5.0 mL of 5 mg/L CN solution = $25.0 \ \mu g \ CN/250 \ mL$
- 10.0 mL of 5 mg/L CN solution = 50.0 µg CN/250 mL
- 20.0 mL of 5 mg/L CN solution = 100.0 µg CN/250 mL

Prepare a standard curve by plotting absorbance vs. μ g CN/250 mL.

- 3.4.2 Aliquot samples.
 - Water Samples: Place 500 mL of sample in the 1 liter boiling flask.
 - b. Soil Samples: Weigh a representative 5 g portion of wet sample and quantitatively transfer it to a boiling flask. Record the sample weight to the nearest 0.01 g. Add 500 mL of reagent water. Shake or stir the sample so that it is dispersed.
- 3.4.3 Add 50 mL of 1.25 N sodium hydroxide to the absorbing tube and dilute if necessary with reagent water to obtain an adequate depth of liquid in the absorber.
- 3.4.4 Connect the boiling flask, condenser, absorber and trap in the train.
- 3.4.5 Start a slow stream of air entering the boiling flask by adjusting the vacuum source. Adjust the vacuum so that approximately one bubble of air per second enters the boiling flask through the air inlet tube.
 - Note: The bubble rate does not remain constant after the reagents have been added and while heat is being applied to the flask. It is necessary to readjust the air rate occasionally to prevent the solution in the boiling flask from backing up into the air inlet tube.
- 3.4.6 Slowly add 25 mL concentrated sulfuric acid through the air

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inlet tube.

- 3.4.7 Rinse the tube with reagent water and allow the airflow to mix the flask contents for 3 minutes.
- 3.4.8 Pour 20 mL of magnesium chloride solution into the air inlet and wash down with a stream of water.
- 3.4.9 Heat the solution to boiling, taking care to prevent the solution from backing up into and overflowing from the air inlet tube. Reflux for one hour.
- 3.4.10 Turn off heat and continue the airflow for at least 15 minutes.
- 3.4.11 After cooling the boiling flask, disconnect absorber and close off the vacuum source.
- 3.4.12 Quantitatively transfer the solution form the absorber into a 250-mL graduated cylinder and bring up to volume with reagent water washings from the absorber tube.
- 3.5 COLORIMETRIC DETERMINATION
 - 3.5.1 Withdraw 5.0 mL or less of the solution from the flatk and transfer to a 100-mL graduated cylinder. If less than 50 mL is taken, dilute to 50 mL with 0.25 N sodium hydroxide solution.
 - 3.5.2 Add 15.0 mL of sodium phosphate solution and mix.
 - 3.5.3 Add 2 mL of chloramine-T and mix.
 - 3.5.4 After 1 to 2 minutes, add 5 mL of pyridine-barbituric acid solution and mix. Dilute to mark with reagent water and mix again.
 - 3.5.5 Allow 15 minutes for color development, then read absorbance at 578 nm using a 1 cm cell.

3.6 CALCULATIONS

3.6.1 Waters

Calculate the cyanide, in μ g/L, in the original sample as follows:

 $CN_{\mu\mu\nu} = \frac{A}{m} \times \frac{250}{B} \times \frac{50}{C}$

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Where: A = net absorbance (absorbance - calibration blank) m = slope of best-fit line (abs. vs. μ g/250 mL) 250 = maximum volume for distillation (mL) B = sample aliquot for distillation (mL) 50 = maximum volume of distillate analyzed (mL)

C = volume used for colorimetric analysis (mL)

The minimum value that can be substituted for A is 5 μ g per 250 mL. That yields a minimum detectable concentration of 10 μ g/L in the distilled sample.

3.6.2 Soils

Calculate the cyanide, in mg/kg, in the original sample as follows:

$$CN_{(mg/kg)} = \frac{A \times 50}{M \times \% \text{ solids/100}}$$

Where: A = absorbance

 $m = \text{slope of best-fit line (abs. vs. <math>\mu g/250 \text{ mL})$ 50 = maximum volume of distillate analyzed (mL)C = volume used for colorimetric analysis (mL)

W = wet weight of original sample (g)

The minimum value that can be substituted for A is 5 μ g per 250 mL. That yields a minimum detectable concentration of 0.5 mg/kg in the distilled sample.

4.0 DATA COLLECTION

Document sample analysis in a bound lab notebook for each set of distillations and measurements performed. Entries must be made at the time of distillation and measurement. An example data logbook entry is shown in Figure 5.

Data collection for samples should include the following:

- brief description of analytical method (e.g., CLP CN).
- date and time distillation started and completed, and analyst(s) signature(s) and employee number(s).
- date and time colorimetric measurement started and completed, and analyst(s) signature(s) and employee number(s).
- LSG sample number and aliquot. Identify any lab quality control samples (method blanks, matrix spike/duplicater 'ab control standards).

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- sample descriptions before distillation and after distillation.
- Iot #s, gram weights, and date prepared for all reagents and standards.
- spikes added, to include the spiking solution identification number and the volume of spike added.
- absorbance values for each sample.
- final results.

5.0 QUALITY CONTROL

5.1 CALIBRATION

Prepare an initial calibration consisting of 4 standards and a blank with each day that samples are distilled. The correlation coefficient (r) of the best fit line must be ≥ 0.995 . If it is not, repeat the distillation of the standards and associated samples.

5.2 CALIBRATION BLANKS

Prepare and analyze an undistilled color blank (i.e., 50 mL of 0.25 N NaOH in a 100-mL graduate) with each set of up to 10 samples. Use the result in absorbance units to calculate net absorbance.

5.3 METHOD BLANKS

Prepare and analyze a distilled method blank (i.e., 250 mL of reagent water) with each batch of samples distilled. If more than 20 samples are included in a batch, prepare an additional method blank.

Note: In such cases, both blanks will be applicable to all samples in the batch for the purpose of quality control evaluation.

If acceptance criteria are not met, the samples associated with the nonconforming blank must be redistilled.

5.4 LABORATORY CONTROL STANDARDS (LCS)

Prepare an aqueous LCS, an independently traceable standard distilled with the samples, at the start and end of the run and for every batch of up to 20 samples. Recolor the aqueous LCS once after 10 samples have been run or at the end of the run (see Figures 4A and 4B). In addition, run the solid reference material for each batch of up to 20 solid samples for total cyanide (see Figure 4B).

The aqueous LCS must pass the CLP criteria of 85-115%. If an

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aqueous LCS fails, redistill and reanalyze all associated samples in the batch.

The soil LCS must pass the material manufacturer's acceptance limits. If a soil LCS fails, redistill and reanalyze all associated samples in the batch.

6.0 INTERFERENCES

- 6.1 Interferences are eliminated or reduced by using the distillation procedure described in Procedure 3.4.
- 6.2 Sulfides adversely affect the colorimetric procedures. Samples are tested for the presence of sulfides and are treated with cadmium carbonate if sulfide is present.
- 6.3 Chlorine adversely affects the colorimetric procedures. Samples are tested for the presence of cholrine and are treated with sodium arsenite if chlorine is present.

7.0 SAFETY PRECAUTIONS

- 7.1 Cyanide is <u>acutely toxic</u> by dermal, inhalation or oral routes of entry. Use requisite safety equipment to avoid contact during sample processing and disposal.
 - 7.1.1 Wear a lab coat and safety glasses with side shields at all times while performing this procedure. Wear gloves to avoid skin contact with acids, bases, organic solvents and possible toxicants used as reagents or contained in the samples for analysis.
 - Should skin or eye contact occur, flush the exposed area(s) with large amounts of water and seek immediate medical attention.
 - 7.1.2 <u>Never</u> pipet materials by mouth. Use a rubber bulb or other approved suction device to transfer materials by pipet.
 - 7.1.3 Manipulate highly concentrated standard or samples during acidification in a closed system or under an operating fume hood.
- 7.2 Dispose of cyanide-containing samples and reagents according to established laboratory waste disposal guidelines.
- 7.3 Handle and store all reagents in accordance with the precautions listed on the material safety data sheets (MSDS).

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- 7.3.1 Consult the MSDS for each reagent listed in this procedure before use. The MSDS will provide pertinent information on toxicity, safety precautions and storage conditions.
- 7.3.2 <u>Always</u> consult the label on the reagent bottle for up-to-date information on safety precautions during handling, preferred storage conditions and expiration data.
- 7.3.3 Label all flasks, vials, etc., wit the intended contents prior to filling. Follow established laboratory procedure in completing and affixing labeling information to equipment.
- 7.4 Avoid breathing solvent and standard solution vapors.

If overexposure to vapors should occur, seek fresh air and immediate medical attention.

7.5 Handle all glass equipment with care.

8.0 APPARATUS

- 8.1 mV meter: Accumet 925, or equivalent.
 - 8.1.1 Glass chloride electrode.
 - 8.1.2 Platinum chloride electrode.
- 8.2 Magnetic stirring plate.
 - 8.2.1 Small stirring bars.
- 8.3 Distillation apparatus: Refer to Figure 5 for assembly information.
 - 8.3.1 Round-bottom flask: 1000-mL with T/s joint.
 - 8.3.2 Condenser: Allihn water-cooled condenser.
 - 8.3.3 Air inlet tube: Tube with T/s joint.
 - 8.3.4 Adaptors.
 - 8.3.5 Gas washer: Fisher-Milligan spiral-type washer.
 - 8.3.6 Extension tubes.
 - 8.3.7 Rubber tubing.
- 8.4 Graduated cylinders: 250- and 100-mL stoppered, glass cylinders.

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- 8.5 Heaters: Mantle-type.
- 8.6 <u>Timer</u>: Accurate to 1 minute.
- 8.7 Buret: 25-mL glass buret.
- 8.8 Flasks: 500-mL Erlenmyer flasks; volumteric flasks, various sizes.
- 8.9 <u>Spectrophotometer</u>: Use at 578 nm and provide a light path of 50 mm or longer.

9.0 REAGENTS

- 9.1 Reagent water: deionized water from in-house line.
- 9.2 Nitric acid: concentrated.
- 9.3 <u>Chloride standard solution (0.01 N)</u>: Dissolve 0.7456 g of KCI (NIST grade dried at 105°C for 1 hour and stored desicated) in reagent water and dilute to volume in a 1-L volumetric flask. Mix thoroughly.
- 9.4 Distillation and Preparation Reagents
 - 9.4.1 Sodium hydroxide solution, 1.25N: Dissolve 50 g of NaOH in reagent water, and dilute to 1 liter with reagent water.
 - 9.4.2 Cadmium carbonate: powdered
 - 9.4.3 Ascorbic acid: crystals
 - 9.4.4 Sulfuric acid: concentrated
 - 9.4.5 Magnesium chloride solution: Weigh 510 g of MgCl₂·6H₂O into a 1000 mL flask. Dissolve and dilute to 1 liter with reagent water.
- 9.5 Stock Standards and Titration Reagents
 - 9.5.1 Stock cyanide solution: Dissolve 0.6258 g of KCN in 40 mL of NaOH and 500 mL of reagent water in a 1-L volumetric flask. Dilute to volume with reagent water and mix thoroughly. Standardize with 0.01 N AgNO₃.
 - 9.5.2 Standard cyanide solution I (5 mg/L CN): Dilute 10.0 mL of stock (1 mL - 1 mg CN) to 1000 mL with reagent water using a volumetric flask. Prepare fresh daily.
 - 9.5.3 Standard cyanide solution II (0.5 mg/L CN): Dilute 50.0 mL of

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solution II to 1000 mL with reagent water using a volumetric flask. Prepare fresh daily.

- 9.5.4 Standard cyanide spiking solution: Dilute 5.0 mL of stock to 500 mL with 0.04 N NaOH using a volumetric flask. This must be independently traceable from the standard cyanide calibration verification solution.
- 9.5.5 Standard cyanide calibration verification solution: Dilute 5.0 mL of stock to 500 mL with 0.04 N NaOH using a volumetric flask. This must be independently traceable from the standard cyanide spiking solution.
- 9.5.6 Standard silver nitrate solution, 0.0192 N: Prepare by crushing approximately 5 g AgNO₃ crystals and drying to constant weight at 40°C. Weight out 3.2647 g of dried AgNO₃, dissolve in distilled water, and dilute to 1000 mL (1 mL = 1 mg CN).
- 9.5.7 Rhodanine indicator: Dissolved 20 mg of p-dimethylaminobenzal-rhodanine in 100 mL of acetone.
- 9.5.8 Sodium hydroxide solution, 0.25 N: Dissolve 10 g of NaOH in reagent water and dilute to 1 liter.
- 9.6 Colorimetric Determination Reagents
 - 9.6.1 Sodium dihydrogenphosphate, 1 M: Dissolved 138 g of NaH₂PO₄·H₂O in a liter of reagent water. Refrigerate this solution.
 - 9.6.2 Chloramine-T solution: Dissolved 1.0 g of white, water soluble chloramine-T in 100 mL of reagent water and refrigerate until ready to use. Prepare fresh weekly.
 - 9.6.3 Pyridine-barbituric acid reagent: Place 15 g of barbituric acid in a 250 mL volumetric flash and add just enough reagent water to wash the sides of the flask and wet the barbituric acid. Add 75 mL of pyridine and mix. Add 15 mL of HCl (sp gr 1.19), mix, and cool to room temperature. Dilute to 250 mL with reagent water and mix. This reagent is stable for approximately six months if stored in a cool, dark place.

12.0 REFERENCES

USEPA Contract Laboratory Program Statement of Work for Inorganic Analyses, Multi-Media, Multi-Concentration, Document Number ILM02.0, including ILM02.1 (9/91) revision, Method 335.2 CLP-M.

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FIGURE 1

STANDARDIZATION OF A9NO3 POTENTIOMETRIC TITRATION

Standard KCI Solution (0.01 N) 0.7455g NBS Grade KCI/1000 ml Lot # KCI_____

- 14

Standard AgNO3 Solution (0.01 N) 1.698g/1000 ml

Manufacturer/Lot # AgNO3

Titrate 10.0 mL of 0.01N KCI with 0.01N AgNO3. Measure the potential of the KCI solution at the intervals specified below.

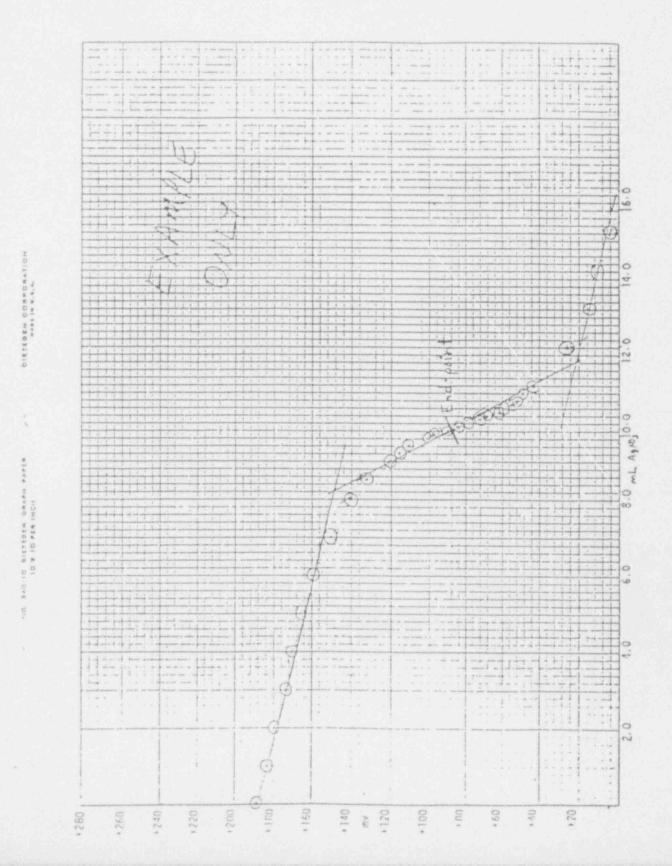
mt AgNOn		Instrument
0.0		
0.0	and the second	And the second sec
1.0	the first bullet of the second the spin of	
2.0	and the second descent in the second second second second second	
3.0	and which are appreciately and an an an and a state of the state of the	
4.0		
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Analyst

Date

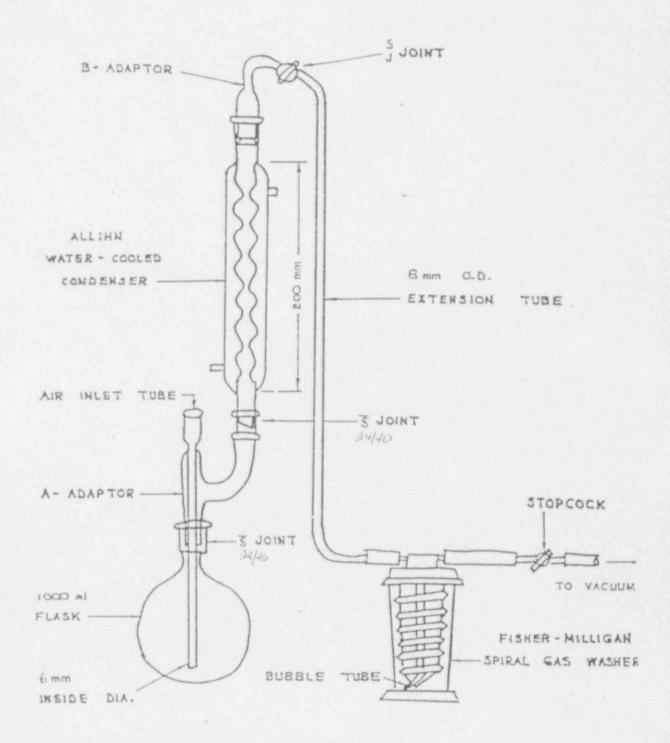
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FIGURE 2



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FIGURE 3 CYANIDE DISTILLATION APPARATUS



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to

FIGURE 4A

Analytical Sequence - Water Matrices

1.	Calibration Blank
2.	Calibration Standard 5 µg/250 mL
3.	Calibration Standard 25 µg/250 mL
4.	Calibration Standard 50 μ g/250 mL
5.	Calibration Standard 100 μ g/250 mL
6.	Aqueous Laboratory Control Standard
7.	Method Blank 1
8.	
9.	Sample 1
	Sample 1 - duplicate {Required at a frequency of 1/20
10.	Sample 1 - matrix spike water samples/SDG}
11.	Sample 2
12.	Sample 3
13.	Sample 4
14.	Sample 5
15.	Sample 6
16.	Sample 7
17.	Sample 8
18.	Sample 9
19.	Sample 10
20.	Laboratory Control Standard 1 (recolored)
21.	Calibration Blank
22.	Sample 11
23.	Sample 12
24.	Sample 13
25.	Sample 14
26.	Sample 15
27.	Sample 16
28.	
29.	Sample 17
30.	Sample 18
	Sample 19
31.	Sample 20
33.	Laboratory Control Standard 2
34.	Calibration Blank
35.	Method Blank 2
	Repeat analytical sequence starting with #8 as necessary
	analyze all samples
n-1.	Laboratory Control Standard
n.	Calibration Blank

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FIGURE 4B

Distillation Analytical Sequence - Soil/Sediment Matrices

1. Calibration Blank 2. Calibration Standard 5 µg/250 mL 3. Calibration Standard 25 µg/250 mL 4. Calibration Standard 50 µg/250 mL 5. Calibration Standard 100 µg/250 mL 6. Aqueous Laboratory Control Standard (Calibration Verification) 7. Calibration Blank 8. Method Blank 1 9. Soil Laboratory Control Standard 1 10. Sample 1 11. Sample 1 - duplicate {Required at a frequency of 1/20 12. Sample 1 - matrix spike water samples/SDG} 13. Sample 2 14. Sample 3 15. Sample 4 16. Sample 5 17. Sample 6 18. Sample 7 19. Sample 8 20. Sample 9 21. Sample 10 22. Aqueous Laboratory Control Standard (recolored) 23. Calibration Blank 24. Sample 11 25. Sample 12 26. Sample 13 27. Sample 14 28. Sample 15 29. Sample 16 30. Sample 17 31. Sample 18 32. Sample 19 33. Sample 20 34. Aqueous Laboratory Control Standard 35. Calibration Blank 36. Method Blank 2 37. Soil Laboratory Control Standard 2 Repeat analytical sequence starting with #8 as necessary to analyze all samples n-1. Aqueous Laboratory Control Standard Calibration Blank 0.

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FIGURE 5

Date Analyzed 22-523-43 Time 1440 Analyst M. Roberts Date Prepped 16-553-43 Time 1100 Analyst M. Robertz Spec # 21-1 1cm curve date 22-53-43 Corr. Coeff. Comments						Entered M Plotted M on back M						
Sample	Code	ID	Dist Alig	Color Aliq	Abs	Net Abs	Curve µg/250ml	Curve	Result	%Solid	Dry Wt mg/kg	Date & Time
Caliber	CC VI	14 2,590	2021	35,1	2641	-263	52.75	344	2440	and a second second second second	10 CB. Bre	2-19-93
Color Hant	CE83				.001							
Parcagy	LAN WAR	OFOL	250,1	V	.023	.02.2	4.25	17	17			2-19-93
Paséans	TXXXXX.	a carrier of the second second second second second		10.1	. 235	.234	47.0	18.8	940			2-19-53
Paalant	XXHXXX	OF 03 Dy Tu		80.1	.03	. 172	34.5	38	140			2-19-93
Pa16277	150005	0F04		1	.107	.106	21.00	84	84			2-19-43
P221,278	XXXXXX	0F 65		10.1	.255	.254	51.0	204	1000			2-19-13
226379		OPOG			.1.56	-255	51.0	204	1000			2-17-93
0863554	ANDREAM	OF07		50_1	1.00	-046	3.0	(2	12			2-19-93
PazezBi	XXXXXX	0 F 0 8			037	.03.6	7.0	28	28			2-19-93
276293	KAX MAX	0501			015	.os4	4.5	18	18			2.19.13
226283	XXXXXX	1502	V		.00.77	.ook	1.0	Ч	10.			2-19-93
Color Black	CCB4				- 1901							
$\zeta_{n}(\cdot,V_{M})$	wa		20,5	V	275	.269	54	216	1100		108 Ths	

Certified by Michael J. U. A		Date 2-17-53
Approved by amen & Millin	Date 2 23 73	Continued on page 3

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FIGURE 5 (CONT.)

Standards:

Stock - 9,6258 g KCN (Febre Lot 12/632) + 40ml 1N NaOH diluted to 1000ml with DI H2O. Made main 13 Solution 1 - 10ml Stock (Sales Lot 73432) + 1.8ml 10N NaOH diluted to 500ml with DI HzO. Made 2-19-53 Solution 2 - 50ml Solution (Faker Lot 731432) + 1.8ml 10N NaOH diluted to 500ml with DI HzO. Made 2-19-93 Spike - 5ml Stock (Fisher Lotasies) dikited to 500ml with 0.04N NaOH. Made 2-19-93 Cal-Ver - 5ml Stock (Well. Lot orm) diluted to 500 nl with 0.04N NaOH, Made 201.92 Reagents: Magnesium Chloride -- 510g MgCl2 (Mall. Lot King) diluted to 980ml with DI H2O. Made _____3 1H2SO4 -- 1000ml H2SO4 (Mall_ Lot x362) diluted to 2000ml with DI H2O. Made a-17-93 Color Reagents: Sodium Phosphate Buffer -- 138g Sodium Phosphate (Mult. Lot Kick)

diluted to 1000ml with DI H2O. Made 2-12-53

Chloramine T -- 1g Chloramine T (FSM, Lot 1-242) diluted to 100ml with DI HzO. Made 3-32-55

Pyridine Barbituric Acid - 60g Barbituric Acid (Fisher Lot 91214) + 60ml conc. HCl + 300ml Pyridine (Bartines Lot Barbiturics Lot 1000ml with DI H2O. Made 20195

000001 B

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Sar	nple Descriptic	n
Sample	Before	After
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8126272		
1224273	V	

BP CHEMICALS, INC. - POND CLOSURE PROJECT

GC/MS PROCEDURE OUTLINE FOR MATRIX SPECIFIC DETECTION LIMIT STUDY (VOAs) METHOD REFERENCE: SW 8240

- 1. Tune GC/MS system to meet BFB criteria (good for 12 hours).
- Calibrate GC/MS system for low level soil VOAs (Routine HALLIBURTON NUS SW-846 Method 8240)

- 5 point initial calibration (meet CCC and SPCC criteria)

10

- -- 1 point continuing calibration (meet CCC and SPCC criteria)
- Analyze a VOA lab blank ("organic-free" sea sand) to demonstrate a "clean" system.
 - Common lab contaminants are allowed at <u><3x</u> lab reporting limit under HALLIBURTON NUS' QA/QC Plan.
- Analyze two separate portions of BP Lima "blank matrix material". (If results of each analysis differ, run a third portion for comparison)
 - Generate chromatograms and quan reports for each analysis.
- 5. Perform three replicate analyses of spiked BP Lima "blank matrix material.
 - -- Spike each replicate at ~3x the estimated MDL with full analyte (8240) spike. (Use previous detection limit study data for MDL values.) This will consist of our standard mixture inclur.
 - Add acetonitrile to the spiked samples prior to analysis.
 - Generate chromatograms and quan reports for each replicate analysis.
 - -- Generate mass spectra for BP Lima target VOAs from one analysis.
 - -- Calculate MDLs for BP Lima analytes according to BP's instructions.
- 6. Perform another set of three replicate analyses spiked at ~5x the estimated MDLs

Generate data in same manner as 5.

BP CHEMICALS, INC. - POND CLOSURE PROJECT GC/MS PROCEDURE OUTLINE FOR MATRIX SPECIFIC DETECTION LIMIT STUDY (VOAs) METHOD REFERENCE: SW 8240 PAGE TWO

- 7. Summarize the two sets of MDL data for each BP Lima VOA analyte only.
- 8. Provide BP Research with a set of chromatograms for review as well as quan reports.

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SOIL MATRIX MDL STUDY FOR SELENIUM METHOD REFERENCE: SW 7740

Background: For metals analysis, routine detection limit studies are done on aqueous standards. Since 1.0 gram of solid sample is added to 100 ml of water, the factor to convert to mg/kg is 100x. The detection limits for aqueous samples is 0.004 mg/l, thus the detection limit (theoretical) for solid samples is 0.4 mg/kg.

Reporting limit and detection limit synonymous for metals analysis. The instrument detection limit is used only for CLP analysis. This is a conservative approach, since the reporting limit is higher than the instrument detection limit.

Sample Preparation:

- 1. Prepare two 1.0 g aliquots of the blank soil matrix material in order to determine background concentration of Selenium. Final volume 100 mL.
- 2. Prepare three 1.0 g aliquots of the soil matrix material spiked at 0.01 mg/L of Selenium. Final volume 100 mL.
- Prepare three 1.0 g aliquots of the soil matrix material spiked at 0.02 mg/L of Selenium. final volume 100 mL.
- 4. Acid digest all sample aliquots (2 blank soil matrix aliquots, 3 aliquots spiked at 0.01 mg/L Se, and 2 aliquots at 0.02 mg/L Se) according to SW 846 Method 3050. A Method Preparation Blank (PB) and a Laboratory Control Sample (LCS) are also to be prepared and acid digested for Selenium according to Method SW 3050.

Sample Analysis

- Analyze Method Preparation Blank and Laboratory Control Sample for Selenium. Internal HALLIBURTON NUS LSG acceptance criteria are to be applied to the PB and LCS.
- 2. Analyze the two blank soil matrix aliquots. A post-digestion, analytical spike must be performed on each blank matrix aliquot. The analytical spike concentration is to be 0.025 mg/L. Recovery of the spike must be within the range 85%-115%. If analytical spike recovery is not within this range, dilute until matrix interference has been eliminated and spike recovery falls within the 85%-115% range. The dilution factor must be kept at a minimum.

BP CHEMICALS, INC. - POND CLOSURE PROJECT SOIL MATRIX MDL STUDY FOR SELENIUM METHOD REFERENCE: SW 7740 PAGE TWO

Analyze the six spiked aliquots. An analytical spike is NOT required for the preacid-digestion spiked aliquots. NOTE: If a dilution was required on the blank soil matrix material due to matrix interference, the same dilution factor must be applied to the spiked sample aliquots. If this results in spike concentrations below the routine reporting limit for Selenium, samples must be redigested with an increased spike concentration in order to compensate for the dilution.

During analysis of actual project samples, the dilution, as required on the blank soil matrix samples, will be performed on ALL ANALYTICAL SAMPLES.

- Quality Control Check Standards (ICV, ICB, CCV, CCB, DL Standard, etc.) and calibration curve acceptance criteria must be applied and evaluated as required in the HALLIBURTON NUS LSG QA/QC Plan.
- 5. All documentation must be performed in a duplicate page notebook.
- Frequency: This procedure is to be repeated for each matrix type encountered at the BP Lima site. Additional aliquots of soil matrix material representative of each additional matrix type will be provided by BP Lima.

BP CHEMICALS, INC. - POND CLOSURE PROJECT

SOIL MATRIX MDL STUDY FOR CYANIDE METHOD REFERENCE SW 9010

Background: Detection limit studies for this method are routinely done in an aqueous matrix. The detection limit for aqueous samples is 0.01 mg/l. Thus, the theoretical detection limit for soil samples is 0.5 mg/kg

 $(0.01 mg/l \times \frac{250 ml \text{ total sample volume}}{5 gram aliquot of sample} = 0.5 mg/kg)$

Sample Preparation:

- 1. Prepare two 5.0 g aliquots of the blank soil matrix material in order to determine background concentration of cyanide. Final volume: 250 ml.
- 2. Prepare three 5.0 g aliquots of the blank soil matrix material spiked at 1.5 mg/kg of cyanide. Final volume: 250 ml.
- 3. Prepare three 5.0 g aliquots of the blank soil matrix material spiked at 2.5 mg/kg of cyanide. Final volume: 250 ml.

Sample Analysis

- 1. Analysis will be performed using SW 9010, which is the method HALLIBURTON NUS utilizes for CLP protocol.
- 2. Prior to analysis of the blank soil matrix material, a 4 point calibration curve will be run. The RSD of the curve must not exceed 7.5%.
- 3. Documentation should be done in a duplicate page notebook, since BP Research will be provided with the raw data.

BP CHEMICALS, INC. - POND CLOSURE PROJECT

GC/MS PROCEDURE OUTLINE FOR MATRIX SPECIFIC DETECTION LIMIT STUDY (SEMIVOLATILES) METHOD REFERENCE: SW 8270

- 1. Tune GC/MS system to meet DFPP criteria (good for 12 hours).
- 2. Calibrate GC/MS system for low level soil semivolatile base neutral compounds (Routine HALLIBURTON NUS SW-846 Method 8270)

- 5 point initial calibration (meet CCC and SPCC criteria)

or

- 1 point continuing calibration (meet CCC and SPCC criteria)
- 3. Analyze a semivolatile extraction lab blank ("organic-free" sand) to demonstrate a "clean" sample prep and a clean system.
- Extract and analyze two separate portions of BP Lima "blank matrix material". (If results of each analysis differ, run a third portion for comparison)
 - Generate chromatograms and guan reports for each analysis.
- 5. Perform three replicate analyses of spiked BP Lima "blank matrix material.
 - Spike each replicate at ~3x the estimated MDL with pyridine and methyl naphthalene (8270) spike. (Use previous detection limit study data for MDL values.)
 - Generate chromatograms and guan reports for each replicate analysis.
 - -- Generate mass spectra for BP Lima target semivolatiles from one analysis.
 - -- Calculate MDLs for BP Lima analytes according to SW 846, December 1987.
- 6. Perform another set of three replicate analyses spiked at ~5x the estimated MDLs.
 - -- Generate data in same manner as 5.

BP CHEMICALS, INC. - POND CLOSURE PROJECT GC/MS PROCEDURE OUTLINE FOR MATRIX SPECIFIC DETECTION LIMIT STUDY (SEMIVOLATILES) METHOD REFERENCE: SW 8270 PAGE TWO

- 7. Summarize the two sets of MDL data for each BP Lima semivolatile analyte only.
- 8. Provide BP Research with a set of chromatograms for review as well as quan reports. Include the mass spectra for target analytes.

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GUIDELINES FOR SCREENING AND SAFE HANDLING OF RADIOACTIVE SAMPLES

The NUS Laboratory Radiation Safety Officer has established the guidelines in this procedure to ensure safe handling of samples containing radioactivity above background. A screening procedure to assist in the assessment of radiation levels is also described.

1.0 ASSESSMENT OF ACTIVITY

The Radiation Safety Officer or his/her designee, the Radiochemistry Group Leader, determines the appropriate handling procedures for samples identified as radioactive materials during sample receipt as follows.

- 1.1 Review documentation received with the samples and, based on the information in Table B-1, categorize the sample as category A, B, or C. Handle the sample in accordance with the generic guidelines defined in sections 2 4 below.
- 1.2 If the documentation is not adequate to categorize the sample, determine the activity level using the following procedure:

1.2.1 Soils

a. Mix the sample thoroughly.

- b. Transfer 0.1 grams of sample to a 2-inch planchet.
- c. Dry thoroughly under a heat lamp. Distribute the material evenly on the planchet.
- d. Using the counting system designated for alpha and beta screening, count the sample for at least 10 minutes.
- e. Transfer the sample to the gamma screening system and count the sample for at least ten minutes.

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f. Calculate the sample activity using the equation:

Activity $(pCi/g) = \frac{Counts}{time (min) \times mass (g) \times 2.22 \times Eff.}$

- g. Categorize and handle the sample in accordance the generic guidelines defined for the category.
- 1.3 Verify the activity of the samples from clients that may potentially ship radioactive samples by sampling and screening one of every twenty samples from each batch of samples using the procedure in section 1.2.
- 1.4 Record all screening data in the radioactive materials receipt log.

2.0 TYPE C SAMPLE HANDLING PRECAUTIONS

- Analysts must be familiar with RS-1.0 and 2.0.
- Smoking, eating, drinking and use of cosmetics are not permitted in any laboratory where radioactive materials are being stored or handled.
- Pipetting by mouth is not permitted.
- Laboratory coats must be worn.
- Protective gloves are recommended. Gloves are required if there are any cuts or wounds on the hands.
- Safety glasses must be worn.
- · Spills or wounds must be reported to the RSO or his designee.
- · Hands should be kept away from the face.
- Hands must be washed and surveyed upon completion of work or leaving the laboratory.

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- The use of a protective covering (absorbent paper) on the lab bench is recommended.
- The immediate work area and lab coats must be surveyed with a meter or smears upon completion of work.
- The sample may be disposed in the sanitary sewer system or as routine trash.
- Glassware is to be rinsed with dilute nitric acid and then washed as routine, soiled glassware.

3.0 TYPE B SAMPLE HANDLING PRECAUTIONS

- All type C precautions must be observed unless a more restrictive precaution is listed below.
- Personnel dosimetry is required.
- Samples must be stored in a restricted area equipped with appropriate caution signs.
- All work with the complete sample should be conducted in Radiochemistry II. If work with the complete sample must be conducted in other laboratories, special precautions may be required, at the discretion of the RSO.
- Extended work area must be surveyed for contamination with meter or smears.
- Air sampling may be required (at the discretion of RSO) in areas involving dusty processing of samples.
- * Analyst must have received radiation safety training or be directly supervised by the RSO or his designee. Training must include the material of procedures RS-1.0, 2.0, 4.0, 5.0, 7.0, and 11.0.

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- Residue from samples and contaminated waste must be collected and returned to Radiochemistry II. The RSO or his designee will determine the appropriate disposition.
- Bioassays may be required if ingestion or inhalation of radioactive materials is suspected.

4.0 TYPE A SAMPLE HANDLING PRECAUTIONS

- All Type C and Type B precautions must be observed unless a more restrictive precaution is listed below.
- The RSO must be consulted prior to the initiation of work.
- Daily surveillance w.... an appropriate meter is required if the storage or work area is designated "High Radiation Area."
- All work must be planned to minimize exposures. This may require shielding, limiting of work time in an area, use of tongs for sample handling, etc. This is to be determined by the RSO or his designee.
- All equipment must be surveyed after completion of work or prior to release from the work area unless transferred to Radiochemistry II.
- All sample fractions and contaminated wastes must be collected and returned to Radiochemistry II for appropriate disposition.
- All glassware and contaminated equipment must be returned to Radiochemistry II for decontamination.
- Documentation must be maintained for sample radiation and activity levels, and work area radiation levels.

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TABLE C-1

LIMITS FOR RADIOACTIVE SAMPLE TYPES A, B, AND C

TYPE A SAMPLES

Sample External Alpha Exposure Rate (X) (1 ft.):

X > 10 mR/hr.

Sample Activity (A):

Alpha: $A \ge 1$ uCi Beta: $A \ge 100$ uCi Low Energy Beta (e.g. C-14, Ni-63, P-32, S-35): $A \ge 10$ mCi

Neutron Dose Equivalent (DE): .

DE > 10 mrem/hr.

TYPE B SAMPLES

Sample External Alpha Exposure Rate (X) (1 ft.):

 $1 \text{ mR/hr} < X \leq 10 \text{ mR/hr}$

Sample Activity (A):

Alpha: 1 nCi < A < 1 uCi Beta: 100 nCi < A < 100 uCi Low Energy Beta (e.g. C-14, Ni-63, P-32, S-35): 10 uCi < A 10 mCi

Neutron Dose Equivalent (DE):

3 x background < DE < 10 mrem/hr



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TABLE C-1

LIMITS FOR RADIOACTIVE SAMPLE TYPES A, B, AND C

(Continued)

TYPE C SAMPLES

Sample External Alpha Exposure Rai (1 ft.):

background $< X \le 1 \text{ mR/hr}$

Sample Activity (A):

Alpha: Background < A \leq 1 nCi: Beta: Background < A \leq 100 nCi Low Energy Beta (e.g. C-14, Ni-63, P-32, S-35): Background < A \leq 10 uCi

- Neutron Dose Equivalent (DE): background < DE < 3 x background
- Activity Concentration up to the limits of 10 CFR 30, Schedule A, exempt concentrations.

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PREVENTIVE MAINTENANCE REQUIREMENTS

INSTRUMENT INDEX

Atomic Absorption/Emission Instruments

Cold Vapor AA Units (Mercury Analysis) Graphite Furnace AA Spectrometers Inductively Coupled Plasma Spectrometers

Balances

Chromatographs

Gas Chromatograph/Mass Spectrometers

Electrodes - General Information

General Care General Calibration Checks Trouble-Shooting

Electrodes - Specific Instruments

pH Electrodes

Heating Units

Incubators Muffle Furnaces Ovens

Hoods



Exhaust Hoods Fume Hoods

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Meters, pi-i/mV

Purge and Trap Units

Radiochemistry Equipment

Gamma Spectrometers Survey Meters

Reagent Water Systems

Recorders

Refrigeration Units

Coolers Freezers





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CRITICAL SPARE PARTS

ATOMIC ABSORPTION/EMISSION INSTRUMENTS

Atomic Absorption Spectrometers

Cold Vapor

- 1) absorption cell with windows and gaskets
- 2) window and gasket replacement kit
- 3) mercury lamp
- 4) aeration and connecting (silastic) tubing
- 5) scrubber kit
- 6) pump
- 7) diaphragm replacement kit (includes gasket and 2 valves)
- 8) photo detector tube

Graphite Furnace

- 1) contact cylinders
- 2) windows
- 3) injector tips
- 4) o-rings
- 5) graphite tubes
- 6) platforms
- 7) gaskets
- 8) EDL and deuterium lamps
- 9) capillary tubing for autosamplers

Inductively Coupled Plasma Spectrometers

- 1) nebulizer hoses
- 2) torch assembly
- 3) mercury lamps
- 4) o-rings
- 5) nebulizer tips
- 6) sample injector
- 7) bonnets (PE units only)

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CRITICAL SPARE PARTS (continued)

Inductively Coupled Plasma Spectrometers (Continued)

- 8) slit chimney (PE units only)
- 9) spray chamber
- 10) purge extension tube (PE units only)
- 11) high solids nebulizer (PE units only)
- 12) chimney (PE units only)
- 13) capillary tubing for autosamplers

CHROMATOGRAPHS

Gas Chromatograph/Mass Spectrometers

- 1) back-up mechanical vacuum pump
- 2) copper gaskets
- glass jet separators for VOAs
- 4) capillary and packed columns
- 5) septa, syringes and ferrurels
- 6) 1/16 to 1/4 inch fittings (Swagelock)
- appropriate o-rings
- turbo molecular pumps
- 9) magnetic tapes
- 10) voltometer; electronic trouble-shooting tools
- 11) Tekmar purge and trap component, heated transfer line and multipart valve

DEIONIZED WATER SYSTEM

- 1) carton of solids filters
- 2) spare cells (i.e., electrodes which monitors resistivity)
- 3) recycle pump

ELECTRODES

Spare ammonia sensing, pH and fluoride electrodes

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CRITICAL SPARE PARTS (continued)

METERS

Spare meter units

RADIOCHEMISTRY EQUIPMENT

Gamma Spectrometers: Liquid nitrogen monitored power supply

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ATOMIC ABSORPTION/EMISSION INSTRUMENTS

Equipment	Frequency	Preventative Maintenance Requirements
Cold Vapor AA (Mercury Analysis)	Daily (Analyst)	Calculate the characteristic mass measurement after running an appropriate standard. If there is over a 20% change in the mass measurement or reproducibility degrades, trouble-shoot the system.
	Semi-annual or as required (Instrument	Clean or, if necessary, replace the sample tube and windows. Replace o-rings.
	Specialist)	Clean pump by flushing with deionized water. Replace pump if background noise becomes very high.
		Inspect and replace tubing as required.
	Annually (Instrument Specialist)	Clean printed circuit boards and switches. Replace any that are worn or damaged.
		Check power supply voltages.
Graphite Furnace AA	Daily (Analyst)	Inspect graphite tube and contact cylinders of furnace units for water and deposits. Clean according to manufacturer's recommendations or replace as necessary. Clean windows according to instrument manufacturer's recommendations.
Furnace AA	Daily (Analyst)	Calculate the characteristic mass Graphite measurement for furnace units and the characteristic concentration measurement for flame units utilizing the appropriate standard for each element to be analyzed on that day. If there is over a 20% change from the constant value in either measurement, or if reproducibility degrades, trouble-shoot the system (e.g., check system set up, prepare fresh standards, inspect and clean nebulizer if necessary, check auto sampler capillary, and replace hollow cathode, electrodeless discharge and/or deuterium arc lamps).
Furnace AA (Continued)	Annually (Instrument Specialist)	Clean spectrometer optics. Visually inspect printed circuit boards throughout the system. Clean and repair as necessary.



ATOMIC ABSORPTION/EMISSION INSTRUMENTS (CONTINUED)

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Equipment	Frequency	Preventative Maintenance Requirements
Inductively Coupled Plasma of Spectrometers	Daily (Analyst)	Evaluate the sensitivity and reproducibility of one or more elements recommended by the instrument manufacturer during standardization. When one or both characteristics degrade, trouble-shoot the system (e.g., check system set-up; prepare fresh working standards from stock solution; and inspect the sample introduction assembly-torch, injector tube, spray chamber, nebulizer, pump tubing and sample tip for wear or deposits. Clean and replace components as necessary).
		Perkin-Elmer ICP: Using an internal standard consisting of an element not likely to be found in the samples, evaluate the relative response factor throughout the analytical run. If, according to manufacturer's recommendations, the factor indicates that sensitivity has degraded, trouble-shoot the system. Most likely an increase in the relative response factor indicates clogging of the nebulizer. To clean, disassemble the nebulizer; and with the baffle removed, place in an ultrasonic bath to remove residue. After reassembly, adjust the nebulizer to deliver a fine, smooth spray.
ICP		Release the clamp on the peristaltic pump tubing at the end of the day.
Inductively Coupled Plasma Spectrometers (Continued)		Inspect autosampler and tubing for solids buildup, cracking or wear. Clean or replace components as required.
	Weekly (Analyst)	Remove torch and replace with clean spare. Clean used torch and inspect it for wear. Put it aside for next scheduled cleaning. Check torch alignment by running appropriate internal checks. A sensitivity check should be performed after replacement of the torch.
	Biweekly (Analyst)	Change peristattic pump tubing. If necessary, adjust pump pressure to deliver a constant and even sample flow.
		Leeman ICPs: Clean nebulizer assembly.



ATOMIC ABSORPTION/EMISSION INSTRUMENTS (CONTINUED)

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Equipment	Frequency	Preventative Maintenance Requirements
Inductively Coupled Plasma Spectrometers (Continued)	Semi-annually (Analyst)	Clean and oil roller assembly of peristaltic pump (Leeman units). Oil only if needed on Perkin-Elmer instruments.









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BALANCES

Equipment	Frequency	Preventative Maintenance Requirements
Balances	Daily (Analyst)	Verify balance calibration.
		For analytical balances (those that read to 0.0001 gm), each check weight should read within its true weight ± 0.0005 gm.
		For less sensitive balances, each check weight should read within its true weight ± 2 in the right-most digit read by the balance.
		Carefully clean the balance pan, the balance, and the area around the balance after each use.
	Annually (Outside Vendor)	Clean and calibrate balances.

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CHROMATOGRAPHS

Equipment	Frequency	Preventative Maintenance Requirements
Gas Chromatograph/Mass Spectrometers	Daily (Analyst)	Run Decatluorotriphenyl Phosphine (DFTPP) or Bromofluorobenzene (BFB) to verify mass spectrometer sensitivity and tuning.
		Evaluate the sensitivity and reproducibility of the system during standardization. When one or both characteristics degrade, trouble-shoot the system.
	Quarterly (Analyst)	Clean and change all air filters.
		Change the mechanical pump oil.
		Clean and change if necessary the fan screens.
	Following Source or Rod Cleaning (Analyst)	Run Perfluorotributylamina (FC-43) to verify resolution and mass range calibration after cleaning the source or rods.
	Semi-Annually (Instrument Specialist)	Check turbo pump oil levels on INCOS 50 Models.
	Annually (Instrument Specialist)	Inspect and clean the power supply and printed circuit boards.
		Clean and replace if necessary, the water filters on FINN 4500 models.
	Tri-Annually (Analyst)	Change the diffusion pump oil.

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ELECTRODES, GENERAL

Equipment	Frequency	Preventative Maintenance Requirements
All Electrodes	Daily (Analyst)	General Care:
		Handle gently at all times.
		Check filling solutions and storage solutions daily.
		Ensure that all electrodes are properly capped and stored in accordance with manufacturer's instructions. Store solution-tilled electrodes in the appropriate storage solution.
	김 주요가 그 같아?	General Calibration Checks:
		Normal slope for all electrodes is approximately 58 mV \pm 3 mV. If outside range, check electrode.
		Check calibration every two (2) hours, whenever ambient/solution temperature changes by 2°C or more, or after every 20 analyses, whichever is more frequent.
	As needed (Analyst)	Trouble-shooting
		Off-Scale/Over Range Reading
		- Check the following
	이 같은 것은 이것의 영상적	connection to meter filling solution
	상태, 그는 것은 것은 것을 했다.	 inner body/sensor junction
		meter diagnostics
		standard/sample matrix
		Erratic (Noisy) Reading:
		- Check the following:
		 membrane/sensor body junction cone inner body
		 meter



ELECTRODES, GENERAL (CONTINUED)

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Equipment	Frequency	Preventative Maintenance Requirements
	As needed (Analyst) (Continued)	Drifting Reading:
	(Communed)	 Check the following: filling solution (both amount and type) matrix membrane/sensor body/junction cone solution temperature inner body
		Low or No Slope:
		Prepare fresh standards from stock solution, perform checks listed for drift.





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ELECTRODES, SPECIFIC INSTRUMENTS

Equipment	Frequency	Preventative Maintenance Requirements
pH Electrodes	Daily (Analyst)	Check glass sensor bear and guard for damage.
		Ensure that no air bubbles are present in the filling gel. If present, shake electrode downward to remove
		 Clean with one or more of the following: DI water (and cotton swab if needed) Methanol or isopropanol (Never use any other solvent) 0.1 M HCL or HNO₃ 0.1 M Tetrasodium EDTA solution IMPORTANT: When using any cleaning agent other than DI water, restore the electrode function by soaking at least 30 minutes in pH 7 buffer before use or storage.
	8 NA 20 AN	Store the electrode with protective cap over sensor. Ensure that cap is moistened with DI water.

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HOODS

Equipment	Frequency	Preventative Maintenance Requirements
Exhaust Hoods	Quarterly (Instrument	Check drive belts for fans, replace as necessary.
	Specialist)	Lubricate the fans.
	Annually (Instrument Specialist)	Measure the air uptake with the air velocity meter to verify that the air uptake is the same value as that measured when the hood was first installed (i.e., brand new). Record the value in the maintenance log as cubic feet per minute.
Specialist)	Quarterly (Instrument Specialist)	Inspect fan drive belt, replace as necessary.
		Lubricate the fans.
	Annually (instrument Specialist)	Measure the air uptake to verify that it is 100 cubic feet per minute. Record the value obtained.

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METERS, mV/pH

Equipment	Frequency	Preventative Maintenance Requirements
mV/pH Meters	Semi-Annually (Instrument Specialist)	Calibrate the meter against a millivolt standard.
	Annually (Instrument Specialist)	Verify the accuracy of the temperature compensator using a resistance standard for instruments having automatic temperature compensation capability. Verify the operation of manual temperature compensators per manufacturer's instructions.

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PURGE AND TRAP UNITS

Equipment	Frequency	Preventative Maintenance Requirements
Purge and Trap Units	Quarterly	Measure the rate of purge gas flow and adjust if necessary.

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RADIOCHEMISTRY EQUIPMENT

Equipment	Frequency	Preventative Maintenance Requirements
Gamma Spectrometers	Daily (Analyst)	Evaluate system performance. Performance checks should include a background count, count rate checks, and peak resolution check. The count rate and resolution checks should be made, as a minimum, at one high and one low gamma energy. (The preferred gammas are the 0.122 MeV peak of Cobalt-57 and the 1.332 MeV peak of Cobalt-60, as these are the same peaks used for detector specifications.)
	Monthly (Analyst)	Visually inspect signal and high voltage cables and connections.
	Quarterly (Analyst)	Inspect and clean or replace all air filters.
		Check high voltage supplies to determine whether regulator drifts or other factors have caused the high voltage to change.
	Semi-Annually (Analyst)	Thoroughly clean sample chambers to remove any contamination.
		Check time bases for any timers used.
	Annually (Analyst)	Check ADC/MDC linearity, either integral or differentia.
		Establish efficiency calibration curves for each geometry routinely used for each system, using an NBS-traceable mixed radionuclide source.
		Calibration curves should also be established whenever the detector is replaced or undergoes a major repair, and whenever daily performance checks reveal unacceptable performance that cannot be resolved through adjustments or minor repairs of electronic modules.

RADIOCHEMISTRY EQUIPMENT (CONTINUED)

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Equipment	Frequency	Preventative Maintenance Requirements
Survey Meters	Semi-Annually (Outside Vendor)	Calibrate each survey meter and probe combination. The use of a meter with a probe other than the one with which it was calibrated constitutes the use of an uncalibrated meter.
		At a minimum, one calibration count rate meter and one calibrated exposure rate meter will be available at the laboratory at all times. Instruments shipped to the vendor for calibration will be cycled to comply with this requirement.





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REAGENT WATER SYSTEMS

Equipment	Frequency	Preventative Maintenance Requirements
Reagent Water Systems	Daily (Surveillance Monitor)	Record the resistivity reading on the secondary meter which monitors the water recycling through the closed loop to the laboratories and back. The meter should read 12 or greater megaohms. The reading should be recorded in the surveillance log. Any major drop i value should be reported to the instrument specialist.
		Check the primary monitor (Emergency make-up monitor at Houston) to insure that it is set on 70-100 kilo-ohms so as to provide an emergency shut off if water does not meet resistivity standards.
		For reverse osmosis units:
		 Check reverse osmosis pressure. Should be ~120 PSIG if pump is running.
		 Check reverse osmosis flow. Should be ~0.2 gal/min if pump is running.
		- Record reverse osmosis gallons used.
		 Record emergency make-up gallons used.
		- Check salt level in water satener tank.
	Daily (Inorganic Laboratory Analyst)	Analyze the conductivity of the finished water to insure that the conductivity is <2 umhos/cm.
	Monthly (Outside Vendor)	Change the solids filter monthly, at a minimum (Pittsburgh) or whenever a restriction in make-up service water is observed as decreased flow rate and/or pressure (Houston).





REAGENT WATER SYSTEM (CONTINUED)

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Equipment	Frequency	Preventative Maintenance Requirements
Reagent Water Systems (Continued)	As needed (Lab Personnel)	Change over cylinder banks when indicated by alarm. The change-over procedure should be posted on the wall near the system. Record which bank was changed over to which other, the date, and their initials in the system log. After a change-over of cylinder banks is performed, contact he procurement representative, who will, in turn contact the outside service technician to replace the spent banks.
	As needed (Instrument Specialist)	Replace recycle pumps as they become noisy or worn.
	Quarterly (Outside Vendor)	The polishing filters should be replaced quarterly sooner if there were drought or low flow conditions for any length of time.
	Annually (Instrument Specialist)	Clean the cells (i.e., in the electrode which measures resistivity) in the secondary meter. Replace if faulty.
		Check the over and under flow values on the make-up tank to insure that they are operational.





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RECORDERS

Equipment Frequency		Preventative Maintenance Requirements		
Recorder	Semi-Annually (Instrument Specialist)	Calibrate those voltage ranges and chart speeds routinely used.		

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REFRIGERATION UNITS

Equipment	Frequency	Preventative Maintenance Requirements		
Coolers/Freezers	Daily (Surveillance Monitor)	Verify that the operating temperatures are within acceptable limits; record the temperature in the surveillance log.		
	Semi-Annually (Maintenance	Clean inside and outside of unit with detergent. Rinse thoroughly.		
	Personnel)	Defrost freezers.		







APPENDIX A

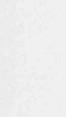
FORMS













Form No. 5-1 BORROW SOURCE CHECKLIST

BORROW SOURCE:		
ESTIMATED VOLUME:	MATERIAL TYPE:	SOURCE NO:
CHECK IF REQUIREMENT SA	TISFIED AND ATTACH COPIES OF	TEST REPORTS)
 No more than 10 percent grav Free of organic matter and del Can be prepared so as to have Within the specified moisture 	inus No. 200 sieve size). ercent and plasticity index greater than el-size particles, with a maximum partici- bris, and not contaminated. a maximum nominal clod size of 2 inc range to allow adequate compaction. > 10 ⁻⁷ cm/sec or less per EPA Mechod	cle size of less than 2 inches.

(ATTACH ALL PERTINENT LAB DATA SHEETS)

DAT	A	REV	TEW	ED	BY	1	
They are the state	1.70	A COMPANY OF					the second second second

DATE:

BORROW SOURCE APPROVED BY:

ENGINEER

_ DATE:____

Form No. 5-2 FILL CONTROL CHECKLIST

LIFT NO:	TOP ELEV:	I	BOTTOM ELEV:	
MATERIAL TYPE:		NO:		
COORDINATES OF AREA:	N		E	
COORDINATES OF AREA	N		E	
	N		E	
	N		E	PAL .
 (CHECK IF REQUIREMENT PLACEMENT No evidence of accidental and Adequate scarification of the Removal of roots, rocks, rocks	SATISFIED PROVI damage to installed p he surface of the pre- ubbish, or off-spec s sistent with samples red to be consistently nore than 2-inches. (ods and uniform dist rater loss and desicca compaction equipm specified soil density tions or holes resulti replaced and undist lifts.	cortions of the under vious lift. oil. used for laboratory / 8-inches. Compacted Clay O tribution of specified tuon cracking befor ent (fill edges, turn y, water content, an ing from density or urbed sections of th	rlayer. tests. nly) d water content. e and after compac around areas, tops id permeability. moisture probes.	ction.
BORROW SOURCE:				
MAX DRY DENSITY	OPT MO	ISTURE:	CURVE	NO:
Number of cubic yards placed	with this curve	(max. of 1,00	X) cy per curve).	
In-Situ Test Density Results (A	attach Test Agency F	leports)		
TEST CO	ORDINATES	DRY DENSITY (PCF)	MOISTURE (%)	PERCENT COMPACTION
DATE PLACED:		CTED BY:		
DATE COMPACTED:		CTED BY:		
DATA REVIEWED & APPR	OVED BY:			

FOLTO NO. 1 -1

Date

Project No.

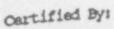
Resin Manufacturer

Quality Control

Material	
Batch No	
Project Manager	
Group Hanager _	and a second

FEQUIRED TEST TEST SPECIFICATIONS RESULTS TEST METHOD ASTM D792 Specific Gravity Hethod A ASTM D1238 Melt Index LOW ASIM D746 Temperature P.coedure B Brittleness





Form No. 2-2

Date

Project No.

Geomembrane Sheet Manufacturer

		the second second	1.5
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Material	
Roll No	
Project Manager _	
Group Manager	annantimationan'i 1977 - ao amin'ny faritr'o dia mampiasa amin'ny faritr'o dia mampiasa amin'ny faritr'o dia ma

TEST	TEST METHOD	TEST RESULIS	SPECIFICATIONS
heet Thickness oros at Yield	ASTM D1593 ASTM D638		
oros at Break	ASTIM D638		
long. at Yield Long. at Break	ASTIM D638 ASTIM D638		
fod. of Elastic.	ASTM D638		
Carbon Black Con.	ASTM D101C/2065 ASTM D1603		-
Dimensional Stab.	ASTM D1204 ASTM D1693		
orvirondental Stress	ASIA DIVIS		

(. Certified By:

1

FORM NO. 16-3

GEDMEMBRANE PANEL PLACENERT

	Date:	
Project Superintendent:	Project No.	
Project Manager:	Project Naz	me:
cmup Manager:		

PANEL	ROLL	SUBGRADE	LENGTH	WIDIH	VISUAL INSPECTION PASS/FAIL	COMENTS
NO	10,	CONDITION	1			
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	12.5					
i		1000				
1000	김 사람이			1		
1-20	1					
1	S - S - S - S					
1	1		1-21-51	1.000	i	NAMES AND TAXABLE PARTY AND DATA STORE

For failures, see Demage and Failure Report.

FORM NO. 26 -4

ON-SITE GELLYOMERANE WELDING REPORT

alder: Welding Machine Used: Wald Type: Project Superintendent: Project Manager:	Dat Pro Pro	e: ject No.: ject Name:	
Group Hanager:		HON-	ON-SITE DEST. PEEL TEST COMMENTS

	ORIGINAL I	AMBIENT	WEATHER COND.	LINER	DEST. TEST PASS/FAIL	PASS/FAIL	
SEAM I.D.		TEMP.					

For failures, see Damage and Pailure Report.

(

FORM NO. 86-5

DAVAGE AND FAILURE REPORT

	Date:	
Project Superintendent:	Project No.:	
Project Manager:	Project Name:	
Group Manager:		

	SEAM	LOCATION OF REPAIR OR	I TYPE OF DAMAGE	INSPECTION DATE	COMPENIS
PANEL NO.	NO.	DAMAGE	LAMAGE 1		
The					
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		and the barrie	1		
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			1.00		

(,

FORM 6-6

IN-SITU WELD TESTING REPORT

TABLE 1

	Date:	
Laboratory Technician:	Project No.:	
Andret Manager:	Project Name:	
Group Manager:		

SAMPLE NO.	TEST	TEST METHOD	
			assadt - *
			•

BP CHEMICALS INC. MIXED WASTE POND CLOSURE PROJECT

GEONET MATERIAL VERIFICATION CHECKLIST

20	AN	19.11	100	×.	100	1911	1.1	13	10	15	
	A N			24				10	PC -	24	3 -
1.0	1.979.4		18.11	6.2		100		4.7	Acres 1	A 7.	

RESIN BATCH NUMBER: _____ PRODUCER: _____

LABORATORY:

TEST DATA (Attach Laboratory Reports)

SPECIFICATION	TEST METHOD	STANDARD	TEST FREQUENCY	RESULT
Meit Index	ASTM-D 1238	1.1g/10min	1/betch	
Density	ASTN - 0 1505	0.93 g/cc	1/batch	
Carbon Black Content	ASTM - 0 1603	2 - 3 %	1/betch	non Realized for Super-
Standard Crush Strength(1)	ASTM - D 1621	7000 ps f	1/10,000 ft ²	
Transmissivity (2)	ASTM - D 4716	10 gpm/ft	1/batch	
Transmissivity (3)		5 gpm/ft	1/batch	

NOTES:

(1) Record minimum value for batch.

- (2) Drainage gradient of 0.02 and 0.25 with 10,000 psf normal load and seating time of 15 minutes with HDPE above and below.
- (3) Drainage gradient of 0.02 and 0.25 with 10,000 psf normal load and seating time of 15 minutes with HDPE below and geotextile and overlying soil above.

BATCH ACCEPTED BY:

Date:

Inspector

APPROVED BY:

Engineer



FORM 7-1

APP'D.

Date:

BP CHMICALS INC. FORM 7-2 MIXED WASTE POND CLOSURE PROJECT

NON-WOVEN GEOTEXTILE MATERIAL VERIFICATION CHECKLIST

MANUFACTURE	R:		
RESIN BATCH	NUMBER:	PRODUCER:	
LABORATORY:			APP'D

TEST DATA (Attach Laboratory Reports)

SPECIFICATION	TEST METHOD	STANDARD	TEST FREQUENCY	RESULT
Wass per unit areas	ASTM- D 3776	B oz/yd2	1/1,000 ft ²	
Permembility	ASTM - D 4491	1.9 sec ⁻¹	1/10,000 ft ²	
Puncture (min)	ASTM - D 3787	100 lbs	1/10,000 ft ²	
Mullen Burst	ASTM - D 3786	245 psi	1/10,000 ft ²	
Trapezoidal Tear Strength	ASTM - D 4533	95 lb	1/10,000 ft ²	
Grab Tensile/Elongation	ASTM - D 4632	225 1b/50%	1/10,000 ft ²	
Wide Width Tensile Strength	ASTM - 0 4595	105 lb/in	1/10,000 ft ²	
UV Resistance (500 hrs)	ASTM - D 4355	>80%	1/batch	

BATCH ACCEPTED BY:

Date:

Inspector

APPROVED BY:

Date:

Engineer



BP CHMICALS INC. FORM 7-3 MIXED WASTE POND CLOSURE PROJECT

WOVEN GEOTEXTILE MATERIAL VERIFICATION CHECKLIST

MANUF	ACTUR	ER:
-------	-------	-----

RESIN BATCH NUMBER: _____ PRODUCER: _____

LABORATORY:

SPECIFICATION	TEST METHOD	STANDARD	TEST FREQUENCY	RESULT
Mass per unit areas	ASTM- 0 3776	8 oz/yd²	1/1,000 ft ²	
Puncture (min)	ASTM - D 3787	1500 lbs	1/10,000 ft ²	
Mullen Burst	ASTM - D 3786	1100 psi	1/10,000 ft ²	
Trapezoidal Tear Strength	ASTM - D 4533	190 Lb	1/10,000 ft ²	
Grab Tensile/Elongation	ASTM - D 4632	4401b/25%	1/10,000 ft ²	
Wide Width Tensile Strength	ASTM - D 4595	290 lb/in	1/10,000 ft ²	
UV Resistance (500 hrs)	ASTM - D 4355	>85%	1/batch	
Flow Rate	ASTM - D 4491	50 gpmyft ²	1/50,000 ft ²	
Apparent Opening Size	ASTM - D 4751	40 sieve	1/1,000 ft ²	

TEST DATA (Attach Laboratory Reports)

BATCH ACCEPTED BY:

Date:

Inspector

APPROVED BY:

Date:

Engineer



APP'D. ____

BP CHEMICALS INC. FORM 7-4 MIXED WASTE POND CLOSURE PROJECT

GEONET/GEOGRID INSTALLATION CHECKLIST

CELL:		MAT'L. TYPE	Geotextile Ceonet
LAYER	(Check One): Leak	Detection	Leachate Collection
DATE:	SHI	FT:	WEATHER:

PANEL	ROLL	ROLL LENGTH	NO LINER DAMAGE	MFR.	BATCH MO.	ROLL NO	ANCHOR TRENCH	SPLICE OR SEAMS	MACH DIR OK	CLEAN	HAT'I
				Contract, Strengtung							
		and the second									
		lan in ann an a									
	1			A COMPANY OF A COMPANY							
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		Competencies and estimated with the									
	and the party in the state of the	Course and there exists a second				Construction and the second second					
							and the second se				
									1		
	-									and a second	
									1		

INSPECTED BY:

Date:

Inspector

APPROVED BY:

Date:

Engineer



BP CHEMICALS INC. FORM 7-5 MIXED WASTE POND CLOSURE PROJECT

DRAINAGE TRENCH INSTALLATION CHECKLIST

CELL:	LAYER	 Leak	Det.		Leach	nate	Coll.
DATE:	 SHIFT:	 		WEATH	HER:		

FROM STATION	TO STATION	NÖ LINER DANAGE	PIPE MFR.	BATCH	PIPE HOLES DOMN	CONN- ECTION OK	LINE GRADE CK'D.	PIPE BEDDED	BACK- FILL PLACED	PIPE CLEAR & FREE
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An and a subground and generated										
4		A REAL PROPERTY AND A DESCRIPTION OF								
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						an phi a dalle sa constant				
				Construction of the second states			Contraction of the local data and the local data an			
			A subject of the second s							

INSPECTED BY:

____ Date: _____

Inspector

APPROVED BY:

Date:

Engineer



BP CHEMICALS INC. FORM 8-1 MIXED WASTE POND CLOSURE PROJECT

BACKFILL MATERIAL VERIFICATION CHECKLIST

MATERIAL TYPE:	=	
BORROW SOURCE:		
LABORATORY:		APP'D.

TEST DATA (Attach Laboratory Reports)

COCCUCICATION	TEST METHOD	STANDARD	TEST FREQUENCY	RESULT
SPECIFICATION			Revelopments and a structure of the second	
		1010 - 1 - 1 - 1 - 1 - 1 - 1 - 1 - 1 - 1		
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	an a	and a second	Construction of the	
				and the second
		for the first of the second		

NOTES & REMARKS:

ACCEPTED BY:

Date: Inspector

PP					

Engineer

Date:



DAILY SUMMARY REPORT FORM NO. 9-1

BP CHEMICALS, INC. LIMA, OHIO MIXED WASTE POND CLOSURE PROJECT

	Submitted By
NAME :	
POSITION:	
COMPANY:	
DATE:	SHIFT:

	WEATHER CONDITIONS		
1)	Temperature:	(*F or *C)	
2)	Visibility (circle one) CLE	EAR CLOUDY	
3)	Precipitation (yes or no): If yes, describe type and intensity below:		
4)	Wind (circle one): none sl If other, describe:	light strong other	
REPARED	ВҮ:	DATE:	
PPROVED	BY:Engineer	DATE:	
		DATE:	



FORM NO. 9-1 (cont

hanned	MEETINGS: List subject and attach minutes.
	MEATINGS, DISC Subject and actaon minaces.
	1)
	2)
	3)
	CALIBRATIONS: List instruments and attach data sheets.
	1)
	2)
	3)
	4)
[]	
Bernard	CONSTRUCTION UNDERWAY: Provide location, description
	personnel and equipment for each unit process. (Attach additional sheets, if necessary)
	1)Location:
	Description:
	Personnel:
	Equipment:
	2)Location: Description:
	Description:
	Personnel:
	Equipment:
	3)Location:
	Description:
	Personnel:
	Equipment:
	Equipment:
	Equipment: 4)Location:
	Equipment: 4)Location:

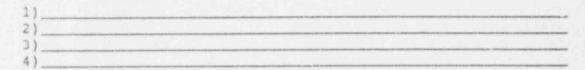
FORM	3703	0-1 /	(cont.)
LOW	160 0	3-7 1	CONF01

Check if Applicable

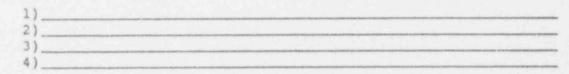
> AREAS OF WORK BEING INSPECTED AND DOCUMENTED. (Attach additional sheets, if necessary).

1)).	
2)).	
3))	
4))	

OFF-SITE MATERIALS RECEIVED. List below and attach delivery tickets and certification documentation of materials received.



APPROVAL OF UNITS OF MATERIALS. (Attach additional sheets, if necessary).



CORRECTIVE ACTIONS TAKEN. (List below and attach Corrective Action Reports)

1))	
2)	
3))	
4)	

APPROVAL OF UNITS OF WORK. (Attach additional sheets, if necessary).

1)	
2)	
3)	
4)	



TABLE OF CONTENTS

TECHNICAL SPECIFICATIONS MIXED WASTE POND CLOSURE PROJECT

BP CHEMICALS, INC. LIMA, OHIO

Division	
or Specification No.	Title
1	General Requirements
2	Site Work
3	Concrete
13	Special Construction
15	Mechanical
16	Electrical
FB-200.3	Shop Fabrication of Steel Tanks
GA-200	Centrifugal Pumps
H-208	Field Fabrication and Erection of Piping
H-209	Field Pressure Testing of Piping
H-229	Piping Materials
H-230	Shot Fabrication of Piping
H-251	Piping Flexibility Analysis
L-219	Insulation Materials
NB.200.1	NEMA Motors 200 HP and Smaller
NB.200.2	Electrical Design and Installation
O-210.1	Shop Painting
O-210.2	Field Painting
SW-200	Welding, Heat Treating and Alloy Sampling





SUBSTITUTIONS AND PROJECT OPTIONS

EXHIBIT 01640-I SCHEDULE OF SUBMITTALS

SPECIFICATION SECTION AND PARAGRAPH

SUBMITTAL TITLE

SUBMITTAL SCHEDULE

01640 1.4.1a

List of Proposed Products to be installed

Within fifteen (15) days after award of Contract

01640 2.2.1

Request for Substitution

Prior to Contract Award





SECTION 01700

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SEC	110	PA	GE
1.0	GEN	ERAL	1
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	1.3	Scope . Site Conditions . Regulations . Submittals .	1
2.0		TENANCE OF DOCUMENTS AND SAMPLES	
	2.1	Doctopents to be Maintained	1
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	3.1 3.2	Joseout Inspection	23

EXHIBIT

01700-I Schedule of Submittals E-0170	E-01700	-1
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1.0 GENERAL

- 1.1 Scope
 - 1.1.1 This section describes requirements and methods for maintaining, recording, and controlling contract documents and procedures for project closeout.

1.2 Site Conditions

1.2.1 Refer to the Drawings for location of Contractor's field office.

1.3 Regulations

1.3.1 Contractor shall comply with all federal, state, local laws and regulations which may be applicable to maintenance of project records and documents.

1.4 Submittals

- 1.4.1 At Contract close-out, deliver record documents to the Owner.
- 1.4.2 Accompany submittal with transmittal letter in duplicate, containing:
 - a. Date
 - b. Project title and number
 - c. Contractor's name and address
 - d. Title and number of each record document
 - e. Certification that each document is complete and accurate
 - f. Signature of Contractor or his authorized representative
- 1.4.3 Refer to Exhibit 01700-I

2.0 MAINTENANCE OF DOCUMENTS AND SAMPLES

- 2.1 Documents to be Maintained
 - 2.1.1 Maintain at the site one record copy of:
 - a. Drawings
 - b. Specifications
 - c. Addenda
 - d. Change Orders and other Modifications to the Contract



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- e. Engineer's Field Orders or Written Instructions
- f. Final Shop Drawings, Product Data and Samples
- g. Field Test Records
- h. All records demonstrating compliance with applicable regulations and requirements.1
- i. Daily Field Logs.1

2.2 Storage Requirements

- 2.2.1 Store documents and samples in Contractor's field office apart from documents used for construction.
 - a. Provide files and racks for storage of documents.
 - b. Provide a locked cabinet or storage space for storage of samples.
- 2.2.2 Store field documents and samples in accordance with Specification sections.
- 2.2.3 Maintain documents in a clean, dry, legible condition and in good order. Do not use record documents for construction purposes.
- 2.2.4 Make documents and samples available at all times for review by Owner.

2.3 Recording

- 2.3.1 Label each document "PROJECT RECORD" in neat large printed letters.
- 2.3.2 Record information concurrently with construction progress.
 - a. Do not conceal any work until required information is recorded.
- 2.3.3 Drawings: See General Conditions for requirements.
- 2.3.4 Specifications and Addenda: Legibly mark each section to record:
 - Manufacturer, trade name, catalog number, and supplier of each product and item of equipment actually installed.
 - b. Changes made by Field Order or by Change Order.

2.4 Daily Field Log1

- 2.4.1 A daily field log shall be maintained by the Contractor Supervisor. It shall contain a summary of the events for each shift including results of all relevant inspections and tests.¹
 - a. This daily log shall meet the requirements of Quality Assurance/Quality Control Plan provided in the Closure Plan.⁴

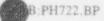


01700-2

3.0 PROJECT CLOSE-OUT INSPECTIONS

3.1 Closeout Inspection

3.1.1 When the Work has reached such a point of completion that it is ready for certification of closure, the Owner shall make a detailed inspection of the Work to insure that all requirements of the Contract have been met and that the Work is complete and acceptable.



3.2 Report of Inspection

- 3.2.1 A copy of the inspection report shall be furnished to the Contractor as the inspection progresses so that the Contractor may proceed without delay with any part of the Work found to be incomplete or defective.
- 3.2.2 When the items appearing on the report of inspection have been completed or corrected, the Contractor shall advise the Owner. After receipt of this notification, the Owner shall inform the Contractor of the date and time of final inspection. A copy of the report of the final inspection containing all remaining contract exceptions, omissions, and incompletions shall be furnished to the Contractor.
- 3.2.3 After receipt of notification of completion and all remaining contract exceptions, omissions, and incompletions from the Contractor, the Owner shall make an inspection to verify completion of the exception items appearing on the report of final inspection.

-- END OF SECTION--



EXHIBIT 01700-I SCHEDULE OF SUBMITTALS

SPECIFICATION SECTION AND PARAGRAPH SUBMITTAL TITLE SUBMITTAL SCHEDULE

01700 1.4.1

Record documents

At Contract closeout



DIVISION 1 GENERAL REQUIREMENTS



DIVISION 1 General Requirements

Section	Title
01010	Summary of Work
01011	Special Conditions and Procedures
01100	Health and Safety Requirements
01200	Project Coordination
01210	Preconstruction and Project Meetings
01220	Submittals
01230	Construction Schedule
01300	Codes and Regulatory Requirements
01310	Definitions and Standards
01400	Contractor Quality Controls
01500	Dissemination of Project Information
01510	Temporary Construction Facilities and Controls
01520	Temporary Utilities
01540	Site Security
01560	Equipment and Material Decontamination
01580	Project Signs
01600	Materials and Equipment
01640	Substitutions and Product Options

01700 Contract Documentation and Project Closeout



SECTION 01010

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	2.2	Equipment Installation	. 5
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	2.4	Replacement Repair and Patching	
	2.5	Obstacles, Interference, and Coordination	
	2.6	Equipment Arrangements	
	2.7	Existing Equipment, Materials, Fixtures, Etc.	
	2.8	Examination of Premises, Drawings, Etc.	6
	2.9	Storage of Material	
	1000 1 100	Clean-Up	
		Construction Schedule	
		Documents Required for Final Payment	

EXHIBIT

01010-1	Schedule of Submittal	state and she	***********		E-01010-I
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1.0 GENERAL

- 1.1 Scope
 - 1.1.1 Work to be Done
 - a. These Specifications cover the technical requirements for closure of four (4) mixed waste surface impoundments (or ponds) at BP Chemicals, Inc. (BP) in the City of Lima, Ohio. The Work shall include, but not be limited to, the following:
 - 1. Preparing a Health and Safety Plan and Radiological Controls Plan.
 - 2. Site preparation, which includes providing, setting up, and the operation of a sludge solidification and stabilization system.
 - 3. Construct and manage Stormwater Control and Management System.
 - 4. Construct cell in V-1 Pond area.
 - 5. Transfer sludge contained in Deepwell and Burn Ponds to Sludge Processing Area.
 - 6. Process sludge through solidification and stabilization system.
 - 7. Transfer and place processed sludge into V-1 cell.
 - 8. Dewater Burn and Deepwell Ponds and process water through Water Management System.
 - Excavate contaminated soil from Deepwell and Burn Ponds, and stock pile in V-1 cell.
 - 10. Perform radiological release survey of Burn and Deepwell Ponds.
 - 11. Construct Burn Pond Cell.
 - 12. Place stockpiled soil in V-1 Cell and Celite Pond area into Burn Pond Cell.
 - 13. Perform radiological release survey of the Celite Pond.
 - 14. Construct Celite Pond.
 - 15. Remove stockpiled soil in V-1 and Burn Pond Cells and place into Celite Cell.
 - 16. Grade waste in cells to match final cap grade.
 - 17. Install caps on all three cells.
 - 18. Install leachate storage tank on a concrete pad with a secondary containment dike.
 - 19. Construct pipe bridges and supports.
 - 20. Install sump pumps and leachate transfer pump.



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- 21. Test all pumps and transfer systems.
- 22. Install leachate storage tank associated equipment and instruments.
- 13. Clean and decontaminate equipment.
- 24. Restore the site to include repairs to roadways and pavement damaged during the work.
- 25. Prepare a turnover package to Owner.
- b. Estimated quantities of materials to be removed are:

Pond	Raw Sludge Volume (yd ³)	Soil Volume (yd ³)
V-1	0.00	0.0
Celite	0.0	50,210 (V-1 and Celite Soil)
Deepwell	16,252 (Deepwell, Celite & V-1 Sludge)	14,298
Burn	14,720	4,702

c. The estimated quantity of stabilized sludge to be stabilized and placed in the closure cells is 30,972 cys and the estimated volume of contaminated soil to be placed in the closure cells is 69,210 cys.

1.1.2 Scope of Work

- a. The Scope of Work in all Sections of this Specification shall consist of the furnishing of all labor, materials, equipment, and appliances and the performance of the Work required by the Contract Documents and/or by the conditions at the site, joining all parts of this Work with itself and the Work of others to form a complete, functioning entity.
- b. Items not specifically mentioned in the Specifications or shown on the Drawings, but which are inherently necessary to make a complete working installation, shall be included.
- 1.1.3 Intent of Contract Documents
 - a. The use of the word (or words):
 - 1. "provide" means furnish, install, connect, calibrate and test ready for use;
 - 2. "furnish" m . 's supply and deliver to job or where directed;
 - 3. "as approved" or "approved" means approval by Owner's designated representative;
 - 4. "as directed" means direction or instruction by Owner's designated representative;



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- "to do", "provide", "furnish", "install", etc., in these Specifications or on Drawings are directions given to the Contractor;
- "concealed" means Work installed in pipe shafts, utility trenches, chases or recesses, behind furred walls, above ceilings, either permanent or removable, beneath ground surface, or covered in any manner;
- 7. "exposed" means all Work not identified as concealed;
- 8. "or equal" means designated Owner's representative approved equal;
- 9. "Owner" means BP Chemicals, Inc.;
- "Owner's designated representative" means the representative designated by the Owner to act on the Owner's behalf during the course of the project;
- "Project" mans all work as defined in the Scope of Work and corresponding drawings and Specifications;
- 12. "Engineer" means person of firm who prepared the designs and contract documents.
- b. Notes or instructions shown on any one Drawing apply, where applicable, to all other Drawings.

1.2 Site Conditions

- 1.2.1 Use of Site
 - a. The Contractor shall carry on the Work in the manner which will cause the least interruption to traffic.
 - b. The Contractor shall post where directed by the Owner, flagmen and suitable signs indicating that construction operations are under way and other warning signs as may be required.
 - c. The Contractor shall safeguard the use by the public and Owner of all adjacent highways, roadways and footpaths, and shall conform to all laws and regulations concerning the use thereof, especially limitations on traffic and the movement of heavy equipment. Access to the site for delivery of construction materials and/or equipment shall be made only at the locations shown in the Contract Documents or approved by the Owner.
 - d. The Contractor shall limit the extent of his activities to that area of the site defined on the Contract Drawings as being within the Project Limit lines.
 - e. All portions of the site, including the staging area, shall be returned to their original condition after completion of Work. Such repair work shall include roadway and pavement restoration and reseeding, if required, and shall be included in the Contractor's Guaranty of Work.



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1.2.2 Parking

- a. Contractor shall cooperate with BP Safety Division:
 - To insure parking by all employees of the Contractor, subcontractors, material suppliers, and others connected with this project only within the designated parking area.
 - 2. Prohibit employees from parking in any other areas, roads, and/or streets.
 - 3. Discharge any employee refusing to comply with theses requirements.

1.3 Regulations

- 1.3.1 All references to codes, specifications and standards referred to in the Specification Sections and on the Drawings shall mean, and are intended to be, the latest edition, amendment and/or revision of such reference standard in effect as of the date of these Contract Documents.
- 1.3.2 Install All Work in Compliance with:
 - a. Ohio State Building Code
 - b. National Electric Code
 - c. Occupational Safety and Health Administration (OSHA)
 - d. All local ordinances
 - e. Ohio Environmental Protection Agency (OEPA) Regulations
 - f. U.S. Nuclear Regulatory Commission (NRC) Regulations
 - g. Project Plans and Specifications in excess of code requirements and not contrary to same
 - h. American Society of Testing Materials (ASTM)
 - i. American Institute of Steel Construction (AISC)
 - j. American National Standard Institute (ANSI)
- 1.3.3 Apply for and obtain all required permits and inspections except those obtained by Owner. Pay all fees and charges for same which shall include all service charges.

2.0 EXECUTION OF WORK

- 2.1 Site Visits
 - 2.1.1 The undertaking of periodic Site Visits by Engineers, Owner's designated representative, or Owner shall not be construed as supervision of actual construction, or make them responsible for the safety of all persons; or make them responsible for means, methods, techniques,

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sequences, or procedures of construction selected by the Contractor or his Subcontractors; or make them responsible for safety programs and precautions incident to the Work, or for the safe access, visit, use, Work, travel or occupancy of any person.

2.2 Equipment Installation

2.2.1 Contractor shall furnish all materials in Contract to meet all requirements of Contract Documents and applicable codes.

2.3 Changeovers and Continuity of Services

- 2.3.1 Make all changeovers, tie-ins and removals, etc., of any part of the Work that would affect the continuity of operation of the adjacent area services at times approved by Owner that will not interfere with the Owner's operations before proceeding. However, the Contractor may perform this Work outside of normal working hours if approved by Owner; no extra payment will be made for resulting overtime expenses.
- 2.3.2 Make all necessary temporary connections required to permit operation of the building services and/or equipment and remove the connections after need has ceased.
- 2.3.3 When connecting new facilities, do not shut off any existing Mechanical/Electrical facilities or services without prior written approval of Owner's Representative.
- 2.3.4 The Contractor shall not, except in an emergency condition, shutdown any utility without the expressed permission of the Owner's Representative. Major shutdowns of utilities will be performed by BP to enable Contractor to perform required work.
- 2.3.5 IN THE EVENT OF AN EMERGENCY THE CONTRACTOR SHALL NOTIFY BP IMMEDIATELY
- 2.3.6 Existing construction not indicated or specified to be removed, replaced or altered, but shown on the drawings, is not included in the Work.

2.4 Replacement Repair and Patching

2.4.1 The Contractor shall replace, repair and patch all surfaces of the ground or any structure disturbed by his operations and his Work which are intended to remain even if such operations and work are outside the property lines. Such replacement, repair and patching shall be with like material and shall restore surfaces as they had previously existed, without any additional cost to the owner.

2.5 Obstacles, Interference, and Coordination

- 2.5.1 General
 - a. Plans show general design arrangement. Install work substantially as indicated and verify exact location and elevations with the Owner's designated representative if there are apparent discrepancies. DO NOT SCALE PLANS.

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b. Due to small scale of Drawings, it is not possible to indicate all offsets, fitting, changes in elevations, interferences, etc. Make necessary changes in the Work, equipment locations, etc., after notifying the Owner's Representative and receiving approval to accommodate the work to encountered obstacles and interferences.

2.6 Equipment Arrangements

- 2.6.1 Since all equipment of equal capacity is not necessarily of same arrangement or size of construction, these Plans are prepared on basis of one manufacturer as "design equipment".
- 2.6.2 If Contractor elects to use specified equipment other than "design equipment" which differs in arrangement, size, etc., he does so subject to follow conditions:
 - a. Submit detailed drawings indicating proposed installations of equipment and showing maintenance and service space required.
 - b. If revised arrangement meets Owner's approval, make all required changes in the work of all trades at no increase in Contract. Provide larger motors and any additional control devices, valves, fittings and other miscellaneous equipment required for proper operation of revised layout, and assume responsibility for proper location of roughing and connections by other trades.
 - c. If revised arrangement does not meet approval, provide equipment which conforms to Contract Drawings and Specifications.

2.7 Existing Equipment, Materials, Fixtures, Etc.

- 2.7.1 Where existing equipment, piping, fittings, etc. are to be removed. Contractor shall submit complete list to Owner. All items that Owner wishes to retain shall be delivered to building storage where directed by Owner. Items that Owner does not wish to retain shall be removed from the site and properly disposed at no additional cost to the owner.
- 2.7.2 Removal handling and disposal of hazardous and/or radioactive materials shall be in accordance with OSHA, NRC, state and federal regulations.

2.8 Examination of Premises, Drawings, Etc.

- 2.8.1 Before Submitting Proposal:
 - a. Examine all Drawings and Specifications relating to Work of all trades to determine scope and relation to other work.
 - Examine all existing conditions affecting compliance with Plans and Specifications, by visiting site.
 - c. Ascertain access to site, available storage and delivery facilities.
- 2.8.2 Before commencing Work on Any Phase or in any Area
 - a. Verify all governing dimensions at site and/or building.

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- b. Inspect all adjacent work.
- Identify all underground utilities and location(s) within the Work Area.
- 2.8.3 Tender of Proposal Confirms Agreement
 - a. All items and conditions referred to herein and/or indicated on accompanying Drawings.
 - b. No consideration of additional monies or time extensions will be granted for alleged misunderstanding.

2.9 Storage of Material

2.9.1 Storage and stockpiling of material shall be only at location(s) as shown on the Drawings. Contractor shall promptly notify Owner designated representative if such locations are inadequate.

2.10 Clean-Up

- 2.10.1 Periodic cleaning: The Contractor at all times during the progress of the Work shall keep the site free from accumulation of waste matter or rubbish and shall confine his apparatus, materials and operations of his work-force to the project limits shown unless approved by Owner's designated representative. Removal of waste matter or rubbish must be performed at least once a week. Contractor shall at all times keep access road and public roads clean of mud and construction debris.
- 2.10.2 Final clean-up: Upon completion of the work covered by the Contract, the Contractor shall leave the completed Project ready for use and occupancy without the need of further cleaning of any kind and with all Work in new condition and in perfect order. In addition, upon completion of all Work, the Contractor shall remove from the vicinity of the Work all treatment facilities, buildings, rubbish, unused materials, concrete forms, and other materials belonging to him or used under his direction during construction. He shall restore such areas affected by the work to their original condition, and, in the event of his failure to do so, the same shall be removed by the Owner at the expense of the Contractor.

2.11 Construction Schedule

- 2.11.1 Conferences will be held with the Engineer, Owner and Contractor at the start of the project to agree mutually on a progress schedule which must be diligently followed. See Section 01210 - Preconstruction and Project Meetings and Section 01230 - Construction Schedule.
- 2.11.2 All required overtime to maintain progress schedule shall be at the Contractor's expense.
- 2.11.3 If in the Owners' judgement, it becomes necessary at any time during construction to accelerate and/or complete certain areas of the project, the Contractor shall concentrate efforts and manpower on those designated areas.
- 2.11.4 The Contractor shall comply with his approved schedule, so as not to interfere with normal operation of Owner occupied areas.

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2.11.5 The Contractor shall cooperate with the Owner and Owner's designated representative in making every reasonable effort to maintain or reduce the Contract time.

2.12 Documents Required for Final Payment

- 2.12.1 Prior to final payment, and before the issuance of a final certificate for payment in accordance with the provisions of the General Conditions, file the following papers with the Owner's designated representative.
 - a. Warranties, Bonds, Service & Maintenance Contracts.
 - 1. Required by the General Conditions and any other extended guarantees stated in the technical sections of the Specifications. See Section 01700.
 - 2. Release or Waiver of Lien.
 - a. As required by the General Conditions.
 - 3. Project Record Documents.
 - a. See Section 01700.
 - 4. Notification that Final Punch List work has been completed.
 - 5. Manufacturers Instruction and Maintenance Manuals.
 - a. See Section 01700.

-- END OF SECTION--



EXHIBIT 01010-I SCHEDULE OF SUBMITTALS

SPECIFICATION SECTION AND PARAGRAPH

01010 2.2

SUBMITTAL TITLE

SUBMITTAL SCHEDULE

Documents required for final payment

Prior to final payment



SECTION 01011

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EXHIBIT

01011-I Schedule of Submittal	 	E-01011-I



1.0 GENERAL

- 1.1 Scope
 - 1.1.1 Provide procedures, training and equipment needed to carry out work safely and in accordance with applicable regulatory requirements.

1.2 Site Conditions

- 1.2.1 Site on which work is to be performed is an active chemical plant.
- 1.2.2 Work site contains hazardous and low level radioactive wastes.
- 1.2.3 Refer to Drawings for project layout and designated project limits.

1.3 Regulations

- 1.3.1 Comply with BP Chemicals Safety Regulations.
- 1.3.2 Comply with applicable state, federal, and local regulations.
- 1.3.3 Comply with NRC regulations for management of low level radioactive waste.

1.4 Submittals

- 1.4.1 Submit Radiation Safety Plan and Health and Safety Plan for review by Owner. Include drawings and specifications for materials and equipment to control access, monitor workers and monitor discharges.
- 1.4.2 Submit certification that all personnel have completed an acceptable OSHA 29 CFR 1910 40hour hazardous waste worker training course.
- 1.4.3 Submit outline for radiation worker safety course for approval by Owner's Radiation Safety Officer.
- 1.4.4 Submit documentation that all personnel have completed Radiation Worker Training per 10 CFR 19 and 20.
- 1.4.5 Refer to Exhibit 01011-I Schedule of Submittals.

2.0 MATERIALS

- 2.1 General
 - 2.1.1 Provide fencing, gates, signs, and monitoring stations as required to control access and prevent the spread of surface contamination from the work area.

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- 2.1.2 Provide instruments to monitor volatile airborne emissions from work area, including but not limited to:
 - a. Volatile Organic Compounds (VOCs).
 - b. Particulates.
 - c. Other emissions identified and associated with sludge processing.
- 2.1.3 Provide Continuous Airborne Monitors (CAMs) in work area to monitor for fugitive radioactively contaminated particles. At least one CAM is to be located downwind of active work areas at all times. Provide wind direction indicator (Sock) to verify proper location of CAM.
- 2.1.4 Provide personnel dosimetry program which includes badging of all personnel who enter the controlled access zone and invivo counting prior to start of onsite work and safety completion of onsite service. This will include Contractor and subcontractor personnel as well as BP, Dames & Moore and state and federal inspection personnel.
- 2.1.5 Provide radiation survey meters and shielded frisking booths at all egress points from the controlled access zone.
- 2.1.6 Provide protective clothing and respirators for Contractor, subcontractor, BP, Dames & Moore and state and federal inspections and BP authorized visitors as required to comply with Owner approved Health & Safety and Radiation Control Plans. All protective clothing must be disposable. No onsite laundering of clothing will be permitted. Arrange for offsite disposal of all contaminated waste material. Include cost of disposal in contract price. Disposal will be in name of Owner and Owner's authorized representative will sign manifests.
- 2.1.7 Provide wipes and counting equipment required to monitor for smearable contamination.

3.0 PERSONNEL TRAINING AND MONITORING

- 3.1 Personnel Training
 - 3.1.1 Radiation worker training shall include at least 16 hours of classroom training and two hours of practical training. Each worker's knowledge, competency, and understanding of the following radiation protection areas will be evaluated:
 - a. Basics of radiation.
 - b. Contamination control.
 - c. Signs and postings.
 - d. Decontamination.
 - e. Personnel monitoring and dosimetry, including bioassay.



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- f. Emergency procedures.
- g. Proper use of protective equipment.
- 3.1.2 All Contractor site personnel shall receive site safety training.
- 3.1.3 Provide all training specified above for Contractor, subcontractor, BP, Dames & Moore and state and federal inspection personnel. Records of training shall be maintained.

3.2 Personnel Monitoring

- 3.2.1 All Personnel in the Controlled Access Zone must wear dosimetry.
- 3.2.2 All personnel must perform a full body frisk prior to leaving the controlled access zone.
- 3.2.3 Provide personnel monitoring for BP, 'Dames & Moore and state and federal inspection personnel.

3.3 ALARA

3.3.1 Plan and perform all operations to keep radiation dosages to workers and public as low as reasonably achievable.

4.0 CONFIRMATION SAMPLING

4.1 Sampling Sequence

- 4.1.1 Perform confirmation sampling when surfaces are excavated to clean level as directed by Owner.
- 4.1.2 Provide results of sample analyses to Owner as soon as received.
- 4.1.3 Provide support to regulatory agency personnel and Contractors to conduct independent confirmation sampling.
- 4.1.4 Allow time in schedule for regulatory review of confirmation sampling data.
 - a. Ohio EPA Review of Chemical Data 8 weeks
 - b. NRC review and confirmation sampling 6 weeks
- 4.2 Sampling Requirements
 - 4.2.1 Take and analyze confirmation samples in accordance with Sampling and Analysis Plan (SAP).
 - 4.2.2 Follow Quality Assurance Plan (QAP) for all sampling, sample transport and analysis.

-- END OF SECTION --

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EXHIBIT 01011-I SCHEDULE OF SUBMITTALS

SPECIFICATION SECTION AND PARAGRAPH	SUBMITTAL TITLE	SUBMITTAL SCHEDULE
01011 1.4.1	Radiation Safety Plan and Health and Safety Plan	15 days after award of contract
01011 1.4.2	40-hr OSHA Haz-waste Training Certificates	Prior to individual to start work onsite
01011 1.4.3	Radiation Worker Training Course Outline	15 days after award of contract
01011 1.4.4	Radiation Worker Training Certificates	Prior to individual to start work onsite
01011 4.1.1	Confirmation Sampling Results	Upon receipt





HEALTI AND SAFETY REQUIREMENTS

SECTION 01100

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EXHIBITS

01100-I	Summary of Sludge Characterization Data	E-01100-I



HEALTH AND SAFETY REQUIREMENTS

1.0 GENERAL

- 1.1 Scope
 - 1.1.1 This section of the Specifications describes health and safety requirements and procedures to be employed during construction of the facilities described herein, and in the Drawings.

1.2 Site Conditions

- 1.2.1 Refer to the Drawings for site conditions and project layout.
- 1.2.2 The Work involves closure of four surface impoundments (ponds) that contain sludges classified as radioactive and hazardous mixed wastes under the Atomic Energy Act of 1954, the Low-Level Radioactive Waste Policy Amendments Act of 1985, and the Resource Conservation and Recovery Act, respectively.
- 1.2.3 The Burn, Deepwell, and Celite Ponds were used to manage acrylonitrile, acetonitrile and catalyst-process wastewaters produced pond sludges containing the EPA-listed wastes K011, K013, and K-014, as well as low levels of depleted uranium. The V-1 Pond was used to manage wastewaters generated from Nitriles maintenance activities associated with caustic wastes. The sludges in this pond thus have a relatively high pH (approximately 12.5). In addition to these contaminants, low levels of depleted uranium were also found in the V-1 Pond during the characterization activities. The contaminated materials present in all four ponds are classified as radioactive mixed waste. The concentrations of these materials in the waste and the estimated quantities are presented in Exhibit 01100-I, Summary of Sludge Characterization Data.

1.3 Regulations

- 1.3.1 This specification requires compliance with all federal, state, local laws and regulations which may be applicable including the Occupational Safety and Health Act, Construction Safety Act as well as Rules, Regulations and Standards of the Secretary of Labor.
- 1.3.2 The Contractor shall comply with all of the approved Health and Safety Plan Requirements for Work at the Site.

1.4 Submittals

- 1.4.1 The Contractor shall submit to the Owner his Health and Safety Plan for his employees and Subcontractors engaged in work at the site.
- 1.4.2 Refer to Exhibit 01100-II, Schedule of Submittals.

1.5 Quality Control/Assurance

- 1.5.1 The Contractor shall maintain and calibrate related Health and Safety equipment and instrumentation on a routine basis.
- 1.5.2 The Contractor shall include in its Health and Safety Plan Quality Control/Assurance procedures for all related Health and Safety equipment and instrumentation.

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HEALTH AND SAFETY REQUIREMENTS

1.5.3 The Contractor shall comply with manufacturers' recommended procedures and frequency for maintenance and calibration of Health and Safety equipment and instrumentation.

2.0 HEALTH AND SAFETY PLAN

2.1 Contractor's Health and Safety Plan

2.1.1 The Contractor shall be responsible for the safety of its personnel while onsite, and shall provide a Health and Safety Plan for its employees and Subcontractors with potential to be exposed to hazardous materials or unsafe conditions. The plan shall be prepared and approved by the Owner prior to the initiation of construction activities at the Site and shall define appropriate personnel protective equipment and safe work procedures to be employed onsite, and will provide specified onsite individuals with stop work authority. It shall also be required that all work be performed in accordance with applicable Federal (i.e., EPA and OSHA, etc.), State of Ohio, and local government regulations.

2.2 Contractor's Responsibility

2.2.1 It is the Contractor's responsibility to assure that all of its employees and Subcontractors perform their Work in accordance with the Health and Safety Plan. The Contractor is also responsible for performing onsite sampling and/or testing necessary to assure the safety of its, or its Subcontractor's personnel onsite.

2.3 Owner's Health and Safety Plan

2.3.1 Contractor may adopt the attached Health and Safety Plan (Appendix A). If the Contractor chooses to develop his own Health and Safety Plan, the plan shall include, at a minimum, all information presented in the attached Health and Safety Plan and must have Owner's approval.

-- END OF SECTION --

EXHIBIT 01100-1

SUMMARY OF SLUDGE CHARACTERIZATION DATA

CONSTITUENT, APPENDIX IX	V-1 POND	CELITE POND	BURN POND	DEEPWELL POND
Metal				
Arsenic	1.0	4.5	2.8	3.2
Barium	65	44	28	59
Cadmium	0.9	0.9	0.8	0.5
Chromium	27	32	40	11.7
Lead	10.5	8.9	8.1	3.8
Mercury	0.14	0.15	0.05	0.6
Selenium	0.4	0.9	0.6	< 0.3
Silver	1.3	1.1	2.0	1.2
Organic				
1,1,1-Trichloroethane	5.2	ND	ND	1.7
Trichloroethylene	ND	ND	7.8	D
Tetrachloroethylene	ND	ND	ND	1.4
Methyl Ethyl Ketone	4.9	D	D	ND
Acetone	2.8	D	D	D
Bromomethane	ND	ND	2.0	D
Bromoform	ND	ND	ND	ND
Chloroform	ND	D	ND	ND
1,1-Dichloroethylene	4.9	ND	ND	D
Methylene Chloride	ND	D	D	ND
Benzene	ND	ND	D	ND
Toluene	ND	ND	D	ND
Ethyl Benzene	ND	ND	D	ND
Acetonitrile	110	6.5	26.8	19.7
Acrylonitrile	ND	8.0	ND	4.0
Pyridine	ND	7.5	57	26
Methyl Pyridine	ND	ND	D	ND
Methyl Naphthalene	ND	0.5	D	ND
Phenol	ND	ND	D	ND
o-Cresol	ND	ND	D	ND
P+M-Cresol	ND	ND	D	ND
Inorganic				
Total Cyanide	186	621	1695	3148

All Results Expressed in mg/kg wet weight D = Compound Detected Below Quantitation Level

ND = Not detected

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HEALTH AND SAFETY REQUIREMENTS

EXHIBIT 01100-I (Continued)

ACTIVITIES OF WASTE

Pond	Activities in Sludge (Ci)	Activities in Soil (Ci)	Total Curies
Deepwell	0.81 (V-1, Celite, and Deepwell Sludges)	0.20	1.01
Burn	2.09	0.12	2.21
Celite	0.00	0.72 (V-1 and Celite Soils)	0.72
V-1	0.00	.00.Q	0.00



HEALTH AND SAFETY REQUIREMENTS

EXHIBIT 01100-II SCHEDULE OF SUBMITTALS

SPECIFICATION SECTION AND PARAGRAPH

SUBMITTAL TITLE

SUBMITTAL SCHEDULE

01100 2.1.1

Health and Safety Plan

7 days following award of contract



PROJECT COORDINATION

SECTION 01200

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PROJECT COORDINATION

1.0 GENERAL

- 1.1 Scope
 - 1.1.1 This section of the Specifications defines requirements for project coordination.
- 1.2 Site Conditions
 - 1.2.1 Refer to the Drawings for site conditions and project layout.
- 1.3 Regulations
 - 1.3.1 The current applicable regulations, ordinances, statutes or codes of the town, city, county or state in which the plant is located, the Federal Government, or other regulatory agency shall apply. Where this specification is more stringent than, and does not conflict with such regulations, ordinances, statues or codes, this specification shall govern.

2.0 CONSTRUCTION MOBILIZATION AND SCHEDULES

- 2.1 Construction Mobilization
 - 2.1.1 Allocation of areas for Contractor's field offices and storage areas shall be made in accordance with instructions from the Owner or Owner's designated representative.
 - 2.1.2 The work shall be executed at such time and in such a way as to cause the least inconvenience to the Owner, and with proper consideration for the rights of other Contractors in the area. The Contractor will be solely responsible for the coordination of schedules for each of his Subcontractors and the Owner shall approve all schedules.
 - 2.1.3 Procedures for project communication shall be established by the Owner and shall be followed at all times.

2.2 Schedules

- 2.2.1 The Contractor shall review the project schedule with the Owner and is required to promptly furnish the Owner with such data as may be requested and incorporate required revisions.
- 2.2.2 The Contractor's approved Project Schedule shall be the basis for the dates for starting and completing the work for the entire Project. It shall be the duty of the Contractor to conform to the approved schedule and to arrange his work in such a manner that it will be installed within the time limits indicated.
- 2.2.3 The Contractor is required by virtue of this Contract to take whatever steps are necessary and to cooperate in every way possible with the other Contractors in order to maintain the schedule and the scheduled completion date. No additional compensation will be considered for such action and consideration.



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PROJECT COORDINATION

- 2.2.4 The Contractor shall coordinate his letting of subcontracts, material purchases, delivery of materials, sequence of operations, etc., to conform to the schedule and shall furnish proof as required by the Owner or Owner's Designated Representative.
- 2.2.5 Use of individual subcontractors are subject to BP approval prior to subcontractor arriving at plant site.

-- END OF SECTION--



PRECONSTRUCTION AND PROJECT MEETINGS

SECTION 01210

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PRECONSTRUCTION AND PROJECT MEETINGS

1.0 GENERAL

- 1.1 Scope
 - 1.1.1 The Owner will schedule and administer preconstruction meeting, periodic progress meetings, and specially called meetings throughout the programs of the work.
 - a. Prepare agenda for meetings.
 - b. Make physical arrangements for meetings.
 - c. Preside at meetings.
 - d. Record the minutes; include all significant proceedings and decisions.
 - e. Duplicate and distribute copies of minutes within three working days after each meeting.
 - 1. To all participants in the meeting.
 - 2. To all parties affected by decisions made at the meeting.
 - 1.1.2 Representatives of Contractor, subcontractors and suppliers attending the meetings shall be qualified and authorized to act on behalf of the entity each represents.

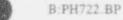
1.2 Site Conditions

- 1.2.1 Owner will identify and provide a central location for preconstruction and project meetings.
- 1.2.2 Preconstruction and project meetings will be held at BP's Lima, Ohio plant.

2.0 MEETINGS

2.1 Preconstruction Meetings

- 2.1.1 The Contractor shall schedule meetings within fifteen (15) days after date of Notice to Proceed.
- 2.1.2 Location: BP, Lima, Ohio.
- 2.1.3 Attendance:
 - a. Owner
 - b. Owner's Designated Representative
 - c. Contractor
 - d. Major subcontractors



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PRECONSTRUCTION AND PROJECT MEETINGS

- e. Major suppliers
- f. Contractor safety representative
- 2.2 Progress Meetings
 - 2.2.1 Schedule regular periodic meetings on the site, not less than once every two weeks throughout the Construction period.
 - 2.2.2 Attendance:
 - a. Owner
 - b. Owner's designated representative
 - c. Contractor
 - d. Subcontractors as appropriate to the agenda
 - e. Suppliers as appropriate to the agenda
 - f. Contractor's safety representative
 - 2.2.3 Minimum Agendum:
 - a. Acknowledge approval of minutes of previous meeting or recommended changes.
 - b. Review percentage of work to be in place by next meeting.
 - c. Review of work progress since previous meeting.
 - d. Field observations, problems, conflicts.
 - e. Problems which impede construction schedule.
 - f. Review of off-site fabrication and delivery schedules.
 - g. Corrective measures and procedures to regain projected schedule.
 - h. Revisions to construction schedule.
 - i. Plan progress, schedule, during succeeding work periods.
 - j. Coordination of schedules.
 - k. Review submittal schedules; expedite as required.
 - 1. Maintenance of quality standards.



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PRECONSTRUCTION AND PROJECT MEETINGS

- m. Review status of all issued proposal requests and change orders.
- n. Review proposed changes for:
 - 1. Effect on construction schedule and on completion date.
 - 2. Effect on other contracts of the Project.
- o. Other business.
- 2.2.4 All decisions, instructions, and interpretations given by the Owner or his designated representative at these meetings shall be binding and conclusive on the Contractor.

-- END OF SECTION --

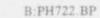


SECTION 01220

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	 3.1 Schedule of Submittals 3.2 Procedure for Making Submittals 	. 3





GENERAL

1.1 Scope

1.1.1 This section provides instructions, method, and schedule for submittals required during construction of the Work. This section includes:

- a. Submittals required with bid.
- b. Shop drawings.
- c. Product data.
- d. Samples.
- e. Manufacturers instructions.
- f. Manufacturers certificates.
- g. Schedule of submittals.
- h. Procedure for making submittals.

Submittals

1.2.1 Refer to Exhibit 01220-I for Master Schedule of Submittals.

SUBMITTAL TYPES

2.1 Submittals Required with Bid

- 2.1.1 Concurrent with submission of bids, bidders shall be required to include a detailed description of the proposed methods and sequence of operation. The proposed work description shall include the following items as a minimum:
 - a. Proposed sequence of construction.
 - b. Proposed stabilization/solidification equipment and any noted deviation from specified methods.
 - c. Sludge removal equipment and methods.
 - d. Decontamination procedures, equipment and control.
 - c. Proposed construction schedule.



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2.1.2 Each of the above items are needed to evaluate bids. Additionally, as specified elsewhere herein, materials, quantifies and methods, proposed by the Contractor, shall be subject to the approval of the Owner. Approval or acceptance of the Contractor's proposed method of operation by the Owner does not constitute any assumed liability on the part of the Owner, Owner's designated representative, or engineer. The Contractor shall remain solely responsible for all acts or omissions.

2.2 Shop Drawings

- 2.2.1 Submit the number of opaque reproductions which Contractor requires plus three (3) which will be retained by the Owner.
- 2.2.2 After review, reproduce and distribute in accordance with Section 01220 and Section 01700.

2.3 Product Data

- 2.3.1 Submit the number of copies which the Contractor requires, plus three (3) copies which will be retained by the Owner.
- 2.3.2 Mark each copy to identify applicable products, models, options and other data. Supplement manufacturers' standard data to provide information unique to this project.
- 2.3.3 After review, distribute in accordance with Section 01220 and Section 01700.

2.4 Samples

- 2.4.1 Submit samples to illustrate functional and aesthetic characteristics of the Product, with integral parts and attachment devices as required. Coordinate sample submittals for interfacing work.
- 2.4.2 Include identification on each sample with full Project information.
- 2.4.3 Submit the number or samples specified in individual specification Sections; one of which will be retained by the Owner.
- 2.4.4 Reviewed samples which may be used in the Work are indicated in individual specification sections.

2.5 Manufacturer's Instructions

- 2.5.1 When specified in individual specification sections, submit manufacturers' printed instructions for delivery, storage, assembly, installation, adjusting and finishing, in quantities specified for Product Data.
- 2.5.2 Identify conflicts between manufacturers' instructions and the Contract Documents.



2.6 Manufacturer's Certificates

- 2.6.1 When specified in individual specification sections, submit manufacturers' certificate of compliance to the Owner for review in quantities specified for Product Data.
- 2.6.2 Indicate whether the material or product conforms to, or exceeds, specified requirements. Submit supporting reference data, affidavits, and certifications as appropriate.
- 2.6.3 Certificates may be recent or previous test results on material or products, but must be acceptable to the Owner.

3.0 METHOD OF SUBMITTAL

3.1 Schedule of Submittals

3.1.1 A schedule listing the submittals to be made under this Contract is shown on Exhibit 01220-I, Master Schedule of Submittals. Submittals which are to be made for approval show the approvals required. Where no approval requirements are shown, the submittal is for record purposes only.

3.2 Procedure for Making Submittals

- 3.2.1 Make all submittals under a numbered transmittal form or letter which includes applicable drawing and/or specification reference and a description of the submittal.
- 3.2.2 All submittals are to be made in triplicate. Original cover sheet, bearing the original signature of an individual authorized to sign for Contractor is to be printed on white paper. Copies of the cover sheet are to be printed on yellow paper.
- 3.2.3 The submittal number is to be shown on the form.
- 3.2.4 Where multiple sequential submittals are to be made under to same number (i.e., schedules or manufacturer data) a sequential letter extension is to be added (i.e., 6.A; 14.BB, etc.).
- 3.2.5 Use multi-letter extensions (i.e., AXE) if necessary.
- 3.2.6 Identify Project Title, Contractor, Subcontractor or supplier; pertinent drawing sheet and detail number(s), and specification section number, as appropriate.
- 3.2.7 Apply Contractor's stamp, signed or initialled certifying that review, verification of products required, field dimensions, adjacent construction Work and coordination of information, is in accordance with the requirements of the Work and Contract Documents. Each sheet of shop drawings must bear such stamp and signature.
- 3.2.8 Schedule submittals to expedite the Project and deliver to Owner at job site. Coordinate submission of related items. Allow at least ten (10) working days for review of submittals or any substitutions or alternatives.
- 3.2.8 Identify variations from Contract Documents and product or system limitations which may be detrimental to successful performance of the completed Work.



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- 3.2.9 Provide space for Contractor and Engineer review stamps.
- 3.2.10 Revise and resubmit submittals as required; identify all changes made since previous submittal.
- 3.2.11 Distribute copies of reviewed submittals to concerned parties. Instruct parties to promptly report any inability to comply with provisions.

-- END OF SECTION --



SECTION 01230

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EXHIBIT

01230-I	Schedule of Submittals							éve.	e	ε (e)	i e a			×		11	11	÷	E-01230-I	Î
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1.0 GENERAL

- 1.1 Scope
 - 1.1.1 Within 15 days after award of contract, the Contractor shall prepare and submit to the Owner estimated construction progress schedules for the entire Work, with subschedules of related activities which are essential to the progress of the Work.
 - 1.1.2 Submit revised progress schedules periodically and when requested to do so by Owner.

1.2 Site Conditions

- 1.2.1 See construction drawings for project layout.
- 1.3 Regulations
 - 1.3.1 The current applicable regulations, ordinances, statutes or codes of the town, city, county or state in which the plan is located, the Federal Government, or other regulatory agency shall apply. Where this specification is more stringent than, and does not conflict with such regulations, ordinances, statues or codes, this specification shall govern.

1.4 Submittals

- 1.4.1 Submit initial Construction Progress Schedules within fifteen (15) calendar days after award of Contract.
 - The Owner will review schedules and return review copy within ten (10) days after receipt.
 - b. If required, resubmit within seven (7) days after return of review copy.
- 1.4.2 Submit progress revision schedules to accompany each application for payment.
- 1.4.3 Refer to Exhibit 01230-I for Schedule of Submittals.

2.0 SCHEDULES

- 2.1 Form of Schedules
 - 2.1.1 Prepare Network Analysis system, or prepare schedules in the form of a horizontal bar chart.
 - a. Provide separate horizontal bar for each trade or operation.
 - b. Horizontal time scale: Identify the first work day of each week.
 - c. Scale and spacing: To allow space for notations and future revisions.
 - 2.1.2 Format of listings: The chronological order of the start of each item of work.
 - 2.1.3 Identification of listings: By specification section numbers.

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2.2 Construction Progress Schedule

- 2.2.1 Show the complete sequence of construction by activity.
- 2.2.2 Show the dates for the beginning, and completion of, each major element of construction. Specifically list:
 - a. Mobilization and site preparation.
 - b. Construct storm water control system.
 - c. Construction of V-1 Cell.
 - d. Processing of sludges and placement into the V-1 Cell.
 - e. Soil removal from Deepwell and Burn Ponds.
 - f. Radiological release survey of Burn and Deepwell Ponds.
 - g. Construction of Burn Pond Cell.
 - h. Placement of stockpiled soil from V-1 Cell and Celite Pond area.
 - i. Complete soil removal from Celite Pond Area.
 - j. Perform radiological release survey of Celite Pond area.
 - k. Construct Celite Cell.
 - Remove stockpiled soil from V-1 and Burn Pond Cells and placement into Celite Cell.
 - m. Installation of caps on three cells.
 - n. Install, calibrate, and test leachate detection system instrumentation.
 - o. Project completion, demobilization and close-out.
- 2.2.3 Show projected percentages of completion for each item, as of the first day of each month.

3.0 PROGRESS REVISIONS AND DISTRIBUTIONS

3.1 Progress Revision

- 3.1.1 Indicate progress of each activity to date of submission.
- 3.1.2 Show changes occurring since previous submission of schedule:
 - a. Major changes in scope.
 - b. Activities modified since previous submis, on.

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- c. Revised projections of progress and completion.
- . Other identifiable changes.
- 3.1.3 Provide a narrative report as needed to define:
 - a. Problem areas, anticipated delays, and the impact on the schedule.
 - b. Corrective action recommended, and its effect.
 - c. The effect of changes on schedules of other prime contractors.

3.2 Distribution

- 3.2.1 Distribute copies of the reviewed schedules to:
 - a. Job site file.
 - b. Subcontractors.
 - c. Other concerned parties.
- 3.2.2 Instruct recipients to report to the Contractor, in writing, any problems anticipated by the projections of the schedule.

-- END OF SECTION--



EXHIBIT 01230-1 SCHEDULE OF SUBMITTALS

SPECIFICATION SUBMITTAL TITLE SUBMITTAL SCHEDULE 01230 1.4.1 Construction Progress Schedule Fifteen (15) days after award of Contract 01230 1.4.2 Progress Revision Schedules Submit with each application for payment

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SECTION 01300

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1.0 GENERAL

- 1.1 Scope
 - 1.1.1 This section covers regulatory requirements for conducting work described in the Specifications. If there is a conflict between applicable regulations and either the requirements specified in other sections of these specifications or between different regulations the more stringent requirement shall apply.

2.0 CODES AND REGULATORY REQUIREMENTS

2.1 References

- 2.1.1 Technical requirements contained in the following regulations, guidelines, and codes form a part of these Specifications.
 - a. Federal Regulations.
 - 1. 10 CFR 20 Standards for Protection Against Radiation.
 - 2. 10 CFR 19 Notices, Instructions, and Reports to Workers.
 - 3. 10 CFR 71 Packaging and Transportation of Radioactive Material.
 - 29 CFR 1910 and 29 CFR 1926 Occupational Safety and Health Standards (OSHA).
 - 5. 40 CFR 61 National Emission Standards for Hazardous Air Pollutants.
 - 6. 40 CFR 112 Oil Pollution Prevention.
 - 7. 40 CFR 122 Permitting Requirements for Land Disposal Facilities.
 - 8. 40 CFR 124 Procedures for Decision-Making.
 - 9. 40 CFR 260 Hazardous Waste Management System: General.
 - 10. 40 CFR 261 Identification and Listing of Hazardous Waste.
 - 11. 40 CFR 262 Standards for Generators of Hazardous Wastes.
 - 12. 40 CFR 263 Standards for Transporters of Hazardous Wastes.
 - 40 CFR 264 Standards for Owners, and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities.
 - 14. 40 CFR 265 Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities.





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- 15. 40 FR 267 Interim Status Standards for Owners and Operators of New Hazardous Waste Land Disposal Facilities.
- 40 CFR 270 Regulations for Federal Administered Hazardous Waste Permit Programs.
- 17. 40 CFR 271 Requirements for Authorization of State Hazardous Waste Programs.

18. 40 CFR 171-179 - Hazardous materials Transportation Regulations.

- b. Congressional Acts.
 - 1. AEA Atomic Energy Act
 - 2. CAA Clean Air Act
 - CERCLA Comprehensive Environmental Response, Compensation, and Liability Act.
 - 4. CWA Clean Water Restoration Act.
 - 5. FWPCA Federal Water Pollution Control Act.
 - 6. LLRWPAA Low-Level Radioactive Waste Policy Amendments Act
 - 7. NEPA National Environmental Policy Act.
 - 8. RCRA Resource Conservation and Recovery Act.
 - 9. SDWA Safe Drinking Water Act.
 - 10. TSCA Toxic Substance Control Act.
 - 11. WQA Water Quality Act.
- 2.1.2 Reference codes and standards: This section lists the reference standards and codes cited in these criteria.
 - a. AAMA American Architectural Manufacturer's Association.
 - b. AASHTO American Association of State Highway and Transportation Officials.
 - c. ACGIH American Conference of Governmental Industrial Hygienists.
 - d. ACI American Concrete Institute.
 - e. ACSM American Congress on Surveying and Mapping.
 - f. AISC American Institute of Steel Construction.

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- g. AISI American Iron and Steel Institute.
- h. AMCA Air Movement and Control Association.
- i. ANS American Nuclear Society.
- j. ANSI American National Standards Institute.
- k. ASCE American Society of Civil Engineers.
- 1. ASME American Society of Mechanical Engineers.
- m. ASTM American Society for Testing and Materials.
- n. AWS American Welding Society.
- o. AWWA American Water Works Association.
- p. BOCA Building Officials and Code Administrators International, Inc.
- q. IEEE Institute of Electrical and Electronic Engineers.
- r. NBS National Bureau of Standards.
- s. NCMA National Concrete Masonry Association.
- t. NEMA National Electrical Manufacturers Association.
- u. NFPA National Fire Protection Association.
- v. PCA Portland Cement Association.
- w. PCI Prestressed Concrete Institute.
- x. UL Underwriters Laboratories.
- y. WRC Water Resources Council, Hydrology Committee.
- z. NRC Nuclear Regulatory Commission.
- aa. USEPA United States Environmental Protection Agency.

-- END OF SECTION --



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SECTION 01310

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	1.1 Scope	





1.0 GENERAL

1.1 Scope

1.1.1 This section defines terms, abbreviations, and responsibilities found in these Specifications.

1.2 Definitions of Terms

- 1.2.1 BPC (Owner)
 - a. BP Chemicals, Inc., Lima, Ohio

1.2.2 Completion

a. Full and exact compliance and conformity with the provisions and requirements, expressed or implied, in the Specifications and Plans, including all duly authorized amendments, revisions, corrections, or additions.

1.2.3 Contract

a. The Contract Documents consisting of Notice to Bidders, Information for Bidders, General Requirements, Scope of Work, the Bid Form, Technical Specifications, the Contract Agreement, Bonds Insurance, and the Drawings, including all addenda and modifications thereof incorported in the Documents before execution as well as change orders agreed to after execution. These Documents form the Contract.

1.2.4 Contractor

- a. Person, firm, or corporation with whom the Contract is made by the Owner and mentioned as such in the Contract Agreement. Contractor applies to the signing Contractor or his authorized representative.
- 1.2.5 Contractor Support Area
 - a. The delineated extent of the project operations used for the placement of contractor temporary office facilities, storage, equipment and material laydown areas as specified on the Drawings.
- 1.2.6 Project Limits (Controlled Access Zone)
 - a. The delineated extent of the Work Area in which the handling of contaminated soils, sludge, debris, and other materials will be restricted to. Access to these zones is to be restricted to authorized persons as required in specifications.
- 1.2.7 Decontamination Area
 - a. The delineated extent of the project operations used for the staging of personnel decontamination equipment and staging area as shown on the Drawings.



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- 1.2.8 Electrical Equipment
 - a. Any equipment operated by or which generates or transmits electrical current.
- 1.2.9 Engineer
 - a. Person or firm who prepared the designs and contract documents and is identified in the Contract Agreement.
- 1.2.10 EPA
 - a. United States Environmental Protection Agency.
- 1.2.11 Material or Materials
 - a. All materials, supplies, and equipment to be used in the work.
- 1.2.12 NRC
 - a. Nuclear Regulatory Commission.
- 1.2.13 OEPA
 - a. Ohio Environmental Protection Agency.
- 1.2.14 Owner
 - Person, firm, or corporation identified as such in the Contractor Agreement (BP Chemicals).
- 1.2.15 Project Work Site
 - a. The various work areas as described and as shown on the plans.
- 1.2.16 Release
 - a. Any spilling, leaking, emitting, discharging, escaping, leaching or disposing of materials into the groundwater, surface water or subsurface soils.
- 1.2.17 Release Detection
 - a. Determining whether a release of a regulated substance has occurred from the pond systems into the environment.
- 1.2.18 Subcontractor
 - a. As employed herein, includes only those having a direct contract with the Contractor and includes one who furnishes material worked to a specification design according to the Plans or Specifications of this work, but does not include one who merely furnishes material not so worked.

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- 1.2.19 Law or Regulations
 - a. The law of the place of work shall govern the construction c, this Contract.
- 1.2.20 Time Limits
 - Time limits stated in the Contract Documents are for completion of the Work as specified.
- 1.2.21 Work
 - a. As used herein, refers to work at site of Project, as that normally done at the location of the Project, and includes all plant, labor, materials, and supplies proper for or incidental to the carrying out and completion of this Contract. The term "work performed" shall be construed to include material delivered to and suitably stored at the Project site.
- 1.2.22 Work Areas
 - a. The area delineated on the drawings inside of which the Contractor shall be allowed to conduct operations and shall be within the project limits (Controlled Access Zone).
- 1.2.23 Written Notice
 - a. Written notice shall be deemed to have been duly served if delivered in person to the individual or to a member of the firm or to an officer of the corporation for whom it is intended, or if delivered at or sent by registered mail to the last business address known to him who gives notice, or if delivered to the Contractor's Superintendent at the site of work.

-- END OF SECTION--



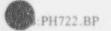
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EXHIBIT





1.0 GENERAL

1.1 Scope

1.1.1 This section describes the basic quality standards required by the Contractor in the performance of this specification. These standards are consistent with good commercial business and workmanship practices in the performance of all work for the Owner.

1.2 Site Conditions

1.2.1 Refer to the Drawings for site conditions and project layout.

1.3 Regulations

1.3.1 This specification requires compliance with all federal, state, local laws and regulations which may be applicable.

1.4 Submittals

- 1.4.1 The Contractor shall submit a Daily Contractor Quality Control (DCQC) Report. The DCQC Report shall contain at a minimum the following: location of work; weather information; work performed; specific inspections performed and results; problems identified; QC problems and corrective actions (if any); verbal or written instructions from the Owner for retesting; samples collected, type of test performed, personnel involved, and results of tests; calibration documentation; Contractor's certification.
- 1.4.2 At the completion of the contract, the Contractor shall submit to the Owner finalized asbuilt drawings and specifications noting any approved deviations or specific construction details not indicated on the original project drawings or specifications.
- 1.4.3 At the conclusion of the project, the Contractor shall submit a final Quality Control Project Summary Report. The report shall outline the practices employed, any problems encountered, and DCQC corrective actions taken. A summary of the DCQC Reports and discussion of significant data as related to project scope shall be included. The final Quality Control Project Summary Report shall be submitted to and approved by the Owner before issuance of final payment.

2.0 PROJECT QUALITY ASSURANCE/QUALITY CONTROL PLAN

2.1 General

- 2.1.1 The Contractor shall monitor quality control over suppliers, manufacturers, products, services, site conditions, drawings, construction documents, and workmanship to produce work as specified in the Project QA/QC Plan.
- 2.1.2 The Contractor shall comply with specified standards as a minimum quality for the work except when more stringent tolerances, codes, or specified requirements indicate higher standards or more precise workmanship.



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2.1.3 The Contractor shall ensure that the work is performed by persons qualified to produce workmanship of specified quality.

-- END OF SECTION --



EXHIBIT 01400-I SCHEDULE OF SUBMITTALS

SPECIFICATION SECTION AND PARAGRAPH	SUBMITTAL TITLE	SUBMITTAL SCHEDULE
01400 1.4.1	Daily Contractor QC Report	On a daily basis
01400 1.4.2	Finalized As-Built Drawings	Completion of contract
01400 1.4.3	Final QC Project Summary Report	Completion of project





DISSEMINATION OF PROJECT INFORMATION

SECTION 01500

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DISSEMINATION OF PROJECT INFORMATION

1.0 GENERAL

- 1.1 Scope
 - 1.1.1 This section covers mandatory requirements concerning release of project information.
 - 1.1.2 All Contractor personnel, subcontractor personnel, and suppliers shall be made aware of the requirements of this section.

1.2 Site Conditions

1.2.1 Refer to Section 01011 - Special Conditions and Procedures and Drawings for project layout and conditions.

1.3 Regulations

1.3.1 The current applicable regulations, ordinances, statutes or codes of the town, city, county or state in which the plant is located, the Federal Government, or other regulatory agency shall apply. Where this specification is more stringent than, and does not conflict with such regulations, ordinances, statues or codes, this specification shall govern.

2.0 DISSEMINATION OF PROJECT INFORMATION

- 2.1 Role of the Owner
 - 2.1.1 The Owner will be the sole party responsible for disseminating project information to the public or regulatory agency.
 - 2.1.2 Any substantive question shall be referred to the Owner.

2.2 Role of the Contractor

- 2.2.1 The nature of the work may require the Contractor to come into contact with the general public who live near the worksite.
- 2.2.2 It is not the intent to prohibit the Contractor from establishing a rapport with those affected by the project, but rather to prevent misunderstandings or false expectations.
- 2.2.3 In particular, the following data is to be considered confidential and shall not be released by anyone except the Owner:
 - a. Scope of project.
 - b. Location and results of any testing.
 - c. Schedule of operations.
 - d. Changes to the Contract.



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DISSEMINATION OF PROJECT INFORMATION

- e. Any hazard or risk assessment.
- f. The rationale or requirements of the Project.
- 2.2.4 Any substantive question shall be referred to the Owner.

3.0 GROUNDS FOR DISMISSAL

3.1 Conditions

3.1.1 The Contractor shall instruct the appropriate personnel of the serious nature of releasing this information to the Public. Release of this information may be grounds for dismissal from the Project.

-- END OF SECTION---





SECTION 01510

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EXHIBIT

01510-I	Schedule of Submit	als		*********		E-01510-I
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GENERAL

- 1.1 Scope
 - 1.1.1 Furnish, install and maintain temporary facilities and controls required for construction, and remove on completion of Work.
- 1.2 Site Conditions
 - 1.2.1 Refer to construction drawings for site conditions and project layout.
- 1.3 Regulations
 - 1.3.1 The current applicable regulations, ordinances, statutes or codes of the town, city, county or state in which the plan is located, the Federal Government, or other regulatory agency shall apply. Where this specification is more stringent than, and does not conflict with such regulations, ordinances, statues or codes, this specification shall govern.
 - 1.3.2 Comply with owner's regulations and requirements.
- 1.4 Submittals
 - 1.4.1 Submit required permits and licenses to Owner prior to construction of Work.
 - 1.4.2 Refer to Exhibit 01510-I, Schedule of Submittals.

2.0 MATERIALS

- 2.1 General
 - 2.1.1 Materials may be new or used, but must not violate requirements of applicable codes, standards, or the contract specifications.

2.2 Temporary First Aid Facilities

- 2.2.1 Provide first aid equipment and supplies, with qualified personnel continuously available to render first aid at the site.
- 2.2.2 Provide a sign, posted at the telephone, listing the telephone numbers for emergency medical services: Physicians, ambulance services and hospitals.

2.3 Temporary Fire Protection

- 2.3.1 Provide a fire protection and prevention program for employees and personnel at the site; and provide and maintain fire extinguishing equipment ready for instant use at all areas of the Work and at specific areas of critical fire hazard.
- 2.3.2 Comply with Owner's specific requirements related to Fire Prevention and Protection.



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2.4 Construction Aids

- 2.4.1 Provide construction aids and equipment required to assure safety for personnel and to facilitate the execution of the Work; scaffolds, staging, ladders, stairs, ramps, runways, platforms, railings, hoists, cranes, chutes and other such equipment.
- 2.4.2 Maintain all equipment in an excellent and safe condition.
- 2.4.3 It is the Contractor's responsibility to either decontaminate or otherwise dispose of as hazardous waste all construction aids that could possibly have been contaminated during construction.

2.5 Guardrails and Barricades

- 2.5.1 Provide guardrails, barricades, fences, footways and other devices necessary to protect personnel and employees at the site, and the public, against hazards on or adjacent to the construction site.
 - a. Provide signs, warning lights, signals, flags and illumination as necessary to alert persons to hazards and to provide safe, adequate visibility in areas of hazards.

2.6 Access Roads and Parking Areas

2.6.1 Provide all access roads as necessary to complete the Work.

- 2.7 Project Identification and Signs
 - 2.7.1 No signs are to be displayed at the project site, unless authorized by the Owner.

2.8 Field Offices and Sheds

- 2.8.1 Provide an adequate weathertight building with raised floor to service as a field office for the use by the Contractor, installed as shown on the Drawings. The office shall remain onsite throughout construction period.
 - a. The contractor's office shall be of size, and shall be furnished, so that it may be used for small progress meetings.
 - b. Provide adequate artificial lighting, heating and cooling to provide comfortable conditions for all occupants.
 - c. Provide direct line telephone service for use by Contractor.
 - d. Furnishings required:
 - For Contractor's office: Racks and files for Contract Documents and for Record Documents; conference table and chairs; and desks and chairs as required by the Contractor.



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- 2.8.2 Provide adequate weathertight storage sheds with raised floors for the storage and protection of products to be incorporated into the Project.
 - a. Provide heat and ventilation as required to maintain specific conditions for storage of products and to comply with applicable code requirements and regulations.

3.0 CONSTRUCTION OF TEMPORARY FACILITIES AND CONTROL

3.1 Preparation

- 3.1.1 Consult with the Owner, review site conditions and factors which affect construction procedures and temporary facilities, including adjacent properties and public facilities which may be affected by execution of the work.
 - Designate the locations and extent of temporary construction, storage, and other temporary facilities and controls required for the expeditious accomplishment of the Work.
 - b. Allow space for use by the Owner and by the other contractors.

3.2 Occupation of Site

- 3.2.1 The Contractor shall confine his equipment and materials within the project limits.
- 3.2.2 While on-site, the Contractor shall store his materials, equipment, and supplies in an area designated by the Owner. The Contractor shall be responsible for the protection and safety of its equipment and materials while on-site.

3.3 Utilities

- 3.3.1 Owner will provide one 480 Volt 3-phase drop with breaker.
- 3.3.2 The Contractor shall be responsible for providing stepdown transformers as required for his needs. Contractor shall submit KVA requirements with bid.
- 3.3.3 The Contractor shall be responsible for providing telephone communications for the field office.
- 3.3.4 The Contractor shall provide suitable portable sanitary facilities for the duration of the project. The Contractor shall also be responsible for maintenance of the facilities, and for arranging proper off-site disposal of all sanitary wastes.
- 3.3.5 Contractor will not be allowed an onsite laundry. All protective clothing must be disposable. Arrange offsite disposal.
- 3.3.6 The Contractor shall provide potable drinking water for construction personnel throughout construction.





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- 3.3.7 Owner will provide a non-potable process water at 40 psi of point source within the project limits. Contractor must install necessary piping and pumping facilities to process water users.
- 3.3.8 Owner will provide steam at 40 psi, point source with the project limits. Contractor must necessary piping and pumping facilities to steam users.
- 3.3.9 Contractor shall be responsible for providing compressed air, if required.

3.4 Erosion and Sediment Control

3.4.1 The Contractor shall perform erosion and sediment control measures, as required, to prevent the discharge of sediment-laden runoff and/or protect the project ar a itom, the effects of erosion.

3.5 Air Emissions

- 3.5.1 The Contractor shall implement measures, such as wetting, to prevent the dispersion of dust from the construction area as required by the Owner or regulatory agencies.
- 3.5.2 In the event that air monitoring shows airborne particulate levels exceeding established levels as specified in the Health and Safety Plan, the Contractor shall take the necessary measures, subject to the Owner's approval, to reduce emissions to acceptable levels.

3.6 Other Requirements

- 3.6.1 Comply with applicable requirements specified in Divisions 2 through 16.
- 3.6.2 Make work structurally, mechanically and electrically sound throughout.
- 3.6.3 Install work in a neat and orderly manner.
- 3.6.4 Maintain, clean, service and repair facilities to the quality of the original histallation.
- 3.6.5 Relocate facilities as required for progress of construction, storage or work requirements, and to accommodate legitimate requirements of the Owner and other contractors working at the site.
- 3.6.6 All construction activities shall comply with conditions and requirements delineated in the Contractor Radiation Safety Plan, (Health and Safety Plan).

3.7 Removal of Temporary Facilities and Controls

- 3.7.1 Completely remove temporary structures, materials, equipment and services:
 - a. When construction needs can be met by use of permanent construction.
 - b. At completion of the Project.

- 3.7.2 Repair damage caused by installation or use of temporary facilities. Clean the areas after removal.
- 3.7.3 Restore existing or permanent facilities used for temporary purposes to original condition.
 - a. Remove foundations and underground installations necessary for temporary construction and utilities after receiving approval by the Owner.
 - b. Grade the areas of the site affected by temporary installations to required elevations and slopes, and clean the area.
- 3.8 Environmental/radiological surveillance of the construction area will be performed by the Contractor to ensure that appropriate and acceptable contaminate concentration levels exist.

-- END OF SECTION--



EXHIBIT 01510-I SCHEDULE OF SUBMITTALS

ŝ		PECIFICATION	SUBMITTAL TITLE	SUBMITTAL SCHEDULE	
0	1510	1.4.1	Permits and Licenses	Prior to construction of work	
0	1510	3.3.2	KVA Requirements	Submit with bid	
0	1510	3.3.7	Process Water Requirement	Submit with bid	
	10	3.3.8	Steam Requirements	Submit with bid	



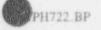


TEMPORARY UTILITIES

SECTION 01520

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	1.2	Site Conditions	
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TEMPORARY UTILITIES

1.0 GENERAL

- 1.1 Scope
 - 1.1.1 Furnish, install and maintain temporary utilities required by all trades for construction and remove upon completion of Work.

1.2 Site Conditions

1.2.1 Refer to construction drawings for site conditions and project layout.

1.3 Regulations

- 1.3.1 The current applicable regulations, ordinances, statutes or codes of the town, city, county or state in which the plant is located, the Federal Government, or other regulatory agency shall apply. Where this specification is more stringent than, and does not conflict with such regulations, ordinances, statues or codes, this specification shall govern.
- 1.3.2 Comply with Federal. State and local codes and safety regulations and with utility company requirements.

2.0 MATERIALS

- 2.1 General
 - 2.1.1 Materials may be new or used, but must be adequate in capacity for the required usage, must not create unsafe conditions, and must not violate requirements of applicable codes and standards.
- 2.2 Temporary Electricity, Lighting and Water
 - 2.2.1 The Contractor shall furnish, install, and maintain temporary lighting and water facilities as necessary.
 - 2.2.2 All temporary power systems including wiring shall be removed by the Contractor when they are no longer required.
- 2.3 Maintenance of Permanent Roadways
 - 2.3.1 The Contractor shall immediately remove dirt and debris which may collect on permanent roadways (public or private), due to the Work and shall properly dispose of the material offsite after determining whether it contains hazardous constituents.
- 2.4 Traffic Control
 - 2.4.1 Routes to and from the Work shall be as indicated in the Contract or as directed by the Owner. Temporary roadways shall be closed only with prior approval of the Owner.

TEMPORARY UTILITIES

2.4.2 Parking areas for the use of contractor personnel shall be as indicated in the Contract or as directed by the Owner.

2.5 Pollution Control

- 2.5.1 Comply with all laws, rules and regulations governing pollution control, including but not limited to those of the Ohio EPA.
- 2.5.2 Take all necessary precautions including, but not limited to digging and maintaining settling basins, dams, diverting streams; and taking all other acti rs that may be necessary to prevent silt, and waste of any kind from being deposited in storm drains or damage ditches draining the site as a result of the Work.
- 2.5.3 Do not dispose of volatile fluid wastes into storm, sanitary sewer systems, approved sewage disposal systems or any waterway.
- 2.5.4 Do not burn, trash, or waste materials onsite.

2.6 Rubbish Removal

- 2.6.1 The Contractor shall:
 - a. Keep the Work free from rubbish at all times.
 - b. Clean all enclosed structures daily.
 - c. Remove rubbish from the Site at least once a week.
 - 2.6.2 The Contractor shall not burn rubbish.
- 2.7 Discontinuance, Charges, and Removal
 - 2.7.1 Discontinue all temporary services required by the Contract when so directed by the Owner. The discontinuance of all temporary utility service prior to the completion of the Work shall not render the Owner liable for any additional cost as a result of the discontinuance.
 - 2.7.2 Remove and relocate such temporary facilities as directed by the Owner, and restore the Site and the Work to a condition satisfactory to the Owner.

2.8 Temporary Telephone Service

- 2.8.1 Arrange with the local telephone service company to provide a direct line telephone service to the construction site for the use of personnel and employees. Service required:
 - a. One direct line to the Field Office for Contractor's requirements.
 - Other instruments at the option of the Contractor, or as required by regulations.



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TEMPORARY UTILITIES

2.8.2 Pay all costs for installation, maintenance and removal, and service charges for telephone calls.

2.9 Temporary Sanitary Facilities

- 2.9.1 Provide adequate toilet and washing facilities for the use of personnel and employees; locate convenient to work areas.
- 2.9.2 Existing plumbing facilities shall not be used by construction personnel.
- 2.9.3 Facilities shall be portable chemical-type toilets or temporary flush toilets connected to a holding tank.
- 2.9.4 Service, clean and maintain facilities and enclosures in a neat, clean and sanitary condition.

3.0 INSTALLATION OF TEMPORARY UTILITIES

3.1 Installation

- 3.1.1 Contractor shall provide all labor and materials for temporary connections and distribution.
- 3.1.2 Comply with applicable requirements specified in Division 15 Mechanical and in Division 16 Electrical.
- 3.1.3 Make work structurally, mechanically and electrically sound throughout.
- 3.1.4 Install work in a neat and orderly manner.
- 3.1.5 Maintain and operate utility systems to assure continuous service, and to provide safe working conditions.
- 3.1.6 Modify and extend systems as work progress requires.

3.2 Removal

- 3.2.1 Completely remove temporary materials and equipment when their use is no longer required.
- 3.2.2 Clean and repair damage caused by temporary installations or use of temporary facilities.
- 3.2.3 Restor existing and permanent facilities used for temporary services to specified, or original conditions.

-- END OF SECTION --



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SITE SECURITY

SECTION 01540

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February 1, 1994

4

1.0 GENERAL

- 1.1 Scope
 - 1.1.1 This section covers minimum site security requirements.
 - 1.1.2 The Contractor is totally and wholly responsible for site security within the project limits and to the extent specified hereafter.
 - 1.1.3 Irrespective of any limitations to responsibility for site security specified hereafter, the Contractor is wholly and totally responsible for the security of Contractor-owned, -rented, or -supplied material and equipment no matter where it is located.

1.2 Site Conditions

1.2.1 Refer to the Drawings for site conditions and project layout.

1.3 Regulations

- 1.3.1 This specification requires compliance with all federal, state, local laws and regulations which may be applicable including the Occupational Safety and Health Act, Construction Safety Act as well as Rules, Regulations and Standards of the Secretary of Labor.
- 1.4 Submittals
 - 1.4.1 The following shall be submitted for approval in accordance with the contract documents:
 - a. Proposed formal security plan outlining Contractor implementation of the security requirements included in this specification section.
 - b. On a weekly basis, submit names and identify those persons designated with security responsibilities.
 - c. Maintain a security log describing functions performed over the duration of the project involving security of the site.
 - 1.4.2 Refer to Exhibit 01540-1, Schedule of Submittals.

2.0 SITE SECURITY

- 2.1 Security Program
 - 2.1.1 Contractor shall provide protection to the work site to prevent entry of unauthorized personnel.
 - 2.1.2 The Contractor shall initiate a program, in coordination with Owner's existing security program, at the start of construction mobilization.
 - 2.1.3 The Contractor shall maintain a program throughout the construction period until the Owner final acceptance precludes the need for Contractor security.



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SITE SECURITY

2.2 Entry Control

- 2.2.1 The Contractor shall restrict the entry of unauthorized personnel and vehicles within the Project Limits.
- 2.2.2 The Contractor shall maintain a primary entry location to the Controlled Access Zone (within project limits) and allow entry at that location to authorized persons with proper identification.
- 2.2.3 All authorized personnel entering or leaving the project limits will be logged in the job site log, which will be turned over to the Owner upon completion of the Project.
- 2.2.4 All discrepancies in the site log shall be reviewed and addressed on a day-to-day or shift-toshift basis by the Contractor. Any unresolved discrepancies will be addressed to the Owner or Owner's Designated Representative.
- 2.2.5 The Contractor and Contractor's security operations shall coordinate access to the site for the Owner's Designated and approved personnel.

2.3 Approved Personnel

- 2.3.1 The Owner shall supply the Contractor with a list of personnel who will be involved in the Project.
- 2.3.2 The support personnel entering the project limits for purposes of technical project support shall conform to project health and safety requirements.

2.4 Security Service

- 2.4.1 The Contractor shall maintain and provide security by outside personnel or members of his staff.
- 2.4.2 The site security services shall be maintained during all work shifts.
- 2.4.3 A formal security plan must be submitted by the Contractor for Owner's approval. The plan will indicate numbers to call in the event of an emergency and the proper procedures to follow in the case of equipment failure or repair.

2.5 Restrictions

- 2.5.1 Possession of a camera and the taking of pictures on the Owner's property are prohibited except with written approval by Owner.
- 7 5.2 All personnel entering the site must have personnel safety training and be monitored in accordance with Section 01011.3 or must be escorted by a person who is trained in accordance with Section 01011.3. Escorted visitors must be equipped with visitors dosimetry and be frisked out in accordance with Section 01011.3.2.

-- END OF SECTION --



01540-2



SITE SECURITY

EXHIBIT 01540-I SCHEDULE OF SUBMITTALS

completion

SPECIFICATION SUBMITTAL TITLE SUBMITTAL SCHEDULE 01540 1.4.1.a Security plan Within one week of project mobilization 01540 1.4.1.b Designated security plan Update on a weekly basis 01540 1.4.1.c Security log Delivery to Owner upon project





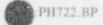
SECTION 01560

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01560-1	Schedule of Submittals		 E-01560)-1
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1.0 GENERAL

- 1.1 Scope
 - 1.1.1 Decontaminate all equipment and materials prior to permitting them to leave the project limits.

1.2 Site Conditions

1.2.1 Refer to construction drawings for site conditions and project layout.

1.3 Regulations

- 1.3.1 The current applicable regulations, ordinances, statutes or codes of the town, city, county or state in which the plan is located, the Federal Government, or other regulatory agency shall apply. Where this specification is more stringent than, and does not conflict with such regulations, ordinances, statues or codes, this specification shall govern. In addition, refer to:
 - a. 10 CFR 20.
 - b. NRC Regulation Guide 1-86.

1.4 Submittals

- 1.4.1 Submit detailed drawings and specifications for the decontamination pad, including the treatment and discharge control system.
- 1.4.2 Submit decontamination plan for equipment and personnel for normal and contingency conditions. Refer to Health and Safety Plan for requirements.

2.0 DECONTAMINATION PAD

- 2.1 General
 - 2.1.1 Materials used to construct decontamination pad shall conform to other material specifications contained in this document.
 - 2.1.2 Construct decontamination pad before starting any work which might contaminate equipment.

2.2 Design

- 2.2.1 Equip decontamination pad with high pressure steam washing equipment and recirculating water system and treatment plant designed for zero discharge. Collected water should be filtered to meet concentration limits for radioactivity in effluents to unrestricted areas as listed in 10 CFR 20, Appendix B, Table II.
- 2.2.2 Equip the decontamination pad with monitoring equipment as specified herein.



01560-1

3.0 OPERATION

- 3.1 General
 - 3.1.1 Clean all equipment with pressurized steam to minimize amounts of contaminated water. Do not use chelating agents or solvents unless specifically approved by owner.
 - 3.1.2 Perform appropriate smear surveys for loose contamination on accessible surfaces. As a minimum, contamination levels should not exceed levels given Exhibit 01560-II.
 - 3.1.3 Perform appropriate fixed contamination surveys. As a minimum, contamination levels should not exceed levels given in Exhibit 01560-II.
- 3.2 Disposal of Radioactive Waste
 - 3.2.1 Package all contaminated protective clothing, trash, etc. in DOT 17H drums or other package approved by Owner and store in designated waste storage area shown on drawings.

-- END OF SECTION ---



EXHIBIT 01560-1

SCHEDULE OF SUBMITTALS

EQUIPMENT AND MATERIAL DECONTAMINATION SECTION 01560

SPECIFICATION SECTION AND PARAGRAPH

SUBMITTAL TITLE

SUBMITTAL SCHEDULE

10 days prior to construction

01560 1.4.1

01560 1.4.2

Decontamination Pad Design

Decontamination Plan

Within 15 days (f award







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EXHIBIT 01560-II

NRC REGULATION GUIDE 1.86

EQUIPMENT AND DECONTAMINATION SECTION 01560

TABLE 1

ACCEPTABLE SURFACE CONTAMINATION LEVELS

MUCLIDE	AVERAGEDE	Maximuso d	REMOVABLES
U-net, U-235, U-238, and associated decay products	\$,000 dpm a/100 cm²	15,000 dpm a/100 cm ²	1,000 6 pm a/100 cm ²
Transuranics, Ra. 226, Ra. 228, Tb. 230, Tb. 228, Pa. 231, Ac. 227, 1-125, 1-129	100 dpm/100 cm ²	300 tpm/100 cm ²	20 d pcs/100 cm ²
Th-net, Tb-232, 5: 90, Rs-223, Rs-224, U-232, I-126, I-131, I-133	1000 d pm/100 cm ²	3000 d pm/100 cm ²	200 dpm/100 cm ²
Beta gamme emitten (nuclides enth decay modes other than alpha emission or spontaneous fission) except Sr-90 and others noted above.	5000 έραι β-γ/100 cm²	15,000 6 pcs \$-7/100 cm ²	1000 d pm \$-7/100 cm ²

Where surface contraination by both alpha- and beta-granma-amitting suchidor axists, the limits antablished for alpha- and beta-granma-constilling socialise about apply independently.

"As need in this table, dpm (disk sepre sions per selects) means the rate of emindoe by meloorthe an textel as determined by exerciting the encasts per minute shearved by an appropriate dranctor for background, efficiency, and group-stric factors associated with the Bartra men La cion.

"He name some ats of everyo contemporat should not be everyond over more than 1 apriles are the. For abjects of love perfore area, the pre rage th ould be derived for each such abject.

"The maximum one pushes too irvel applies to an area of not more than 100 em?.

"The arcore at of removable radioactive material per 100 cm² of merican area should be determined by whoing that area with dry filter or roll absorberst paper, applying moderate pressure, and amending the amount of actions the material on the whose with an appropriate betramont of knows efficiency. When memorphic enclusion on abjects of hen mark- area is determined, the pertinent break should be reduced proportionally and the on the perface should be whost.

SECTION 01580

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4.0	ADVERTISING AND BILLBOARDS	2
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EXHIBIT

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.0 GENERAL

- 1.1 Scope
 - 1.1.1 This section covers work required to provide, erect, maintain, and remove project signs which include:
 - a. Warning signs.
 - b. Traffic control signs.
 - c. Other signs necessary for performance of the project work.

1.2 Site Conditions

1.2.1 Refer to the Drawings for site conditions and project layout.

1.3 Regulations

- 1.3.1 The current applicable regulations as specified in Code of Federal Regulation, Title 29, Chapter 1910.145 (29 CFR 1910.145) and other ordinances, statutes or codes of the town, city, county or state in which the plant is located, the Federal Government, or other regulatory agency shall apply. Where this specification is more stringent than, and does not conflict with such regulations, ordinances, statues or codes, this specification shall govern.
- 1.3.2 The applicable regulations in Title 10 CFR, Part 20-203, "Caution Signs, Labels, Signals, and Controls".
- 1.4 Submittals
 - 1.4.1 The following shall be submitted for approval in accordance with the Contract documents:
 - a. Submit shop drawings for all signs showing content, layout, lettering, colors, foundation, structure, and size of signs prior to mobilization.

1.5 Quality Control/Assurance

- 1.5.1 Signs and structure/mounting supporting signs will be of material that is able to withstand 50 mph wind velocity.
- 1.5.2 Sign materials of construction will be adequate to withstand weathering, fading, and chipping for duration of project.

2.0 MATERIALS

- 2.1 General
 - 2.1.1 Materials of construction shall be exterior grade medium density plywood overlay with minimum thickness of 3/4 inch, or 20 gauge minimum galvanized steel or as approved by Owner.



01580-1



- 2.1.2 Dimensions of all signs shall be of a minimum 10" x 14" size.
- 2.1.3 Rough hardware shall be of galvanized steel or aluminum construction.
- 2.1.4 Paint, primer, and surface materials shall be of exterior quality. All painted surfaces are to consist of two coats of paint.
- 2.1.5 Lettering shall be of a minimum height of 1" in the vertical type or as approved by Owner.
- 2.1.6 All sign surfaces and lettering are to consist of contrasting colors as appropriate.

3.0 PROJECT SIGNS

- 3.1 Installation
 - 3.1.1 Project signs are to be installed within 10 days after start of mobilization onsite.
 - 3.1.2 Erect or mount signs at locations designated on the project drawings such that signs are of high visibility and placement does not obstruct personnel, vehicular traffic, or plant operations.

3.2 Maintenance

- 3.2.1 Maintain signs and supports in a clean condition. Repair signs resulting from deterioration and damage for the duration of project.
- 3.3 Removal
 - 3.3.1 Remove signs, framing and supports at the completion of project or as instructed by the Owner and restore area to original condition.

4.0 ADVERTISING AND BILLBOARDS

- 4.1 General
 - 4.1.1 No advertising or billboard signs are to be permitted on or around the project site.

-- END OF SECTION --

EXHIBIT 01580-I SCHEDULE OF SUBMITTALS

SPECIFICATION SECTION AND PARAGRAPH

SUBMITTAL TITLE

SUBMITTAL SCHEDULE

01580 1.4.1a

Shop Drawings - project Prior to mobilization signs



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MATERIALS AND EQUIPMENT

SECTION 01600

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	2.1 Storage and Protection	





01600-i

MATERIALS AND EQUIPMENT

1.0 GENERAL

1.1 Scope

1.1.1 This section describes requirements and procedures for storage of material and equipment on the Site.

1.2 Site Conditions

1.2.1 Contractor shall store material and equipment at location(s) shown on the Drawings.

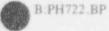
1.3 Regulations

- 1.3.1 The current applicable regulations, ordinances, statutes or codes of the town, city, county or state in which the plant is located, the Federal Government, or other regulatory agency shall apply. Where this specification is more stringent than, and does not conflict with such regulations, ordinances, statues or codes, this specification shall govern.
- 1.4 Quality Control/Assurance
 - 1.4.1 Contractor shall store and protect equipment and material as required to insure that the quality and useability of the items is not adversely effected.

2.0 STORAGE OF MATERIAL AND EQUIPMENT

- 2.1 Storage and Protection
 - 2.1.1 Materials stored on the Site shall be neatly piled and protected, and shall be stored in an orderly fashion at locations shown on the Drawings.
 - 2.1.2 Should it become necessary during the course of the Work to move materials or equipment stored on the Site, the Contractor, at the direction of the Owner or the Owner's Representative, shall move such materials or equipment.

-- END OF SECTION--



01600-1

SUBSTITUTIONS AND PROJECT OPTIONS

SECTION 01640

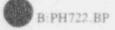
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SECTION

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		20000



1.0 GENERAL

1.1 Scope

1.1.1 Furnish and install the products specified, under the options and conditions for substitutions stated in this Section.

1.2 Site Conditions

1.2.1 Refer to Section 01011 - Specified Conditions and Procedures, and Drawings for site conditions.

1.3 Regulations

1.3.1 Contractor shall insure that substitutions and product options comply with all federal, state, local laws, regulations and codes which may be applicable to construction of the Work.

1.4 Submittals

- 1.4.1 The following shall be submitted for approval in accordance with the Contract documents:
 - a. Within fifteen (15) days after the award of Contract, submit to the Owner's Representative five copies of a complete list of products which are proposed for installation.
 - b. Tabulate the products by listing under each specification section title and number.
 - c. For products specified only by reference standards, list for each such product:
 - 1. Name and address of the manufacturer
 - 2. Trade name
 - 3. Model or catalog designation
 - 4. Manufacturer's data:
 - -- Reference standards
 - -- Performance test data
- 1.4.2 Refer to Exhibit 01640-1 Schedule of Submittals.

1.5 Quality Control/Assurance

1.5.1 Contractor shall be responsible for maintaining and insuring quality control of all substitutions and product options.

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SUBSTITUTIONS AND PROJECT OPTIONS

2.0 SUBSTITUTIONS AND PRODUCT OPTIONS

2.1 Contractor's Options

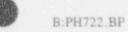
- 2.1.1 For products specified only by reference standard, select any product meeting that standard, by any manufacturer.
- 2.1.2 For products specified by naming several products or manufacturers, select any one of the products and manufacturers named.
- 2.1.3 For products specified by naming one or more products or manufacturers and stating "or equal," the Contractor shall submit a request as for substitutions, for any product or manufacturer not specifically named. Such substitution shall have been listed on Bid Form as required in Instructions to Bidders. If not so listed, no substitution will be allowed.
- 2.1.4 For products specified by naming only one product and manufacturer, there is no option and no substitution will be considered unless it was listed on the Bid Form as provided in the Instructions to Bidders.

2.2 Substitutions

- 2.2.1 Submit a separate request for each substitution in triplicate. Support each request with:
 - a. Completed "Data for Evaluation of Materials, Products, and Systems" on form obtained from the Owner.
 - b. Complete data substantiating compliance of the proposed substitution with requirements stated in Contract Documents:
 - 1. Product identification, including manufacturer's name and address
 - 2. Manufacturer's literature; identify:
 - -- Product description
 - Reference standards
 - -- Performance and test data
 - 3. Samples, as applicable
 - 4. Name and address of similar projects on which product has been used, and the date of each installation
 - c. An itemized comparison of the proposed substitution with the product specified

1. List any variations

d. Data relating to any changes in the construction schedule



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SUBSTITUTIONS AND PROJECT OPTIONS

- e. The effect of the substitution on other work specified by the Project
- f. List any changes required in other work or projects
- g. Designate any required license fees or royalties
- h. Designate availability of maintenance services, source of replacement materials
- 2.2.2 Substitutions shall not result in additions to the Contract Sum.
- 2.2.3 Substitutions will not be considered when:
 - a. They are indicated or implied on shop drawings or product data submittals without a formal request from the Contractor.
 - b. They are requested by a subcontractor or supplier without the Contractor's prior concurrence and submission to the Owner.
 - c. The acceptance will require substantial revision of Contract Documents.
- 2.2.4 Substitute products shall not be ordered or installed without written acceptance by the Owner.
- 2.2.5 The Owner shall be the sole judge of the acceptability of the proposed substitution.

2.3 Contractor's Representation

- 2.3.1 In making a formal request for a substitution, the Contractor represents that:
 - a. He has personally investigated the proposed product and has determined that it is equal to or superior in all respects to that specified.
 - b. He will provide the same warranties or bonds for the substitution as for the product specified.
 - c. He will coordinate the installation of an accepted substitution into the Work, and will make such changes as may be required for the Work to be complete in all respects.
 - He waives all claims for additional costs related to the substitution which may subsequently become apparent.

2.4 Owner's Duties

2.4.1 Review Contractor's request for substitutions with reasonable promptness and notify the Contractor of the decision for acceptance or rejection of the request for substitution.

-- END OF SECTION --



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DIVISION 2 SITE WORK

DIVISION 2 Site Work

Section	Title
02220	Excavation and Backfill
02221	Sludge Mobilization
02712	Pipe Underci vins
02720	Storm Drainage Systems
02831	Fences and Gates
02940	Seeding and Mulching



SECTION 02220

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SECTION PAGE

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	Backfilling Schedule															
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1.0 GENERAL

1.1 Scope

- 1.1.1 This work shall consist of excavation, construction of embankments, placement, grading, and compaction which is within the project limits necessary for the project construction in accordance with the specifications and in conformity with the lines, grades, thicknesses and typical cross sections shown on the project plans or established by the Owner.
- 1.1.2 As used in these specifications the term lift refers to the volume of soil placed and compacted in a continuous operation within a single shift.
- 1.1.3 A test fill pad (or pads) shall be constructed for soils to be used in the low-permeable liner system.

1.2 Site Conditions

1.2.1 The contractor shall remove all debris, all excavated materials and leave the site in a neat and presentable condition throughout daily and upon completion of the work.

1.3 Regulations

1.3.1 This specification requires compliance with all federal, state, local laws and regulations which may be applicable including the Occupational Safety and Health Act, Construction Safety Act as well as Rules, Regulations and Standards of the Secretary of Labor.

1.4 Submittals

- 1.4.1 The following shall be submitted for approval in accordance with the contract documents:
 - a. Test results for maximum dry density, optimum moisture content, and in-place density tests using test methods specified in this section.
 - b. Gradation, modified proctor, and Atterberg Limits test results of proposed borrow material using test methods specified in this section.
 - c. Proposed testing agency and qualifications.
 - d. Results of tests for compacted clay materials using test methods and procedures as specified in the "Work Plan Test Fill" supplied with these contract documents.
 - e. Documented evidence including surveys, test borings and test pits that sufficient borrow volume is available to complete the project.

- f. Documented evidence by the test methods specified below that the material is free of chemical contamination.
 - 1. Volatile Organics; Method 8240 (Gas Chromatography/Mass Spectroscopy).
 - 2. Total Petroleum Hydrocarbons; by NYSDOH Method.
 - 3. TCLP List Constituents (including acrylonitrile).
 - 4. Total metals per EPA Method 200.7/601/J, and EPA Method 335.2 for cyanide.

1.5 Quality Control/Assurance

- 1.5.1 The following tests are to be taken on the proposed fill material, prior to start of backfill operations for each 1,000 cubic yards of material placed, and when a source has changed or there is an apparent change in material characteristics:
 - Maximum dry density and optimum moisture content per ASTM D 1557 (modified proctor).
- 1.5.2 The Contractor shall provide a written verification, based on requirements of 1.4 of this section, that there is sufficient borrow material available, free of chemical contamination, and has concentrations of metals below those established for background at the site.



- b. Gradation per ASTM D-422 (Full Sieve Analysis).
- c. The following Atterberg Limit Tests on Select Backfill:
 - 1. ASTM D 423, AASHO T-89 Liquid Limit
 - 2. ASTM D 424, AASHO T-90 Plastic Limit
 - 3. ASTM D 424, AASHO T-91 Plasticity Index
- Hydraulic conductivities per EPA SW 846; (Falling Head Method), for drainage materials.
- 1.5.2 The following field tests are to be made during backfill operations; minimum four per lift or one per 100 cy whichever is greater, at locations directed by the Owner:
 - a. In-place density of soil, per either ASTM D 1556, D 2167, or D 2922, which shall be a minimum of 95 percent maximum density as obtained by ASTM D 1557. Nuclear testing of in-place densities must be checked by one of the other methods each day of backfilling and compaction activities.
 - b. Moisture content of soil sample per ASTM D 2216 or D 3017, shall be at an optimum to +4 percent.
 - c. Contractor must provide surveyed coordinates of each test location to owner.
- 1.5.3 All testing shall be performed by an independent testing agency to be engaged by contractor, qualified in performing the prescribed test.
- 1.5.4 The Contractor quality assurance represented' a must observe backfilling and compaction operations for conformance with these specifications.
- 1.5.5 The contractor shall provide a grid system and the means to establish one, tied to the site coordinate system, that can be used for locating the extent of each lift and sample locations. Elevations will be included with each grid point and tied to the site bench mark elevations.
- 1.5.6 Contractor shall locate the coordinates of the corners of each iff and it's elevation to the established grid system. This work shall be completed at least once for each shift for lifts that are constructed in multiple shifts.
- 1.5.7 Volumes to determine testing frequency are to be based on as compacted volumes of material placed.
- 1.5.8 Testing required for Test Fill Pad Construction shall be as specified in the "Work Plan Test Fill" included with these contract documents.



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2.0 EXCAVATION

2.1 General Excavation

- 2.1.1 The excavation shall conform to the dimensions and elevations indicated on the drawings or as directed by the Owner, or his designated representative.
- 2.1.2 Where the excavation is made below the elevations indicated on the drawings, after approval by the Owner, or his designated representative, the excavation shall be restored to the proper elevation in accordance with the procedures specified for backfill.
- 2.1.3 Excavation shall extend a sufficient distance from walls and footings to allow for placing and removal of forms, installation of services and for inspection, except where the concrete for the walls or footings is to be deposited directly against excavated surfaces or shoring.
- 2.1.4 Undercutting of footings or walls shall not be permitted.



- 2.1.5 Where sidewall material is unsuitable to stand without caving as determined by a Ohioregistered engineer, it shall be shored, sloped, or stepped to prevent sliding into excavations. Comply with OSHA Guidelines related to excavations and trenches.
- 2.1.6 The bottom of all excavations shall be properly leveled off and all loose material shall be removed before the liner system or backfill is placed.
- 2.1.7 Excavations shall be kept free from water, other liquids and debris until the installation and backfill have been completed and approved.
- 2.1.8 Excavation for underground work shall generally be to the depth indicated on the engineering drawings.
- 2.1.9 Where excavation is required for many footings in the general area, the entire area may be excavated when approval by BP Chemicals, Inc.
- 2.1.10 An imaginary 45° line extending downward and outward from the bottom edge of any existing foundation shall not intersect any intended excavation for adjacent foundation or utilities, unless noted otherwise on the design drawings.

2.2 Shoring and Protection

- 2.2.1 The contractor shall assume full responsibility for maintaining the stability of all excavated faces until final acceptance of the work.
- 2.2.2 The slope of embankments and various methods of shoring, bracing and underpinning shall be subject to Contractor approval unless specifically detailed on the drawings.
- 2.2.3 The contractor shall place and maintain all temporary fences, guard rails, barricades, lights and other protective measures required for the safety of the premises.

2.3 Excavated Material

- 2.3.1 Excavated material which is approved for backfill shall be stockpilled at a location adjacent to the construction site or as directed by the Owner, or his designated representative.
- 2.3.2 Excavated material which is considered contaminated shall be handled in accordance with Section 01100, "Health and Safety Requirements" and the Project Health and Safety Plan.
 - a. All contaminated material shall be handled within the designated controlled access zone (project limits). No material or equipment that has been exposed to contaminated material shall be allowed out of the controlled access zone until it has been decontaminated in accordance with Section 01560, "Decontamination Procedure", and approval is granted by the Owner or his designated representative.
 - All excavation work involving contaminated materials shall be done with the material in a wet (or saturated) state.



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- c. Transfer of contaminated material shall be done using a closed conveying system, (or equivalent). Transference of contaminated soil in standard dump trucks or by open conveyer shall be permitted only with approval by the Owner or his designated representative.
- 2.3.3 All surplus clean backfill and unapproved materials shall be transported off the site and shall be at the contractor's expense.

2.4 Bottom of Cut

2.4.1 Where soft, unstable or otherwise unsuitable material is encountered at the bottom of the cut, after approval by the Owner, or his designated representative, excavation shall continue to suitable soil and the cut then refilled to the required elevation with suitable material and compacted as specified for backfill.

2.5 Piping and Culverts

- 2.5.1 The bottom of trenches shall be graded and compacted where required to give equal bearing along the bottom of the pipe. A minimum six inch layer of bedding sand or gravel shall be provided.
- 2.5.2 Trenches shall be of sufficient width to provide a six inch minimum clearance between outside of pipe and trench wall.

2.6 Cable Trenches

- 2.6.1 Unless specified otherwise on drawings, minimum invert trench elevation for cable not in conduit shall be three feet six inches.
- 2.6.2 Treaches shall be reasonably smooth and free of projecting rocks, etc, and with a minimum six inch layer of approved bedding materials.
- 2.6.3 Changes in trench direction or elevation shall be such that the permissible bending radius of the cables are not exceeded.

3.0 BACKFILLING AND GRADING

3.1 General

- 3.1.1 A test fill pad is to be constructed for each type of borrow material to be used as a low-permeability soil in the liner and cap systems. The construction of the test fill will be in accordance with the "Work Plan Test Fill" included with these contract documents. Currently _______c.y.s. of material as is available for the V-1 Cell liner construction (a test fill has been constructed using this material and it has met the required criteria).
- 3.1.2 After completion and approval of subsurface installations, and prior to backfilling, the excavation shall be cleared of all water, ice, snow, trash and debris.



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- 3.1.3 Materials for backfilling (see Section 3.2 and Exhibit I) shall consist of approved excavation material, and shall be free of rock, trash, lumber or other debris.
- 3.1.4 The cost of purchased backfill, if required, and testing for determining its suitability shall be the responsibility of the contractor.





3.1.5 Immediately prior to installation of the designed compacted clay layer, observe the supporting surface. Where soft, unstable or otherwise unsuitable material is encountered at supporting surface, after approval by the Owner, or his designated representative, corrective measures as directed by the engineer will be taken. The integrity of the underlying materials is the responsibility of the Contractor.

3.2 Backfill

- 3.2.1 Backfill shall not be placed until the excavation has been inspected by the Owner, or his designated representative and approval given to proceed.
- 3.2.2 Excavated areas shall be backfilled to the grade designated on the engineering drawings.
- 3.2.3 Backfill material shall be obtained from excavated soil, surplus earth from grading or from a designated suitable source that conforms to the following requirements:
 - a. Type A Bank Run Gravel with the following minimum gradation:

Sieve Size	Percent Passing
2 inches	100
1 inch	95 to 100
3/4 inch	95 to 100
5/8 inch	75 to 100
3/8 inch	55 to 85
No. 4	35 to 60
No. 16	15 to 35
No. 40	10 to 25
No. 200	5 to 10

b. Type B-Pea Gravel, washed, graded in accordance with ANSI/ASTM C 136 to the following:

> Minimum Size 1/4 inch Mazimum Size 5/8 inch

- c. Type C 1 inch to dust crushed limestone.
- d. Type D Sand, natural river or bank sand, washed, free of silt, clay loam, friable, soluble, or organic materials; graded in accordance with ANSI/ASTM D-422, within the following limits:

Sieve Size	Percent Passing
1/4 inch 50	0-100 percent 0-35
100	0-:0



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- e. Type E Select Backfill; a granular material, maximum particle size of 3 inches graded from coarse to fine, conforming to classification A-1, A-2-4, A-2-5, or a sandy or gravely clay conforming to classification A-2-6 or A-6 with the exception that the plasticity index shall not exceed 20.
- f. Type F Unit fill shall be free draining crushed stone or coarse gravel with the following gradation:

Maximum Size: 3/4 inch No more than 10% passing No. 200 sieve

- g. Type G Rounded Stone Fill used for pipe underdrains shall exhibit the following properties:
 - 1. Bc graded as follows:

Sieve Size	Percent Passing
1 inch	100
3/4 inch	0

- Have a hydraulic conductivity of 20 cm/sec or greater per EPA Method SW 846 (Falling Head Method).
- 3.2.4 Materials having all of the following characteristics shall be acceptable for use as compacted clay low-permeability material on this project (pending acceptable Test Fill Pond results).
 - a. Are from approved borrow sources or from required project excavation.
 - b. Classified according to ASTM D 2487 as CL or CH.
 - c. Contain at least 60-percent fines (minus No. 200 sieve size).
 - d. Have a liquid limit greater than 25 percent and a plasticity index greater than 10 but less than 40.
 - e. Have no more than 10-percent gravel-size particles, with a maximum particle size of less than 2 inches.
 - f. Are free of organic matter and debris.
 - g. Have a maximum nominal clod size of 2 inches before placement for compaction.
 - h. Are within the specified moisture range immediately before compaction.
 - i. Have a hydraulic conductivity of 1.0 x 10⁻⁷ cm/sec or less per EPA Method SW 846, (Falling Head Method).
- 3.2.5 Materials having the characteristics listed for "Type B" or "Type D" material shall be acceptable for use as drainage materials of the cap with the following addition:

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- Have a hydraulic conductivity of 1.0 x 10⁻² or greater per EPA Method SW 846, (Falling Head Method).
- 3.2.6 Type G backfill shall be placed in a dry state (i.e., the sand and clay mixture must be dry before and immediately prior to placement).
- 3.2.7 Materials having all of the following characteristics shall be acceptable for use as topsoil on this project:
 - a. Free of roots, rocks, larger than 1/2" in diameter, subsoil, debris, large weeds, and foreign matter.
 - b. Acidity range (pH) of 5.5 to 7.5.
 - c. Containing a minimum of 4 percent, and a maximum of 25 percent inorganic matter.
- 3.2.8 Backfill shall be placed symmetrically to prevent eccentric loading upon or against structures.
 - a. Backfill, including trench backfill, shall be placed in horizontal layers not to exceed eight inches in loose thickness and shall have the proper moisture content for the required degree of compaction and the top one inch of subgrade shall be scarified prior to backfill placement.
 - b. Large fills compacted with tractor drawn compactors may be placed in layers not to exceed 8 inches in loose thickness, subject to the provision of 3.2.7 a, and a uniform surface shall be maintained during compaction operations in order to insure compaction of the entire layer.
 - c. Each layer shall be compacted by hand or machine tampers or other suitable equipment to at least 95 percent of maximum dry density at optimum moisture content to +4 percent of optimum as determined by ASTM D-1557 unless noted otherwise on drawings. Each layer shall achieve the required density before proceeding with the next layer. If the material fails to meet the required density, the material shall be reworked, replaced or construction methods altered as necessary to obtain the required density.
 - d. Any areas improperly backfilled, or where settlement occurs, shall be reopened to the depth required for proper compaction, refilled and compacted with the surface restored to the required grade and compaction.
 - e. Low-permeable soil being placed for liner and cap systems shall be done in a consistent manner with the results of the respective test fill pad.
 - f. Protective sand layer must be compacted with hand operated plate vibrator.

- 3.2.9 Backfill placed against or around pavement, piles, sewers, utility structures and similar facilities shall, within six inches of such structures, contain no particles exceeding two inches in largest dimension.
- 3.2.10 Pipe joints shall be left exposed until required tests have been performed and in the case of concrete pipe for at least 24 hours after the joint is made.
- 3.2.11 Construction equipment or other vehicles shall not cross over culverts until the fill has reached a depth of 1/5 the diameter or nine inches, whichever is greater, over the top of the culvert.
- 3.2.12 Heavy equipment shall not be used closer to a foundation than a distance equal to the height of the backfill unless approved in writing by the Owner.
- 3.2.13 No backfill shall be placed against foundations for at least 3 days after pouring concrete.
- 3.2.14 The minimum earth cover above pipe in trenches shall be as follows or as indicated on the contract drawings:

Pipe Size	Cover
6 inches and smaller	6 inches
8 inches to 12 inches, incl.	12 inches
14 inches to 22 inches, incl.	18 inches
24 inches and larger	24 inches

3.2.15 Fill shall not be frozen nor should fill be placed on frozen subgrade.

- a. Protect fill surfaces from freezing including final lifts of compacted clay liners and cap materials.
- 3.2.16 Provide final survey of locations and elevations of final surfaces of clay liner, leak detection and leachate collection trenches and each cap layer. Survey must include coordinates and elevations of all grade change points and a grid no greater than 25 feet square. Survey must be plotted on an appropriately scaled map.

-- END OF SECTION--

EXCAVATION AND BACKFILL

EXHIBIT 02220-I BACKFILLING SCHEDULE

ELEMENT	BACKFILL TYPE	COMPACTION REQUIREMENTS	COMMENTS
Under collection/ detection and drain pipes	Type A or B G	95 percent	Hand consolidate to stabilize material
Pipe culvert trench and drainage structures except when under road when under road or cells	Турс А	90 percent	Top with topsoil if in grassy area, seed and mulch, Modified Proctor
Pipe culvert trench and drainage structures under road	Type C	95 percent	Modified Proctor
Low-permeability Compacted Clay layers	Low-permeable material Compacted clay	95 percent	Modified Proctor, and per respective Test Fill Pond results.
Drainage Layer	Type B, D, and G with acceptable hydraulic conductivities	As shown on project plans	Material placed using loader or bulldozer to achieve a medium dense state
Protective Sand Layer	Type D	95 percent	Must be compacted with a hand held plate vibrator
Select Backfill	Туре Е	85-95 percent	Visually inspected by Owner or Representative
Under Foundations	Type A	95 percent	Modified Proctor
Around Foundations	Type E	90 percent	Modified Proctor



EXCAVATION AND BACKFILL

EXHIBIT 02220-II SCHEDULE OF SUBMITTALS

SPECIFICATION SECTION AND PARAGRAPH	SUBMITTAL TITLE	SUBMITTAL SCHEDULE
02220 1.4.1a	Field test reports	Within one week of completion of testing or inspection
02220 I.4.1b	Borrow material test reports	Prior to use 45 days prior to placement, changes in source, or appearance, and for each 1000 cubic yards of material placed.
02220 1.4.1c	Testing agency and qualifications	Prior to use 10 days after award of contract
02220 1.4.1d	Results of permeability tests	45 days prior to use of low- permeability compacted clay and drainage materials (refer to Requirements of Test Fill)
02220 1.4.1e	Documentation of sufficient borrow material	With borrow test reports 1.4.1.b
02220 1.4.2	Analytical results of compacted clay and Type E- select backfill sources	30 days prior to placement, changes in source, or appearance, and for each 1000 cubic yards of material placed

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EXHIBIT

NEXTI-I DEMEMBER OF STORAGE CONTRACTOR CONTR	02221-I	Schedule of Submittals	***************************************	E-02221-I
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1.0 GENERAL

- 1.1 Scope
 - 1.1.1 This work consists of removal of sludges from ponds and movement and placement to the stabilization system for processing.
 - 1.1.2 This section addresses requirements for moving sludge from the Burn and Deepwell Ponds to the Sludge Processing Area. The contractor is required to present a cost effective means and method for the safe and productive movement of the sludge.
 - 1.1.3 The work includes provision of on-site spill control, containment and countermeasure equipment.
- 1.2 Site Conditions
 - 1.2.1 The Contractor shall maintain the work in a clean and workmanlike manner and contain and remove all spilled and leaked material immediately.
 - 1.2.2 Provide access control to work area prior to starting any sludge mobilization operations.
- 1.3 Regulations
 - 1.3.1 The current applicable regulations, ordinauces, statutes or codes of the town, city, county or state in which the plan is located, the Federal Government, or other regulatory agency shall apply. Where this specification is more stringent than, and does not conflict with such regulations, ordinances, statues or codes, this specification shall govern.
 - 1.3.2 Comply with owner's regulations and requirements for Contractors.
- 1.4 Submittals
 - 1.4.1 Submit detailed plan, procedures and shop drawings for proposed sludge movement including:
 - a. Listing of equipment.
 - b. Operating requirements.
 - c. Control systems.
 - d. Transfer systems.
 - e. Productivity.
 - 1.4.2 Subrat Spill Control, Containment and Countermeasure Plan.
 - 1.4.3 Submit daily records of quantity of sludge transferred.

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2.0 EXECUTION

2.1 General

- 2.1.1 Do all transfer operations under manual control. Operator must be in visual contact with transfer operations or in verbal or radio contact with individuals who are in visual contract with transfer operations at all times.
- 2.1.2 Continue sludge removal until color of material being removed clearly demonstrates that clay bottom has been reached. Determination of color change or the presence of clay soils must be confirmed by Owner's Engineer.
- 2.1.3 Stop operations whenever there is evidence of leak or spill.
- 2.1.4 All excavation and movement of sludge shall be performed under wet or saturated conditions.
- 2.1.5 If sludge is pumped it shall be done in double contained piping (a pipe within a pipe).

-- END OF SECTION--



EXHIBIT 02221-I SCHEDULE OF SUBMITTALS

SPECIFICATION SECTION AND PARAGRAPH	SUBMITTAL TITLE	SUBMITTAL SCHEDULE
02221 1.4.1	Sludge Mobilization Plan and Shop Drawings	10 days before start of mobilization work
02221 1.4.2	Spill Control, Containment and Countermeasures Plan	10 days before start of work
02221 1.4.3	Daily Records	Within 24 hours





SECTION 02712

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1.0 GENERAL

- 1.1 Scope
 - 1.1.1 The work included in this section of the specifications shall consist of furnishing and installing pipe underdrains to be used as part of the leachate collection, leak detection, and perimeter drainage systems.
- 1.2 Site Conditions
 - 1.2.1 See construction drawings for prepared grades and project layout.
- 1.3 Regulations
 - 1.3.1 The current applicable regulations, ordinances, statutes or codes of the town, city, county or state in which the plant is located, the Federal Government, or other regulatory agency shall apply. Where this specification is more stringent than, and does not conflict with such regulations, ordinances, statues or codes, this specification shall govern.
- 1.4 Submittals
 - 1.4.1 The following shall be submitted for approval in accordance with the contract documents:
 - a. Product data; provide data on pipe and pipe accessories.
 - b. Refer to Exhibit 02712-I for Schedule of Submittals.
- 1.5 Quality Control/Assurance
 - 1.5.1 The Subcontractor shall verify that field measurements and elevations are as indicated on contract drawings.

2.0 MATERIALS

- 2.1 Pipe
 - 2.1.1 PVC pipe shall be Schedule 80 PVC with bell end or couple end joints of the size and diameter shown on the contract drawing, unless otherwise noted, and meet the following:
 - ASTM D 1784 Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds.
 - ASTM D 1785 Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80 and 120.
 - ASTM D 3139 Specifications for Joints for Plastic Pressure Pipes Using Elastomeric Seals.
 - d. ASTM D 3034 Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings.

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- e. ASTM F 412 Definitions of Terms Relating to Plastic Pipe Systems.
- 2.1.2 PVC pipe solvent cements and primers shall be in conformance with ASTM D 2564 and shall be used as per the pipe and solvent manufacturers' recommendations.
- 2.1.3 PVC pipe perforations shall be half inch diameter (max.).

3.0 STORAGE AND HANDLING

- 3.1 When pipe is received in standard lifts, it should remain in the lift until ready for use. Lifts should not be stacked more than three high and should always be stacked wood on wood. Loose pipe must be stored on racks with a minimum support spacing of 3 feet. Pipe must be shaded but not covered directly when stored outside in high ambient temperatures. This will provide for free circulation of air and reduce the heat buildup due to direct sunlight exposure. Care shall be exercised during loading, unloading, and in transit to ensure that the pipe is not damaged by abrasion or sharp edges.
- 3.2 Fittings should be stored in their original cartons to keep them free of dirt and reduce the possibility of damage. If possible, fittings should be stored indoors.
- 3.3 Solvent cements have a definite shelf life and each can and carton is clearly marked with a date of manufacture. PVC cement must be used within 2 years of the date of manufacture. Solvent cements and primers should be stored in a relatively cool shelter away from direct sun exposure.
- 3.4 Care shall be exercised to avoid rough handling of thermoplastic pipe and fittings. They must not be dragged over sharp projections, dropped, or have objects dropped upon them. Pipe ends shall be inspected for cracks resulting from such abuse. Transportation by truck or pipe trailer will require that the pipe be continuously supported, and all sharp edges on the trailer bed that could come in contact with the pipe must be padded.
- 3.5 Keep containers for solvent cements tightly closed except when in use. Avoid prolonged breathing of solvent vapors, and when pipe and fittings are being joined in partially enclosed areas, use a ventilating device to attenuate vapor levels. Keep solvent cements. primers, and cleaners away from all sources of ignition, heat, sparks, and open flames.
- 3.6 Care shall be exercised during loading, unloading, and in transit to ensure that the pipe is not damaged by abrasion or sharp edges.

4.0 PIPE DRAIN BEDDING

- 4.1 Following excavation of the trench, geofabric, (having material properties that are in conformance with Section 13400), shall be placed in the trench.
- 4.2 A bed of filter and bedding material, (having material properties that are in conformance with Section 02220), shall be placed on the fabric. The depth of the material shall be as shown on the construction drawings or as indicated in Section 02220.

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5.0 PIPE DRAIN INSTALLATION

- 5.1 The pipe shall be placed on the filter and bedding material to the established line and grade.
- 5.2 Pipe shall be laid with the perforations at the lower quarter points of the section.
- 5.3 Jointing of pipe and closure of upstream ends shall be made with the specified couplings and end caps. The downstream end of the pipe shaft shall be connected to the drainage structures by methods recommended by the manufacturer.

6.0 BACKFILLING

- 6.1 The trench shall be backfilled with filter material to the specified depth. Care shall be taken to avoid damage or displacement of the pipe. Fabric shall be folded into place and lapped as shown on the construction drawings. Excess fabric shall be trimmed and removed.
- 6.2 Backfilling of the underdrain shall be completed by placing soil above the fabric. Backfill material and compaction, and the fabric material shall be as specified in other sections of these specifications.

-END OF SECTION--

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EXHIBIT 02712-1 SCHEDULE OF SUBMITTALS

SPECIFICATION SECTION AND PARAGRAPH

SUBMITTAL TITLE

SUBMITTAL SCHEDULE

02712 1.4.1a

Product data on pipe underdrains and accessories Ten days prior to their use



STORM DRAINAGE SYSTEMS

SECTION 02720

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EXHIBIT

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STORM DRAINAGE SYSTEMS

1.0 GENERAL

- 1.1 Scope
 - 1.1.1 The work included in this section of the specifications shall consist of furnishing and installing storm drainage facilities, and repairs and modifications of existing structures as required. This work shall also include cleaning of existing facilities.

1.2 Site Conditions

1.2.1 See construction drawings for prepared grades and project layout information.

1.2.2 The contractor shall be responsible for the proper control and containment of stormwater in and around the work areas during construction.

1.3 Regulations

- 1.3.1 The current applicable regulations, ordinances, statutes or codes of the town, city, county or state in which the plant is located, the Federal Government, or other regulatory agency shall apply. Where this specification is more stringent than, and does not conflict with such regulations, ordinances, statues or codes, this specification shall govern.
- 1.4 Submittals
 - 1.4.1 The following shall be submitted for approval in accordance with the contract documents:
 - a. Product data; provide data on storm drainage products and accessories.
 - b. Refer to Exhibit 02720-I for Schedule of Submittals.

1.5 Quality Control/Assurance

1.5.1 The Contractor shall verify that field measurements and elevations are as indicated on contract drawings.

2.0 MATERIALS

- 2.1 Reinforced Concrete Pipe (RCP)
 - 2.1.1 RCP, bell and spigot with compression type joints shall conform to ASTM C 76, Class III, Wall B.
 - 2.1.2 RCP joint gaskets shall be Neoprene O-Ring Gaskets conforming to ASTM C 443.

2.2 Construction Castings

2.2.1 Construction castings shall be E. L. LeBaron No. LA-244 frame and cover for manholes and No. LAG-244 frame and grate with 151 square inch water pass area for catch basins, or Owner approved equal.



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2.3 Granular Fill (Gravel Bedding)

2.3.1 Granular fill used shall be Type A or B as specified in Section 02220.



STORM DRAINAGE SYSTEMS

- 5.1.2 Pipe shall be protected during handling against impact shocks and free fall. The Contractor shall furnish and use the necessary facilities for lowering the pipe into the trench in a manner that will not damage or disturb either the pipe or the trench.
- 5.1.3 Except by special permission, no pipe shall be laid except in the presence of the Owner or his designated representative. No pipe shall be laid unless the trench subgrade is in a condition satisfactory to the Owner or his designated representative. Pipe shall not be laid on frozen ground or when the condition of the trench or the weather is unsuitable for such work. Pipe shall be kept clean at all times.
- 5.1.4 Keep trenches dry during pipe laying.
- 5.1.5 Clean joint contact surfaces immediately prior to jointing. Use cleaner, solvents and other jointing or coating material such as lubricants, primers, cements, mortars, adhesives as recommended by the pipe or pipe coating manufacturer.
- 5.1.6 Care shall be taken to protect the pipe from the intrusion of foreign materials during installation.
- 5.1.7 When the laying of the pipe has stopped for the day, all joints shall be finished. When pipe laying is not in progress, the ends of the pipe line shall be kept closed to prevent the accumulation of any debris or dirt inside the pipe.

6.0 BACKFILLING TRENCHES

- 6.1 Unless otherwise directed, backfill trenches immediately after the pipe is tested and accepted. Do not permit water to rise in trenches after the pipe is in place. In process areas and under roads backfill to grade to 95 percent compaction.
- 6.2 The backfill material placed above and immediately adjacent to the pipe shall be free of rocks, stones, brush, debris and junk which would damage the coating. Place no rock or stones or jagged concrete pieces having a dimension larger than two inches in the trench backfill.
- 6.3 All areas, including roads or paved areas, shall be restored to its original condition.

7.0 INSTALLATION OF POLYETHYLENE SEWER PIPE JOINTS

7.1 All polyethylene pipe shall be joined by personnel experienced with butt fusion in accordance with the recommendations of the pipe manufacturer.

8.0 INSTALLATION OF CONSTRUCTION CASTINGS

8.1 Frames, covers and grates shall be placed true to line and grade. Covers, grates and frames shall make firm, full and even bearing on their respective underlying surfaces and shall be non-rocking under loads.

9.0 INSTALLATION OF SPILL APRONS

9.1 Spill aprons shall be placed to dimensions as shown on the project plans.



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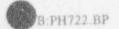
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STORM DRAINAGE SYSTEMS

D.0 HYDROSTATIC TESTING

- 10.1 Storm sewers shall be hydrostatically tested, prior to covering joints and in the presence of the Owner or his designated representative, in accordance with the following provisions:
 - 10.1.1 Sewers constructed with compression joints shall sustain a maximum limit of 0.40 gallons per inch of diameter per hour per 100 feet of line when field tested by actual infiltration conditions. If the groundwater level is below the sewer invert, exfiltration testing is required, and an allowance of an additional ten percent of leakage shall be permitted above that allowed for infiltration testing for each additional two feet of head, over a basic two feet minimum internal head.
 - 10.1.2 Water level in the test section of sewer during the exfiltration test shall be at the lowest catch basin or manhole rim elevation.
 - 10.1.3 Concrete sewer pipe and manholes shall be presoaked for a minimum of 24 hours to allow for water absorption which shall be replenished prior to exfiltration testing.
 - 10.1.4 Test shall be terminated upon reaching a satisfactory stable leakage rate as specified above in paragraph 10.1.1 for a period of one hour. A report summarizing the results of each test shall be submitted to the Owner (reference Exhibit 02720-J). The report shall include the date of the test, procedure used, individual who performed the test, the Owner's designated representative who witnessed the test and the results.

-END OF SECTION--



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SECTION 02831

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SECTION

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	1.5 Quality Control/Assurance
	TEMPORARY FENCING MATERIALS
	2.1 Fabric
3.0	INSTALLATION
	3.1 Installation and Removal of Construction (Temporary) Fence

EXHIBIT

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1.0 GENERAL

1.1 Scope

- 1.1.1 This section is provided for information only and shall be utilized if replacement or security fencing and/or grates are required.
- 1.1.2 This Section specifies the requirements for installation and removal of a 4-foot high temporary construction fence, with high visibility construction webbing at the location shown on the drawings.

1.2 Site Conditions

1.2.1 See construction drawings for site conditions and project layout.

1.3 Regulations

1.3.1 The current applicable regulations, ordinances, statues or codes of the town, city, county or state in which the plant is located, the Federal Government, or other regulatory agency shall apply. Where this specification is more stringent than, and does not conflict with such regulations, ordinances, statues or codes, this specification shall govern.

1.4 Submittals

- 1.4.1 The following shall be submitted for approval in accordance with the contract documents:
 - a. Submit product data for all fence materials.
 - Submit a layout of the new fence with dimensions and locations for site access, anchorage devices, spacing of components, accessories, fittings, and schedule of components.
 - c. Name and resume of fence subcontractor.
 - d. See Exhibit 02831-I for schedule of submittals.

1.5 Quality Control/Assurance

1.5.1 Install the temporary construction fence in compliance with manufacturer's recommendations.

1.5.2 Use only a company that has been installing fencing for at least 5 years.

2.0 TEMPORARY FENCING MATERIALS

- 2.1 Fabric
 - 2.1.1 Fabric shall be 1047-6-11, 6-inch square mesh 47-inch high farm type fence wire, having a 9 gauge top and bottom strand with 11 gauge intermediate strands.

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2.1.2 48-inch high orange polyethylene safety netting.

- 2.2 Posts
 - 2.2.1 Temporary fence posts shall be 6-foot metal studded "T"-Posts driven to a depth of 2-feet below grade at 10-foot intervals.

3.0 INSTALLATION

- 3.1 Installation and Removal of Construction (Temporary) Fence
 - 3.1.1 Site Grading and clearing for fence erection is the responsibility of the Contractor.
 - 3.1.2 Drive posts to the Jepths recommended by the fence majufacturer.
 - 3.1.3 Secr ly fasten the fabric to the fence using appropriate hooks or clips.
 - 3.1.4 Contractor shall be responsible for adequately maintaining the temporary fence during building construction.
 - 3.1.5 The orange polyethylene safety netting shall be fastened to the wire fence fabric to provide enhanced visibility.
 - 3.1.6 Follo ig completion of construction, as defined by Owner, the Contractor shall remove and prope dispose of all temporary fencing materials.

-- END OF SECTION--



EXHIBIT 02831-I SCHEDULE OF SUBMITTALS

SPECIFICATION SECTION AND PARAGRAPH	SUBMITTAL TITLE	SUBMITTAL SCHEDULE
02831 1.4.1a	Product data	Ten days before installation
02831 1.4.1b	Fence layout	Ten days before installation
02831 1.4.1c	Name and resume of fence subcontractor	Ten days before installation

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SECTION 02940

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1.0 GENERAL

- 1.1 Scope
 - 1.1.1 This section shall consist of furnishing all seed, lime commercial fertilizer, mulching material, geotextile netting, water, placing and incorporating and monitoring as specified in the contract drawings and this specification. This includes all areas outside of specified limits where the vegetative growth has been injuriously disturbed or destroyed by the Contractor.

1.2 Site Conditions

- 1.2.1 The Contractor shall remove all debris, all excavated materials and leave the site in a neat and presentable condition throughout daily and upon completion of the work.
- 1.3 Regulations
 - 1.3.1 This specification requires compliance with all federal, state, local laws and regulations which may be applicable including the Occupational Safety and Health Act, Construction Safety Act as well as Rules, Regulations and Standards of the Secretary of Labor.
- 1.4 Submittals
 - 1.4.1 The following shall be submitted for approval in accordance with the contract documents:
 - a. Results of agronomic testing.
 - b. Materials to be used for mulching.
 - c. Type of geotextile and manufacturers specifications for netting to be placed over mulch.
 - 1.4.2 Refer to Exhibit 02936-I for Schedule of Submittals.

2.0 MATERIALS

- 2.1 General
 - 2.4.1 Fertilizer used for the cover seeding shall be 20-15-15 analysis in the spring, or 10-20-20 analysis in the fall.
 - 2.4.2 The soil cover, in order to guarantee correct seed growth and pH properties, shall receive an application of lime, the quantity of which will conform to the requirements indicated by agronomic testing of the soil cover as described in Section 2.03.
 - 2.4.3 The standard permanent cover mixture of seeding for the cover in the fall shall consist of Timothy, Wheat, Alsike Clover and Red Clover. The relative poundage of each is shown in Table 1. A fall temporary cover mixture is provided to allow for erosion protection if the permanent cover cannot be established. A spring permanent cover mixture is provided and spring seeding is required at the site.

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- 2.4.4 An organic mulch shall be placed over the seed as a moisture holding medium. Materials used for mulching shall be straw or hay. They shall be reasonably free of weed seed and such foreign materials as may detract form their effectiveness as a mulch or injurious to desired plant growth.
- 2.4.5 Geotextile netting of a polypropylene or polyethylene type shall be applied over the mulch as designated in Section 3.02 of this specification.

	Standard Seed Mixture	PLS ¹ Seeding (lbs/acre)	Time of Seeding
Fall-Permanent Cover	Timothy Wheat Alsike Clover* Red Clover*	4 8 4 <u>12</u> 28 preferred rate	August-October
Fall-Temporary Cover	Wheat Timothy	26 _6 32	
Spring-Permanent Cover	Timothy Bromograss Orchard grass Alsike Clover* Red Clover*	6 4 6 <u>4</u> 26	Late February-Late May

TABLE 1

PLS¹ Pure live seed. Note: Use only a high-purity seed with high germination percentage.

* And appropriate rhizobium inoculant.

2.2 Acceptable Manufacturers

- 2.2.1 A list of suppliers of fertilizer, lime, and seeding shall be given to the Enginee. by the Contractor. This list shall be approved by the Owner or his representative before the shipment or materials.
- 2.2.2 Geotextile netting shall be AMXCO erosion control netting manufactured by the American Excelsior Company, Arlington, Texas. Similar products may be substituted upon written permission of the Owner or his representative prior to delivery.
- 2.3 Agronomic Testing
 - 2.3.1 After the cover soil has been placed, it shall be tested to determine its specific lime requirements.



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3.0 FOUNDATION AND PREPARATION

- 3.1 General
 - 3.1.1 Seeding and mulching will be delayed until construction has been completed. The Contractor shall be prepared to seed and mulch disturbed areas immediately following construction upon request of the Engineer.

4.0 INSTALLATION

4.1 Surface Profile Mixing

4.1.1 The soil material shall be disced with ordinary field-finishing implements such as tandem spring rake or tandem disk harrow provided the equipment can mix at a consistent 5 or 6 inch depth. Mixing should be done when the clean fill is in a dry or semi-dry consistency. Mixing should not be attempted after a rain to avoid incomplete mixing of the cover soil material.

4.2 Fertilizer Application

4.2.1 Application of fertilizer over the area should be done at the rate of 300 pounds per acre of 20-15-15 analysis (spring application) or 10-20-20 analysis (fall application) fertilizer. This is the equivalent of 6.9 pounds of fertilizer per 1,000 sq ft. The fertilizer can be applied from a spreader (hopper) or broadcast as long as a uniform application rate can be maintained.

4.3 Lime Application

- 4.3.1 Lime to be applied to the soil cover shall consist of agricultural or dolomitic ground limestone or pelletized limestone with a total neutralizing potential (TNP) of 90+. In no circumstances shall hydrated, calcined lime or limestone sludges be substituted for agricultural or dolomitic lime.
 - a. The quantity of limestone determined from Part II, Section 2.03 above, shall be uniformly spread over the cover soil area using a limestone spreader (hopper) following an agricultural tractor. The limestone shall be spread prior to seeding the cover soil, during the active growing season, during dry weather.
 - b. Subsequent to surface application, the limestone shall be incorporated into the surface to a depth of 5 inches, with a roller blade disk harrow to a tandem roller harrow. Either implement is satisfactory for covering soil mixing and will prepare the surface for subsequent seeding.

4.4 Seeding Mixtures and Application Rates

- 4.4.1 The seed shall be spread from a broadcast spreader or hydroseeder as required. The preferred mixture is provided in Table 1 and has been tailored to the conditions of the site.
 - a. Legumes should be inoculated immediately prior to seeding with the specific legume inoculant. Seeding shall be accomplished during the periods specified on Table 1.

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4.5 Mulch Application

4.5.1 Within 24 hours after seeding, the vegetative mulching material shall be evenly placed over all seeded areas at the rate of approximately 3,100 pounds (1.55 tons) per acre for straw, or 2.3 tons per acre for hay. This is the equivalent of 71 pounds of straw per 1,000 sq ft or 106 pounds of hay per 1,000 sq ft.

4.6 Use of Geotextile Netting

- 4.6.1 Seeded and mulched areas susceptible to storm erosion forces and outslopes having slope gradients equal to or steeper than 4:1 (H:V) shall be covered with geotextile netting of a polypropylene type (3/4 to 1/2 inch mesh weave). The seeding and mulching are to be completed within 24 hours of the final grading. If conditions warrant a longer prior, then a geotextile netting shall b placed immediately over the entire cover areas to protect the soil, seed, and mulch. This netting is placed over the mulch or soil and fastened to the ground with 8-inch wire staples (available through the netting supplier) affixed at 2-foot intervals along the netting rolls.
 - a. Once prepared with netting, reseeded areas should be protected from any vehicular traffic which could destroy or degrade the protection provided by the geotextile netting.

4.7 Watering

4.7.1 After completion of installation of fertilizer, lime, seed, mulch, and erosion control netting, the newly-seeded area will be watered. Watering of the seeded area will be accomplished using either canvas "soaker" hoses laid in parallel strips across the seeded area, and connected to a source of potable water, or the flat ribbon "spray" hoses connected to a source of potable water of the seeded area vill be watered sufficiently to provide at least 1-1/2 inches of water per week during the first 3 weeks of cover vegetation establishment. An estimate of the amount of water delivered to the seeded area will be obtained using several plastic rain gauge to collect water placed on the seeded portion of the site. Care should be taken during watering to prevent complete soil saturation from occurring. Generally, more frequent watering of short time duration is more successful than prolonged watering periods. Avoid watering from mid-day to late afternoon to avoid scorching the germinated seedlings.

5.0 MAINTENANCE PROGRAM

5.1 General

5.1.1 The cover soil area of the site will be inspected biweekly for the first full growing season to determine the extent of vegetation cover and establishment. Areas of poor vegetation growth, or of erosion action, will be promptly repaired and reseeded. The seed, fertilizer, lime, and mulch specifications detailed in this section will be used in repairing any site areas requiring maintenance.

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6.0 CLEANUP

- 6.1 General
 - 6.1.1 Prior to final acceptance, the Contractor shall remove all machinery, equipment, supplies materials, rubbish, etc. from the project. Pavement and storm drainage facilities shall be cleaned and all soils and other debris removed.

-END OF SECTION-



EXHIBIT 02940-I SCHEDULE OF SUBMITTALS

SPECIFICATION SECTION AND PARAGRAPH	SUBMITTAL TITLE	SUBMITTAL SCHEDULE
02940 1.4.1a	Agronomic Test Results	10 days prior to their topsoil placement
02940 1.4.15	Mulching Materials	10 days prior to mulching placement
02940 1.4.1c	Geotextiles	10 days prior to placement



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DIVISION 3 Concrete

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- 03330 Sludge Solidification and Stabilization
- 03410 Precast Concrete
- 03420 Cast-in-Place Concrete
- 03430 Ready-Mix Concrete

SECTION 03330

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1.0 GENERAL

- 1.1 Scope
 - 1.1.1 Provide plant and equipment necessary to remove sludges from Deepwell and Burn Ponds, transport sludge to stabilization plant, receive, unload and store stabilization reagents, mix sludge with stabilization reagents, transport stabilized sludge to closure cells and place stabilized sludge in closure cells.
 - 1.1.2 Furnish all air pollution controls needed to conduct stabilization mixing and placement operations in accordance with applicable regulations and owners requirements set forth in these specifications.
 - 1.1.3 Erect, test and operate equipment defined in 1.1.1 and 1.1.2 to place stabilized waste in ponds.
 - 1.1.4 Perform pilot sca's testing to verify mix design and determine mixing procedures.
 - 1.1.5 Decontaminate, dismantle and remove all equipment defined in 1.1.1 and 1.1.2 from job site at end of work.
 - 1.1.6 Furnish all stabilization reagents needed for project. Remove excess materials from job site at end of project.

1.2 Site Conditions

- 1.2.1 Refer to construction drawings for site conditions and project layout.
- 1.2.2 Promptly remove and decontaminate as necessary any dust emitted from mixing unit, reagent unloading operations and reagent storage facilities.

1.3 Regulations

- 1.3.1 The current applicable regulations, ordinances, statutes or codes of the town, city, county or state in which the plant is located, the Federal Government, or other regulatory agency shall apply. Where this specification is more stringent than, and does not conflict with such regulations, ordinances, statues or codes, this specification shall govern.
- 1.3.2 Comply with owner's regulations and requirements for Contractors.

1.4 Submittals

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- 1.4.1 Submit detailed drawings and equipment specifications for the following systems:
 - a. Sludge removal equipment including level controls, positioning systems and controls.
 - Sludge transport pipeline including equalization tanks, monitoring and control systems and secondary contaminants (if used).

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- c. Stabilization plant including control systems, air pollution controls, containments, reagent unloading and storage, etc.
- d. Stabilized sludge punping and placement system including controls, discharging positioning system, placement forms, secondary containments and supports and connections (where appropriate).
- 1.4.2 Submit Quality Assurance and Control Plan including:
 - a. Sampling systems built into equipment.
 - b. Sampling frequency and methodology.
 - c. Test procedures and details of onsite laboratory facilities.
 - d. Data management and analysis systems.
 - e. Set points and authorities for corrective action.
- 1.4.3 Submit source identity and test data for reagents including:
 - a. Chemical Analysis.
 - b. Particle Size Analysis.
 - c. Documentation that sufficient quantities are available to complete the project.
- 1.4.4 Submit documentation plan for approval by Owner.
- 1.4.5 Submit pilot scale test results for each sludge source.
- 1.4.6 Submit daily production and quality control records in machine readable form.
- 1.4.7 Submit updated maps and sections of entire closure cells showing disposal location for each batch.
- 1.4.8 Maintain computer data base in a format as approved by Owner, of production and QA/QC records and submit at end of project.
- 1.4.9 Conduct operational readiness review with Owner before starting system. Provide checklist to Owner.

1.5 Quality Control/Assurance

- 1.5.1 Cast three cubes for each batch.
 - a. Test each cube with pocket penetrometer at 2, 5, 10, 15, 20, and 28 days after casting record values.
 - b. Stop testing when values specified in 3.3.1 are reached.

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- c. If values specified in 3.3.1 are not reached in 28 days, take core specimens (6" min. dia.) from closure cell and test to verify that batch meets requirements of 3.3.2.
- d. If batch does not meet 3.3.2 requirements leave material in place if:
 - 1. There are no nonconforming batches below it.
 - 2. There are no nonconforming batches within 30 feet of it.

Otherwise remove material and place debris in cell with 3000 psi concrete.

- e. If nonconforming material is left in place, use 3000 psi concrete for lift above it.
- 1.5.2 Cast six 6*-diameter cylinders per solidification unit per ten shifts (8 hr. shifts).
 - a. Measure pocket penetrometer compressive strength for each cylinder.
 - b. Perform product acceptance tests per Section 3.3.2, for each set of cylinders.
 - Modify penetrometer acceptance, values, and mix design as required based on test results.
- 1.5.3 Perform all analytical testing and sampling in accordance with QA/QC plan.

2.0 SLUDGE MOBILIZATION

- 2.1 Removal and Transport
 - 2.1.1 Remove and transport sludge in accordance with Section 02221.
- 2.2 Dewatering
 - 2.2.1 Screen large particles with screening unit.
 - 2.2.2 Increase sludge solids content as necessary with a continuous feed centrifuge.

3.0 SLUDGE STABILIZATION

3.1 Materials

(To be determined)



3.2 Method

3.2.1 Stabilize sludge by adding reagents needed to achieve product quality specified in Section 3.3.1 on bench scale text, the following mix proportions as established during bench scale testing should be considered:

> Approximate Reagent Application (% by dry weight of sludge)

Deep Well/Celite Burn V-1

Sludge

Source

- 3.2.2 Mix sludge with reagents in pug mill or appropriate mixer.
 - Perform trial batches (5 cy minimum) to determine mixer retention time to meet product quality requirements.
 - b. Provide sufficient mixer capacity to process 400 cubic yards of raw sludge per day.

3.3 Air Pollution Controls

- 3.3.1 Perform all reagent additions and mixing inside of an enclosure under negative pressure.
- 3.3.2 Use misters to prevent formation of fugitive dust.
- 3.3.3 Route off gas from enclosure through scrubbers.
- 3.3.4 Transport scrubber liquid to water management system at location specified by Owner.
- 3.3.5 Place scrubber sludge into mixing plant influent stream at a rate not to exceed 5 percent of pond sludge.



- 3.4 Product Quality
 - 3.4.1 Provide product with, at 48 hrs after mixing, has a 48 hr set strength measured with a pocket penetrometer as follows:

Sludge Source

48 hr. set Strength (psi)

Celite/Deep Well Burn V-1

Above values may be modified with approval of Owner based on Contractor's submittal of correlation data with cylinder test results.

3.4.2 Provide product with, at 28 days after mixing: compressive strength greater than 50 psi measured by ASTM D 2166 and no toxic leachate by TCLP leaching procedure cited in 40 CFR 261. Also test for TCLP extract leachable 1,1,1-trichloroethane according to EPA SW 846 method 8010 or 8240; and leachable according to EPA SW 846 method 8030 or 8240.

4.0 PLACEMENT IN DISPOSAL CELL

- 4.1 Method
 - 4.1.1 Use concrete pump and closed pipe system to move stabilized sludge from mixer to closure ceil.
 - 4.1.2 Place stabilized sludge in formed areas so that thickness of batch is no greater than two for ".
 - 4.1.3 Vibrate placed sludge to climinate trapped air.
- 4.2 Documentation
 - 4.2.1 Maintain records of top and bottom elevations and coordinates of corners for each batch.
 - 4.2.2 Develop record-keeping plan and submit for approval by Owner. Plan must:
 - a. Record location of each batch.
 - b. Record QA/QC test results for each batch.

-- END OF SECTION---



EXHIBIT 03330-I SCHEDULE OF SUBMITTALS

S	SPECIFICATION SECTION AND PARAGRAPH		SUBMITTAL TITLE	SUBMITTAL SCHEDULE	
0	3330	1.4.1a	Sludge Removal Equipment Shop Drawings	5 days*	
0	3330	1.4.1b	Sludge Transport System	5 days*	
C	3330	1.4.1c	Stabilization Plant Shop Dwgs	15 days	
0	13330	1.4.1d	Stabilized Sludge Pumping System Shop Dwgs	15 days	
0	3330	1.4.2	Sludge Stabilization QA/QC Plan	15 days before start of operations	
C	3330	1.4.3	Reagent Data	5 days	
0	3330	1.4.4	Documentation Plan	15 days before start of operations	
Q	3330	1.4.5	Pilot Scale Test Results	1 day after completion	
Q	13330	1.4.6	Production QA/QC Data	Weekly	
0	3330	1.4.7	Maps and Sections of Batch Disposition	Weekly	
0	3330	1.4.8	Computer Data Base of	End of job	
0	3330	1.4.9	Operational Readiness Review Checklist	5 days before review	

* Days after start of job unless otherwise noted.

SPECIFICATION



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	1.3 Regulations
	1.4 Submittals
2.0	MATERIALS
	2.1 Precast-Concrete Catch Basin/Manholes
3.0	CATCH BASIN/MANHOLES INSTALLATION

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1.0 GENERAL

1.1 Scope

1.1.1 The work included in this section of these specifications shall consist of furnishing and installing precast concrete (excluding reinforced concrete pipe) as shown on the project plans.

1.2 Site Conditions

1.2.1 See construction drawings for site conditions and project layout.

1.3 Regulations

1.3.1 The current applicable regulations, ordinances, statutes or codes of the town, city, county or state in which the plant is located, the Federal Government, or other regulatory agency shall apply. Where this specification is more stringent than, and does not conflict with such regulations, ordinances, statues or codes, this specification shall govern.

1.4 Submittals

- 1.4.1 The following shall be submitted for approval in accordance with the contract documents:
 - a. Product data; provide data on precast products, accessories, and installation information.
 - b. Manufactures certificate; certify that the precast products meet or exceed the applicable referenced standards.
 - c. Method used to cover holes in precast sections of drop inlets and sumps.
 - d. Refer to Exhibit 03410-I for Schedule of Submittals.
- 1.5 Quality Control/Assurance
 - 1.5.1 All precast manhole and catch basin sections shall be cured by an approved method and shall not be shipped nor manhole steps subjected to loading until the concrete compressive strength has attained 3000 psi and not before 5 days after fabrication and/or repair, whichever is longer.
 - 1.5.2 Where holes must be covered in the precast section to accommodate pipes, cover shall be done in accordance with an approved method to setting them in place.

2.0 MATERIALS

- 2.1 Precast-Concrete Catch Basin/Manholes
 - 2.1.1 Precast-concrete catch basin-manholes and sumps shall conform to ASTM C 478.
 - 2.1.2 Concrete shall have a compressive strength equal to or greater than 4000 psi.



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- 2.1.3 Dimensions shall conform to those shown on project plans.
- 2.1.4 Plastic-coated steel steps shall conform to latest ASTM C 478 Spec. (para. 11).
- 2.1.5 All sections shall have tongue and grove joints with an approved round, or fine type neoprene gasket which conforms to the requirements of ASTM C 443.
- 2.1.6 Top portion shall be steel reinforced to meet or exceed HS-20 loading.
- 2.1.7 Reinforced steel shall conform to the ASTM A 185.
- 2.1.8 Bitumastic coating shall be applied to the exterior of the catch basins and manholes prior to installation.
- 2.1.9 Catch basins and manholes shall have circular cutouts to accommodate inlet and outlet pipe cast in the manhole base section at the required location.
- 2.1.10 Catch basins and manholes shall be supplied with neoprene boots cast into the concrete or held in place by stainless steel compression bands. Adjustable stainless steel bands shall seal the boot to the incoming pipe.

3.0 CATCH-BASIN/MANHOLES INSTALLATION

- 3.1 Catch-Basin/manholes/sumps shall be placed on a thoroughly compacted gravel subbase as shown on the project plans.
- 3.2 The top of the inlet or cover shall be placed at the elevation as indicated on the project plans.
- 3.3 Joints between sections shall be sealed by O-rings provided for that purpose by the manhole manufacturer. Bituminous self adhering rope sealant may be used with O-rings.

-- END OF SECTION --



EXHIBIT 03410-1 SCHEDULE OF SUBMITTALS

SPECIFICATION SECTION AND PAPAGRAPH	SUBMITTAL TITLE	SUBMITTAL SCHEDULE
03 10 1 4.1a	Product data on precast products	Ten days prior to their use
03410 1.4.1b	Manufactures Certification	Ten days prior to their use
03410 1.4.1c	Method used to cover holes	Ten days prior to their use
<u>03410¹ 1.4.1d¹</u>	Shop drawing on gutters ¹	30 days prior to their use ¹





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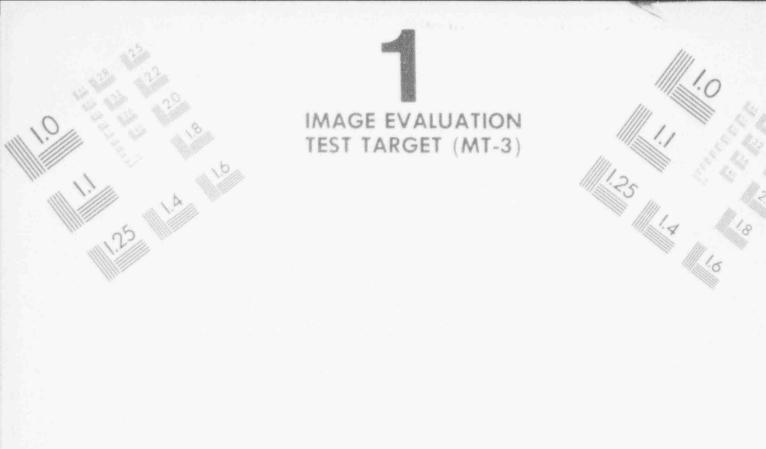




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1.0 GENERAL

- 1.1 Scope
 - 1.1.1 This Specification covers the requirements for installation of cast-in-place concrete work.
 - 1.1.2 The work shall include, but not be limited to, the following:
 - a. Sui eying.
 - b. Construction of all plain and reinforced concrete work including concrete paving, and foundations.
 - c. Placing of anchor bolts and other embedded items.

1.2 Site Conditions

- 1.2.1 Refer to construction drawings for site conditions and project layout.
- 1.3 Regulations
 - 1.3.1 The current applicable regulations, ordinances, statutes or codes of the town, city, county or state in which the plant is located, the Federal Government, or other regularity agency shall apply. Where this specification is more stringent than, and does not conflict with such regulations, ordinances, statues or codes, this specification shall govern.

1.4 Submittals

- 1.4.1 The following shall be submitted for approval in accordance with the .ontract documents:
 - a. Name and address of testing laboratory proposed by Contractor.
 - b. Results of all required testing.
 - c. Concrete supplier.
 - d. Refer to Exhibit 03420-I for Schedule of Submitals.
- 1.5 Applicable Specifications and Codes
 - 1.5.1 All concrete work shall be in accordance with the specifications referred to herein and the following:
 - a. "Specification for Structural Concrete for Buildings" ACI 301-84.
 - b. "Guide for Concrete Floor and Slab Construction" ACI 302.1R-80.
 - *Recommended Practice for Measuring, Mixing, Transporting and Placing Concrete* ACI 304-73.

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- d. "Report on Placing Concrete by Pumping" ACI 304.2R-71 (Revised 1982).
- e. "Ohio Basic Building Code" (OBBC).



- f. "Hot Weather Concreting" ACI 305R-77 (Revised 1982).
- g. "Cold Weather Concreting" ACI 306R-78 (Revised 1983).
- h. "Practice for Curing Concrete" ACI 308-81.
- Practice for Consolidation of Concrete* ACI 309-72.
- *Details for Detailing of Concrete Reinforcement* ACI 315-80.
- k. "Recommendations for Construction of Concrete Pavements and Concrete Bases" ACI 316R-82.
- *Building Code Requirements Reinforced Concrete (using strength design method) ACI 318-83.
- m. "Building Code Requirements for Reinforced Concrete" ACI 301-83.
- n. "Recommended Practice for Concrete Formwork" ACI 347-78.
- o. "Method of Making and Curing Concrete Test Specimens in the Field" ASTM C31-84.
- p. "Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens" ASTM C39-84.
- q. "Test Method for Slump of Portland Cement Concrete" ASTM C143-78.
- r. "Method for Sampling Freshly Mixee Concrete" ASTM C172-82.
- *Test Method for Air Content of Freshly Mixed Concrete by Volumetric Method* ASTM C178-78.
- "Recommended Practice for Inspection and Testing Agencies for Concrete, Steel and Bituminous Materials as Used in Construction" ASTM E329-77 (Revised 1983).
- u. "Structural Welding Code Reinforcing Steel" AWS D1.4-79.
- v. "Test Method for Early Volume Change of Cementitious Mixtures" ASTM C827-82.
- w. "Specification for Concrete Aggregates" ASTM C33-84.
- x. "Specification for Portland Cement" ASTM C150-84.
- y. "Specification for Ready-Mixed Concrete" AA-220.
- z. "Specification for Fabrication of Concrete Reinforcement" AA-230.
- a. "Specification for Concrete Work" AA-240.

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1.6 Quality Control/Assurance

- 1.6.1 Tests of concrete used shall be made by a properly equipped independent laboratory qualified in accordance with ASTM E329 and approved by Owner. Cost of testing shall be assumed by the Contractor.
- 1.6.2 Testing shall include compressive tests of molded concrete cylinders, tests for slump, unit weight, air content (where air-entrainment is required), and fresh concrete temperature.



2.0 TESTING

2.1 Compressive Strength Tests

- 2.1.1 Concrete shall be sampled, cured and tested for compressive strength in accordance with ASTM C172, C31, and C39. Compressive test cylinders shall be prepared in sets of three cylinders for each test. Specimens for each set shall be obtained from the same batch of concrete after about one-half of the batch has been placed in the forms. The rate of sampling shall be as follows:
 - a. Structures and Foundations: One set per 100 cubic yards of concrete. At least one set shall be obtained for each structure or foundation, except when placing a number of items each smaller than 15 cubic yards, one set per 15 cubic yards shall suffice.
 - b. Paving and Slabs at Grade: One set per 50 cubic yards of concrete.
 - c. Underground and Fireproof: One set taken at the beginning of each day's concrete work.
 - d. All other Concrete: Same as Paragraph 2.1.1.a.
 - e. Take additional samples when observations on tests indicate nenconformance with specifications.
- 2.1.2 Concrete for foundations shall develop a minimum compressive strength of 4000 psi in 28 days.
- 2.2 Tests for Slump, Air Content, and Temperature
 - 2.2.1 Slump tests shall be taken for each set of test cylinders in accordance with ASTM C143.
 - 2.2.2 The acceptance test for the air content of air-entrained concrete shall be made regularly in accordance with ASTM C173.
 - 2.2.3 The temperature of the fresh concrete for each set of cylinders shall be recorded.
- 2.3 Labeling, Storage, and Reporting
 - 2.3.1 Test cylinder sets shall be dated and numbered consecutively. Each cylinder of each set shall also be given an identifying letter (A, B and C). The following data shall be recorded on the cylinder mold at the time the cylinders are prepared and shall be included in the test report:
 - a. Test cylinder number and letter.
 - b. All foundations or structures covered by this test.
 - Proportions of concrete mix or mix identification (include transit mix delivery slip if applicable).

- d. Maximum size of coarse aggregate.
- e. Specified strength f.
- f. Slump, air content and fresh concrete temperature.
- g. Data and time poured.
- h. Ambient temperature at time of pour.
- i. Name of inspector making cylinders.
- 2.3.2 All cylinders must be immediately stored and cured in accordance with ASTM C 31 Section 7 Curing. Protect the outside surfaces of cardboard molds from all contact with wet material for the first 24 hours after molding. Water may cause the molds to expand and damage the concrete cylinders at this early age. Avoid any impact during this critical 24 hour period.
- 2.3.3 After initial storage, the cylinders (still in their molds) shall be packed in sealed polyethylene bags, wet sand or other resilient material for shipment to the testing laboratory, in accordance with ASTM C 31 Section 8, "Shipment to Laboratory".
- 2.3.4 The testing laboratory shall moist-cure the cylinders until they are tested.
- 2.3.5 Each set of cylinders shall be tested as follows:
 - a. Cylinder A at seven days. The result should be at least 60 percent of f.
 - b. B and C cylinders at 28 days.
 - c. The average of the B and C cylinder strengths shall be defined as the strength test result for this set.
- 2.3.6 The testing laboratory shall air mail or deliver copies of all up-to-date cylinder test reports, including all data recorded when the cylinders were prepared, to the Owner at least once a week during the testing period.
- 2.3.7 The Owner must be notified immediately if any of the strength tests fall 500 psi below the specified value. The Owner will immediately advise the field staff of any required action.
- 2.3.8 If the cylinder tests fall below the specified value, Owner at its sole option, may require immediate removal of the appropriate placed concrete or in-place core tests with the expense of all rework, additional tests or subsequent repair of tests borne by the Contractor.

3.0 EXCAVATION

3.1 General



- 3.1.1 Excavations shall be made to the dimensions and elevations indicated on the Drawings. Excavations shall extend a sufficient distance from walls and footings to allow for placing and removal of forms, installation of services and inspection; but generally should be kept to a minimum.
- 3.1.2 All foundations shall be placed on undisturbed soil. Where excavations are made too deep, they shall be backfilled per requirements of Section 02220 Excavation and Backfill.
- 3.1.3 Excavations shall be kept free of water during the placing of reinforcing steel and concrete.

3.2 Shoring, Sheeting and Bracing

- 3.2.1 Excavations shall be properly shored, shorted and braced as the nature of the ground may require to prevent shifting of material with possible damage to existing or incomplete structures.
- 3.2.2 Excavations shall be sloped in accordance with OSHA regulations 1926.651 and 1926.652.

4.0 FORMWORK

- 4.1 General
 - 4.1.1 The design and construction of the formwork shall be in accordance with ACI 347 and shall be the responsibility of the Contractor.
 - 4.1.2 Unless otherwise noted on the design drawings, formwork shall be constructed so that the concrete surfaces conform to the tolerance limits listed in ACI 301, Table 4.3.1.

4.2 Forms

- 4.2.1 Forms for exposed concrete shall be of plywood or metal. The design of these exposed surface forms shall be such that after stripping, a smooth uniform concrete surface shall result.
- 4.2.2 All exposed exterior come s of concrete shall be chamfered 3/4 inch.
- 4.2.3 Contact surfaces of forms, with the exception of forms in contact with concrete surfaces against which additional concrete or other material is to be bonded, shall be coated with form oil. No form release agents of any kind should be used on forms in contact with concrete surfaces against which additional concrete or other material is to be bonded without Owner approval.

4.3 Removal of Forms

- 4.3.1 Forms for walls and other vertical forms not supporting concrete weight may be removed 48 hours after placing, if the concrete has hardened sufficiently.
- 4.3.1 Forms for slabs and other parts requiring support shall remain in place until the concrete has attained 60 percent of its specified 28-day strength.



5.0 REINFORCING STEEL

5.1 Placing Reinforcing Steel

- 5.1.1 Reinforcement at the time concrete is placed shall be free from loose, flaky rust, mud, oil or other coatings that will destroy or reduce bond.
- 5.1.2 All reinforcing shall be supported and wired together to prevent displacement during placing of concrete. On ground work supporting concrete blocks may be used. Accessories in contact with the formwork for exposed concrete shall be galvanized or be made of plastic.
- 5.1.3 Welded wire fabric shall have lapped splices so that the overlap measured between outermost cross wires of each fabric sheet is not less than the spacing of the cross wires plus 2 inches. It shall be supported as required for reinforcing bars.
- 5.1.4 Bars shall be placed in accordance wiht the tolerances in ACI 301 Chapter 5.
- 5.1.5 Bar splices shall be made by the method and to the dimensions shown on the design draw. Any deviation will require the approval of the Structural Engineer.
- 5.1.6 When welded splices are specified on the design drawings, the welding shall conform to AWS D1.4.

5.2 Materials

- 5.2.1 Reinforcing bars shall conform to ASTM A615, Grade 60.
- 5.2.2 Welded wire fabric shall conform to ASTM A185 and shall be furnished in 60-inch widths (65,000 psi yield stress).
- 5.2.3 Reinforcement placing accessories in contact with the formwork for exposed concrete shall be galvanized or made of plastic.

5.3 Detailing

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- 5.3.1 The fabricator shall supply checked placing drawings and bar lists in accordance with "Manual of Standard Practice for Detailing Concrete Structures" ACI 315-80 for review by BP Chemical Inc. Approval prior to fabrication is waived unless stated otherwise in purchase order.
- 5.3.2 Hooks and bends shall conform to Section 7.1 of "Building Code Requirements for Reinforced Concrete" ACI 318-83.
- 5.3.3 Fabricator may use BP Chemicals, Inc. design drawings as placing drawings; however, BP Chemicals, Inc. title block shall be replaced with Fabricator's title block.
- 5.3.4 All drawings shall indicate related BP Chemicals, Inc. drawing number, Purchase Order number, and foundation or structure item number.

5.3.5 The fabricator shall transmit with each shipment of reinforcing steel one complete set of print of bending schedules and placing drawings.

5.4 Fabrication

- 5.4.1 Reinforcing bars shall conform accurately to the dimensions shown on the design drawings and within the tolerances given in ACI 315-80.
- 5.4.2 Reinforcing bars shall not be bent or straightened in a manner that will Injure the material. Heating of the reinforcing bars for straightening or for bending is not permitted.
- 5.4.3 Strength welding of reinforcing bars to replace field splices shall not be used for steels in which sulfur, phosphorus and carbon contents exceed the allowable limits of 0.06 percent each for sulfur and phosphorus and of 0.3 percent for carbon.
- 5.4.4 Closed ties of columns, piers, and flexural members shall have 135° bends at ends.

5.5 Marking and Shipping

- 5.5.1 Reinforcing steel with like marks shall be securely wired together in individual bundles. Such items may be further bundled for shipment.
- 5.5.2 Welded wire fabric shall be in rolls.
- 5.5.3 Metal tags shall be securely wired to each individual bundle or roll. Tags shall show destination by name, address and purchase order number. Each bundle of straight bars shall be tagged to show number of pieces, size and length. Each bundle of bent bars shall be tagged to show the design drawing number, size, number of pieces and mark number as shown on placing drawings. Each roll of welded wire fabric shall be tagged to show size and length.
- 5.5.4 Additional information may be required on tags as noted on the drawings.

6.0 PLACING CONCRETE

- 6.1 General
 - 6.1.1 Placing concrete shall be in accordance with ACI 301, Chapter 8.
 - 6.1 All inserts, sleeves and anchor bolts for structural, electrical and piping, and all underground piping and electrical conduit shall be checked by Contractor field engineer prior to placing concrete.



- 6.1.3 Concrete shall not be dropped from a height exceeding 6 feet. In the case of foundations deeper than 6 feet, concrete shall be placed by means of chutes. The slope of the chutes shall have a slope not exceeding one vertical to two horizontal and not less than one vertical to three horizontal.
- 6.1.4 Concrete shall be deposited in layers of such thickness that no concrete will be deposited on concrete which has hardened sufficiently to cause the formation of seams or planes of weakness within the section.
- 6.1.5 Over-vibrating and use of vibrators to transport concrete within forms shall not be allowed.

6.2 Cold Weather Concreting

6.2.1 When the mean daily temperature falls below 40°F, the minimum temperature of the concrete shall be 50°F and the concrete placement shall be in accordance with "Recommended Practice for Cold Weather Concreting," ACI 306.

6.3 Hot Weather Concreting

6.3.1 When the temperature of the concrete exceeds 90°F, concrete placement, protection and curing shall be in accordance with "Recommended Practice for hot Weather Concreting," ACI 305.

6.4 Holding Times

6.4.1 "Ready-mix" concrete from truck, shall not be poured if the concrete remains in the truck for more than 1½ hours. Time will be taken from truck delivery ticket.

7.0 FINISHING

- 7.1 General
 - 7.1.1 Formed surface shall be finished in accordance with ACI 301 unless otherwise specified herein or on the design drawings. "Public View" shall be interpreted to mean, "accessible to the plant operator's view."
 - 7.1.2 All exposed concrete work, unless otherwise noted, shall have a steel trowel finish.
 - 7.1.3 Foundations on which grout is to be placed shall be provided with a rough, clean surface.
- 7.2 Repairs
 - 7.2.1 Honeycomb and other defective concrete surfaces shall be patched and repaired in accordance with ACI 301, Chapter 9.

8.0 CURING

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8.1 General

8.1.1 Curing and protection shall be in accordance with ACI 301, Chapter 12. See Section 3.5 of Specification AC-210 for precautions if concrete is exposed to acid.

8.2 Exposed Concrete

- 8.2.1 Exposed concrete surfaces will be sprayed with curing compound immediately after, placement and initial concrete set.
- 8.2.2 Exposed concrete surfaces and formed surfaces stripped earlier than seven days after placing shall be treated with a concrete curing compound.
- 8.2.3 Curing compound shall be "Clear Bond" as manufactured by Guardian Chemical Company, Atlanta, Georgia, or approved equal. Application shall be in accordance with manufacturer's specifications.

9.0 SLUMP

9.1 Slumps at the Point of Delivery

- 9.1.1 Slumps at the point of delivery shall be as follows:
 - a. Slabs, and walls: 4 inches to 1 inch
 - b. Footings and mats: 3 inches to 2 inch
- 9.1.2 The maximum slump may be increased by one inch for methods of consolidation other than vibration.
- 9.1.3 When concrete arrives at the pour site with a slump too low for proper placing, water may be added only if neither the maximum permissible water-cement ratio of the authorized mix design nor the maximum allowable slump is exceeded. The water must be incorporated by additional mixing equal to at least half of the total mixing required for the batch. Concrete with any addition of water above that permitted by the limitation on water-cement ratio shall be rejected and removed from the site. The addition of water shall be authorized by the Owner.

10.0 ANCHOR BOLTS

- 10.1 Anchor bolt material shall conform to ASTM A-36-84.
- 10.2 Anchor bolts shall be designed for an allowable tensile stress of 14,000 psi at the tensile stress area of thread. No increase is allowed when considering wind or earthquake loads.
- 10.3 Anchor bolts and nuts shall be uncoated unless exposed to corrosive atmospheres or spills. This exposed to corrosive atmospheres shall be hot-dip galvanized; those exposed to corrosive spills shall be protected with a suitable epoxy. When coatings are required; the type shall be indicated on the drawings.
- 10.4 Auchor bolts shall not be less than 3/4" in diameter.



- 10.5 Anchor bolts subject to uplift or vibration shall be locked with two nuts.
- 10.6 Nuts shall be ASTM A-307. Anchor bolt threads shall conform to American Standard Course Class 2 fit, NC-2
- 10.7 Anchor bolts shall be inside the reinforcing steel cage.
- 10.8 All anchor bolts and other embedded items, at the time they are placed, shall be free from scale, grease, oil or other surface coatings which will reduce their bond to the concrete.
- 10.9 Anchor bolts shall be placed to the following tolerances:
 - 10.9.1 Bolt projection:

+1/4 inch/-0 inches

10.9.2 Bolt location (w/o sleeves): +1/16 inch.

11.0 GROUTING

- 11.1 Grout shall be standard dry pack Portland cement grout.
- 11.2 Grout thickness shall be one inch thick for standard solumn base plates and normal equipment bases.
- 11.3 Grout thickness shall be 1-1/2 inches minimum for large towers and heavy equipment bases.
- 11.4 Application of grout types shall be as follows or as specified on the drawings.
 - 11.4.1 Cement-Based Non-shrink Grout
 - a. Compressors, generators, blowers, pumps with bases wider than 2 feet, motors, and other rotating equipment subject to vibration.
 - b. Equipment with cast bases.
 - c. Equipment on base frames with cover plates.
 - 11.4.2 Epoxy Non-shrink Grout
 - a. If required by equipment manufacturer.
 - 11.4.3 Sand-Cement Poured Grout
 - a. Vessels and heat exchangers.
 - b. Pumps with bases 2 feet or less in width.
 - 11.4.4 Drypack Grout
 - a. Structural column base plates.

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- b. Small equipment with flat plate bases.
- 11.4.5 Acid Resistant Grout
 - a. Equipment handling Maleic Anhydride or any acid.
- 11.5 Preparation for Grouting
 - 11.5.1 Concrete foundations shall be at least 7 days old prior to surface preparation.
 - 11.5.2 Concrete surfaces shall be prepared for grouting or dry-packing by clipping back to sound concrete. The surface shall be clean, with all laitance, grease, oil, dirt or loosened aggregate removed prior to setting leveling plates.
 - 11.5.3 Set all leveling plates to the proper elevation. The number and type of leveling plates will be determined by the Construction Manager in accordance with the recommendations of the equipment manufacturer, other project documents or his experience. In subcontracted work, the number and type of leveling plates will be determined by the Equipment Installation Subcontractor.
 - 11.5.4 Concrete surfaces on which cement-based grout or drypack is to be placed shall be thoroughly soaked with water for 24 hours just prior to grouting, the water shall be removed leaving only a damp film. All standing water shall be removed from anchor bolt sleeves.
 - 11.5.5 Concrete surfaces on which epoxy grout is to be placed shall be completely dry before grouting. (This is not to be construed to override the requirements for curing.)
 - 11.5.6 Metal surfaces in contact with the grout or drypack shall be clean and free of oil and grease, and other foreign substances. The presence of tightly bonded paint is not objectionable.
 - 11.5.7 The exposed grout shall be neatly chamfered from the edge of the base plate.
- 11.6 Cement-based Non-shrink Grout shall be Five Star "Non-shrink" Grout or an approved equal.
 - 11.6.1 The grout shall be mixed, place, finished and cured in strict accordance with the manufacturer's instructions.
 - 11.6.2 The grout shall be a premixed, proportioned factory packaged product consisting of a mixture of cement, sand, and inert materials.
 - 11.6.3 The grout shall meet the following requirements:
 - Minimum compressive strength of 5000 psi at 28 days when tested in accordance with ASTM C109.
 - b. The grout shall have a minimum working time of 60 minutes at 75 F (24 C).
 - c. The grout shall show no shrinkage (0.0 percent) when tested in accordance with ASTM C827.



d. The grout shall be flowable.

11.4 Epoxy Non-shrink Grout shall be Ceilcote 648 High Strength Epoxy Grout or an approved equal.

- 11.4.1 The grout shall be mixed, placed, finished and cured in strict accordance with the manufacturer's instructions.
- 11.4.2 Non-shrink epoxy grout shall be proportioned, factory packaged product consisting of specially formulated resin, hardener and aggregate.
- 11.4.3 The grout shall meet the following requirements:
 - a. Epoxy grout shall have a minimum compressive strength of 5000 psi (350 kg/cm) at 24 hours when tested in accordance with ASTM C579.
 - b. Epoxy grout shall have 0 minimum working time of 45 minutes at 75 F (24 C).
 - c. The grout shall show a maximum shrinkage of 0.002 inch/inch when tested in accordance with ASTM D-2566.
 - d. The grout shall be flowable.
- 11.5 Sand-Cement Poured Grout
 - 11.5.1 Materials
 - a. Grout is a mixture of cement and sand with pouring consistency. The mix shall consist of i part of Portland cement and 2 parts of sand by volume.
 - b. The water-cement ratio shall be limited to 0.45 by weight.
 - c. Portland cement shall conform to ASTM C150, Types I, II, IV, or V.
 - d. Sand shall conform to ASTM C33.
 - 11.5.2 Mixing

Ingredients shall be thoroughly dry-mixed before adding water. After adding water, the batch shall be mixed for 3 to 5 minutes. Batches shall be sized to allow continuous placement of freshly mixed grout. Grout not used within on hour after mixing shall be discarded.

11.5.3 Placing

When placing grout the temperature of the foundation, base plate and grout shall be within the temperature range of 40 F to 90 F (5 C to 32 C) as determined by a surface thermometer. Maintain this temperature range for 3 days following grouting.

11.6 Drypack Grout



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11.6.1 Materials

- a. Drypack shall be a mixture of one part cement and 2-1/2 parts of sand by volume proportioned at the job site and mixed thoroughly with just enough water to produce a consistency such that when a sample is tightly squeezed in a hand only enough moisture will come to the surface to moisten the hand.
- b. Portland cement shall conform to ASTM C1550, Types I, II, IV or V.
- c. Sand shall conform to ASTM C33.
- 11.6.2 Mixing

Ingredients shall be thoroughly dry-mixed before adding water. After adding water, the batch shall be mixed for 3 to 5 minutes. Batches shall be sized to allow continuous placement of freshly mixed drypack. Drypack grout not used within one hour after mixing shall be discarded. Retempering will not be allowed.

11.6.3 Placing

- a. The space between the top of the concrete bearing surface and the bottom of the base plate shall be filled with drypack grout by tamping with a bar until the voids are eliminated.
- b. When placing drypack grout, the temperature of the foundations, base plate and drypack grout shall be within the temperature range of 40 F to 90 F (5C to 32 C) as determined by surface thermometer. Maintain this temperature range for 3 days following grouting.
- 11.7 Acid Resistant Grout shall be 1.W. Industries Poly-Plus 165 Acid Resistant Grout or an approved equal.
 - 11.7.1 The grout shall be mixed, placed, finished and cured in strict accordance with the manufacturer's instructions.
 - 11.7.2 Acid resistant grout shall be a proportioned, factory packaged product consisting of specially formulated resin, hardener and aggregate.
 - 11.7.3 The grout shall meet the following requirements:
 - a. Acid resistant grout shall have a minimum compressive strength of 5000 psi at 24 hours when tested in accordance with ASTM C579.
 - b. Acid resistant grout shall have a minimum working time of 45 minutes at 75 F.
 - c. The grout shall show a maximum shrinkage of 0.002 when tested in accordance with ASTM D-2566.
 - d. The grout shall be flowable.

11.8 Technical Services

For non-shrink and epoxy groups, a manufacturer's technical representative shall be called to the field office for a pregrouting conference to assure that all grouting steps are followed in accordance with the manufacturer's instructions. The representative should remain at the job site until the Construction Manager is assured that the correct procedures are being followed and the warranty is not in jeopardy. The BP Chemicals, Inc. Civil Engineer shall be advised if the manufacturer's representative recommends anything contrary to this specification.

12.0 CONSTRUCTION JOINTS

- 12.1 Joints not shown on the drawings shall be in accordance with ACI 301 and shall be so made and located as to least impair the strength of the structure and shall have the prior approval of the BP Chemicals, Inc. Civil Engineer. In areas subject to acid spills, the joints shall be sealed with acid resistant joint sealer as called for on the drawings.
- 12.2 Where a joint is made, the surface of the concrete shall be thoroughly cleaned and all laitance and standing water removed. Vertical joints also shall be thoroughly wetted and coated with neat cement grout immediately before placing concrete.
- 12.3 Where watertight construction is required, waterstops shall be placed in all construction joints.
- 12.4 Paving or slab construction joints not specified on the design drawings, shall be located at column centerlines and at intermediate intervals so that each panel shall be not more than 600 square feet in area. Concrete shall be placed in alternate checkerboard patterns or may be placed in alternate paving lanes utilizing expansion, construction and contraction joints to provide panels of size specified.

-- END OF SECTION--



EXHIBIT 03420-I SCHEDULE OF SUBMITTALS

SPECIFICATION SECTION AND PARAGRAPH	SUBMITTAL TITLE	SUBMITTAL SCHEDULE
03420 1.4.1.a	Concrete Testing Laboratory	Submit after contract award
03420 1.4.1.b	Test Results	One day after completion of tests
03420 1.4.1.c	Concrete Supplier	Submit after contract award



SECTION 03430

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1.0 SCOPE

1.1 This specification covers the manufacture and delivery of ready-mixed concrete.

2.0 APPLICABLE SPECIFICATIONS

- 2.1 Ready-mixed concrete shall be mixed and delivered in accordance with ASTM C94.
- 2.2 Air-entraining agents shall be in accordance with ASTM C260-77 Standard Specification of Air-Entraining Admixtures for Concrete.
- 2.3 Ready-mixed concrete shall be batched, mixed and tra. sported in accordance with ACI 301-84.

3.0 COMPRESSIVE STRENGTH OF CONCRETE

- 3.1 Concrete for superstructures, including pipe racks, shall develop a minimum compressive strength of 4000 psi in 28 days.
- 3.2 Concrete for foundations and paving shall develop a minimum compressive strength of 3000 psi in 28 days.
- 3.3 Concrete for electrical conduit encasement and cast in place fireproofing shall develop a minimum compressive strength of 2500 psi in 28 days.

4.0 CEMENT

- 4.1 Cement shall conform to ASTM C150, Type 1
- 4.2 Cement for air-entrained concrete shall conform to ASTM C150, Type IA.
- 4.3 One brand of cement shall be used throughout the work to maintain uniform color and to establish undivided responsibility.

5.0 WATER

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5.1 Water used in mixing concrete shall be clean and free from injurious amounts of oils, acids, alkalis, salts, organic materials, or other substances that may be deleterious to concrete or steel.

6.0 COARSE AGGREGATE

- 6.1 Aggregates shall conform to ASTM C33.
- 6.2 Size Number 467 (1-1/2 inches to No. 4) shall be used for foundations.
- 6.3 Size Number 67 (3/4 inch to No. 4) shall be used for beams, columns, and slabs greater than 4 inches thick.
- 6.4 Size Number 7 (i/2 inch to No. 4) shall be used for thin slabs (4 inches thick or less), elevated floor slabs with top and bottom layers of reinforcing and electrical conduit encasement.

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6.5 Size Number 8 (3/8 inch to No. 8) shall be used for cast in place fireproofing.

7.0 ADMIXTURES

- 7.1 Air-entrained concrete using Type IA cement shall be used for area paving and cast in place fireproofing.
- 7.2 Air-entrained concrete shall have an air content of 6 percent plus or minus 1.5 percent of the volume of the concrete as measured at the point of discharge from the mixer.
- 7.3 No admixtures, such as set retarders, water reducers etc., shall be used unless approved by BP Chemicals Inc.
- 7.4 Calcium Chloride shall not be used.

8.0 SLUMP

- 8.1 Slumps at the point of delivery shall be as follows:
 - 8.1.1 Slabs, beams, walls and columns: 4 inches to 1 inch
 - 8.1.2 Footings, mats and piers: 3 inches to 1 inch
- 8.2 The maximum slump may be increased by one inch for methods of consolidation other than vibration.

9.0 PROPORTIONING OF MIX

9.1 The supplier shall be responsible for the selection of the proportions for the concrete mixture for each class of concrete specified.

9.2 The supplier shall, prior to actual delivery of the concrete, furnish a statement to the Contractor's field office, and owner or owners representative giving the dry weights of cement and saturated surface dry weights of fine and coarse aggregate and quantities, type and name of admixtures (if any allowed) and of water per cubic yard of concrete that will be used in the manufacture of each class of concrete. He shall also furnish satisfactory evidence that the materials used and proportions selected will produce concrete of the quality specified.

10.0 ACCEPTANCE OF CONCRETE

- 10.1 Strength of laboratory cured concrete cylinders at 28 days shall be used as a basis for acceptance of concrete.
 - 10.1.1 Cylinders at jobsite shall be made by BP Chemicals Inc. field engineer or his appointed representative.
 - 10.1.2 Concrete not meeting the slump limits shall be rejected and removed from the site at supplier's cost. No retempering or addition of cement at site will be accepted.



- 10.2 Testing of concrete cylinders will be made by an independent laboratory selected by BP Chemicals Inc. at no cost to the supplier.
- 10.3 Evaluation of strength of concrete shall be in accordance with Chapter 4 of ACI 318-83.
- 10.4 When concrete tested falls to meet the strength requirements of this specification, the Field Engineer may require the in-place concrete be tested using the Windsor probe method.
- 10.5 If the test reports are still unsatisfactory, the defective material shall be removed from the work, or strengthened in a manner acceptable to Owner, at the expense of the supplier.
- 10.6 Any testing required due to failure of concrete to meet the strength requirements of this specification shall be paid for by the supplier.



DIVISION 13 SPECIAL CONSTRUCTION



DIVISION 13 Special Construction

Section	Title
13200	Geosynthetic Membranes
13300	Geonets
13400	Geotextile



GEOSYNTHETIC MEMBRANES

SECTION 13200

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EXHIBIT

13200-I Schedule of Submittals E-13200-I
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GEOSYNTHETIC MEMBRANES

1.0 GENERAL

- 1.1 Scope
 - 1.1.1 The work included in this section of these specifications shall consist of furnishing and installing high density polyethylene (HDPE) geomembranes to be used as liners in the locations as shown on the project plans.

1.2 Site Conditions

1.2.1 See construction drawings for site conditions and project layout.

1.3 Regulations

- 1.3.1 The current applicable regulations, ordinances, statutes or codes of the town, city, county or state in which the plant is located, the Federal Government, or other regulatory agency shall apply. Where this specification is more stringent than, and does not conflict with such regulations, ordinances, statues or codes, this specification shall govern.
- 1.4 Submittals
 - 1.4.1 The following shall be submitted for approval in accordance with the contract documents:
 - a. Product Data: Provide data on geomembrane products to used showing that they meet or exceed the applicable referenced standards.
 - b. Manufactures Certificates: Certify that the geomembrane products meet or exceed the applicable referenced standards.
 - c. Field Drawings: Layout drawings showing linear panel layout.
 - d. Daily Reports: Which include the following:
 - 1. Total amount of liner placed and see ned for that day.
 - 2. Location of seams placed.
 - 3. Changes in drawings.
 - 4. Seaming equipment and products used.
 - 5. Seam testing performed, and results of seam tests.
 - 6. Location of test samples.
 - 7. Location and results of repairs.

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GEOSYNTHETIC MEMBRANES

- Condition of surface on which membrane is to be installed for the next day, and it is acceptable.
- 9. Seam inspection report.
- e. Seaming equipment and products to be used.
- f. Final report indicating compliance of installation and noting any deviations.
- g. Refer to Exhibit 13200-I for Schedule of Submittals.

1.5 Quality Control/Assurance

- 1.5.1 Contractor requirements for quality control/assurance are presented in the Project Quality Assurance/Quality Control Plan provided as in the Closure Plan.
- 1.5.2 Contractor shall check Geomembrane Materials upon delivery to assure that the proper material has been received.
- 1.5.3 Upon arrival at the site, contractor shall conduct a surface observation of all rolls for defects and for damage. This inspection shall be conducted without unrolling rolls unless defects or damages are found or suspected. Contractor shall not use flawed material unless approved to do so by Owner, or his designated representative.

2.0 MATERIALS

2.1 HDPE Geomembrane Material:

The geomembrane material shall be High Density Polyethylene (HDPE), 60-mil and 100-mil in thickness as specified on the drawings, have material properties consistent with those specified in the Liner Capability Report provided in Appendix 6 of the Project Closure Plan, and have the following physical properties as exhibited by the referenced test method. Geomembrane in cap shall be embossed HDPE. Properties required for embossed HDPE, if different are shown in parentheses.

2.1.1	Minimum Tensile Properties (ASTM D 638)		60-mil	100-mil
	a.	Tensile strength at break	240 (130) lbs/in	400 lbs/in
	b.	Tensile strength at yield	140 lbs/in	240 lbs/in
	c.	Elongation at break	700%	700%
	d.	Elongation at yield	13%	13%
2.1.2	Coefficient of Linear Thermal Expansion (ASTM D 696)		1.2 x 10 ⁴ cm cm°c	1.2 x 10 ⁴ cm cm°c

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2.1.3	Low Temperature Brittleness (ASTM D 746)	-112°F	-112°F
2.1.4	Dimensional Stability (% change - each direction; ASTM D 1204)	± 2%	± 2%
2.1.5	Maximum Melt Flow Index (ASTM D 1238)	0.3 g/10 min	0.3 g/10 min
2.1.6	Specific Gravity (ASTM D 792)	0.93	0.93
2.1.7	Thickness (ASTM D 1593)	60 mils	100 mils
2.1.8	Maximum Carbon Black Content (ASTM D 1603)	2.5%	2.5%
2.1.9	Environmental Stress Cracking (min) (ASTM D 1693)	1500 hrs	1500 hrs
2.1.10	Resistance to Soil Burial (ASTM D 3083 and D 638)		
	a. % change in tensile strength at break and yield	± 10%	± 10%
	 % change in elongation at break and yield 	± 10%	± 10%
2.1.11 T	hermal Stability (min) (ASTM D 3895)	2000 hrs	2000 hrs
2.1.12 P	Puncture Resistance (FTMS 101C-2065)	80 (70) lbs	130 lbs
2.1.13	Minimum angle of friction between HDPE and soil	15° (27°)	15°

2.1.14 Refer to the project Quality Assurance/Quality Control Plan provided the Closure Plan for required number and frequency of the above tests that shall be performed by the Contractors quality personnel.

2.2 Welding Materials

- 2.2.1 All welding material shall be of a type recommended and supplied by the manufacturer and shall be delivered in the original sealed containers each with an indelible label bearing the brand name, manufacturer's mark number, and directions for use.
- 2.2.2 The welding equipment used shall be capable of continuously monitoring and controlling the temperature of the zone of contact where the machine is actually fusing the lining material so as to ensure that changes in environmental conditions will not affect the integrity of the weld.

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2.2.3 All clamps, clips, bolts, nuts, or other fasteners used to secure the liner around each appurtenance shall have a life span equal to or exceeding the liner and be those recommended for use by the liner manufacturer.

3.0 GEOMEMBRANE INSTALLATION

- 3.1 Trench Anchorage System
 - 3.1.1 The anchor trench shall be excavated in accordance with Section 02220 to the lines and widths shown on the project plans, prior to geomembrane placement.
 - 3.1.2 If the anchor trench is excavated in a clay liner susceptible to desiccation, no more than the amount of trench required for the geomembrane to be anchored in one day shall be excavated (unless otherwise specified) to minimize desiccation potential of the anchor trench clay soils.
 - 3.1.3 Slightly rounded corners shall be provided in the trench where the geomembrane adjoins the trench so as to avoid sharp bends in the geomembrane. No loose soil shall be allowed to underlie the geomembrane in the anchor trench.
 - 3.1.4 Backfilling of the anchor trench shall be conducted in accordance with Paragraph 3.8 of this Section.
- 3.2 Geomembrane Placement
 - 3.2.1 Immediately prior to installation of the designed geomembrane liner, the clay surface shall be observed by the Contractor and the Owner's designated representative. The decision to repair cracks, if any, shall be made by the Owner or his designated representative. The subgrade shall be walked by the Contractor and the Owner or his designated representative for joint approval. The contractor and subcontractor performing liner installation will sign acceptance of the surface condition of the subgrade. The integrity of the underlying soil is the responsibility of the contractor.
 - 3.2.2 No liner shall be placed on surfaces not previously found acceptable by the Contractor and his liner installation Subcontractor.
 - 3.2.3 Surfaces to be lined shall be flat within \pm 0.2 feet in any 100 square feet (or as shown in the drawings) and to the grades as shown on the Contract plans. All intersections between planes shall be made along straight lines. No sharp stones or other hard objects that will not pass through a 3/8 inch screen shall be present in the top 1 inch of the surface to be covered.
 - 3.2.4 Surfaces to be lined shall be smooth and free of all rocks, sharp stones, sticks, roots, sharp objects, or debris of any kind. The surface should provide a firm, unyielding foundation for the membrane with no sudden, sharp or abrupt changes or break in grade.
 - 3.2.5 Field Panel Identification



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- a. A field panel is the unit area of geomembrane which is to be seamed in the field; i.e., a field panel is a roll or a portion of roll cut in the field.
- b. At the time of installation, the Contractor's Field Supervisor shall give each field panel an "identification code" (number or letter-number) consistent with the layout plan. This identification code shall be agreed upon by the Owner or his designated representative. This field panel identification code shall be as simple and logical as possible.
- c. Layout Drawings: Layout drawings will be made and submitted to the client prior to start-up of construction. All layout drawings will be strictly adhered to. No changes will be made unless agreed to by the client.
- 3.2.6 Field Panel Placement
 - a. Location
 - Field panels are to be installed at the locations indicated in the layout plan, or as modified by the Contractors Field Supervisor based upon existing site conditions, and approval from the Owner or his designated representative.
 - b. Installation Schedule
 - 1. Field panels may be installed using any one of the following schedules:
 - All field panels are placed prior to field seaming (in order to protect the subgrade from erosion by rain or wind);
 - Field panels are placed one at a time, and each field panel is seamed after its placement (in order to minimize the number of unseamed field panels); and

Any combination of the above.

- The Contractor shall record the identification code, location, and date of installation of each field panel.
- c. Weather Conditions
 - Welding shall not take place during any precipitation, in the presence of excessive moisture (e.g., fog, dew), in an area of ponded water, or in the presence of excessive winds (unless wind barriers are provided).
- d. Method of Placement
 - 1. The Contractor shall verify the following:
 - Any used equipment will not damage the geomembrane by handling, trafficking, excessive heat, leakage of hydrocarbons, or other means;

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- The prepared surface underlying the geomembrane has not deteriorated since previous acceptance and is still acceptable immediately prior to geomembrane placement;
- Any geosynthetic elements immediately underlying the geomembrane are clean and free of debris;
- All personnel working in the area of geomembrane placement shall not smoke, wear shoes that are abrasive, or engage in other activities which could damage the geomembrane;
- The method used to unroll the panels does not cause scratches or crimps in the geomembrane and does not damage the supporting soil;
- The method used to place the panels minimizes wrinkles (especially differential wrinkles between adjacent panels);
- Provide adequate temporary loading and/or anchoring (e.g., sand bags, tires). The anchoring methods will not cause damage the geomembrane and have been placed to prevent uplift by wind continuous loading, by adjacent sand bags, or soil is recommended along edges of panels to minimize risk of wind under the panels).
 - Direct contact with the geomembrane is minimized (i.e., the geomembrane is protected by geotextiles, extra geomembrane, or other suitable materials in areas where excessive traffic may be expected).
 - The Contractor shall inform the Owner or his designated representative.
- e. Damage
 - 1. The Contractor shall inspect each panel after placement and prior to seaming for damage. The Contractor shall advise the Owner or his designated representative which panels or portions of panels should be repaired or accepted. Damaged pairs or portions of damaged panels which have been rejected shall be marke, and their removal from the work area recorded by the Contractor. Repairs shall be made accordingly to procedures described in Paragraph 3.6.3 of this Section.

3.3 Field Seaming

- 3.3.1 Seam Layout
 - a. Upon commencement of the installation, the Contractor shall provide the Owner with a proposed panel layout drawing; i.e., a drawing of the facility to be lined based upon submitted engineering drawings. The proposed panel layout drawing is tentative and may be modified by the Contractor Field Supervisor with the Owner's approval.

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- b. In general, seams should be oriented parallel to the line of maximum slope; i.e., oriented along, not across, the slope. In corners and odd-shaped geometric locations, the number of seams should be minimized. No horizontal seam should be less than 5 feet (1.5 m) from the toe of the slope or areas of potential stress concentrations unless otherwise authorized.
- c. A seam numbering system compatible with a panel numbering system shall be agreed upon at the Pre-Construction Meeting.
- 3.3.2 Seaming Equipment and Products
 - a. The approved processes for field seaming are extrusion welding and fusion (hot wedge) welding. Proposed alternate processes shall be documented and submitted to the Owner for their approval.
 - b. The extrusion welding apparatus shall be equipped with gauges giving the temperature of the apparatus at the nozzle.
 - c. The fusion-welding apparatus must be an automated vehicular-mounted device which produces a double seam with an enclosed space.
 - d. The fusion welding apparatus shall be equipped with gauges giving the applicable temperatures.
 - e. The Contractor shall log apparatus temperatures, extrudate temperatures, ambient temperatures, and geomembrane surface temperatures at appropriate intervals.
 - f. The Contractor shall verify that:
 - 1. Equipment used for seaming is not likely to damage geomembrane;
 - The extrusion welder is purged prior to beginning a seam until all heatdegraded extrudate has been removed from the barrel;
 - The electric generator is placed on a smooth base such that no damage occurs to the geomembrane;
 - Buffing shall be completed no more than one (1) hour prior to extrusion welding;
 - A smooth insulating plate or fabric is placed beneath the hot welding apparatus after usage; and
 - 6. The geomembrane is protected from damage in heavily trafficked areas.

3.3.3 Seam Preparation

- a. The Contractor shall verify that:
 - 1. Prior to seaming, the seam area is clean and free of moisture, dust, dirt, debris of any kind, and foreign material;

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- Seams are aligned with the fewest possible number of wrinkles and "fishmouths".
- 3.3.4 Weather Conditions for Seaming
 - a. Welding is not to be conducted during any precipitation, in the presence of excessive moisture (e.g., fog, dew), in an area of ponded water, or in the presence of excessive wind without the use of wind barriers. Welding is to be conducted with ambient temperatures between 34°F and 105°F. Welding may be performed at temperatures below 34°F if the ambient temperature above the liner is artificially heated, provided the liner is not damaged.
 - b. The Contractor shall verify that these weather conditions are fulfilled and will advise the Owner if they are not. The Owner shall then decide if the installation shall be stopped or postponed.

3.3.5 General Seaming Procedures

- Unless otherwise specified, the general seaming procedure used by Contractor shall be as follows:
 - The rolls of membrane shall be overlapped by a minimum of four (4) inches (100 mm) for fusion welding and three (3) inches (75 mm) for extrusion welding.
 - 2. "Fishmouths" or wrinkles at the seam overlaps shall be cut along the ridge of the wrinkle in order to achieve a flat overlap. The cut "fishmouths" or wrinkles shall be seamed and any portion where the overlap is inadequate shall then be patched with an oval or round patch of the same geomembrane extending a minimum of 6 inches beyond the cut in all directions.
 - Searning shall extend up the panels, 6 inches past the crest of the anchor trench.
 - 4. All cross seams are to be extrusion welded where they intersect.
 - 5. For fusion welding, a movable protective layer of plastic may be required to be placed directly below the overlapped membranes being seamed. This is to prevent any moisture buildup between the sheets to be welded.
 - 6. Prior to welding seams the weld type, welding machine number, and the welders name are to be recorded in daily logs. The welder is to identify on the daily logs if the weld is original or a repair.

3.4 Nondestructive Seam Continuity Testing

3.4.1 The Contractor shall nondestructively test all field seams over their full length using a vacuum test unit, air pressure testing, or other approved method as specified in the Project Quality Assurance/Quality Control Plan. (Vacuum testing is described in Paragraph 3.4.2 of this Section and air pressure testing is described in Paragraph 3.4.3

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of this Section.) The purpose of nondestructive tests is to check the continuity of seams. It does not provide information on seam strength. Continuity testing shall be carried out as the seaming work progresses, not at the completion of all field seaming.

- 3.4.2 Vacuum Testing
 - a. The equipment shall be comprised of the following:
 - A vacuum box assembly consisting of a rigid housing, a transparent viewing window, a soft neoprene gasket attached to the bottom, port hole or valve assembly, and a gauge to indicate chamber vacuum;
 - A steel vacuum tank and pump assembly equi, ped with a pressure controller and pipe connections;
 - 3. A rubber pressure/vacuum hose with fittings and connections;
 - 4. A bucket and wide brush or spray assembly;
 - 5. A soapy solution;
 - b. The following procedures shall be followed:
 - Energize the vacuum pump and reduce the tank pressure to approximately 5 psi (10 inches of Hg.) gauge;
 - Wet a strip of geomembrane approximately 12 inches by 48 inches (0.3 m by 1.2 m) with the soapy solution;
 - 3. Place the box over the wetted area;
 - 4. Close the bleed valve and open the vacuum valve;
 - 5. Ensure that a leak tight seal is created;
 - For a period of approximately 5 to 10 seconds, examine the geomembrane through the viewing window for the presence of soap bubbles;
 - If no bubble appears after 10 to 15 seconds, close the vacuum valve and open the bleed valve, move the box over the next adjoining area with a minimum 4 inches (75 mm) overlap, and repeat the process;
 - All areas where soap bubbles appear shall be marked and repaired in accordance with Section 3.4;
 - 9. Vacuum tested seams are recorded on Daily Progress Reports.
- 3.4.3 Air Pressure Testing (For Double Fusion Seam Only)
 - a. The equipment shall be comprised of the following:

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- An air pump (manual or motor driven) equipped with pressure gauge capable of generating and sustaining a pressure between 25 and 30 psi (160 and 200 kPa);
- 2. A rubber hose with fittings and connections;
- 3. A sharp hollow needle, or other approved pressure feed device.
- b. The following procedures shall be followed:
 - 1. Seal both ends of the seam to be tested;
 - Insert needle or other approved pressure feed device into the tunnel created by the fusion weld;
 - 3. Energize the air pump to a pressure between 25 and 30 psi (160 and 200 kPa), close valve, and sustain pressure for approximately two minutes;
 - 4. If loss of pressure exceeds 2 psi (15 kPa), or does not stabilize, locate faulty area and repair in accordance with Paragraph 3.6 of this Section.
 - 5. Remove needle or other approved pressure feed device and seal.
- 3.4.4 Bolting: All bolting will be done as per details in the design drawings. All batten strips will be visually inspected to assure compression of the neoprene gasketing. All batten strips will be tapped in the center between two bolts, with a ballpeen hamme. A high pitched ringing sound indicates proper pressure between the strip and the gasket. A low pitched sound indicates a lack of pressure between the strip and the gasket. All anchor bolts are to be re-checked for tightness using a standard ratchet assembly.

3.5 Destructive Testing

- 3.5.1 At a minimum, every 500 linear feet 6, seam will be tested as follows:
 - a. A test strip, 54 inches in length by 12 inches in width, will be removed.
 - b. Three 6-inch by 1-inch samples will be tested in peel with a manual tensiometer immediately.
 - c. The Contractor will keep 12 inches, give the QA/QC Engineer 12 inches for 3rd party testing and give the client 12 inches to store in their archives.
 - d. As required, the Contractor's portion will be tested by their personnel in accordance with the following:
 - 1. Seam strength ASTM D 3083 100% of sheet yield strength
 - 2. Peal adhesion ASTM D 413 Film tearing bond
 - e. 50 coupons, 6 inches by 1-inch per sample are to be tested.



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- All areas that have been destructively tested will be repaired with patches and welded by the extrusion method and vacuum tested.
- 3.6 Defects and Repairs
 - 3.6.1 Identification
 - a. All seams and non-seam areas of the geomembrane shall be examined by the Contractor for identification of defects, holes, blisters, undispersed raw materials and any sign of contamination by foreign matter.

3.6.2 Evaluation

a. Each suspect location, both in seam and non-seam areas, shall be nondestructively tested using the methods described in Section 3.4 as appropriate. Each location which fails the non-destructive testing shall be marked by the Contractor and repaired. Work shall not proceed with any materials which will cover locations which have been repaired until laboratory test results with passing values are available.

3.6.3 Repair Procedures

- a. Any portion of the geomembrane exhibiting a flaw or failing an destructive or nondestructive test shall be repaired. Several procedures exist for the repair of these areas. The final decision as to the appropriate repair procedure shall be agreed upon between the Owner or his designated representative and the Contractor. The procedures available include:
 - Patching--used to repair large holes, tears, and contamination by foreign matter;
 - 2. Buffing and rc-welding--used to repair small sections of extruded seams;
 - Spot welding or seaming-used to repair small tears, pinholes, or other minor localized flaws;
 - 4. Capping-used to repair large lengths of failed seams;
 - Topping-used to repair areas of inadequate seams which have an exposed edge;
 - 6. In addition, the following provisions shall be satisfied:
 - Surfaces of the geomembrane which are to be repaired shall be buffed no more than one hour prior to the repair;
 - All surfaces must be clean and dry at the time of the repair;
 - All seaming equipment used in repairing procedures must be approved;

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- The repair procedures, materials, and techniques shall be approved in advance of the specific repair by the Owner or his designated representative and the Contractor.
- Patches or caps shall extend at least 6 in. beyond the edge of the defect, and all corners of patches shall be rounded with a radius of at least 3 inches.

3.6.4 Verification of Repairs

- a. Each major repair requiring a patch or cap shall be identified on the as-built drawing. Each repair shall be non-destructively tested using the methods described in 3.4 of this Section as appropriate. Repairs which pass the nondestructive test shall be taken as an indication of an adequate repair. Failed tests indicate that the repair shall be re-done and re-tested until a passing test results.
- 3.7 Factory seams shall meet the same requirements as those specified for field seaming.
- 3.8 Backfilling of Anchor Trench
 - 3.8.1 The anchor trench, if any, shall be adequately drained to prevent ponding or otherwise softening of the adjacent soils while the trench is open. The anchor trench shall be backfilled as outlined in those specifications and drawings.
 - 3.8.2 Since backfilling the anchor trench can affect material bridging at toe of slope, consideration sb .4d be given to backfill the liner at its most contracted state; preferably during the cool of the morning or extended period of over-cast skies. Care shall be taken when backfilling the trenches to prevent any damage to the geosynthetics.
 - 3.8.3 Anchor Trench: The anchor trench will be excavated to the lines and grades shown in the design drawings. Excavation will not exceed the amount to be lined in two (2) days. The anchor trench will be compacted as per the technical specification.

4.0 LINING SYSTEM ACCEPTANCE

- 4.1 General
 - 4.1.1 The geosynthetic lining system shall be accepted when:
 - a. The installation or portion for backfilling is finished;
 - b. Verification of the adequacy of all seams and repairs including associated testing is complete;
 - c. All documentation for installation is completed.
 - d. Requirements of the project Quality Assurance/Quality Control Plan provided in Appendix B are met.



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5.0 SOIL/EARTH COVER ON TOP OF GEOMEMBRANE

- 5.1 General
 - 5.1.1 Placement of soils, sand or other types of earth cover on top of the liner shall not be performed until all destructive and non-destructive testing has been performed and accepted by the Owner.
 - 5.1.2 Placement should be performed to minimize wrinkles. Equipment operators should be briefed on method of placement and affects of thermal expansion and contraction of the liner.
 - 5.1.3 Material placed on top of the liner should be stock piled and displaced off the stockpile to create a cascading effect of the cover material on top of the liner.
 - 5.1.4 If a wrinkle forms, every effort should be made to walk the wrinkle out.
 - 5.1.5 Minor folding over the wrinkles is acceptable providing an even transition occurs at the tail of the wrinkle. If excessive stress points are created at the tail of the wrinkle, the wrinkle should be cut out and repaired per Paragraph 3.6 of this Section.

-- END OF SECTION--



EXHIBIT 13200-I SCHEDULE OF SUBMITTALS*

	PECIFICATION ON AND PARAGRAPH	SUBMITTAL TITLE	SUBMITTAL SCHEDULE
13200	1.4.1a	Product Data	Ten Fifteen days after start of project prior to installation of membrane liner
13200	1.4.1b	Manufactures Certification	Fifteen days prior to installation of membrane liner
13200	1.4.1c 3.2.6al	Field Layout Drawings	Prior to installation of membrane liner
13200	1.4.1d	Daily Reports	At the end of each day
13200	1.4.1e 3.3.2a	Seaming Equipment	Fifteen days prior to its use
13200	1.4.1f	Final Report	Five days after installation is complete

* In addition to the above listed Submittals refer to the Project Quality Assurance/Quality Control Plan provided as part of the Closure Plan for additional Contractor submittals required.



SECTION 13300

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EXHIBIT

13300-I	Schedule of Submittals	E.	13300-I
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1.0 GENERAL

- 1.1 Scope
 - 1.1.1 The work included in this section of these specifications shall consist of furnishing and installing the Geonet to be used as drainage media in the double liner leachate collection and leak detection system.

1.2 Site Conditions

1.2.1 See construction drawings for site conditions and project layout.

1.3 Regulations

1.3.1 The current applicable regulations, ordinances, statues or codes of the town, city, county or state in which the plant is located, the Federal Government, or other regulatory agency shall apply. Where this specification is more stringent than, and does not conflict with such regulations, ordinances, statues or codes, this specification shall govern.

1.4 Submittals

- 1.4.1 Product data: The contractor shall provide a list of guaranteed minimum physical properties for the specified geonet to be installed.
- 1.4.2 Each roll of geonet shall bear a label which identifies the following:
 - a. Manufacturer
 - b. Product identification
 - c. Unique roll or lot number
 - d. Roll dimension
- 1.4.3 Manufactures certificates: Certify that the geonet products meet or exceed the applicable referenced standards.
- 1.4.4 Provide test data from an independent laboratory for each property listed in Section 2.1 for each different lot furnished. Sample locations are to be selected by Owner's inspector. Transmissivity test data must use HDPE liner material to be furnished under Section 13200, geotextile furnished under Section 13400, and protective sand layer Type D material furnished under Section 02220. (Refer to project Quality Assurance/Quality Control Plan provided in the Closure Plan, for the frequency of each test required.)
- 1.4.5 Provide placement plan for approval by Owner. Plan must show layout of each panel, and anchoring and tying details.
- 1.4.6 Refer to Exhibit 13300-I for Schedule of Submittals.

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1.5 Quality Control/Assurance

- 1.5.1 Contractor shall check the Geonet upon delivery to assure that the proper material has been received.
- 1.5.2 Upon arrival at the site contractor shall conduct a surface observation of all rolls for defects and for damage. This inspection shall be conducted without unrolling rolls unless defects or damages are found or suspected. Contractor shall report to the Owner or his designated representative by identification number and roll description, the condition of each roll and note whether any flaws were observed.
- 1.5.3 The Owner or his designated representative shall provide a location for storage of Geonet. Contractor shall be responsible for protecting geomembrane materials in the storage area.

2.0 MATERIALS

- 2.1 Geonet
 - 2.1.1 The Geonet material shall be of high density polyethylene (HDPE) and at a minimum have the following properties;

1.	Melt Index (ASTM D 1238)	1.1 g/10 min
2.	Density (ASTM D 1505)	0.93 g/cc
3.	Carbon Black Content (%) (ASTM D 1603)	2 to 3%
4.	Standard Crush Strength (min) (ASTM D 1621)	7000 psf
5.	Transmissivity (ASTM D 4716-87) ² - (See note 2)	10 gal/min/ft ¹ (See note 1) 5 g.al/min/ft ³ (See note 3)

2.1.2 Refer to the project Quality Assurance/Quality Control Plan provided in the Closure Plan for frequency of tests required.

3.0 INSTALLATION OF GEONET

3.1 Geonets shall be handled in such a manner as to ensure they are not damaged in any way.

- ² Drainage gradient of 0.2 to 0.25, pressure of 10,000 psf² and seating time of 15 min.
- ³ HDPE below and geotextile and soil above.¹

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¹ HDPE above and below.¹

- 3.1.1 On slopes, geonets shall be anchored in the anchor trench; then rolled down the slope in such a manner as to continually keep the material in tension.
- 3.1.2 In the presence of wind, the materials shall be weighted with sandbags until final covers are installed.
- 3.1.3 Care shall be taken to assure that any underlying layers are not damaged during placement.
- 3.1.4 Care shall be taken to assure that stones, mud, and dirt are not entrapped in the geonet during placement and seaming operations.
- 3.2 Geonets may be butt joined or lapped. Nylon cable ties shall be applied to the net edge at 5 foot intervals along the edge.
- 3.3 End splices shall be made as follows:
 - 3.3.1 Do not make end splices on slopes or within 15 feet of edge of slope on uphill side.
 - 3.3.2 On bottoms, the ends shall overlap a minimum of 2 inches and one row of three cable ties applied.
- 4.0 <u>REPAIRS</u>
 - 4.1 Any holes or tears in geonets shall be repaired by patching with the same geonet material. The patch shall be a minimum of 12" larger in all directions than the area to be repaired. The patch shall be tied in place using a minimum of four nylon cable ties.

5.0 PLACEMENT OF COVER MATERIAL

- 5.1 Cover material such as geotextile or geomembrane liners which are placed over geonets shall be placed in such a manner as to assure that the geonet is not damaged.
- 5.2 Care shall be taken to minimize any slippage of the geonet and to assure that no tensile stress is induced in the materials.

-- END OF SECTION--



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EXHIBIT 13300-I SCHEDULE OF SUBMITTALS

ata Ten days after start of project
res certification Fifteen Ten days prior to
Ten days prior to start of liner construction

13300 1.4.5

Placement Plan

Ten days prior to start of placement





SECTION 13400

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EXHIBIT



1.0 GENERAL

- 1.1 Scope
 - 1.1.1 The work included in this section of these specifications shall consist of furnishing and installing the Geotextile to be used as filter fabric between layers of soil and as a filter/separator protective layer betw sen Geonet and protective sand layer placed over it and Geomembrane as shown on the project plane drawings.

1.2 Site Conditions

1.2.1 See construction drawings for site conditions and project layout.

1.3 Regulations

1.3.1 The current applicable regulations, ordinances, statues or codes of the town, city, county or state in which the plant is located, the Federal Government, or other regulatory agency shall apply. Where this specification is more stringent than, and does not conflict with such regulations, ordinances, statues or codes, this specification shall govern.

1.4 Submittals

- 1.4.1 The Contractor shall provide a list of guaranteed minimum average roll value properties for the specified geotextile to be installed.
- 1.4.2 Each roll of geotextile shall bear a label which identifies the following:
 - a. Manufacturer
 - b. Product identification
 - c. Unique roll or lot number
 - d. Roll dimension
- 1.4.3 Manufacturers Certificate: Certify that the geotextile products meet or exceed the applicable referenced standards.
- 1.4.4 Placement drawing layout showing location and orientation for each panel.
- 1.4.5 Refer to Exhibit 13400-I for Schedule of Submittals.
- 1.4.6 Provide test data from an independent laboratory for each property listed in Section 2.1 Testing is to be performed on samples cut from rolls at locations designated by Owner's inspector. Refer to Section 7 of QA/QC Plan Appendix 9 to Closure Plan for frequency of testing required.
- 1.5 Quality Control/Assurance



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- 1.5.1 Contractor shall check geotextile upon delivery to assure that the proper material has been received.
- 1.5.2 Upon arrival at the site contractor shall conduct a surface observation of all rolls for defects and for damage. This inspection shall be conducted without unrolling rolls unless defects or damages are found or suspected. Contractor shall report to the Owner, by identification number and roll description, the condition of each roll and note whether any flaws were observed.
- 1.5.3 The Owner shall provide a location for storage of Geotextile. Contractor shall be responsible for protecting geotextile materials in the storage area.

2.0 MATERIALS

- 2.1 Geotextile
 - 2.1.1 The geotextile material used for separation shall be of the non-woven type made of polypropylene fibers.
 - 2.1.2 The geotextile used between the protective sand layer and the geonet shall be of the woven type made of polypropylene.
 - 2.1.3 If needle-punched; the geotextile shall be needle-free.
 - 2.1.4 The geotextile material used shall have the following typical roll properties:

а.	Mass per unit area (min)	Nonwoven	Woven
	(ASTM D 3776)	8 oz/yd²	8 oz/yd²
b.	Permittivity (ASTM D 4491)	1.3 sec ⁻¹	NR
c.	Puncture (min) (ASTM D 3787)	100 lbs	150 Ibs
d.	Mullen Burst (min) (ASTM D 3786)	245 psi	1100 psi
e.	Trapezoid Tear Strength (min) (ASTM D 4533)	95 lbs	190 Ib
f.	Grab Tensile/Elongation (ASTM D 4632)	203 to 225 lbs/50%	400/25%
g.	Wide Width Strip (ASTM D 4595) Weakest direction	105 lb/in	290 lb/in
h.	UV Resistance (500 hrs) ASTM D 4355)	> 80% strength retained	>85% strength retained



j.,	Flow rate (ASTM D 4991)	NR	50 gpm/ft ²¹
j.	Apparent opening size (ASTM D 4751)	NR	40 sieve

3.0 INSTALLATION OF GEOTEXTILE

- 3.1 Geotextile shall be handled in such a manner as to ensure they are not damaged in any way.
 - 3.1.1 On slopes, geotextiles shall be anchored in the anchor trench; then rolled down the slope in such a manner as to continually keep the material in tension.
 - 3.1.2 In the presence of wind, the materials shall be weighted with sandbags until final covers are installed.
 - 3.1.3 Care shall be taken to assure that any underlying layers are not damaged during placement.
 - 3.1.4 Care shall be taken to assure that stones, mud, and dirt are not entrapped in the geotextile during placement and seaming operations.
- 3.2 Geotextiles may be installed by per manufacturer's recommendation for this type of installation or use.
 - 3.2.1 If se wing is required, thread shall be a polymeric material with chemical resistance similar to the geotextile.
 - 3.2.2 Install geotextiles on slopes with the machine direction. In the ap/down slope direction.
 - 3.2.3 Do not join, seam or lap geotextiles on slopes or within 15 feet of crest on uphill sides.

4.0 REPAIRS

4.1 Any holes or tears in geotextiles shall be removing that section of geotextile.

5.0 PLACEMENT OF COVER MATERIAL

- 5.1 Any cover material such as soil or geomembrane liners which is placed over geotextiles shall be placed in such a manner as to assure that the geotextile is not damaged.
- 5.2 Care shall be taken to minimize any slippage of the geotextile and to assure that no tensile stress is induced in the materials.
- 5.3 Vehicular traffic will not be permitted on geotextile or sand material over the geotextile.
- 5.4 Compact cover layer with hand operated vibratory plate only.

-- END OF SECTION--

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EXHIBIT 13400-1 SCHEDULE OF SUBMITTALS

SPECIFICATION SECTION AND PARAGRAPH	SUBMITTAL TITLE	SUBMITTAL SCHEDULE
13400 1.4.1	Product data	Ten days after contract award
13400 1.4.3	Manufactures certification	Fifteen days prior to installation
13400 1.4.41	Field Layout	Fifteen days prior to installation





DIVISION 15 MECHANICAL

DIVISION 15 Mechanical

Section <u>Title</u> 15200 Process Equipment

SECTION 15200

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2	3.	220	520	520	520	520	520	520	520	22	32	31	3	2	2	ļ	į	l	l	l		l	l	l		į	ļ	ļ	l	l	l	į	l	l	l	ļ	l	ļ	ļ	l	l	l	ļ	l	l	į	l	į	l	ļ	l	l	l	l	8	į,	į,	8	8	l	l	ļ	ļ	l	ļ	l	ļ	l	l	l	l	l	l	8	g	l	l	8	1	g	g	8	l	l	8	1	ļ	ļ	ļ	g	g	8	l	8	g	g	l	8
2	5,	120	120	120	120	120	\$20	520	22	22	22	3	þ.	þ	þ	ļ		l	ļ	ł	į	ł	l	ł	į		l	l	ł	ł	l		ł	ł	ł	ļ	ł	l	l	ł	ł	ł	ļ	ļ	ļ		l		ļ	ļ	ļ	ļ	2	2	2	1	1	2	2	2	ļ	ļ	ļ	ļ	ļ	ļ	ļ	ļ	ļ	ļ	ļ	ļ	2	2	1	ļ	ļ	8	1	1	1	8	ļ	2	8	1	ļ	ļ	ļ	1	1	8	2	2	1	1	ļ	2
2	5,	120	120	120	120	120	\$20	520	22	22	22	3	þ.	þ	þ	ļ		l	ļ	ł	į	ł	l	ł	į		l	l	ł	ł	l		ł	ł	ł	ļ	ł	l	l	ł	ł	ł	ļ	ļ	ļ		l		ļ	ļ	ļ	ļ	2	2	2	1	1	2	2	2	ļ	ļ	ļ	ļ	ļ	ļ	ļ	ļ	ļ	ļ	ļ	ļ	2	2	1	ļ	ļ	8	1	1	1	8	ļ	2	8	1	ļ	ļ	ļ	1	1	8	2	2	1	1	ļ	2
2	1	120	120	120	120	120	120	120	124	12	12	1	h	ł	ł	ł	ł	ļ	ļ	ļ	l	ļ	ļ	ļ	l	ł	ł	ł	ł	ł	ł	ł		ł	ł	ł	ł	ł	ł	ł		ļ	ļ	ļ	ļ	ł	ł	ł	ļ	ļ	p	2	2	2	2	ļ	ļ	2	ļ	2	2	p	p	ļ	ļ	ļ	ļ	p	p	p	p	p	2	ļ	ļ	2	ļ	l	ļ	l	l	l	2	ļ	l	ļ	l	l	ļ	l	l	l	2	ļ	l	ļ	2	ļ
2	5,	120	120	120	120	120	\$20	520	22	22	22	3	þ.	þ	þ	ļ		l	ļ	ł	į	ł	l	ł	į		l	l	ł	ł	l		ł	ł	ł	ļ	ł	l	l	ł	ł	ł	ļ	ļ	ļ		l		ļ	ļ	ļ	ļ	2	2	2	ļ	ļ	2	2	2	ļ	ļ	ļ	ļ	ļ	ļ	ļ	ļ	ļ	ļ	ļ	ļ	2	2	ļ	ļ	ļ	l	ļ	l	l	l	ļ	2	l	ļ	l	l	ļ	l	l	l	2	2	l	ļ	ļ	2
1	3.	520	520	520	520	520	520	520	520	520	32	3.	3	2	3	ļ	ł	į	ł		l		į		l	ł	ļ	ļ	l	l	l	ł	ļ	l	l	ļ	l	ļ	ļ	l	ļ		ļ	ļ	ł	ł	l	ł	ł	ļ	ļ	ļ	ļ	ļ	1	1	1	1	ļ	ļ	ļ	ļ	ļ	ļ	ļ	ļ	ļ	ļ	ļ	ļ	ļ	ļ	ļ	ļ	1	ļ	ļ	ļ	ļ	1	1	ļ	ļ	ļ	ļ	ļ	ļ	ļ	ļ	1	1	ļ	ļ	ļ	1	1	ļ	1
1	3.	20	\$20	520	520	\$20	\$20	24	520	323	32	3.	3	2	3	ļ	į	l	l	ļ	i	ļ	l	ļ	i	į	ļ	ļ	l	l	l	į	ļ	l	ļ	ļ	ļ	ļ	ļ	ļ	ļ	ļ	ļ	l	l	į	l	į	l	ļ	l	ļ	1	1	1	ļ	ļ	1	1	1	1	ļ	ļ	l	ļ	l	ļ	l	l	l	l	l	1	1	ļ	1	1	1	1	1	1	1	1	1	1	1	l	l	ļ	1	1	1	1	1	1	ļ	1	8
2	5	120	120	120	120	120	\$20	\$20	120	12	32	37	2	ł	į	ļ	l	l	l	l	l	l	l	l	l	l	l	l	l	l		l	ł	l	l	ļ	l	l	l	l	ł	l	ļ	ļ	l	l		l	l	ļ	l	P	2	2	2	ļ	ļ	2	2	2	2	ļ	ļ	l	ļ	l	ļ	l	l	l	l	l	2	2	ļ	2	ļ	l	ļ	l	l	l	2	2	l	ļ	l	l	ļ	l	l	l	2	2	l	ļ	2	2
8	3.	220	520	520	520	520	520	520	520	22	32	31	3	2	2	ļ	į	l	l	l		l	l	l		į	ļ	ļ	l	l	l	į	l	l	l	ļ	l	ļ	ļ	l	l	l	ļ	l	l	į	l	į	l	ļ	l	l	l	l	8	g	g	8	8	l	l	ļ	ļ	l	ļ	l	ļ	l	l	l	l	l	l	8	g	l	l	8	1	8	8	8	l	l	8	1	ļ	ļ	ļ	8	8	8	l	8	8	g	l	8
2	5,	120	120	120	120	120	\$20	520	22	22	22	3	þ.	þ	þ	ļ		l	ļ	ł	į	ł	l	ł	į		l	l	ł	ł	l		ł	ł	ł	ļ	ł	l	l	ł	ł	ł	ļ	ļ	ļ		l		ļ	ļ	ļ	ļ	2	2	2	1	1	2	2	2	ļ	ļ	ļ	ļ	ļ	ļ	ļ	ļ	ļ	ļ	ļ	ļ	2	2	1	ļ	ļ	8	1	1	1	8	ļ	2	8	1	ļ	ļ	ļ	1	1	8	2	2	1	1	ļ	2
8	3.	220	520	520	520	520	520	520	520	22	32	31	3	2	2	ļ	į	l	l	l		l	l	l		į	ļ	ļ	l	l	l	į	l	l	l	ļ	l	ļ	ļ	l	l	l	ļ	l	l	į	l	į	l	ļ	l	l	l	l	8	g	g	8	8	l	l	ļ	ļ	l	ļ	l	ļ	l	l	l	l	l	l	8	g	l	l	8	1	8	8	8	l	l	8	1	ļ	ļ	ļ	8	8	8	l	8	8	g	l	8
2	5	120	120	120	120	120	\$20	\$20	120	12	32	37	2	ł	į	ļ	l	l	l	l	l	l	l	l	l	l	l	l	l	l		l	ł	l	l	ļ	l	l	l	l	ł	l	ļ	ļ	l	l		l	l	ļ	l	P	2	2	2	ļ	ļ	2	ŝ	2	2	ļ	ļ	l	ļ	l	ļ	l	l	l	l	l	2	ŝ	ļ	2	ļ	8	ļ	l	l	8	2	2	8	ļ	l	l	ļ	l	l	8	2	ŝ	l	ļ	2	ŝ
g	3,	520	520	520	520	520	520	520	520	22	32	3	3	2	2	ļ	ł	į	l		l		į		l	ł	ļ	ļ	l	l	l	ł	ļ	l	l	ļ	l	ļ	ļ	l	ļ		ļ	ļ	l	ł	l	ł	l	ļ	ļ	ļ	ļ	ļ	g	g	g	g	1	ļ	ļ	ļ	ļ	ļ	ļ	ļ	ļ	ļ	ļ	ļ	ļ	ļ	ļ	1	g	ļ	ļ	ļ	1	8	8	1	ļ	ļ	ļ	1	ļ	ļ	ļ	8	8	1	ļ	1	8	g	ļ	1
P	5	120	120	120	120	120	\$20	\$20	120	12	32	37	2	ł	į	ļ	l	l	l	l	l	l	l	l	l	l	l	l	l	l		l	ł	l	l	ļ	l	l	l	l	ł	l	ļ	ļ	l	l		l	l	ļ	l	P	P	P	P	ļ	ļ	P	ļ	P	P	ļ	ļ	l	ļ	l	ļ	l	l	l	l	l	P	ļ	ļ	P	ļ	l	ļ	l	l	l	P	ļ	l	ļ	l	l	ļ	l	l	l	P	ļ	l	ļ	P	ļ
1	3,	520	520	520	520	520	520	520	520	22	32	3	3	2	2	ļ	ł	į	l		l		į		l	ł	ļ	ļ	l	l	l	ł	ļ	l	l	ļ	l	ļ	ļ	l	ļ		ļ	ļ	l	ł	l	ł	l	ļ	ļ	ļ	ļ	ļ	1	1	1	1	1	ļ	ļ	ļ	ļ	ļ	ļ	ļ	ļ	ļ	ļ	ļ	ļ	ļ	ļ	1	1	ļ	ļ	ļ	1	1	1	1	ļ	ļ	ļ	1	ļ	ļ	ļ	1	1	1	ļ	1	1	1	ļ	1
1	3,	520	520	520	520	520	520	520	520	32	32	3	3	3	3	ļ	ł	į	ł	ł	l	ł	į	ł	l	ł	ļ	ļ	l	l	l	ł	ļ	l	ł	ļ	ł	ļ	ļ	ł	ļ	ł	ļ	ļ	ł	ł	l	ł	ł	ļ	ļ	ļ	ļ	ļ	1	1	1	1	1	ļ	ļ	ļ	ļ	ļ	ļ	ļ	ļ	ļ	ļ	ļ	ļ	ļ	ļ	1	1	ļ	ļ	ļ	1	1	1	1	ļ	ļ	ļ	1	l	l	ļ	1	1	1	ļ	1	1	1	ļ	1
1	3,	520	520	520	520	520	520	520	520	525	32	3.	5	5	3	ļ	ļ		l	į	l	į		į	l	ļ	ļ	ļ	ļ	ļ	l	ļ	ļ	ļ	ļ	ļ	ļ	ļ	ļ	ļ	ļ	į	l	l	l	ļ	l	ļ	l	l	l	l	l	l	1	1	1	1	ļ	l	l	l	l	l	l	l	l	l	l	l	l	l	l	ļ	1	l	l	l	ļ	1	1	ļ	l	l	l	ļ	ļ	ļ	ļ	1	1	ļ	l	ļ	1	1	l	1
2	5,	120	120	120	120	120	\$20	520	22	22	22	3	þ.	þ	þ	ļ		l	ļ	ł	į	ł	l	ł	į		l	l	ł	ł	l		ł	ł	ł	ļ	ł	l	l	ł	ł	ł	ļ	ļ	ļ		l		ļ	ļ	ļ	ļ	2	2	2	1	1	2	2	2	ļ	ļ	ļ	ļ	ļ	ļ	ļ	ļ	ļ	ļ	ļ	ļ	2	2	1	ļ	ļ	8	1	1	1	8	ļ	2	8	1	ļ	ļ	ļ	1	1	8	2	2	1	1	ļ	2
2	5,	120	120	120	120	120	\$20	520	22	22	22	3	þ.	þ	þ	ļ		l	ļ	ł	į	ł	l	ł	į		l	l	ł	ł	l		ł	ł	ł	ļ	ł	l	l	ł	ł	ł	ļ	ļ	ļ		l		ļ	ļ	ļ	ļ	2	2	2	1	1	2	2	2	ļ	ļ	ļ	ļ	ļ	ļ	ļ	ļ	ļ	ļ	ļ	ļ	2	2	1	ļ	ļ	8	1	1	1	8	ļ	2	8	1	ļ	ļ	ļ	1	1	8	2	2	1	1	ļ	2
2	5,	120	120	120	120	120	\$20	520	22	22	22	3	þ.	þ	þ	ļ		l	ļ	ł	į	ł	l	ł	į		l	l	ł	ł	l		ł	ł	ł	ļ	ł	l	l	ł	ł	ł	ļ	ļ	ļ		l		ļ	ļ	ļ	ļ	2	2	2	1	1	2	2	2	ļ	ļ	ļ	ļ	ļ	ļ	ļ	ļ	ļ	ļ	ļ	ļ	2	2	1	ļ	ļ	8	1	1	1	8	ļ	2	8	1	ļ	ļ	ļ	1	1	8	2	2	1	1	ļ	2
2	5,	120	120	120	120	120	\$20	520	22	22	22	3	þ.	þ	þ	ļ		l	ļ	ł	į	ł	l	ł	į		l	l	ł	ł	l		ł	ł	ł	ļ	ł	l	l	ł	ł	ł	ļ	ļ	ļ		l		ļ	ļ	ļ	ļ	2	2	2	ļ	ļ	2	2	2	ļ	ļ	ļ	ļ	ļ	ļ	ļ	ļ	ļ	ļ	ļ	ļ	2	2	ļ	ļ	ļ	l	ļ	l	l	l	ļ	2	l	ļ	l	l	ļ	l	l	l	2	2	l	ļ	ļ	2
1	5.	520	520	520	520	520	\$20	520	520	525	32	3.	5	2	2	ļ	į	l	l	l		l	l	l		į	ļ	ļ	l	l	l	į	ļ	l	l	ļ	l	ļ	ļ	l	ļ	l	ļ	l	l	į	l	į	l	ļ	l	l	1	1	1	ļ	ļ	1	1	1	1	l	l	l	ļ	l	ļ	l	l	l	l	l	1	1	ļ	1	1	1	ļ	l	l	1	1	1	1	ļ	l	l	ļ	l	l	1	1	1	l	ļ	1	8
1	3,	520	520	520	520	520	520	520	520	22	32	3	3	2	2	ļ	ł	į	l		l		į		l	ł	ļ	ļ	l	l	l	ł	ļ	l	l	ļ	l	ļ	ļ	l	ļ		ļ	ļ	l	ł	l	ł	l	ļ	ļ	ļ	ļ	ļ	1	1	1	1	1	ļ	ļ	ļ	ļ	ļ	ļ	ļ	ļ	ļ	ļ	ļ	ļ	ļ	ļ	1	1	ļ	ļ	ļ	1	1	1	1	ļ	ļ	ļ	1	ļ	ļ	ļ	1	1	1	ļ	1	1	1	ļ	1
g	3,	520	520	520	520	520	520	520	324	323	32	3,	3	3	3	ļ	l		l	į	l	į		į	l	l	ļ	ļ	l	l	l	l	ļ	l	ļ	ļ	ļ	ļ	ļ	ļ	ļ	į	l	l	l	l	l	l	l	l	l	l	l	l	8	g	g	8	1	l	l	ļ	ļ	l	l	l	l	l	l	l	l	l	l	1	8	l	l	l	1	g	g	1	l	l	l	1	ļ	ļ	ļ	g	g	1	l	1	g	8	l	1
ij	3,	520	520	520	520	520	520	520	524	525	52	3,	3	2	3	þ	ļ	l	l	ļ	l	ļ	l	ļ	l	ļ	Ņ	Ņ	ļ	ļ	ļ	ļ	ļ	ļ	Ņ	þ	Ņ	Ņ	Ņ	Ņ	ļ	ļ	ļ		l	ļ	ļ	ļ	l	ļ	ļ	ļ	ļ	ļ	ļ	ļ	ļ	ļ	ļ	ļ	ļ	ļ	ļ	l	ļ	l	ļ	ļ	ļ	ļ	ļ	ļ	ļ	ļ	ļ	ļ	ļ	ļ	ļ	ļ	ļ	ļ	ļ	ļ	ļ	ļ	ļ	ļ	ļ	ļ	ļ	ļ	ļ	ļ	ļ	ļ	ļ	ļ
į,	3,	520	520	520	520	520	520	520	524	323	32	3,	3	3	3	ģ	ļ	l	į	l	l	l	l	l	l	ļ	ļ	ļ	ļ	ļ	l	ļ	ļ	ļ	ļ	ģ	ļ	ļ	ļ	ļ	ļ	l	l	l	į	ļ	l	ļ	į	l	l	l	l	l	ļ	l	l	ļ	ļ	l	l	l	l	l	l	l	l	l	l	l	l	l	l	ļ	ļ	l	l	l	ļ	ļ	ļ	ļ	l	l	l	ļ	l	ļ	ļ	ļ	ļ	ļ	l	ļ	ļ	ļ	l	ļ
g	3,	520	520	520	520	520	520	520	520	22	32	3	3	2	2	ļ	ł	į	l		l		į		l	ł	ļ	ļ	l	l	l	ł	ļ	l	l	ļ	l	ļ	ļ	l	ļ		ļ	ļ	l	ł	l	ł	l	ļ	ļ	ļ	ļ	ļ	g	g	g	g	1	ļ	ļ	ļ	ļ	ļ	ļ	ļ	ļ	ļ	ļ	ļ	ļ	ļ	ļ	1	g	ļ	ļ	ļ	1	8	8	1	ļ	ļ	ļ	1	ļ	ļ	ļ	8	8	1	ļ	1	8	g	ļ	1
2	5	120	120	120	120	120	\$20	\$20	120	12	32	37	2	ł	į	ļ	l	l	l	l	l	l	l	l	l	l						l				ļ						l	ļ	ļ	l	l		l	l	ļ	l	P	2	2	2	ļ	ļ	2	2	2	2	ļ	ļ	l	ļ	l	ļ	l	l	l	l	l	2	2	ļ	2	ļ	l	ļ	l	l	l	2	2	l	ļ	l	l	ļ	l	l	l	2	2	l	ļ	2	2
2	5,	120	120	120	120	120	\$20	520	22	22	22	3	þ.	þ	þ	ļ		l	ļ	ł	į	ł	l	ł	į		l	l	ł	ł	l		ł	ł	ł	ļ	ł	l	l	ł	ł	ł	ļ	ļ	ļ		l		ļ	ļ	ļ	ļ	2	2	2	1	1	2	2	2	ļ	ļ	ļ	ļ	ļ	ļ	ļ	ļ	ļ	ļ	ļ	ļ	2	2	1	ļ	ļ	8	1	1	1	9	ļ	2	8	1	ļ	ļ	ļ	1	1	9	2	2	1	1	ļ	2
2	5	120	120	120	120	120	\$20	\$20	120	12	32	37	2	ł	į	ļ	l	l	l	l	l	l	l	l	l	l						l				ļ						l	ļ	ļ	l	l		l	l	ļ	l	P	2	2	2	ļ	ļ	2	2	2	2	ļ	ļ	l	ļ	l	ļ	l	l	l	l	l	2	2	ļ	2	ļ	l	ļ	l	l	l	2	2	l	ļ	l	l	ļ	l	l	l	2	2	l	ļ	2	2
2	5,	120	120	120	120	120	\$20	520	22	22	22	3	þ.	þ	þ	ļ		l	ļ	ł	į	ł	l	ł	į		l	l	ł	ł	l		ł	ł	ł	ļ	ł	l	l	ł	ł	ł	ļ	ļ	ļ		l		ļ	ļ	ļ	ļ	2	2	2	1	1	2	2	2	ļ	ļ	ļ	ļ	ļ	ļ	ļ	ļ	ļ	ļ	ļ	ļ	2	2	1	ļ	ļ	8	1	1	1	8	ļ	2	8	1	ļ	ļ	ļ	1	1	8	2	2	1	1	ļ	2
2	5	120	120	120	120	120	120	120	124	123	12	1	į	ł	ł	l	ł	l	l	l	l	l	l	l	l	ł	ł	ł	i	i	l	ł	ł	i	l	l	l	ł	ł	l	ł	l	ļ	ļ	l	ł	l	ł	l	ļ	2	2	2	2	P	ļ	ļ	P	ļ	2	2	P	P	P	ļ	P	ļ	2	2	2	2	2	2	ļ	ļ	2	ļ	l	ļ	l	l	l	2	ļ	l	ļ	l	l	ļ	l	l	l	P	ļ	l	ļ	2	ļ
2	5,	120	120	120	120	120	\$20	520	22	22	22	3	þ.	þ	þ	ļ		l	ļ	ł	į	ł	l	ł	į		l	l	ł	ł	l		ł	ł	ł	ļ	ł	l	l	ł	ł	ł	ļ	ļ	ļ		l		ļ	ļ	ļ	ļ	2	2	2	ļ	ļ	2	2	2	ļ	ļ	ļ	ļ	ļ	ļ	ļ	ļ	ļ	ļ	ļ	ļ	2	2	ļ	ļ	ļ	l	ļ	l	l	l	ļ	2	l	ļ	l	l	ļ	l	l	l	2	2	l	ļ	ļ	2
ļ	5.	\$20	\$20	520	120	\$20	\$20	\$20	520	525	32	3.	5	þ	þ	ļ		ļ	ļ	ł	į	ł	ļ	ł	į		ł	ł	ł	ł	l		ł	ł	ł	ļ	ł	ł	ł	ł	ł	ł	ļ	ļ	ļ		l		ļ	ļ	ļ	ļ	ļ	ļ	ļ	ļ	ļ	ļ	ļ	ļ	2	ļ	ļ	ļ	ļ	ļ	ļ	ļ	ļ	ļ	ļ	ļ	ļ	ļ	ļ	2	2	1	ļ	l	l	1	2	ļ	1	ļ	ļ	ļ	ļ	l	l	1	ļ	ļ	l	ļ	1	2
1	5.	520	520	520	520	520	\$20	520	520	525	32	3.	5	2	2	ļ	į	l	l	l		l	l	l		į	ļ	ļ	l	l	l	į	ļ	l	l	ļ	l	ļ	ļ	l	ļ	l	ļ	l	l	į	l	į	l	ļ	l	l	1	1	1	ļ	ļ	1	1	1	1	l	l	l	ļ	l	ļ	l	l	l	l	l	1	1	ļ	1	1	1	ļ	l	l	1	1	1	1	ļ	l	l	ļ	l	l	1	1	1	l	ļ	1	8
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SECTION 15200

1.0 GENERAL

1.1 Scope

- 1.1.1 Contractor shall provide all labor, materials, equipment, and services required to furnish and place in operation following equipment items:
 - P-1, P-2, P-3, P-4 sump pumps for leachate
 - T-1 Vertical 304SS vessel with a nominal capacity of 1,000 gallons for storage of leachate
 - P-5 Leachate Transfer pump
 - F-1 1 micron bag filter
 - F-2 Vent carbon adsorber
 - F-3 1 micron bag filter

PV-1 Pressure-vacuum conservation vent

S-1 Containment Dike

For additional information regarding the above listed equipment, see Equipment Data Sheets following this section.

1.1.2 THE SPECIFICATIONS OUTLINING THE REQUIREMENTS FOR THE EQUIPMENT TO BE USED FOR THE COLLECTION, STORAGE, AND TRANSFER OF THE LEACHATE ARE CONTAINED IN SPECIFICATION NUMBERS FB-200.3 THROUGH SW-200.

- 1.1.3 Conractor shall provide all labor, materials, equipment, and services required to furnish and place in operation the instrumentation items as described in this section and on the Instrument Data Sheets following this section.
- 1.1.4 The Contractor shall provide equipment and instruments that shall be heavy duty, suitable for continuous, efficient, and dependable operation under the conditions imposed by the installation.
- 1.2 Site Conditions
 - 1.2.1 Process equipment shall be installed at locations shown of the Drawings.
 - 1.2.2 Refer to the Drawings for site conditions and project layout.



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15200-1

1.3 Regulations

1.3.1 The current applicable regulations, ordinances, statutes or codes of the town, city, county or state in which the plant is located, the Federal Government, or other regulatory agency shall apply. Where this specification is more stringent than, and does not conflict with such regulations, ordinances, statues or codes, this specification shall govern.

1.4 Bid Submittals

- 1.4.1 Submit the following with the bid:
 - a) Names of pumps, piping, tank, vent carbon adsorber, filters, and conservation vent manufacturers along with specifications for each.
 - b) Names of instrument manufacturers along with specifications for each.
 - c) Shop Drawings.
 - d) As-built Drawings.
 - (c) Refer to Exhibit 15200-1 for Schedule of Submittals.

1.5 Quality Control/Assurance

- 1.5.1 The Contractor shall verify that field measurements and elevations are as indicated on contract drawings.
- 1.5.2 The Contractor shall test pumps, motors, switches, controls, and alarms in accordance with requirement specified elsewhere in these Specification.
- 1.5.4 Manufacturer shall warrant the unit being supplied against defects in workmanship and materials for a period of one year under normal use. The warranty shall be in printed form and apply to all similar units.

2.0 MATERIALS

2.1 Equipment

- 2.1.1 The materials of construction for the equipment and all internals shall be corrosion-resistant to the chemicals listed as present in the leachate.
- 2.1.2 Furnish all necessary piping in accordance with Specification No. H229.
- 2.2 Instrument
 - 2.2.1 Instrument and control equipment specified in this Section shall include those items specified on the specification sheets.



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15200-2

3.0 EXECUTION

- 3.1 Equipment Installation
 - 3.1.1 Equipment shall be installed in strict conformance with the manufacturer's recommendations.
 - 3.1.2 Equipment mounting assembly shall be leveled and bolted to the machinery base or foundation. Equipment piping to be equipped with disconnect flanges for easy removal and servicing.
 - 3.1.3 Contractor to provide start-up and testing services by the equipment manufacturer or other qualified personnel to adequately test and ensure proper adjustments of the units and controls prior to acceptance of equipment by Owner.



EXHIBIT 15200-I SCHEDULE OF SUBMITTALS

SPECIFICATION SECTION AND PARAGRAPH

SUBMITTAL TITLE

SUBMITTAL SCHEDULE

Product Data

Shop Drawings

As-Built Drawings

With bid

15 days after award of contract

At project closeout

15200 1.4.1a + b

15200 1.4.1d

15200 1.4.1c







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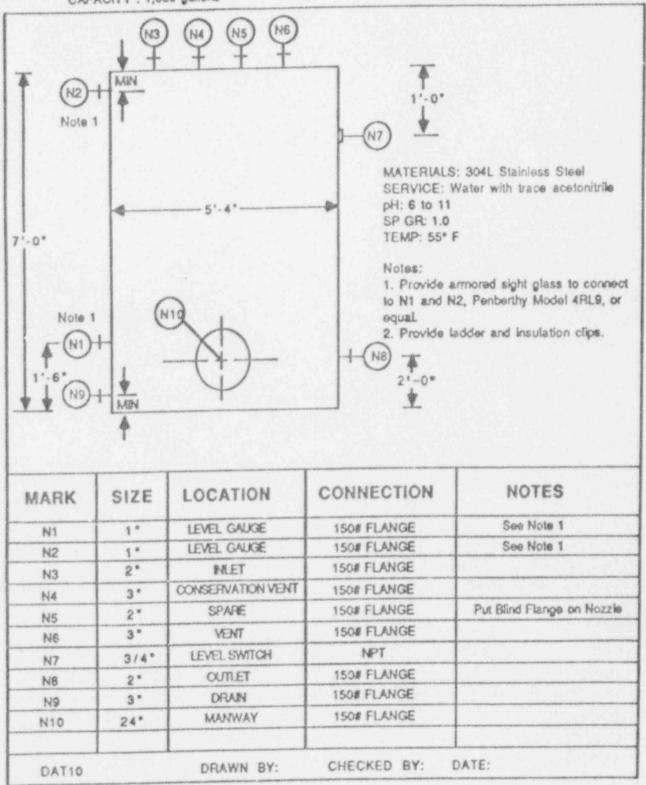


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BP CHEMCIALS LIMA, OHIO LEACHATE STORAGE TANK VESSEL DATA SHEET

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5	MAXIMUM FLOW, ACFM	Ambient
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-	BODY	Stainless Steel
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0	CARBON TYPE	3mm Pellet, Notes 1,2
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5	CONN. SIZE	2 1/2" NPT
6	CONN. LOCATION	Mfr. Sid.
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9	TYPE	Mercury Switch
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DIVISION 16 ELECTRICAL

DIVISION 16 Electrical

Section	Title
16000	Electrical Design and Installation
16100	600V Power and Control Cable
16500	Leak Detection Instrumentation

SECTION 16000

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1.0 GENERAL

1.1 Scope

1.1.1 This specification covers the electrical design, standards, guidelines, equipment, materials, installation and testing of the electrical system.

1.2 Site Conditions

1.2.1 Contractor shall verify all field measurements and details prior to start of work.

1.3 Codes, Regulations and Standards

Reference to the following codes, regulations and standards infers equipment and installations shall be in accordance with applicable portions of the latest edition of these publications.

1.3.1 Codes

- a. National Electrical Code.
- b. National Electrical Safety Code.
- c. Applicable Local Electrical Codes.

1.3.2 Regulations

- a. National Board of Fire Underwriters for Electrical Wiring and Apparatus
- b. Federal Occupational Safety and Health Act (OSHA).

1.3.3 Standards

- a. IEEE, ANSI, and NEMA for equipment.
- b. ICEA Publications, for current carrying capacities of power cables.
- c. Standard drawings approved for this project.
- d. Underwriter's Laboratories (UL).
- e. American Petroleum Institute (API).
- 1.3.4 Technical Specifications
- 1.4 Submittals

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- 1.4.1 The Contractor shall submit the following in accordance with the Contract documents:
 - a. Manufacturers drawings.

- b. Shop drawings.
- c. As built drawings.
- d. Test data and results.

1.5 Quality Control/Assurance

- 1.5.1 The Contractor shall be responsible for assuring that all equipment furnished and manufactured is in accordance with the Technical Specifications for this project.
- 1.5.2 Any factor tests shall be witnessed the Owner as necessary to fulfill the above requirement.

2.0 MATERIALS

- 2.1 General
 - 2.1.1 Materials shall be as specified, and in accordance with applicable codes, regulations, and standards.
 - 2.1.2 Where a conflict exists between specified materials and codes, regulations, or standards, the more stringent shall apply.

3.0 ELECTRICAL DESIGN CONSTRUCTIONS AND STANDARD PRACTICE

3.1 General

- 3.1.1 The electrical system shall be economically designed for:
 - a. Continuous and reliable service.
 - b. Safety to personnel and equipment.
 - c. Ease of maintenance and operation.
 - d. Minimum power losses.
 - e. Mechanical protection of equipment.
 - f. Interchangeability of new and existing equipment.
 - g. Addition of future loads.
- 3.1.2 Voltage insulation levels, interrupting capacities, continuous current capacities, circuit protective devices, and mechanical strengths shall be selected and coordinated in accordance with the recommendations of IEEE, NEMA, ICEA, and ANSI. Calculations shall be made to ensure all equipment is suitable for the required service.

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- 3.1.3 System protective devices (relays, fuses, breaker trip units, etc.) shall be selected and coordinated to ensure that the interrupter nearest the point of fault (or high overload) will open first and minimize disturbance to the rest of the system.
- 3.1.4 All electrical equipment and material shall be new and supplied by approved manufacturers. All equipment and materials shall be adequately protected from damage, deterioration, and the weather during construction.
- 3.1.5 In consideration of economics and other factors, maximum use of high quality, preassembled and prewired equipment shall be used where practical.
- 3.1.6 The electrical system for which the equipment is to be designed, shall, in general, be as listed below. All motors shall be furnished with a service factor of 1.15 or greater. Exceptions thereto may be taken into consideration where economic or other special conditions so warrant.

	Service	Nominal System Voltage	Utilization Voltage
a.	3/4 HP to 200 HP	480 V, 3 phase, 60 Hz	460 V, 3 phase 60 Hz $$
b.	Noncritical Motors 1/2 HP & below 2 wire, derived from the power panels		115 V, 1 phase, 60 Hz
c.	Receptacles 3 phase, grounded neutral	208/120 V, 4W	115 V, 1 phase 60 Hz
d.	Instrument supplies grounded neutral	120 V, 1 phase 2 wire, 60 Hz	120 V, 1 phase 60 Hz

3.1.7 In general, every attempt shall be made to incorporate the alarm and control systems into the instrument data highway to provide maximum control and lower cost.

4.0 DRAWINGS

4.1 Manufacturer's Drawings

- 4.1.1 Manufacturer's drawings for major items of electrical equipment shall include:
 - a. Dimensional outline drawings.
 - b. Floor plans, including anchor bolt locations.
 - c. Equipment weight.
 - d. Schematic wiring diagrams.
 - e. Bills of material describing components of multi-component equipment.

- f. Elementary diagrams.
- g. Any other information which would be useful in commissioning or maintaining the equipment.
- h. Operation and maintenance manuals.

4.2 Construction Drawings

- 4.2.1 Construction drawings shall include:
 - a. Complete one line diagrams showing power distribution from the incoming source to the ultimate motor loads and lighting panels.
 - b. Plan drawings, showing all underground conduit runs, overhead lines, etc., and the location and identification of all major electrical equipment.
 - c. Erection details for all major equipment, junction and pull boxes, panelboards, etc. One typical drawing may be used for identical installations.
 - d. Physical location and identification of each underground conduit (duct bank sections).
 - e. Conduit and cable schedule showing:
 - 1. Conduit or cable number, size, type and length.
 - 2. Wire size, type of installation (if shielded, type of shield and jacket) and length.
 - 3. Number of conductors in the conduit, for all power and control circuits.
 - f. Elementary wiring diagrams for all motor control circuits and instrument (solenoids, etc.) circuits. The normally open and normally closed position of switch and relay contacts shall be clearly designated with respect to the shelf conditions. One typical drawing may be used for similar installations.
 - g. Connection wiring diagrams for control, alarm, and instrument circuits, and complicated or unusual power circuits, including all junction boxes.
 - h. Any additional information that may be beneficial during construction.
 - i. Area classification drawings for any area where electrical and instrument equipment is to be installed.
 - j. Plan drawings showing all above grade conduit and/or cable.
 - k. Instrument plan drawings showing the routing and fill of all overhead instrument conduits.

4.3 Drawing and Drafting Procedures

4.3.1 Electrical Drawings

- a. Construction Standard Drawings All construction standard drawings shall be drawn on standard "D" size mylar using pencil or ink and shall include details of commonly used Electrical frandards which contain recommended standard installations. "State of the Art" or innovative techniques and materials shall be redrawn and submitted for approval.
- b. Motor sch matics and interconnection wiring shall be drawn on 11 x 17 inch sheets; one drawing per each motor control circuit, typical drawings are not acceptable. For special cases, "D" size sheets are acceptable.
- c. Standard "D" size mylar reproducible drawing sheets, using pencil or pen, shall be used for grounding, lighting, power, area classification, single liens and miscellaneous system drawings.
- d. Scale The scale used on the various types of drawings as listed in Section 4.2 shall be as required for clarity.
 - 1. A scale marker shall be added to the right margin of all drawings such that the drawing can be scaled when reduced in size.
- e. Symbols Drafting symbols shall conform to the Engineering Contractor's standard, subject to approval by Owner's Electrical Engineer.
- f. Drawing Numbers Each category of installation drawings shall be on separate sheets and shall be assigned separate drawing numbers which will identify the unit area involved and the category (key plan, area classification, etc.). Where more than one sheet is required in a particular category for a unit area, the drawing number shall remain the same except for a suffix letter (AA, AB, etc.) or a sheet designation (Sht. _____ of ____). All drawing numbers shall be suffixed with appropriate revision number.
- g. Vendor Drawings Erection Details Installation or erection details which are required for orderly construction and are included in Manufacturer's Drawings shall be redrawn on the Contractor's drawings and have the Contractor's Manufacturer's Drawing file number and Manufacturer's Drawing number included on the Contractor's Construction Drawing in a manner which will make it obvious that the detail is required for a complete system.
- h. Vendor Drawings Elementary and Wiring Diagrams Electrical elementary and wiring diagrams of equipment which are included in Vendor drawings shall be made reference to on the Contractor's construction drawings.
- i. At the completion of the project, all drawings shall be supplied to the client on computer disks compatible with the Owner's Autocad Software (Release 11).



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4.3.2 Summaries

- a. Material Summary Sheets Electrical material summary sheets shall be prepared. The summaries shall be oriented to the associate plan drawings. A composite Bill of Material shall be prepared for the required instrumentation installation.
- b. Motor Impedance Data Include node number, voltage, HP, BHP, kVA code, R+jX, and any other pertinent information required in the computer study. Use 8½ x 11 inch paper.
- c. Motor List Summary To include horsepower, speed, enclosure, voltage, phases, service factor, service, item number, FLA and LRA.

5.0 AREA CLASSIFICATION

- 5.1 General
 - 5.1.1 For the purpose of selecting type of equipment and methods of wiring, area classification for Class 1 areas shall, in general, follow the "API Recommended Practice for Classification of Areas for Electrical Installation in Petroleum Refineries," API Publication RP-500A, latest edition. These recommended practices shall be modified as appropriate based on NFPA 497.
 - 5.1.2 Each equipment enclosure shall be suitable for the respective area classification in which it is installed.

5.2 Classifications

- 5.2.1 The areas under consideration are the following:
 - a. Class I, Group D, Division 2 Areas

These areas include all outdoor locations within 50 feet (15 meters) of the process equipment, also adequately ventilated pump houses and compressor buildings where hydrocarbons are processed or handled.

b. Class I, Group D, Division 1 Areas

These areas include enclosed pump houses, compressor buildings, analyzed buildings and buildings where hydrocarbons are processed or handled and where adequate ventilation is not provided, also below grade location such as sumps or trenches within the limits of Class I, Division 2 Areas.

c. Nonhazardous Areas

All other areas outside the limits described above, also pressurized or purged rooms, buildings, or enclosures located within the limits of Class I, Division 2 Areas in accordance wit the recommendations of NFPA-496.

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d. Non-Classified Areas

All areas which due to lack of installations on these areas have not been considered as to area classification such as the pond areas.

5.2.2 In general, the installation of electrical equipment in Division 1 areas will be minimized.

6.0 LOW VOLTAGE MOTOR CONTROLLERS

6.1 General

- 6.1.1 In general, controllers for noncritical single phase, 115 volt motors shall be manual motor starters with thermal overload devices, located adjacent to the motor they control. Starters shall have provision for padlocking in the OFF position. Short circuit protection shall be provided by circuit breakers in the 120 volt panelboards.
- 6.1.2 In hazardous areas, the manual motor starters shall be of the Crouse-Hinds factory-sealed explosion-proof type.

6.2 Controllers and Starters

- 6.2.1 Controllers for three phase, 460 volt motors shall be combination molded case circuit breaker magnetic contractor-type motor starters. Minimum starter size shall be NEMA size 1. Each starter unit shall have three overloads, a 120 volt control power transformer with one secondary leg fused and the other grounded, and provisions for padlocking in the OFF position.
- 6.2.2 Motor starters for installation in indoor, nonhazardous locations shall be grouped in NEMA 1, metal enclosed, freestanding type motor control center. All motor control centers shall have NEMA Class I, Type B wiring.
- 6.2.3 Motor starters for installation in outdoor nonhazardous locations shall be in individual NEMA 4 enclosures mounted on preassembled switch racks or in prefabricated buildings, if applicable.
- 6.2.4 Motor starters for installation in hazardous areas shall be located in prefabricated purged buildings. In cases where very small groups of motor starters are required to be installed in a hazardous area, they shall be in individual NEMA 7 enclosures mounted on prefabricated switchracks.
- 6.2.5 Time delay undervoltage circuits for 480 volt critical motor starters shall contain one or two auxiliary timing relays.
 - a. On voltage failure, all motors will drop out instantly. When a H.O.A. switch is used for any metry, the motor will restart immediately upon power being restored when the H.O.A. switch is in "Hand" position. When a "Start/Stop" pushbutton station is used the motor will restart upon return of power if running before power loss and the outage is 4 seconds or less in duration. Less critical machines shall restart four seconds later.



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6.3 Switch Racks

6.3.1 Switch rack and motor control center assemblies shall be designed for 480 volts, 3 phase, 3 wire high resistance, grounded 60 Hz service.

7.0 MOTORS AND MOTOR ACCESSORIES

7.1 General

- 7.1.1 In general, motor voltages will be as shown in Section 3.1.6. 200 HP Motors and less shall, in general, shall be TEFC severe duty type.
- 7.1.2 The ground pole of each receptacle shall be solidly and permanently connected to the plant grounding system through the conduit and the exposed grounding system.

8.0 CONDUIT, FITTINGS AND CABLE TRAYS

8.1 General

- 8.1.1 Areas or units within each major plant will be classified as hazardous, nonhazardous, or general. The preferred approach is to avoid routing cable raceways through hazardous areas when these cables do not serve the area. Hazards to be avoided include: fire, explosion, and heavy equipment.
- 8.1.2 Where it is impractical or uneconomical to avoid routing cable raceways through hazardous areas the routing shall be designed to minimize potential problems.
- 8.1.3 Distribution systems power and control cables will generally be installed in areas outside the battery limits of the process unit.
- 8.1.4 When these cables are installed within the battery limits of the process unit, and may be subject to damage by explosion or fire, the following guides shall be used:
 - a. In the case of a double ended process substation, the raceway arrangement shall provide separation for the main power cables (i.e., separate cable trays where practical).
 - b. Design of raceway installation shall be such that an explosion or fire in one process area will not damage cables supplying power to other process units.
- 8.1.5 Motor and control circuits shall be installed underground in conduit or overhead in cable trays or conduit. The preferred method is overhead cable tray with final connection via conduit.
- 8.1.6 All conduits for instrument wiring shall be rigid galvanized steel, both inside and outside the battery limits. In highly corrosive areas, rigid steel conduit with permanently bused PVC coating shall be used.
- 8.1.7 All conduits for instruments shall be run in separate banks from power wiring.
- 8.1.8 Flexible conduit shall be liquid tight and suitable for the area classification in which it is installed with appropriate external bonding lugs on the fittings.

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- 8.1.9 Flexible conduit connections between rigid conduit and all motor junction boxes shall be 18 inches maximum length.
- 8.1.10 Steel conduit shall be rigid, hot dipped galvanized.
- 8.1.11 PVC conduit shall be PVC Schedule 40.
- 8.1.12 Use of rigid, nonmetallic PVC (polyvinyl chloride) conduit shall be limited to underground installations.
- 8.1.13 90° bends in all conduit installations (either underground or overheads) shall be the long radius type with a minimum radius of 14 inches. It is recommended that between pull points, underground installations be limited to the equivalent of two 90° bends and overhead installations to three 90° bends.
- 8.1.14 Designs of raceway systems are to recognize the fact that water will accumulate in the conduits and provisions must be made for draining.
- 8.1.15 In outdoor locations, it is preferred that conduit enter equipment from the bottom. Where side or top entry is necessary in outdoor locations, drain type sealing fittings shall be used.
- 8.1.16 The flexible connections at the field mounted devices shall be made in a manner to form a drip loop with provisions for draining.
- 8.1.17 All conduits shall be blown out or swabbed before pulling wire and cable.

8.2 Underground Conduits

- 8.2.1 Conduits shall be 1 inch minimum size and shall be encased in a red dyed concrete envelope. Providing minimum encasement of 3 inches on all sides, and 1½ inches between conduits. The top of the concrete envelope shall be a minimum of 18 inches below finished grade.
- 8.2.2 Concrete envelope shall be dyed red throughout for identification.
- 8.2.3 If conduit is used for power cable distribution outside process areas, it may be PVC if reinforced by rebar.
- 8.2.4 Wherever a conduit is brought up outdoors, the concrete shall be extended a minimum of 6 inches above grade and tapered to prevent water from standing around the conduit.
- 8.2.5 Conduits shall clear other underground piping and sewers.
- 8.2.6 Conduit runs under roads and railroads shall have extra steel reinforcing.
- 8.2.7 When going from an overhead cable tray into an underground installation, a covered cable tray shall be used for the vertical run. For the portion more than 7 feet above grade level, the cover may be omitted.



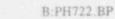
- 8.2.8 In areas of heavy traffic, additional protection may be required, such as a steel railing or bumper posts surrounding the cable tray as it enters the trench.
- 8.2.9 All underground duct banks shall contain a minimum of 20% spare conduits.

8.3 Aboveground Conduits

- 8.3.1 Conduits installed aboveground shall be 3/4 inch minimum size, except ½ inch may be used for the back of instrument panels.
- 8.3.2 Conduits shall be rigid galvanized steel, no PVC conduit shall be used aboveground. Conduits and fittings in high corrosive areas, such as cooling towers, shall be coated with a field repairable, corrosion inhibiting coating.
- 8.3.3 Conduits shall be run exposed on walls, ceilings or structures. They shall run parallel or at right angles with beams, walls or columns, and where several conduits are run in a group, they shall be equidistant from each other, with a minimum spacing of one inch.
- 8.3.4 Exposed conduits shall, in general, be fastened to structural steel by means of C.C. Korns Company pipe clamps, or equal, which require no drilling of steel. Conduit shall be fastened to masonry or concrete structures by means of one screw, clampback type, galvanized malleable iron pipe or heavy stamped steel clamp, Appleton Electric Company Type CF or equal. For conduit runs consisting of a group of conduits, special supports made of structural steel or unistrut shall be employed.
- 8.3.5 Exposed conduit shall be supported as per NEC with maximum spacing between supports every 12½ feet.
- 8.3.6 Lateral conduit runs outside of pipe racks may be supported from piping with normal operating temperatures of 150°F or lower, providing the line is not in vibrating service.
- 8.3.7 Rigid steel conduit concealed in concrete walls or floors shall be 1 inch minimum size.
- 8.3.8 All conduits shall enter the field junction boxes from the side or bottom and shall be provided with drains. All connections to junction boxes shall be made with factory hubs or Myers-type hubs.
- 8.3.9 Conduit routed behind ladders shall be installed in such a manner that will not cause a false or insecure step.
- 8.3.10 A minimum of 3* clearance between handrail and electrical conduits, fittings, devices, etc., shall be maintained.

8.4 Conduit Joints

8.4.1 Joints in threaded conduit shall be made by applying "Never Seez," or approved equal, to the threads to make them watertight and to insure conductivity. All ends of conduit shall be capped during construction.



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- 8.4.2 All threaded joints shall be made with at least 5 full threads engaged. No running threads or all thread close nipples shall be used.
- 8.4.3 Rigid conduit shall be used between the cable trays and the field mounted equipment. The conduit termination at the trays shall be in a manner to avoid water tracking along the cables and entering the conduits. Clamp to tray for ground continuity.

8.5 Conduit Fittings

- 8.5.1 Conduit fittings in Division 2 areas shall be vaporproof, gasketed, highly corrosion resistant finish and shall be cast ferrous alloy body and cover, Crouse-Hinds Form 7 or approved equal.
- 8.5.2 In Division 1 areas all fittings shall be explosion proof and shall be of the same material as in 8.5.1.
- 8.5.3 Seal fittings shall be of the same material as 8.5.1.
- 8.5.4 Seal fittings for general (vertical) installation shall be Crouse-Hinds Type EZD with inspection covers or drain covers as required for 2 inches and under, and Type EYS for 2½ inches and larger.
- 8.5.5 Seal fittings for general (horizontal) installations or bulkhead shall be Crouse-Hinds Type EZD installation with the packing and pouring access opening pointing up.
- 8.5.6 Seals for use on selected applications such as 4000 volt motors and instrument junction boxes shall be Crouse-Hinds Type ES.
- 8.5.7 Drain seals shall be provided at low points of long runs of vertically mounted conduit on outdoor towers and structures.
- 8.5.8 Approved sealing fittings shall be located in conduit systems in accordance with code requirements.
- 8.5.9 Seal fittings, drains and breathers shall be employed in conduit systems as may be required to prevent accumulation of condensation.

9.0 POWER WIRE AND CABLE

- 9.1 Wire Type
 - 9.1.1 All wire shall be stranded copper and insulated with cross-linked polyethylene (XLP) or ethylene propylene (EPR) 90°C insulation with a PVC jacket.

9.2 Color Codes

- 9.2.1 Lighting and control wires shall be color coded in accordance with the following:
 - a. Lighting circuits color coding shall be as required by Owner.
 - b. Power and control wires shall be color coded as per manufacturer's standard.

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9.3 Minimum Wire Sizes

- 9.3.1 Minimum wire sizes shall be as listed below or as required by short circuit current withstandability.
 - a. Circuits: Motor Control (Individual) No. 12 AWG
 - b. No. 14 AWG (Multi-conductor control cable).

9.4 Multi-Conductor Cable

9.4.1 Multi-Conductor cable may be installed in conduit runs when coming from a cable tray to a field located device.

9.5 Wire Identification

- 9.5.1 Wiring to be tagged on both ends with "FROM TO" information.
 - Labels shall be either printed heat shrinkable tubing or typed Thomas & Betts wire labels Type WTW.
 - b. This section does not apply to simple 480 volt motor control, a standardized color coding of wires to the control station is required. If one or more instruments or remote relays is in the control circuit the wires shall be labeled.

9.6 Wire and Cable Pulling

- 9.6.1 Wire and cable pulling, splicing, and terminating shall not be performed at temperatures below 40°F.
- 9.6.2 Power wire and cables shall be pulled into conduits using a lubricant per the Wire Manufacturer's recommendations. No oil or grease base compound shall be used for this purpose.
- 9.6.3 If no lubricant is recommended by the manufacturer, American Polywater Corporation, Polywater Type G shall be used.

9.7 Splices and Terminations

- 9.7.1 Splices and terminations in 600 volt cable shall be insulated as follows:
 - a. Bolts shall be trimmed to minimum length.
 - b. Large voids filled with Scotchfill putty.
 - c. Apply one layer of varnished cambric.
 - d. Apply one layer of Scotch #130C.
 - e. Seal with Scotch #33+.

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- a. Trim bolts to minimum length.
- b. Install Raychem heat shrink splice kit or termination.
- 9.7.2 Mechanical spring connectors, such as 3M Scotchlocks, may be used on No. 10 AWG and smaller wires in lighting and receptacle circuits only. Mechanical spring connectors shall not be used on motor or control connections for any voltage level or wire size.

10.0 INSTRUMENT SYSTEMS

- 10.1 General
 - 10.1.1 Separate systems consisting of conduit, wire, and junction boxes shall be provided for:
 - a. Control wiring having the same nominal voltage.
 - b. Electronic milliampere signal wire.
 - c. Alarm wiring.
 - d. Special signal wiring.

10.2 Junction Boxes

- 10.2.1 Junction boxes shall have a ¼ inch weep hole in the bottom, and no provisions for heating.
- 10.2.2 All boxes shall have threaded hubs for conduit connections.
- 10.2.3 Field junction boxes shall be located a minimum 24 inches above grade.
- 10.2.4 Field junction boxes shall be kept to a minimum and junction box locations shall be approved by the Owner.
- 10.2.5 Each junction box shall be numbered and identified with a permanent laminated plastic nameplate. Plastic nameplate shall be screwed on, not glued on. Lettering shall be black on a white background.
- 10.3 Terminal Blocks
 - 10.3.1 Terminal blocks shall be polypropylene or nylon, two screw (headless type) tubular clamps, barrier sectional type rated 300 volts.
 - 10.3.2 Blocks shall be mounted on mounting channels.
 - 10.3.3 Block spacing on panels except the main control board shall be a minimum of 6 inches.
 - 10.3.4 Block spacing in field junction boxes shall be 6 inches block to side of box, and 6 inches between block centerline.



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- 10.3.5 Incoming wires shall be connected to one side of the terminal block and outgoing wires connected to the other side.
- 10.3.6 All junction points shall be permanently identified, both on the wire and on the terminal block.

10.4 Instrument Wire and Cable

- 10.4.1 Multi-pair cables shall be used for "home runs" from the process area junction boxes to the control house for the thermocouples, DC alarms and electronic instrument signals.
- 10.4.2 Single pair cables shall be used between the junction boxes and individual field instruments.
- 10.4.3 In general, 600 volt single conductor wires shall be used on the AC power and DC solenoid circuits.
- 10.4.4 Twenty percent spare pairs shall be provided in all multi-pair/triad cables.
- 10.4.5 All instrument wire shall be premium grade, designed for noise critical application.
- 10.4.6 Single pair instrument and alarm wire shall be No. 16 AWG, twisted, stranded copper conductor, with 90°C PVC insulation, a tinned copper drain wire and overall shield and an overall PVC jacket.

11.0 GROUNDING SYSTEM

- 11.1 General
 - 11.1.1 The grounding system shall be a loop system consisting of driven rods and bare copper cables with radial taps to equipment.
 - a. In general, each process unit shall have its own loop system, except one or more small process units in a small area may be provided with a single loop system.
 - b. All loop systems shall be physically interconnected by main ground cables, unless otherwise specified.
 - c. The resistance to ground from any point in the system shall be less than 5 ohms.

11.2 Equipment to be Grounded

- 11.2.1 All electrical equipment shall be grounded.
- 11.3 Grounding Conductors
 - 11.3.1 The conductors from the grounded equipment to the grounding loop shall be no smaller than No. 2 AWG bare, stranded, annealed copper. A heavier conductor shall be used if the setting of the protective device in the circuit serving the particular piece of grounded equipment is greater than 600 amperes, as specified in the National Electrical Code.

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11.4 Connection at Equipment

- 11.4.1 A grounding conductor shall be attached to each motor, lighting panel, circuit breaker, pushbutton station, motor starter, etc., by means of a compression lug, cap screw and lockwasher, (or equal). A hole shall be drilled and tapped for the cap screw into a foot or webb of the apparatus in such a manner as not to weaken the structure. Under no circumstances shall the hole be drilled directly into the housing of the apparatus. Bolts or bolt holes intended for mounting of motors shall not be used for attaching the conductor.
- 11.4.2 All conduit connected to lighting panels, junction boxes, motor starters, or distribution switchgear shall be connected to grounding conductors by means of ground straps, Crouse-Hinds Type "GC" or equal.
- 11.4.3 All cable trays and conduits when properly bonded and grounded are considered to be proper return paths for ground fault currents of motors.
- 11.4.4 Lighting and miscellaneous transformers with 120 volt, 240/120 volt, or 208/120 volt secondaries shall have the neutral solidly grounded on the secondary side.
- 11.4.5 Transformer neutrals shall be connected to the grounding system at or near a ground well.
- 11.4.6 Motors shall be grounded directly to the ground system and through the cable, cable tray or conduit system where conduits are metallic.

12.0 CHECKOUT, TESTING AND INSPECTION

- 12.1 Factory Inspections and Testing
 - 12.1.1 Electrical equipment such as switchgear, relay and control panels, motor controllers, switch racks, power transformers, or large motors and generators shall be inspected by the Contractor and the Owner for proper materials, workmanship, operation, and compliance with the specifications at the Vendor's plant. This inspection shall include but not be limited to:
 - a. Wire check.
 - b. Dimensional check.
 - c. Hypot or megger test.
 - d. Energized functional test.

12.1.2 The Contractor will be responsible for all testing.

12.2 Field Inspection and Testing

- 12.2.1 All inspections and tests shall be recorded for future reference.
- 12.2.2 All equipment and materials shall be inspected immediately after receipt at jobsite for shipping damage. The inspection shall include but not be limited to the following:

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- a. Motors
 - 1. Megger to frame with a 1000 volt DC megger.
 - 2. Rotate shaft (unless bearings are oil lubricated).
 - 3. Inspect for chips, dents, etc.
 - 4. Energize space heaters (if any) and store in a dry warm area.
- b. 600 Volt Wire, Cable and Instrument Cable
 - 1. Inspect for physical damage.
 - 2. Store in a protected area.
- 12.2.3 Detailed written checkout procedures for use in the field shall be written in conjunction with the Owner for each electrical item or system. They shall be written in such a manner that the field personnel may complete them in a step-by-step manner recording pertinent information on the procedure for future reference. The Owner shall witness all testing.

12.2.4 In general, the checkout shall consist of but not be limited to the following:

- a. 600 Volt Power and Control Cables
 - 1. Record and verify wire size and connections.
 - 2. Megger and record insulation resistance values of each phase with a 1000 volt megger.
- b. Instrument Wires and Cables
 - 1. Megger wires conductor to conductor, conductor to shield, with a 500 volt megger and record.
 - 2. Verify all connections by ringing out all circuits.
 - 3. Release system for instrument loop check.
- c. Induction Motors and Control (Below 20 HP)
 - 1. Megger with a 1000 volt megger and record reading.
 - 2. Verify overload, breaker, and contractor settings and types.
 - 3. Verify control wiring by functional test (motor leads disconnected).
 - 4. Run for rotation (uncoupled).
 - 5. Run uncoupled for one hour and check and record current balance, vibration, bearing noise, and bearing temperature.

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- d. Conduit System
 - 1. Check integrity, support, and tightness of connections.
 - 2. Verify that all seals are installed as required.
 - 3. Verify that all drains are installed as required.
 - 4. Check for conformance to specifications, standards, and drawings.

-END OF SECTION-



SECTION 16100

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1.0 GENERAL

- 1.1 Scope
 - 1.1.1 The specification covers the minimum requirements for single conductor and multiconductor, 600 volt insulated power and control cable. Cable shall conform to this specification unless written approval is obtained for exceptions.
 - 1.1.2 The work included in this section includes furnishing and installing 600 volt insulated power cable and control cable as required for construction of the leak detection systems and pump station and related electrical systems.

1.2 Site Conditions

- 1.2.1 See construction drawings for location and design of electrical systems.
- 1.2.2 Installation
 - a. The cable shall be suitable for installation in heavy industrial plants, either indoors or outdoors, where a multiplicity of cable support systems are employed including installation in rigid metallic conduit, plastic or fiber conduit, concrete encased duct systems, cable trench or trough (including tunnel), cable tray or wireway and on aerial support systems. The cable shall be suitable for use in a high resistance (5 amperes max.) grounded system.

1.2.3 Exposure

a. The cable shall be suitable for installation in petrochemical complexes with exposure to continuous sunlight and moisture, rain, occasional hydro-carbon, acid and alkali and ambient temperature variations between -29°C (-20°F) and 43°C (110°F). The cables shall withstand these exposures without loss of cable life or reliability.

1.3 Regulations

- 1.3.1 All applicable sections of the latest Standards and Codes listed below are a part of this specification for design, construction and testing unless amended herein. It shall be the Contractor's and/or Manufacturer's responsibility become knowledgeable of the requirements of these standards and codes and any changes or alterations to the equipment to make it meet the requirements of the Standards and Codes shall be at the expense of the Contractor.
 - a. ANSI American National Standards Institute
 - b. NEMA National Electrical Manufacturer's Association
 - c. ICEA Insulated Cable Engineers' Association
 - d. ASTM American Society of Testing Materials

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- e. UL Underwriter's Laboratories
- f. NEC National Electric Code

1.4 Submittals

- 1.4.1 The following information shall be submitted:
 - a. Specific listing of any exceptions to those requirements specified.
 - b. Features included but not necessarily specified.
 - c. Complete descriptive data including:
 - 1. Weight in pounds per 1000 feet.
 - 2. Cable impedance (R, X, Z) in both magnetic and nonmagnetic ducts for each size and type cable ordered.
 - d. The manufacturer's standard "packaging" of reels (i.e., lagging, banding, etc.).
 - e. The Contractor shall complete Exhibit 16100-1.
- 1.4.2 The following certified information shall be supplied with the contract documents:
 - a. All information requested with quotation.
 - Detailed description of recommended handling, storage, installation, operation and maintenance procedures.
- 1.4.3 Refer to Exhibit 16100-II for Schedule of Submittals.

1.5 Quality Control/Assurance

1.5.1 The Contractor shall verify that all wire and cable are of the size, type, and meet the requirements of this specification.

2.0 MATERIALS

- 2.1 Copper Conductors
 - 2.1.1 Copper conductors shall be annealed, uncoated or coated copper, in accordance with ASTM B 3, with physical and electrical properties conforming to ICEA standards and with Class B concentric layer standing in accordance with ASTM B 8.
 - 2.1.2 Conductors shall be of the size and type shown on the Drawings.

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2.2 Insulation

- 2.2.1 Cross-linked Synthetic Thermosetting Polymer
 - a. Cross-linked synthetic thermosetting polymer shall meet the requirements of ICEA Standards, be suitable for operation at a conductor temperature of 90°C (194°F), pass the UL vertical rack flame test with a 70,000 BTU ribbon burner flame source, and be classified as type XHHW VW-1.
 - b. The insulation shall be applied directly over the surface of the stranded conductor forming a homogeneous void free mass.
 - c. The insulation shall strip clean from the conductor for makeup of terminations and splices.
 - d. The insulation system shall be flame retardant, and moisture, heat, and sunlight resistant.

2.3 Multiconductor Assembly

- 2.3.1 Twin Conductor Cable
 - a. Twin conductor cable shall be formed by laying two insulated and covered color coded conductors in a flat parallel lay or formed by cabling the two conductors in a round configuration.
- 2.3.2 Multiple Conductor Cable
 - a. Multiple conductor cable shall be formed by cabling three or more insulated and cover color coded conductors, arranged in color sequence with ground wire (if specified) in a cylindrical configuration.
 - b. The "lay" of the conductors shall be in direction and length to conform with ICEA standards.
 - c. Fillers of nonwicking, flame retardant material or dummy conductors shall be used where necessary to provide a uniform spacing of conductors in a firm, cylindrical shape.
 - d. Binders of glass reinforced tape shall be applied over the conductor assembly, if required to retain its shape while the jacket is being applied.
- 2.3.3 Grounding
 - a. Grounding, if specified, shall be of the same conductor material as that used for the basic conductors. If specified "green insulation," they shall be covered with he same insulation as that used for the basic conductor. If specified "bare," the insulation shall be omitted.

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2.4 Jackets

- 2.4.1 A protective jacket made of flame, sunlight, and moisture resistant polyvinyl chloride materials shall be applied directly and fit tightly over the surface of the flat or round twin conductor or multiple conductor cylindrical assemble. The jacket shall meet ICEA requirements at a UL rated temperature of 90°C (194°F).
- 2.4.2 The thickness of the cable jacket shall be the nominal values of Section 2.5 and the minimum thickness shall not be less than 90 percent of nominal.

2.5 Insulation and Jacket Thickness

2.5.1 Multiconductor cable shall have overall jacket thickness as follows:

Diameter Under Jacket (Inches)	PVC Jacket Thickness (Mils)
0.550 or less	45
0.551 to 0.900	60
0.901 to 1.700	80
1.701 to 2.500	110
2.501 or larger	140

- 2.6 Surface Marking and Color Coding
 - 2.6.1 Single Conductor Cable
 - a. The surface of the insulation shall have a durable marking, at intervals not exceeding 24 inches along the entire length, which shall consist of the manufacturer's name, trademark, or other distinctive marking which identifies the organization responsible for the product, the wire size in AWG or MCM, the voltage rating (600 volts), and NEC type designation.
 - 2.6.2 Multiconductor Cables
 - a. Individual conductors shall be color coded by ICEA Method 1 or otherwise identified by ICEA Method 3. Method 1 is preferred.
 - b. The overall jacket shall have white permanent surface printing at regular intervals along the entire length of the cable giving wire size, number of conductors, voltage rating, manufacturer's name, cable catalog number, and NEC type designation.



2.7 Warning Tape

2.7.1 Warning tape shall be 6-inches wide, yellow polyethylene not less than 3.5 mil thick with a minimum break strength of 1500 PSI. Tape shall have black lettering on two lines as follows:

CAUTION CAUTION CAUTION BURIED ELECTRICAL LINE BELOW

3.0 INSTALLATION OF WIRE AND CABLE

3.1 Wire and Cable-600V

- 3.1.1 All wiring must be installed in conduit unless otherwise noted. All wire installed underground shall be rated for direct burial applications.
- 3.1.2 Pull no wire until the conduit system is completely and thoroughly swabbed. Use inert pulling compounds approved for the type of jacket material or insulation.
- 3.1.3 In aluminum conduit, install wiring by means of nylon pulling wire propelled through conduit by carbon dioxide or compress air. Use of metal fish tapes is prohibited. Do not install bare copper ground wires in aluminum conduit.
- 3.1.4 Splice #10 and smaller wire with pressure connectors-3M "Scotchlock", Ideal "Wing-Nut," Thomas & Betts "Piggy," or Buchanan "B-Caps."
- 3.1.5 Splice and terminate #8 and larger wire with color-keyed compression connector, as manufactured by Anderson, Burndy, Ilsoco, or Thomas & Betts.
- 3.1.6 Where splices are made at temperatures below 40°F, all-weather "Scotch No. 88" plastic electrical tap shall be used in place of "Scotch No. 33+."
- 3.1.7 Connect branch circuits per Drawings, and tag by circuit number, in panel gutter.
- 3.1.8 Tag control wire with numbers as shown on the Contract Drawings at all pull boxes, junction boxes, or other enclosures. Train and lace control wiring with enclosures, and connect with suitable crimp terminals.
- 3.1.9 Make all spare wires in cabinets or panelboards of adequate length for connection to most remote terminal in enclosure. Terminate spare wires with insulating tape, and tag.
- 3.1.10 Install leak detection control wiring in raceways separate from power cable.

3.2 Underground Wire and Cable

- 3.2.1 Underground conduits shall be encased in concrete in accordance with Section 16000 of these Specifications. Backfill shall be placed to finished grades a specified in Section 02220 of this Specification.
- 3.2.2 Construct cable trenches in accordance with Section 02220 of this Specification.

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- 3.2.3 Use epoxy-filled or rubber-sealed splice kits on all underground splices for leak detection control cable. Use Raychem WCSM heat shrink splice or Owner-approved equal. Tape wrap splice with Scotch #33 waterproof tape.
- 3.2.4 Use Raychem WCSM heat shrink splice on all underground splices for power cables.

3.3 Shipping

- 3.1.1 Preparation for shipment shall be in accordance with manufacturer's standards unless otherwise noted. Manufacturer shall be solely responsible for the adequacy of the preparation for shipment provisions application, to insure that the wire reaches its designation in exworks condition when handled by commercial carrier system.
- 3.1.2 When cable is shipped on reels, each reel shall have a waterproof tag (metal or plastic) firmly attached, indicating conductor size, actual length, manufacturer's type, voltage and NEC type designation and a reel identification umber.
- 3.1.3 Watertight, heat-shrinkable seals shall be applied to the ends of the cable to prevent entrance of moisture during transit outdoor storage.

-- END OF SECTION--



EXHIBIT 16100-I SCHEDULE OF SUBMITTALS

	N AND PARAGRAPH	SUBMITTAL TITLE	SUBMITTAL SCHEDULF
16100	1.4.1a	Listing of exceptions	Fifteen days prior to use
16100	1.4.2b	Features enclosed but not specified	Fifteen days prior to use
16100	1.4.1c	Manufacturer's Data Sheet	Fifteen days prior to use
16100	1.4.2b	Exhibit 16100-1 (completely filled)	Fifteen days prior to use

CONTRACT & TOTAL



SECTION 16500

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EXHIBIT

16500-I	Schedule of Submittals		. E-16500-1
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1.0 GENERAL

- 1.1 Scope
 - 1.1.1 Work shall include installation of leak detection instrumentation, connection of annunciators, and all mechanical and electrical hookups requirer' o construct the Work.

1.2 Site Conditions

1.2.1 Refer to construction drawings for site conditions, location of leak detection points, cable runs, and location of annunciators.

1.3 Codes, Regulations and Standards

- 1.3.1 Reference to the following codes, regulations and standards infers equipment and installations shall be in accordance with applicable portions of the latest edition of these publications.
 - a. National Electrical Code
 - b. National Electrical Safety Code
 - c. Applicable Local Electrical Codes
- 1.3.2 Regulations
 - a. National Board of Fire Underwriters for Electrical Wiring and Apparatus
 - b. Federal Occupational Safety and Health Act (OSHA)
- 1.3.3 Standards
 - a. IEEE, ANSI, and NEMA for equipment.
 - b. Standard drawings approved for this project.
 - c. Underwriter's Laboratories (UL).
- 1.3.4 Related Specifications
 - a. Section 16000 Electrical Design and Installation.
 - b. Section 16100 600V Power and Control Cable.
- 1.3.5 Contract Drawings
- 1.4 Submittals
 - 1.4.1 The following shall be submitted for approval in accordance with the contract documents:
 - a. Submit shop drawings for leak detection system sensors and annunciator. Show:



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- 1. Size, location and mounting method.
- 2. Component layout and configuration.
- 3. Connections to Owner's electrical supply.
- 4. Complete wiring diagram showing all controls, components and connections.
- b. Submit product data and manufacturer's standard schematic drawings and diagrams for sensors, relays, and annunciators.
- c. Submit As-Built drawings of the leak detection system.
- 1.4.2 Refer to Exhibit 16500-I for Schedule of Submittals.
- 1.5 Quality Control/Assurance
 - 1.5.1 Contractor shall inspect all equipment and instrumentation for damage and operation prior to installation.
 - 1.5.2 Contractor shall verify all field measurements, connections, and hook-ups shown on Drawings.
 - 1.5.3 Contractor shall protect cable, instrumentation, and related components from damage during construction of the Work.
 - 1.5.4 Contractor shall demonstrate to the Owner proper operation of leak detection system in accordance with the Specifications.

2.0 MATERIALS

- 2.1 Leak Detection Electrodes
 - 2.1.1 Leak detection electrodes shall be of the style and type shown on the Drawings. Electrodes shall be protected with a plastic molded shield. Electrode material shall be 303 grade stainless steel. Use Magnetek Type E-1S electrode or Owner-approved equal.
 - 2.1.2 Electrode suspension wire shall be of the size and type shown on the Drawings and compatible with the electrode type to provide a watertight seal at the connection. Wire shall be single conductor, 18 AWG, 41 stand copper with 4/64" vinyl insulation. Use Magnetek Type SW or equal.
- 2.2 Alarm Panels
 - 2.2.1 Alarm panels shall provide combination visual and audible signal alarms. Audible alarms shall have a minimum decibel rating of 85 db at 10 feet with a manual reset silence switch.
 - 2.2.2 Alarm shall be adjusted to activate on a high level condition.

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2.2.3 Alarm panel enclosures shall be type NEMA-12.

2.2.4 Use Magnetek Catalog Number 8040-SC1H-H-L1-N12-1500-57 or Owner-approved equal.

2.3 Signal Cable

- 2.3.1 Signal cable shall be used from the electrode suspension cable terminal to the alarm panel as shown on the Drawings.
- 2.3.2 Conductors shall be stranded 16 AWG (7 x 24) copper.
- 2.3.3 Primary insulation shall be TFN-TFFN. Color coding shall be per ICEA method 1: pairs are black and white.
- 2.3.4 Jacket shall be flame-retardant black PVC, moisture resistant, sunlight resistant, rated at 70°C. Jackets shall be marked by the manufacturer suitable for direct burial.
- 2.3.5 Signal cable shall be two-conductor shielded cable. Use Belden 1069 A or Owner-approved equal.

2.4 Signal Cable Splice Kits

2.4.1 Signal cable splice kits shall be Scotchcast Sinal and Control Cable Inline Splicing Kits, manufactured by 3-M Company, or Owner-approved equal.

3.0 INSTALLATION OF LEAK DETECTION SYSTEM

- 3.1 General
 - 3.1.1 The location of the alarm panel and instrumentation connections are approximate as shown on the drawings. It shall be the Contractor's responsibility to check manufacturer drawings, shop drawings, sump locations, and other pertinent and related data and information to determine exact locations and connection requirements.
 - 3.1.2 No work shall be covered or hidden from view until it has been checked and approved by the Owner.
 - 3.1.3 Any workmanship or materials not meeting the requirements of the Specifications or Drawings shall be immediately replaced by the Contractor without cost to the Owner and to the satisfaction of the Owner.

3.2 Electrode Installation

- 3.2.1 Electrode pairs shall be installed in each leak detection sump shown on the Drawings.
- 3.2.2 Electrodes shall be secured to the suction pipe with stainless steel hose clamps. Sustaination cable shall be secured to the suction pipe with nylon wire ties placed every 12-inches.
- 3.2.3 Position electrodes on suction pipe as shown on the Drawings.



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3.3 Signal Cable

- 3.3.1 Signal cable shall be installed using continuous lengths. No more than one splice per 1000 feet of installed signal cable shall be allowed. Signal cable shall be selected and installed based on manufacturer's recommendations.
- 3.3.2 Above-ground lengths of signal cable shall be placed in rigid galvanized steel conduits. Separate signal cable conduits shall be used; signal cable shall not be placed in power cable conduits.
- 3.3.3 Signal cables shall be placed in the utility trench as indicated on the Drawings. Multiple signal cable spliced in a common trench shall be bundled using nylon wire ties.

3.4 Splicing

- 3.4.1 Signal cable splices shall be made in Scotchcast Signal and Cable Splice Kits, or Ownerapproved equivalent.
- 3.4.2 Splice connectious shall be made with solderless, insulated butt-connectors of the appropriate size. Drain wires shall be spliced in the manner as conductors.
- 3.4.3 The Contractor shall perform continuity tests on each spliced connection and submit results to the Owner.

3.5 Labeling

3.5.1 Tag all wire, cable, and conduit at each end or termination with suitable tags, printed, stamped, or engraved with the wire, cable, conduit, or instrument identification number.

3.6 Testing

- 3.6.1 The Contractor shall test the leak detection system following completion of the work and demonstrate proper operation to the satisfaction of the Owner.
- 3.6.2 Test instrument wires and cables in accordance with Section 16000.

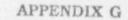
-- END OF SECTION ---



EXHIBIT 16500-I SCHEDULE OF SUBMITTALS

SPECIFICATION SECTION AND PARAGRAPH	SUBMITTAL TITLE	SUBMITTAL SCHEDULE
16500 1.4.1.a	Shop Drawings	15 days after award of Contract
16500 1.4.1.b	Product Data	15 days after award of Contract
16500 1.4.1.c	As-Built Drawings	At project closeout





LOGS OF BORINGS AND WELLS

BORING NU	MBERE-	TOTAL DEPTH 30' S.W.L. (BGL) Dry
Sample Number	From 0 to 30 Feet	(Z-81-E-1) Lithologic Description
	0 - 1	CRUSHED STONE FILL
	1 - 3	CLAY; silty, w/sand, some gravel, brown, moist
analishina ar tan dirente ar	3 - 5	CLAY; silty, sand, some gravel, gray, wet
	5 - 6	CLAY; silty, sand, w/gravel, gray, wet
GAM TATA AN AN A TATA AN AN AN AN AN AN AN AN AN AN	6 - 11.5	CLAY TILL; silty, sand, w/gravel, wet
		2 split spoon samples 10'-10'7" & 10'7"-11'3"
anda migin dia dara mang senara dia penarati penara mandra di	11.5 - 30	CLAY JILL; silty, sand and angular gravel, gray, mois
		collars, large gravel w/depth, wetter w/depth, occ.
and the second second second second second second second second second second second second second second second		saturaled zone
	-30	BEDROCK; constant grinding w/bit
		gravel from side used to fill well
		water level on 5/12 - 24 ft. BTOC
Piezometer	Screen	924 #7 Pipe 30' Total Depth (BGL) 30'
BORING NN 8/5/8	MBER	TOTAL DEPTH 37' S.W.L.(BGL)
Sample Number	From 0 to 37 Feet	Lithologic Description
	0 - ł ₂	CRUSHED STONE FILL
	k - 3	CLAY; sandy, w/gravel, brown, moist
	3 - 4	CLAY; sandy, w/gravel, dk. gray, moist
	4 - 6	CLAY; silty, w/sand, gravel, brown, wet
	6 - 13	CLAY; silty, w/some gravel, brown, mottled
		Moist split spoon sample 5-7'
	nan 🖉 sing was been and a state of a state of the state of the Arabien Anna Arabien Anna Arabien Anna Arabien Ar	



Piezometer:

Screen ____ Pipe ____ Total Depth (BGL) ____

13 - 30

30 - 33 33 - 36

36 - 37

BEDROCK; weathered layer, sample from bit, dry

Actual sample very tight 10'-2" and 10'-10"

CLAY SILT; some gravel, tight, gray, moist

10'-10" and 11'-6" and 11'6" and 12'2"

CLAY TILL; gravel, gray (wet 32-33*)

GRAVEL & CLAY TILL; gray, wet

Actual sample 5'-3" and 5'11"

Split spoon sample 10-12'

con't.

Sample Number	MBER <u>EPW-2568</u> EZ cont From to Feet	(2-81-E-23+0) Lithologic Description
		Redrilled EPW-2 after having left open borehole si
		5/11/81
		Redrilled to 38 ft. to clean hole
		Set 40 ft. galvanized 2-inch casing w/924 stainles
and an interaction of the second second second second second second second second second second second second s	an an an an an an an an an an an an an a	steel screen
		Set to rock
		Backfilled w/washed sand to 5 ft. from surface
		Grouted from 30 ft. to surface
		Set shallow wells 17'2" galvanized casing 924 stai
		steel screen - washed
		Bentonite from screened area 2 ft. to surface
		Pipe Total Depth (BGL)
BORING N 8/6/ Sample	UMBER $\underline{-EPW-3} = \overline{E-3}$ /81 $(2-81-\overline{E-3})$ From 0 to 23	TOTAL DEPTH 23' S.W.L.(BGL) Dry
BORING N 8/6,	UMBER $\frac{EPW-3}{(2-81-E-3)}$ From 0 to 23 Feet	TOTAL DEPTH 23' S.W.L.(BGL) Dry
BORING N 8/6/ Sample	UMBER <u>EPW-3</u> $E-3$ 1/81 $(2-81-E-3)From 0 to 23Feet0 - 4$	TOTAL DEPTH 23' S.W.L.(BGL) Dry Lithologic Description CLAY; silty, sandy, some small gravel, brown, damp
BORING N 8/6/ Sample	UMBER $\frac{EPW-3}{(2-81-E-3)}$ From 0 to 23 Feet	TOTAL DEPTH 23' S.W.L.(BGL) Dry Lithologic Description CLAY; silty, sandy, some small gravel, brown, damp CLAY; silty, sandy, small gravel, gray-brown, damp
BORING N 8/6/ Sample	UMBER <u>EPW-3</u> $E-3$ 1/81 $(2-81-E-3)From 0 to 23Feet0 - 4$	TOTAL DEPTH 23' S.W.L.(BGL) Dry Lithologic Description CLAY; silty, sandy, some small gravel, brown, damp CLAY; silty, sandy, small gravel, gray-brown, damp CLAY; silty, some sand, gravel, gray, moist, incre
BORING N 8/6/ Sample	UMBER <u>EPW-3</u> $E-3$ /81 $(2-81-E-3)$ From 0 to 23 Feet 0 - 4 4 - 9 9 - 21	TOTAL DEPTH 23' S.W.L.(BGL) Dry Lithologic Description CLAY: silty, sandy, some small gravel, brown, damp CLAY: silty, sandy, small gravel, gray-brown, damp CLAY: silty, some sand, gravel, gray, moist, incre moisture w/dept
BORING N 8/6/ Sample	UMBER <u>EPW-3</u> $E-3$ /81 $(2-81-E-3)$ From 0 to 23 Feet 0 - 4 4 - 9	TOTAL DEPTH 23' S.W.L.(BGL) Dry Lithologic Description CLAY; silty, sandy, some small gravel, brown, damp CLAY; silty, sandy, small gravel, gray-brown, damp CLAY; silty, some sand, gravel, gray, moist, incre
BORING N 8/6/ Sample	UMBER <u>EPW-3</u> $E-3$ /81 $(2-81-E-3)$ From 0 to 23 Feet 0 - 4 4 - 9 9 - 21	TOTAL DEPTH 23' S.W.L.(BGL) Dry Lithologic Description CLAY; silty, sandy, some small gravel, brown, damp CLAY; silty, sandy, small gravel, gray-brown, damp CLAY; silty, some sand, gravel, gray, moist, incre moisture w/dept
BORING N 8/6/ Sample	UMBER <u>EPW-3</u> $E-3$ /81 $(2-81-E-3)$ From 0 to 23 Feet 0 - 4 4 - 9 9 - 21	TOTAL DEPTH 23' S.W.L.(BGL) Dry Lithologic Description CLAY: silty, sandy, some small gravel, brown, damp CLAY: silty, sandy, small gravel, gray-brown, damp CLAY: silty, some sand, gravel, gray, moist, incre moisture w/dept CLAY TILL: w/gravel, gray-brown, damp
BORING N 8/6/ Sample	UMBER <u>EPW-3</u> $E-3$ /81 $(2-81-E-3)$ From 0 to 23 Feet 0 - 4 4 - 9 9 - 21	TOTAL DEPTH 23' S.W.L.(BGL) Dry Lithologic Description CLAY; silty, sandy, some small gravel, brown, damp CLAY; silty, sandy, small gravel, gray-brown, damp CLAY; silty, some sand, gravel, gray, moist, incre moisture w/depth CLAY TILL; w/gravel, gray-brown, damp 14.3' BGL to sand pack
BORING N 8/6/ Sample	UMBER <u>EPW-3</u> $E-3$ /81 $(2-81-E-3)$ From 0 to 23 Feet 0 - 4 4 - 9 9 - 21	TOTAL DEPTH 23' S.W.L.(BGL) Dry Lithologic Description CLAY: silty, sandy, some small gravel, brown, damp CLAY: silty, sandy, small gravel, gray-brown, damp CLAY: silty, some sand, gravel, gray, moist, incre moisture w/depth CLAY TILL: w/gravel, gray-brown, damp 14.3' BGL to sand pack natural clay fill to 10'
BORING N 8/6/ Sample	UMBER <u>EPW-3</u> $E-3$ /81 $(2-81-E-3)$ From 0 to 23 Feet 0 - 4 4 - 9 9 - 21	TOTAL DEPTH 23' S.W.L.(BGL) Dry Lithologic Description CLAY; silty, sandy, some small gravel, brown, damp CLAY; silty, sandy, small gravel, gray-brown, damp CLAY; silty, some sand, gravel, gray, moist, incre moisture w/depth CLAY TILL; w/gravel, gray-brown, damp 14.3' BGL to sand pack natural clay fill to 10' 10' - 1/2 bag bentonite
BORING N 8/6/ Sample	UMBER <u>EPW-3</u> $E-3$ /81 $(2-81-E-3)$ From 0 to 23 Feet 0 - 4 4 - 9 9 - 21	TOTAL DEPTH 23' S.W.L.(BGL) Dry Lithologic Description CLAY; silty, sandy, some small gravel, brown, damp CLAY; silty, sandy, small gravel, gray-brown, damp CLAY; silty, some sand, gravel, gray, moist, incre moisture w/depth CLAY TILL; w/gravel, gray-brown, damp 14.3' BGL to sand pack natural clay fill to 10' 10' - 1/2 bag bentonite

Piezometer: Screen⁹²⁴ #10 Pipe 23' Total D all s.s. screen added 3' casing

Sample Number	From 0 to 24 Feet	(2-81-E-4) Lithologic Description
	0 - 1	CRUSHED STONES; fill and brown clay
	1 - 2	CLAYEY SILT; w/gravel, brown, moist
	2 - 3	CLAY; silty, w/gravel, gray, wet
	3 - 5	CLAY; silty, w/gravel, mottled, gray-brown, wet Split spoon sample 5-7'
		Actual sample 5'4"-6', tight
		Note: Sand pack producing water
and the second second second second second second second second second second second second second second second		Surface water through gravel
	5 - 8	CLAY; gravel, silt, saturated, brown
	8 - 11	CLAY; silty, gravel, brown, wet
etan dan katan managaran dan ay d		Split spoon sample 10-12'
an an an an an an an an an an an an an a		Actual sample 10'-10'9" and 11'5"-12'1"
	11 - 18	CLAY TILL; silty, w/gravel, mottled, gray-brown, mois
	18 - 29	CLAY TILL; silty gravel, gray, wet, tight
Piezometer	r: Screen_	Pipe Total Depth (BGL)

Sample	From to	Lithologic Description
Number	Feet	
	29 - 33	CLAY TILL; extensive gravel, moist, gray, very tight
	33 - 34	BEDROCK; weathered limestone
an an an an an an an an an an an an an a		
	and executive classes which are the set of t	

Sample Number	From 0 to 53 Feet	(2-81-E-B-6) Lithologic Description
	0 - 1	CLAY & CRUSHED STONE FILL; moist
	1 - 6	CLAY TILL; silty, some gravel, brown, moist
	6 - 7	GRAVEL & CLAY TILL; wet, brown
		Split spoon sample 6-8'
		Actual sample 6'3"-7'1" and 7'1"-7'9"
	7 - 11	CLAY TILL; silty, some gravel, brown-gray, moist
	11 - 13	CLAY TILL; silty, gravel, gray, wet, tight
		Split spoon sample 11'-11'7" and 11'7"-12'3"
	13 - 21	CLAY; silty, little gravel, moist, gray, tight
	32 - 53	CLAY TILL; gravel, silty, gray, tight, moist
	53	BEDROCK; hole stopped
		Hole backfilled with bentonite and natural materia
iezomete:	Screen	Pipe Total Depth (BGL)
Terome ee.		
		TOTAL DEPTH S.W.L.(BGL)
	UMBER	
BORING N Sample	UMBER	_ TOTAL DEPTH S.W.L.(BGL)
BORING N Sample	UMBER	_ TOTAL DEPTH S.W.L.(BGL)
BORING N Sample	UMBER	_ TOTAL DEPTH S.W.L.(BGL)
BORING N Sample	UMBER	_ TOTAL DEPTH S.W.L.(BGL)

Sample Number	MBER DEW-1 8-1 From 0 to 18 Feet	(2-81-B-1) Lithologic Description
and a second second second second second second second second second second second second second second second	0 - 4	CLAY FILL
	4 - 18	CLAY TILL; sandy, moist, brown, saturated at approx
		12' w/increasing sand and gravel
	18	REFUSAL; suspect bedrock
an an an an an an an an an an an an an a		screened at approx. 18-16'
alaali waxaa ahay oo ahay ahaana		sand pack 18-14'
		native 14-10'
e ana ga an an an an an an an an an an an an an		bentonite 10-8'
an an an an an an an an an an an an an a		native 8-3'
		bentonite 3-0'
and the second		

POPING MIMBER DEN-2 B-2 TOTAL DEPTH _____ 41' S.W.L. (BGL) 27.90'

Sample Number	From 0 to 41 Feet	Lithologic Description
	0 - 1	CRUSHED STONE FILL
	1 - 5	CLAY; sandy, w/silt, angular gravel, red-brown, moist
nalasian da senara ani admini separat incom d	5 - 7	GRAVEL & CLAY; saturated, brown
And		Split spoon sample 5'-5'8" and 5'8"-6'4"
and an article of the second second	7 - 9	CLAY TILL; sand, silt and gravel, gray, wet
	9 - 13	CLAY TILL; silty, w/angular gravel, gray, wet
		Split spoon sample 10-12' and 10'8"-11'4"
	13 - 30	CLAY TILL; extensive gravel, gray, saturated,
		occasional lenses of soft silty clay
	30 - 41	SILT, SAND, CLAY; some gravel
	41	BEDROCK
nan tanan sebarah sebarah sebarah sebarah sebarah sebarah sebarah sebarah sebarah sebarah sebarah sebarah seba		
and the second second second second second second second second second second second second second second second		



Piezometer: Screen 924 #7 Pipe 40' Total Depth (BGL) 37'

Sample Number	From 0 to 49 Feet	TOTAL DEPTH S.W.L.(BTSS) 30.09' (2-81-B-3 Lithologic Description
	0 - 3	FILL; broken limestone and clay
	3 - B	CLAY; w/gravel, brown
	8 - 13	CLAY; w/silt and sand, saturated, gray
	13 - 49	CLAY TILL; gray, w/silty lenses
	49	REFUSAL; suspect bedrock
	and a star when the star and a star in the star and a star and a star and a star and a star and a star and	
iezometei	Screen_	924 #7 Pipe 50' Total Depth (BGL) 47.1
	·	
BORING M	·	TOTAL DEPTH 23' S.W.L.(BGL) Dry 4)
BORING M Sample	$\frac{DPW-4}{2-8I-B}$ From 0 to 23 Feet	Lithologic Description
BORING M Sample	MBER DPW-4 B-4 2-81-B- From 0 to 23	TOTAL DEPTH 23' S.W.L.(BGL) Dry 4) Lithologic Description FILL; sand and clay w/rocks
BORING M Sample	UMBER DPG $B-4$ 2-81-B From 0 to 23 Feet 0 - 4	TOTAL DEPTH 23' S.W.L.(BGL) Dry 4) Lithologic Description FILL; sand and clay w/rocks
BORING M Sample	UMBER DPG4 B -4 2-81-B- From 0 to 23 Feet 0 - 4 4 - 10	TOTAL DEPTH 23' S.W.L.(BGL) Dry 4) Lithologic Description FILL; sand and clay w/rocks CLAY; w/sand and high gravel, med. organics, dk. br
BORING M Sample	UMBER DPG $B-4$ 2-81-B From 0 to 23 Feet 0 - 4	TOTAL DEPTH 23' S.W.L.(BGL) Dry 4) Lithologic Description FILL; sand and clay w/rocks CLAY; w/sand and high gravel, med. organics, dk. br moist
BORING M Sample	UMBER DP $_{24} B^{-4}$ $2 - 8I - B^{-4}$ From 0 to 23 Feet 0 - 4 4 - 10 10 - 19	TOTAL DEPTH 23' S.W.L.(BGL) Dry 4) Lithologic Description FILL; sand and clay w/rocks CLAY; w/sand and high gravel, med. organics, dk. br moist CLAY TILL; gray, tight
BORING M Sample	$ \begin{array}{c} DP & 4 & B - 4 \\ 2 - 8 I - B - 4 \\ 2 - 8 I - B - 4 \\ 2 - 8 I - B - 4 \\ 2 - 8 I - B - 4 \\ 2 - 8 I - B - 4 \\ 2 - 8 I - B - 4 \\ 2 - 8 I - B - 4 \\ 2 - 8 I - B - 4 \\ 2 - 8 I - B - 4 \\ 2 - 8 I - B - 4 \\ 2 - 8 I - B - 4 \\ 2 - 8 I - B - 4 \\ 2 - 8 I - B - 4 \\ 2 - 8 I - B - 4 \\ 4 - 10 \\ 10 - 19 \\ 10 - 19 \\ 19 - 23 \end{array} $	TOTAL DEPTH 23' S.W.L.(BGL) Dry 4) Lithologic Description FILL; sand and clay w/rocks CLAY; w/sand and high gravel, med. organics, dk. br moist CLAY TILL; gray, tight WEATHERED BROKEN LIMESTONE REFUSAL
BORING M Sample	$ \begin{array}{c} DP & 4 & B - 4 \\ 2 - 8 I - B - 4 \\ 2 - 8 I - B - 4 \\ 2 - 8 I - B - 4 \\ 2 - 8 I - B - 4 \\ 2 - 8 I - B - 4 \\ 2 - 8 I - B - 4 \\ 2 - 8 I - B - 4 \\ 2 - 8 I - B - 4 \\ 2 - 8 I - B - 4 \\ 2 - 8 I - B - 4 \\ 2 - 8 I - B - 4 \\ 2 - 8 I - B - 4 \\ 2 - 8 I - B - 4 \\ 2 - 8 I - B - 4 \\ 4 - 10 \\ 10 - 19 \\ 10 - 19 \\ 19 - 23 \end{array} $	TOTAL DEPTH 23' S.W.L.(BGL) Dry 4) Lithologic Description FILL; sand and clay w/rocks CLAY; w/sand and high gravel, med. organics, dk. br moist CLAY TILL; gray, tight WEATHERED BROKEN LIMESTONE REFUSAL screened at approx. 18-16'
BORING M Sample	$ \begin{array}{c} DP & 4 & B - 4 \\ 2 - 8 I - B - 4 \\ 2 - 8 I - B - 4 \\ 2 - 8 I - B - 4 \\ 2 - 8 I - B - 4 \\ 2 - 8 I - B - 4 \\ 2 - 8 I - B - 4 \\ 2 - 8 I - B - 4 \\ 2 - 8 I - B - 4 \\ 2 - 8 I - B - 4 \\ 2 - 8 I - B - 4 \\ 2 - 8 I - B - 4 \\ 2 - 8 I - B - 4 \\ 2 - 8 I - B - 4 \\ 2 - 8 I - B - 4 \\ 4 - 10 \\ 10 - 19 \\ 10 - 19 \\ 19 - 23 \end{array} $	TOTAL DEPTH 23' S.W.L.(BGL) Dry 4) Lithologic Description FILL; sand and clay w/rocks CLAY; w/sand and high gravel, med. organics, dk. br moist CLAY TILL; gray, tight WEATHERED BROKEN LIMESTONE REFUSAL
BORING M Sample	$ \begin{array}{c} DP & 4 & B - 4 \\ 2 - 8 I - B - 4 \\ 2 - 8 I - B - 4 \\ 2 - 8 I - B - 4 \\ 2 - 8 I - B - 4 \\ 2 - 8 I - B - 4 \\ 2 - 8 I - B - 4 \\ 2 - 8 I - B - 4 \\ 2 - 8 I - B - 4 \\ 2 - 8 I - B - 4 \\ 2 - 8 I - B - 4 \\ 2 - 8 I - B - 4 \\ 2 - 8 I - B - 4 \\ 2 - 8 I - B - 4 \\ 2 - 8 I - B - 4 \\ 4 - 10 \\ 10 - 19 \\ 10 - 19 \\ 19 - 23 \end{array} $	TOTAL DEPTH 23' S.W.L.(BGL) Dry 4) Lithologic Description FILL; sand and clay w/rocks CLAY; w/sand and high gravel, med. organics, dk. br moist CLAY TILL; gray, tight WEATHERED BROKEN LIMESTONE REFUSAL screened at approx. 18-16' sand pack 18-14' native 14-10'
BORING M Sample	$ \begin{array}{c} DP & 4 & B - 4 \\ 2 - 8 I - B - 4 \\ 2 - 8 I - B - 4 \\ 2 - 8 I - B - 4 \\ 2 - 8 I - B - 4 \\ 2 - 8 I - B - 4 \\ 2 - 8 I - B - 4 \\ 2 - 8 I - B - 4 \\ 2 - 8 I - B - 4 \\ 2 - 8 I - B - 4 \\ 2 - 8 I - B - 4 \\ 2 - 8 I - B - 4 \\ 2 - 8 I - B - 4 \\ 2 - 8 I - B - 4 \\ 2 - 8 I - B - 4 \\ 4 - 10 \\ 10 - 19 \\ 10 - 19 \\ 19 - 23 \end{array} $	TOTAL DEPTH 23' S.W.L.(BGL) Dry (4) Lithologic Description FILL; sand and clay w/rocks CLAY; w/sand and high gravel, med. organics, dk. br moist CLAY TILL; gray, tight WEATHERED BROKEN LIMESTONE REFUSAL screened at approx. 18-16' sand pack 18-14'

Piezometer: Screen 924 #10pipe 20' Total Depth (BGL) 19.28

Sample Number	From 0 to 15 Feet	(2-81-B-5) Lithologic Description
and the second second second second second second second second second second second second second second second	0 - 3	CLAY FILL
	3 - 15	CLAY; sandy, w/fine gravel, brown, turning gray @
	15	REFUSAL; suspect bedrock
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an an thirt an an a tai an an an an		
iezomete:	r: Screen_	924 #7 Pipe 16' Total Depth (BGL) 14.4
		924 #7 Pipe 16' Total Depth (BGL) 14.4 TOTAL DEPTH S.W.L.(BGL)
BORING N	UMBER	
BORING N Sample	UMBER	TOTAL DEPTH S.W.L.(BGL)
BORING N Sample	UMBER	TOTAL DEPTH S.W.L.(BGL)
BORING N Sample	UMBER	TOTAL DEPTH S.W.L.(BGL)
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BORING N Sample	UMBER	TOTAL DEPTH S.W.L.(BGL)
BORING N Sample	UMBER	TOTAL DEPTH S.W.L.(BGL)

FORING NI	JMBER TW-11	TOTAL DEPTH 24' S.W.L. (BGL) 24.25'
Sample Number	From 0 to 24 Feet	(2-81-C-1) Lithologic Description
	0 - 3	CLAY FILL
	3 - 4	SAND CLAY; w/high organics, black
	4 - 18	CLAY; w/minor sand, dk. brown, becomes mixed w/grav
		and increased sand at 12'
	1.8 - 2.2	UNSORTED GRAVEL; saturated w/high fines, brown
	- 22 - 24	CLAY TILL
	24	REFUSAL: suspect bedrock
Section and section of the section o		
iezometer		2
iezometer BORING M		2/
BORING M		dry of a second s
BORING M Sample	MBER TW-12 (2-81-C From 0 to 26	TOTAL DEPTH S.W.L. (BOB) 17.76'
BORING M Sample	$\frac{1}{\frac{1}{\frac{2-81-c}{1}}}$	TOTAL DEPTH S.W.L.(BOB) 17.76' -2) Lithologic Description
BORING M Sample	$\frac{1}{2 - 81 - c}$ $\frac{1}{2 - 81 - c}$ From 0 to 26 Feet $0 - 4$	TOTAL DEPTH 26' S.W.L.(BOB) 17.76' -2) Lithologic Description FILL
BORING M Sample	$\frac{1}{20 - 23} = \frac{1}{20 - 23}$	TOTAL DEPTH 26' S.W.L.(WOWS) 17.76' -2) Lithologic Description FILL CLAY; sandy, w/gravel, brown GRAVEL; unsorted, w/high fines
BORING M Sample	$ \frac{\text{TW-12}}{(2-81-c)} $ From 0 to 26 Feet $0 - 4$ $4 - 20$ $20 - 23$ $23 - 26$	TOTAL DEPTH 26' S.W.L.(BOX) 17.76' -2) Lithologic Description FILL CLAY; sandy, w/gravel, brown GRAVEL; unsorted, w/high fines CLAY TILL; gray, tight
BORING M Sample	$\frac{1}{20 - 23} = \frac{1}{20 - 23}$	TOTAL DEPTH 26' S.W.L.(BOB) 17.76' -2) Lithologic Description FILL CLAY; sandy, w/gravel, brown GRAVEL; unsorted, w/high fines
BORING M Sample	$ \frac{\text{TW-12}}{(2-81-c)} $ From 0 to 26 Feet $0 - 4$ $4 - 20$ $20 - 23$ $23 - 26$	TOTAL DEPTH 26' S.W.L.(WOWS) 17.76' -2) Lithologic Description FILL CLAY; sandy, w/gravel, brown GRAVEL; unsorted, w/high fines CLAY TILL; gray, tight
BORING M Sample	$ \frac{\text{TW-12}}{(2-81-c)} $ From 0 to 26 Feet $0 - 4$ $4 - 20$ $20 - 23$ $23 - 26$	TOTAL DEPTH 26' S.W.L.(BOB) 17.76' -2) Lithologic Description FILL CLAY; sandy, w/gravel, brown GRAVEL; unsorted, w/high fines CLAY TILL; gray, tight
BORING M Sample	$ \frac{\text{TW-12}}{(2-81-c)} $ From 0 to 26 Feet $0 - 4$ $4 - 20$ $20 - 23$ $23 - 26$	TOTAL DEPTH 26' S.W.L.(BOB) 17.76' -2) Lithologic Description FILL CLAY; sandy, w/gravel, brown GRAVEL; unsorted, w/high fines CLAY TILL; gray, tight
BORING M Sample	$ \frac{\text{TW-12}}{(2-81-c)} $ From 0 to 26 Feet $0 - 4$ $4 - 20$ $20 - 23$ $23 - 26$	TOTAL DEPTH 26' S.W.L.(BOB) 17.76' -2) Lithologic Description FILL CLAY; sandy, w/gravel, brown GRAVEL; unsorted, w/high fines CLAY TILL; gray, tight
BORING M Sample	$ \frac{\text{TW-12}}{(2-81-c)} $ From 0 to 26 Feet $0 - 4$ $4 - 20$ $20 - 23$ $23 - 26$	TOTAL DEPTH 26' S.W.L.(WOWS) 17.76' -2) Lithologic Description FILL CLAY; sandy, w/gravel, brown GRAVEL; unsorted, w/high fines CLAY TILL; gray, tight
BORING M Sample	$ \frac{\text{TW-12}}{(2-81-c)} $ From 0 to 26 Feet $0 - 4$ $4 - 20$ $20 - 23$ $23 - 26$	TOTAL DEPTH 26' S.W.L.(BOB) 17.76' -2) Lithologic Description FILL CLAY; sandy, w/gravel, brown GRAVEL; unsorted, w/high fines CLAY TILL; gray, tight
BORING M Sample	$ \frac{\text{TW-12}}{(2-81-c)} $ From 0 to 26 Feet $0 - 4$ $4 - 20$ $20 - 23$ $23 - 26$	TOTAL DEPTH 26' S.W.L.(BOB) 17.76' -2) Lithologic Description FILL CLAY; sandy, w/gravel, brown GRAVEL; unsorted, w/high fines CLAY TILL; gray, tight
BORING M Sample	$ \frac{\text{TW-12}}{(2-81-c)} $ From 0 to 26 Feet $0 - 4$ $4 - 20$ $20 - 23$ $23 - 26$	TOTAL DEPTH 26' S.W.L.(BOB) 17.76' -2) Lithologic Description FILL CLAY; sandy, w/gravel, brown GRAVEL; unsorted, w/high fines CLAY TILL; gray, tight

Piezometer: Screen 924 #7 Pipe 25' Total Depth (BGL) 23.65'

JOE NUMBE		
EORING NU	MBER TW-4 (cont.)	TOTAL DEPTH S.W.L.(BGL)
Sample Number	From_to	Lithologic Description
	29 - 33	CLAY TILL; heavy gravel, moist, gray., v. tight
	33 - 34	BEDROCK; weathered limestone
iezometei	Screen	Pipe Total Depth (BGL)
iezometer	Screen_	Pipe Total Depth (BGL)
	1	
	IMBER TW - 5	TOTAL DEPTH 47' S.W.L.(BGL)
BORING M Sample	1	TOTAL DEPTH 47' S.W.L.(BGL)
BORING M Sample Number	MBER <u>TW - 5</u> (2-8/-0 From 0 to 47 Feet	TOTAL DEPTH 47' S.W.L.(BGL) C-3) Lithologic Description
BORING M Sample Number 1	$\frac{1}{MBER TW - 5} = \frac{7}{(2 - 8/-6)}$ From 0 to 47 Feet $0 - 1 - 2$	TOTAL DEPTH 47' S.W.L.(BGL) C-3) Lithologic Description CLAY, till, silty, w/gravel, gray, moist
BORING M Sample Number 1 2	$\frac{1}{MBER TW - 5} = \frac{7}{(2 - 8) - 6}$ From 0 to 47 Feet $0 - 1 - 2$ $2 - 3$	TOTAL DEPTH 47' S.W.L.(BGL) C-3) Lithologic Description CLAY, till, silty, w/gravel, gray, moist CLAY; till, silty, w/gravel, green, moist
BORING M Sample Number 1	$\frac{1}{MBER TW - 5} = \frac{7}{(2 - 8/-6)}$ From 0 to 47 Feet $0 - 1 - 2$	TOTAL DEPTH 47' S.W.L.(BGL) C-3) Lithologic Description CLAY, till, silty, w/gravel, gray, moist
BORING M Sample Number 1 2	$\frac{1}{MBER TW - 5} = \frac{7}{(2 - 8) - 6}$ From 0 to 47 Feet $0 - 1 - 2$ $2 - 3$	TOTAL DEPTH 47' S.W.L.(BGL) C-3) Lithologic Description CLAY, till, silty, w/gravel, gray, moist CLAY; till, silty, w/gravel, green, moist CLAY Till, silt, w/gravel, green/gray, moist
BORING M Sample Number 1 2 3 4	$ \begin{array}{r} \text{JMBER} TW - 5 \\ \hline $	TOTAL DEPTH 47' S.W.L.(BGL) Lithologic Description CLAY, till, silty, w/gravel, gray, moist CLAY; till, silty, w/gravel, green, moist CLAY Till, silt, w/gravel, green/gray, moist Split Spoon Sample 5 - 5'7" CLAY; till, silt, mottled, reddish gray, moist, w/grav
BORING N Sample Number 1 2 3 4 5	$ \begin{array}{r} \text{MBER} \underline{\text{TW}} = 5 \\ \hline (2-8/-6) \\ \hline From 0 to 47 \\ Feet \\ 0-1-2 \\ 2 - 3 \\ 3 - 5 \\ 6 - 10 \\ 10 - 13 \\ \end{array} $	TOTAL DEPTH 47' S.W.L.(BGL) Lithologic Description CLAY, till, silty, w/gravel, gray, moist CLAY; till, silty, w/gravel, green, moist CLAY; till, silt, w/gravel, green, moist CLAY Till, silt, w/gravel, green/gray, moist Split Spoon Sample 5 - 5'7" CLAY; till, silt, mottled, reddish gray, moist, w/grav GRAVEL; medcoarse, angular, rounded, moist
BORING M Sample Number 1 2 3 4	$ \begin{array}{r} \text{JMBER} TW - 5 \\ \hline $	TOTAL DEPTH 47' S.W.L.(BGL) Lithologic Description CLAY, till, silty, w/gravel, gray, moist CLAY; till, silty, w/gravel, green, moist CLAY; till, silt, w/gravel, green/gray, moist CLAY Till, silt, w/gravel, green/gray, moist Split Spoon Sample 5 - 5'7" CLAY; till, silt, mottled, reddish gray, moist, w/grav GRAVEL; medcoarse, angular, rounded, moist CLAY; till, silty, mottled, w/angular gravelyellowing
BORING N Sample Number 1 2 3 4 5	$ \begin{array}{r} \text{MBER} \underline{\text{TW}} = 5 \\ \hline (2-8/-6) \\ \hline From 0 to 47 \\ Feet \\ 0-1-2 \\ 2 - 3 \\ 3 - 5 \\ 6 - 10 \\ 10 - 13 \\ \end{array} $	TOTAL DEPTH 47' S.W.L.(BGL) Lithologic Description CLAY, till, silty, w/gravel, gray, moist CLAY, till, silty, w/gravel, green, moist CLAY till, silt, w/gravel, green, moist CLAY Till, silt, w/gravel, green/gray, moist Split Spoon Sample 5 - 5'7" CLAY; till, silt, mottled, reddish gray, moist, w/grav GRAVEL; medcoarse, angular, rounded, moist CLAY; till, silty, mottled, w/angular gravel, yellowis gray, moist
BORING N Sample Number 1 2 3 4 5 6	$ \begin{array}{r} TW - 5 \\ $	TOTAL DEPTH 47' S.W.L.(BGL) C-3) Lithologic Description CLAY, till, silty, w/gravel, gray, moist CLAY; till, silty, w/gravel, green, moist CLAY Till, silt, w/gravel, green/gray, moist Split Spoon Sample 5 - 5'7" CLAY; till, silt, mottled, reddish gray, moist, w/grav GRAVEL; medcoarse, angular, rounded, moist CLAY; till, silty, mottled, w/angular gravel, yellowis gray, moist Split Spoon Sample 10'4" - 17'0"
BORING N Sample Number 1 2 3 4 5 6	$ \begin{array}{r} \text{MBER} \underline{\text{TW}} = 5 \\ \hline $	TOTAL DEPTH 47' S.W.L.(BGL) C-3) Lithologic Description CLAY, till, silty, w/gravel, gray, moist CLAY; till, silty, w/gravel, green, moist CLAY Till, silt, w/gravel, green/gray, moist Split Spoon Sample 5 - 5'7" CLAY; till, silt, mottled, reddish gray, moist, w/grav GRAVEL; medcoarse, angular, rounded, moist CLAY; till, silty, mottled, w/angular gravel yellowis gray, moist Split Spoon Sample 10'4" - 17'0" GRAVEL; w/sand & silt, some clay, sat., @ 17', brown
Sample Number 1 2 3 4 5 6	$ \begin{array}{r} TW - 5 \\ $	TOTAL DEPTH 47' S.W.L.(BGL) C-3) Lithologic Description CLAY, till, silty, w/gravel, gray, moist CLAY; till, silty, w/gravel, green, moist CLAY Till, silt, w/gravel, green/gray, moist Split Spoon Sample 5 - 5'7" CLAY; till, silt, mottled, reddish gray, moist, w/grav GRAVEL; medcoarse, angular, rounded, moist CLAY; till, silty, mottled, w/angular gravel, yellowis gray, moist Split Spoon Sample 10'4" - 17'0"

Piezometer: Screen 924 #10 Pipe 40' Total Depth (BGL) 39'

SCREENED 37 - 39'

ING NI	MBER TW-13 From 0 to 49	TOTAL DEPTH 49' S.W.L. (BGL) 30.09'
Sample Number	From 0 to 49 Feet	Lithologic Description
	0 - 3	FILL; broken limestone and clay
	3 - 8	CLAY; w/gravel, brown
	8 - 13	CLAY; w/silt and sand, saturated, gray
	13 - 49	CLAY TILL; gray, w/silty lenes
	49	REFUSAL; suspent bedrock
		이 같은 것 같은 것 같은 것 같은 것 같은 것 같은 것 같은 것 같이 같이 같이 같이 같이 같이 같이 같이 같이 같이 같이 같이 같이
the state of the s	and the second second second second second second second second second second second second second second second	
ezometer	Screen_	
		924 #7 Pipe <u>504</u> Total Depth (BGL) <u>47</u> . TOTAL DEPTH <u>53'</u> S.W.L.(BOX) <u>29.23'</u> -C-4)
ORING NU Sample		REAL REAL
ORING NU Sample	MBER	TOTAL DEPTH 53' S.W.L. (2002) 29.23'
ORING NU Sample	MBER	TOTAL DEPTH 53' S.W.L. (2008) 29.23' -C-4) Lithologic Description
ORING NU Sample	$\frac{\text{TW-14}}{\text{(2-81)}}$ From 0 to 53 Feet $0 - 3$	TOTAL DEPTH 53' S.W.L.(2003) 29.23' -C-4) Lithologic Description FILL; clay w/gravel, red-brown CLAY; sandy w/gravel, brown
ORING NU Sample	$\frac{\text{TW-14}}{\text{(2-81)}}$ From 0 to 53 Feet $0 - 3$ $3 - 13$	TOTAL DEPTH 53' S.W.L.(2003) 29.23' -C-4) Lithologic Description FILL; clay w/gravel, red-brown CLAY; sandy w/gravel, brown
ORING NU Sample	$\frac{\text{TW-14}}{\text{(2-81)}}$ From 0 to 53 Feet $0 - 3$ $3 - 13$	TOTAL DEPTH 53' S.W.L. (2003) 29.23' -C-4) Lithologic Description FILL; clay w/gravel, red-brown CLAY; sandy w/gravel, brown GRAVEL; medcoarse, w/sand and high fines, brown,
ORING NU Sample	$ \underline{MBER} \xrightarrow{TW-14} \\ \underline{(2-8)} \\ \underline{From} & 0 & to & 53 \\ \underline{0 - 3} \\ \underline{3 - 13} \\ \underline{13 - 20} \\ 13$	TOTAL DEPTH 53' S.W.L.(BOX) 29.23' -C-4) Lithologic Description FILL; clay w/gravel, red-brown CLAY; sandy w/gravel, brown GRAVEL; medcoarse, w/sand and high fines, brown, saturated
ORING M Sample	$ \frac{\text{MBER}}{\text{From } 0 \text{ to } 53} \\ \hline From & 0 \text{ to } 53 \\ \hline Feet \\ 0 - 3 \\ 3 - 13 \\ 13 - 20 \\ \hline 20 - 53 \\ \end{array} $	TOTAL DEPTH 53' S.W.L. (BOX) 29.23' -C-4) Lithologic Description FILL; clay w/gravel, red-brown CLAY; sandy w/gravel, brown GRAVEL; medcoarse, w/sand and high fines, brown, saturated CLAY TILL; w/occasional silty lenes
ORING M Sample	$ \frac{\text{MBER}}{\text{From } 0 \text{ to } 53} \\ \hline From & 0 \text{ to } 53 \\ \hline Feet \\ 0 - 3 \\ 3 - 13 \\ 13 - 20 \\ \hline 20 - 53 \\ \end{array} $	TOTAL DEPTH 53' S.W.L. (BOX) 29.23' -C-4) Lithologic Description FILL; clay w/gravel, red-brown CLAY; sandy w/gravel, brown GRAVEL; medcoarse, w/sand and high fines, brown, saturated CLAY TILL; w/occasional silty lenes
ORING M Sample Number	$ \frac{\text{MBER}}{\text{From } 0 \text{ to } 53} \\ \hline From & 0 \text{ to } 53 \\ \hline Feet \\ 0 - 3 \\ 3 - 13 \\ 13 - 20 \\ \hline 20 - 53 \\ \end{array} $	TOTAL DEPTH 53' S.W.L. (BOX) 29.23' -C-4) Lithologic Description FILL; clay w/gravel, red-brown CLAY; sandy w/gravel, brown GRAVEL; medcoarse, w/sand and high fines, brown, saturated CLAY TILL; w/occasional silty lenes
ezometer ORING M Sample Number	$ \frac{\text{MBER}}{\text{From } 0 \text{ to } 53} \\ \hline From & 0 \text{ to } 53 \\ \hline Feet \\ 0 - 3 \\ 3 - 13 \\ 13 - 20 \\ \hline 20 - 53 \\ \end{array} $	TOTAL DEPTH 53' S.W.L.(BOX) 29.23' -C-4) Lithologic Description FILL; clay w/gravel, red-brown CLAY; sandy w/gravel, brown GRAVEL; medcoarse, w/sand and high fines, brown, saturated CLAY TILL; w/occasional silty lenes
ORING M Sample Number	$ \frac{\text{MBER}}{\text{From } 0 \text{ to } 53} \\ \hline From & 0 \text{ to } 53 \\ \hline Feet \\ 0 - 3 \\ 3 - 13 \\ 13 - 20 \\ \hline 20 - 53 \\ \end{array} $	TOTAL DEPTH 53' S.W.L. (BOX) 29.23' -C-4) Lithologic Description FILL; clay w/gravel, red-brown CLAY; sandy w/gravel, brown GRAVEL; medcoarse, w/sand and high fines, brown, saturated CLAY TILL; w/occasional silty lenes
ORING M Sample Number	$ \frac{\text{MBER}}{\text{From } 0 \text{ to } 53} \\ \hline From & 0 \text{ to } 53 \\ \hline Feet \\ 0 - 3 \\ 3 - 13 \\ 13 - 20 \\ \hline 20 - 53 \\ \end{array} $	TOTAL DEPTH 53' S.W.L. (BOX) 29.23' -C-4) Lithologic Description FILL; clay w/gravel, red-brown CLAY; sandy w/gravel, brown GRAVEL; medcoarse, w/sand and high fines, brown, saturated CLAY TILL; w/occasional silty lenes

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LOG OF BORING NO. 1 (1-82-1)

EXISTING DEEP WELL POND DIKE - VISTRON CORPORATION - LIMA, OHIO

BORING LOCATION: As shown on boring location plan DATE STARTED: 8-18-82

64.2'

DATE COMPLETED: 8-18-82

STRATUM	DESCRIPTION OF MATERIAL	SAMPLE NO. & TYPE	SAMPLE DEPTH	BLOWS FER 6" ON SAMPLER	"N" BLOWS /FT. OR CORE REC
0.0'	(FILL) Crushed stone				
- 0.5'	(FILL) Very stiff gray silt and clay, some sand, trace of gravel, moist	1.4	1.0- 2.5	9-10-13	23
	(FILL) Very stiff brow: and gray silt, some clay, some sand, traces of gravel and organic material,	2A	3.5- 5.0	7- 9-15	24
7.0'	moist	3A	6.0- 7.5	8-12-24	35
8.5	(FILL) Hard black and brown silt, some clay, some sand, trace of gravel, moist	4A	8.5-10.0	12-19-35	54
<u>o'</u>	Hard brown silt and clay, some sand, trace of gravel, moist	5A	11.0-12.5	12-16-24	40
		6A	13.5-15.0	12-19-30	49
<u>5'</u> - 16.5'	Hard gray clay, some silt, some	- 818	16.0-17.5	10-13-21	34
	sand, trace of gravel, moist				
ō*	(Becomes very stiff at 18.5')	8A	18.5-20.0	8-11-12	23
		10	20.5-22.5		24**
- 	(Becomes hard at 23.5')	64 9A	23.5-25.0	12-15-20	35
L 	(Becomes very stiff at 28.5')	9362	28.5-30.0	6-10-17	27
METHOD:	Hollow Auger WATER OBSET			TYPE SAMPLE	R:

BOWSER - MORNER

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c.

SHELBY TUBE

HOB NO .:

33945 (11)

HRS.

DEPTH AFTER

LOG OF BORING NO. 1 - continued (1-82-1)

EXISTING DEEP WELL POND DIKE - VISTRON CORPORATION - LIMA, OHIO

BORING LOCATION: As shown on boring location plan DATE STARTED: 8-18-82

SURFACE ELEVATION: 864.2"

DATE COMPLETED: 8-18-82

STRATUM	DESCRIPTION OF MA	TFRIAL SAMPLE NO. & TYPE	SAMPLE DEPTH	BLOWS PER 6" ON SAMPLER	"N" BLOW /FT. OR CORE REC
30'					÷
33.7' 35'	Very dense brown and g silt, traces of gravel moist	gray sand and L and cobbles,	33.5-34.0	100/5"	100+
_		12A	38.5-38.6	100/1"	100+
	Bottom of boring at 38				
METHOD:	RE ADD KE	WATER OBSERVATIONS	X	TYPE SAMPLER A. SPLITS 8.	
		COMPLETION DEPTH: NONE	X		

TESTING LABORATORIES, INC.

LOG OF BORING NO. 2 (1-82-2)

EXISTING DEEP WELL POND DIKE - VISTRON CORPORATION - LIMA, OHIO

BORING LOCATION: As shown on boring location plan DATE STARTED: 8-10-82

SURFACE ELEVATION: 863.8"

DATE COMPLETED: 8-10-82

DESCRIPTION OF MATERIAL	SAMPLE NO. & TYPE	SAMPLE DEFTH	BLOWS PER B" ON SAMPLER	THT BLOWS
(FILL) Crushed stone				
(FILL) Gray and brown clay, some silt, some sand, trace of gravel, moist	1.4	1.0- 2.5	5- 6- 7	13
(Becomes very stiff at 3.5')	2A	3.5- 5.0	8- 9-11	20
(FILL) Medium dense brown and gray sand and silt, trace of clay, mosit	3A	6.0- 7.5	6- 7-15	22
material at 8.0')	10	8.0-10.0		24"
trace of gravel, moist	4A	11.0-12.5	16-19-23	42
(Becomes very stiff at 13.5')	5A	13.5-15.0	7- 6-15	21
(Becomes hard at 16.0')	6A	16.0-17.5	15-18-23	41
Very stiff gray clay, some silt,	-844	18.5-20.0	- 6- 9-11	20
some sand, trace of gravel, moist	8A	21.0-22.5	7- 7- 9	16
	9A	23.5-25.0	6- 7- 9	16
	10A	28.5-30.0	7-11-13	24
Bottom of boring at 30.0'				1
N. BC and RF	10.0'	<u></u>		
	(FILL) Crushed stone (FILL) Gray and brown clay, some silt, some sand, trace of gravel, moist (Becomes very stiff at 3.5') (FILL) Medium dense brown and gray sand and silt, trace of clay, mosit (With silty clay and some organic material at 8.0') Hard brown silt and clay, some sand trace of gravel, moist (Becomes very stiff at 13.5') (Becomes hard at 16.0') Very stiff gray clay, some silt, some sand, trace of gravel, moist Some sand, trace of gravel, moist Become shard at 16.0') Very stiff gray clay, some silt, some sand, trace of gravel, moist Bottom of boring at 30.0' Hollow Auger WATER OBSER WITIAL DEPTH:	Very stiff gray clay, some silt, some sand, trace of gravel, moist IA (FILL) Gray and brown clay, some silt, some sand, trace of gravel, moist IA (Becomes very stiff at 3.5') 2A (FILL) Medium dense brown and gray sand and silt, trace of clay, mosit IA (With silty clay and some organic material at 8.0') IC Hard brown silt and clay, some sand, trace of gravel, moist IA (Becomes hard at 16.0') 6A Very stiff gray clay, some silt, some sand, trace of gravel, moist 8A 9A IOA Botrom of boring at 30.0' IOA Hollow Auger WATER OBSERVATIONS INITIAL DEPTH IO.0'	DescriptionNO. & SAMPLE DEFTH(FILL) Crushed stoneIA1.0-2.5(FILL) Gray and brown clay, some silt, some sand, trace of gravel, moist (Becomes very stiff at 3.5')IA1.0-2.5(FILL) Medium dense brown and gray sand and silt, trace of clay, mosit (With silty clay and some organic material at 8.0')IA6.0-7.5(Hith silty clay and some organic material at 8.0')IC8.0-10.0Hard brown silt and clay, some sand, trace of gravel, moist (Becomes hard at 16.0')IA11.0-12.5(Becomes hard at 16.0')6A16.0-17.5Very stiff gray clay, some silt, some sand, trace of gravel, moist84A18.5-20.0Very stiff gray clay, some silt, some sand, trace of gravel, moist8A21.0-22.59A23.5-25.0IOA28.5-30.0Bottom of boring at 30.0'IOA28.5-30.0Hollow Auger water BC and RFWATER OBSERVATIONS INITIAL DEFTHX	DESCRIPTION OF MATCHINGNO. A SAMPLERSAMPLER(FILL) Crushed stone (FILL) Gray and brown clay, some silt, some sand, trace of gravel, moist (Becomes very stiff at 3.5')1A1.0-2.55-6-7(FILL) Medium dense brown and gray sand and silt, trace of clay, mosit (With silty clay and some organic material at 8.0')3A6.0-7.56-7-15(Hard brown silt and clay, some sand, trace of gravel, moist (Becomes hard at 16.0')4A11.0-12.516-19-23(Becomes hard at 16.0')5A13.5-15.07-6-15(Becomes hard at 16.0')6A16.0-17.515-18-23Very stiff gray clay, some silt, some sand, trace of gravel, moist8A21.0-22.57-7-9(Very stiff gray clay, some silt, some sand, trace of gravel, moist10A28.5-30.07-11-13Battom of, boring at 30.0'10A28.5-30.07-11-13Hollow Auger w t BC and RFWATER OBSERVATIONS COMPLETION OFTH: NONETYPE SAMPLER

BOWSER - MORNER TESTING LABORATORIES, INC.

LOG OF BORING NO. 3 (1-82-3)

EXISTING DEEP WELL POND DIKE - VISTAON CORPORATION - LIMA, OHIO

BORING LOCATION: As shown on boring location plan DATE STARTED: 8-19-82

SURFACE ELEVATION: 864.2"

DATE COMPLETED: 8-19-82

STRATUM	DESCRIPTION OF MATERIAL	SAMPLE NO. & TYPE	SAMPLE DEPTH	BLOWS PER 6" ON SAMPLER	VFT. OR CORE REC
0.0'	(FILL) Crushed stone				
0.5'	(FILL) Medium stiff brown a clay and silt, some sand, t gravel, moist	and gray 1A trace of	1.0- 2.5	11- 8-18	19
51		2A	3.5- 5.0	5- 7- 9	16
- 6.0'	(FILL) Medium stiff brown a slightly organic silt, some	and gray 3A a clay,	6.0- 7.5	2- 4- 6	10
10'	some sand, moist	4A	8.5-10.0	6-10-12	22
_ 11.5'	Hard brown and gray clay an some sand, trace of gravel	nd silt, 1C	11.5-13.5		15"
15'		SA	13.5-15.0	11-18-19	37
		6A	16.0-17.5	17-24-27	51
20, 19.7'	Hard gray clay, some silt,	SOME STR	18.5-20.0	10-18-22	40
_	sand, trace of gravel, moi	st * 8A	21.0-22.5	8-12-19	31
25*		9A	23.5-25.0	8-11-21	32
		10A	28.5-30.0	11-13-15	28
	Bottom of boring at 30.0"				1
METHOD:	Hollow Auger	WATER OBSERVATIONS	x	TYPE SAMPLE	R:
TECHNICIAN	N: BC and RF	ETION DEPTH: None			
JOB NO .:	33945 (j1) DEPTH	AFTER: HRS	X	C. SHEL	BYTUBE

BOWSER - MORNER

815

LOG OF BORING NO. 4 (1-82-4)

EXISTING DEEP WELL POND DIKE - VISTRON CORPORATION - LIMA, OHIO

BORING LOCATION: As shown on boring location plan DATE STARTED: 8-19-82

SURFACE ELEVATION:

ATION: 864.2'

DATE COMPLETED: 8-19-82

STRATUM	DESCRIPTION OF MATERIAL	NO. &	SAMPLE DEPTH	BLOWS PER 6" ON SAMPLER	INT BLOWS
0.0'	(FILL) Crushed stone				an an an an an an an an an an an an an a
0.5'	(FILL) Stiff brown clay, some silt.				12.20
	some sand, trace of gravel, moist	1A	1.0- 2.5	3- 3- 8	11
	(Becomes medium stiff at 3.5')				100.00
5'		2A	3.5- 5.0	4- 4- 6	10
- 7.51	(Becomes very stiff at 6.0')	3A	6.0- 7.5	5-11-12	23
- 8.5' 10' 11.0'	Medium stiff black organic clay and silt, some sand, moist Stiff brown clay, some silt, some sand, moist	- 4A	8.5-10.0	6- 7-11	18
	Very stiff brown silt and clay, some sand, trace of gravel, moist	5A	11.0-12.5	6- 7-18	25
15'	(Becomes hard at 13.5')	6A	13.5-15.0	11-20-24	44
		7A	16.0-17.5	10-18-22	40
-					
20*		A8	18.5-20.0	8-15-18	33
_	(With moist gray silt and sand layer at 21.0')	9A	21.0-22.5	10-25-17	32
23.5'	Very stiff brown and gray clay, some silt, some sand, trace of gravel, moist	10A	23.5-25.0	11-13-15	28
27.0'		637			
- ī0*	Very stiff gray clay, some silt, trace of sand, moist	11A	28.5-30.0	8- 9-11	20
METHOD:	Hollow Auger WATER OBSERV	ne	X	TYPE SAMPLER: A. SPLIT SP	
JOB NO.:	BC and RF COMPLETION DEPTH: . 33945 (j1) DEPTH AFTER:			B. C. SHELBY	TURE

BOWSER - MORNER TESTING LABORATORIES, INC.

		_	1-82-4	2	9.29
	LOG OF BO	RING NO.	4 - cont	inued	
	EXISTING DEEP WELL POND DIKE - VIS	TRON CORPO	ORATION - LI	MA, OHIO	
BORING	LOCATION: As shown on boring locati	on plan	DATE STA	RTED: 8	-19-82
SURFACE	ELEVATION: 864.2"		DATE CON	PLETED: 8	-19-82
TRATUM	DESCRIPTION OF MATERIAL	SAMPLE NO. & TYPE	SAMPLE DEPTH	BLOWS PER 6" ON SAMPLER	INT BLOW
1				POMPLEN	CORE HE
	(Becomes hard at 33.5')				1
1	(becomes mard at 33.5)	12A	33.5-35.0	8-18-36	54
				0 10 50	1 24
37.0'					
	Hard gray silt and sand, traces				12.18
	of gravel and clay, moist				100
-		13A	39.0-40.0	50- 62	112
	Bottom of boring at 40.0'				446
1.1					1.55
-					1-155
		1 1			
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				원 가지에	
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TECHNICIAN:

JOB NO .:

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BC and RF

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33945

C. SHELBY TUBE - BOWSER - MORNER

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SPLIT SPOON

HRS ...

INITIAL DEPTH NOTE

DEPTH AFTER:

COMPLETION DEPTH: None

TESTING LABORATORIES, INC.

	OCATION: As shown on bo ELEVATION: 846.5'	ring location	a plan	DATE STAT	ATED:	-1-82 -3-82
STRATUM	DESCRIPTION OF MATER	IAL S	NO. &	SAMPLE DEPTH	SLOWS PER S' ON SAMPLER	THE BLOWS
0.0' 1.5' 4.0' 8.0' 12.0' 15' 20' 25'	<pre>(FILL) Brown sand and gra Brown silt, some sand, to gravel, moist Brown silt, some clay, so trace of gravel, moist Brown sand and gravel, so Gray clay, some silt, so trace of gravel, moist (With trace of cobbles f 50.0')</pre>	ome sand, ome silt,wet				
30' METHOD: TECHNIC	IAN: BK and CL	WATER OBSER	0'(heav 7.0)*		ER: IT SPOON

2-82-05 LOG OF BORING NO. C-5 - continued WELL INSTALLATION - VISTRON CORPORATION - LIMA, OHIC 9-1-82 DATE STARTED: BORING LOCATION: As shown on boring location plan DATE COMPLETED: 9-3-82 846.5' SURFACE ELEVATION: "N" BLOWS /FT. OR CORE REC. BLOWS PER SAMPLE DESCRIPTION OF MATERIAL 6" ON SAMPLER SAMPLE STRATUM NO. A DEPTH TYPE 30' (Apparent rock at 30.5') 35" 40" 45" -----50* (Auger refusal at 50.5') Bottom of boring at 50.5' -----TYPE SAMPLER: WATER OBSERVATIONS Hollow Auger METHOD: INITIAL DEPTH: 8.0' (heavy) SPLIT SPOON ă, X 7.0' TECHNICIAN: BK and CL ñ., COMPLETION DEPTH: _ DEPTH AFTER: 24.0 HRS 7.0" SHELEY TUBE C, JOB NO .: 33954 (11)

BOWSER - MORNER TESTING LABORATORIES, DAC.

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30.21 2-82-06 LOG OF BORING NO. C-6 WELL INSTALLATION - VISTRON CORPORATION - LIMA, OHIO . 9-3-82 DATE STARTED: BORING LOCATION: As shown on boring location plan 9-7-82 DATE COMPLETED: 850.5' SURFACE ELEVATION: "N" BLOWS BLOWS PER 6" ON SAMPLER SAMPLE IFT. OR CORE REC. DESCRIPTION OF MATERIAL SAMPLE STRATUM NO. A DEPTH TYPE (FILL) Brown silt, some sand, some 0.0' gravel, moist 1.0' Brown silt, some sand, traces of clay and gravel, moist 4.0" Brown clay, some silt, some sand, 51 trace of gravel, moist (With 6" brown sand seams from 8') 10' 12.0" Gray clay, some silt, some sand, trace of gravel, moist 15' 20" 22.0' Gray clay, some silt, some sand, some gravel, moist (With some cobbles from 25.0°) 25' 30" YYPE SAMPLER: WATER OBSERVATIONS Hollow Auger METHOD: SPLIT SPOON INITIAL DEPTH: 8.0' (LTACE) A., BK and CL 8. TECHNICIAN: COMPLETION DEPTH: _ SHELSY TURE C. DEPTH AFTER: _____ HRS. _ JOB NO .: 33954 (j1)

BOWSER - MORNER TESTING LABORATORIES, DMC.

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LOG	OF	BORING	NO.	C-6	-	continued	5-5	12-66	

WELL INSTALLATION - VISTRON CORPORATION - LIMA, OHIO

BORING LOCATION: As shown on boring location plan DATE STARTED: 9-3-82

SURFACE ELEVATION: 850.5'

DATE COMPLETED: 9-7-82

STRATUM	DESCRIPTION OF M	ATERIAL	SAMPLE NO. & TYPE	SAMPLE DEPTH	BLOWS PER 6" ON SAMPLER	"N" BLOWS /FT. OR CORE REC.
30'						
Label a comment						
					1.17.2848	
-						
35'						
-				1112	Second 12	
-						
Des 1						
40°			-		1	
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nem.						
-			3 B	1.4.352	1970-003	
51					16.000	
2. Aurona			- 1993			
			6 (b) (c) (c)			
-						
50'			1.18.2	15-112-1	승규는 것같이	
45' 	(Apparent rock at 52. Bottom of boring at	.0') 52.5'				
-	BOLLOW OF DOLLING OF				11111	
-						
				1.1.1.1		
	김 아이님 아이는 것이다.					
			이 지수요.	1.00		
	la recolation de			_		
METHOD:	Hollow Auger		OBSERVATIONS	ce)	TYPE SAMP	LEA:
TECHNICH	AN: BK and CL	COMPLETION	DEPTH:		8. C. SHI	ELBY TUBE
JOB NO .:	33954 (11)	DEPTH AFTER	HRS		BOWSER -	the strength on other sectors are sectors where the sector sectors are set of the sector sectors and the sector sectors are set of the sector sectors and the sector sectors are set of the sector sectors are set of the sector sectors are set of the sector sectors are set of the sector sectors are set of the sector sectors are set of the sector sectors are set of the sector sectors are set of the sector sectors are set of the sector sectors are set of the sector sectors are set of the sector sectors are sectors are set of the sector sectors are s

TESTING LABORATORIES, DIC.

A CONTRACTOR OF MERICAL PROPERTY OF				02-17	
LOG OF	BORING	NO.	C-7	2-82-07	

WELL INSTALLATION - VISTRON CORPORATION- LIMA, OHIO

BORING LOCATION: As shown on boring location plan DATE STARTED: 9-7-82

836.0'

SURFACE ELEVATION:

DATE COMPLETED: 9-10-82

BLOWS PER B"ON SAMPLER "N" BLOWS SAMPLE DESCRIPTION OF MATERIAL IFT. OR CORE REC. SAMPLE STRATUM NO. & DEPTH TYPE (FILL) Crushed stone .0.0' 1.0' Brown silt, some clay, some sand, trace of gravel, moist (Becomes wet at 3.5') 5.0' Gray clay, some silt, some sand, trace of gravel, moist 10* (With limestone fragments from 11.0 to 21.0') 15' 20' 21.0' Gray silt, some sand, some clay, traces of gravel and cobbles, moist 25' 30' TYPE SAMPLER: WATER OBSERVATIONS Hollow Auger METHOD: SPLIT SPOON A. INITIAL DEPTH: * BK and SS 20.2' TECHNICIAN: 8. COMPLETION DEPTH: ___ DEPTH AFTER: ____ HRS. 20.0" SHELEY TUBE 33954 (j1) C. JOB NO .:

* 3.5' (medium); 21.0' (medium); 30.0' (heavy) \$32.5' 815' 806' BOWSER - MORNER TESTING LABORATORIES, INC.

	DCATION: As shown on ELEVATION: 836.0*	boring location plan	DATE STA		9-7-82 9-10-82
STRATUM	DESCRIPTION OF MA	TERIAL SAMPLE NO. & TYPE	SAMPLE DEPTH	BLOWS PER 6" ON SAMPLER	"N" BLOW
30' 35' 36.0' 40' 40' 55'	Gray clay, some silt, traces of cobbles and	some sand, gravel, moist			
TECHNICH	Hollow Auger IN: BK and SS 33954 (j1)	WATER OBSERVATION INITIAL DEPTH:	20.0'	B.	ER: T SPOON

TESTING LABORATORIES, INC.

LOG OF BORING NO. C-7 - continued 2-82-C7

WELL INSTALLATION - VISTRON CORPORATION - LIMA, OHIO

BORING LOCATION: As shown on boring location plan DATE STARTED: 9-7-82

SURFACE ELEVATION: 836.01

DATE COMPLETED: 9-10-82

STRATUM	DESCRIPTION OF	MATERIAL	SAMPLE NO. & TYPE	SAMPLE DEPTH	BLOWS PER 6" ON SAMPLER	"N" BLOWS /FT. OR CORE REC.
60*						
and the second se						10 Ca. 31
integer .						6-3-64
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METHOD	Hollow Auger	WATER OBSER	VATIONS		TYPE SAMPLER:	
TECHNICIAN	BK and SS	INITIAL DEPTH	*		A. SPLIT SP	OON
TECHNICIAN	nk and so	COMPLETION DEPTH	20.2'		в.	
0.04	33954 (j1)	DEPTH AFTER		2"	C. SHELBY	TUBE
* 3.5'(m	edium); 21.0'(medium)	; 30.0'(heavy)			BOWSER - MO	

ORING NUN	IBER A-1 T	OTAL DEPTH_ 18.5' S.W.L.(BGL)_3.5'
Sample Number	From 0 tol8.5' Feet	(84-A-1) Lithologic Description
A pale of a second spin large part of the second spin large spin second spin second spin second spin second sp	0.0" - 1.0"	Clay w/ crushed lime rock as fill
and a star and a star of the second star	1.0' - 3.0'	* Fill: Clay, w/ medcoarse gravel, brn., moist
		not cohesive.
	3. ' - 8.5'	* Sand medcoarse w/ clay; w/ gravel, fine-med.,
		brn., saturated w/ chunks of grey clay.
	8.5' - 18.5'	Till; clay w/ medcoarse gravel; grey, moist,
		very tight saturated 0 6.5'
		* S.L. claims this entire area is fill to an
piezomete:	r: 🖸 Screen	unknown but extensive area. PipeTotal Depth (BGL)
BORING NU	MBERT	OTAL DEPTHS.W.L(BGL)3.0"
Sample Number	From 0 to8.5' Feet	(84-A-2) Lithologic Description
	0.0' ~ 0.5'	Clay w/ crushed lime rock fill.
	0.5' - 8.5'	* Clay w/ medcoarse gravel, brn, moist, not
		cohesive, sand as the major component,
		medcoarse angular, saturated @ 3.0
Piezomete	r: 🖸 Screen	PipeTotal Depth (BGL)
BORING NU	MBER A-3 T	OTAL DEPTH 8.5 S.W.L. (BGL) 3.0'
Sample Number	From 0 to 8.5' Feet	
Number	0.0' - 7.5'	* Clay w/ medcoarse well rounded gravel, brn.,
and a state of the second second		moist, not cohesive.
a gala ta sa sa gala in sa na mangan	7.5' - 8.5'	Till, clay w/ medcoarse well rounded gravel,
M	1.3 0.5	grey, moist.
elemente statuten i sur a contesta formagen		

OB NUMBER	R0300-209	DATE5-17-84PAGE
DRING NUM	MBER <u>84 - A-4</u> TO	DTAL DEPTH 18.5' S.W.L.(BGL) 3.0'
Sample Number	From 0 to 18.5' Feet	84-A-4 Lithologic Description
	0.0* - 1.0*	Sand & gravel; w/ clay; moist, brn. Sand & gravel; w/ clay; saturated, brn. Sand medcoarse gravel, fine-med. saturated.
	1.0' - 4.0'	Sand & gravel, w/ clay, moist, brn.
inde - and a second second second second second second second second second second second second second second	4.0" - 7.5"	Sand & gravel; w/ clay; saturated, brn.
	7.5' - 8.5'	
	8.5' - 18.5'	Till: clay w/ gravel medcoarse, grey, moist,
		W/ ICILLUILL DE LA PJULE DE LA PJULE VER CARA COMPANY
		gravel. (Natural gravel pack, sealed w/ bentonite
	1	slurry & dry bentonite @ surface.)
lezomete	r: 🛛 Screen <u>92</u> 4	2" x 20' 4-#7 Pipe Galv. Total Depth (BGL) 18.5'
ORING NUT	MBER <u>84-A-5</u> TC	DTAL DEPTH 18.5' S.W.L(BGL) 4.0'
Sample Number	From 0 to 18.5' Feet	(84-A-5) Lithologic Description
	0.0' - 3.0'	W/ crushed lime rock; clay w/ medcoarse gravel,
		brn. w/ grey chunks, not cohesive, grey chunks
		are cohesive.
	3.0' - 12.5'	Clay w/ medcoarse gravel; brn., mottled grey,
		not cohesive.
	12.5' - 16.0'	Till; clay w/ medcoarse gravel, grey, moist,
		cohesive.
	16.0' - 18.5'	tine-marse gravel, (Natural gravel pack, sealed)
Diezomete	r: Screen 92	4-#7 Pipe 2"x20'Galv. Total Depth (BGL) 18.5
Teromene	and the second se	
and an interfer to well of the second state of the second	MBER <u>89-A-6</u> TO	OTAL DEPTH_ 18.5' S.W.L. (BGL)_ 4.0'
and an interfer to well of the second state of the second	the second s	
BORING NU	MBER <u>89-A-6</u> TC	
BORING NU	MBER <u>89-A-6</u> TC From 0 to 18.5' Feet	(84-A-6) Lithclogic Description
BORING NU Sample Number	MBER <u>89-A-6</u> TC From 0 to 18.5' Feet	<pre>(84-A-6) Lithologic Description Clay w/ medcoarse sand; brn., moist, not cohe- sive. Clay w/ sand medcoarse; gravel fine-coarse,</pre>
BORING NU	MBER <u>84-A-6</u> TC From 0 to 18.5' Feet 0.0' - 3.0'	(84-A-6) Lithologic Description Clay w/ medcoarse sand; brn., moist, not cohe- sive.
BORING NU Sample Number	MBER <u>84-A-6</u> TC From 0 to 18.5' Feet 0.0' - 3.0'	<pre>(84-A-6) Lithologic Description Clay w/ medcoarse sand; brn., moist, not cohe- sive. Clay w/ sand medcoarse; gravel fine-coarse, brn., saturated, not cohesive.</pre>
BORING NU Sample Number	MBER <u>84-A-6</u> TC From 0 to 18.5' Feet 0.0' - 3.0' 3.0' - 13.0'	<pre>(84-A-6) Lithologic Description Clay w/ medcoarse sand; brn., moist, not cohe- sive. Clay w/ sand medcoarse; gravel fine-coarse, brn., saturated, not cohesive.</pre>
BORING NU Sample Number	MBER <u>84-A-6</u> TC From 0 to 18.5' Feet 0.0' - 3.0' 3.0' - 13.0'	<pre>(84-A-6) Lithologic Description Clay w/ medcoarse sand; brn., moist, not cohe- sive. Clay w/ sand medcoarse; gravel fine-coarse, brn., saturated, not cohesive. Sand, medcoarse, gravel fine-coarse, w/ clay,</pre>

Galv.

ORING NUN	IBER A-7-D T	OTAL DEPTH 24.0' S.W.L.(BGL) 13.4'
Sample Number	From to Feet	84-A-7-D Lithologic Description
	0.0' - 0.5'	Clay: Brn, moist
	0.5' - 8.0'	Clay: Grey; moist
	8.0' - 13.0'	Till: Clay, clay w/ medcoarse gravel & small
ang alla mang mang mang mang mang mang mang man		cobbles, grey, moist.
na fara da antina da antina da antina	13.0' - 18.0'	Till; clay w/ sand medcoarse & gravel fine-med.,
		grey, saturated.
	18.0' - 24.0'	Till; clay w/ gravel fine-coarse & some coarse
		sand, grey, saturated.
) iezomete:	24.0' - ? r: 🖸 Screen 92	Bedrock: Reported as dolomite in this area. 24-#7 Pipe 2" x 20' Total Depth (BGL) 21.0'
		OTAL DEPTHS.W.L(BGL)
Sample Number	From_to Feet	(84-A-7-5) Lithologic Description
	0.0' - 0.5'	Clay; brn, moist
uppergrade and a second second second	0.5' - 8.0'	Clay; grey, moist
	8.0" - 14.0"	Till; clay w/ medcoarse gravel & small cobbles,
		grey, moist.
		50# + 40M gravel pack; sealed w/ bentonite
		slurry & dry bentonite @ surface.
		24-#7 Pipe 2" x 12'Gal Total Depth (BGL) 11.5' OTAL DEFTH 24.0' S.W.L.(BGL)
BORING NU	MBER A-7-B T	A-7-B approx. 15' from A-7-D
Sample Number	From 0 to 24" Feet	(84-A-7-B) Lithologic Description
	0.0' - 0.5'	Clay: brn, moist
	$0.5^{*} - 7.5^{*}$	Clay: grey, moist
	7.5' - 12.0'	Till: Clay w/ medcoarse gravel & small cobbles,
ч		grey, moist.
	12.0' - 18.0'	Till: Clay w/ sand fine-coarse & coarse gravel:
		grey, saturated.
	18.0' - 24.0'	Till: Clay w/ gravel fine-coarse & some coarse
		sand, grey, saturated.
NAME AND ADDRESS OF TAXABLE PARTY.	24.0' -	Bedrock: reported as dolonite in this area, sealed Pipe Total Depth (BGL) and dry bento

ORING NUME	3ER <u>-A-8-D</u> T	DTAL DEPTH 44.5' S.W.L.(BGL)
Sample Number	From to Feet	84-C-8D Lithologic Description
	0.0" - 3.0"	Fill: clay w/ gravel medcoarse & + 13" crushed
		limestone, hrn., moist.
	3.0' - 11.0'	Fill(?): clay w/ gravel medcoarse, hrn, moist.
a nagati ki na mka na karan na kata ka mka manaka ka	11.0' - 14.5'	Clay w/ fine-med. gravel, brn., saturated, rounded
		gravel.
Jaroe mobile	²⁵ 14.5' - 30.0'	Till (?), clay w/ medcoarse gravel; grey, sat.
Easierdrlq.	30.0' - 38.0'	Till(?), clay w/ fine-med. grvl; grey, sat.
	38.0' - 44.5'	Clay w/ medcoarse sand; med. grvl, grey, sat.
Piezometer	44.5' - ? : Screen 92	Bedrock: Reported as dolomite in this area. ***See 1 4-#7 Pipe 2' x 40' Total Depth (BGL) 39.0'
BORING NUM	BER <u>ASS</u> T	OTAL DEPTH 19.0" S.W.L(BGL)
Sample Number	From 0 to19.0' Feet	84-C-85 Lithologic Description
	0.0' - 2.0'	Fill: Clay w/ grvl., medcoarse & + 11/2" crushed
		limestone; brn., moist.
	2.0' - 11.0'	Fill(?) clay w/ grvl, medcoarse: brn, moist
	11.0' - 15.0'	Clay: w/ fine-med. gravel, brn, saturated
	15.0' - 19.0'	Till(?) Clay w/ medcoarse grvl, grey, saturated
		Sealed w/ bentonite slurry grout & dry bentonite
		@ surface.
Piezometer	: Screen_92	24-#7 Pipe2" x 20'Gal.Total Depth (BGL) 19.0
BORING NUM	BERT	OTAL DEPTHS.W.L.(BGL)
Sample Number	From_to Feet	Lithclogic Description
	n ann an t-stada an an Antoine an Antoine an Antoine an Antoine an Antoine an Antoine an Antoine an Antoine an	
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*** Sealed w/ bentonite slurry grout & dry bentonite @ surface.

CONTRO MOUT	to langle 30) TOTAL DEPTH 5.W.L. (BGL)
Sample Number	From 0 to 45 Feet	Lithologic Description
	0 - 17	CLAY-SILT; w/coarse sand & fine gravel, damp, brown
	17 - 45	CLAY-SILT; w/fine gravel, damp, gray, gravel content
		greater w/depth; at 25 ft. gravel content decreases;
		at 35 ft. gravel content greater
		samples taken every 5 ft bagged and turned over t
		S. Lang
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JOB MANBER	0300-209 85-8		23.1		
BORING NUMB	SER -5-15-	TOTAL DEPTH	31'	S.W.L. (BGL)	
Sample Number	From 0 to 31 Feet		Litholog	gic Description	
S.S.S.	0 - 4	CLAY-SILT; w/	small amour	t coarse sand &	fine gravel,
		damp, brown (drilled)		
	4 - 6	CLAY-SILT; W/	small amour	t coarse sand &	fine gravel,
		damp, brown w	/white mott	ling	
	7 - 9	CLAY-SILT; w/	small amour	t coarse sand &	fine gravel,
		damp, brown w	/white mott	line	
	9 - 11	CLAY-SILT; W/	coarse sand	& fine gravel,	brown-gray
		mottling, dam	p, brown w,	sand stringers	
	11 - 13	CLAY-SILT; W/	coarse san	l & fine gravel,	sand stringer
		damp, gray			
	14 - 16	CLAY-SILT; W/	coarse san	1 & fine gravel,	sand stringer
		damp, gray			
	16 - 18	CLAY-SILT; W/	coarse san	1 & fine gravel,	damp, gray,
		small amount	mottling		
	19 - 21	CLAY-SILT; W/	coarse san	1 & fine gravel,	sand stringer
		damp, gray			
	21 - 22	CLAY-SILT; W/	small amou	nt fine gravel,	damp, gray
	24 - 26	CLAY-SILT; W/	small amou	nt fine gravel (to approx. 25
		ft.), coarse	sand from	25 - 26 ft., no	silt
	26 - 28	SAND; fine-me	d., sorted	, occasional sil	t lenses, dry,
		brown-white-t	olack		
	29 - 31	SAND; fine-me	ad., sorted	, occasional sil	t lenses, dry,
		brown, last	2 inches li	nestone	
e de s					
		samples taker	n every 5 f	t bagged and	turned over to
$(a,b) \in \{a,b\}$		S. Lang			
74					

JOB NUMBER	0300-209	DATE May 23, 1985 PAGE
BORING NUME	85-5-C BER E-12 (angle 30 [°]) TOTAL DEPTH 31' S.W.L. (BGL)
Sample Number	From 0 to 31 Feet	Lithologic Description
	0 - 5	CLAY-SILT; w/fine gravel, moist, brown
	5 -/8	CLAY-SILT; w/fine gravel, dry, brown
	18 - 20	CLAY-SILT; w/fine gravel, moist, gray
	20 - 31	CLAY-SILT; w/fine gravel, dry, gray
		samples taken every 5 ft bagged and turned over t
		S. Lang
	Law Application	

Piezometer: D Screen ____ Pipe ___ Total Depth (BGL)

BORING NUMB	85-40-D	TOTAL DEPTH S.W.L. (BGL)
Sample Number	From 0 to 32 Feet	Lithologic Description
drilled	0 - 4	CLAY-SILT; w/fine-med. gravel, dry, brown
S.S.S.	4 - 6	CLAY-SILT; w/fine-med. gravel, dry, brown
	9 - 11	CLAY-SILT; w/fine-med. gravel, dry, brown
	14 - 16	CLAY-SILT; w/fine-med. gravel, dry, brown
drilled	20 - 32	CLAY-SILT; w/fine-med. gravel, damp, gray
		samples collected at 6 ft., 16 ft., 11 ft., 20 ft.,
		25 ft. and 30 ft.
	4	
×1		

Piezometer: D Screen ____ Pipe ____ Total Depth (BGL)____

JOB NUMBER	0300-209	DATE May 23, 1985 PAGE
BORING NUMBER		TOTAL DEPTH S.W.L. (BGL)
Sample Number	From 0 to 31 Feet	Lithologic Description
	0 - 15	CLAY-SILT; w/fine-med. gravel, dry, brown
	15 - 31	CLAY-SILT; w/fine-med. gravel, damp, gray
	31	BEDROCK
		samples collected every 5 ft bagged and turned over
		to S. Lang
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JOB NUMBER	0300-209	5-F
BORING NUME		TOTAL DEPTH 21' S.W.L. (BGL)
Sample Number	From 0 to 21 Feet	Lithologic Description
s.s.s.	0 - 1	TOPSOIL & LIMESTONE GRAVEL ROAD
	1 - 3	CLAY-SILT; w/fine-med. gravel, dry, brown
	4 - 6	CLAY-SILT; w/fine-med. gravel, dry, brown
	7 - 9	CLAY-SILT; w/fine-med. gravel, dry, brown
	9 - 11	CLAY-SILT; w/fine-med. gravel, dry, brown
	12 - 14	CLAY-SILT; w/fine-med. gravel, damp, gray, occasional
		sand stringers
	14 - 16	CLAY-SILT; w/fine-med. gravel, damp, gray, occasional
	-	sand stringers
	17 - 19	CLAY-SILT; w/fine-med. gravel, damp, gray, occasional
		sand stringers
	19 - 21	CLAY-SHIT; w/fine-med. gravel, damp, gray, occasional
		sand stringers
	21	BEDROCK
si		
	1 in the second	

OB NLABER	0300-209	DATE May 21, 1985 PAGE
BORING NUMB	85-G ER E-19 E-14	TOTAL DEPTH 28" S.W.L. (BGL)
Sample Number	From 0 to 28 Feet	Lithologic Description
S.S.S.	0 - 2	CLAY-SILT; w/fine gravel & coarse sand, mottled, damp
		brown
	2 - 4	CLAY-SILT; 2 - 3 ft. oil stained, some mottling, mois
		3 - 4 ft. mottled, no staining, moist
	4 - 6	CLAY-SILT; w/small amount med. gravel, mottled, moist
		gray
	6 - 8	CLAY-SILT; traces of coarse sand & fine gravel,
		mottling, fine roots, damp, gray, oil stained
	8 - 10	CLAY-SILT; w/coarse sand & fine gravel, mottling, dam
		gray, oil stained
	10 - 12	CLAY-SILT; w/fine-coarse gravel, mottling, 11 - 12 ft
		becoming dryer than 10 - 11 ft., gray
	14 - 16	CLAY-SILT; w/fine gravel, moist, gray, very small
		amount of mottling
	16 - 18	CLAY-SILT; w/gravel (size increases w/depth), moist,
		gray, lack of mottling
	18 - 20	CLAY-SILT; w/fine-med. gravel, moist, gray
	21 - 23	CLAY-SILT; w/fine-med. gravel, moist, gray
		boring slurry grouted to within 7 ft. of surface -
		natural materials backfill with bentonite plug at
		surface

Piezometer: D Screen ____ Pipe ____ Total Depth (BGL)____

JOB MAYBER	0300-209	DATE May	23, 1985	PAGE
BORING NUME	$\frac{(85-E-5)}{E-5}$	TOTAL DEPTH 27	S.W.L.	(BGL)
Sample Number	From 0 to 27 Feet	Lithologic Description CLAY-SILT; w/fine-med. gravel, brown, dry		
	0 - 22			
	22 - 27	CLAY-SILT; w/fine g	gravel, gray, m	oist
	27	BEDROCK		
		11	DCT	
		well set 25 - 27 ft	and the second se	d and turned over t
		S. Lang	7 5 It Dagge	d and turned over t
		gravel packed to w	ithin 10 ft. of	surface
				ace with bentonite
		plug		
		a substantin and a substantion of the		
	and the second second			
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Piezometer:
Screen 924 #7 Pipe 2" Galv. Total Depth (BGL) 27"

BORING NUME	BER 85-E-6	TOTAL DEPTH 23' S.W.L. (BGL)				
Sample	From 0 to 23	Lithologic Description				
Number	Feet	Lithologic Description				
	0 - 3	CLAY-SILT; w/fine-med. gravel, dry, brown				
	3 - 20	CLAY-SILT; w/fine-med. gravel, moist, gray GRAVEL; w/small amount of clay				
	20 - 23					
	23	BEDROCK				
		well set 21 - 23 ft. BGL				
		samples taken every 5 ft bagged and turned over to				
		S. Lang				
		sand packed to within 10 ft. of surface				
		natural material backfill with bentonite plug				
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Piezometer: D Screen 924 #7 Pipe 2" Galv. Total Depth (BGL) 25'

BORING NUM	BER E-11	TOTAL DEPTH 33' S.W.L. (BGL)
Sample Number	From 0 to 33 Feet	Lithologic Description
drilled	0 - 4	CLAY-SILT; w/fine-med. gravel, damp, brown
S.S.S.	4 - 6	CLAY-SILT; w/fine-med. gravel, damp, brown, slight
		mottling
	9 - 11	CLAY-SILT; w/fine-med. gravel, dry, brown, slight
		mottling
	14 - 16	CLAY-SILT; w/fine-med. gravel, dry, brown, slight
		mottling
	19 - 21	CLAY-SILT; w/fine-med. gravel, dry, gray, slight
		mottling
	24 - 26	CLAY-SILT; w/fine-med. gravel, dry, gray, slight
		mottling
	29 - 31	CLAY-SILT; w/wet clay cuttings
	33	BEDROCK
		well set 31 - 33 ft. BGL
		sand packed and bentonite seal at surface

Piezometer: D Screen <u>924 #12</u> Pipe <u>2" Galv.</u> Total Depth (BGL) <u>33</u>.

Sample Number	From 0 to 30 Feet	Lithologic Description
	0 - 17	CLAY-SILT; w/fine-med. gravel, dry, brown
	17 - 30	CLAY-SILT; w/fine-med. gravel, damp, gray
	30	BEDROCK
		well set 28 - 30 ft. BGL
		sand packed and bentonite seal at surface
		*
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	in the second second second second second second second second second second second second second second second	

BORING NUME	85-E-10 BER	TOTAL DEPTH S.W.L. (BGL)
Sample Number	From 0 to 31 Feet	Lithologic Description
drilled	0 - 3	LIMESTONE GRAVEL FILL
drilled	3 - 9	CLAY-SILT; w/fine gravel, damp, brown, black stained
		cuttings at 7 ft.
S.S.S.	9 - 11	CLAY-SILT; w/coarse sand & fine gravel, dry, brown
	11 - 13	CLAY-SILT; w/fine-med. gravel, dry, brown
	14 - 16	CLAY-SILT; w/fine-med. gravel, dry, brown
	16 - 18	CLAY-SILT; w/fine-med. gravel, dry, gray, fine sand
		stringers
	19 - 21	CLAY-SILT; w/fine-med. gravel, dry, gray, fine sand
		stringers
	22 - 24	CLAY-SILT; w/fine-med. gravel, dry, gray, fine sand
		stringers
	24 - 26	CLAY-SILT; w/fine-med. gravel, dry, gray, fine sand
		stringers
	26 - 28	CLAY-SILT; w/fine-med. gravel, dry, gray, fine sand
		stringers
	28 - 31	CLAY-SILT; w/fine-med. gravel, dry, gray, fine sand
		stringers
	31	BEDROCK
		well set 29 - 31 ft. BGL
		sand packed and bentonite seal at surface
71		
		· · · · · · · · · · · · · · · · · · ·

Piezoneter: D Screen 924 #12 Pipe 2* Galv. Total Depth (BGL) 31*

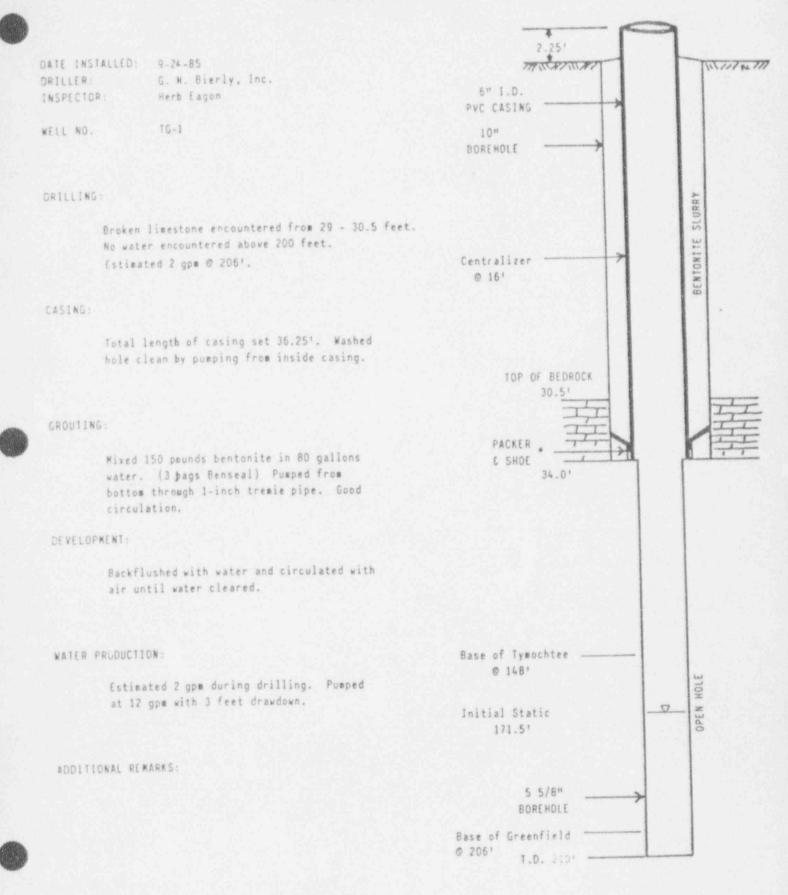
Sample Number	From 0 to 30 Feet	Lithologic Description
	0 - 3	CLAY-SILT; w/fine gravel, damp, brown
	3 - 4	CLAY-SILT; w/fine gravel, damp, gray
	4 - 8	CLAY-SILT; w/coarse sand & fine gravel, damp, gray-
		black stained
	8 - 22	CLAY-SILT; w/coarse sand & fine gravel, damp, brown,
		gravel content and size greater w/depth
	22 - 30	CLAY-SILT; w/coarse sand & fine gravel, damp, brown,
		gravel content and size greater w/depth
		well set 27 - 29 ft.
		samples taken every 5 ft bagged and turned over t
		S. Lang
		sand packed and bentonite plug at surface
4	12.	

IOB NUMBER	0300-209 85-E-/Z	DATE May 28, 1985 PAGE
BORING NUMB		TOTAL DEPTH 35' S.W.L. (BGL)
Sample Number	From 0 to 35 Feet	Lithologic Description
drilled	0 - 5	CLAY-SILT; w/fine-med. gravel, dry, brown
s.s.s.	5 - 6	CLAY-SILT; w/fine-med. gravel, dry, brown
	10 - 11	CLAY-SILT; w/fine-med. gravel, damp, gray
	15 - 16	CLAY-SILT; w/fine-med. gravel, damp, gray
	20 - 21	CLAY-SILT; w/fine-med. gravel, damp, gray
	24 - 26	CLAY-SILT; w/fine-med. gravel, damp, gray
	29 - 31	CLAY-SILT; w/fine-med. gravel, damp, gray
	34 - 36	BEDROCK at 35 ft.
		well set 33 - 35 ft. BGL
-		sand packed and bentonite plug at surface
i .		
	and the second second second second	
	and the second second	
	and the second second second second second second second second second second second second second second second	
M		

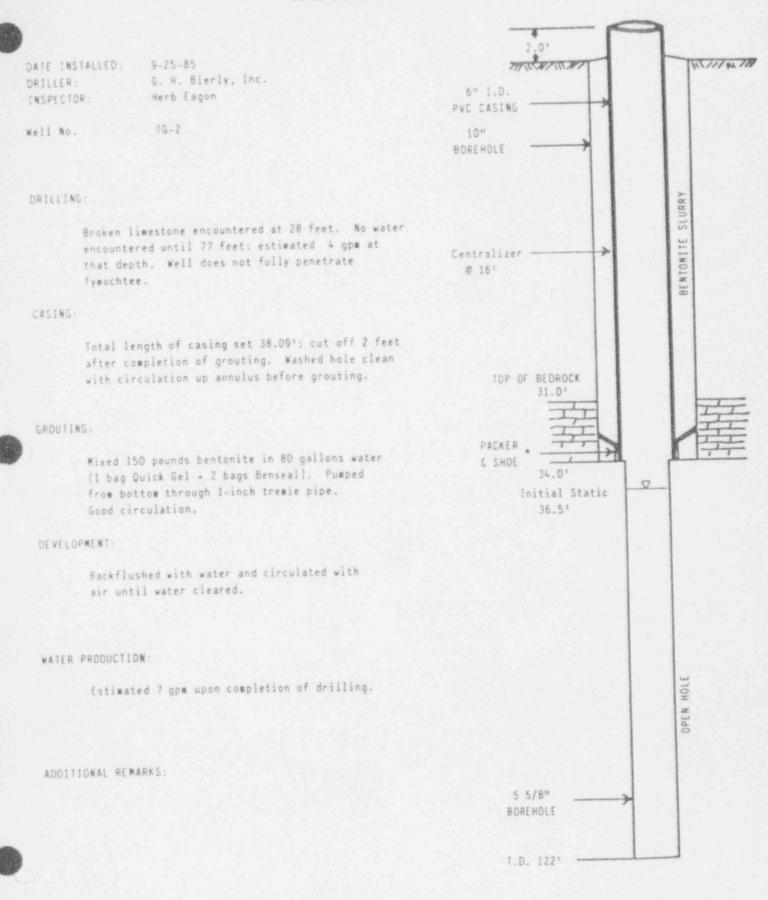
Piezometer:
Screen <u>924 #12</u> Pipe <u>2" Galv.</u> Total Depth (BGL) <u>35'</u>

Sample	From 0 to 16.5	
Number	Feet	117 38 Lithologic Description
	0 - 6	CLAY; w/coarse sand (approx. 40%), fine gravel, dam
		brown
	6 - 16.5	CLAY-SILT; w/fine-med. gravel, dry, brown (color we
		gray at 10 ft.)
	16.5	BEDROCK
		backfill with natural materials and bentonite seal
		at surface
ale and a second		
and the second second second second second second second second second second second second second second second		
VI.		

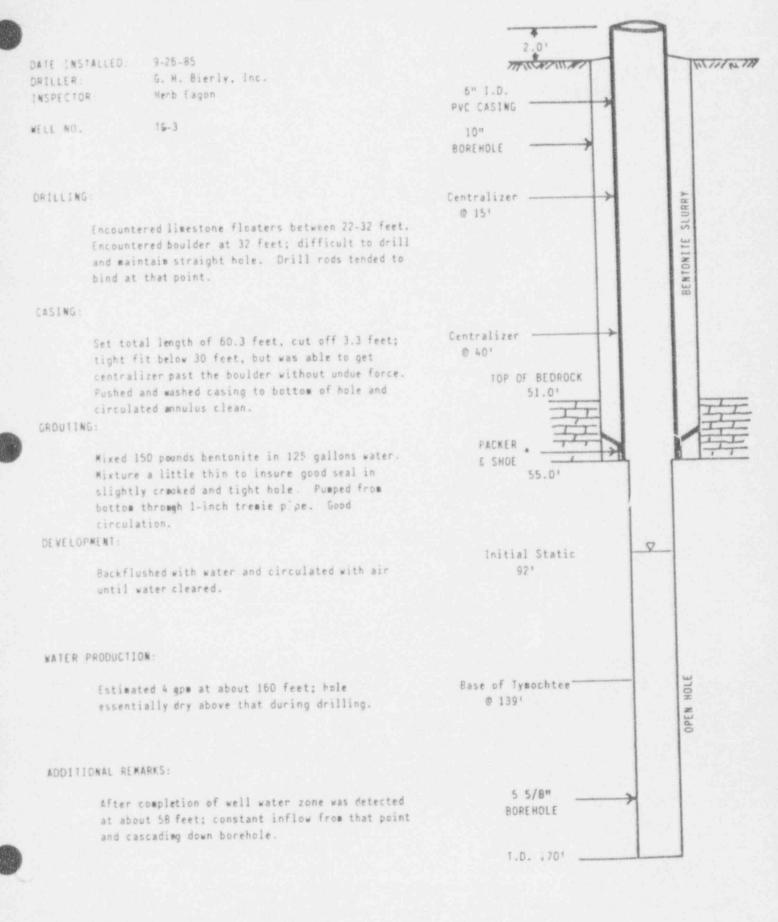
NONITOR WELL INSTALLATION REPORT SONIO CHEMICAL COMPANY



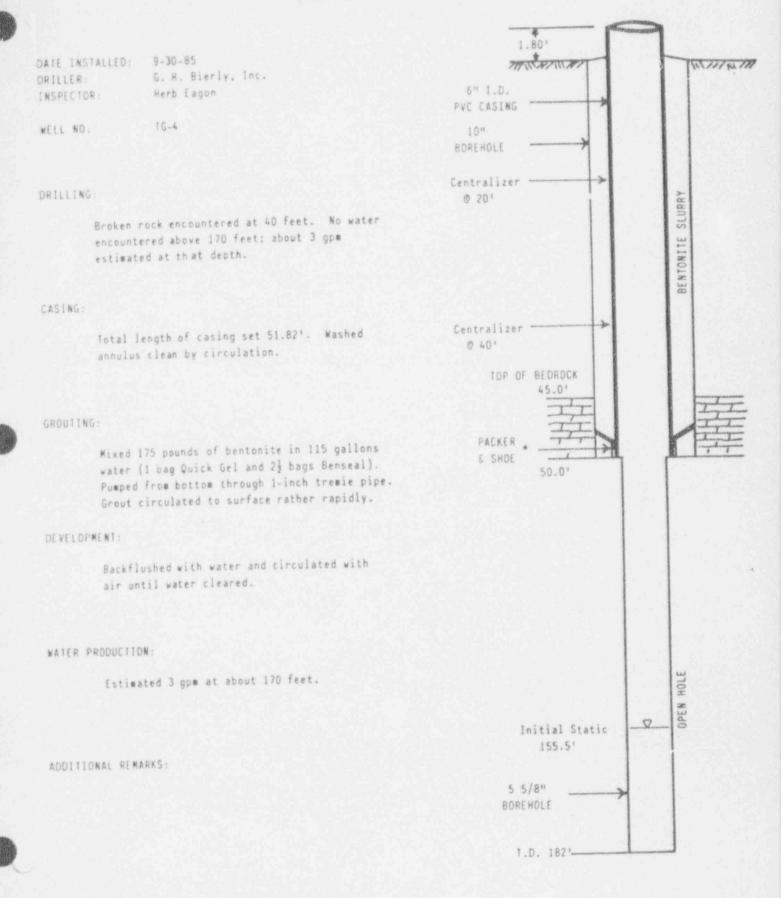
NONITOR WELL INSTALLATION REPORT SOHIO CHEMICAL COMPANY



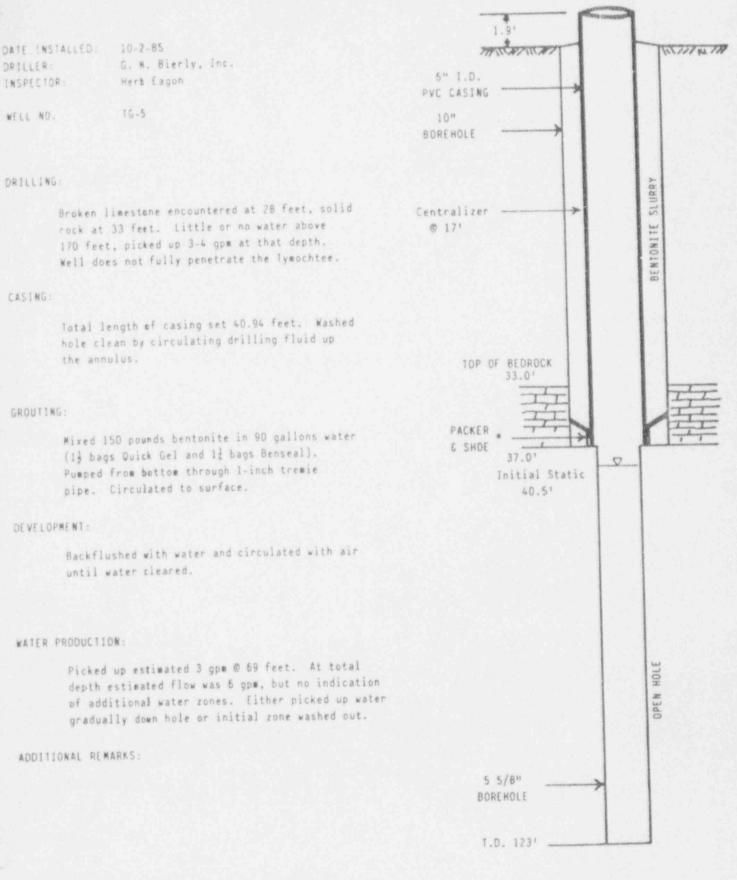
NONITOR WELL INSTALLATION REPORT SOMIO CHEMICAL COMPANY



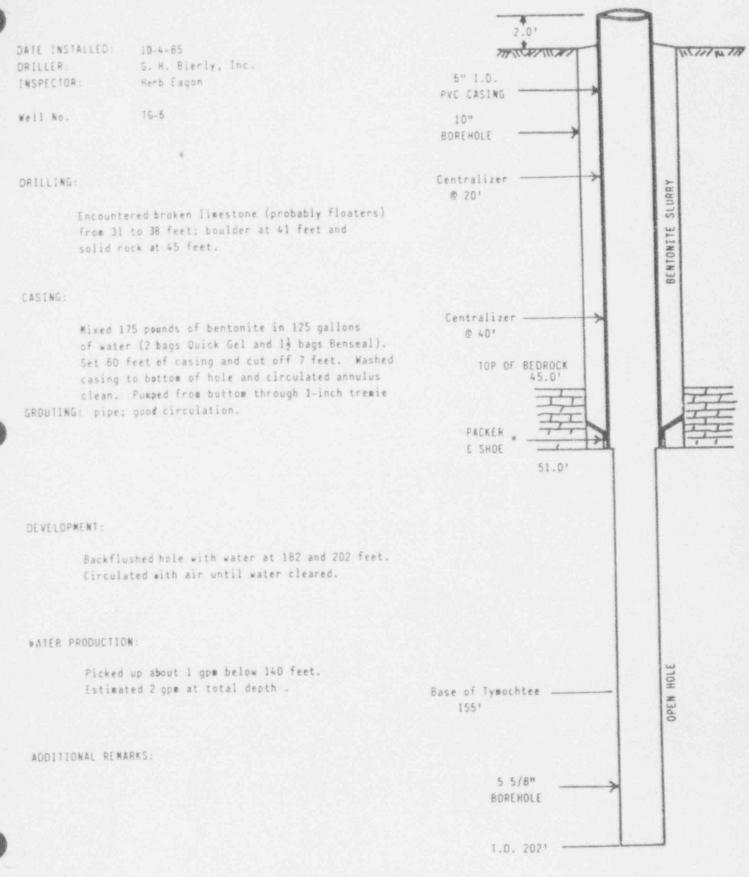
MONITOR WELL INSTALLATION REPORT SOHIO CHEMICAL COMPANY



MONITOR WELL INSTALLATION REPORT SONID CHEMICAL COMPANY



MONITOR WELL INSTALLATION REPORT SOHIO CHEMICAL COMPANY



NONITOR WELL INSTALLATION REPORT SONTO CHEMICAL COMPANY

DATE INSTALLED:	10-30-85
DRILLER	G. H. Bierly, Inc.
INSPECTOR:	Herb Eagon

Well No.: IG-7

DRILLING:

Broken limestone with clay and gravel encountered at 29 feet, solid rock at 41 feet. Soft zones in bedrock between 41 and 44 feet. No water zones of significance detected in drilling.

CASING:

Total length of casing set 49.79 feet. Casing would not go past 35 feet; pulled out, reamed hole again, washed by circulating fluid. Second try casing went in easily.

GROUIING:

Mixed 150 pounds bentonite in 115 gallons water (2 bags Quick Gel and 1 bag Benseal.) Pumped from bottom through 1-inch tremie pipe. Circulated to surface.

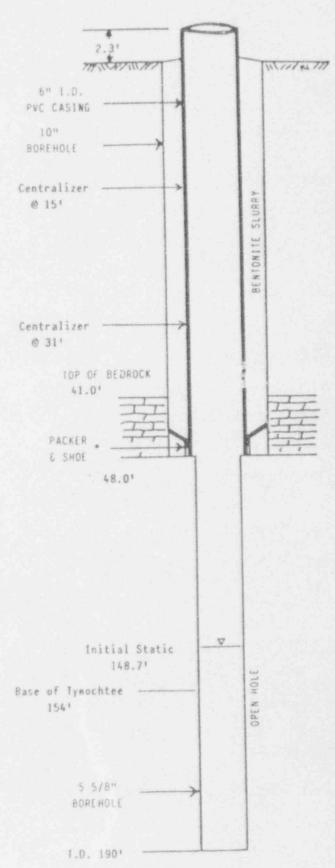
DEVELOPHENT:

Backflushed with water and circulated with air until water cleared.

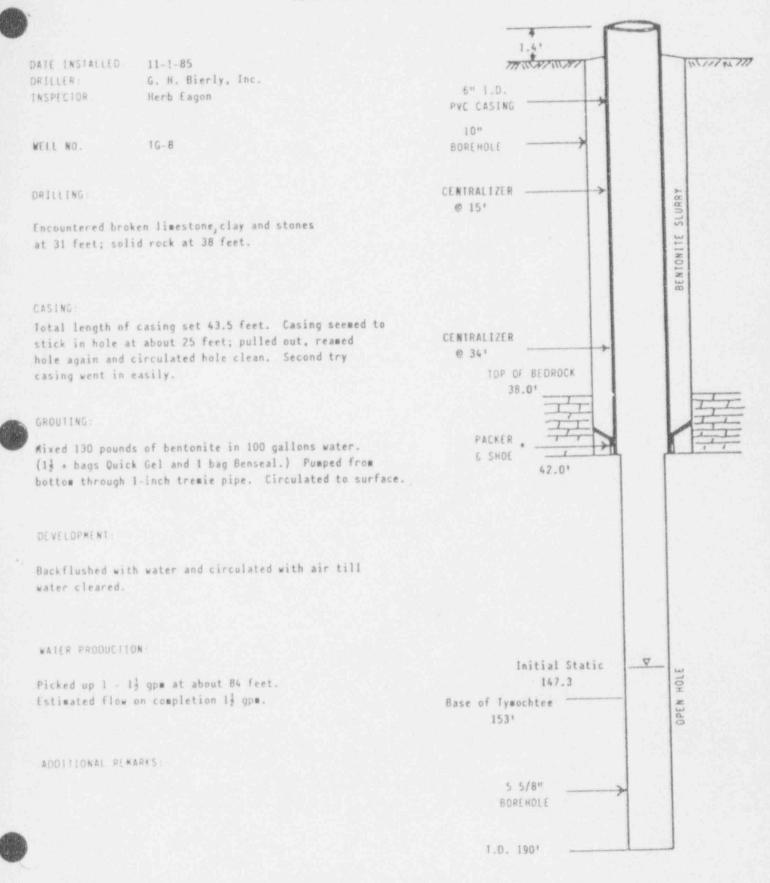
WATER PRODUCTION:

Estimated flow of less than 1 gpm on completion.

ADDITIONAL REMARKS:



MONITOR WELL INSTALLATION REPORT SONIO CHEMICAL COMPANY



LOG OF BORING NO. 87-10

BORING LOCATION: As shown on boring location plan DATE STARTED: 12-11-87

SIN FACE ELEVATION:

DATE COMPLETED: 12-18-87

TRATUM	DESCRIPTION OF MATE	RIAL SAMPLE NO.& TYPE	SAMPLE DEPTH	BLOWS PER 6" ON SAMPLER	IFT. OR
0.0'	(FILL) Crushed stone and	i clay			
1.0'	(FILL) Yery stiff brown	and grav 1A	0.0-2.0	15-14-8-10	18
	silt, some clay, some c traces of sand, gravel,	rushed stone, 24	2.0- 4.0	18-30-36-45	81
	moist	3A	4.0- 6.0	18-21-27-40	67
7.5'		4A	6.0- 8.0	7-21-28-39	67
	Hard brown clay and sil of sand and gravel, moi (With trace of gray cla	st	8.0-10.0		24"
<u>)'</u>	(with trace or gray and	5A	10.0-12.0	8-16-29-31	60
		6A	12.0-14.0	7-18-22-30	52
. 13.5 <u>-</u>	Hard gray clay and silt sand and gravel, moist (With some stones at 1	IA I	14.0-16.0	6-10-12-14	26
	(WITH Some stones of a	20	16.0-18.0		24"
	- ARADA	A8	18.0-20.0	8-9-10-11	21
0'	THE AND AND AND AND AND AND AND AND AND AND	9A	20.0-22.0	4-8-12-12	24
-	P. M. B. Co.	10A	22.0-24.0	15-16-25-30	54
5'	OATE	11A	24.0-26.0	12-19-20-20	40
-	DE-	12A	26.0-28.0	4-7-12-13	25
30*		13A	28.0-30.0	16-19-21-23	44
METHOD	Hollow Auger	WATER OBSERVATIO	es	TYPE SAMPLE	R:
TECHNIC	0.01011120	INITIAL DEPTH: 0.0		A. SPLIT	spoom ore
00200		DEPTH AFTER: HRS			TURE

LOG OF BORING NO. 87-10 - continued

BORING LOCATION: As shown on boring location plan DATE STARTED:

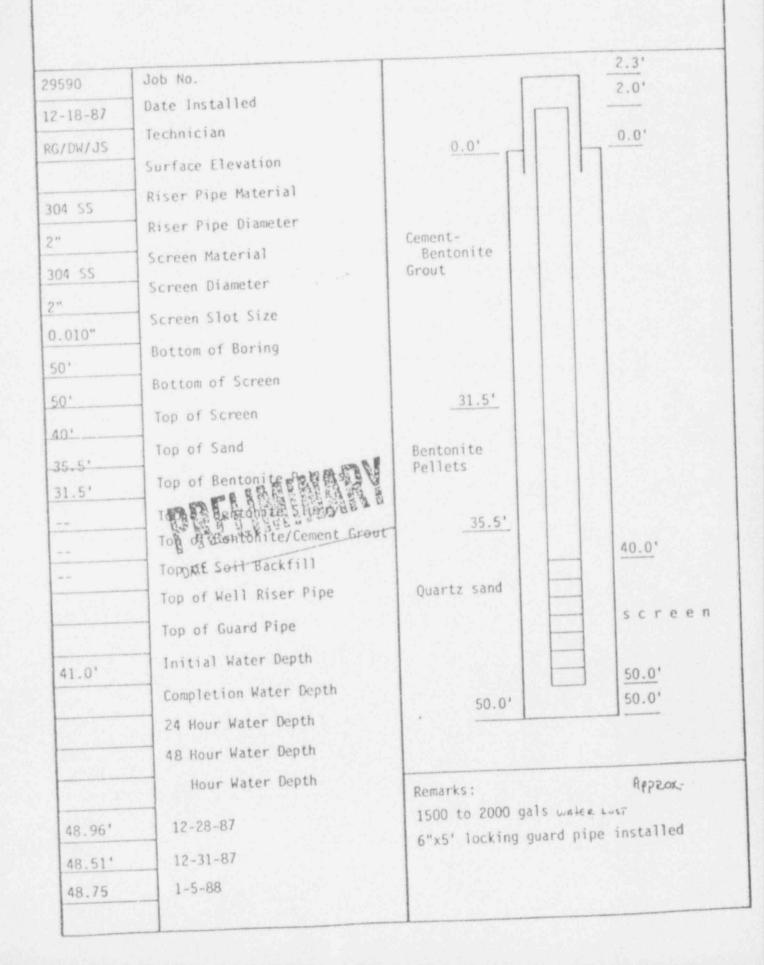
12-11-87

SURFACE ELEVATION:

12-18-87 DATE COMPLETED:

STRATUM	DESCRIPTION OF	RATERIAL	SAMPLE NO. & TYPE	SAMPLE	BLOWS PER 8" ON SAMPLER	TH' BLOWS
0*	(With 1/2" gray silt at 31.0')	and sand seam	14A	30.0-32.0	5-13-18-20	38
- 31.1'	Hard gray silt and c	lay, traces of	15A	32.0-33.5	20-50-53	103
32.5'	sand and gravel, moi (With large stones a	st t 32.0')	30	33.5-35.0		10"
5-35.5'	Hard gray clay, some sand, some coarse gr	silt, some	16A	35.5-36.5		90
	Hard gray clay, some	silt, traces	17A	36.5-37.4	20-81/5"	101+
36.5'	of sand, gravel and Very dense coarse sa	cobbles, moist	18A	37.5-37.7	100/3"	100+
40.0' 	trace of clay, dry (Auger refusal at 37 Hard gray slightly w bedded dolomite with shale partings	veathered medium	18	40.0-45.0		60"
45.0' Hard gray slightly bedded shaley dolor		veathered medium te	28	45.0-50.0		60*
	Bottom of boring at	- 24				
METHOD	Hollow Auger	WATER OBSE	0.0'		e NX (SPOON
	29590				C. SHEL	

Log of Well No. 87-10





LOG OF BORING NO. 87-11

BORING LOCATION: As shown on boring location plan DATE STARTED: 12-21-87

SURFACE ELEVATION:

DATE COMPLETED 12-22-87

TRATUM	DESCRIPTION OF MATERIAL	SAMPLE NO. & TYPE	SAMPLE DEPTH	BLOWS PER 6" ON SAMPLER	IFT. OR CORE REC
0.0'	(FILL) Crushed Timestone				
0.1'	(FILL) Coarse brown sand	1A	0.1- 2.0	6-6-10-12	22
2.0'	(FILL) Very stiff brown clay silt, trace of gravel, moist	2A	2.0- 4.0	8-10-14-16	30
	(FILL) Very stiff brown and g clay and silt, traces of sand gravel, moist	i and 1C	4.0-6.0		21"
- 6.5'	(With sand pocket at 4.5') Hard brown clay and silt, tra	aces of 3A	6.0- 8.0	16-16-18-23	41
	sand and gravel, moist	4A	8.0-10.0	14-16-19-22	41
10.0'	Hard brown and gray silt and clay, traces of sand and gravel, moist		10.0-12.0	14-18-18-21	39
	Craces of Sund Side Storers	6A	12.0-14.0	18-25-23-39	62
15.0'		7A	14.0-16.0	16-17-19-21	40
_ 16.0' -	Hard gray silt and clay, tra sand and gravel, moist Hard gray clay and silt, tra	84	16.0-18.0	7-10-14-19	33
	sand and gravel, moist	20	18.0-20.0		24"
20'		AC 96	20.0-22.0	8-10-16-19	35
	meine	10A IOA	22.0-24.0	10-11-16-22	38
25'	EN CONCOUNT	11A	24.0-26.0	11-14-18-20	38
	DATE	12A	26.0-28.0	9-12-18-19	37
30'	(With cobbles at 29.5')	13A	28.0-30.0	9-10-13-87	100
METHOD	Hollow Auger	TER OBSERVATIONS		TYPE SAMPLEP	ti -
TECHNICI	INITIAL	DEPTH 52.5'	0 ⁴ X		ore
JOB NO :		FTER	<u>X</u>	C. SHELE	Y TUBE

LOG OF BORING NO. 87-11 - continued

BORING LOCATION: As shown on boring location plan DATE STARTED: 12-21-87

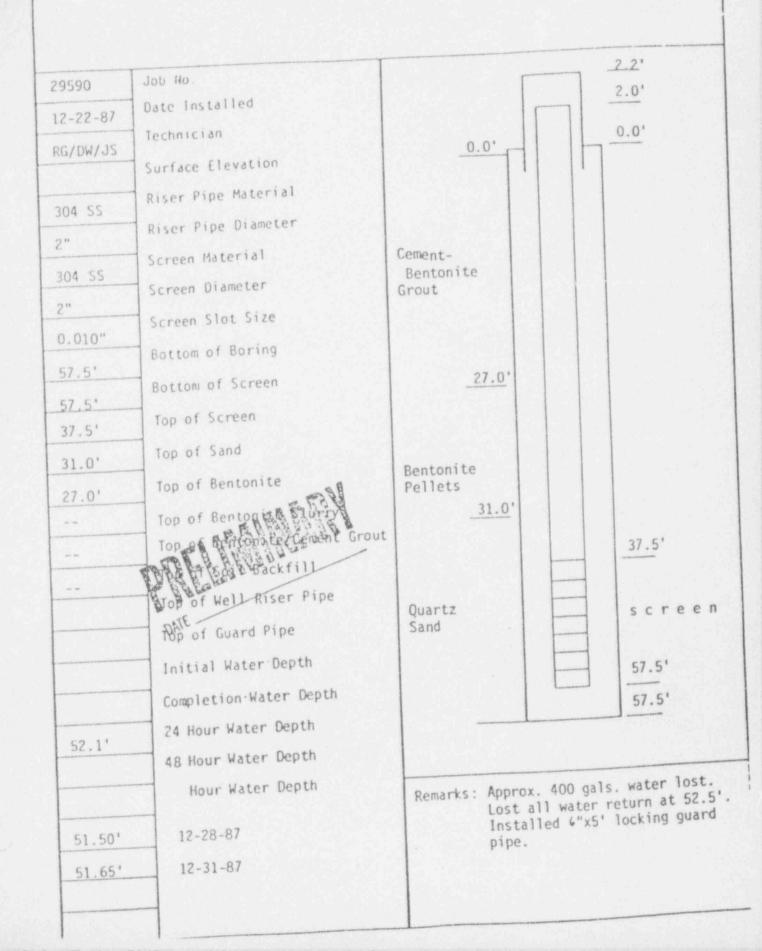
SURFACE ELEVATION:

DATE COMPLETED: 12-22-88

STRATUM	DESCRIPTION OF MAT	ERIAL SAMPLE NO & TYPE	SAMPLE DEPTH	BLOWS PER 6" ON SAMPLER	THT BLOWS IFY. OR COME REC
0'	and an an an in the defension of a second state is a second state in the defension of the defension of the	30	29.0-30.5		0"
31.0'	Dense coarse sand and g	aravel, trace 14A	30.5-32.5	31-17-10-32	42
_ 32.0*	of clay, moist (With cobbles at 31.5')	15A	32.5-33.0	100/4"	100+
	Very dense fine gray sa	and and silt, 16A	33.0-34.5	30-30-40/3"	70+
<u>5'</u> 35.5'	traces of clay and coar moist	rse gravel, 17A	34.5-35.5	60-40/3"	100+
37.5' 	Apparent bedrock (Auger refusal at 37.5 Hard gray medium to the slightly weathered sha	inly bedded	37.5-47.5		120"
-	(With vertical fractur	re at 48.5') 28	47.5-57.5		120
<u>50</u> ,49.5' 55'	Hard gray thinly bedde shaley dolomite (With vertical fractur (With slightly weather (With weathered fractur some fine material and	re at 52.0') red zone at 53') ure filled with			
	Bottom of boring at 5	7.5'			
METHOO	Hollow Auger	WATER OBSERVATION		Showing the second second second second second second second second second second second second second second s	R: sroon Core
юв NO.: 29590		COMPLETION DEPTH:	Contractor Contractor		

BOWSER - MORNER

Log of Well No. 87-11



LOG OF BORING NO. 87-12

BORING LOCATION: As shown on boring location plan DATE STARTED: 12-23-87

SURFACE ELEVATION:

12-31-87 DATE COMPLETED:

TRATUM	DESCRIPTION OF MATE	ERIAL	NO & TYPE	SAMPLE DEPTH	BLOWS PER 8" ON SAMPLER	IN BLOW	
0.0'	(FILL) Crushed limeston	e					
0.3'	(FILL) Hard brown clay traces of sand and grav	and silt,	1A	0.0-2.0	22-26-16-16	32	
	traces or sand and grav		2A	2.0- 4.0	8-8-8-11	19	
4.0'	(FILL) Very stiff brown silt, some sand, trace	of gravel.	ЗA	4.0- 6.0	4-4-8-13	21	
6.0*	moist (FILL) Very stiff brown		4A	6.0- 8.0	4-8-10-11	21	
	clay, some silt, traces gravel and brick, moist	s of sand,	5A	8.0-10.0	2-3-7-8	15	
0' 11.0'	Texus Man shiff black	k clay come	6A	10.0-12.0	1-6-7-18	25	
11.5'	silt, traces of sand an	nd gravel,	7A	12.0-14.0	7-10-18-28	46	
5'	Wery stiff brown clay	and silt,	10	14.0-16.0		13"	
	Hard brown and gray clay, some silt, traces of sand, gravel and			16.0-18.0	10-15-19-22	41	
	black clay, moist		9A	18.0-20.0	8-16-27-30	57	
20.5		+ traces of	10A	20.0-22.0	7-9-15-22	37	
	Hard gray clay and sil sand and gravel, moist	m Pell	11A	22.0-24.0	7-8-12-18	30	
25'	noclass		20	24.0-26.0		24'	
-	A FALLEGALNO		12A	26.0-28.0	7-13-13-22	35	
30.0	Very stiff gray silt a of gravel and coarse of	and clay, trac gravel, moist	es13A	28.0-30.0	8-12-11-15	26	
Hallow Augor		WATER OBSER	SERVATIONS TYPE SA		TYPE SAMPLE	PLER:	
TECHNIC	IAN: RG/DW/JS	COMPLETION DEPTH			NX cor		
JOB NO .:	29590	DEPTH AFTER	HRS		C. SHEL	BY TUBE	

BOWSER - MORNER

LOG OF BORING NO. 87-12 - continued

BORING LOCATION: As shown on boring location plan DATE STARTED: 12-23-87

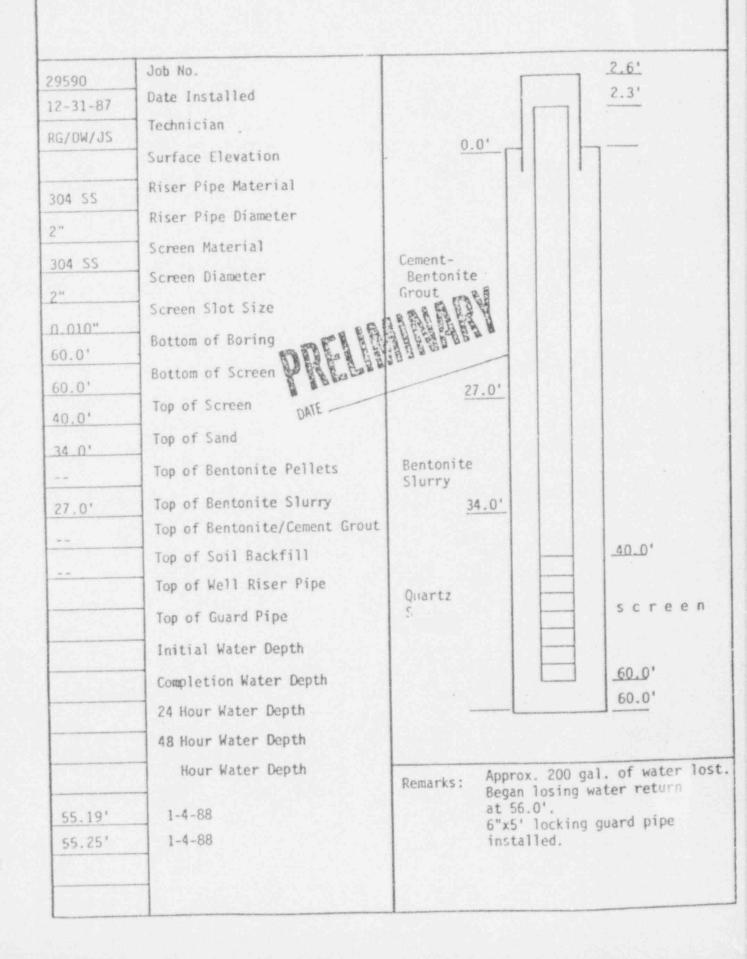
SURFACE ELEVATION:

DATE COMPLETED: 12-31-87

MUTART	DESCRIPTION OF MAT	TERIAL SAMPLE NO. & TYPE	SAMPLE DEPTH	BLOWS FER B''ON SAMPLER	IFT. OR	
<u>)'</u>		14A	30.0-32.0	5-8-12-20	32	
- 36.0'	Very dense brown sand Very dense brown and g silt, traces of gravel Very dense fine gray s	ray sand and 16A , dry 17A	35.0-36.0	45-55 40-60 18-82/3"	24" 100 100 100+	
- 40.σ'	moist Apparent bedrock	18	40.0-45.0		60"	
	(Auger refusal at 38.0 Brown to gray medium b dolomite with some sma (With clay layer with gravel at 42.0') Gray thin to medium be shaley dolomite	edded weathered 11 vugs some large 2B	45.0-54 Q	Contraction of the second	108'	
53.0'	Gray thinly bedded un dolomite (With weathered fract some fine natural fi	ued zone with	54.0-60.0		72*	
	Bottom of boring at 6	0.0'				
METHOD	Hollow Auger	WATER OBSERVATION	s	TYPE SAMPL		
TECHNICIAN RG/DW/JS		INITIAL DEPTH 56 0'	.9* ×_	s. N	X CORE	
JOB NO .:	29590	DEPTH AFTER HRS.	X	C. 5HE	HELEY TUBE	

BOWSER - MORNER

Log of Well No. 87-12



LOG OF BORING NJ. 87-13

BORING LOCATION: As shown on boring location plan DATE STARTED: 1-4-88

SURFACE ELEVATION:

DATE COMPLETED: 1-8-88

TRATUM	DESCRIPTION OF MATERIAL	SAMPLE NO. & TYPE	SAMPLE OEPTH	BLOWS FER B'ON SAMPLER	IFT. DA	
0.0'	(FILL) Soft brown and gray cla	ay and				
	silt, traces of sand and gravel, wet		0.0-2.0	1-2-2-2	4	
	58	2A 2A	2.0- 4.0	2-2-2-3	5	
	BR NER SAL	AC BE 3A	4.0- 6.0	2-2-2-3	5	
	DEFERRESS	4A	6.0- 8.0	1-1-2-2	4	
	DATE	5A	8.0-10.0	1-1-2-2	4	
10.0'	Hard brown and gray silt and	clay, 6A	1.0-12.0	9-12-21-31	52	
	traces of sand and gravel, moist		12.0-14.0		24"	
14.0' 5'	Hard brown silt and clay, tra	ces of 7A	14.0-16.0	15-25-31-38	69	
16.0'	sand and gravel, moist Hard brown and gray silt and clay, traces of sand and gravel, moist		16.0-18.0	12-12-26-30	56	
- 18.5'	Hard gray silt and clay, trac	00	18.0-20.0	6-11-17-25	42	
:0'_	sand and gravel, moist (With 1/4" silt seam at 23.5')		20.0-22.0	18-19-24-28	52	
-			22.0-24.0	12-14-21-24	45	
25'			24.0-26.0		24*	
			26.0-28.0 28.0-28.5	the second second second second second second second second second second second second second second second se	33 100	
- 29.5 30'			28.5-29.5		105	
a and the second second second second	Hollow Auger	TER OBSERVATIONS		TYPE SAMPLE	R:	
TECHNICIAN: RG/DW/JS INITIAL DEPTH			X	A. SPLIT	SPOON	
JOB NO.: 29590 DEPTH AFTER:			X	X C. SHELEY TUB		

BOWSER - MORNER

LOG OF BORING NO. 87-13 - continued

BORING LOCATION: As shown on boring location plan DATE STARTED: 1-4-88

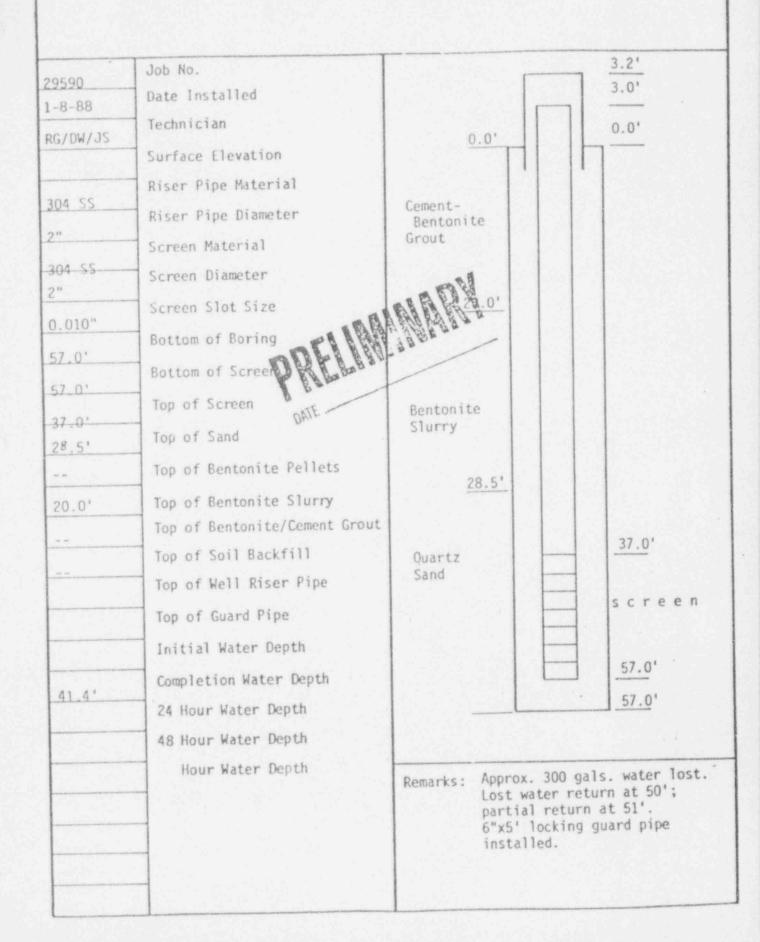
SURFACE ELEVATION:

DATE COMPLETED: 1-8-88

RATUM	DESCRIPTION OF MATERIAL	SAMPLE NO. & TYPE	SAMPLE DEPTH	BLOWS PER 6" ON SAMPLER	VFT. OH
		16A	30.5-31.5	55-45/3"	100+
A	Hard gray silt and sand, some gray trace of clay, moist	vel, 17A	31.5-33.0	40-43-40/3"	83+
33.0*	Apparent rock (Auger refusal at 35.0')				
37.0'		1B	37.0-38.0		12"
	Hard gray to black slightly weathered medium bedded dolomite with occasional shale partings (With vertical fracture at 39.0')	18	38.0-43.5		66"
	(With vertical fracture at 41.5')				
.51	Hard gray unweathered medium to		43.5-48.5		60"
.0'	thin bedded shaley dolomite Hard gray unweathered thin bedded shaley dolomite				
	(With fine pyrite crystals at 47.	51 4B	48.5-57.0		102"
	(Weathered fractured zone at 50' with accumulation of fine mater (With fine pyrite crystals in sha below 52.0')	ial) ile	RELI		T
	(With small vugs filled with bitu from 55-57')	men	DATE		
	Bottom of boring at 57.0'				
				TYPE SAMPLE	A:
ETHOD:		SERVATION			SPOON
ECHNICI	AN: RG/DW/JS COMPLETION DE	A 1	.4*	x e. NX c	ore
ION BOL	29590 DEPTHAFTER	HRS	HAS C. SHELEY		

BOWSER - MORNER

Log of Well No. 87-13



EAGON & ASSOCIATES, INC. BOREHOLE LOG

Site Name: BP Chemicals Inc., Lima, Ohio Boring No: 91-T2

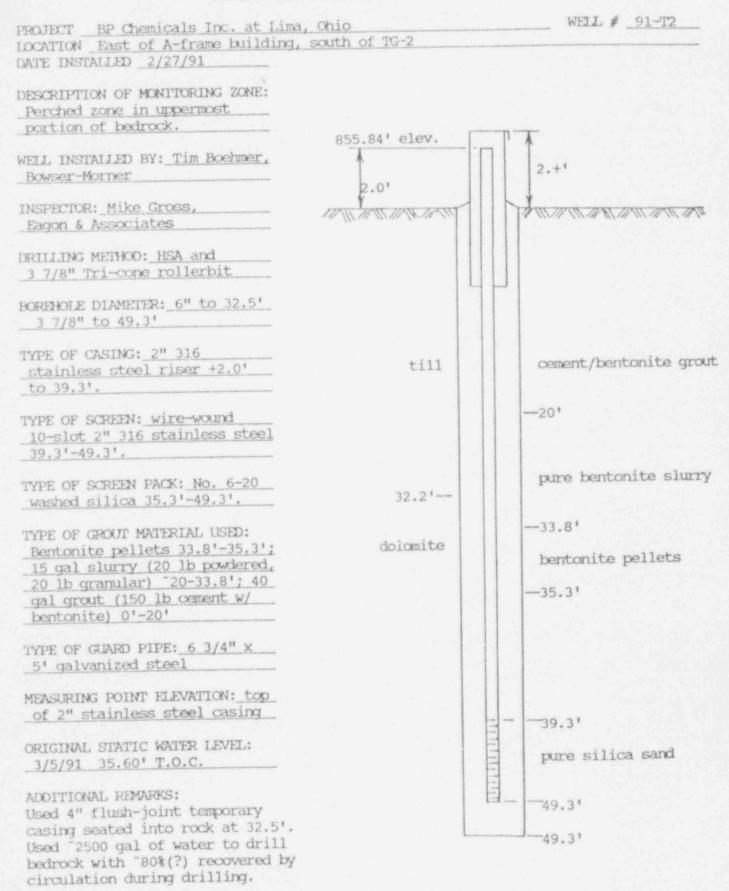
Surface Elevation: 853.8' Date Drilled: 2/26 & 27/91 Location: S. of TG-2, Driller: Bowser-Morner Drilling Method: HSA & Tri-Cone Roller Bit E. of A-frame building Geologist: Mike Gross

INTERVAL	SAMPLE RECOVERY	STRATUM	DESCRIPTION OF MATERIAL
0-0.5	Auger Returns	Stone Fill	
0.5-11		Brown Till	Clay, Trace Sand & Gravel, Damp.
11-32.2		Gray Till	Clay, Trace Sand & Gravel, Damp. (Auger Refusal at 32.2')
32.2-49.3	Tri-Cone Roller Bit Returns	Dolomíte	Brown & Gray, Micro-crystalline, Shaly
			B.O.B 49.3'

EAGON & ASSOCIATES, INC. Consulting Geologists

6877 N. High Street, Suite 302 / Worthington, Ohio 43085 / (614) 888-5760

MONITOR WELL INSTALLATION REPORT



EAGON & ASSOCIATES, INC. BOREHOLE LOG

Site Name: BP Chemicals Inc., Lima, Ohio Boring No: 91-T6

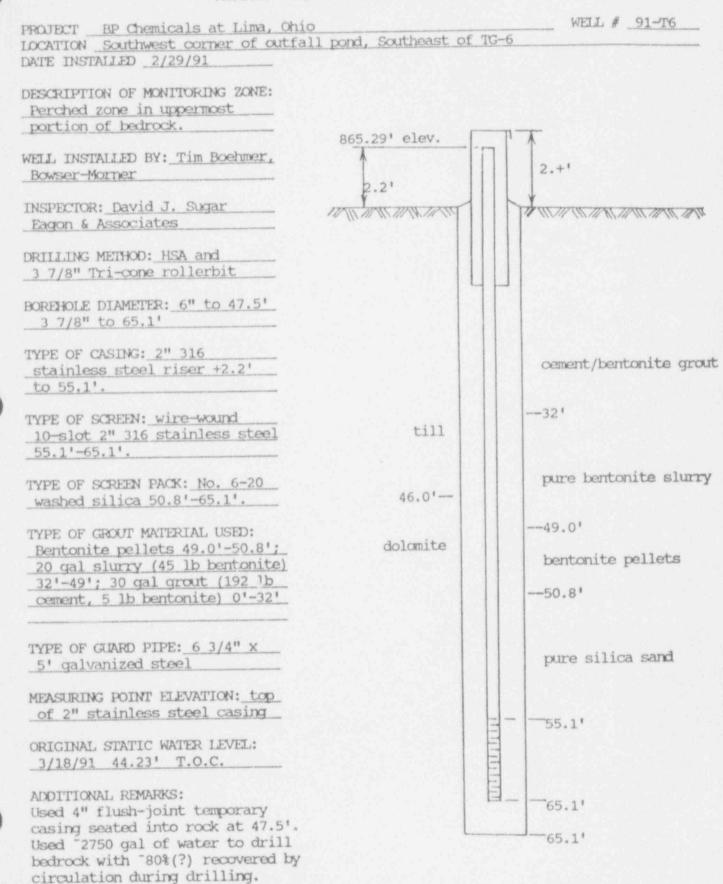
Date Drilled: 2/26/91	Surface Elevation: 863.1
Driller: Bowser-Morner	Location: SE of TG-6,
Drilling Method: HSA & Tri-Cone Roller Bit	SW corner of outfall pond
Distanting means at means	Geologist: Mike Gross

INTERVAL	SAMPLE RECOVERY	STRATUM	DESCRIPTION OF MATERIAL
0-1	Auger Returns	Stone Fill	
1-18		Brown Till	Clay, Trace Sand & Gravel, Damp.
18-46		Gray Till	Clay, Trace Sand & Gravel, Damp.
			(Auger Refusal at 46')
46-65.1	Tri-Cone Roller Bit Returns	Dolomite	Brown & Gray, Micro-crystalline, Shaly.
			B.O.B 65.1'

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MONITOR WELL INSTALLATION REPORT



EAGON & ASSOCIATES, INC. BOREHOLE LOG

Site Name: BP Chemicals Inc., Lima, Ohio Boring No: 91-T7

Date Drilled: 2/13/91 Driller: Bowser-Morner Drilling Method: HSA & Tri-Cone Roller Bit

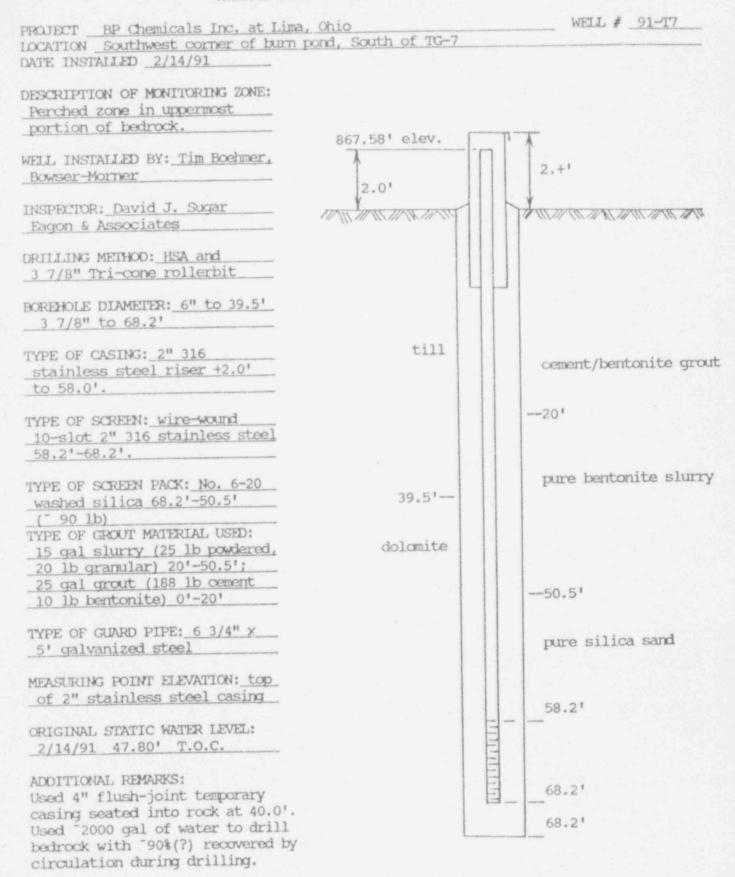
Surface Elevation: 865.6' Location: S. of TG-7, SW corner of burn pond Geologist: Mike Gross

INTERVAL	SAMPLE RECOVERY	STRATUM	DESCRIPTION OF MATERIAL
0-1	Auger Returns	Stone Fill	
1-13		Brown Till	Clay, Trace Sand & Gravel, Damp.
13-39,5		Gray Till	Clay, Trace Sand & Gravel, Damp. Fine Sand zone near top of rock.
			(Auger Refusal at 39.5')
		and an overlap and shares of the stress of the	
39.5-68.0	Tri-Cone Roller Bit Returns	Dolomite	Brown & Gray, Micro-crystalline, Shaly
			B.O.B 68.0'

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MONITOR WELL INSTALLATION REPORT



EAGON & ASSOCIATES, INC. BOREHOLE LOG

Site Name: BP Chemicals Inc., Lima, Ohio Boring No: 91-T8

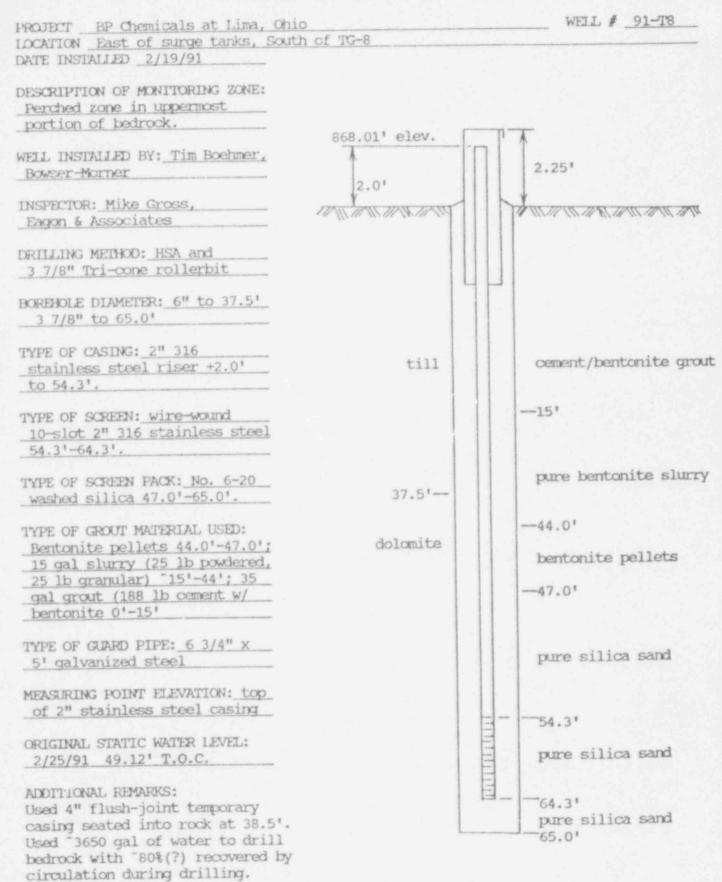
Surface Elevation: 866.0' Date Drilled: 2/15 & 18/91 Location S. of TG-8, E. of surge tanks Driller: Bowser-Morner Drilling Method: HSA & Tri-Cone Roller Bit Geologist: Mike Gross

SAMPLE RECOVERY	STRATUM	DESCRIPTION OF MATERIAL
Auger Returns	Stone Fill	
	Brown Till	Clay, trace Sand & Gravel, Damp
	Gray Till	Clay, trace Sand & Gravel, Damp (Auger Refusal at 37.5')
Tri-Cone Roller Bit Returns	Dolomite	Brown & Gray, Micro-crystalline, Shaly.
		B.O.B 65.0'
	RECOVERY Auger Returns Tri-Cone Roller Bit	RECOVERY STRATUM Auger Returns Stone Fill Brown Till Gray Till Tri-Cone Roller Bit Dolomite

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BORING LOG - No. T-9 BP CHEMICALS INC.

DATE DRILLED: 8/24/88 SURFACE ELEVATION: 849.2

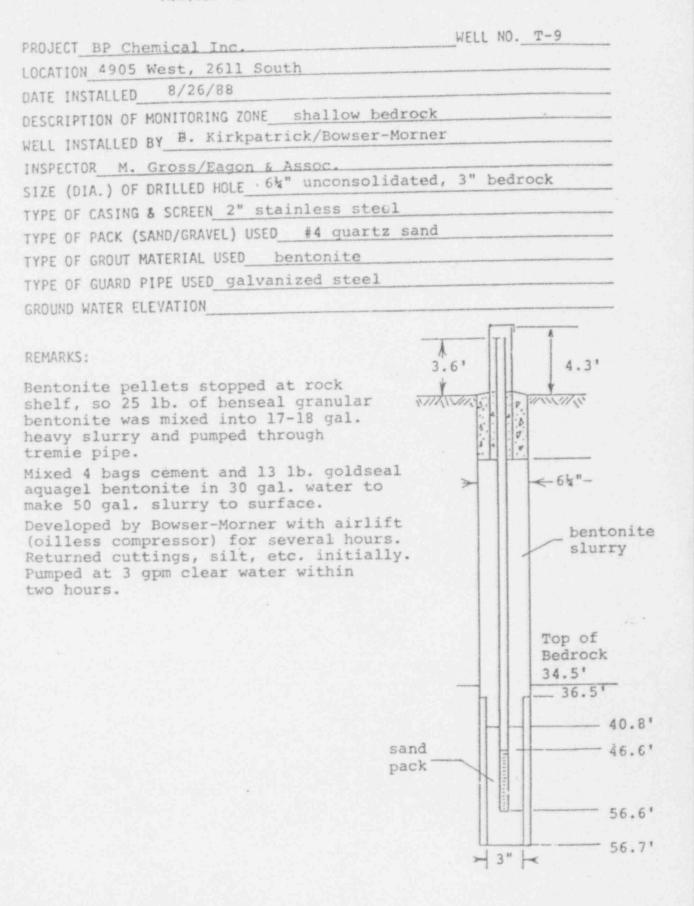
SAMPLE	BLOWS PER 6"	SAMPLE RECOVERY	STRATUM	DESCRIPTION OF MATERIAL
0-5			0-6.4	Brown gravelly CLAY. Very sandy toward base.
5-7	2-3-3-3	2.0'	6.4-7.7	Grey-brown fine to coarse SAND. Very clay-rich and pebbly. Wet.
7-9	2-2-7-10	1.8'	7.7-10	Brown SILT and CLAY. Scattered pebbles. Damp.
9-11	no sample	0		
11-13:	8-14-20-29	2.0'	10-11.5	Brown and grey fine to coarse SAND. Very clay-rich and pebbly. Gradational lower contact. Wet.
13-15	7-10-20-24	2.0'	11.5-22.2	Grey SILTY CLAY and CLAYEY SILT.
	5-9-13-16	1.7*		Minor pebbles. Brown vertical
	6-9-11-20	2.01		fractures near top. Sandy lamin-
19-21	3-12-15-36	0.6*	(cobb	ation at 18.5'. Trace of sand near bottom. Damp.
21.5-23	2-20-23	1.4'	22.2-23.5	Grey fine to pebbly SAND. Poorly sorted, clay-rich. Wet.
24-24.5	24-75-60	1.4'	23.5-24.5	Grey SILTY CLAY. Trace sand. Damp.
	37-63-51 26-44-57 22-34-31	0.8' 1.1' 0.8'	24.5-33.5	Crey-brown fine to pebbly SAND. Very poorly sorted, some clay. Cobbles and silt lenses increase downward. Dry.
	523-110/3"	0.65'	33.5-34.5	Grey SILT. Some pebbles. Damp.
36.7- 46.7 46.7-	core	1	1.111	Grey microcrystalline DOLOMITE. Abundant shale laminations
56.7	core	9.80*	T.D 56.7'	throughout. Some vertical fracturing in upper ten feet.
E.S.			241	







MONITOR WELL INSTALLATION REPORT



EAGON & ASSOCIATES, INC. BOREHOLE LOG

Site Name: BP Chemicals Inc., Lima, Ohio Boring No: 91-710

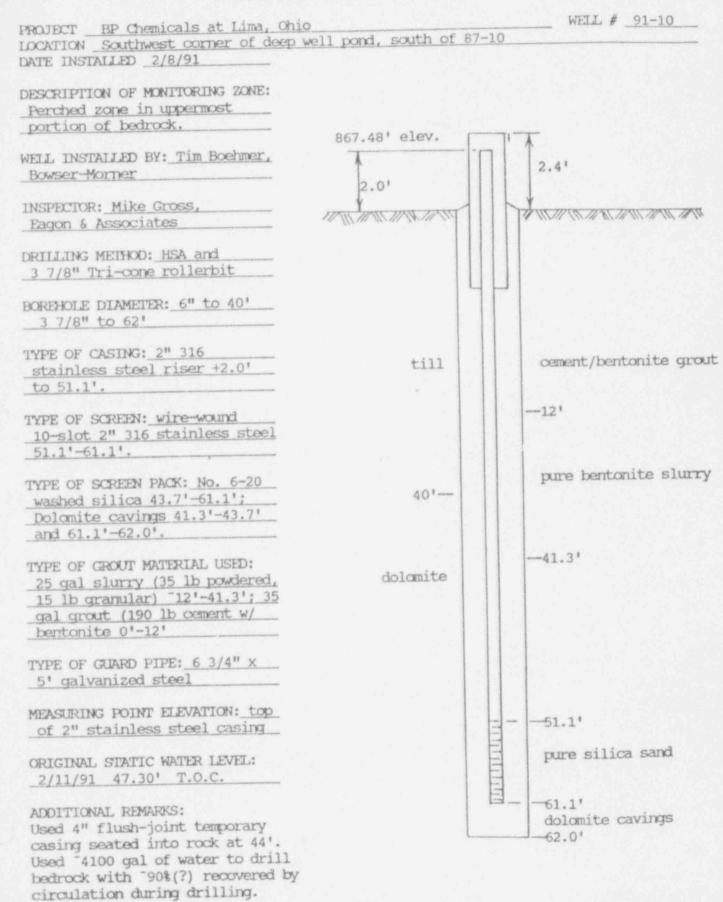
Surface Elevation: 865.5' Date Drill d: 2/6 & 7/91 Location: S. of 87-10, Driller: Boyser-Morner SW corner of deep well pond Drilling Method: HSA & Tri-Cone Roller Bit Geologist: Mike Gross

INTERVAL	SAMPLE RECOVERY	STRATUM	DESCRIPTION OF MATERIAL
			(See Boring Log 87-10 for detailed description of 0-50 ft, interval.)
0-1	Auger Returns	Stone Fill	
1-18		Brown Till	Damp
18-40		Gray Till	Damp
			(Auger Refusal at 40')
		an an ann an stain an stain an stain an stain an stain an stain an stain an stain an stain an stain an stain a	
40-50	Tri-Cone Roller Bit Returns	Dolomite	Gray & Brown, Micro-crystalline, Shaly
50-60	10.0' of 3" Core	Dolomite	Gray & Brown, Argillaceous, Micro-crystalline, subhorizontal Shale partings throughout; minor subvertical filled hairline fractures, in-places.
			Ream to 62.0'
			B.O.B 62.0'

EAGON & ASSOCIATES, INC. Consulting Geologists

6877 N. High Street, Suite 302 / Worshington, Ohio 43085 / (614) 888-5760

MONITOR WELL INSTALLATION REPORT



EAGON & ASSOCIATES, INC. BOREHOLE LOG

Site Name: BP Chemicals Inc., Lima, Ohio Boring No: 91-T11

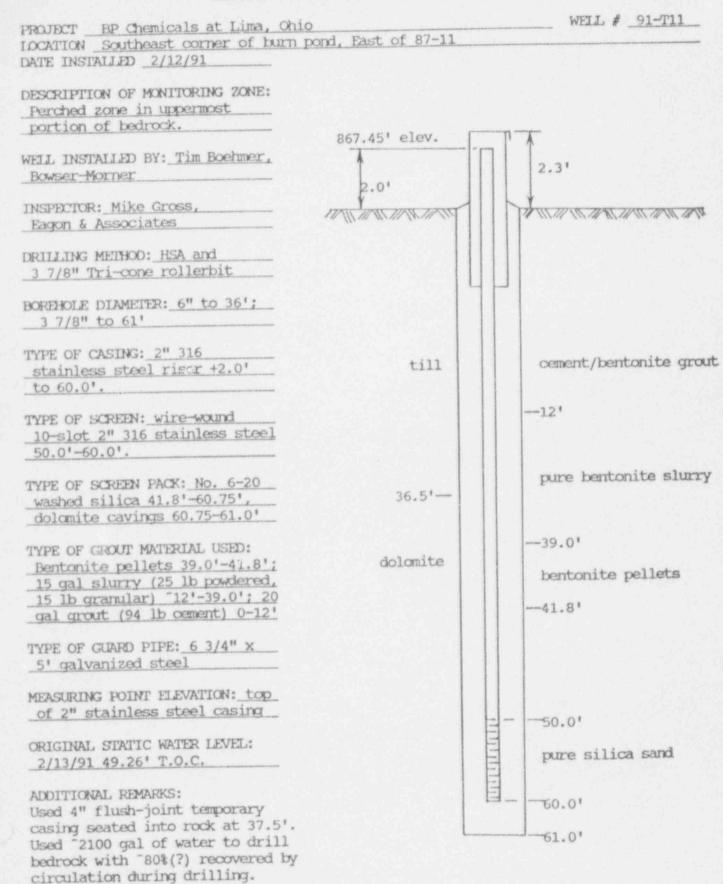
Surface Elevation: 865.5' Date Drilled: 2/8 & 11/91 Location: E. of 87-11, Driller: Bowser-Morner SE corner of burn pond Drilling Method: HSA & Tri-Cone Roller Bit Geologist: Mike Gross

INTERVAL	SAMPLE RECOVERY	STRATUM	DESCRIPTION OF MATERIAL
			(See Boring Log 87-11 for detailed description of material.)
0-1	Auger Returns	Stone Fill	
1-13		Brown Till	Dry
13-36		Gray Till	Damp
			(Auger Refusal at 36.0')
36-61	Tri-Cone Roller Bit Returns	Dolomite	Gray & Brown, Micro-crystalline, Shaly
			B.O.B 61.0'

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6877 N. High Street, Suite 302 / Worthington, Ohio 43085 / (614) 888-5760

MONITOR WELL INSTALLATION REPORT



EAGON & ASSOCIATES, INC. BOREHOLE LOG

Site Name: BP Chemicals Inc., Lima, Ohio Boring No: 91-T12

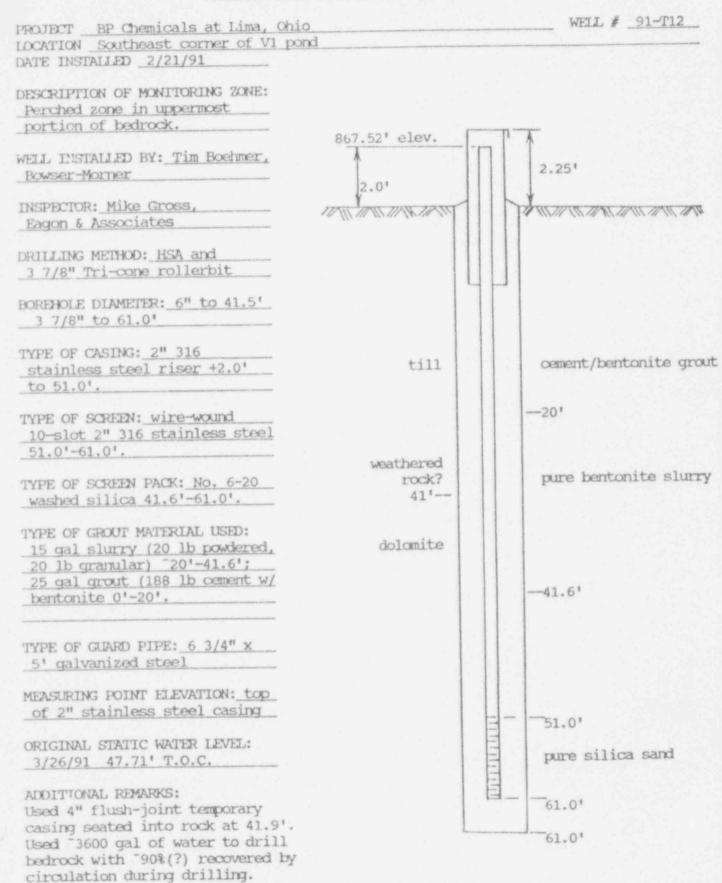
Date Drilled: 2/19 & 20/91	Surface Elevation: 865.5'
Driller: Bowser-Morner	Location: SE corner of V1 Pond
Drilling Method: HSA & Tri-Cone Roller Bit	Geologist: Mike Gross

INTERVAL	SAMPLE RECOVERY	STRATUM	DESCRIPTION OF MATERIAL
0-0.5	Auger Returns	Stone Fill	
0.5-13		Brown Till	Clay, trace Sand & Gravel, Dry
13-41		Gray Till	Clay, trace Sand & Gravel, Damp; some dry Gravel on top of Bedrock.
			Possible weathered Bedrock below 39' (Auger Refusal at 41.5')
41-61.0	Tri-Cone Roller Bit Returns	Dolomite	Gray & Brown, Micro-crystalline, Shal
			B.O.B 61.0'

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MONITOR WELL INSTALLATION REPORT



EAGON & ASSOCIATES, INC. BOREHOLE LOG

Site Name: BP Chemicals Inc., Lima, Ohio Boring No: 91-T13

Date Drilled: 2/21/91 Driller: Bowser-Morner Drilling Method: HSA & Tri-Cone Roller Bit Geologist: Mike Gross

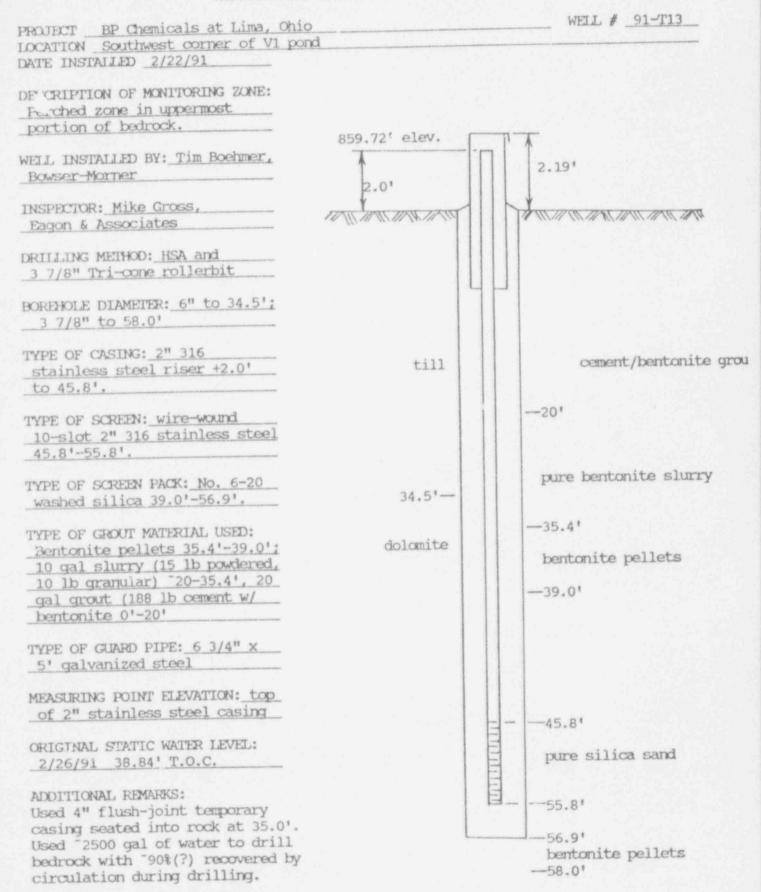
Surface Elevation: 857.7' Location: SW corner of V1 Pond

I	NTERVAL	SAMPLE RECOVERY	STRATUM	DESCRIPTION OF MATERIAL
			Store Bill	Water-bearing surface drainage.
	0-5	Auger Returns	Stone Fill	요즘 이 가 있는 것이 많이 가 귀찮다.
4.	5-18		Brown Till	Clay, trace Sand & Gravel, Damp.
1	8-34,5		Gray Till	Clay, trace Sand & Gravel, Damp.
				(Auger Refusal at 34.5')
34	.5-58.0	Tri-Cone Roller Bit	Dolomite	Gray & Brown, Micro-crystalline, Shaly.
		Returns		
				B.O.B 58.0'

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MONITOR WELL INSTALLATION REPORT



EAGON & ASSOCIATES, INC. BOREHOLE LOG

Site Name: BP Chemicals Inc., Lima, Ohio Boring No: 91-T14

Date Drilled: 3/4/91 Driller: Bowser-Morner Drilling Method: HSA & Tri-Cone Roller Bit celite pond beside R.R. tracks

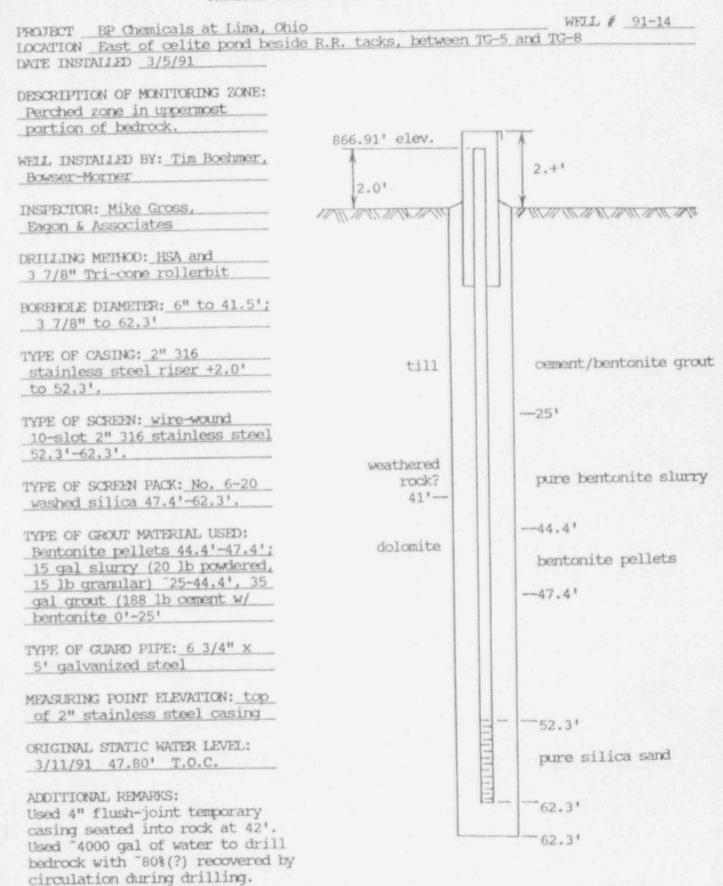
Surface Elevation: 864.9' Location: Between TG-5 & TG-8, E. of Geologist: Mike Gross

INTERVAL	SAMPLE RECOVERY	STRATUM	DESCRIPTION OF MATERIAL
0-13	Auger Returns	Brown Till	Clay, trace Sand & Gravel, Damp
13-41		Gray Till	Clay, trace Sand & Gravel, Damp
			Possible weathered Bedrock below 36' (Auger Refusal at 41.5')
41-62.3	Tri-Cone Roller Bit Returns	Dolomite	Gray & Brown, Micro-crystalline, Shaly
			B.O.B 62.3'

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MONITOR WELL INSTALLATION REPORT



3065 SOUTHWESTERN BOULEVARD, SUITE 202, ORCHARD PARK, NEW YORK 14127-1240 (716) 675-7130 FAX: (716) 675-7136 (716) 675-7137

DAMES & MOORE

May 21, 1992

BP Chemicals, Inc. Fort Amanda Road P.O. Box 628 Lima, Ohio 45802

Attn: Mr. Kenneth C. Wardwell, P.E. Project Manager

> Liner Compatibility Testing Pond Closure Project BP Chemicals, Inc. Lima, Ohio

Dear Mr. Wardwell:

Enclosed please find the final reports from GeoSyntec Consultants, our subcontract laboratory for liner testing. I hereby certify based on knowledge and belief that the liner testing described in these reports was performed in accordance with Method 9090 as specified in EPA publication SW-846, using HDPE material of the type and thickness specified for use on the subject project and a leach medium formulated in accordance with EPA SW-846 method 1312, which simulates acid rain conditions, the leaching scenario which could be anticipated in the event of a penetration through the closure cell cap. The leachate was produced from samples of sludge taken from the four ponds and the solidification reagents in the proportions specified for use in the pond closure.

The results of these tests did not reveal any deterioration of the performance characteristics of the liner material or seams constructed from it in accordance with the specifications for the subject project.



DAMES & MOORE

In consideration of these facts, it is my opinion that the liner material specified for use on the subject project is compatible with the leachate which might be expected to be generated in the closure cells constructed from it.

04 0 Very truly yours ERT or Robert R Blickweden B ONAL Principal Ohio Professional Engineer #55746

cc: Mr. William Rupert, P.E. BP Chemicals, Inc. Lima, Ohio

RRB:ph Attachment

RRB:92:11:034



GEOSYNTEC CONSULTANTS

3050 S.W. 14th Place * Suite 18 Boyston Beach, Florida 33426 * USA Tel. (407) 736-5400 * Fax (407) 732-9917

> RECEIVED Dames & Moore

MAR 1 1 1992

5 March 1992

Mr. Mike Hanchak Dames & Moore 3065 S.W. Boulevard Orchard Park, New York 14127

Subject: Chemical Compatibility Testing of HDPE Geomembrane with Industrial Waste Leachate, 120-Day Final Report

Dear Mr. Hanchak:

Thank you for the opportunity to perform your chemical compatibility testing. Enclosed is our report dated 5 March 1992 for GeoSyntec project no. MC187-003.

If you have any comments or recommendations concerning the format of reports you receive from us or concerning any other testing services, please contact me.

Sincerely,

GEOSYNTEC CONSULTANTS MATERIALS TESTING LABORATORY

Louis G. Tisinger Program Manager, Chemistry

Enclosure

SLP:03:187-003A



Corporate Office: 1200 S. Federal Highway * Suite 202 Boynton Beach, FL 33435 * USA Tel. (407) 736-5400 * Fax (407) 736-4998 MCI Mail * EMS: 4681168 * MXB: Annep@BCHQLM1 Regional Offices: Aurora, CO * Boymon Beach, FL Huntington Beach, CA * Norcross, GA Picasaus Hill, CA * Timonium, MD Brussels, Belgiam Laboratorica: Boyaton Beach, FL Huntington Beach, CA Norcross, GA

EPA 9090 TESTING OF GEOMEMBRANE

WITH LEACHATE

FINAL REPORT

Prepared for

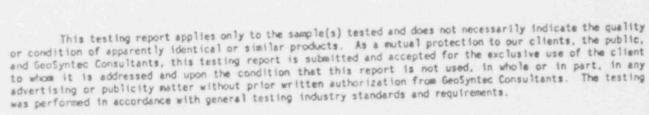
Dames and Moore 3065 Southwestern Blvd Suite 202 Orchard Park, New York 14127-1240

Prepared by

GeoSyntec Consultants Materials Testing Laboratory 3050 S.W. 14th Place, Suite 18 Boynton Beach, Florida 33426

GeoSyntec Consultants Project No. MC187-003

5 March 1992





CAYEAT

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- 2. SCOPE
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- 4.2.10 Summary of Mechanical Properties
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MC187-003/F920126

1. INTRODUCTION

GeoSyntec Consultants' Materials Testing Laboratory (GeoSyntec) prepared this report as requested by Mr. M. Hanchak of Dames and Moore. GeoSyntec was asked to interpret EPA method 9090 test results on Gundle Lining Systems (Gundle) high density polyethylene (HDPE) geomembrane with industrial waste leachate supplied by Dames and Moore.

2. SCOPE

Two HDPE geomembrane samples were immersed in leachate for 30, 60, 90, and 120 days, one at 23°C and one at 50°C. The following properties were measured on control (unexposed) samples and on leachate-exposed samples after immersion in leachate for 30, 60, 90, and 120 days:

Physical Properties

Property

Mass Thickness Dimensions Specific Gravity Volatiles Extractables

Method

EPA 9090 ASTM D 374C EPA 9090 ASTM D 792 ASTM D 3030 (SW 870) ASTM D 3421 (SW 870)

Mechanical Properties

Property	Method
Hardness	ASTM D 2240
Yield Stress	ASTM D 638
Yield Elongation	ASTM D 638
Break Stress	ASTM D 638
Break Elongation	ASTM D 638
Modulus of Elasticity	ASTM D 638
Initial Tearing Strength	ASTM D 1004
Puncture Resistance	FTMS 101C Method 2065
Mullen Burst Strength	ACTU D 3700
(hydrostatic resistance)	ASTM D 3786

The specific test parameters are provided in Appendix A. Data generated from the tests are presented in Appendix B. The leachate analysis is included in Appendix C.

3. EXPOSURE OF GEOMEMBRANE SAMPLES TO LEACHATE

The geomembrane samples were exposed to leachate contained in stainless steel exposure cells fitted with reflux condensers. The leachate was stirred constantly, mitigating its stratification and stagnation, and was changed after every exposure period. The exposure cells were stored in constant temperature chambers maintained at 23°C and at 50°C. All exposure and sample retrieval procedures were performed according to EPA 9090.

The geomembranes were exposed to leachate according to the following schedule:

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Milestone

Date

Initial Exposure 30 Day Period 60 Day Period 90 Day Period 120 Day Period 4 November 1991
4 December 1991
3 January 1992
2 February 1992
3 March 1992

4. DISCUSSION

4.1 Physical Properties

4.1.1 Mass

Mass was constant throughout the test, indicating that leachate was not absorbed by the geomembrane.

4.1.2 Thickness

Just as mass remained constant throughout the test, so did thickness remain constant, indicating that the geomembrane did not swell (absorption of leachate causes geomembranes to swell) [Haxo, 1988]. Swelling of the geomembrane was not expected because: (i) the leachate analysis indicated a very low volatile organic chemical content (volatile organic chemicals can be absorbed by HDPE); and (ii) mass was constant.

4.1.3 Dimensions

Consistent with absence of swelling of the HDPE geomembrane, dimensions were constant throughout the test.

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4.1.4 Specific Gravity

Specific gravity was constant throughout the test, indicating that absorption of leachate by the HDPE geomembrane did not occur.

4.1.5 Volatiles Loss

Volatiles loss of the HDPE geomembrane was variable. Because experience indicates that volatiles loss measurements on HDPE geomembranes typically introduce error greater than the real value (which is a very small quantity) [White and Verschoor, 1990], it is likely that the results may be attributed to experimental error and to material variability and not to the geomembrane's interaction with the leachate.

4.1.6 Extractables Content

Extractables content of the HDPE geomembrane decreased during the test, indicating that the leachate removed geomembrane constituents. The largest extraction by the leachate appeared to occur within the 30-day immersion period; this extraction was indicated by the essentially constant percentage of extractables observed in subsequent exposure periods.

Because HDPE geomembranes do not contain plasticizers, as do polyvinyl chloride geomembranes, only antioxidants and low molecular weight polyethylene (wax) could have been removed by the leachate. An artifact of the geomembrane manufacturing process, wax is in the highest concentration on the surface of HDPE geomembranes [EPA, 1990] and, therefore, does not affect geomembrane performance.

Extraction of antioxidants by this test procedure is very difficult

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due to the large size of modern antioxidant molecules, inhibiting their extraction from materials such as HDPE [Ciba-Geigy, 1987, Rodriguez, 1970, and USI, 1986]. Because of this molecular feature, it is unlikely that antioxidants account for a significant percentage of the total extractables content, a detail verified by previous test programs in which wax was the only identifiable extractable [GeoSyntec Consultants, 1990].

The loss of the geomembrane's extractables (largely consisting of wax) probably occurred because of the geomembrane's exposure to leachate. Because wax does not contribute to the fundamental properties of HDPE materials, its loss should not affect the performance of the HDPE geomembrane.

4.1.7 Environmental Stress Cracking Resistance

Because the leachate did not cause the HDPE geomembrane to swell, the samples did not undergo stress cracking. When materials swell, the cohesive forces of adjacent polymer molecules are reduced. As a result, stress cracks develop more easily in the material when a mechanical stress is applied. This test was conducted using ASTM D 1693, often referred to as the "bent strip" test. The test requires that a small notch be cut longitudinally in a small strip of geomembrane, concentrating stress when it is applied. The strip is then bent approximately 180°, normal to the longitudinal axis, and maintained in the bent configuration in a chemical solution. In this test program, the bent strip was immersed in leachate for 120 days at 23°C and at 50°C. Under these conditions, the bent strips (10 per temperature) did not undergo stress cracking.

5

4.1.8 Summary of Physical Properties

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The physical properties of the HDPE geomembrane were generally constant throughout the test. Only volatiles loss and extractables content changed as a function of the immersion period - changes attributable to variability both in the material and in the test (in the case of volatiles loss) and to wax (in the case of extractables) geomembranes. The physical property test results indicate that the HDPE geomembrane did not absorb leachate.

4.2 Mechanical Properties

4.2.1 Hardness

The HDPE geomembrane's hardness was constant throughout the test, indicating that the leachate did not HDPE's degree of hardness. These results are in agreement with the physical property test results which indicated that that the leachate did not affect the geomembrane.

4.2.2 Stress At Yield

The HDPE geomembrane's stress at yield was generally constant throughout the test. The slight post-exposure changes were generally within one standard deviation of the mean control value, indicating that slight changes may be attributed to material and experimental variability.

4.2.3 Strain At Yield

The HDPE geomembrane strain at yield was slightly variable. The changes, both positive and negative, were generally within one standard deviation of the mean control value. The roll-direction samples were generally uniform up to the 90-day exposure period; however, strain at

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yield varied in samples exposed to leachate for 90 and 120 days. For example, the 90-day values for the roll direction samples maintained at 23°C and 50°C increased approximately 5 percent and 12 percent, respectively; the 120-day values decreased 11 percent and 4 percent, respectively. In contrast to the roll-direction samples, strain at yield of the cross-roll-direction samples was generally more uniform throughout the test. These findings indicate that the post-exposure changes in strain at yield were probably due to material and experimental variability and probably not due to the chemical environment, since chemical interaction of the geomembrane with the leachate should result in similar changes in both the HDPE geomembrane roll and cross-roll directions.

4.2.4 Stress At Break

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Stress at break was generally constant throughout the test. Most of the post-exposure mean values were within one standard deviation of the mean control value, indicating that the post-exposure changes in stress at break may be attributed to experimental and material variability.

4.2.5 Strain At Break

Generally constant throughout the test, strain at break of the HDPE geomembrane did not significantly change as a result of the geomembrane's immersion in leachate. The post-exposure values were generally within one standard deviation of the mean control value, indicating that the changes in strain at break may be attributed to material and experimental variability.

4.2.6 Modulus of Elasticity

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Modulus of elasticity values of HDPE geomembrane were generally nonuniform throughout the test. Such nonuniformity in modulus values is expected, because experience indicates that modulus of elasticity cannot be accurately measured by the conventional, industry standard technique. Modulus of elasticity is measured by selecting a point from the steepest segment of the initial section of the stress strain curve from which to draw a tangent line for calculation of the modulus of elasticity value. Because HDPE is a viscoelastic material, the initial section is not linear, therefore, point selection is largely subjective. In order to mitigate the subjectivity of point selection, GeoSyntec Consultants uses a computer to calculate modulus of elasticity. As a result, changes in modulus of elasticity such as those observed in this test program are likely due to material var. ility.

4.2.7 Initial Tear Resistance

Unaffected by immersion in leachate, the HDPE geomembrane's initial tear resistance in the roll direction was constant throughout the test. The cross-roll-direction sample underwent some change; however, there was no observable trend. Because the roll-direction sample did not undergo significant change, and because the leachate should affect similarly both the roll-direction and cross-roll direction samples, the changes in the post-exposure cross-roll direction sample may be attributed to material variability.

4.2.8 Puncture Resistance

The HDPE geomembrane's puncture resistance varied somewhat during the test. A slight increase in puncture resistance at the 30-day immersion period was followed by a gradual decrease during the remaining 90 days of immersion. Had changes occurred as a result of the geomembrane's interaction with the leachate, then the reduction in puncture resistance

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should have begun during the 30-day exposure period. When materials undergo property changes due to interaction with chemicals, resulting property values typically display trends, phenomena not observed in these test results [Dudzik and Tisinger, 1990]. Because of the absence of a discernible trend in these test results, the changes in puncture strength may be attributed to material variability.

4.2.9 Bursting Strength (Mullen)

Changes in the HDPE geomembrane's bursting strength were very small, generally within one standard deviation of the mean control value. Unaffected by exposure to leachate, bursting strength of the HDPE geomembrane was, therefore, constant.

4.2.10 Summary of Mechanical Properties

The HDPE geomembrane's mechanical properties were generally constant throughout the test. Some small changes were observed in various properties; however, because the changes were not consistent with probable leachate effects, the changes may be attributed to material and experimental variability.

5. CONCLUSIONS

The physical property test results indicated that the HDPE geomembrane was not affected by exposure to the leachate. Consistent with the absence of interaction with the leachate, the HDPE geomembrane's mechanical properties were generally stable throughout the test. These tests indicate that the HDPE geomembrane is compatible with the leachate.

REFERENCES

Dudzik, B.E., Tisinger, L.G., "An Evaluation of Chemical Compatibility Test Results of High Density Polyethylene Geomembrane Exposed to Industrial Waste Leachate", Proceedings from "Geosynthetic Testing for Waste Containment Applications", ASTM STP 1081, 1990, pp 37-54.

EPA, Technical Guidance Document: "The Fabrication of Polyethylene FML Field Seams", EPA/530/SW-89/069, September, 1989, 42 p.

GeoSyntec Consultants, Private Files, 1987-1991

Rodriguez, F., "Principles of Polymer Systems", McGraw-Hill, NY, 1970, 560 p.

USI Chemicals, "Petrothene Polyolefins... a processing guide", Fifth Edition, 1986, 139 p.

White, D.F., Verschoor, K.L., "Practical Aspects of Evaluating the Chemical Compatibility of Geomembranes for Waste Containment Applications", Proceedings from "Geosynthetic Testing for Waste Containment Applications", ASTM STP 1081, 1990, pp 25-36. APPENDIX & STANDARDS USED IN TESTING

STANDARDS USED IN GEOMEMBRANE TESTING

- EPA Method <u>Dimensions/Mass</u> -- "Compatibility Test for Wastes and Membrane 9090 Liners"
- ASTM D374C Thickness -- "Test Methods for Thickness of Solid Electrical Insulation"
- ASTM D2240 Hardness -- "Test Method for Rubber Property -- Durometer Hardness"
- ASTM D792 <u>Density/Specific Gravity</u> -- "Test Methods for Specific Gravity and Density of Plastics by Displacement"
- ASTM D3030 <u>Volatiles Loss</u> -- "Test Method for Volatile Matter (Including Water) of Vinyl Chloride Resins"
- ASTM D3421 <u>Extractables Content</u> -- "Recommended Practice for Extraction and Analysis of Plasticizer Mixtures from Vinyl Chloride Plastics"
- ASTM D1693 <u>Environmental Stress Cracking Resistance (ESCR)</u> -- "Test Method for Environmental Stress-Cracking of Ethylene Plastics"
- ASTM D638 <u>Tensile Properties/Modulus of Elasticity</u> -- "Test Method for Tensile Properties of Plastics"
- ASTM D1004 Initial Tear Resistance -- "Test Method for Initial Tear Resistance of Plastic Film and Sheeting"
- ASTM D3786 <u>Bursting Strength</u> -- "Test Method for Hydraulic Bursting Strength of Knitted Goods and Nonwoven Fabrics -- Diaphragm Bursting Strength Tester Method"
- FTMS 101C <u>Puncture Strength</u> -- "Puncture Resistance and Elongation Tests" Method 2065

APPENDIX B TEST RESULTS

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CHEMICAL COMPATIBILITY TEST RESULTS

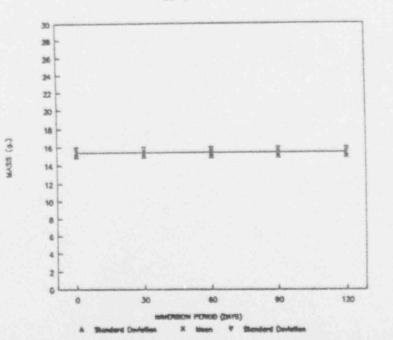
30

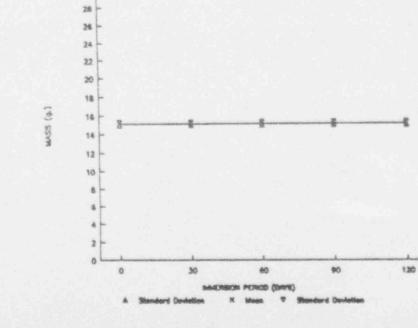
CLENT: DAMES & MOORE MARKIFACTURER: GUNDLE LINENS BYSTEMS METHOD: EPA 9060 DATE TESTED: 3/5/85 BEORYHITEC JOB NO.: MC187-200 MATERNAL TYPE: NOPE, MEMBRANE CHANNECTERBITICH: 60 MS., LEACHATE: PHOLOSTRAL MONSTE

PROPERTY: MASS DIRECTION: N/A

WHICH BE DEDUCT	UNIT				29*C				1.1				80°°C			Reynderd	Parevent	
DOMOBULINE PERIMOO	g.	Bpen. 1	Bpec. 2	Open. 3	Spec. 4	Spec. 5	Mach	Blanderd Deviation	Purpant Change	Bpec. 1	8pec. 2	Spec. 3	Spec. 4	8pos. 8	Idean	Dovidation	Change	Toohalah
	-	1									18.006	14,923	16,197	15.364	18,126	0,187	PREA	2570
CONTROL BAMPLE	1.1	14.987	18,731	18.046	16,762	18,447	15,5983	0.384	NEA	16.068	and the second second	14,822	18,194	18.377	16,129	0.184	-0.01	812
30 DAY BAMPLE		14,991	15,734	18,049	18,788	16.451	15.398	0,864	90.0	18.090	16.008	14,822	18,188	16,330	18,115	0.156	-0.08	30
BO DAY BAMPLE		14.989	18.733	18.048	18.784	18,480	15,395	0,384	0.01	16,084	16.066	and the second second second second	18,180	16.329	18.154	0.184	-6,00	85
BO DAY BAMPLE		14,991	18,734	18.047	18,766	18,481	18.308	0,305	0.02	15.084	18,085	14.915	and the second state of th	15.328	16,109	10, 165	-0, 90	89
120 DAY BAMPLE		14.968	16.732	15.045	18.783	18.448	16,908	0.905	0.00	18.078	16.050	14.909	18.184	10.390	16,195	10, 100		
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CHEMICAL COMPATIBILITY TEST RESULTS

CLIENT: DAMES & MOORE MANAFACTURER CUANDLE LINING BYSTEAR METHOD: ANTH DEVIC ANTE TEBRTED: SOME

REDUKTIVEN, IMPORTE HOPE, MEMORYME BHC187-900 00 MM. AREORITATIES JOB NO.: MATERIAL TYPE CHANANCTERBERCE LEADMATE

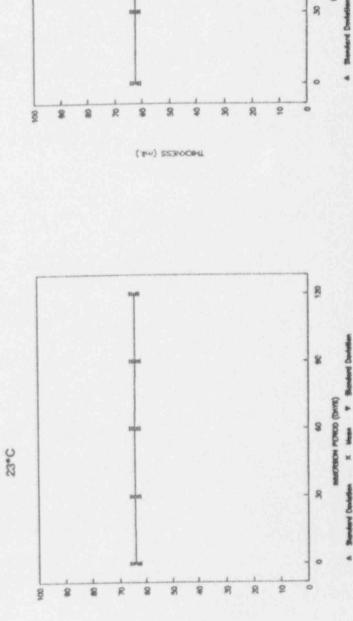
> PROPERTY: THICKNESS DIRECTION: N/A

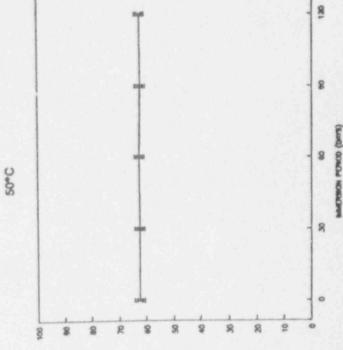
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CHEMICAL COMPATIBILITY TEST RESULTS

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CLIENT: DVANES & INCOME MANARENCTUREN: GVINDLE LINING BYBTEAKS METHOD: EPA BOBD DATE TESTED: JONNE

PROPERTY: DIMENSIONS DIRECTION: ROLL

BUCKARTYMAN IMPARTE

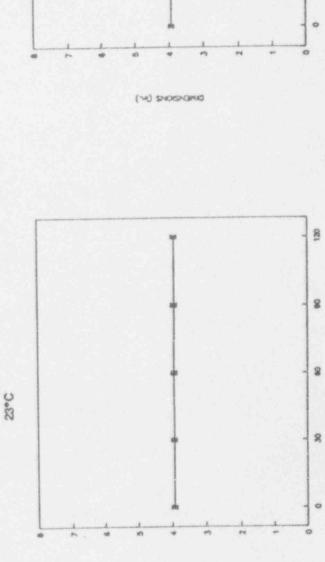
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DECOMPATIES LOB MOL. MATESNAL TYPE CHANNETESNITCH LEADMATE

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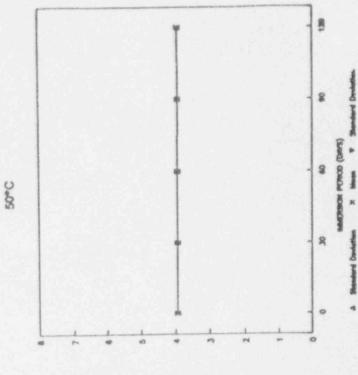
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CHEMICAL COMPATIBILITY TEST RESULTS

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CLIEPHT: DAMICS & INCOME MAMARACTURER OUNCLE LINEING BYTETERS METHOD: EPA 8000 DATE TEBRTED: 30590

PROPERTY: DRAENSIONS DRRECTION: CROSS-ROLL

BACCUBITIONAL WORKER

LENOWATE

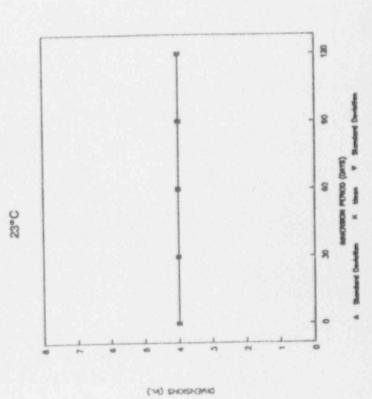
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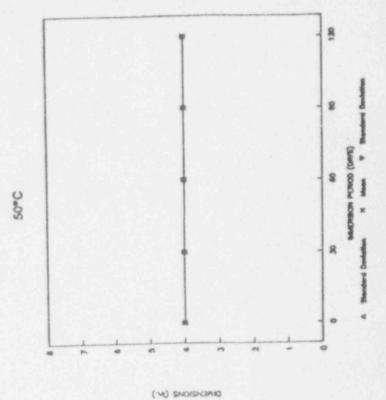
DECENTRES JOB NO.: MATERNA, TYPE: CHANNETERNETCE

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CLIENT: DAMES & MOONE CTURER GUNCKE LINGNE BYSTENS

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ARCHING STREAM

CHEMICAL COMPATIBILITY TEST RESULTS

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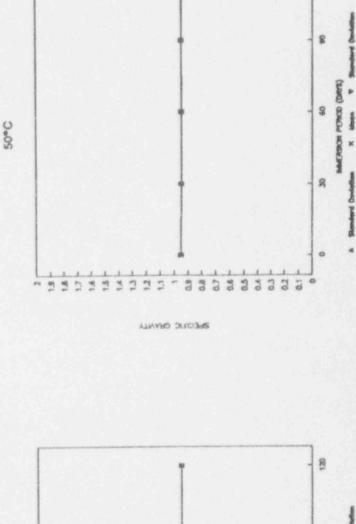
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PROPERTY: SPECIFIC GRAVITY DIRECTION: N/A

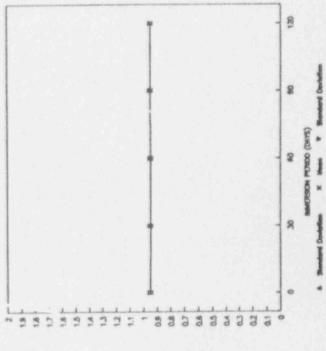
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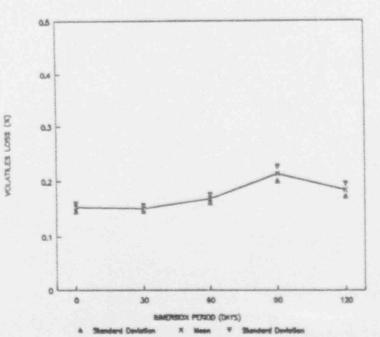
CLIENT: DAMES & WOORE MANUFACTURER OUNDLE LIMING BYSTEMS METHOD: ABTH 08080 DATE TESTED: MYNR

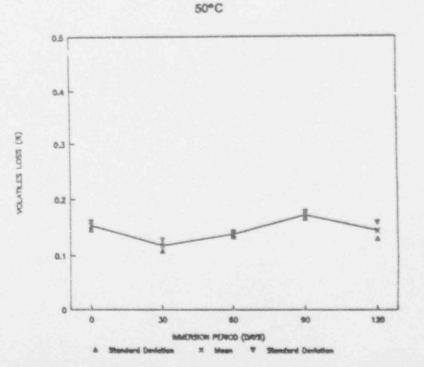
BEDENNTEC JOE NO .: BIC187-088 MATERIAL TYPE MORE, MEMBRANE CHAPACTERRETICS: 80 MR. LEACHATE INDUSTRIAL WARTE

PROPERTY: VOLATILES LOSS DIRECTION: N/A

CPCIBURE PERIOD	THE				2990			Bandard	Percent				89*C			Standard	Permant	Tautolata
	-	Bpec. 1	8pec. 2	Spen. 3	Spor. 4	Spec. 6	kiam	Devilation	Change	Bpec, 1	Bose. 2	Bpec. 3	Врен. 4	Bpea, 6	Bhaan	Devication	Chango	1 and the second
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XONTROL BAMPLE		0,1558	0,1891	0.1489			0.1816	6.0046	-1.88	0.1128	0,1128	0.1263			9.1188	0,0085	-82.98	80
30 DAY BAMPLE		0,1482	0.1826	0,1850			0.1691	0.0087	90,99	0,1428	0.1360	0,1360			0.1982	0,0098	- 10,08	82
BO DAY BAMPLE		0.1826	0.1001	0,1758	Concession, Name and Address		0,2183	9,0126	98.69	0.1791	0,1891	0,1691	The second second second second		0.1724	6,0068	19.38	82
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CLUENT: DAMER A INCOME MANAGYARTANGR BUNKLE LAWAD BYSTEANS METHOD: ANTH DANTI DATE TENTED: BOMR

PROPERTY: EXTRACTABLES CONTENT

BACKASTTEAL WALGTE

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MC187-003

GEOBNATEC JOB NO.:

CHEMICAL COMPATIBILITY TEST RESULTS

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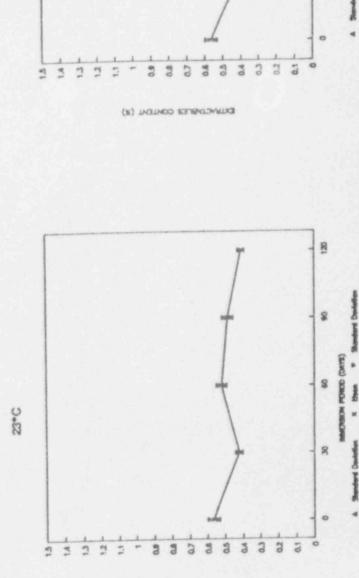
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DIRECTION: N/A

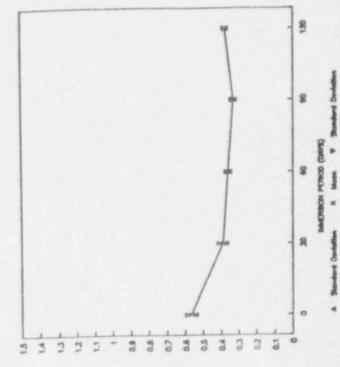
No. Spec. S	CORONA SIG PERSON LINES	Laur				out the								009			Duration	Parameter	
Main Openant Openant <thopenant< th=""> <thopenant< th=""> <thopen< th=""><th></th><th></th><th></th><th></th><th></th><th>-</th><th>America R</th><th>-</th><th>Blanderd</th><th>Present Change</th><th>Bipaco, 1</th><th>Bipers. R</th><th>Speer 5</th><th>ginner a</th><th>Bpox 6</th><th>Islaar</th><th>Development</th><th>Change</th><th>Tourhoide</th></thopen<></thopenant<></thopenant<>						-	America R	-	Blanderd	Present Change	Bipaco, 1	Bipers. R	Speer 5	ginner a	Bpox 6	Islaar	Development	Change	Tourhoide
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0.6411 0.5479 0.5479 0.5471 0.5479 0.5479 0.2705 N/A 0.6411 0.5479 0.2016 -40.28 <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td>Second Second Second</td> <td>the second secon</td> <td></td> <td></td> <td></td> <td></td> <td>A head</td> <td>0.0006</td> <td>peciel.</td> <td>8</td>										Second Second Second	the second secon					A head	0.0006	peciel.	8
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0.4006 0.4720 0.4016 0.4853 0.0186 -14.06 0.5064 0.5766 0.3766 0.3766 0.4007 4.6016 4.6106 4.6107 4.6107 4.	THE REAL PROPERTY AND			÷ł.				100×2 ×	0.0430	02 m		0.3667				1 2000 0	And the second s		1
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0.4066 0.4164 0.4164 0.4164 0.4167127.306 0.3626 0.3754 0.4877 0.487	The second secon		0.40404	Ł				0,4853	0,0186	- M-08		0.3676				and a second	and an a		-
0.4064 0.4164 0.4164 0.4164	BO FRAT BUTTER		Augusta .	1	Name of Concession, Name of Street, or other	and the second s				APP 240	L	0 278.6				2018/0	Photo: th	LATIN	-
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DURACTABLES CONTONT (X)





OLEANT: DAVIESE À INOCHE IMANUEXACTURESE OLIMINE E LINING BYBITEME IMETREDE ANNUE TONIO DAVIE TEORTED: ANNUE

CHEMICAL COMPATIBILITY TEST RESULTS

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BEOBTWITEC JOB MD.: MICHAP-400 MATTERMAL TYPE: HOPE, MEDIBIPANE CHANNACTERBETICR: 82 MBL. LEACHAITE: INDUBITIRAN, INNETE

PROPERTY: ENVIRONMENTAL STRESS CRACKING RESISTANCE

DIRECTION: N/A

CORECH SMINDOLDG	P OF	P OF
CONTROL BAMPLE	0	0
30 DAY SAMPLE	0	0
BO DAY BARPLE	0	0
BO DAY SAMPLE	0	8
120 DAY BAMPLE	0	0

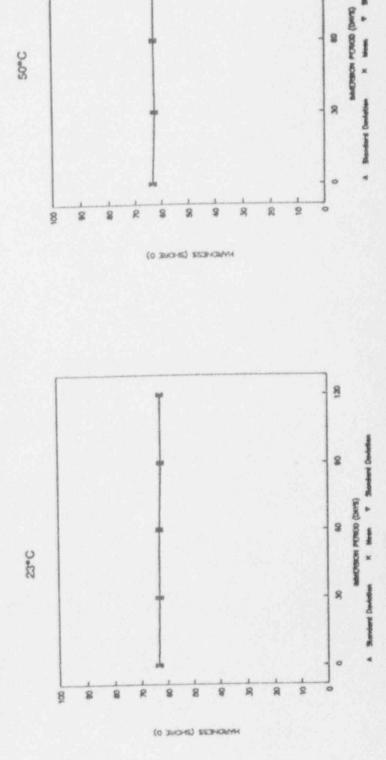
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ILTS	INCTOT-D INDIFE, M 60 MBL, INDURTY
CHEMICAL COMPATIBILITY TEST RESULTS	CORMANTES JOB NO.
	CLIENT: DAMES A INCOME MANAJFACTLARESP: DAMAGE A INCOME MANAJFACTLARESP: DAMAGE A INCOME METHOD: ANTH DESHO DATE TESTED: ANHE
	CLEHT: MANASFACTURER METHOC: DATE TESTED

BACKINGTINGAL NAMETE NOME, MARKERMAN BACYS7-000 - 10 HE DECONTATEC JOB NO.: MATERNA, TYPE CHAMACTERNETICE LEADHATE

PROPERTY: HARDNESS (SHORE) DRECTION: N/A

Opport Speet Speet <t< th=""><th>O Approx I Space I <!--</th--><th>D Bpen. 2 Bpen. 3 Spen. 4 Spen. 5 cc ex ex ex ex ex cc ex ex ex ex ex cc ex ex ex ex ex</th><th>Develo</th><th>Change</th><th></th><th></th><th></th><th>2.4</th><th>in the second</th><th>1</th><th></th><th>Parente Osarge</th><th>Traductions</th></th></t<>	O Approx I Space I </th <th>D Bpen. 2 Bpen. 3 Spen. 4 Spen. 5 cc ex ex ex ex ex cc ex ex ex ex ex cc ex ex ex ex ex</th> <th>Develo</th> <th>Change</th> <th></th> <th></th> <th></th> <th>2.4</th> <th>in the second</th> <th>1</th> <th></th> <th>Parente Osarge</th> <th>Traductions</th>	D Bpen. 2 Bpen. 3 Spen. 4 Spen. 5 cc ex ex ex ex ex cc ex ex ex ex ex cc ex ex ex ex ex	Develo	Change				2.4	in the second	1		Parente Osarge	Traductions
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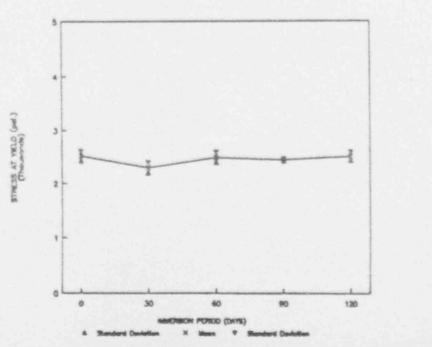
CLENT: DAMES & MOORE MANUFACTURER: GUNCLE LINING INSTEMS METHOD: AITTI DISS DATE TERTED: \$5000 BEDEFYNTEC JOB NO.: MC187-803 BATERIAL TYPE: NOPE, MEBBRINANE CHARACTERIBITICS: 80 ME. LEACHATE: BHDLATTHAL WARTE

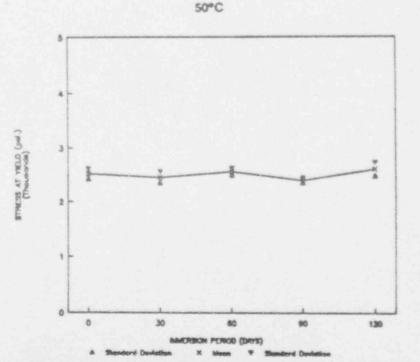
PROPERTY: STRESS AT YIELD

DIRECTION: ROLL

						Disensiond	Persont							Dependent	Persent	
Apec. 1	Spec. 2	Spec. 3	Bpec. d	8pec. 8	Maan	Devlasion	Change	Bpea. 1	8pm. 2	Bprc. 3	Spec. d	Bpea. 6	Alleven	Doviation	Change	Technicia
	2402	10000	2442	24.24	0510	100	N/A	24.99	2487	2052	2642	2894	28140	9.0	AMA	BM
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and the second s	And and a state of the state of	the second second second second second second second second second second second second second second second s	Contractor and the second second	and the second se		And the second se	And the second second second second second second second second second second second second second second second	and the second second second second second second second second second second second second second second second	268.5	24834	2482	26,20	2062	94	1,75	SIM.
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2547	2576	2576	2411	2670	2618	73	-0.10	2796	2662	2548	2006	2462	8811	\$17	8,87	(BWY
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23°C



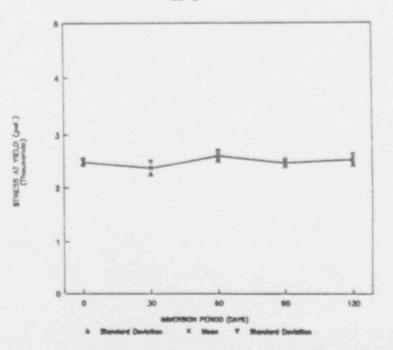


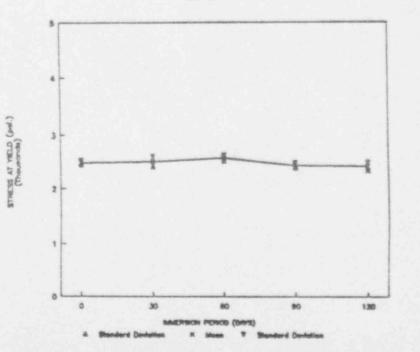
CLEAT: DAMES & MOORE MANUFACTURER: BUNKLE LINENS BYSTEMS METHOD: ASTH DRM DATE TESTED: SOME BECKEYWITEC JOB KO.: MC187-000 MATERIAL TYPE: HOPE, MERGEROADE OMARACTERENTIOS: 00 MK. LEACHATE: BROURTPOAL WRITE

PROPERTY: STRESS AT YIELD DIRECTION: CROSS-ROLL

EXPOBLINE PERIOD	UNIT				23°C								80°C			Share does	Possed	
	pol	8pen. 1	Bpec. 8	Apec. 3	Bpec, 4	Spec. 8	Moun	Bannelord Doviation	Parasal Change	Spec. 1	8040.2	Spen 3	Bpec. 4	Spore 6	blass	Develotion	Change	Toutonicity
		2682	2450	24.98	2802	2486	2600	34	RMA	2562	2480	2480	2602	3486	2500	949	NEIA	9W4
CONTROL BAMPLE		2462	2407	2366	2192	24.90	2391	115	-4.76	2607	2448	2435	2987	26.26	2614	60	0.80	BMA
30 DAY BARFUE		2647	2050	2947	2440	2827	199711	74	8.1.7	2861	2847	2643	2680	2809	2678	Ø5	截 14	(PMV)
O DAY BAMPLE		2493	2442	2848	3489	24.26	8478	.68	-1.07	2602	2432	2427	24.73	2373	2641	48	-2.58	(BMA)
SO DAY BAMPLE		2401	2863	2/80/4	2910	2617	2587	86	1.80	2396	2476	2347	2903	2610	9420	72	-8.50	SAG.
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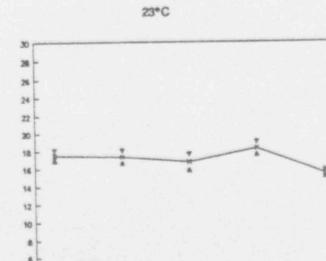
CLIENT: DAMES & MOORE MANUFACTURER OUNDLE LINING BYSTERS METHOD: ASTM DISS DATE TERTED MAR

GEOSTATEC JOB NO.: MC187-083 MATERIAL TYPE HOPE MEMORANE CHARACTERISTICS IN MIL LEACHATE INCLUSTRIAL WARTE

PROPERTY: STRAIN AT YIL

DIRECTION: ROLL

OXPOBURE PERIOD	UNIT				See								80°°C			Renderd	Parent	
AFGRAGE FERROR	*	Stores, 1	Spec. 2	Spec. 3	fipeo. 4	Spen, 5	African	Blandard Devietion	Percent Change	Spec. 1	Bpec. 2	Bpwc. 3	Spero, d	Spec, 6	Maan	Develoption	Change	Toohnible
											17.89	17.73	16.80	17.87	17,48	0.64	RSKA	SMA.
CONTROL SAMPLE		17.37	17.89	17.73	18.60	17.87	17,06	0,84	M/A	17.37	17.09	17.28	18.84	17.75	17,40	6.72	9.02	RMA.
30 DAY BAMPLE		17.22	16,40	10.40	17.30	17.25	17,8%	0.68	-9,80	17.33	16.90	17.84	17.86	18.02	17,68	6,88	1.00	BIN
OD DAY BAMPLE		17.87	18.97	16.95	17,41	16,80	16,79	36.6	-6.16	17,90	19,74	19.80	18.42	19.94	19.84	0,68	\$1.71	8W
NO DAY BARPLE		17.36	19.13	17.88	18,05	18,63	16,85	Ø.71	4,79	19.94	16.81	15.84	18.46	17,45	18.81	1,84	-8.87	(BW)
120 DAY BAMPLE		18.48	18.91	16.32	18.33	16.07	18.80	8,83	-11,40	17.99	19,01	13.04						1.0
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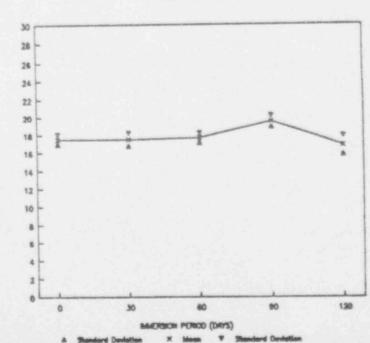
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MMERSION PERIOD (DAYS) A Standard Davidian X Mean V Standard Davidies

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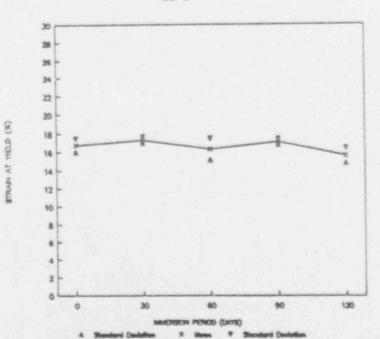
OLIENT: DAMES & MOORE MAARUFACTURIER: OUNDLE LINING SYSTEMS METHOD: ASTH DISM DATE TESTED: 93492

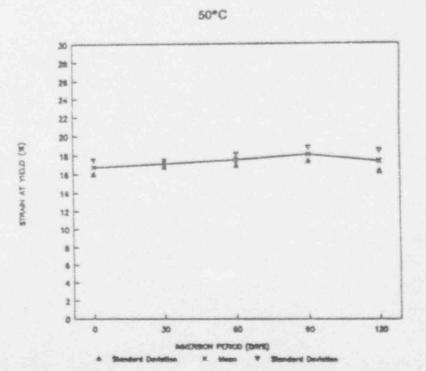
BEOEVHTEC JOB NO .: MC187-803 MATERIAL TYPE HOPE, MEMBRANE CHARACTERISTICS: 80 ME. LEACHATE INDUSTRIAL WINITE

PROPERTY: STRAIN AT YIELD DIRECTION: CROSS-ROLL

OPORURE PERIOD	UNET				389°C			Desident	Pareent				50°°C			Standard	Persont	
10 A 10	*	Bpen. 1	Spec. 2	Spec. 3	Spec. 4	Bpec. 8	Mean	Bandard Deviletion	Change	дряка, 1	Spec. 2	Spec. 3	Spec. 4	Вряв. 8	Mear	Develation	Chengo	Testinisia
			16.69	16.94	16.66	17.88	18,74	0,71	NER	18,70	16.60	18.94	18.68	17.88	18.74	0,71	NEA	(BHA
CONTROL BAMPLE		18,70	17,13	17,90	17.24	17.12	17,20	0.32	3.84	17,26	17.25	17,28	17.27	16.00	17.18	0.90	2.85	and a
SO DAY BAMPLE		17.20	15.18	1	18,19	17.88	16.92	1,18	-2.81	17.88	18.61	17.88	17.91	17.42	17,66	0,08	4.77	illeret
90 DAY BAMPLE		17.23	17.24	1.26	17.36	16.60	17.56	8.31	2,61	19.32	17.88	17,00	17,77	17.76	18,79	8,67	8.39	87.4
120 DAY BAMPLE	1.1	16.32	18.43	14.98	16.08	16.73	16.04	0.70	-8,84	18.67	17.99	18.09	17.87	18.04	17,48	1.08	4,16	Ban
	1																	1

23°C





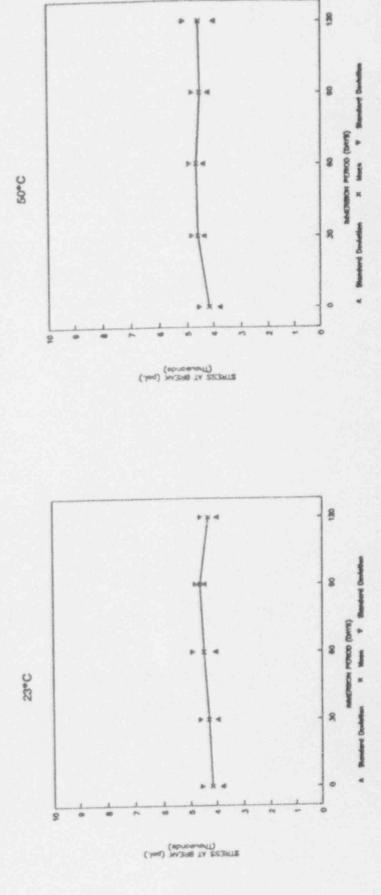


OLEENT: DAMETE A INCOME MANUFACTURER QUINCLE LINERD BYTETEME METHOD: ANTH DRIV DATE TEBRTED: SOME

GEORMATTEC JOB NO.: MC187-003 MATEBRAL TYPE: NOPE, MC3409NAME OFMMACTEBRAL TYPE: RO MK. LEACHATE: PROLATTEM, NOVATTE

PROPERTY: STRESS AT BREAK DIRECTION: ROLL

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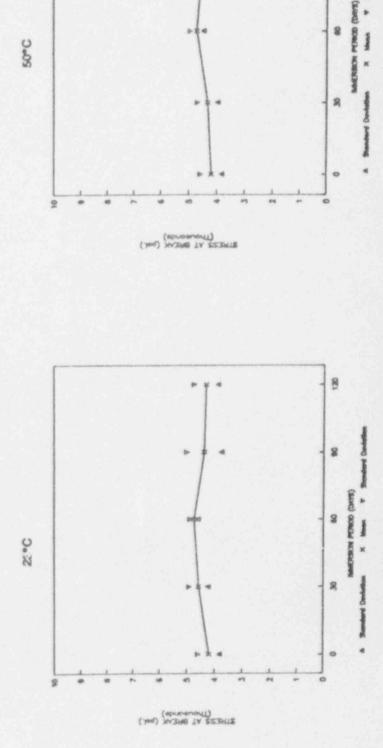
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RACKURTTRAL HEARTE INCTRIT-AND MOPE, INCOMPANE 00 MM DECORTATIZE JOB NO.: BRATERIAL TYPE CRAMMACTERNETICOR LEACHATE

PROPERTY: STRESS AT BREAK DIRECTION: CROSS-ROLL

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CHEMICAL COMPATIBILITY TEST RESULTS

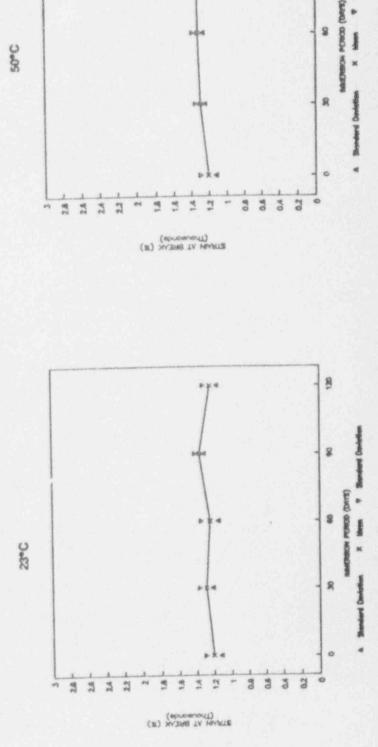
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PROPERTY: STRAIN AT BREAK DIRECTION: ROLL

MANAMPACTURGER OLIVERLE LINIMO SYRTESINS INFERIOLO: ANTH DISCH DATE TESTESI: SKINNE

CLEAT: DAMES & MOONE

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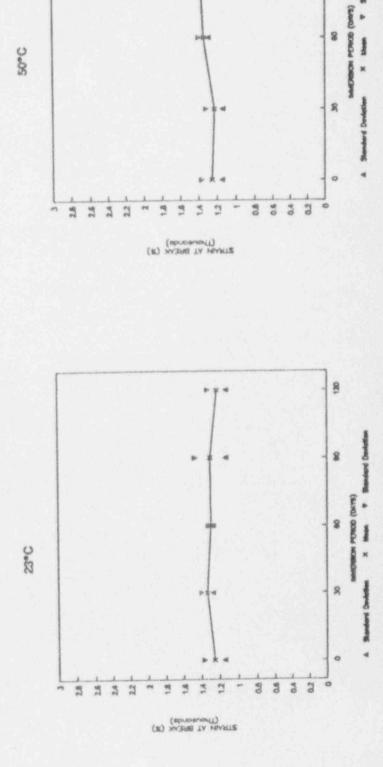


CUERT: DAMES & MOCRE MANAGENCTURER: OLIMICS & MOCRE METHOD: AST'N DRIS DATE TERTED: SCHE

CREORYMATES JOB NO.: BACTR7-JBB MATTERAL TYPE: HOME JAESABRAARE CHANAACTESTISTE: BY MR... LEACHATE: BACUBITEAN, INMATE

> PROPERTY: STRAIN AT BREAK DIRECTION: CROSS-ROLL

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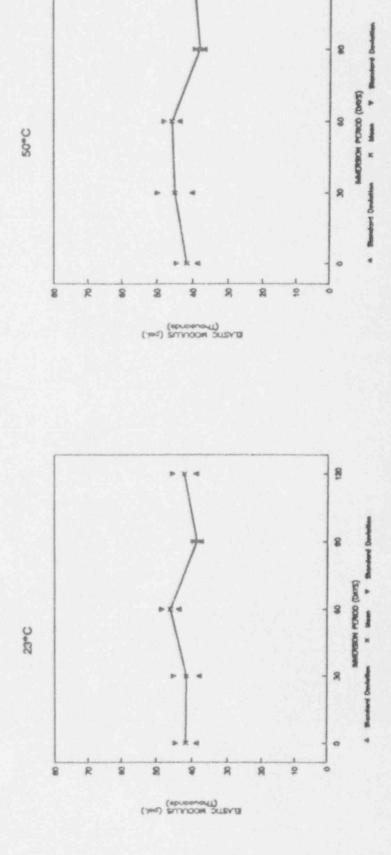
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CLEAT: DAMES & MOONE MANUFACTURESE, DAMES & MOONE ABTIM DBDM BANKS DATE TEBTED

BROUKTTRAK, WINGTE HOME' INCOMPANY MC187-308 - 2019 COS DECOMMITES ADE MOL: MATERIAL TYPE CHMMATERIAL TYPE LENOMITE

PROPERTY: ELASTIC MODULUS DIRECTION: ROLL

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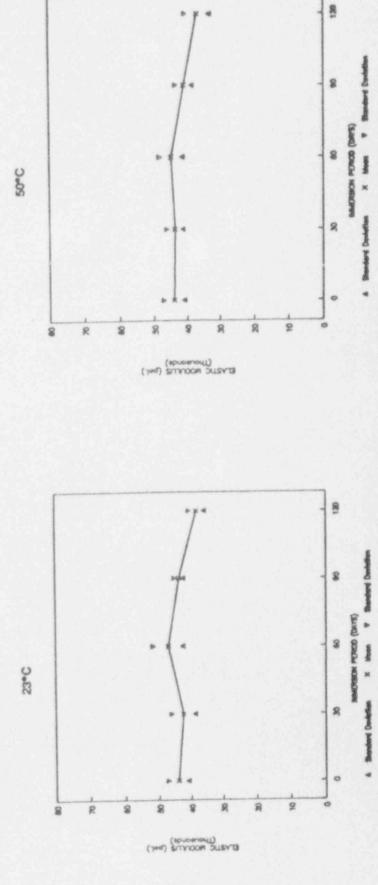
CHEMICAL COMPATIBILITY TEST RESULTS

CURSHT: DAVIES & INCOME MUMURFACTURER OLIVER LARNO BYETEMS METHOD: ANTH DASH DATE TEATED: SAME

OCCORPTEC JOB IN: MCHR20000 MATERIAL JAPTE HONE, MEMBRANE MANAGTERINCH STORE MEMBRANE LENCHATE MCHR20000

> PROPERTY: ELASTIC MODULUS DIRECTION: CROSS-ROLL

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CLEAT: DAMES & MOORE CTUNESE GUALDE LARMO BYBITEMS

ABTM D1004 303492 MANNUFACTUNESE METHOD?

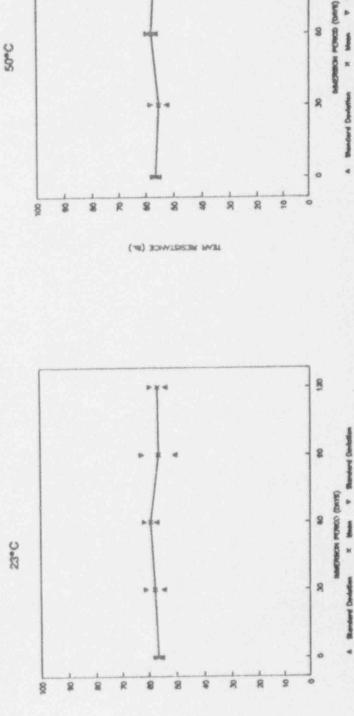
CHEMICAL COMPATIBILITY TEST RESULTS

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BIENNELIANT MONTLE NOVE DEGREGADE MC167-000 10 MK ARDAMMTEC JOB NO.: MATEPAAL TYPE CHANACTEPARTICE LEADMTE

PROPERTY: INITIAL TEAR RESISTANCE DIRECTION: ROLL

No. Oppose I	Tanu Oomer Provide Land	1340				D-48				1				BUNC			-	Į	
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TEAR RESISTANCE (BL)



CLIENT: DAMES & MOORE MANUFACTURER: OLINIX F LINING BYBTEND HETHOR ANTH DINN DATE TERTED: 3/5482

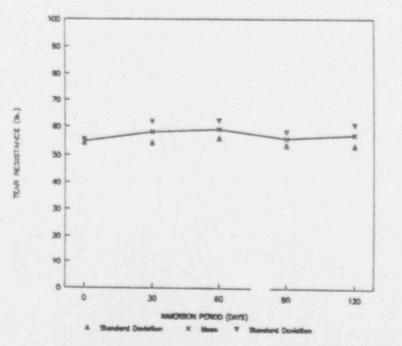
GEOSYNTEC JOB NO .: MC187-030 MATERIAL TYPE: NORE MERINANE CHARACTERNITICS IN MIL

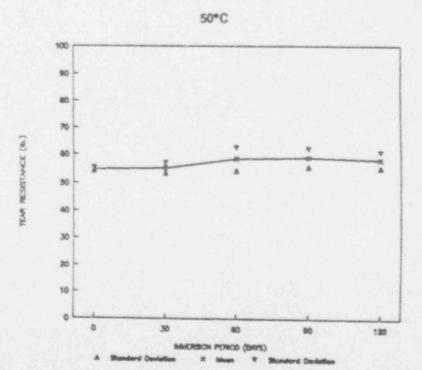
LEACHATE: BROURTPRAL HOUSTE

PROPERTY: INITIAL TEAR RESISTANCE DIRECTION: CROSS-ROLL

EXPOSURE PERIOD	UNIT				28°C								60°C					
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CONTROL BAMPLE		68.00	64.75	64.06	84.96	66.10	64.09	0.42	M/A.	86.00	84.78	84.08	54.85	66,10	84,09	9.42	NEA	BHY
30 DAY BAMPLE	1111	68.50	89.98	\$4.20	83.70	86.68	66.00	8.82	8.08	66.80	64.88	65.66	88.96	82,36	96.09	1,73	0.71	- URW
BO DAY BAMPLE		61,48	60.06	82.10	84.18	89.06	58,60	8,16	7,81	64.56	83.75	60.00	66,00	87.86	58.57	4,16	8.73	BNM
90 DAY RAMPLE	1.11	83.26	58.26	\$4.28	BHP. 10	66.36	56,04	2.84	1,74	66.10	84.00	65,96	88.30	80.90	68,77	8.29	7 AB	BW
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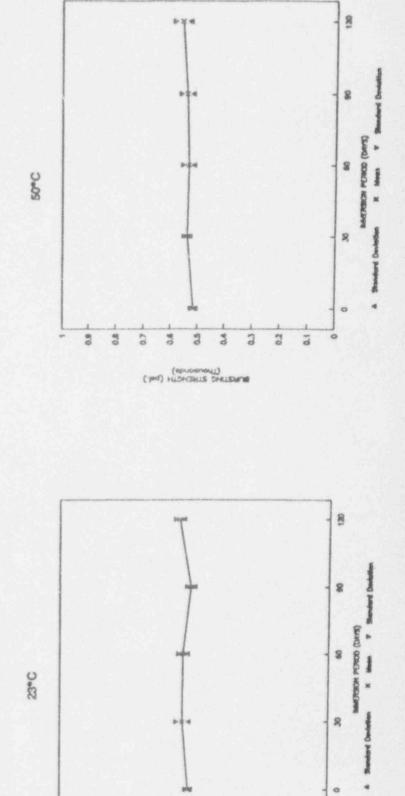
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CHEMICAL COMPATIBILITY TEST RESULTS

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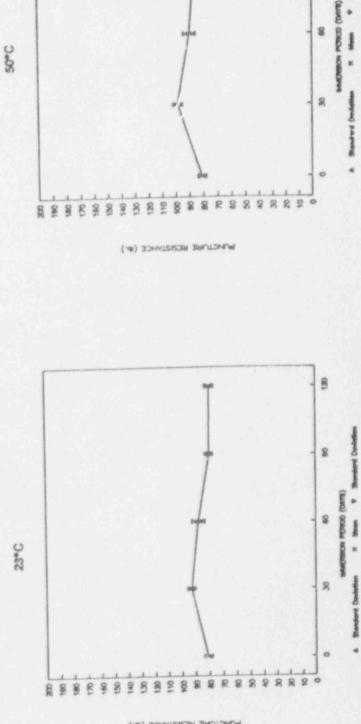
PROPERTY: PUNCTURE RESISTANCE

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APPENDIX C LEACHATE ANALYSIS

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Total Constituent Analysis Pre - Leaching TABLE S.1.3

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SUMMARY OF SLUDGE CHARACTERIZATION DATA

CONSTITUENT, APPENDIX IX	V-I POND	CELITE POND	BURN	DEEPWELL POND
Total Metal				
Arsenic	 1.0	4.5	2.8	3.2
Barium	65	44	28	59
Cadmium	0.9	0.9	0.8	0.5
Chromium	2."	32	60	11.7
Lead	10.5	8.9	8.1	3.8
Mercury	0.14	0.15	0.05	0.6
Selenium	0.4	0.9	0.6	< 0.3
Silver	1.3	1.1	2.0	1.2
Total Organic				
1,1,1-Trichloroethane	5.2	ND	ND	1.7
Trichioroethylens	ND	ND	7.8	D
Tetrachloroethylene	ND	ND	DN	1.4
Methyl Ethyl Ketone	4.9	D	D	ND
Acetope	2.8	D	D	D
Bromomethane	ND	ND	2.0	D
Bromoform	ND	ND	ND	ND
Chloroform	ND	D	ND	ND
1.1-Dichloroethylene	4.9	ND	ND	D
Methylene Chloride	ND	D	D	ND
Benzene	ND	ND	D	ND
Toluene	ND	ND	D	ND
Eibyl Benzene	ND	ND	D	ND
Acetonitrile	110	6.5	26.8	19.7
Acrylonitrile	ND	8.0	ND	4.0
Pyridine	ND	7.5	57	26
Methyl Pyridine	ND	ND	D	ND
Methyl Naphthalene	ND	0.5	D	ND
Pheool	ND	ND	D	ND
o-Cresol	ND	ND	D	ND
p.m-Cresol	ND	ND	D	ND
Inorganic			1404	2140
Total Cyanide	186	621	1695	3148

All results are expressed in mg/kg wet weight

D - Compound Detected Below Quantitation Level

ND - Not detected