



October 19, 2009

Nuclear Regulatory Commission
Materials Licensing Branch
US Nuclear Regulatory Commission, Region III
2443 Warrenville Road, Suite 210
Lisle, IL 60532-4352

ATTN: George M. McCann

RE: License Amendment Request – License No. 24-13365-01, Amendment 36,
Decommissioning Plan for Sanitary Lagoon and Drainfield

Mr. McCann:

Analytical Bio-Chemistry Laboratories is submitting the Decommissioning Plan for the Sanitary Lagoon and Drainfield. Enclosed is the Site Characterization Data and proposed Remediation Plan and the Radiation Protection and Instrumentation Procedures. If you have any questions or need further information, please feel free to contact Sheila C. Hecht at 573-777-6070.

Sincerely,

A handwritten signature in blue ink that reads 'Sheila Hecht'.

Sheila C. Hecht
Director, Safety and Occupational Health

RECEIVED OCT 21 2009

Estimated burden per response to comply with this mandatory collection request: 4.4 hours. Submittal of the application is necessary to determine that the applicant is qualified and that adequate procedures exist to protect the public health and safety. Send comments regarding burden estimate to the Records and FOIA/Privacy Services Branch (T-5 F53), U.S. Nuclear Regulatory Commission, Washington, DC 20555-0001, or by internet e-mail to infocollects@nrc.gov, and to the Desk Officer, Office of Information and Regulatory Affairs, NEOB-10202, (3150-0120), Office of Management and Budget, Washington, DC 20503. If a means used to impose an information collection does not display a currently valid OMB control number, the NRC may not conduct or sponsor, and a person is not required to respond to, the information collection.

APPLICATION FOR MATERIAL LICENSE

INSTRUCTIONS: SEE THE APPROPRIATE LICENSE APPLICATION GUIDE FOR DETAILED INSTRUCTIONS FOR COMPLETING APPLICATION. SEND TWO COPIES OF THE ENTIRE COMPLETED APPLICATION TO THE NRC OFFICE SPECIFIED BELOW.

APPLICATION FOR DISTRIBUTION OF EXEMPT PRODUCTS FILE APPLICATIONS WITH:

DIVISION OF INDUSTRIAL AND MEDICAL NUCLEAR SAFETY
OFFICE OF NUCLEAR MATERIALS SAFETY AND SAFEGUARDS
U.S. NUCLEAR REGULATORY COMMISSION
WASHINGTON, DC 20555-0001

ALL OTHER PERSONS FILE APPLICATIONS AS FOLLOWS:

IF YOU ARE LOCATED IN:

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DIVISION OF NUCLEAR MATERIALS SAFETY
U.S. NUCLEAR REGULATORY COMMISSION, REGION I
475 ALLENDALE ROAD
KING OF PRUSSIA, PA 19406-1415

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2443 WARRENVILLE ROAD, SUITE 210
LISLE, IL 60532-4352

ALASKA, ARIZONA, ARKANSAS, CALIFORNIA, COLORADO, HAWAII, IDAHO, KANSAS, LOUISIANA, MONTANA, NEBRASKA, NEVADA, NEW MEXICO, NORTH DAKOTA, OKLAHOMA, OREGON, PACIFIC TRUST TERRITORIES, SOUTH DAKOTA, TEXAS, UTAH, WASHINGTON, OR WYOMING, SEND APPLICATIONS TO:

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U.S. NUCLEAR REGULATORY COMMISSION, REGION IV
611 RYAN PLAZA DRIVE, SUITE 400
ARLINGTON, TX 76011-4005

PERSONS LOCATED IN AGREEMENT STATES SEND APPLICATIONS TO THE U.S. NUCLEAR REGULATORY COMMISSION ONLY IF THEY WISH TO POSSESS AND USE LICENSED MATERIAL IN STATES SUBJECT TO U.S. NUCLEAR REGULATORY COMMISSION JURISDICTIONS.

1. THIS IS AN APPLICATION FOR *(Check appropriate item)*

A. NEW LICENSE

B. AMENDMENT TO LICENSE NUMBER 24-13365-01

C. RENEWAL OF LICENSE NUMBER _____

2. NAME AND MAILING ADDRESS OF APPLICANT *(Include ZIP code)*

Analytical Bio-Chemistry Laboratories, Inc.
7200 E. ABC Lane
Columbia MO 65202

3. ADDRESS WHERE LICENSED MATERIAL WILL BE USED OR POSSESSED

Analytical Bio-Chemistry Laboratories, Inc.
7200 E. ABC Lane
Columbia MO 65202

4. NAME OF PERSON TO BE CONTACTED ABOUT THIS APPLICATION

Sheila C. Hecht

TELEPHONE NUMBER

(573) 777-6070

SUBMIT ITEMS 5 THROUGH 11 ON 8-1/2 X 11" PAPER. THE TYPE AND SCOPE OF INFORMATION TO BE PROVIDED IS DESCRIBED IN THE LICENSE APPLICATION GUIDE.

5. RADIOACTIVE MATERIAL

a. Element and mass number; b. chemical and/or physical form; and c. maximum amount which will be possessed at any one time.

6. PURPOSE(S) FOR WHICH LICENSED MATERIAL WILL BE USED.

7. INDIVIDUAL(S) RESPONSIBLE FOR RADIATION SAFETY PROGRAM AND THEIR TRAINING EXPERIENCE.

8. TRAINING FOR INDIVIDUALS WORKING IN OR FREQUENTING RESTRICTED AREAS.

9. FACILITIES AND EQUIPMENT.

10. RADIATION SAFETY PROGRAM.

11. WASTE MANAGEMENT.

12. LICENSE FEES *(See 10 CFR 170 and Section 170.31)*

FEE CATEGORY	AMOUNT ENCLOSED	\$

13. CERTIFICATION. *(Must be completed by applicant)* THE APPLICANT UNDERSTANDS THAT ALL STATEMENTS AND REPRESENTATIONS MADE IN THIS APPLICATION ARE BINDING UPON THE APPLICANT.

THE APPLICANT AND ANY OFFICIAL EXECUTING THIS CERTIFICATION ON BEHALF OF THE APPLICANT, NAMED IN ITEM 2, CERTIFY THAT THIS APPLICATION IS PREPARED IN CONFORMITY WITH TITLE 10, CODE OF FEDERAL REGULATIONS, PARTS 30, 32, 33, 34, 35, 36, 39, AND 40, AND THAT ALL INFORMATION CONTAINED HEREIN IS TRUE AND CORRECT TO THE BEST OF THEIR KNOWLEDGE AND BELIEF.

WARNING: 18 U.S.C. SECTION 1001 ACT OF JUNE 25, 1948 62 STAT. 749 MAKES IT A CRIMINAL OFFENSE TO MAKE A WILLFULLY FALSE STATEMENT OR REPRESENTATION TO ANY DEPARTMENT OR AGENCY OF THE UNITED STATES AS TO ANY MATTER WITHIN ITS JURISDICTION.

CERTIFYING OFFICER - TYPED/PRINTED NAME AND TITLE

Sheila Hecht, Director Safety and Occupational Health

SIGNATURE *Sheila Hecht*

DATE

10/19/2009

FOR NRC USE ONLY

TYPE OF FEE	FEE LOG	FEE CATEGORY	AMOUNT RECEIVED	CHECK NUMBER	COMMENTS
			\$		
APPROVED BY				DATE	

**Site Characterization and Remediation
Plan in Support of Decommissioning
for
Analytical Bio-Chemistry
Laboratories
Sanitary Lagoon, Application Area &
Drain Field Rev.0**

**Site Characterization and Remediation Plan in
Support of Decommissioning for
Analytical Bio-Chemistry Laboratories
Sanitary Lagoon, Application Area & Drain Field
Rev.0**

Co-Authored By: Paul Nipper
Paul Nipper, QA Manager, Bionomics, Inc.

Date: 10/15/09

Co-Authored By: Andy Lombardi
Andy Lombardi, CHP, Safety & Ecology Corp.

Date: 10/15/09

Reviewed By: Sheila Hecht
Sheila Hecht, Director Safety and Occupational
Health, ABC Laboratories, Inc.

Date: 10/15/09

Approved By: Scott Ward
Scott Ward, Senior Vice President,
ABC Laboratories, Inc.

Date: 10/20/09

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Disposal of C-14 Contaminated Soil
In accordance with 10 CFR 20.2002 and pursuant to a 10 CFR 30.11 exemption

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1.0 INTRODUCTION

ABC Labs requests that the NRC categorize this decommissioning as a Group 4 decommissioning "Unrestricted Release with Site-Specific Dose Analysis and No Ground Water Contamination; Decommissioning Plan Required." under NUREG 1757 "Consolidated NMSS Decommissioning Guidance" because subsurface (>15cm depth) contamination is present in excess of the C-14 default screening value. From NUREG 1757: "Group 4 facilities have residual radiological contamination present in building surfaces and soils, but the licensee cannot meet, or chooses not to use, screening criteria, and the ground water is demonstrably not contaminated. The licensees are able to demonstrate that residual radioactive material may remain at their site but within the levels specified in NRC criteria for unrestricted use (10 CFR 20.1402, "Radiological Criteria for Unrestricted Use") by applying site-specific criteria in a comprehensive dose analysis.

This plan was developed using the guidance provided in NUREG 1757, "Consolidated NMSS Decommissioning Guidance" and NUREG 1575, "Multi Agency Radiation Survey and Site Investigation Manual" (MARSSIM). It will provide the approach, methods, and techniques for the radiological decommissioning of impacted areas of the facility. Final status surveys will be designed to implement the protocols and guidance provided in MARSSIM to demonstrate compliance with the project release criteria.

The sanitary lagoon, application area and drain field (Impacted Areas) have been characterized and areas have been identified which require remediation in order to achieve unrestricted release. The sanitary lagoon contains the highest levels of contamination and is approximately 0.31 acre in size. The application area is comprised of the field on the western side of the lagoon and contains lower levels of contamination. The drainfield consists of the p.v.c piping which distributed the effluent from the lagoon with moderate levels of contamination found at the northern discharge point. The p.v.c piping is buried at approximately 1-2 foot depending on the lay of the land and is covered with gravel and a geo textile material. The p.v.c. piping had holes drilled into the pipe to allow effluent from the lagoon to disperse into the surrounding soil. Discussions with facility personnel indicate that this system was not very efficient and that the piping system would periodically become plugged and required flushing. Sample results indicate that higher levels are found at the discharge point versus around the piping itself. Soil was removed to uncover the p.v.c. piping so that samples could be obtained at the surface and subsurface of the piping.

This plan identifies those areas with proposed remedial action. In brief, areas requiring remediation will be excavated down to a level which meets criteria for unrestricted use. The total area the licensee requests unrestricted release for in this plan comprises approximately 28 acres of the Westside of the facility and encompasses the Residential and Agricultural zoned areas with the exception of Building M as shown in **Attachment IB Facility Map grid locations A-D 25-28**. The areas described above comprise a Partial Site Release for unrestricted use and will not remain under the control of the broadscope license with no intention of future licensed activities being conducted. The PSR will be offered for sale after the PSR has been released for Unrestricted Use. Administrative controls shall be implemented to restrict access to the area by unauthorized employees.

Excavated material will be disposed of at a commercial licensed facility. This material has been categorized as exempt material with final disposition at the US Ecology disposal site in Idaho. **ABC requests NRC review and approval to dispose of this material as exempt material based on the assessment in Section 11. The Energy Solutions site in Utah is designated as an alternative site. The NRC shall be notified if this option for disposal is used.**

1.1 Facility Background

Analytical Biochemistry Laboratories is a contract research organization that conducts research, development, and manufacturing of pharmaceuticals and agricultural chemicals. ABC Labs incorporated and purchased the site property in 1968. Operation at the site began in 1968. An Atomic Energy Commission License was obtained in 1972 for possession and use of electron capture detectors in gas chromatography instruments. Use of radioactive materials increased over time with the addition of other radionuclides, primarily carbon-14 and tritium. ABC Labs currently performs research, development, manufacturing and distribution of radioactive materials.

The Missouri Department of Natural Resources (MDNR) issued Construction Permit number 26-1030 on May 15, 1986 and a Letter of Approval on June 6, 1986, authorizing the construction of a single 13,500 square foot (0.31 acre) surface lagoon with 540 linear feet of 2 inch diameter piping, to accommodate an average flow of 10,000 gallons per day. The lagoon, application area and drain field were constructed on the west side of the site. This lagoon served the sanitary needs of the facility until March 2, 2004 when sewerage discharge was diverted to Boone County Regional Sewer District. This lagoon system is regulated by MDNR under the National Pollutants Discharge Elimination System (NPDES) permit number **MO-0104591**.

1.2 Facility Description

The Analytical Bio-Chemistry (ABC) Laboratory facility is located at 7200 East ABC Lane in Columbia, Missouri 65202 adjacent to Interstate 70 approximately 3 miles northeast of the city of Columbia. The site is approximately 56 acres in size and is zoned as Planned Office, General Industrial, and Controlled Industrial Districts in central Boone County. The sanitary lagoon application area and drain field are now situated in the General Industrial District (M-P).

Boone County is comprised of 691 square miles of which 685 square miles are land and six square miles is water. The 2007 population was estimated at 152,435. The population of Columbia, MO is 94,000 according to US Census records.

As part of their research and development, the facility uses some radioactive materials, primarily ¹⁴C (Carbon-14) under the U.S. Nuclear Regulatory Commission (NRC) broad-scope license number 24-13365-01. There are three main laboratory/office buildings, two smaller laboratory buildings previously used for in-vivo animal studies, two greenhouses,

maintenance building, warehouse and waste storage facility as shown in Attachment IB Facility Map.

As part of the facility, a sanitary surface lagoon, application area and drain-field as shown in Attachment I B was built in 1986 on the western part of the site above Grindstone Creek. The lagoon had a design area of 0.31 acre (13,500 ft²) and a design operating depth of three feet and maximum depth of about six feet. The lagoon was permitted by the Missouri Department of Natural Resources, to serve the facilities sanitary needs. Discharges to the lagoon were conveyed by a single sanitary (PVC) sewer line four inches in diameter. This sewer line originally feeding the lagoon and conveying radioactive materials (¹⁴C) in the form of aqueous solutions has been terminated and plugged with concrete effectively eliminating further discharge of radioactive material and contamination to the lagoon. This conveyance was terminated by plugging one end of the pipe. The remaining section of pipe from that point to the discharge point in the lagoon is open (not filled with concrete) and was sampled to determine the radiological condition. The results did not indicate the piping was contaminated. Further sampling will be conducted during the decommissioning process to validate this statement. In the event the piping exceeds limits established in this DP the affected section of piping will be remediated.

In March of 2004, the facilities sewerage discharge was diverted to the Boone County Regional Sewer District and the use of the sanitary lagoon was discontinued. Through site operations, a small amount of ¹⁴C in aqueous solutions had been periodically discharged to the sanitary lagoon under the land application provision as described and permitted in condition 20 of Amendment 26 in the radioactive materials license. This material was very dilute aqueous effluent from environmental fate and aquatic toxicology activities in building J and no other discharge of radioactive materials were authorized or allowed. The amount of ¹⁴C in aqueous solution discharged averaged less than one curie per year in conformance with 10 CFR section 20.2003.

Prior to the construction and operation of the sanitary lagoon in 1986 two "Historical Sanitary Ponds" were used to collect the discharge of the facility from 1968 until 1986. These ponds were backfilled and this area is currently used as an employee parking lot. There is no data available that indicates these ponds were permitted either by the Missouri Department of Natural Resources or the NRC. The historical sanitary ponds are not covered under the scope of this DP.

During the initial site characterization the historical ponds and discharge pathway were sampled. Results are attached for informational use only. All samples were below default screening levels and no further action is outlined in this DP for the historical ponds.

There is an additional area on site which previously used radioactive materials designated as the lysimeter area. This area is not covered under the scope of this DP and PSR as well.

The Historical Sanitary Ponds and Lysimeter area will be addressed by ABC Labs as required in separate submittals.

1.3 Environmental Information –NUREG-1748

1.3.1 Land Use

The impacted area proposed for remediation is currently zoned M-P General Industrial. The area is in a dormant state and is anticipated to remain dormant after release. The facility is bounded by residential, agricultural and commercially zoned areas which appear to be in a stable phase of growth. Remediation of the affected areas will not affect present or future land use in these areas.

1.3.2 Transportation

Approximately fifty to sixty shipments of packaged soil/debris will be transported from ABC labs to the Columbia Terminal railroad transload facility located at 6501 Brown Station Road in Columbia, MO 65201 for transfer to gondola rail cars. Seven to ten flatbed shipments per day to the transload facility are planned for seven days. Due to the close proximity of the transload facility (a distance of 10.81 miles) and the relative number of shipments per day the impact to local traffic and the environment will not be affected. The route the waste will follow is from ABC east on ABC Lane to right on MO-Z, merge onto I-70W/US-40 W. Exit on 128A to US-63 N to MO-B ramp to Paris Rd. to North Brown Station Rd. The material is classified as D.O.T. exempt in regards to radioactivity. External exposure on the packaged material will not be a factor due to the radionuclide ¹⁴C involved. Exposure to the public and transportation workers from this operation is not applicable.

1.3.3 Geology and Soils

Two geological formations are found in Boone County which are designated as Pennsylvanian-Age Bedrock and Mississippian-Age Bedrock. The site has been characterized as deep, moderately well drained, moderately sloping, eroded soils of the uplands. The permeability of the soil is indicated to be 1.2" per hour. The surface soil is Linley loam and clay loam 4" to 7" deep overlying plastic sandy clay. Reference USDA Soil Survey

1.3.4 Water Resources

The aquifer in Boone County is designated as Mississippian Limestones, Ordovician and Cambrian Dolomites and Sandstones. The watershed is described as the "Bonne Femme" and is a karst watershed. Depth to water table on the site is designated as 12" to 36". Reference: USDA Soil Survey. Additionally, the average depth to water level as recorded in a Columbia, MO observation well has recently averaged a mean value of 191.33 feet. Ref: USGS Information from MDNR indicates depth to water on site @ 145

feet Ref: MEGA Missouri Environmental Geology Atlas Div. of Geology and Land Surveys

(See Attachment III)

1.3.5 Meteorology, Climatology

Boone County has a climate that is marked by extremes in temperature. The average annual precipitation is about 38 inches; a considerable part of this occurs during the growing season. The average annual snowfall is about 16 inches. The climate is fairly uniform through out the county, and no major differences exist among the soils because of it.

1.3.6 Noise

An increase in noise will be generated from mechanical excavation equipment and transportation vehicles during the remediation of the site. These operations are scheduled between the hours of 0800 to 1700. The nearest residential area is 1000 feet from the remediation activities and no impact is anticipated.

1.3.7 Historic and Cultural Resources – N/A

1.3.8 Visual/Scenic Resources – N/A

1.3.9 Socioeconomic – N/A

1.3.10 Public and Occupational Health – N/A

1.3.11 Waste Management – **See Section 10.0**

1.3.12 Conclusion

The proposed remediation of the lagoon, application area and drain field poses no significant impact to the local wildlife habitat and environs.

2.0 AREAS REQUIRING REMEDIATION

Based upon sample results and dose modeling, the primary area requiring remediation has been identified. This primary area is: **See Attachment IA Stoplight Map & IB Facility Grid Map Grids I-M 19-21**

Sanitary Lagoon and Embankment Area (Berm)



Sample results indicate the removal of the sediment layer covering the clay liner to achieve release criteria. The sediment layer depth is from zero to six inches deep. The clay liner will also require limited remediation. Anticipated excavation will be to a depth of six to eight inches. The estimated disposal volume is <22,000 cubic feet.

3.0 AREAS ABOVE BACKGROUND <Acceptance Criteria (210 pCi/g)

The following areas have elevated levels of ^{14}C but are below the average DCGL of 210 picocuries per gram (See Attachment IA). *Selected areas* within these areas will be subject to limited remediation as part of ABC Labs proactive approach thus assuring that administrative levels of 89 picocuries per gram are achieved. In the event sampling indicates levels (after remediation) are >89 picocuries per gram but less than 210 picocuries per gram an assessment will be performed to determine the value of removing additional soil relative to cost to achieve the administrative limit.

Sample results indicate the removal of the topsoil in selected areas to achieve release criteria. The topsoil depth is from zero to six inches deep. Anticipated excavation will be to a depth of six inches to eight inches.

Sanitary Lagoon Drain-field and soil surrounding System Piping

Areas to be remediated include the Northern discharge area of the drain field piping system. Additional sampling will be performed on the drain field piping system to assure remediation goals are achieved as well as in selected areas around and down gradient from the piping. It is estimated an area from the northern discharge end of the piping will require removal to a depth of six inches to eight inches and ten feet out from the pipe discharge outlet. The locations ABC-DF-05, ABC-DF-06, ABC-DF-07, ABC-DF-08 (>210 pCi/g) and ABC-DF-21.

Field Application Area

There are three locations identified in this area as ABC-FA-14, ABC-FA -B-27 and ABC- FA-B-31.

4.0 GPS SAMPLE LOCATIONS (See Attachment I A Stoplight Map)

Note: Lagoon GPS locations were not obtained in the lagoon since this area will not require cross referencing for remediation purposes. Berm sample locations bound the perimeter of the lagoon.

5.0 CHARATERIZATION DATA SUMMARY

(See Attachment IA Facility Maps for sample locations and Attachment II for sample results)

Sample Location Determination

A review of drawings and physical inspection of the lagoon drainage system was made to determine logical sampling points based on the engineering design of the system. Additionally, interviews with ABC personnel were conducted to further gain insight to the system. The lagoon itself had been sampled previously and demonstrated elevated activity for ^{14}C . Additional sampling was performed and confirmed earlier sample results. Please note that attached maps do not have sample locations listed in the lagoon.

The application area sampling locations were determined using a bias and grid approach while taking the physical lay of the land into account for water runoff. Please note the term application area is defined as the area that the lagoon effluent would have seeped into from the drainfield piping system. Typically a drain field system is defined as the piping system and leach field.

The drainfield piping system consists of p.v.c piping. The discharge points were determined to be logical sample points as discussions with ABC personnel indicated the system at times did not function efficiently and effluent would flow to the discharge points rather than seep thru the piping system as engineered. Additional sampling was taken every 50 feet on the piping system. The pipe was exposed by excavating and removing the gravel surrounding the pipe so that a representative soil sample could be obtained.

5.1 Background Samples

See Attachment IA and Attachment II Sample Results

As part of the site characterization, ten samples were collected to document the levels of natural ^{14}C in the environment. These levels are expected to be low in comparison to the characterization screening criterion.

All background samples were collected from a non-affected area within the 56 acre site boundary with similar geologic characteristics to the areas of concern. These samples were taken from areas of the site up-gradient of the areas of concern

Number of samples – 10

Results = <MDA

5.2 Sanitary Lagoon and Embankment Area (Berm)

See Attachment IA and Attachment II Sample Results

5.2.1 Lagoon

5.2.1.1 Number of samples – 38

5.2.1.2 Results

High - 3570 pCi/g
Low - 13 pCi/g
Mean - 950 pCi/g

- 5.2.2 Top of Embankment (Berm)
 - 5.2.2.1 Number of samples - 30
 - 5.2.2.2 Results

High - 2.8 pCi/g
Low - <MDA
Mean - <MDA

5.3 Field Application Area
See Attachment IA and Attachment II Sample Results

- 5.3.1 Number of samples - 39
- 5.3.2 Results

High - 153 pCi/g
Low - <MDA
Mean - 40 pCi/g

5.4 Drain Field Piping System
See Attachment IA and Attachment II Sample Results

- 5.4.1 Number of samples - 32
- 5.4.2 Results

High - 247 pCi/g
Low - <MDA
Mean - 37 pCi/g

5.5 Well Samples
See Attachment II Sample Results

- 5.5.1 Number of samples - 4
- 5.5.2 Results
 - Old Well - 197 pCi/L
 - Well #1 - 0 pCi/L
 - Well #2 - 525 pCi/L
 - Deep Well - 0 pCi/L

6.0 REMEDIATION PLAN

This plan will be implemented to achieve unrestricted release of the impacted areas, which comprise a total of 28 acres. ABC Laboratories is committed to assuring all remediation activities are conducted in accordance with written approved procedures in a safe and compliant manner in order to safeguard the public, environment and workers during all phases of the sanitary lagoon, drain field and application area remediation. Please note: We have been in contact with the State of Missouri MDNR regarding their requirements in regards to a lagoon closure plan. This DP may be accepted by MDNR as adequate for meeting their requirements.

Remediation work will be performed under contract by Bionomics, Inc. and Safety and Ecology Corporation (SEC) employees. Contractor activities shall be performed by trained and qualified personnel under the terms and conditions of the SEC Kentucky Radioactive Materials License number 201-650-90. Reciprocity will be applied for and granted prior to remediation activities.

Health & Safety, Quality Assurance and Operating procedures as outlined in the SEC RAM License and SEC H&S Plan will be implemented and adhered to during remediation. All personnel involved directly or indirectly will be trained in their areas of responsibilities.

OVERALL PROJECT

Phase One

The first phase will consist of mobilization of personnel and equipment on site. Facility and project orientation will be conducted and any site specific training will be performed and documented. Radworker training shall be given commensurate with individuals' job duties. Prior training may be accepted in lieu of on site training. Initial Bioassays for project employees will be obtained. Area boundaries will be established to control access.

Phase Two

The second phase of the project consists of removing soil and will start at the northern end discharge point of the drain pipe system. Remediated soil will be placed in the lagoon to provide temporary containment. Samples will be obtained of these remediated areas to determine if cleanup goals have been achieved. If results indicate elevated values further remediation will be implemented. After the drain field (piping system) and discharge areas have been remediated the application area will be remediated. Remediated soil from this area will be placed in the lagoon as well with sampling done to confirm release levels are achieved.

Phase Three

The third phase will consist of removing soil from the lagoon itself and packaging into lift liners. The loaded lift liners will be staged for loading onto transport vehicles.

Phase Four

The fourth phase consists of shipping packaged material off site for disposal

Phase Five

The fifth phase consists of performing the final site survey.

Phase Six

This is the final phase of the project and consists of submitting FSS information to the NRC for review and determination and concurrence that the PSR meets unrestricted release criteria.

6.1 Anticipated Waste Volumes and Type

6.1.1 Soil/Debris - <26,000 ft³ NRC Waste Class - Exempt

6.1.2 Liquids - <2000 liters of Aqueous Liquid

6.2 Excavation and Packaging Phases

The primary hazards associated with this project will be from working on and around mechanical equipment. Standard safeguards will be taken and addressed in operating procedures as well as in Radiation Work Permits. Soil will be removed using mechanical excavation equipment. The first phase of remediation will concentrate on the removal of soil/debris from the drain field and application area. This material will be placed within the lagoon as temporary containment.

The second phase of remediation will concentrate on the Sanitary Lagoon and embankment area. Soil will be packaged into Pac-Tec LP-85 10 yd³ lift liners or similar packaging. The approximate weight per package is estimated at 20,000 pounds.

The third phase of remediation will involve the shipping of packaged material to the COLT rail spur facility in Columbia for loading into rail cars.

6.3 Staging Area

A staging area will be set up and maintained as a Radioactive Materials storage area for the temporary staging and storage of excavated material prior to shipment to the COLT rail spur. At the time of shipment the packages will be loaded by mechanical means (forktruck, crane) onto flat bed trailers for transport to the spur. This area is currently designated on:

Attachment IB Facility Map grid areas I-J 22-23

6.4 Additional Sampling Requirements

Additional sampling (Remedial Action Support Surveys) will be required during the remediation phase to assure removal of material and remediation goals have been accomplished. These samples will be counted on site with 10% sent to an offsite lab for comparison. These samples will be sent to General Engineering Labs or another accredited lab for analysis with appropriate chain of custody documentation. These confirmatory samples may be utilized in the Final Survey Data.

6.5 Disposal Shipments

At a minimum all shipments and packaging will meet DOT requirements for the material being shipped for disposal. Disposal site waste acceptance criteria will also apply. This material will not be classified as a Class 7 radioactive material for purposes of transportation. Material will be packaged and transported approximately eleven miles via flatbed trailers to the Columbia Terminal Railroad spur. The packaged material will then be transferred to gondola cars for shipment to the US Ecology disposal site in Idaho. Radiological surveys will be conducted on waste packages and transport vehicles to assure DOT requirements and disposal site waste acceptance criteria are met.

7.0 REMEDIATION ALARA ANALYSIS PLAN (See Attachment VI)

8.0 PROJECT SCHEDULE AND COST

8.1 Schedule

This project is dependent on NRC review and approval. Plan is scheduled for delivery to the NRC on October 20, 2009 with anticipated approval by December 21, 2009. The tentative start date is May 3, 2010, dependent on weather conditions. With remediation activities scheduled for completion by July 15, 2010. The final site survey and report is scheduled for completion and submittal to the NRC August 4, 2010. This schedule will be dictated by weather conditions.

Please note that should the schedule change and require revision the NRC will be notified. Should the scheduled completion date be delayed a request for amending the DP with revised completion date will be submitted to the NRC. Attachment IV describes work phases, resources and timeline.

8.2 Cost

The estimated disposal volume is <26,000 cubic feet. The estimated total cost for the project is \$1,807,725.00. **See Attachment IV** for cost breakdown.

9.0

DECOMMISSIONING MANAGEMENT ORGANIZATION

This decommissioning will be performed by the Bionomics, Inc. and Safety & Ecology team. Paul Nipper will be the on site Project Manager for Bionomics, Inc. Bionomics, Inc. will be providing the personnel and equipment for remediation (soil excavation), waste packaging and waste transportation activities. All activities are subject to and controlled by SEC D&D License and procedures in addition to any ABC Radioactive Materials License requirements. SEC will be providing Health Physics support. ABC Labs will be auditing the decommissioning process.

Andy Lombardo is the CHP assigned to the project.

Mr. Nipper has over twenty years experience in the Radioactive Waste Management arena and is responsible for overall project operations. All work is to be performed under the terms and conditions of the SEC Radioactive Materials License.

Mr. Lombardo has over twenty years experience in Health Physics, D& D; and MARSSIM disciplines, in a variety of project settings. Mr. Lombardo is responsible for all project Radiation Protection activities as well as the Final Site Survey.

10.0

RADIATION HEALTH & SAFETY PROGRAM (See Attachment IX)

Contained in SEC Procedure Binder

11.0

EXEMPTION REQUEST (See Attachment V)

Disposal of C-14 Contaminated Soil

In accordance with 10 CFR 20.2002 and pursuant to a 10 CFR 30.11 exemption

Attachment V contains the exemption request with supporting documentation for the US Ecology Site in Grandview, ID.

12.0

RADIOACTIVE WASTE MANAGEMENT PROGRAM

12.1

Solid Waste

An estimated 26,000 cubic feet of solid waste is anticipated to be generated for remediation. The majority will be soil, gravel, concrete, pvc piping and protective clothing. The radionuclide involved is ¹⁴C with total activity <600 mCi.

25,300 ft³ soil

500 ft³ gravel

100 ft³ pvc piping

50 ft³ concrete

50 ft³ protective clothing, gloves, paper towels, misc.

12.2 Liquid Waste

An estimated 2000 liters of aqueous liquid waste may be generated. This liquid may be generated during equipment decontamination operations and pumping of the lagoon should significant rainfall occur. All liquids will be contained and sampled prior to waste determination. ¹⁴C is the radionuclide involved with total estimated activity of <10 mCi.

12.3 Mixed Waste – Not Applicable

Initial sampling was performed and analysis performed that indicated no chemical impacts in the lagoon. See Attachment II. Additional sampling has been performed and has been submitted. Results have not been reported as of this writing. Analytical data is scheduled for delivery on October 21, 2009 and will be submitted under separate cover. As soon as the results are available they will be reviewed and submitted to MDNR for concurrence that Mixed Waste is not an issue.

13.0 QUALITY ASSURANCE

Quality Assurance requirements will be governed as applicable in the SEC QA Procedure contained in Attachment IX.

14.0 FSSP (See Attachment VI) Includes DCGL Report, Sensitivity Analysis, ALARA Analysis Evaluation and VSP Hot Spot Detection

15.0 FINANCIAL ASSURANCE

The Financial Assurance mechanism for the remediation of the Sanitary Lagoon, Application Area and Drain Field will be in the form of a Surety Bond.

16.0 ATTACHMENTS

See Table of Contents

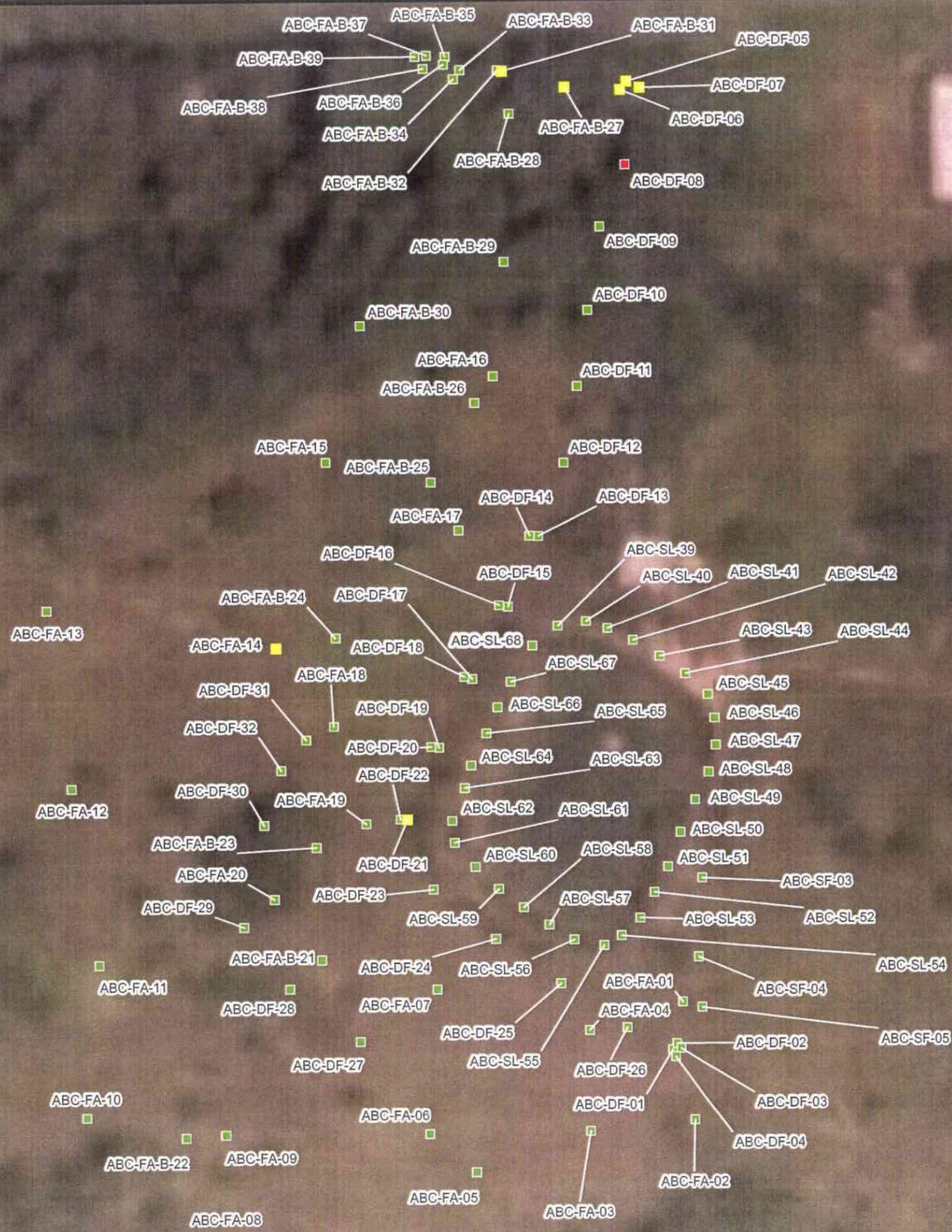
ATTACHMENT I.A

FACILITY MAPS “STOP LIGHT”

Note: These maps have sample ID labels as recorded with GPS. The first map is the western section of the facility that contains the lagoon, drain field and application areas. This area comprises the Partial Site Release.

Samples inside the lagoon were not labeled.

The second map is of the eastern section of the facility and sample ID labels are of the Historical Sanitary Ponds and are for information only. Background samples are also depicted on this map.



Map Extent

Legend

C-14 Contamination (pCi/gm)

- < 89
- 89 - 210
- > 210



Soil Samples (0 - 6 inches) (Western Portion),
ABC

	Date	09/25/09
	Drawing	09092501.B



Map Extent

Legend

C-14 Contamination (pCi/gm)

- < 89
- 89 - 210
- > 210



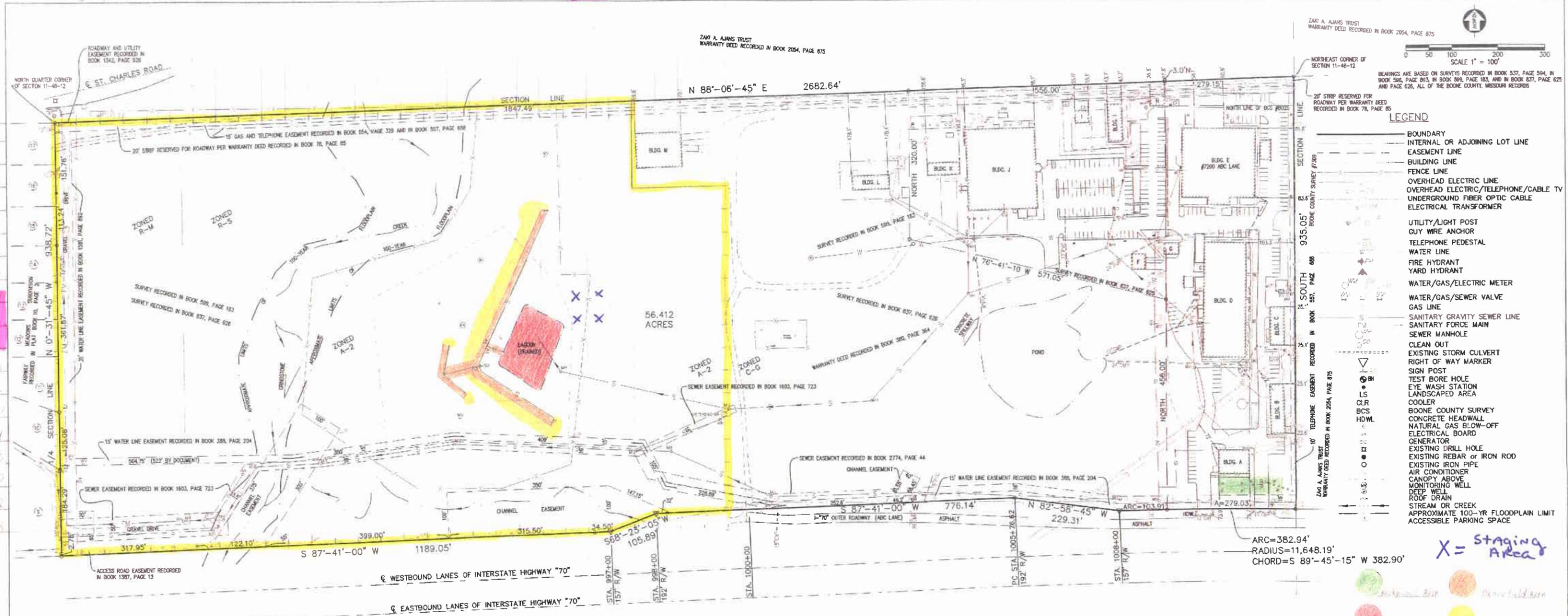
Soil Samples (0 - 6 inches) (Eastern Portion)
ABC

	Date	09/25/09
	Drawing	09092502.b

ATTACHMENT I.B

FACILITY MAPS “Grid Map”

Note: This map is gridded.
This map depicts the entire facility.
The Partial Site Release is bounded in yellow.



ZAO A. AJANS TRUST
WARRANTY DEED RECORDED IN BOOK 2054, PAGE 875

SCALE 1" = 100'

BEARINGS ARE BASED ON SURVEYS RECORDED IN BOOK 537, PAGE 594, IN BOOK 596, PAGE 803, IN BOOK 599, PAGE 183, AND IN BOOK 837, PAGE 625 AND PAGE 626, ALL OF THE BOONE COUNTY, MISSOURI RECORDS

- LEGEND**
- BOUNDARY
 - INTERNAL OR ADJOINING LOT LINE
 - EASEMENT LINE
 - BUILDING LINE
 - FENCE LINE
 - OVERHEAD ELECTRIC LINE
 - OVERHEAD ELECTRIC/TELEPHONE/CABLE TV
 - UNDERGROUND FIBER OPTIC CABLE
 - ELECTRICAL TRANSFORMER
 - UTILITY/LIGHT POST
 - GUY WIRE ANCHOR
 - TELEPHONE PEDESTAL
 - WATER LINE
 - FIRE HYDRANT
 - YARD HYDRANT
 - WATER/GAS/ELECTRIC METER
 - WATER/GAS/SEWER VALVE
 - GAS LINE
 - SANITARY GRAVITY SEWER LINE
 - SANITARY FORCE MAIN
 - SEWER MANHOLE
 - CLEAN OUT
 - EXISTING STORM CULVERT
 - RIGHT OF WAY MARKER
 - SIGN POST
 - TEST BORE HOLE
 - EYE WASH STATION
 - LANDSCAPED AREA
 - COOLER
 - BOONE COUNTY SURVEY
 - CONCRETE HEADWALL
 - NATURAL GAS BLOW-OFF
 - ELECTRICAL BOARD
 - GENERATOR
 - EXISTING DRILL HOLE
 - EXISTING REBAR or IRON ROD
 - EXISTING IRON PIPE
 - AIR CONDITIONER
 - CANOPY ABOVE
 - MONITORING WELL
 - DECK
 - ROOF DRAIN
 - STREAM OR CREEK
 - APPROXIMATE 100-YR FLOODPLAIN LIMIT
 - ACCESSIBLE PARKING SPACE

ARC=382.94'
RADIUS=11,648.19'
CHORD=S 89°-45'-15" W 382.90'

X = Staging Area

PSR Bounded in Yellow

NOTES
CORRESPONDING TO SCHEDULE B EXCEPTIONS
CHICAGO TITLE INSURANCE COMPANY
COMMITMENT FOR TITLE INSURANCE
COMMITMENT NO: 020073475 DATED SEPTEMBER 26, 2007

1. NO ENCROACHMENTS EXIST ON THIS PROPERTY, EXCEPT AS SHOWN ON THIS SURVEY. UNDERGROUND UTILITY SERVICE LINES ARE NOT SHOWN IN THEIR ENTIRETY.
2. THE TOTAL AREA OF THE TWO TRACTS DESCRIBED HEREON IS 56.412 ACRES.
3. ZONING OF THIS 52.412 ACRE TRACT IS C-G (GENERAL COMMERCIAL) FOR THE EASTERN 1230± FEET OR ABOUT 26+ ACRES, AND A-2 (AGRICULTURE) FOR THE REMAINING PART LYING EAST OF GRINDSTONE CREEK. THE WESTERN PART OF THE 52.412 ACRE TRACT LYING WEST OF GRINDSTONE CREEK IS R-S (SINGLE-FAMILY RESIDENTIAL), EXCEPT FOR THE WESTERN 270 FEET AS MEASURED ALONG THE NORTH SECTION LINE, WHICH IS ZONED R-M (MODERATE DENSITY RESIDENTIAL) AND DEFINED BY A LINE 390 FEET EAST OF AND PARALLEL WITH THE EAST RIGHT-OF-WAY LINE OF DEMARET DRIVE.
4. ON THIS DATE, THE FLOOD INSURANCE RATE MAP, COMMUNITY-PANEL NUMBER 290034 0150 B, DATED JUNE 15, 1983, WAS REVIEWED. THE REVIEW SHOWED THAT THE WESTERN PART OF THIS 52.412 ACRE TRACT, LYING ALONG GRINDSTONE CREEK, IS CONTAINED WITHIN THE 100-YEAR FLOODPLAIN, THE APPROXIMATE LIMITS OF WHICH ARE SHOWN. THE MAP SHOWS THE LIMITS OF THE 100-YEAR FLOODPLAIN ALONG THE NORTH PROPERTY LINE TO BE APPROXIMATELY 300 FEET ACROSS, AND NARROWING TO APPROXIMATELY 70 FEET ACROSS AT THE SOUTH PROPERTY LINE AT THE I-70 RIGHT-OF-WAY. THE REMAINDER OF THE TRACT HOWEVER, IS NOT CONTAINED IN ANY DESIGNATED FLOOD HAZARD AREA.
5. MODOT PLANS FOR IMPROVING INTERSTATE HIGHWAY 70 AND ITS OUTER ROADWAY SYSTEM CALL FOR A ROAD TO BE BUILT THROUGH THE WEST PART OF THIS TRACT CONNECTING THE EAST END OF THE OUTER ROADWAY, KNOWN AS ABC LANE, WITH ST. CHARLES ROAD AT THE NORTHWEST CORNER AREA OF THIS 52.412 ACRE TRACT. SEE THE MISSOURI DEPARTMENT OF TRANSPORTATION'S WEBSITE OF www.improvet70.org FOR ADDITIONAL INFO.
6. HOWEVER, BOONE COUNTY PLANNING & ZONING, IN CONJUNCTION WITH BOONE COUNTY PUBLIC WORKS DEPARTMENT, HAS A GENERAL OVERALL PLAN FOR THE RE-ROUTING OF ST. CHARLES ROAD ALONG THE NORTH LINE OF THIS 52.412 ACRE TRACT EXTENDING IT EASTERLY FOR A MILE AND 3/4 FROM THE NORTHWEST CORNER THEREOF TO STATE ROUTE 21. PRELIMINARY PLANNING CALLS FOR THE RIGHT-OF-WAY FOR THIS COLLECTOR ROADWAY TO BE TAKEN MOSTLY FROM THE ADJACENT TRACT TO THE NORTH OF THE SECTION LINE.
7. (COMMITMENT NOTE 13) A ROAD AND UTILITY EASEMENT OF 167 SQUARE FEET IS LOCATED AT THE NORTHWEST CORNER OF THIS TRACT AS SHOWN HEREON AND IS RECORDED IN BOOK 1342, PAGE 926. IT IS TRIANGULAR IN SHAPE, EXTENDING 58.36 FEET EASTERLY ALONG THE NORTH LINE, AND EXTENDING 5.73 FEET SOUTHERLY ALONG THE WEST LINE OF THIS TRACT FROM THE NORTHWEST CORNER.
8. (COMMITMENT NOTE 14) THE SOUTH 95 FEET OF THE WEST 70 FEET OF THIS TRACT IS SUBJECT TO A SEWER EASEMENT OF 6647 SQUARE FEET TO BOONE COUNTY REGIONAL SEWER DISTRICT, RECORDED IN BOOK 1387, PAGE 13 AND SHOWN HEREON.
9. (COMMITMENT NOTE 15) THE WEST 35 FEET OF THIS TRACT IS SUBJECT TO A WATER LINE EASEMENT TO PUBLIC WATER SUPPLY DISTRICT NO. 9, RECORDED IN BOOK 1581, PAGE 892 AND SHOWN HEREON.
10. (COMMITMENT NOTE 16) A RIGHT-OF-WAY EASEMENT, TEN FEET WIDE AND TO WILLIAMS COMMUNICATIONS, INC., IS RECORDED IN BOOK 1598, PAGE 43, AND IS LOCATED WITHIN THE OIL & GAS RIGHT-OF-WAY OF NO DESIGNATED WIDTH AND 'BLANKET-TYPE', COVERING THE PIPELINES SHOWN ALONG THE SOUTHEAST PART OF THIS TRACT. SEE NOTE 14 REGARDING THE PIPELINES.
11. (COMMITMENT NOTE 17) TEMPORARY CONSTRUCTION EASEMENTS OF 0.40 ACRE AND 0.29 ACRE IN SIZE TO BOONE COUNTY REGIONAL SEWER DISTRICT AND RECORDED IN BOOK 1603, PAGE 721, HAVE EXPIRED AND ARE NO LONGER ARE IN EFFECT.

12. (COMMITMENT NOTE 18) A SEWER EASEMENT IN THE SOUTHWEST PART OF THIS TRACT, BEING 50 FEET WIDE FOR THE WESTERN COURSE, NARROWING TO 33.5 FEET WIDE ON THE NEXT COURSE, AND TO 16 FEET WIDE FOR THE EASTERN FOUR COURSES, TO BOONE COUNTY REGIONAL SEWER DISTRICT AND RECORDED IN BOOK 1603, PAGE 723, IS LOCATED AS SHOWN WITHIN THE SOUTH 230 FEET OF THE WEST 1470 FEET OF THIS TRACT.
13. (COMMITMENT NOTE 19) THIS 52.412 ACRE TRACT IS SUBJECT TO RIGHTS GRANTED TO THE STATE OF MISSOURI, ACTING BY AND THROUGH THE STATE HIGHWAY COMMISSION OF MISSOURI (MODOT) PER CONVEYANCE OF RIGHT-OF-WAY RECORDED IN BOOK 5, PAGE 116. SAID RIGHTS INCLUDE LIMITING THE DIRECT ACCESS TO THE INTERSTATE ONLY TO THE ADJACENT OUTER ROADWAY.
14. (COMMITMENT NOTE 20) AN EASEMENT OF NO DESIGNATED WIDTH AND 'BLANKET-TYPE' ACROSS THE ENTIRE TRACT, COVERING THE PIPELINES SHOWN ACROSS THE SOUTHEAST PART OF THIS TRACT, TO TEXAS-EMPIRE PIPE LINE COMPANY, NOW TO WILLIAMS PIPELINE CO., IS RECORDED IN BOOK 189, PAGE 234.
15. (COMMITMENT NOTE 21) THIS 52.412 ACRE TRACT IS SUBJECT TO RIGHTS GRANTED TO THE STATE OF MISSOURI, ACTING BY AND THROUGH THE STATE HIGHWAY COMMISSION OF MISSOURI (MODOT) PER CONVEYANCE OF RIGHT-OF-WAY RECORDED IN BOOK 2, PAGE 414. SAID DESCRIPTION WITHIN THIS CONVEYANCE APPEARS TO BE SUPERSEDED BY BOOK 5, PAGE 116. SEE NOTE 13.
16. (COMMITMENT NOTE 22) A WATER LINE EASEMENT, 15 FEET WIDE TO PUBLIC WATER SUPPLY DISTRICT NO. 9, RECORDED IN BOOK 388, PAGE 204 AND SHOWN HEREON ALONG THE EAST 1150± FEET OF THE SOUTH LINE AND THROUGH THE SOUTHWEST PART OF THIS 52.412 ACRE TRACT.
17. (COMMITMENT NOTE 23) A WATER LINE EASEMENT, 20 FEET WIDE AND 'BLANKET-TYPE' ACROSS THE ENTIRE TRACT AND TO PUBLIC WATER SUPPLY DISTRICT NO. 9, IS RECORDED IN BOOK 396, PAGE 761. THIS EASEMENT APPEARS TO BE SUPERSEDED BY THE WATER LINE EASEMENT RECORDED IN BOOK 388, PAGE 204. SEE NOTE 16 ABOVE.
18. (COMMITMENT NOTE 24) A GAS EASEMENT, 15 FEET WIDE TO UNION ELECTRIC COMPANY, NOW AMEREN UE, AND WITHIN THE NORTH 50 FEET OF THIS TRACT, IS RECORDED IN BOOK 554, PAGE 329 AND IS LOCATED 7.5 FEET ON EACH SIDE OF THE ELECTRIC LINE AS SHOWN HEREON ALONG THE NORTH LINE OF THIS TRACT.
19. (COMMITMENT NOTE 25) A TELEPHONE LINE EASEMENT, 15 FEET WIDE TO GENERAL TELEPHONE COMPANY, NOW CENTURYTEL, AND WITHIN THE NORTH 50 FEET OF THIS TRACT, IS RECORDED IN BOOK 557, PAGE 688 AND IS LOCATED 7.5 FEET ON EACH SIDE OF THE ELECTRIC LINE AS SHOWN HEREON ALONG THE NORTH LINE OF THIS TRACT. THE EAST TEN FEET OF THIS TRACT IS ALSO SUBJECT TO A TELEPHONE LINE EASEMENT TO GENERAL TELEPHONE COMPANY, NOW CENTURYTEL, RECORDED IN THE SAME BOOK 557, PAGE 688 AND SHOWN HEREON.
20. (COMMITMENT NOTE 26) THE NORTH 20 FEET OF THIS TRACT IS DESCRIBED AS BEING RESERVED BY THE GRANTOR IN NOVEMBER, 1891 FOR A ROADWAY TO NO SPECIFIC ENTITY, PER A WARRANTY DEED RECORDED IN BOOK 78, PAGE 85 AND IS SHOWN HEREON. SAID ROAD IS ALSO SHOWN ALONG THE NORTH SECTION LINE BY SURVEYS RECORDED IN BOOK 598, PAGE 893 AND IN BOOK 837, PAGE 625 AND PAGE 626.
21. (COMMITMENT NOTE 27) A SEWER EASEMENT OF 24,023 SQUARE FEET TO THE CITY OF COLUMBIA, MISSOURI, 16 FEET WIDE AND RECORDED IN BOOK 2774, PAGE 44, IS SHOWN HEREON IN THE EAST 1450± FEET OF THE SOUTH PART OF THIS 52.412 ACRE TRACT.
22. (COMMITMENT NOTE 28) A TEMPORARY CONSTRUCTION EASEMENT OF 35,945 SQUARE FEET IN SIZE TO THE CITY OF COLUMBIA, MISSOURI AND RECORDED IN BOOK 2774, PAGE 45, HAVE EXPIRED DUE TO CONSTRUCTION COMPLETION AND ARE NO LONGER ARE IN EFFECT.

TWO TRACTS OF LAND IN THE NORTH HALF OF THE NORTHEAST QUARTER OF SECTION 11, T48N, R12W, BOONE COUNTY, MISSOURI, THE WESTERN PART BEING THE 45.418 ACRE TRACT SHOWN AND DESCRIBED BY A SURVEY RECORDED IN BOOK 837, PAGE 626, AND THE EASTERN PART BEING THE 10.994 ACRE TRACT SHOWN AND DESCRIBED BY A SURVEY RECORDED IN BOOK 837, PAGE 627, TOGETHER COMPRISING THAT TRACT DESCRIBED BY A WARRANTY DEED RECORDED IN BOOK 380, PAGE 364, ALL OF THE BOONE COUNTY RECORDS, BEING DESCRIBED AS FOLLOWS:

BEGINNING AT THE NORTH QUARTER CORNER OF SECTION 11, T48N, R12W; THENCE N88°-06'-45"E, ALONG THE NORTH LINE OF SAID SECTION, 2682.64 FEET TO THE NORTHEAST CORNER OF SAID SECTION; THENCE SOUTH, ALONG THE EAST LINE OF SAID SECTION, 935.05 FEET TO THE NORTH RIGHT-OF-WAY LINE OF INTERSTATE HIGHWAY 70 ON A CURVE HAVING A RADIUS OF 11,648.19 FEET; THENCE, FOLLOWING SAID NORTH RIGHT-OF-WAY LINE; ALONG SAID CURVE TO THE LEFT, 382.94 FEET (A CHORD S89°-45'-15" W 382.90 FEET) TO HIGHWAY STATION 1008+00; N82°-58'-45" W 229.31 FEET TO THE PC STATION OF SAID CURVE; S87°-41'-00" W 776.14 FEET TO HIGHWAY STATION 998+00; S88°-23'-05" W 105.89 FEET TO HIGHWAY STATION 997+00; AND S87°-41'-00" W 1189.05 FEET TO THE WEST LINE OF THE NORTHEAST QUARTER OF SAID SECTION; THENCE, LEAVING SAID RIGHT-OF-WAY LINE, N0°-31'-45" W, ALONG SAID QUARTER SECTION LINE, 938.72 FEET TO THE POINT OF BEGINNING AND CONTAINING 56.412 ACRES.

SURVEY CERTIFICATE
THE UNDERSIGNED HEREBY CERTIFIES, AS OF OCTOBER 31, 2007, TO FIRST NATIONAL BANK, SILICON VALLEY BANK, ANALYTICAL BIO-CHEMISTRY LABORATORIES, INC., A MISSOURI CORPORATION AND ITS SUCCESSORS AND ASSIGNS, UNGARETTI & HARRIS, LLP AND ITS SUCCESSORS AND ASSIGNS AND CHICAGO TITLE INSURANCE COMPANY, THAT HE IS A DULY REGISTERED LAND SURVEYOR OF THE STATE OF MISSOURI; THAT THIS PLAT OF SURVEY IS MADE AT LEAST IN ACCORDANCE WITH THE MINIMUM STANDARDS ESTABLISHED BY SAID STATE FOR SURVEYS AND LAND SURVEYORS AND WITH THE REGISTERED REQUIREMENTS FOR LAND TITLE SURVEYS AS ADOPTED BY THE AMERICAN LAND TITLE ASSOCIATION AND AMERICAN CONGRESS ON SURVEYING AND MAPPING; THAT THIS SURVEY CORRECTLY SHOWS THE LOCATION OF ALL BUILDINGS, STRUCTURES AND OTHER IMPROVEMENTS SITUATED ON THE SUBJECT PREMISES; AND THAT, EXCEPT AS SHOWN, THERE ARE NO VISIBLE EASEMENTS OR RIGHTS-OF-WAY ACROSS SAID PREMISES OR ANY OTHER EASEMENTS OR RIGHTS-OF-WAY OF WHICH THE UNDERSIGNED HAS BEEN ADVISED, NO PARTY WALLS, NO ENCROACHMENTS ONTO ADJOINING PREMISES, STREETS OR ALLEYS BY ANY OF SAID BUILDINGS, STRUCTURES OR OTHER IMPROVEMENTS, AND NO ENCROACHMENTS ONTO SAID PREMISES BY BUILDINGS, STRUCTURES OR OTHER IMPROVEMENTS SITUATED ON ADJOINING PREMISES; I FURTHER CERTIFY THAT THE PROPERTY CONTAINS STRIPED SPACES FOR 237 VEHICLES, INCLUDING 4 ACCESSIBLE SPACES.

MARSHALL ENGINEERING AND SURVEYING, INC.
BY:

RONALD G. LUECK
PROFESSIONAL LAND SURVEYOR
MISSOURI LS #1957

11/08/07	N.R./M.D.S.	INITIAL RELEASE	R.G.L.
Date	By	Description	Apprval/By
PROJECT ANALYTICAL BIO-CHEMISTRY LABORATORIES, INC. BOONE COUNTY, MISSOURI			
SHEET TITLE ALTA/ASTM SURVEY			
Marshall Engineering and Surveying, Inc. 300 Saint James Street Columbia, MO 65201-4302 (573) 678-8632 FAX: (573) 875-1039 marshall@marshalleng.com			JOB NO. 07665/2197 J 07 SHEET 1 3

ATTACHMENT II

SAMPLE RESULTS

	BACKGROUND SAMPLES						
	SAMPLE DEPTH				QC SAMPLES		
	0-6"				GEL LABORATORIES		
SAMPLE LOCATION	dpm	pCi/.5g		pCi/g			pCi/g
ABC-BK-01	-21.98	-9.91078		-19.8216			-0.561
ABC-BK-02	-17.82	-8.03504		-16.0701			
ABC-BK-03	-28.73	-12.9544		-25.9087			
ABC-BK-04	-32.03	-14.4423		-28.8847			
ABC-BK-05	-22.98	-10.3617		-20.7234			
ABC-BK-06	-18.71	-8.43634		-16.8727			
ABC-BK-07	-13.78	-6.2134		-12.4268			
ABC-BK-08	-18.32	-8.26049		-16.5210			
ABC-BK-09	-15.89	-7.1648		-14.3296			
ABC-BK-10	-10.59	-4.77503		-9.5501			

	HISTORICAL SANITARY PONDS						
	FOR INFORMATION ONLY						
	SAMPLE DEPTH				QC SAMPLES		
	0-6"				GEL LABORATORIES		
SAMPLE LOCATION	dpm	pCi/.5g	pCi/g		pCi/g		
ABC-SP-01	-31.24	-14.0861	-28.1722				
ABC-SP-02	-26.43	-11.9173	-23.8346		1.47		
ABC-SP-03	-26.26	-11.8406	-23.6813				
ABC-SP-04	-27.84	-12.5531	-25.1061				
ABC-SP-05	-13.97	-6.29907	-12.5981				
ABC-SP-06	-27.51	-12.4043	-24.8085				
ABC-SP-07	-29.4	-13.2565	-26.5129		1.08		
ABC-SP-08	-28.8	-12.9859	-25.9718				

		HISTORICAL PONDS DISCHARGE							
		SAMPLE DEPTH			QC SAMPLES				
		0-6"			GEL LABORATORIES				
	SAMPLE LOCATION	dpm	pCi/.5g	pCi/g	pCi/g				
	ABC-PD-01	5.64	2.543076	5.086152					
	ABC-PD-02	-23.64	-10.6593	-21.3186					
	ABC-PD-03	-20.4	-9.19836	-18.3967					
	ABC-PD-04	-27.35	-12.3321	-24.6642					
	ABC-PD-05	-20.7	-9.33363	-18.6673					
	ABC-PD-06	-20.19	-9.10367	-18.2073	0.806				
	ABC-PD-07	-32.51	-14.6588	-29.3175					
	ABC-PD-08	-20.8	-9.37872	-18.7574					
	ABC-PD-09	-7.7	-3.47193	-6.94386					
	ABC-PD-10	-19.21	-8.66179	-17.3236					
	ABC-PD-11	-22.23	-10.0235	-20.047					
	ABC-PD-12	-28.79	-12.9814	-25.9628					

SANITARY LAGOON			
SAMPLE DEPTH			
0-6"			
SAMPLE LOCATION	dpm	pCi/.5g	pCi/g
ABC-SL-01	1664.35	719.0728	1438.146
ABC-SL-02	100.26	13.82459	27.64919
ABC-SL-03	917.85	382.4759	764.9519
ABC-SL-04	952.29	398.0049	796.0098
ABC-SL-05	271.83	91.18551	182.371
ABC-SL-06	168.54	44.61205	89.22409
ABC-SL-07	2084.56	908.5455	1817.091
ABC-SL-08	853.45	353.438	706.8759
ABC-SL-09	1018.69	427.9447	855.8894
ABC-SL-10	2484.57	1088.91	2177.82
ABC-SL-11	110.38	18.3877	36.7754
ABC-SL-12	84.19	6.578631	13.15726
ABC-SL-13	4028.96	1785.275	3570.551
ABC-SL-14	2436.36	1067.172	2134.344
ABC-SL-15	132.79	28.49237	56.98474
ABC-SL-16	256.65	84.34085	168.6817
ABC-SL-17	611.8	244.478	488.956
ABC-SL-18	2479.56	1086.651	2173.302
ABC-SL-19	125.47	25.19178	50.38357
ABC-SL-20	1709.1	739.2506	1478.501
ABC-SL-21	1153.27	488.6268	977.2536
ABC-SL-22	2915.09	1283.031	2566.063
ABC-SL-23	511.11	199.0769	398.1537
ABC-SL-24	1405.1	602.177	1204.354
ABC-SL-25	778.78	319.7693	639.5385
ABC-SL-26	1201.29	510.279	1020.558
ABC-SL-27	1468.47	630.7505	1261.501
ABC-SL-28	1375.88	589.0017	1178.003
ABC-SL-29	1675.35	724.0327	1448.065
ABC-SL-30	1157.23	490.4124	980.8247
ABC-SL-31	507.79	197.5799	395.1597
ABC-SL-32	449.2	171.1616	342.3233
ABC-SL-33	1208.95	513.7329	1027.466
ABC-SL-34	978.11	441.0298	882.0596
ABC-SL-35	1280.43	577.3459	1154.692
ABC-SL-B-36	563.25	253.9694	507.9389
ABC-SL-B-37	488.73	220.3684	440.7367
ABC-SL-B-38	3256.89	1468.532	2937.063

	SANITARY LAGOON				
	TOP OF BERM				
	SAMPLE DEPTH			Q.C. SAMPLES	
	0-6"			GEL LABORATORIES	
SAMPLE LOCATION	dpm	pCi/.5g	pCi/g	pCi/g	
ABC-SL-39	-21.42	-9.65828	-19.3166		
ABC-SL-40	-23.22	-10.4699	-20.9398		
ABC-SL-41	-21.26	-9.58613	-19.1723		
ABC-SL-42	-24.05	-10.8441	-21.6883		
ABC-SL-43	-28.5	-12.8507	-25.7013	0.9	
ABC-SL-44	-19.08	-8.60317	-17.2063		
ABC-SL-45	-15.88	-7.16029	-14.3206		
ABC-SL-46	-15.08	-6.79957	-13.5991		
ABC-SL-47	-25.09	-11.3131	-22.6262		
ABC-SL-48	-31.47	-14.1898	-28.3796		
ABC-SL-49	-22.28	-10.0461	-20.0921		
ABC-SL-50	-24.41	-11.0065	-22.0129		
ABC-SL-51	-17.11	-7.7149	-15.4298		
ABC-SL-52	3.05	1.375245	2.75049		
ABC-SL-53	-17.24	-7.77352	-15.547	0.301	
ABC-SL-54	-17.09	-7.70588	-15.4118		
ABC-SL-55	-18.67	-8.4183	-16.8366		
ABC-SL-56	-26.03	-11.7369	-23.4739		
ABC-SL-57	-16.59	-7.48043	-14.9609		
ABC-SL-58	-24.84	-11.2004	-22.4007		
ABC-SL-59	-28.21	-12.7199	-25.4398		
ABC-SL-60	-27.47	-12.3862	-24.7724		
ABC-SL-61	-23.31	-10.5105	-21.021	0.411	
ABC-SL-62	-20.51	-9.24796	-18.4959		
ABC-SL-63	-20.12	-9.07211	-18.1442		
ABC-SL-64	-14.49	-6.53354	-13.0671		
ABC-SL-65	-13.45	-6.06461	-12.1292		
ABC-SL-66	-21.67	-9.771	-19.542		
ABC-SL-67	-20.55	-9.266	-18.532		
ABC-SL-68	-25.74	-11.6062	-23.2123		

APPLICATION FIELD							
SAMPLE LOCATION	SAMPLE DEPTH 0-6"			SAMPLE DEPTH 6-8"			QC SAMPLES GEL LABORATORIES
	dpm	pCi/.5g	pCi/g	dpm	pCi/.5g	pCi/g	pCi/g
ABC-FA-01	39.03	17.59863	35.19725	-18.28	-8.242452	-16.4849	
ABC-FA-02	-1.76	-0.79358	-1.58717				
ABC-FA-03	-19.57	-8.82411	-17.6482				
ABC-FA-04	80.23	36.17571	72.35141	-31.83	-14.35215	-28.70429	
ABC-FA-05	-10.31	-4.64878	-9.29756				
ABC-FA-06	-7.28	-3.28255	-6.5651				5.62
ABC-FA-07	23.41	10.55557	21.11114	-26.7	-12.03903	-24.07806	
ABC-FA-08	-6.76	-3.04808	-6.09617				
ABC-FA-09	-13.82	-6.23144	-12.4629				
ABC-FA-10	-17.12	-7.71941	-15.4388				-0.387
ABC-FA-11	-24.97	-11.259	-22.5179				0.484
ABC-FA-12	-21.73	-9.79806	-19.5961				
ABC-FA-13	-3.65	-1.64579	-3.29157				
ABC-FA-14	133.64	60.25828	120.5166	-19.42	-8.756478	-17.51296	
ABC-FA-15	30.48	13.74343	27.48686				
ABC-FA-16	-6.7	-3.02103	-6.04206				
ABC-FA-17	49.57	22.35111	44.70223	-6.45	-2.908305	-5.81661	
ABC-FA-18	20.19	9.103671	18.20734	-28.66	-12.92279	-25.84559	
ABC-FA-19	30.64	13.81558	27.63115	-29.41	-13.26097	-26.52194	
ABC-FA-20	8.12	3.661308	7.322616				
ABC-FA-B-21	-16.56	-7.4669	-14.9338				
ABC-FA-B-22	19.54	8.810586	17.62117	-27.93	-12.58913	-25.17826	
ABC-FA-B-23	-14.14	-6.37573	-12.7515				
ABC-FA-B-24	35.91	16.19182	32.38364	-25.63	-11.55657	-23.11313	36.7
ABC-FA-B-25	10.88	4.905792	9.811584				
ABC-FA-B-26	18.48	8.332632	16.66526	-10.58	-4.770522	-9.541044	
ABC-FA-B-27	129.48	58.38253	116.7651	-28.18	-12.70636	-25.41272	
ABC-FA-B-28	-19.11	-8.6167	-17.2334				1.41
ABC-FA-B-29	-17.82	-8.03504	-16.0701				
ABC-FA-B-30	-21.06	-9.49595	-18.9919				
ABC-FA-B-31	169.54	76.44559	152.8912	-25.15	-11.34014	-22.68027	
ABC-FA-B-32	56.18	25.33156	50.66312	-29.52	-13.31057	-26.62114	
ABC-FA-B-33	-17.74	-7.99897	-15.9979				
ABC-FA-B-34	-29.89	-13.4774	-26.9548				
ABC-FA-B-35	-10.69	-4.82012	-9.64024				
ABC-FA-B-36	8.8	3.96792	7.93584				
ABC-FA-B-37	-21.58	-9.73042	-19.4608				
ABC-FA-B-38	-18.32	-8.26049	-16.521				
ABC-FA-B-39	-19.96	-8.99996	-17.9999				

DRAIN FIELD EXTERIOR PIPING SAMPLES
(AFTER REMOVAL OF SOIL & GRAVEL TO EXPOSE PIPE)

SAMPLE LOCATION	SAMPLE DEPTH 0-6"			SAMPLE DEPTH 6-8"			QC SAMPLES GEL LABORATORIES
	dpm	pCi/.5g	pCi/g	dpm	pCi/.5g	pCi/g	pCi/g
	ABC-DF-01	118.16	21.8957	43.7914	-31.99	-14.42429	-28.84858
ABC-DF-02	80.04	4.707396	9.41479				
ABC-DF-03	79.48	4.454892	8.90978				4.43
ABC-DF-04	65.08	-2.03807	-4.07614				
ABC-DF-05	270.19	90.44603	180.892	262.33	118.2846	236.5692	Shown as yellow on sample map
ABC-DF-06	298.83	103.3598	206.72	-26.35	-11.88122	-23.76243	
ABC-DF-07	228.89	71.82386	143.648	-37.2	-16.77348	-33.54696	
ABC-DF-08	344.52	123.9614	247.923	-30.18	-13.60816	-27.21632	
ABC-DF-09	-11.5	-5.18535	-10.3707				
ABC-DF-10	6.65	2.998485	5.99697				
ABC-DF-11	-2.74	-1.23547	-2.47093				
ABC-DF-12	9.48	4.274532	8.54906				
ABC-DF-13	-14.62	-6.59216	-13.1843				13.2
ABC-DF-14	-17.14	-7.72843	-15.4569				
ABC-DF-15	4.8	2.16432	4.32864				
ABC-DF-16	85.09	38.36708	76.7342	-27.93	-12.59364	-25.18727	
ABC-DF-17	8.4	3.78756	7.57512				10
ABC-DF-18	21.73	9.798057	19.5961	-28.66	-12.92279	-25.84559	
ABC-DF-19	10.07	4.540563	9.08113				
ABC-DF-20	47.75	21.53048	43.061	-29.02	-13.08512	-26.17024	
ABC-DF-21	115.9	52.25931	104.519	-28.18	-12.70636	-25.41272	
ABC-DF-22	-2.17	-0.97845	-1.95691				
ABC-DF-23	29.2	13.16628	26.3326	-27.8	-12.53502	-25.07004	
ABC-DF-24	-13.08	-5.89777	-11.7955				
ABC-DF-25	-13.07	-5.89326	-11.7865				4.59
ABC-DF-26	-23.34	-10.524	-21.048				
ABC-DF-27	-20.57	-9.27501	-18.55				
ABC-DF-28	-22.49	-10.1407	-20.2815				2.96
ABC-DF-29	-15.32	-6.90779	-13.8156				
ABC-DF-30	-16.73	-7.54356	-15.0871				
ABC-DF-31	51.43	23.18979	46.3796	-32.82	-14.79854	-29.59708	
ABC-DF-32	-24.18	-10.9028	-21.8055				

THESE SAMPLES WERE TAKEN ABOVE SEWER LINE FORMERLY FEEDING LAGOON

SEWER FEED SAMPLES				
SAMPLE DEPTH				
		0-6"		
SAMPLE LOCATION	dpm	pCi/.5g	pCi/g	
ABC-SF-1	-22.96	-10.3527	-20.7053	
ABC-SF-2	-16.19	-7.30007	-14.6001	
ABC-SF-3	18.87	8.508483	17.017	
ABC-SF-4	18.47	8.328123	16.6562	
ABC-SF-5	18.59	8.382231	16.7645	

WELL SAMPLE RESULTS

Eberline Services Final Report of Analysis			Report To:					Work Order Details:					
			Paul Nipper					SDG:	07-10102				
			Bionomics, Inc.					Project:	Lagoon				
			P.O. Box 817					Analysis Category:	ENVIRONMENTAL				
			Kingston, TN 37763					Sample Matrix:	WA				
Lab ID	Sample Type	Client ID	Sample Date	Receipt Date	Analysis Date	Batch ID	Analyte	Method	Result	CU	CSU	MDA	Report Units
07-10102-01	LCS	KNOWN	10/18/07 00:00	10/18/2007	10/21/2007	07-10102	Carbon-14	ENIC Modified	1.49E+03	4.18E+01			pCi/l
07-10102-01	LCS	SPIKE	10/18/07 00:00	10/18/2007	10/21/2007	07-10102	Carbon-14	ENIC Modified	1.18E+03	1.55E+01	8.13E+00	6.01E+00	pCi/l
07-10102-02	MBL	BLANK	10/18/07 00:00	10/18/2007	10/21/2007	07-10102	Carbon-14	ENIC Modified	-3.04E+00	3.44E+00	1.75E+00	6.06E+00	pCi/l
07-10102-03	DUP	OLD WELL #2	10/15/07 14:20	10/18/2007	10/21/2007	07-10102	Carbon-14	ENIC Modified	1.97E+02	3.35E+01	1.71E+01	4.91E+01	pCi/l
07-10102-04	DO	OLD WELL #2	10/15/07 14:20	10/18/2007	10/21/2007	07-10102	Carbon-14	ENIC Modified	1.73E+02	3.31E+01	1.69E+01	4.93E+01	pCi/l
07-10102-05	TRG	WELL #1	10/16/07 10:50	10/18/2007	10/21/2007	07-10102	Carbon-14	ENIC Modified	0.00E+00	1.43E+01	7.27E+00	2.45E+01	pCi/l
07-10102-06	TRG	WELL #2	10/16/07 10:40	10/18/2007	10/21/2007	07-10102	Carbon-14	ENIC Modified	5.25E+02	2.49E+01	1.27E+01	2.47E+01	pCi/l
07-10102-07	TRG	DW #1	10/16/07 14:10	10/18/2007	10/21/2007	07-10102	Carbon-14	ENIC Modified	0.00E+00	1.62E+01	8.25E+00	2.78E+01	pCi/l

CU=Counting Uncertainty;CSU=Combined Standard Uncertainty (1-sigma);MDA=Minimal Detected Activity;LCS=Laboratory Control Sample; MBL=Blank; DUP=Duplicate; TRG=Normal Sample; DO=Duplicate Original

GEL LABORATORIES LLC

2040 Savage Road Charleston SC 29407 - (843) 556-8171 - www.gel.com

Certificate of Analysis Report for

ABCL001 ABC Labs

Client SDG: 195047 GEL Work Order: 195047

The Qualifiers in this report are defined as follows:

- * A quality control analyte recovery is outside of specified acceptance criteria
- ** Analyte is a surrogate compound
- J Value is estimated
- U Analyte was analyzed for, but not detected above the MDL, MDA, or LOD.
- h Preparation or preservation holding time was exceeded
- ND The analyte concentration is not detected above the detection limit.

The above sample is reported on a dry weight basis except where prohibited by the analytical procedure.

Where the analytical method has been performed under NELAP certification, the analysis has met all of the requirements of the NELAC standard unless qualified on the Certificate of Analysis.

This data report has been prepared and reviewed in accordance with GEL Laboratories LLC standard operating procedures. Please direct any questions to your Project Manager, Jake Crook.

Reviewed by



GEL LABORATORIES LLC

2040 Savage Road Charleston SC 29407 - (843) 556-8171 - www.gel.com

Certificate of Analysis

Company : ABC Laboratories, Inc.
Address : 7200 East ABC Lane
Columbia, Missouri 65202

Report Date: November 1, 2007

Contact: Sheila Hecht
Project: **Routine Analytical - Hecht**

Client Sample ID: ABC-SL-QC06-060
Sample ID: 195047003
Matrix: Solid
Collect Date: 19-SEP-07 08:00
Receive Date: 04-OCT-07
Collector: Client

Project: ABCL00107
Client ID: ABCL001

Parameter	Qualifier	Result	Uncertainty	DL	RL	Units	DF	AnalystDate	Time	Batch	Method
Rad Gamma Spec Analysis											
<i>GammaSpec, Gamma, Solid (Standard List)</i>											
Potassium-40		11.6	+/-2.58	1.26	1.00	pCi/g		MJH1 10/27/07	0251	690323	1
Rad Liquid Scintillation Analysis											
<i>LSC, Tritium Dist, Solid</i>											
Tritium	U	0.0925	+/-1.65	2.92	6.00	pCi/g		BXF1 10/30/07	0719	691743	2
<i>Liquid Scint C14, Solid</i>											
Carbon-14	U	0.301	+/-0.797	1.37	2.00	pCi/g		BXF1 10/23/07	2225	690715	3

The following Prep Methods were performed

Method	Description	Analyst	Date	Time	Prep Batch
Dry Soil Prep	Dry Soil Prep GL-RAD-A-021	BXJ1	10/22/07	1724	690075

The following Analytical Methods were performed

Method	Description	Analyst Comments
1	EML HASL 300, 4.5.2.3	
2	EPA 906.0 Modified	
3	EPA EERF C-01 Modified	

GEL LABORATORIES LLC

2040 Savage Road Charleston SC 29407 - (843) 556-8171 - www.gel.com

Certificate of Analysis

Company : ABC Laboratories, Inc.
Address : 7200 East ABC Lane
Columbia, Missouri 65202

Report Date: November 1, 2007

Contact: Sheila Hecht
Project: **Routine Analytical - Hecht**

Client Sample ID: ABC-SL-QC06-50
Sample ID: 195047004
Matrix: Solid
Collect Date: 18-SEP-07 17:30
Receive Date: 04-OCT-07
Collector: Client

Project: ABCL00107
Client ID: ABCL001

Parameter	Qualifier	Result	Uncertainty	DL	RL	Units	DF	Analyst	Date	Time	Batch	Method
Rad Gamma Spec Analysis												
<i>GammaSpec, Gamma, Solid (Standard List)</i>												
Potassium-40		9.63	+/-1.66	0.933	1.00	pCi/g		MJH1	10/27/07	0456	690323	1
Rad Liquid Scintillation Analysis												
<i>LSC, Tritium Dist, Solid</i>												
Tritium	U	0.423	+/-1.77	3.09	6.00	pCi/g		BXF1	10/30/07	0752	691743	2
<i>Liquid Scint C14, Solid</i>												
Carbon-14	U	0.900	+/-0.881	1.47	2.00	pCi/g		BXF1	10/23/07	2241	690715	3

The following Prep Methods were performed

Method	Description	Analyst	Date	Time	Prep Batch
Dry Soil Prep	Dry Soil Prep GL-RAD-A-021	BXJ1	10/22/07	1724	690075

The following Analytical Methods were performed

Method	Description	Analyst Comments
1	EML HASL 300, 4.5.2.3	
2	EPA 906.0 Modified	
3	EPA EERF C-01 Modified	

GEL LABORATORIES LLC

2040 Savage Road Charleston SC 29407 - (843) 556-8171 - www.gel.com

Certificate of Analysis

Company : ABC Laboratories, Inc.
Address : 7200 East ABC Lane
Columbia, Missouri 65202

Report Date: November 1, 2007

Contact: Sheila Hecht
Project: **Routine Analytical - Hecht**

Client Sample ID: ABC-SL-QC06-068
Sample ID: 195047005
Matrix: Solid
Collect Date: 19-SEP-07 08:00
Receive Date: 04-OCT-07
Collector: Client

Project: ABCL00107
Client ID: ABCL001

Parameter	Qualifier	Result	Uncertainty	DL	RL	Units	DF	AnalystDate	Time	Batch	Method
Rad Gamma Spec Analysis											
<i>GammaSpec, Gamma, Solid (Standard List)</i>											
Potassium-40		11.0	+/-2.18	1.14	1.00	pCi/g		MJH1 10/27/07	0701	690323	1
Rad Liquid Scintillation Analysis											
<i>LSC, Tritium Dist, Solid</i>											
Tritium	U	-0.552	+/-1.97	3.59	6.00	pCi/g		BXF1 10/30/07	0824	691743	2
<i>Liquid Scint C14, Solid</i>											
Carbon-14	U	0.411	+/-0.855	1.46	2.00	pCi/g		BXF1 10/23/07	2258	690715	3

The following Prep Methods were performed

Method	Description	Analyst	Date	Time	Prep Batch
Dry Soil Prep	Dry Soil Prep GL-RAD-A-021	BXJ1	10/22/07	1724	690075

The following Analytical Methods were performed

Method	Description	Analyst Comments
1	EML HASL 300, 4.5.2.3	
2	EPA 906.0 Modified	
3	EPA EERF C-01 Modified	

GEL LABORATORIES LLC

2040 Savage Road Charleston SC 29407 - (843) 556-8171 - www.gel.com

Certificate of Analysis

Company : ABC Laboratories, Inc.
Address : 7200 East ABC Lane
Columbia, Missouri 65202

Report Date: November 1, 2007

Contact: Sheila Hecht
Project: **Routine Analytical - Hecht**

Client Sample ID: ABC-FA-OC06-6
Sample ID: 195047006
Matrix: Solid
Collect Date: 19-SEP-07 15:00
Receive Date: 04-OCT-07
Collector: Client

Project: ABCL00107
Client ID: ABCL001

Parameter	Qualifier	Result	Uncertainty	DL	RL	Units	DF	Analyst	Date	Time	Batch	Method
Rad Gamma Spec Analysis												
<i>GammaSpec, Gamma, Solid (Standard List)</i>												
Potassium-40		13.0	+/-2.33	1.22	1.00	pCi/g		MJH1	10/27/07	0906	690323	1
Rad Liquid Scintillation Analysis												
<i>LSC, Tritium Dist, Solid</i>												
Tritium	U	0.555	+/-1.87	3.33	6.00	pCi/g		BXF1	10/30/07	1052	691743	2
<i>Liquid Scint C14, Solid</i>												
Carbon-14		5.62	+/-1.10	1.56	2.00	pCi/g		BXF1	10/23/07	2315	690715	3

The following Prep Methods were performed

Method	Description	Analyst	Date	Time	Prep Batch
Dry Soil Prep	Dry Soil Prep GL-RAD-A-021	BXJ1	10/22/07	1724	690075

The following Analytical Methods were performed

Method	Description	Analyst Comments
1	EML HASL 300, 4.5.2.3	
2	EPA 906.0 Modified	
3	EPA EERF C-01 Modified	

GEL LABORATORIES LLC

2040 Savage Road Charleston SC 29407 - (843) 556-8171 - www.gel.com

Certificate of Analysis

Company : ABC Laboratories, Inc.
Address : 7200 East ABC Lane
Columbia, Missouri 65202

Contact: Sheila Hecht
Project: **Routine Analytical - Hecht**

Report Date: November 1, 2007

Client Sample ID: ABC-FA-OC618-11
Sample ID: 195047007
Matrix: Solid
Collect Date: 19-SEP-07 17:15
Receive Date: 04-OCT-07
Collector: Client

Project: ABCL00107
Client ID: ABCL001

Parameter	Qualifier	Result	Uncertainty	DL	RL	Units	DF	Analyst	Date	Time	Batch	Method
Rad Gamma Spec Analysis												
<i>GammaSpec, Gamma, Solid (Standard List)</i>												
Potassium-40		8.24	+/-1.85	1.17	1.00	pCi/g		MJH1	10/27/07	1111	690323	1
Rad Liquid Scintillation Analysis												
<i>LSC, Tritium Dist, Solid</i>												
Tritium	U	-0.501	+/-1.88	3.54	6.00	pCi/g		BXF1	10/30/07	1108	691743	2
<i>Liquid Scint C14, Solid</i>												
Carbon-14	U	0.484	+/-0.893	1.52	2.00	pCi/g		BXF1	10/23/07	2331	690715	3

The following Prep Methods were performed

Method	Description	Analyst	Date	Time	Prep Batch
Dry Soil Prep	Dry Soil Prep GL-RAD-A-021	BXJ1	10/22/07	1724	690075

The following Analytical Methods were performed

Method	Description	Analyst Comments
1	EML HASL 300, 4.5.2.3	
2	EPA 906.0 Modified	
3	EPA EERF C-01 Modified	

GEL LABORATORIES LLC

2040 Savage Road Charleston SC 29407 - (843) 556-8171 - www.gel.com

Certificate of Analysis

Company : ABC Laboratories, Inc.
Address : 7200 East ABC Lane
Columbia, Missouri 65202

Report Date: November 1, 2007

Contact: Sheila Hecht
Project: **Routine Analytical - Hecht**

Client Sample ID: ABC-FA-QC618-10
Sample ID: 195047008
Matrix: Solid
Collect Date: 19-SEP-07 17:15
Receive Date: 04-OCT-07
Collector: Client

Project: ABCL00107
Client ID: ABCL001

Parameter	Qualifier	Result	Uncertainty	DL	RL	Units	DF	AnalystDate	Time	Batch	Method
Rad Gamma Spec Analysis											
<i>GammaSpec, Gamma, Solid (Standard List)</i>											
Potassium-40		11.6	+/-1.78	0.880	1.00	pCi/g		MJH1 10/26/07	1630	690323	1
Rad Liquid Scintillation Analysis											
<i>LSC, Tritium Dist, Solid</i>											
Tritium	U	0.752	+/-1.93	3.41	6.00	pCi/g		BXF1 10/30/07	1125	691743	2
<i>Liquid Scint C14, Solid</i>											
Carbon-14	U	-0.387	+/-0.740	1.32	2.00	pCi/g		BXF1 10/23/07	2348	690715	3

The following Prep Methods were performed

Method	Description	Analyst	Date	Time	Prep Batch
Dry Soil Prep	Dry Soil Prep GL-RAD-A-021	BXJ1	10/22/07	1724	690075

The following Analytical Methods were performed

Method	Description	Analyst Comments
1	EML HASL 300, 4.5.2.3	
2	EPA 906.0 Modified	
3	EPA EERF C-01 Modified	

GEL LABORATORIES LLC

2040 Savage Road Charleston SC 29407 - (843) 556-8171 - www.gel.com

Certificate of Analysis

Company : ABC Laboratories, Inc.
Address : 7200 East ABC Lane
Columbia, Missouri 65202

Contact: Sheila Hecht
Project: **Routine Analytical - Hecht**

Report Date: November 1, 2007

Client Sample ID: ABC-FA-QC06-24
Sample ID: 195047009
Matrix: Solid
Collect Date: 20-SEP-07 09:00
Receive Date: 04-OCT-07
Collector: Client

Project: ABCL00107
Client ID: ABCL001

Parameter	Qualifier	Result	Uncertainty	DL	RL	Units	DF	Analyst	Date	Time	Batch	Method
Rad Gamma Spec Analysis												
<i>GammaSpec, Gamma, Solid (Standard List)</i>												
Potassium-40		12.7	+/-2.25	0.955	1.00	pCi/g		MJH1	10/26/07	1632	690323	1
Rad Liquid Scintillation Analysis												
<i>LSC, Tritium Dist, Solid</i>												
Tritium	U	1.38	+/-2.40	4.15	6.00	pCi/g		BXF1	10/30/07	1142	691743	2
<i>Liquid Scint C14, Solid</i>												
Carbon-14		36.7	+/-1.81	1.48	2.00	pCi/g		BXF1	10/24/07	0005	690715	3

The following Prep Methods were performed

Method	Description	Analyst	Date	Time	Prep Batch
Dry Soil Prep	Dry Soil Prep GL-RAD-A-021	BXJ1	10/22/07	1724	690075

The following Analytical Methods were performed

Method	Description	Analyst Comments
1	EML HASL 300, 4.5.2.3	
2	EPA 906.0 Modified	
3	EPA EERF C-01 Modified	

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2040 Savage Road Charleston SC 29407 - (843) 556-8171 - www.gel.com

Certificate of Analysis

Company : ABC Laboratories, Inc.
Address : 7200 East ABC Lane
Columbia, Missouri 65202

Report Date: November 1, 2007

Contact: Sheila Hecht
Project: **Routine Analytical - Hecht**

Client Sample ID: ABC-FA-OC06-28
Sample ID: 195047010
Matrix: Solid
Collect Date: 20-SEP-07 09:00
Receive Date: 04-OCT-07
Collector: Client

Project: ABCL00107
Client ID: ABCL001

Parameter	Qualifier	Result	Uncertainty	DL	RL	Units	DF	Analyst	Date	Time	Batch	Method
Rad Gamma Spec Analysis												
<i>GammaSpec, Gamma, Solid (Standard List)</i>												
Potassium-40		13.2	+/-2.34	1.10	1.00	pCi/g		MJH1	10/26/07	1633	690323	1
Rad Liquid Scintillation Analysis												
<i>LSC, Tritium Dist, Solid</i>												
Tritium	U	0.406	+/-2.08	3.74	6.00	pCi/g		BXF1	10/30/07	1158	691743	2
<i>Liquid Scint C14, Solid</i>												
Carbon-14	U	1.41	+/-0.916	1.50	2.00	pCi/g		BXF1	10/24/07	0021	690715	3

The following Prep Methods were performed

Method	Description	Analyst	Date	Time	Prep Batch
Dry Soil Prep	Dry Soil Prep GL-RAD-A-021	BXJ1	10/22/07	1724	690075

The following Analytical Methods were performed

Method	Description	Analyst Comments
1	EML HASL 300, 4.5.2.3	
2	EPA 906.0 Modified	
3	EPA EERF C-01 Modified	

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Certificate of Analysis

Company : ABC Laboratories, Inc.
Address : 7200 East ABC Lane
Columbia, Missouri 65202

Report Date: November 1, 2007

Contact: Sheila Hecht
Project: **Routine Analytical - Hecht**

Client Sample ID: ABC-BK-OC06-01
Sample ID: 195047011
Matrix: Solid
Collect Date: 20-SEP-07 13:20
Receive Date: 04-OCT-07
Collector: Client

Project: ABCL00107
Client ID: ABCL001

Parameter	Qualifier	Result	Uncertainty	DL	RL	Units	DF	Analyst	Date	Time	Batch	Method
Rad Gamma Spec Analysis												
<i>GammaSpec, Gamma, Solid (Standard List)</i>												
Potassium-40		12.2	+/-1.99	0.668	1.00	pCi/g		MJH1	10/26/07	1634	690323	1
Rad Liquid Scintillation Analysis												
<i>LSC, Tritium Dist, Solid</i>												
Tritium	U	0.300	+/-2.91	5.08	6.00	pCi/g		BXF1	10/31/07	1949	691743	2
<i>Liquid Scint C14, Solid</i>												
Carbon-14	U	-0.561	+/-0.853	1.53	2.00	pCi/g		BXF1	10/24/07	0038	690715	3

The following Prep Methods were performed

Method	Description	Analyst	Date	Time	Prep Batch
Dry Soil Prep	Dry Soil Prep GL-RAD-A-021	BXJ1	10/22/07	1724	690075

The following Analytical Methods were performed

Method	Description	Analyst Comments
1	EML HASL 300, 4.5.2.3	
2	EPA 906.0 Modified	
3	EPA EERF C-01 Modified	

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Report Date: November 1, 2007

Contact: Sheila Hecht
Project: **Routine Analytical - Hecht**

Client Sample ID: ABC-PD-OC06-6
Sample ID: 195047012
Matrix: Solid
Collect Date: 20-SEP-07 13:00
Receive Date: 04-OCT-07
Collector: Client

Project: ABCL00107
Client ID: ABCL001

Parameter	Qualifier	Result	Uncertainty	DL	RL	Units	DF	Analyst	Date	Time	Batch	Method
Rad Gamma Spec Analysis												
<i>GammaSpec, Gamma, Solid (Standard List)</i>												
Potassium-40		11.9	+/-2.54	0.900	1.00	pCi/g		MJH1	10/26/07	1635	690323	1
Rad Liquid Scintillation Analysis												
<i>LSC, Tritium Dist, Solid</i>												
Tritium	U	-1.03	+/-2.15	4.12	6.00	pCi/g		BXF1	10/30/07	1232	691743	2
<i>Liquid Scint C14, Solid</i>												
Carbon-14	U	0.806	+/-0.837	1.40	2.00	pCi/g		BXF1	10/24/07	0055	690715	3

The following Prep Methods were performed

Method	Description	Analyst	Date	Time	Prep Batch
Dry Soil Prep	Dry Soil Prep GL-RAD-A-021	BXJ1	10/22/07	1724	690075

The following Analytical Methods were performed

Method	Description	Analyst Comments
1	EML HASL 300, 4.5.2.3	
2	EPA 906.0 Modified	
3	EPA EERF C-01 Modified	

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Company : ABC Laboratories, Inc.
Address : 7200 East ABC Lane
Columbia, Missouri 65202

Contact: Sheila Hecht
Project: **Routine Analytical - Hecht**

Report Date: November 1, 2007

Client Sample ID: ABC-SP-QC06-2
Sample ID: 195047013
Matrix: Solid
Collect Date: 20-SEP-07 10:25
Receive Date: 04-OCT-07
Collector: Client

Project: ABCL00107
Client ID: ABCL001

Parameter	Qualifier	Result	Uncertainty	DL	RL	Units	DF	AnalystDate	Time	Batch	Method
Rad Gamma Spec Analysis											
<i>GammaSpec, Gamma, Solid (Standard List)</i>											
Potassium-40		8.53	+/-1.90	1.68	1.00	pCi/g		MJH1 10/26/07	1636	690323	1
Rad Liquid Scintillation Analysis											
<i>LSC, Tritium Dist, Solid</i>											
Tritium	U	0.00	+/-1.92	3.52	6.00	pCi/g		BXFI 10/30/07	1249	691743	2
<i>Liquid Scint C14, Solid</i>											
Carbon-14	U	1.47	+/-0.943	1.54	2.00	pCi/g		BXFI 10/24/07	0112	690715	3

The following Prep Methods were performed

Method	Description	Analyst	Date	Time	Prep Batch
Dry Soil Prep	Dry Soil Prep GL-RAD-A-021	BXJ1	10/22/07	1724	690075

The following Analytical Methods were performed

Method	Description	Analyst Comments
1	EML HASL 300, 4.5.2.3	
2	EPA 906.0 Modified	
3	EPA EERF C-01 Modified	

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Report Date: November 1, 2007

Contact: Sheila Hecht
Project: **Routine Analytical - Hecht**

Client Sample ID: ABC-SP-QC618-07
Sample ID: 195047014
Matrix: Solid
Collect Date: 20-SEP-07 10:30
Receive Date: 04-OCT-07
Collector: Client

Project: ABCL00107
Client ID: ABCL001

Parameter	Qualifier	Result	Uncertainty	DL	RL	Units	DF	AnalystDate	Time	Batch	Method
Rad Gamma Spec Analysis											
<i>GammaSpec, Gamma, Solid (Standard List)</i>											
Potassium-40		7.75	+/-1.62	1.24	1.00	pCi/g		MJH1 10/26/07	1637	690323	1
Rad Liquid Scintillation Analysis											
<i>LSC, Tritium Dist, Solid</i>											
Tritium	U	1.82	+/-1.96	3.28	6.00	pCi/g		BXF1 10/30/07	1305	691743	2
<i>Liquid Scint C14, Solid</i>											
Carbon-14	U	1.08	+/-0.707	1.16	2.00	pCi/g		BXF1 10/24/07	0129	690715	3

The following Prep Methods were performed

Method	Description	Analyst	Date	Time	Prep Batch
Dry Soil Prep	Dry Soil Prep GL-RAD-A-021	BXJ1	10/22/07	1724	690075

The following Analytical Methods were performed

Method	Description	Analyst Comments
1	EML HASL 300, 4.5.2.3	
2	EPA 906.0 Modified	
3	EPA EERF C-01 Modified	

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Company : ABC Laboratories, Inc.
Address : 7200 East ABC Lane
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Report Date: November 1, 2007

Contact: Sheila Hecht
Project: **Routine Analytical - Hecht**

Client Sample ID: ABC-DF-OC06-13
Sample ID: 195047015
Matrix: Solid
Collect Date: 19-SEP-07 11:30
Receive Date: 04-OCT-07
Collector: Client

Project: ABCL00107
Client ID: ABCL001

Parameter	Qualifier	Result	Uncertainty	DL	RL	Units	DF	AnalystDate	Time	Batch	Method
Rad Gamma Spec Analysis											
<i>Gammascpec, Gamma, Solid (Standard List)</i>											
Potassium-40		9.29	+/-1.72	0.855	1.00	pCi/g		MJH1 10/26/07	1638	690323	1
Rad Liquid Scintillation Analysis											
<i>LSC, Tritium Dist, Solid</i>											
Tritium	U	0.660	+/-1.94	3.44	6.00	pCi/g		BXF1 10/30/07	1322	691743	2
<i>Liquid Scint C14, Solid</i>											
Carbon-14		13.2	+/-1.28	1.49	2.00	pCi/g		BXF1 10/24/07	0145	690715	3

The following Prep Methods were performed

Method	Description	Analyst	Date	Time	Prep Batch
Dry Soil Prep	Dry Soil Prep GL-RAD-A-021	BXJ1	10/22/07	1724	690075

The following Analytical Methods were performed

Method	Description	Analyst Comments
1	EML HASL 300, 4.5.2.3	
2	EPA 906.0 Modified	
3	EPA EERF C-01 Modified	

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Report Date: November 1, 2007

Contact: Sheila Hecht
Project: **Routine Analytical - Hecht**

Client Sample ID: ABC-DF-OC06-28
Sample ID: 195047016
Matrix: Solid
Collect Date: 19-SEP-07 14:00
Receive Date: 04-OCT-07
Collector: Client

Project: ABCL00107
Client ID: ABCL001

Parameter	Qualifier	Result	Uncertainty	DL	RL	Units	DF	Analyst	Date	Time	Batch	Method
Rad Gamma Spec Analysis												
<i>GammaSpec, Gamma, Solid (Standard List)</i>												
Potassium-40		15.2	+/-2.26	0.652	1.00	pCi/g		MJH1	10/26/07	1640	690323	1
Rad Liquid Scintillation Analysis												
<i>LSC, Tritium Dist, Solid</i>												
Tritium	U	1.28	+/-2.08	3.58	6.00	pCi/g		BXF1	10/30/07	1339	691743	2
<i>Liquid Scint C14, Solid</i>												
Carbon-14		2.96	+/-0.976	1.50	2.00	pCi/g		BXF1	10/24/07	0202	690715	3

The following Prep Methods were performed

Method	Description	Analyst	Date	Time	Prep Batch
Dry Soil Prep	Dry Soil Prep GL-RAD-A-021	BXJ1	10/22/07	1724	690075

The following Analytical Methods were performed

Method	Description	Analyst Comments
1	EML HASL 300, 4.5.2.3	
2	EPA 906.0 Modified	
3	EPA EERF C-01 Modified	

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Contact: Sheila Hecht
Project: **Routine Analytical - Hecht**

Report Date: November 1, 2007

Client Sample ID: ABC-DF-OC06-25
Sample ID: 195047017
Matrix: Solid
Collect Date: 19-SEP-07 11:30
Receive Date: 04-OCT-07
Collector: Client

Project: ABCL00107
Client ID: ABCL001

Parameter	Qualifier	Result	Uncertainty	DL	RL	Units	DF	AnalystDate	Time	Batch	Method
Rad Gamma Spec Analysis											
<i>GammaSpec, Gamma, Solid (Standard List)</i>											
Potassium-40		12.9	+/-2.01	0.765	1.00	pCi/g		MJH1 10/26/07	1646	690323	1
Rad Liquid Scintillation Analysis											
<i>LSC, Tritium Dist, Solid</i>											
Tritium	U	0.380	+/-1.95	3.51	6.00	pCi/g		BXF1 10/30/07	1355	691743	2
<i>Liquid Scint C14, Solid</i>											
Carbon-14		4.59	+/-1.11	1.63	2.00	pCi/g		BXF1 10/24/07	0218	690715	3

The following Prep Methods were performed

Method	Description	Analyst	Date	Time	Prep Batch
Dry Soil Prep	Dry Soil Prep GL-RAD-A-021	BXJ1	10/22/07	1724	690075

The following Analytical Methods were performed

Method	Description	Analyst Comments
1	EML HASL 300, 4.5.2.3	
2	EPA 906.0 Modified	
3	EPA EERF C-01 Modified	

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Certificate of Analysis

Company : ABC Laboratories, Inc.
Address : 7200 East ABC Lane
Columbia, Missouri 65202

Contact: Sheila Hecht
Project: **Routine Analytical – Hecht**

Report Date: November 1, 2007

Client Sample ID: ABC-DF-QC06-17
Sample ID: 195047018
Matrix: Solid
Collect Date: 19-SEP-07 11:30
Receive Date: 04-OCT-07
Collector: Client

Project: ABCL00107
Client ID: ABCL001

Parameter	Qualifier	Result	Uncertainty	DL	RL	Units	DF	AnalystDate	Time	Batch	Method
Rad Gamma Spec Analysis											
<i>GammaSpec, Gamma, Solid (Standard List)</i>											
Potassium-40		13.8	+/-2.07	0.855	1.00	pCi/g		MJH1 10/26/07	1647	690323	1
Rad Liquid Scintillation Analysis											
<i>LSC, Tritium Dist, Solid</i>											
Tritium	U	0.575	+/-1.94	3.45	6.00	pCi/g		BXF1 10/30/07	1412	691743	2
<i>Liquid Scint C14, Solid</i>											
Carbon-14		10.0	+/-1.20	1.49	2.00	pCi/g		BXF1 10/24/07	0235	690715	3

The following Prep Methods were performed

Method	Description	Analyst	Date	Time	Prep Batch
Dry Soil Prep	Dry Soil Prep GL-RAD-A-021	BXJ1	10/22/07	1724	690075

The following Analytical Methods were performed

Method	Description	Analyst Comments
1	EML HASL 300, 4.5.2.3	
2	EPA 906.0 Modified	
3	EPA EERF C-01 Modified	

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Certificate of Analysis

Company : ABC Laboratories, Inc.
Address : 7200 East ABC Lane
Columbia, Missouri 65202

Contact: Sheila Hecht
Project: **Routine Analytical - Hecht**

Report Date: November 1, 2007

Client Sample ID: ABC-DF-QC06-003
Sample ID: 195047019
Matrix: Solid
Collect Date: 18-SEP-07 17:00
Receive Date: 04-OCT-07
Collector: Client

Project: ABCL00107
Client ID: ABCL001

Parameter	Qualifier	Result	Uncertainty	DL	RL	Units	DF	AnalystDate	Time	Batch	Method
Rad Gamma Spec Analysis											
<i>GammaSpec, Gamma, Solid (Standard List)</i>											
Potassium-40		11.8	+/-2.76	1.24	1.00	pCi/g		MJH1 10/29/07	1046	690323	1
Rad Liquid Scintillation Analysis											
<i>LSC, Tritium Dist, Solid</i>											
Tritium	U	-1.42	+/-1.84	3.62	6.00	pCi/g		BXF1 10/30/07	1429	691743	2
<i>Liquid Scint C14, Solid</i>											
Carbon-14		4.43	+/-1.00	1.46	2.00	pCi/g		BXF1 10/24/07	0252	690715	3

The following Prep Methods were performed

Method	Description	Analyst	Date	Time	Prep Batch
Dry Soil Prep	Dry Soil Prep GL-RAD-A-021	BXJ1	10/22/07	1724	690075

The following Analytical Methods were performed

Method	Description	Analyst Comments
1	EML HASL 300, 4.5.2.3	
2	EPA 906.0 Modified	
3	EPA EERF C-01 Modified	

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Certificate of Analysis

Company : ABC Laboratories, Inc.
 Address : 7200 East ABC Lane
 Columbia, Missouri 65202

Report Date: November 1, 2007

Contact: Sheila Hecht
 Project: **Routine Analytical – Hecht**

Client Sample ID:	ABC-01-SL	Project:	ABCL00107
Sample ID:	195047020	Client ID:	ABCL001
Matrix:	Solid		
Collect Date:	03-OCT-07 12:30		
Receive Date:	04-OCT-07		
Collector:	Client		

Parameter	Qualifier	Result	Uncertainty	DL	RL	Units	DF	AnalystDate	Time	Batch	Method
Mercury Analysis-CVAA											
<i>TCLP Hg in Solid</i>											
Mercury	U	-0.000539		0.0003	0.002	mg/L	1	RDD1	10/24/07	1138	694050 1
Metals Analysis-ICP											
<i>TCLP ICP Metals for Solid</i>											
Arsenic		0.177		0.050	0.150	mg/L	1	JWJ	10/24/07	2213	693761 2
Barium		0.127		0.010	0.050	mg/L	1				
Cadmium	J	0.0134		0.010	0.050	mg/L	1				
Chromium	U	0.00991		0.010	0.050	mg/L	1				
Lead	U	-0.000937		0.025	0.100	mg/L	1				
Selenium	J	0.146		0.050	0.150	mg/L	1				
Silver	U	0.000343		0.010	0.050	mg/L	1				
Rad Liquid Scintillation Analysis											
<i>Liquid Scint C14, Solid</i>											
Carbon-14		203	+/-4.11	1.54	2.00	pCi/g		BXF1	10/24/07	0308	690715 3
Semi-Volatile-GC/MS											
<i>TCLP BNA SOLID 8270C 3510C</i>											
1,4-Dichlorobenzene	U	0.00		0.010	0.050	mg/L	1	NAG1	10/19/07	1516	693942 4
2,4,5-Trichlorophenol	U	0.00		0.005	0.050	mg/L	1				
2,4,6-Trichlorophenol	U	0.00		0.010	0.050	mg/L	1				
2,4-Dinitrotoluene	U	0.00		0.010	0.050	mg/L	1				
Hexachlorobenzene	U	0.00		0.010	0.050	mg/L	1				
Hexachlorobutadiene	U	0.00		0.010	0.050	mg/L	1				
Hexachloroethane	U	0.00		0.010	0.050	mg/L	1				
Nitrobenzene	U	0.00		0.015	0.050	mg/L	1				
Pentachlorophenol	U	0.00		0.010	0.050	mg/L	1				
Pyridine	U	0.00		0.005	0.050	mg/L	1				
m,p-Cresols	U	0.00		0.015	0.050	mg/L	1				
o-Cresol	U	0.00		0.010	0.050	mg/L	1				
Semi-Volatiles-HERB											
<i>8151A TCLP Herbicides Soil</i>											
2,4,5-TP	U	0.00		0.0166	0.100	mg/L	1	AMY	10/23/07	2242	695106 5
2,4-D	U	0.00		0.0166	1.00	mg/L	1				
Semi-Volatiles-Pesticide											

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Company : ABC Laboratories, Inc.
 Address : 7200 East ABC Lane
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Report Date: November 1, 2007

Contact: Sheila Hecht
 Project: **Routine Analytical - Hecht**

Client Sample ID: ABC-01-SL
 Sample ID: 195047020

Project: ABCL00107
 Client ID: ABCL001

Parameter	Qualifier	Result	Uncertainty	DL	RL	Units	DF	Analyst	Date	Time	Batch	Method
Semi-Volatiles-Pesticide												
<i>8081A/3510C TCLP PEST Solid</i>												
Chlordane (tech.)	U	0.00		0.000765	0.0025	mg/L	1	HXJ1	10/23/07	2255	695102	6
Endrin	U	0.00		0.00005	0.0004	mg/L	1					
Heptachlor	U	0.00		0.000066	0.0002	mg/L	1					
Heptachlor epoxide	U	0.00		0.00005	0.0002	mg/L	1					
Methoxychlor	U	0.00		0.0005	0.002	mg/L	1					
Toxaphene	U	0.00		0.0015	0.005	mg/L	1					
gamma-BHC (Lindane)	U	0.00		0.00005	0.0002	mg/L	1					
Volatile Organics												
<i>TCLP Volatiles in Solid</i>												
1,1-Dichloroethylene	U	0.00		0.003	0.010	mg/L	10	RXY1	10/25/07	1340	696164	7
1,2-Dichloroethane	U	0.00		0.0025	0.010	mg/L	10					
1,4-Dichlorobenzene	U	0.00		0.0025	0.010	mg/L	10					
2-Butanone	U	0.00		0.0125	0.050	mg/L	10					
Benzene	U	0.00		0.003	0.010	mg/L	10					
Carbon tetrachloride	U	0.00		0.0025	0.010	mg/L	10					
Chlorobenzene	U	0.00		0.0025	0.010	mg/L	10					
Chloroform	U	0.00		0.0025	0.010	mg/L	10					
Tetrachloroethylene	U	0.00		0.0025	0.010	mg/L	10					
Trichloroethylene	U	0.00		0.0025	0.010	mg/L	10					
Vinyl chloride	U	0.00		0.005	0.010	mg/L	10					

The following Prep Methods were performed

Method	Description	Analyst	Date	Time	Prep Batch
SW846 1311	SW846 1311 TCLP Leaching	MXW3	10/16/07	1200	693255
SW846 1311	SW846 1311 TCLP Leaching	MXW3	10/16/07	1500	693512
SW846 1311	SW846 1311 TCLP Volatiles Prep	MXW3	10/16/07	1500	693513
SW846 3010A	ICP-TRACE TCLP by SW846 3010A	FGA	10/17/07	1700	693759
SW846 3510C	3510C BNA TCLP/SPLP Prep-8270C Analysis	AXS4	10/18/07	2318	693939
SW846 3510C	3510C PEST TCLP Liquid Prep	PXB2	10/23/07	1352	695100
SW846 7470A Prep	EPA 7470A Mercury Prep TCLP Liquid	SXJ1	10/23/07	1400	694049
SW846 8151A Prep	8151A Herbicide TCLP Prep in Liquid	PXB2	10/23/07	1425	695105

The following Analytical Methods were performed

Method	Description	Analyst Comments
1	SW846 7470A	

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Certificate of Analysis

Company : ABC Laboratories, Inc.
Address : 7200 East ABC Lane
Columbia, Missouri 65202

Contact: Sheila Hecht
Project: **Routine Analytical - Hecht**

Report Date: November 1, 2007

Client Sample ID: ABC-01-SL
Sample ID: 195047020

Project: ABCL00107
Client ID: ABCL001

Parameter	Qualifier	Result	Uncertainty	DL	RL	Units	DF	AnalystDate	Time	Batch	Method
2	SW846 3010/6010B										
3	EPA EERF C-01 Modified										
4	SW846 8270C										
5	SW846 8151A										
6	SW846 8081A										
7	SW846 8260B										

Surrogate/Tracer recovery	Test	Result	Nominal	Recovery %	Acceptable Limits
2-Fluorobiphenyl	TCLP BNA SOLID 8270C 3510C	0.121 mg/L	0.250	48	(41%-99%)
Nitrobenzene-d5	TCLP BNA SOLID 8270C 3510C	0.166 mg/L	0.250	67	(39%-99%)
p-Terphenyl-d14	TCLP BNA SOLID 8270C 3510C	0.163 mg/L	0.250	65	(41%-115%)
2,4,6-Tribromophenol	TCLP BNA SOLID 8270C 3510C	0.319 mg/L	0.500	64	(35%-107%)
2-Fluorophenol	TCLP BNA SOLID 8270C 3510C	0.218 mg/L	0.500	44	(15%-67%)
Phenol-d5	TCLP BNA SOLID 8270C 3510C	0.140 mg/L	0.500	28	(10%-53%)
2,4-Dichlorophenylacetic acid	8151A TCLP Herbicides Soil	1.03 mg/L	1.00	103	(66%-131%)
4cmx	8081A/3510C TCLP PEST Solid	0.00537 mg/L	0.010	54	(42%-107%)
Decachlorobiphenyl	8081A/3510C TCLP PEST Solid	0.00761 mg/L	0.010	76	(37%-115%)
1,2-Dichloroethane-d4	TCLP Volatiles in Solid	0.550 mg/L	0.065	85	(68%-121%)
Bromofluorobenzene	TCLP Volatiles in Solid	0.604 mg/L	0.065	93	(80%-120%)
Dibromofluoromethane	TCLP Volatiles in Solid	0.590 mg/L	0.065	91	(78%-124%)
Toluene-d8	TCLP Volatiles in Solid	0.554 mg/L	0.065	85	(77%-122%)

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Certificate of Analysis

Company : ABC Laboratories, Inc.
 Address : 7200 East ABC Lane
 Columbia, Missouri 65202

Report Date: November 1, 2007

Contact: Sheila Hecht
 Project: **Routine Analytical - Hecht**

Client Sample ID:	ABC-02-LB	Project:	ABCL00107
Sample ID:	195047021	Client ID:	ABCL001
Matrix:	Solid		
Collect Date:	03-OCT-07 12:30		
Receive Date:	04-OCT-07		
Collector:	Client		

Parameter	Qualifier	Result	Uncertainty	DL	RL	Units	DF	Analyst	Date	Time	Batch	Method
Mercury Analysis-CVAA												
<i>TCLP Hg in Solid</i>												
Mercury	U	-0.000369		0.0003	0.002	mg/L	1	RDD1	10/24/07	1140	694050	1
Metals Analysis-ICP												
<i>TCLP ICP Metals for Solid</i>												
Arsenic	J	0.0536		0.050	0.150	mg/L	1	JWJ	10/24/07	2221	693761	2
Barium		0.805		0.010	0.050	mg/L	1					
Cadmium	U	0.00524		0.010	0.050	mg/L	1					
Chromium	U	0.00741		0.010	0.050	mg/L	1					
Lead	U	0.00607		0.025	0.100	mg/L	1					
Selenium	U	0.0125		0.050	0.150	mg/L	1					
Silver	U	0.0012		0.010	0.050	mg/L	1					
Semi-Volatile-GC/MS												
<i>TCLP BNA SOLID 8270C 3510C</i>												
1,4-Dichlorobenzene	U	0.00		0.010	0.050	mg/L	1	NAG1	10/19/07	1622	693942	3
2,4,5-Trichlorophenol	U	0.00		0.005	0.050	mg/L	1					
2,4,6-Trichlorophenol	U	0.00		0.010	0.050	mg/L	1					
2,4-Dinitrotoluene	U	0.00		0.010	0.050	mg/L	1					
Hexachlorobenzene	U	0.00		0.010	0.050	mg/L	1					
Hexachlorobutadiene	U	0.00		0.010	0.050	mg/L	1					
Hexachloroethane	U	0.00		0.010	0.050	mg/L	1					
Nitrobenzene	U	0.00		0.015	0.050	mg/L	1					
Pentachlorophenol	U	0.00		0.010	0.050	mg/L	1					
Pyridine	U	0.00		0.005	0.050	mg/L	1					
m,p-Cresols	U	0.00		0.015	0.050	mg/L	1					
o-Cresol	U	0.00		0.010	0.050	mg/L	1					
Semi-Volatiles-HERB												
<i>8151A TCLP Herbicides Soil</i>												
2,4,5-TP	U	0.00		0.0166	0.100	mg/L	1	AMY	10/23/07	2310	695106	4
2,4-D	U	0.00		0.0166	1.00	mg/L	1					
Semi-Volatiles-Pesticide												
<i>8081A/3510C TCLP PEST Solid</i>												
Chlordane (tech)	U	0.00		0.000765	0.0025	mg/L	1	HXJ1	10/24/07	0017	695102	5
Endrin	U	0.00		0.00005	0.0004	mg/L	1					

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Certificate of Analysis

Company : ABC Laboratories, Inc.
 Address : 7200 East ABC Lane
 Columbia, Missouri 65202

Report Date: November 1, 2007

Contact: Sheila Hecht
 Project: **Routine Analytical – Hecht**

Client Sample ID: ABC-02-LB
 Sample ID: 195047021

Project: ABCL00107
 Client ID: ABCL001

Parameter	Qualifier	Result	Uncertainty	DL	RL	Units	DF	Analyst	Date	Time	Batch	Method
Semi-Volatiles-Pesticide												
<i>8081A/3510C TCLP PEST Solid</i>												
Heptachlor	U	0.00		0.000066	0.0002	mg/L	1					
Heptachlor epoxide	U	0.00		0.00005	0.0002	mg/L	1					
Methoxychlor	U	0.00		0.0005	0.002	mg/L	1					
Toxaphene	U	0.00		0.0015	0.005	mg/L	1					
gamma-BHC (Lindane)	U	0.00		0.00005	0.0002	mg/L	1					
Volatile Organics												
<i>TCLP Volatiles in Solid</i>												
1,1-Dichloroethylene	U	0.00		0.003	0.010	mg/L	10	RXY1	10/25/07	1407	696164	6
1,2-Dichloroethane	U	0.00		0.0025	0.010	mg/L	10					
1,4-Dichlorobenzene	U	0.00		0.0025	0.010	mg/L	10					
2-Butanone	U	0.00		0.0125	0.050	mg/L	10					
Benzene	U	0.00		0.003	0.010	mg/L	10					
Carbon tetrachloride	U	0.00		0.0025	0.010	mg/L	10					
Chlorobenzene	U	0.00		0.0025	0.010	mg/L	10					
Chloroform	U	0.00		0.0025	0.010	mg/L	10					
Tetrachloroethylene	U	0.00		0.0025	0.010	mg/L	10					
Trichloroethylene	U	0.00		0.0025	0.010	mg/L	10					
Vinyl chloride	U	0.00		0.005	0.010	mg/L	10					

The following Prep Methods were performed

Method	Description	Analyst	Date	Time	Prep Batch
SW846 1311	SW846 1311 TCLP Leaching	MXW3	10/16/07	1200	693255
SW846 1311	SW846 1311 TCLP Leaching	MXW3	10/16/07	1500	693512
SW846 1311	SW846 1311 TCLP Volatiles Prep	MXW3	10/16/07	1500	693513
SW846 3010A	ICP-TRACE TCLP by SW846 3010A	FGA	10/17/07	1700	693759
SW846 3510C	3510C BNA TCLP/SPLP Prep-8270C Analysis	AXS4	10/18/07	2318	693939
SW846 3510C	3510C PEST TCLP Liquid Prep	PXB2	10/23/07	1352	695100
SW846 7470A Prep	EPA 7470A Mercury Prep TCLP Liquid	SXJ1	10/23/07	1400	694049
SW846 8151A Prep	8151A Herbicide TCLP Prep in Liquid	PXB2	10/23/07	1425	695105

The following Analytical Methods were performed

Method	Description	Analyst Comments
1	SW846 7470A	
2	SW846 3010/6010B	
3	SW846 8270C	

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Certificate of Analysis

Company : ABC Laboratories, Inc.
Address : 7200 East ABC Lane
Columbia, Missouri 65202

Report Date: November 1, 2007

Contact: Sheila Hecht
Project: **Routine Analytical - Hecht**

Client Sample ID: ABC-02-LB
Sample ID: 195047021

Project: ABCL00107
Client ID: ABCL001

Parameter	Qualifier	Result	Uncertainty	DL	RL	Units	DF	AnalystDate	Time	Batch	Method
4	SW846	8151A									
5	SW846	8081A									
6	SW846	8260B									

Surrogate/Tracer recovery	Test	Result	Nominal	Recovery%	Acceptable Limits
2-Fluorobiphenyl	TCLP BNA SOLID 8270C 3510C	0.128 mg/L	0.250	51	(41%-99%)
Nitrobenzene-d5	TCLP BNA SOLID 8270C 3510C	0.151 mg/L	0.250	61	(39%-99%)
p-Terphenyl-d14	TCLP BNA SOLID 8270C 3510C	0.167 mg/L	0.250	67	(41%-115%)
2,4,6-Tribromophenol	TCLP BNA SOLID 8270C 3510C	0.268 mg/L	0.500	54	(35%-107%)
2-Fluorophenol	TCLP BNA SOLID 8270C 3510C	0.214 mg/L	0.500	43	(15%-67%)
Phenol-d5	TCLP BNA SOLID 8270C 3510C	0.127 mg/L	0.500	25	(10%-53%)
2,4-Dichlorophenylacetic acid	8151A TCLP Herbicides Soil	1.10 mg/L	1.00	110	(66%-131%)
4cmx	8081A/3510C TCLP PEST Solid	0.00762 mg/L	0.010	76	(42%-107%)
Decachlorobiphenyl	8081A/3510C TCLP PEST Solid	0.00822 mg/L	0.010	82	(37%-115%)
1,2-Dichloroethane-d4	TCLP Volatiles in Solid	0.537 mg/L	0.065	83	(68%-121%)
Bromofluorobenzene	TCLP Volatiles in Solid	0.585 mg/L	0.065	90	(80%-120%)
Dibromofluoromethane	TCLP Volatiles in Solid	0.583 mg/L	0.065	90	(78%-124%)
Toluene-d8	TCLP Volatiles in Solid	0.560 mg/L	0.065	86	(77%-122%)

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QC Summary

Report Date: November 1, 2007

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ABC Laboratories, Inc.
7200 East ABC Lane
Columbia, Missouri

Contact: Sheila Hecht

Workorder: 195047

Parmname	NOM	Sample	Qual	QC	Units	RPD%	REC%	Range	Anlst	Date	Time
Metals Analysis-ICP											
Batch	693761										
QC1201441592 195047021 DUP											
Arsenic		J	0.0536	J	0.0538	mg/L	N/A ^	(+/-0.150)	JWJ	10/24/07	22:28
Barium			0.805		0.790	mg/L	2	(0%-20%)			
Cadmium		U	0.00524	U	0.00486	mg/L	N/A ^	(+/-0.050)			
Chromium		U	0.00741	U	0.00649	mg/L	N/A ^	(+/-0.050)			
Lead		U	0.00607	U	0.00794	mg/L	N/A ^	(+/-0.100)			
Selenium		U	0.0125	U	0.0426	mg/L	N/A ^	(+/-0.150)			
Silver		U	0.0012	U	-0.00194	mg/L	N/A ^	(+/-0.050)			
QC1201441591 LCS											
Arsenic	50.0				47.6	mg/L		95 (80%-120%)		10/24/07	22:04
Barium	100				100	mg/L		100 (80%-120%)			
Cadmium	10.0				9.79	mg/L		98 (80%-120%)			
Chromium	50.0				49.6	mg/L		99 (80%-120%)			
Lead	50.0				50.3	mg/L		101 (80%-120%)			
Selenium	10.0				9.05	mg/L		91 (80%-120%)			
Silver	5.00				4.80	mg/L		96 (80%-120%)			
QC1201441590 MB											
Arsenic				U	-0.01	mg/L				10/24/07	21:49
Barium				U	0.00209	mg/L					
Cadmium				U	-0.00127	mg/L					
Chromium				J	0.0185	mg/L					
Lead				U	-0.00539	mg/L					
Selenium				U	-0.0328	mg/L					
Silver				U	0.000575	mg/L					
QC1201440391 195047021 MS											
Arsenic	5.26	J	0.0536		5.14	mg/L		97 (75%-125%)		10/24/07	22:35
Barium	10.5		0.805		11.0	mg/L		97 (75%-125%)			
Cadmium	1.05	U	0.00524		0.996	mg/L		94 (75%-125%)			
Chromium	5.26	U	0.00741		5.06	mg/L		96 (75%-125%)			
Lead	5.26	U	0.00607		4.96	mg/L		94 (75%-125%)			
Selenium	1.05	U	0.0125		0.982	mg/L		92 (75%-125%)			
Silver	0.526	U	0.0012		0.496	mg/L		94 (75%-125%)			
QC1201441594 195047021 SDILT											
Arsenic		J	5.36	U	2.63	ug/L	N/A			10/24/07	22:42
Barium			80.5		16.9	ug/L	4.69				
Cadmium		U	0.524	U	0.0787	ug/L	N/A				
Chromium		U	0.741	U	0.263	ug/L	N/A				
Lead		U	0.607	U	0.0208	ug/L	N/A				
Selenium		U	1.25	U	-1.48	ug/L	N/A				

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QC Summary

Workorder: 195047

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Parmname	NOM	Sample	Qual	QC	Units	RPD%	REC%	Range	Anlst	Date	Time
Rad Liquid Scintillation											
Batch	690715										
Carbon-14	23.0			22.4 +/-1.31	pCi/g		98	(75%-125%)		10/24/07	04:14
QC1201434582	MB										
Carbon-14			U	-0.0152 +/-0.680	pCi/g				BXF1	10/24/07	03:23
QC1201434584	195047012 MS										
Carbon-14	30.3	U	0.806 +/-0.837	29.1 +/-1.68	pCi/g		96	(75%-125%)		10/24/07	03:57
Batch	691743										
QC1201436889	195047006 DUP										
Tritium		U	0.555 +/-1.87	-0.492 +/-1.85	pCi/g	0		N/A	BXF1	10/30/07	15:02
QC1201436891	LCS										
Tritium	19.6			15.5 +/-2.90	pCi/g		79	(75%-125%)		10/30/07	09:23
QC1201436888	MB										
Tritium			U	0.623 +/-1.83	pCi/g					10/30/07	14:45
QC1201436890	195047006 MS										
Tritium	35.9	U	0.555 +/-1.87	35.0 +/-5.75	pCi/g		98	(75%-125%)		10/30/07	09:06
Semi-Volatile-GC/MS											
Batch	693942										
QC1201441932	LCS										
1,4-Dichlorobenzene	0.100			0.0613	mg/L		61	(28%-96%)	NAG1	10/19/07	11:57
2,4,5-Trichlorophenol	0.100			0.0755	mg/L		76	(50%-104%)			
2,4,6-Trichlorophenol	0.100			0.067	mg/L		67	(49%-105%)			
2,4-Dinitrotoluene	0.100			0.0733	mg/L		73	(50%-110%)			
Hexachlorobenzene	0.100			0.0719	mg/L		72	(51%-106%)			
Hexachlorobutadiene	0.100			0.0673	mg/L		67	(22%-104%)			
Hexachloroethane	0.100			0.0589	mg/L		59	(17%-101%)			
Nitrobenzene	0.100			0.0751	mg/L		75	(47%-101%)			
Pentachlorophenol	0.100			0.0826	mg/L		83	(40%-119%)			
Pyridine	0.100			0.0627	mg/L		63	(12%-68%)			
m,p-Cresols	0.100			0.0516	mg/L		52	(35%-81%)			
o-Cresol	0.100			0.0551	mg/L		55	(42%-86%)			
**2,4,6-Tribromophenol	0.100			0.0643	mg/L		64	(35%-107%)			
**2-Fluorobiphenyl	0.050			0.0332	mg/L		66	(41%-99%)			
**2-Fluorophenol	0.100			0.0442	mg/L		44	(15%-67%)			
**Nitrobenzene-d5	0.050			0.0431	mg/L		86	(39%-99%)			
**Phenol-d5	0.100			0.0266	mg/L		27	(10%-53%)			
**p-Terphenyl-d14	0.050			0.0351	mg/L		70	(41%-115%)			
QC1201441931	MB										
1,4-Dichlorobenzene			U	0.00	mg/L					10/19/07	11:35
2,4,5-Trichlorophenol			U	0.00	mg/L						

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QC Summary

Workorder: 195047

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Parmname	NOM	Sample	Qual	QC	Units	RPD%	REC%	Range	Anlst	Date	Time
Semi-Volatile-GC/MS											
Batch	693942										
2,4,6-Trichlorophenol			U	0.00	mg/L						
2,4-Dinitrotoluene			U	0.00	mg/L				NAG1	10/19/07	11:35
Hexachlorobenzene			U	0.00	mg/L						
Hexachlorobutadiene			U	0.00	mg/L						
Hexachloroethane			U	0.00	mg/L						
Nitrobenzene			U	0.00	mg/L						
Pentachlorophenol			U	0.00	mg/L						
Pyridine			U	0.00	mg/L						
m,p-Cresols			U	0.00	mg/L						
o-Cresol			U	0.00	mg/L						
**2,4,6-Tribromophenol	0.100			0.0539	mg/L		54	(35%-107%)			
**2-Fluorobiphenyl	0.050			0.0233	mg/L		47	(41%-99%)			
**2-Fluorophenol	0.100			0.0403	mg/L		40	(15%-67%)			
**Nitrobenzene-d5	0.050			0.0306	mg/L		61	(39%-99%)			
**Phenol-d5	0.100			0.0237	mg/L		24	(10%-53%)			
**p-Terphenyl-d14	0.050			0.0322	mg/L		64	(41%-115%)			
QC1201441933 195047020 MS											
1,4-Dichlorobenzene	0.500	U	0.00	0.297	mg/L		59	(26%-98%)		10/19/07	15:37
2,4,5-Trichlorophenol	0.500	U	0.00	0.410	mg/L		82	(40%-114%)			
2,4,6-Trichlorophenol	0.500	U	0.00	0.330	mg/L		66	(41%-110%)			
2,4-Dinitrotoluene	0.500	U	0.00	0.391	mg/L		78	(47%-110%)			
Hexachlorobenzene	0.500	U	0.00	0.352	mg/L		71	(45%-110%)			
Hexachlorobutadiene	0.500	U	0.00	0.321	mg/L		64	(21%-103%)			
Hexachloroethane	0.500	U	0.00	0.284	mg/L		57	(16%-103%)			
Nitrobenzene	0.500	U	0.00	0.373	mg/L		75	(44%-104%)			
Pentachlorophenol	0.500	U	0.00	0.428	mg/L		86	(23%-140%)			
Pyridine	0.500	U	0.00	0.330	mg/L		66	(13%-81%)			
m,p-Cresols	0.500	U	0.00	0.267	mg/L		53	(26%-98%)			
o-Cresol	0.500	U	0.00	0.285	mg/L		57	(32%-101%)			
**2,4,6-Tribromophenol	0.500		0.319	0.328	mg/L		66	(35%-107%)			
**2-Fluorobiphenyl	0.250		0.121	0.166	mg/L		67	(41%-99%)			
**2-Fluorophenol	0.500		0.218	0.224	mg/L		45	(15%-67%)			
**Nitrobenzene-d5	0.250		0.166	0.210	mg/L		84	(39%-99%)			
**Phenol-d5	0.500		0.140	0.141	mg/L		28	(10%-53%)			
**p-Terphenyl-d14	0.250		0.163	0.164	mg/L		66	(41%-115%)			
QC1201441934 195047020 MSD											
1,4-Dichlorobenzene	0.500	U	0.00	0.274	mg/L	8	55	(0%-21%)		10/19/07	15:59
2,4,5-Trichlorophenol	0.500	U	0.00	0.375	mg/L	9	75	(0%-24%)			
2,4,6-Trichlorophenol	0.500	U	0.00	0.296	mg/L	11	59	(0%-21%)			
2,4-Dinitrotoluene	0.500	U	0.00	0.337	mg/L	15	67	(0%-20%)			
Hexachlorobenzene	0.500	U	0.00	0.348	mg/L	1	70	(0%-20%)			
Hexachlorobutadiene	0.500	U	0.00	0.287	mg/L	11	57	(0%-24%)			

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QC Summary

Workorder: 195047

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Parmname	NOM	Sample	Qual	QC	Units	RPD%	REC%	Range	Anlst	Date	Time
Semi-Volatile-GC/MS											
Batch	693942										
Hexachloroethane	0.500	U	0.00	0.253	mg/L	12	51	(0%-24%)			
Nitrobenzene	0.500	U	0.00	0.332	mg/L	12	66	(0%-20%)	NAG1	10/19/07	15:59
Pentachlorophenol	0.500	U	0.00	0.367	mg/L	15	73	(0%-23%)			
Pyridine	0.500	U	0.00	0.310	mg/L	6	62	(0%-24%)			
m,p-Cresols	0.500	U	0.00	0.245	mg/L	9	49	(0%-22%)			
o-Cresol	0.500	U	0.00	0.255	mg/L	11	51	(0%-22%)			
**2,4,6-Tribromophenol	0.500		0.319	0.289	mg/L		58	(35%-107%)			
**2-Fluorobiphenyl	0.250		0.121	0.154	mg/L		62	(41%-99%)			
**2-Fluorophenol	0.500		0.218	0.222	mg/L		44	(15%-67%)			
**Nitrobenzene-d5	0.250		0.166	0.190	mg/L		76	(39%-99%)			
**Phenol-d5	0.500		0.140	0.135	mg/L		27	(10%-53%)			
**p-Terphenyl-d14	0.250		0.163	0.166	mg/L		66	(41%-115%)			
QC1201440969	TB										
1,4-Dichlorobenzene			U	0.00	mg/L					10/19/07	11:13
2,4,5-Trichlorophenol			U	0.00	mg/L						
2,4,6-Trichlorophenol			U	0.00	mg/L						
2,4-Dinitrotoluene			U	0.00	mg/L						
Hexachlorobenzene			U	0.00	mg/L						
Hexachlorobutadiene			U	0.00	mg/L						
Hexachloroethane			U	0.00	mg/L						
Nitrobenzene			U	0.00	mg/L						
Pentachlorophenol			U	0.00	mg/L						
Pyridine			U	0.00	mg/L						
m,p-Cresols			U	0.00	mg/L						
o-Cresol			U	0.00	mg/L						
**2,4,6-Tribromophenol	0.500			0.191	mg/L		38	(35%-107%)			
**2-Fluorobiphenyl	0.250			0.071	mg/L		28*	(41%-99%)			
**2-Fluorophenol	0.500			0.132	mg/L		26	(15%-67%)			
**Nitrobenzene-d5	0.250			0.0953	mg/L		38*	(39%-99%)			
**Phenol-d5	0.500			0.0792	mg/L		16	(10%-53%)			
**p-Terphenyl-d14	0.250			0.119	mg/L		48	(41%-115%)			
Semi-Volatiles-HERB											
Batch	695106										
QC1201444536	LCS										
2,4,5-TP	0.002		J	0.00165	mg/L		82	(69%-126%)	AMY	10/23/07	22:15
2,4-D	0.002		J	0.00173	mg/L		86	(68%-130%)			
**2,4-Dichlorophenylacetic acid	0.005			0.00513	mg/L		103	(66%-131%)			
QC1201444535	MB										
2,4,5-TP			U	0.00	mg/L					10/23/07	21:48
2,4-D			U	0.00	mg/L						
**2,4-Dichlorophenylacetic acid	0.005			0.00519	mg/L		104	(66%-131%)			
QC1201444537	195886001	MS									
2,4,5-TP	0.400	U	0.00	0.318	mg/L		80	(64%-127%)		10/24/07	03:42

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Parname	NOM	Sample	Qual	QC	Units	RPD%	REC%	Range	Anlst	Date	Time
Semi-Volatiles-HERB											
Batch	695106										
2,4-D	0.400	U	0.00	J	0.319	mg/L	80	(61%-132%)			
**2,4-Dichlorophenylacetic acid	1.00		1.04		0.924	mg/L	92	(66%-131%)	AMY	10/24/07	03:42
QC1201444538		195886001	MSD								
2,4,5-TP	0.400	U	0.00		0.348	mg/L	9	(0%-23%)		10/24/07	04:10
2,4-D	0.400	U	0.00	J	0.346	mg/L	8	(0%-24%)			
**2,4-Dichlorophenylacetic acid	1.00		1.04		1.02	mg/L	102	(66%-131%)			
QC1201440969		TB									
2,4,5-TP			U		0.00	mg/L				10/23/07	20:26
2,4-D			U		0.00	mg/L					
**2,4-Dichlorophenylacetic acid	1.00				1.15	mg/L	115	(66%-131%)			
Semi-Volatiles-Pesticide											
Batch	695102										
QC1201444532		LCS									
Chlordane (tech.)			U		0.00	mg/L		(57%-118%)	HXJ1	10/23/07	20:10
Endrin	0.005				0.00466	mg/L	93	(66%-108%)			
Heptachlor	0.005				0.00322	mg/L	64	(58%-115%)			
Heptachlor epoxide	0.005				0.00422	mg/L	84	(59%-118%)			
Methoxychlor	0.050				0.0532	mg/L	106	(61%-126%)			
Toxaphene			U		0.00	mg/L		(55%-136%)			
gamma-BHC (Lindane)	0.005				0.00446	mg/L	89	(51%-129%)			
**4cmx	0.010				0.00549	mg/L	55	(42%-107%)			
**Decachlorobiphenyl	0.010				0.00814	mg/L	81	(37%-115%)			
QC1201444533		LCS									
Chlordane (tech.)			U		0.00	mg/L		(57%-118%)		10/23/07	20:22
Endrin			U		0.00	mg/L		(66%-108%)			
Heptachlor			U		0.00	mg/L		(58%-115%)			
Heptachlor epoxide			U		0.00	mg/L		(59%-118%)			
Methoxychlor			U		0.00	mg/L		(61%-126%)			
Toxaphene	0.100				0.0947	mg/L	95	(55%-136%)			
gamma-BHC (Lindane)			U		0.00	mg/L		(51%-129%)			
**4cmx	0.010				0.00527	mg/L	53	(42%-107%)			
**Decachlorobiphenyl	0.010				0.00817	mg/L	82	(37%-115%)			
QC1201444534		LCS									
Chlordane (tech.)	0.100				0.0897	mg/L	90	(57%-118%)		10/23/07	20:34
Endrin			U		0.00	mg/L		(66%-108%)			
Heptachlor			U		0.00	mg/L		(58%-115%)			
Heptachlor epoxide			U		0.00	mg/L		(59%-118%)			
Methoxychlor			U		0.00	mg/L		(61%-126%)			
Toxaphene			U		0.00	mg/L		(55%-136%)			
gamma-BHC (Lindane)			U		0.00	mg/L		(51%-129%)			
**4cmx	0.010				0.00519	mg/L	52	(42%-107%)			
**Decachlorobiphenyl	0.010				0.00753	mg/L	75	(37%-115%)			
QC1201444522		MB									

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Parmname	NOM	Sample	Qual	QC	Units	RPD%	REC%	Range	Anlst	Date	Time
Semi-Volatiles-Pesticide											
Batch	695102										
Chlordane (tech.)			U	0.00	mg/L					10/23/07	19:59
Endrin			U	0.00	mg/L				HXJI		
Heptachlor			U	0.00	mg/L						
Heptachlor epoxide			U	0.00	mg/L						
Methoxychlor			U	0.00	mg/L						
Toxaphene			U	0.00	mg/L						
gamma-BHC (Lindane)			U	0.00	mg/L						
**4cmx	0.010			0.00614	mg/L		61	(42%-107%)			
**Decachlorobiphenyl	0.010			0.00803	mg/L		80	(37%-115%)			
QC1201444523	195047020	MS									
Chlordane (tech.)		U	0.00	U	0.00	mg/L		(37%-133%)		10/23/07	23:06
Endrin	0.005	U	0.00	0.0051	mg/L		102	(46%-121%)			
Heptachlor	0.005	U	0.00	0.00337	mg/L		68	(46%-117%)			
Heptachlor epoxide	0.005	U	0.00	0.00466	mg/L		93	(43%-119%)			
Methoxychlor	0.050	U	0.00	0.0581	mg/L		116	(41%-139%)			
Toxaphene		U	0.00	U	0.00	mg/L		(38%-153%)			
gamma-BHC (Lindane)	0.005	U	0.00	0.00467	mg/L		93	(43%-125%)			
**4cmx	0.010	0.00537		0.0064	mg/L		64	(42%-107%)			
**Decachlorobiphenyl	0.010	0.00761		0.00861	mg/L		86	(37%-115%)			
QC1201444524	195047020	MS									
Chlordane (tech.)		U	0.00	U	0.00	mg/L		(37%-133%)		10/23/07	23:30
Endrin		U	0.00	U	0.00	mg/L		(46%-121%)			
Heptachlor		U	0.00	U	0.00	mg/L		(46%-117%)			
Heptachlor epoxide		U	0.00	U	0.00	mg/L		(43%-119%)			
Methoxychlor		U	0.00	U	0.00	mg/L		(41%-139%)			
Toxaphene	0.100	U	0.00	0.0882	mg/L		88	(38%-153%)			
gamma-BHC (Lindane)		U	0.00	U	0.00	mg/L		(43%-125%)			
**4cmx	0.010	0.00537		0.00785	mg/L		79	(42%-107%)			
**Decachlorobiphenyl	0.010	0.00761		0.00826	mg/L		83	(37%-115%)			
QC1201444525	195047020	MS									
Chlordane (tech.)	0.100	U	0.00	0.0899	mg/L		90	(37%-133%)		10/23/07	23:53
Endrin		U	0.00	U	0.00	mg/L		(46%-121%)			
Heptachlor		U	0.00	U	0.00	mg/L		(46%-117%)			
Heptachlor epoxide		U	0.00	U	0.00	mg/L		(43%-119%)			
Methoxychlor		U	0.00	U	0.00	mg/L		(41%-139%)			
Toxaphene		U	0.00	U	0.00	mg/L		(38%-153%)			
gamma-BHC (Lindane)		U	0.00	U	0.00	mg/L		(43%-125%)			
**4cmx	0.010	0.00537		0.00722	mg/L		72	(42%-107%)			
**Decachlorobiphenyl	0.010	0.00761		0.00776	mg/L		78	(37%-115%)			
QC1201444529	195047020	MSD									
Chlordane (tech.)		U	0.00	U	0.00	mg/L	0	(0%-20%)		10/23/07	23:18
Endrin	0.005	U	0.00	0.00485	mg/L	5	97	(0%-20%)			
Heptachlor	0.005	U	0.00	0.00296	mg/L	13	59	(0%-20%)			

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Parmname	NOM	Sample	Qual	QC	Units	RPD%	REC%	Range	Anlst	Date	Time
Semi-Volatiles-Pesticide											
Batch	695102										
Heptachlor epoxide	0.005	U	0.00	0.00414	mg/L	12	83	(0%-20%)			
Methoxychlor	0.050	U	0.00	0.0566	mg/L	3	113	(0%-20%)	HXJ1	10/23/07	23:18
Toxaphene		U	0.00	U	0.00	mg/L	0	(0%-20%)			
gamma-BHC (Lindane)	0.005	U	0.00	0.00431	mg/L	8	86	(0%-20%)			
**4cmx	0.010		0.00537	0.00629	mg/L		63	(42%-107%)			
**Decachlorobiphenyl	0.010		0.00761	0.00839	mg/L		84	(37%-115%)			
QC1201444530 195047020 MSD											
Chlordane (tech.)		U	0.00	U	0.00	mg/L	0	(0%-20%)		10/23/07	23:42
Endrin		U	0.00	U	0.00	mg/L	0	(0%-20%)			
Heptachlor		U	0.00	U	0.00	mg/L	0	(0%-20%)			
Heptachlor epoxide		U	0.00	U	0.00	mg/L	0	(0%-20%)			
Methoxychlor		U	0.00	U	0.00	mg/L	0	(0%-20%)			
Toxaphene	0.100	U	0.00	0.0743	mg/L	17	74	(0%-20%)			
gamma-BHC (Lindane)		U	0.00	U	0.00	mg/L	0	(0%-20%)			
**4cmx	0.010		0.00537	0.00747	mg/L		75	(42%-107%)			
**Decachlorobiphenyl	0.010		0.00761	0.00787	mg/L		79	(37%-115%)			
QC1201444531 195047020 MSD											
Chlordane (tech.)	0.100	U	0.00	0.084	mg/L	7	84	(0%-20%)		10/24/07	00:05
Endrin		U	0.00	U	0.00	mg/L	0	(0%-20%)			
Heptachlor		U	0.00	U	0.00	mg/L	0	(0%-20%)			
Heptachlor epoxide		U	0.00	U	0.00	mg/L	0	(0%-20%)			
Methoxychlor		U	0.00	U	0.00	mg/L	0	(0%-20%)			
Toxaphene		U	0.00	U	0.00	mg/L	0	(0%-20%)			
gamma-BHC (Lindane)		U	0.00	U	0.00	mg/L	0	(0%-20%)			
**4cmx	0.010		0.00537	0.00716	mg/L		72	(42%-107%)			
**Decachlorobiphenyl	0.010		0.00761	0.00817	mg/L		82	(37%-115%)			
QC1201440969 TB											
Chlordane (tech.)				U	0.00	mg/L				10/23/07	19:35
Endrin				U	0.00	mg/L					
Heptachlor				U	0.00	mg/L					
Heptachlor epoxide				U	0.00	mg/L					
Methoxychlor				U	0.00	mg/L					
Toxaphene				U	0.00	mg/L					
gamma-BHC (Lindane)				U	0.00	mg/L					
**4cmx	0.010			0.00618	mg/L		62	(42%-107%)			
**Decachlorobiphenyl	0.010			0.00857	mg/L		86	(37%-115%)			
Volatile-GC/MS											
Batch	696164										
QC1201447011 LCS											
1,1-Dichloroethylene	0.050			0.0484	mg/L		97	(75%-135%)	RXY1	10/25/07	10:24
1,2-Dichloroethane	0.050			0.0454	mg/L		91	(75%-124%)			
1,4-Dichlorobenzene	0.050			0.0468	mg/L		94	(78%-126%)			
2-Butanone	0.250			0.215	mg/L		86	(60%-139%)			

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Parname	NOM	Sample	Qual	QC	Units	RPD%	REC%	Range	Anlst	Date	Time
Volatile-GC/MS											
Batch	696164										
Benzene	0.050			0.0469	mg/L		94	(74%-123%)			
Carbon tetrachloride	0.050			0.0536	mg/L		107	(78%-136%)	RXYI	10/25/07	10:24
Chlorobenzene	0.050			0.0469	mg/L		94	(78%-120%)			
Chloroform	0.050			0.0475	mg/L		95	(76%-120%)			
Tetrachloroethylene	0.050			0.0473	mg/L		95	(75%-133%)			
Trichloroethylene	0.050			0.0479	mg/L		96	(79%-129%)			
Vinyl chloride	0.050			0.0349	mg/L		70	(66%-127%)			
**1,2-Dichloroethane-d4	0.065			52.6	mg/L		81	(68%-121%)			
**Bromofluorobenzene	0.065			60.3	mg/L		93	(80%-120%)			
**Dibromofluoromethane	0.065			59.2	mg/L		91	(78%-124%)			
**Toluene-d8	0.065			55.3	mg/L		85	(77%-122%)			
QC1201447006	MB										
1,1-Dichloroethylene			U	0.00	mg/L						10/25/07 12:15
1,2-Dichloroethane			U	0.00	mg/L						
1,4-Dichlorobenzene			U	0.00	mg/L						
2-Butanone			U	0.00	mg/L						
Benzene			U	0.00	mg/L						
Carbon tetrachloride			U	0.00	mg/L						
Chlorobenzene			U	0.00	mg/L						
Chloroform			U	0.00	mg/L						
Tetrachloroethylene			U	0.00	mg/L						
Trichloroethylene			U	0.00	mg/L						
Vinyl chloride			U	0.00	mg/L						
**1,2-Dichloroethane-d4	0.065			54.2	mg/L		83	(68%-121%)			
**Bromofluorobenzene	0.065			61.1	mg/L		94	(80%-120%)			
**Dibromofluoromethane	0.065			59.2	mg/L		91	(78%-124%)			
**Toluene-d8	0.065			56.3	mg/L		87	(77%-122%)			
QC1201447007	195047021 PS										
1,1-Dichloroethylene	50.0	U	0.00	49.1	ug/L		98	(67%-134%)			10/25/07 18:48
1,2-Dichloroethane	50.0	U	0.00	51.2	ug/L		102	(72%-131%)			
1,4-Dichlorobenzene	50.0	U	0.00	47.1	ug/L		94	(70%-125%)			
2-Butanone	250	U	0.00	224	ug/L		90	(54%-134%)			
Benzene	50.0	U	0.00	50.8	ug/L		102	(70%-122%)			
Carbon tetrachloride	50.0	U	0.00	54.4	ug/L		109	(70%-137%)			
Chlorobenzene	50.0	U	0.00	49.8	ug/L		100	(71%-121%)			
Chloroform	50.0	U	0.00	50.9	ug/L		102	(72%-120%)			
Tetrachloroethylene	50.0	U	0.00	48.5	ug/L		97	(68%-129%)			
Trichloroethylene	50.0	U	0.00	50.4	ug/L		101	(74%-127%)			
Vinyl chloride	50.0	U	0.00	46.9	ug/L		94	(63%-125%)			
**1,2-Dichloroethane-d4	65.0		53.7	54.7	ug/L		84	(68%-121%)			
**Bromofluorobenzene	65.0		58.5	56.1	ug/L		86	(80%-120%)			
*Dibromofluoromethane	65.0		58.3	60.2	ug/L		93	(78%-124%)			

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Parname	NOM	Sample	Qual	QC	Units	RPD%	REC%	Range	Anlst	Date	Time
Volatile-GC/MS											
Batch	696164										
**Toluene-d8	65.0	56.0		55.1	ug/L		85	(77%-122%)			
QC1201447009 195047021 PSD											
1,1-Dichloroethylene	50.0	U	0.00	48.1	ug/L	2	96	(0%-20%)	RXY1	10/25/07	19:17
1,2-Dichloroethane	50.0	U	0.00	50.5	ug/L	1	101	(0%-20%)			
1,4-Dichlorobenzene	50.0	U	0.00	46.5	ug/L	1	93	(0%-20%)			
2-Butanone	250	U	0.00	196	ug/L	14	78	(0%-20%)			
Benzene	50.0	U	0.00	50.2	ug/L	1	100	(0%-20%)			
Carbon tetrachloride	50.0	U	0.00	52.7	ug/L	3	105	(0%-20%)			
Chlorobenzene	50.0	U	0.00	49.5	ug/L	1	99	(0%-20%)			
Chloroform	50.0	U	0.00	50.7	ug/L	0	101	(0%-20%)			
Tetrachloroethylene	50.0	U	0.00	46.8	ug/L	3	94	(0%-20%)			
Trichloroethylene	50.0	U	0.00	49.7	ug/L	2	99	(0%-20%)			
Vinyl chloride	50.0	U	0.00	43.6	ug/L	7	87	(0%-20%)			
**1,2-Dichloroethane-d4	65.0		53.7	53.7	ug/L		83	(68%-121%)			
**Bromofluorobenzene	65.0		58.5	59.0	ug/L		91	(80%-120%)			
**Dibromofluoromethane	65.0		58.3	60.7	ug/L		93	(78%-124%)			
*Toluene-d8	65.0		56.0	56.5	ug/L		87	(77%-122%)			
QC1201440970 TB											
1,1-Dichloroethylene			U	0.00	mg/L					10/25/07	12:44
1,2-Dichloroethane			U	0.00	mg/L						
1,4-Dichlorobenzene			U	0.00	mg/L						
2-Butanone			U	0.00	mg/L						
Benzene			U	0.00	mg/L						
Carbon tetrachloride			U	0.00	mg/L						
Chlorobenzene			U	0.00	mg/L						
Chloroform			U	0.00	mg/L						
Tetrachloroethylene			U	0.00	mg/L						
Trichloroethylene			U	0.00	mg/L						
Vinyl chloride			U	0.00	mg/L						
**1,2-Dichloroethane-d4	0.065			54.8	mg/L		84	(68%-121%)			
**Bromofluorobenzene	0.065			61.2	mg/L		94	(80%-120%)			
**Dibromofluoromethane	0.065			59.4	mg/L		92	(78%-124%)			
**Toluene-d8	0.065			57.4	mg/L		88	(77%-122%)			

Notes:

The Qualifiers in this report are defined as follows:

- ** Analyte is a surrogate compound
- < Result is less than value reported
- > Result is greater than value reported
- A The TIC is a suspected aldol-condensation product
- B For General Chemistry and Organic analysis the target analyte was detected in the associated blank.

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Parmname	NOM	Sample	Qual	QC	Units	RPD%	REC%	Range	Anlst	Date	Time
BD											
C											
D											
E											
E											
H											
J											
M											
N											
N/A											
ND											
NJ											
P											
R											
U											
UI											
X											
Y											
^											
h											

N/A indicates that spike recovery limits do not apply when sample concentration exceeds spike conc. by a factor of 4 or more.

^ The Relative Percent Difference (RPD) obtained from the sample duplicate (DUP) is evaluated against the acceptance criteria when the sample is greater than five times (5X) the contract required detection limit (RL). In cases where either the sample or duplicate value is less than 5X the RL, a control limit of +/- the RL is used to evaluate the DUP result.

* Indicates that a Quality Control parameter was not within specifications.

For PS, PSD, and SDILT results, the values listed are the measured amounts, not final concentrations.

Where the analytical method has been performed under NELAP certification, the analysis has met all of the requirements of the NELAC standard unless qualified on the QC Summary.

2007/025695

Page: <u>1</u> of <u>3</u>	<h2 style="margin:0;">GEL Chain of Custody and Analytical Request</h2> <h1 style="margin:0;">195047</h1>	General Engineering Laboratories, LLC 2040 Savage Road Charleston, SC 29407 Phone: (843) 556-8171 Fax: (843) 766-1178
Project #: _____		
GEL Quote #: <u>GEL07-0818</u>		
COC Number ⁽¹⁾ : <u>1</u>		
PO Number: <u>33734</u>		

Client Name: <u>ABC Laboratories, Inc.</u>	Phone #: <u>(573) 443-9070</u>	Sample Analysis Requested ⁽⁵⁾ (Fill in the number of containers for each test)
--	--------------------------------	---

Project/Site Name: <u>ABC Laboratories, Inc</u>	Fax #: <u>(573) 443-9033</u>	← Preservative Type (6)
---	------------------------------	-------------------------

Address: <u>7200 E. ABC Lane Columbia MO, 65202</u>	Should this sample be considered:	
Collected by: <u>SHEILA HECHT</u>	Send Results To: <u>SHEILA HECHT</u>	<p style="text-align: center;">Comments</p> <p style="text-align: center;">Note: extra sample is required for sample specific QC</p>

Sample ID	Date Collected (mm-dd-yy)	Time Collected (Military) (hh:mm)	QC Code (³)	Field Filtered (⁴)	Sample Matrix (⁶)	Radioactive	TSCA Regulated	Total number of containers								
									C-14	H-3	K-40					
ABC-SL-QC06-020	09-18-07	1008	FD		SD	✓		1	1	1	1					
ABC-SL-QC06-035	09-18-07	1036	FD		SD	✓		1	1	1	1					
ABC-SL-QC06-060	09-19-07	0800	FD		SD	✓		1	1	1	1					
ABC-SL-QC06-50	09-18-07	1730	FD		SD	✓		1	1	1	1					
ABC-SL-QC06-068	09-19-07	0800	FD		SD	✓		1	1	1	1					
ABC-FA-QC06-6	09-19-07	1500	FD		SO	✓		1	1	1	1					
ABC-FA-QC618-11	09-19-07	1715	FD		SO	✓		1	1	1	1					
ABC-FA-QC618-10	09-19-07	1715	FD		SO	✓		1	1	1	1					
ABC-FA-QC06-24	09-20-07	0900	FD		SO	✓		1	1	1	1					
ABC-FA-QC06-28	09-20-07	0900	FD		SO	✓		1	1	1	1					

TAT Requested: Normal: <input checked="" type="checkbox"/> Rush: _____ Specify: _____ (Subject to Surcharge)	Fax Results: <input checked="" type="checkbox"/> Yes / No	Circle Deliverable: C of A / QC Summary / Level 1 / <u>Level 2</u> / Level 3 / Level 4
--	---	--

Remarks: Are there any known hazards applicable to these samples? If so, please list the hazards

Chain of Custody Signatures			Sample Shipping and Delivery Details	
Relinquished By (Signed)	Date	Time	Received by (signed)	Date Time
1 <u>Sheila Hecht</u>	<u>10/03/07</u>	<u>14:30</u>	1 <u>Danigan T Brown</u>	<u>03/10/07 14:30</u>
2			2 <u>Mike Kulaw</u>	<u>10/4/07 0920</u>
3			3	

<p>1.) Chain of Custody Number = Client Determined</p> <p>2.) QC Codes: N = Normal Sample, TB = Trip Blank, FD = Field Duplicate, EB = Equipment Blank, MS = Matrix Spike Sample, MSD = Matrix Spike Duplicate Sample, G = Grab, C = Composite</p> <p>3.) Field Filtered: For liquid matrices, indicate with a - Y - for yes the sample was field filtered or - N - for sample was not field filtered.</p> <p>4.) Matrix Codes: DW = Drinking Water, GW = Groundwater, SW = Surface Water, WW = Waste Water, W = Water, SO = Soil, SD = Sediment, SL = Sludge, SS = Solid Waste, O = Oil, F = Filter, P = Wipe, U = Urine, F = Fecal, N = Nasal</p> <p>5.) Sample Analysis Requested: Analytical method requested (i.e. 8260B, 6010B/7470A) and number of containers provided for each (i.e. 8260B - 3, 6010B/7470A - 1).</p> <p>6.) Preservative Type: HA = Hydrochloric Acid, NI = Nitric Acid, SEH = Sodium Hydroxide, SA = Sulfuric Acid, AA = Ascorbic Acid, HEX = Hexane, ST = Sodium Thiosulfate. If no preservative is added = leave field blank</p>	<p>For Lab Receiving Use Only</p> <p>Custody Seal Intact?</p> <p>YES NO</p> <p>Cooler Temp:</p> <p><u>-15 C</u></p>
--	---

Page: 2 of 3
 Project #:
 GEL Quote #: GELP07-0818
 COC Number ⁽¹⁾: 1
 PO Number: 33734

GEL Chain of Custody and Analytical Request

195047

General Engineering Laboratories, LLC
 2040 Savage Road
 Charleston, SC 29407
 Phone: (843) 556-8171
 Fax: (843) 766-1178

Client Name: ABC Laboratories, Inc. Phone #: (573) 443-9070 Sample Analysis Requested ⁽⁵⁾ (Fill in the number of containers for each test)

Project/Site Name: ABC Laboratories, Inc. Fax #: (573) 443-9033 Should this sample be considered: Yes No

Address: 7200 E. ABC Lane Columbia MO 65202

Collected by: SHEILA HECHT Send Results To: SHEILA HECHT

Sample ID	Date Collected (mm-dd-yy)	Time Collected (Military) (hh:mm)	QC Code (3)	Field Filtered (4)	Sample Matrix (4)	Radioactive	TSCA Regulated	Total number of containers	Preservative Type (6)							Comments Note: extra sample is required for sample specific QC		
									C-14	H-3	K-40	TCLP-VOC	TCLP-SVOC	TCLP-Herbicides	TCLP-Pesticides		TCLP-Metals	
ABC-BK-QC06-01	09-20-07	1320	FD		SD	✓		1	1	1	1							
ABC-PD-QC06-6	09-20-07	1300	FD		SD	✓		1	1	1	1							
ABC-SP-QC06-2	09-20-07	1025	FD		SD	✓		1	1	1	1							
ABC-SP-QC618-07	09-20-07	1030	FD		SD	✓		1	1	1	1							
ABC-DF-QC06-13	09-19-07	1130	FD		SD	✓		1	1	1	1							
ABC-DF-QC06-28	09-19-07	1400	FD		SD	✓		1	1	1	1							
ABC-DF-QC06-25	09-19-07	1130	FD		SD	✓		1	1	1	1							
ABC-DF-QC06-17	09-19-07	1130	FD		SD	✓		1	1	1	1							
ABC-DF-QC06-003	09-18-07	1700	FD		SD	✓		1	1	1	1							
ABC-01-SL	10-03-07	1230	N		SD	✓		1				1	1	1	1			

TAT Requested: Normal: Rush: Specify: (Subject to Surcharge) Fax Results: Yes / No Circle Deliverable: C of A / QC Summary / Level 1 / Level 2 / Level 3 / Level 4

Remarks: Are there any known hazards applicable to these samples? If so, please list the hazards

Chain of Custody Signatures				Sample Shipping and Delivery Details			
Relinquished By (Signed)	Date	Time	Received by (signed)	Date	Time	GEL PM:	
1 Sheila Hecht	10/3/07	14:30	1 Damien Brown	03/06/07	14:31	Method of Shipment:	Date Shipped:
2			2 Mike Kuber	10/4/07	09:20	Airbill #:	
3			3			Airbill #:	

1.) Chain of Custody Number = Client Determined
 2.) QC Codes: N = Normal Sample, TB = Trip Blank, FD = Field Duplicate, EB = Equipment Blank, MS = Matrix Spike Sample, MSD = Matrix Spike Duplicate Sample, G = Grab, C = Composite
 3.) Field Filtered: For liquid matrices, indicate with a - Y - for yes the sample was field filtered or - N - for sample was not field filtered.
 4.) Matrix Codes: DW = Drinking Water, GW = Groundwater, SW = Surface Water, WW = Waste Water, W = Water, SO = Soil, SD = Sediment, SL = Sludge, SS = Solid Waste, O = Oil, F = Filter, P = Wipe, U = Urine, F = Fecal, N = Nasal
 5.) Sample Analysis Requested: Analytical method requested (i.e. 8260B, 6010B/7470A) and number of containers provided for each (i.e. 8260B - 3, 6010B/7470A - 1).
 6.) Preservative Type: HA = Hydrochloric Acid, NI = Nitric Acid, SH = Sodium Hydroxide, SA = Sulfuric Acid, AA = Ascorbic Acid, HEX = Hexane, ST = Sodium Thiosulfate, if no preservative is added = leave field blank

For Lab Receiving Use Only

Custody Seal Intact?
 YES NO

Cooler Temp:
 -15 C

ATTACHMENT III

WATER RESOURCES

Attached are two reports reflecting depth to groundwater data.



National Water Information System: Web Interface

USGS Water Resources

Data Category:

Real-time

Geographic Area:

United States

GO

[News](#) [New Mapper](#) and [Experimental Real-Time Web Service](#) - updated August 2009

USGS 385718092234201 Columbia

PROVISIONAL DATA SUBJECT TO REVISION

Available data for this site

Time-series: Real-time data

GO



Ground-water level observation well operated by Missouri Department of Natural Resources. For more information contact Jim

Vandike: jim.vandike@dnr.mo.gov

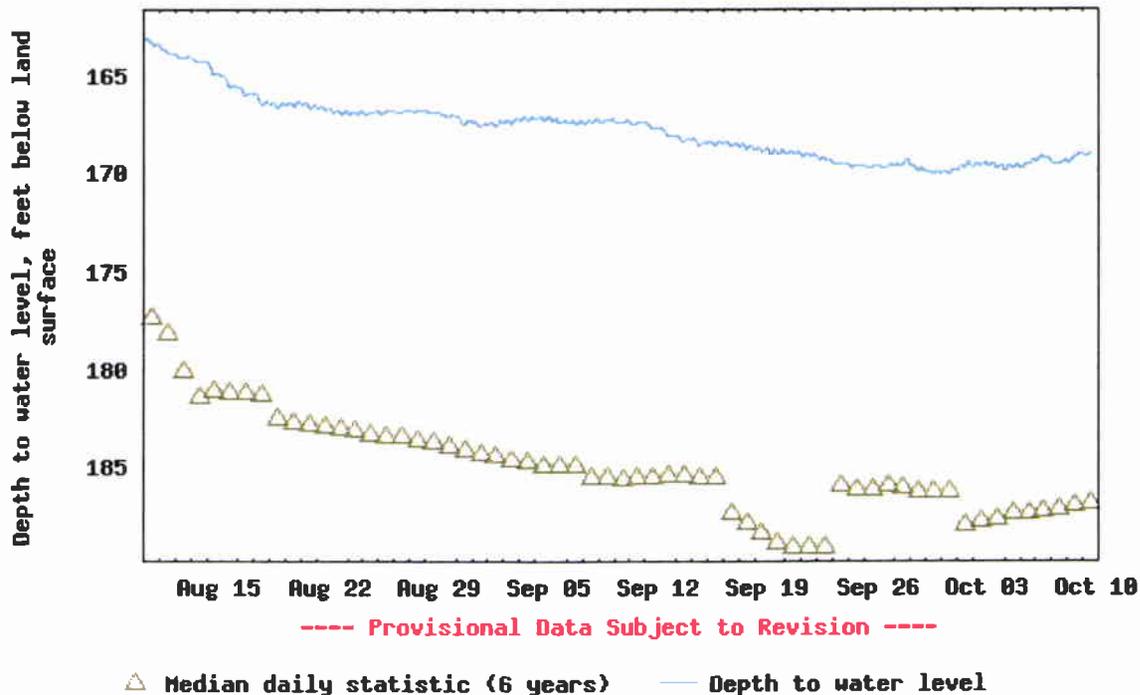
<p>Available Parameters</p> <p><input checked="" type="checkbox"/> All 1 Available Parameters for this site</p> <p><input checked="" type="checkbox"/> 72019 WaterLevel, BelowLSD</p>	<p>Output format</p> <p><input type="checkbox"/> Graph</p> <p><input checked="" type="checkbox"/> Graph w/ stats</p> <p><input type="checkbox"/> Graph w/o stats</p> <p><input type="checkbox"/> Table</p> <p><input type="checkbox"/> Tab-separated</p>	<p>Days</p> <p>60</p> <p>(1-60)</p>	<p>GO</p>
--	---	--	-----------

Summary of all available data for this site

Depth to water level, feet below land surface

Most recent instantaneous value: 169.09 10-09-2009 11:00

USGS 385718092234201 Columbia



Daily waterlevel, belowslsd statistics, in ft, for Oct 9 based on 7 years of record [more](#)

Most Recent Instantaneous Value	Min (2002)	20th percentile	Median	Mean	80th percentile	Max (2008)
169.09	180.62	181.26	186.90	191.33	208.88	210.60

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[U.S. Department of the Interior](#) | [U.S. Geological Survey](#)
Title: USGS Real-Time Water Data for the Nation
URL: <http://waterdata.usgs.gov/nwis/uv?>



Page Contact Information: [Missouri NWISWeb Maintainer](#)
Page Last Modified: 2009-10-09 13:37:46 EDT
3.25 2.36 ca03

TOP
OF
MAP N↑



ATTACHMENT IV

PROJECT TIMELINE AND RESOURCES

ID	Task Name	Start	Finish	2010				2011				2012				2013		
				Qtr 4	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Qtr 1	Qtr 2
1	send "DP" to "NRC" for approval	10/20/09	12/21/09	●														
2	receive approval of " DP " from NRC	12/21/09	12/21/09	21	●													
3	mobilize	5/3/10	5/4/10															
4	on site training & training on rwp's	5/4/10	5/5/10															
5	rope off area to remove soil and stage equipment	5/5/10	5/12/10															
6	remove soil from application field & place in lagoon	5/12/10	5/18/10															
7	sample area	5/18/10	5/19/10															
8	count samples at site	5/19/10	5/20/10															
9	send QC samples out	5/19/10	5/20/10															
10	remove pipe & soil from drain field & place in lagoon	5/20/10	5/27/10															
11	sample area	5/27/10	5/28/10															
12	count samples at site	5/31/10	6/1/10															
13	send QC samples out	5/31/10	6/1/10															
14	soil removal from lagoon and load bags	6/1/10	6/15/10															
15	sample lagoon and bags	6/15/10	6/16/10															
16	count samples at site	6/16/10	6/18/10															
17	send QC samples out	6/16/10	6/17/10															
18	load bags for shipment to rail spur	6/16/10	6/30/10															
19	manifest shipment	6/30/10	7/1/10															
20	ship soil to burial	7/1/10	7/2/10															
21	layout final status survey	7/5/10	7/6/10															
22	sample for final status survey	7/6/10	7/9/10															
23	count samples at site	7/12/10	7/13/10															
24	send QC samples to lab	7/12/10	7/13/10															
25	survey all equipment used	7/13/10	7/15/10															
26	demobilize	7/15/10	7/16/10															
27	prepare final report	7/19/10	8/4/10															



Project: ABC LABS
Date: 10/12/09

Task



Summary



Rolled Up Progress



Progress



Rolled Up Task



Milestone



Rolled Up Milestone



Budget Report as of 10/13/09
ABC LABS
Paul Nipper

ID	Task Name	Fixed Cost	Total Cost	Baseline	Variance
20	ship soil to burial	\$0.00	\$1,503,900.00	\$0.00	\$1,503,900.00
14	soil removal from lagoon and load bags	\$0.00	\$46,800.00	\$0.00	\$46,800.00
18	load bags for shipment to rail spur	\$0.00	\$46,800.00	\$0.00	\$46,800.00
27	prepare final report	\$0.00	\$27,500.00	\$0.00	\$27,500.00
3	mobilize	\$0.00	\$25,850.00	\$0.00	\$25,850.00
10	remove pipe & soil from drain field & place in lagoon	\$0.00	\$23,400.00	\$0.00	\$23,400.00
6	remove soil from application field & place in lagoon	\$0.00	\$17,550.00	\$0.00	\$17,550.00
22	sample for final status survey	\$0.00	\$17,550.00	\$0.00	\$17,550.00
5	rope off area to remove soil and stage equipment	\$0.00	\$15,600.00	\$0.00	\$15,600.00
24	send QC samples to lab	\$0.00	\$13,750.00	\$0.00	\$13,750.00
25	survey all equipment used	\$0.00	\$11,700.00	\$0.00	\$11,700.00
4	on site training & training on rwp's	\$0.00	\$5,850.00	\$0.00	\$5,850.00
21	layout final status survey	\$0.00	\$5,850.00	\$0.00	\$5,850.00
26	demobilize	\$0.00	\$5,850.00	\$0.00	\$5,850.00
9	send QC samples out	\$0.00	\$5,625.00	\$0.00	\$5,625.00
13	send QC samples out	\$0.00	\$5,625.00	\$0.00	\$5,625.00
17	send QC samples out	\$0.00	\$5,625.00	\$0.00	\$5,625.00
7	sample area	\$0.00	\$3,900.00	\$0.00	\$3,900.00
11	sample area	\$0.00	\$3,900.00	\$0.00	\$3,900.00
15	sample lagoon and bags	\$0.00	\$3,900.00	\$0.00	\$3,900.00
19	manifest shipment	\$0.00	\$3,900.00	\$0.00	\$3,900.00
23	count samples at site	\$0.00	\$3,900.00	\$0.00	\$3,900.00
16	count samples at site	\$0.00	\$1,700.00	\$0.00	\$1,700.00
8	count samples at site	\$0.00	\$850.00	\$0.00	\$850.00
12	count samples at site	\$0.00	\$850.00	\$0.00	\$850.00
1	send "DP" to "NRC" for approval	\$0.00	\$0.00	\$0.00	\$0.00
2	receive approval of "DP" from NRC	\$0.00	\$0.00	\$0.00	\$0.00
		\$0.00	\$1,807,725.00	\$0.00	\$1,807,725.00

ATTACHMENT V

Disposal of C-14 Contaminated Soil

**Exemption Request and US Ecology
Supporting Documentation**

Disposal of C-14 Contaminated Soil
In accordance with 10 CFR 20.2002 and a
10 CFR 30.11 exemption

1. INTRODUCTION

ABC Labs believes that specified ^{14}C -contaminated soil can be safely disposed at the US Ecology Idaho RCRA disposal facility (an alternate disposal method). For purposes of implementing its decommissioning plan, ABC Labs requests that NRC approve the alternate disposal of the described waste and issue a 10 CFR 30.11 exemption for the disposal of same at the US Ecology Idaho RCRA facility

2. DISPOSAL SITE

US Ecology Idaho is a fully permitted RCRA facility, located 10.5 miles NW of Grand View, Idaho. A further description of site history and geology is provided as Attachment 1. USEI's permit allows it to dispose of certain non-AEA regulated, naturally occurring or accelerator produced radioactive materials and radioactive materials for which the NRC has granted an exemption.

USEI's attached Waste Acceptance Criteria (Attachment 2), Table C.4b provides numeric criteria and conditions for receipt of byproduct material, including the ^{14}C material from ABC Labs. The subsequent discussion will demonstrate that ABC Labs material meets USEI's Waste Acceptance Criteria.

3. DESCRIPTION OF THE WASTE

The total volume of ^{14}C -contaminated soil to be disposed is approximately 963 cubic yards. Slightly contaminated soils from the drain field and application field areas will be transferred to the lagoon, which contains the highest concentration of ^{14}C (average 579 pCi/g). Some mixing will occur during excavation of the lagoon. If averaged over the total mass of soil to be removed, the concentration of the mixture of the less and more contaminated materials will be approximately 525 pCi/g. The total activity of ^{14}C in the contaminated soil to be disposed is estimated to be 597 mCi.

4. RADIOLOGICAL ASSESSMENTS

For the applicable exposure scenarios the dose equivalent for the Maximally Exposed Individual (MEI) must not exceed a few (e.g., five (5)) millirem/yr. This standard of a "few millirem/yr" to a member of the public is defined in NRC Regulatory Issue Summary 2004-08. The transportation workers and workers at the US Ecology site are treated as members of the public as the US Ecology site is

not licensed by the NRC. Evaluations of both potential external and internal dose hazards to the transportation worker are discussed below. As ^{14}C emits no gamma radiation, external exposure is not required in the dose assessment.

4.1. Transport Worker Dose Assessment

The waste will not be regulated as Class 7 radioactive material by the US Department of Transportation (DOT) because its concentration is well below the DOT exempt concentration for ^{14}C , 270,000 pCi/g.

Contaminated soil will be placed in bags prior to shipment. Consequently, no potential for intake of radionuclides exists for transporters.

4.2. USEI Worker Dose Assessment

As for the transportation workers, no consideration for external exposure is warranted for the US Ecology Idaho workers. Bags received at the rail transfer facility (RTF) will be removed with an excavator. For the purpose of the assessment, it is assumed that the contents of all bags are released in the gondola cars as the contents are excavated and loaded into trucks to carry them from the rail transfer facility (RTF) to the main site, approximately 35 miles. Also for the purpose of the assessment, it is assumed that 10 rail cars will transport the bagged soil. Estimates of the inhalation dose to the excavator operator are based on dust loading (0.2 mg/m^3) previously measured with label air sampling and assumed inhalation rate of 1.2 m^3 per hour. The concentration of airborne ^{14}C at the RTF is calculated at $8.61\text{E-}4 \text{ pCi/m}^3$. The maximum resulting dose to a worker in the RTF for the project is calculated at $3.28\text{E-}8 \text{ mrem}$. The dose calculated for an RTF excavator operator represents the dose to the maximally exposed member of the USEI work force.

4.3. Closure and Post-Closure Dose Assessment

US Ecology's permit requires it demonstrate that no person will receive a dose exceeding 15 millirem for 1000 years after closure of the facility. The Resrad code was used for that demonstration. USEI is required by its permit to assure that the concentration of ^{14}C in its cells will not exceed an average concentration over the entire mass of disposed waste of 10 pCi/g. With the addition of this waste, the average concentration of ^{14}C in the cell is calculated at approximately 0.13 pCi/g.

Consistent with NUREG-1757 Volume 2, USEI has performed an evaluation of the long term potential for exposure to radionuclides disposed in its disposal cell.

RESRAD modeling approach

The RESRAD model using the resident farmer and family scenario is employed to assess the intruder and long term dose consequences of disposal of radionuclides. The most recent US Ecology revision to RESRAD's site-specific parameters was performed by US Ecology and its consultants in 2005 to support a request to the State of Idaho Department of Environmental Quality (IDEQ) for a permit modification authorizing the disposal of fission and activation products that would be specifically exempted from regulation by the US Nuclear Regulatory Commission or its Agreement States. The modification – employing an updated RESRAD model was subsequently approved by the IDEQ.

As part of the justification for disposal of exempt materials, USEI generated a review of the geological and hydrological characteristics of the site based on data developed to support the original RCRA permit (Attachment 1). The resulting report produced a more representative description of the vadose zone(s) for the RESRAD model and also addressed the K_d for ^{14}C in the waste volume (contaminated zone). The number of vadose zones was increased from one to five.

The first zone consists of the 3 foot thick clay liner at the base of the cell. No credit is taken for any liners made of artificial materials, i.e. the double HDPE liners required by RCRA. The remaining layers of the vadose zone consist of alternating strata of gravel, clay and sand as indicated by the results of borings made during characterization of the site for the RCRA permit. A copy of the report was made a part of the permit and is enclosed (Attachment 3).

A discussion of the methodology for selection of values for the K_d 's for radionuclides is included in the report. For the most part K_d 's were derived from the literature, in cases where they were not available or inconsistent, the RESRAD default values were used. Using tritium as a surrogate for water, the model predicts that infiltrating water will reach the nearest ground water (a lens at approximately 200 feet) in 237 years. Those radionuclides for which K_d 's were not found are assumed to travel with the infiltration water and concentrations are determined based on decay of the radionuclides during 237 years of travel to the first ground water. If the concentrations calculated do not cause any additional dose of significance, then they are found acceptable for disposal.

Given that the area is classified as semi-arid – the annual rainfall is 18 cm -- and that the annual pan evaporation rate is approximately 50 inches per year, realistically, there is very little chance that precipitation will be a source of infiltration water. Additionally, a recent study of infiltration of water by Daniel B. Stephens & Associates, Inc. demonstrated that water from precipitation will not penetrate the native soil beyond a depth of four feet.

Before a request is submitted to the NRC or the IDEQ, USEI performs its own assessment of the expected doses from the radionuclides in a prospective customer's waste. The assessment is used to assure that any dose from the customer's waste will not cause a significant increase in the maximum dose

projected by the currently authorized model. The assessment also includes a RESRAD output describing the contribution of the customer's waste alone to the post-closure dose. The assessment for ABC Lab's waste is enclosed (Attachment 5). The calculated dose to the modeled individual (a "resident farmer") is 0.0528 mrem (approximately 1.5 % of the 4 millirem allowed by the currently approved model for ^{14}C).

Impact of ^{14}C on modeling approach

Longer lived radionuclides that have the potential to reach the first ground water within the time frame of the model are restricted by IDEQ with specific concentration limits for disposal. Carbon-14 is one of these radionuclides, and is restricted to 10 pCi/g averaged over the entire disposal volume of the landfill (2,964,255.6 m³). For these "select" radionuclides USEI is required to track the total activity added to the modeled waste volume (2964225.6 m³), to assure their individual concentration limits are not exceeded, and report this information to IDEQ on a regular basis. To date, very little C-14 has been received for disposal by USEI, and as a result, the facility's disposal capacity for C-14 is virtually unused. The total activity of ^{14}C allowed by the current limit, 10 pCi/g, is 44.46 Ci.

USEI has calculated the impact of ABC wastes on ^{14}C capacity at its disposal facility. At expected ^{14}C concentrations and volumes, the ABC material will increase USEI ^{14}C average activity to 0.13 pCi/g, a negligible amount, and well within the total facility limit of an average of 10 pCi/g.

Intruder analysis

As part of its RESRAD model, USEI has utilized the "resident farmer / family" intruder scenario. The resident farmer scenario will result in the highest dose to an intruder as it includes many, if not all, of the pathways and exposure occurs for an extended period of time. Other intruder scenarios, although they may involve higher external dose rates and or intake rates, will not include many pathways (such as water dependent pathways, which contribute significantly to post closure dose) and will entail much shorter exposure times. This approach is considered very conservative.

5. Conclusion

In summary, this analysis has demonstrated that USEI facility's permit specifically allows it to accept NRC-exempted, byproduct material at concentrations well above the discussed values for ABC Labs. Further, the material can be safely packaged, transported and disposed in compliance with USEI's permits and NRC regulations limiting dose to any member of the public to "a few millirem."

C.3 WASTE ACCEPTANCE CRITERIA

C.3.1 Pre-acceptance Review

The preacceptance protocol has been designed to ensure that only hazardous and radioactive material that can be properly and safely stored, treated and/or disposed of by USEI are approved for receipt at the facility. A two-step approach is taken by USEI. The first step is the chemical and/or radiological and physical characterization of the candidate waste stream by the generator. The second step is the preacceptance evaluation performed by USEI to determine the acceptability of the waste for receipt at the facility. Figure C-2 presents a logic diagram of the preacceptance protocol that is utilized at the facility.

C.3.2 Radioactive Material Waste Acceptance Criteria

The following waste acceptance criteria are established for accepting radiological contaminated waste material that is generally or specifically exempted from regulation by the Nuclear Regulatory Commission (NRC) or an Agreement State under the Atomic Energy Act of 1954 ("AEA"), as amended. Material may also be accepted if it is not regulated or licensed by the NRC or has been authorized for disposal by the IDEQ and is within the numeric waste acceptance criteria. Waste acceptance criteria are consistent with these restrictions.

The following five tables establish types and concentrations of radioactive materials that may be accepted. These tables are based on categories and types of radioactive material not regulated by the NRC based on statute or regulation or specifically approved by the NRC or an Agreement State for alternate disposal. The criteria are consistent with these restrictions and detailed analyses set forth in *Waste Acceptance Criteria and Justification for FUSRAP Material*, prepared by Radiation Safety Associates, Inc. (RSA) as subsequently refined, expanded and updated in *Waste Acceptance Criteria and Justification for Radioactive Material*, prepared by USEI.

Material may be accepted if the material has been specifically exempted from regulation by rule, order, license, license condition, letter of interpretation, or specific authorization under the following conditions: Thirty (30) days prior to intended shipment of such materials to the facility, USEI shall notify IDEQ of its intent to accept such material and submit information describing the material's physical, radiological, and/or chemical properties, impact on the facility radioactive materials performance assessment, and the basis for determining that the material does not require disposal at a facility licensed under the AEA. The IDEQ will have 30 days from receipt of this notification to reject USEI's determination or require further information and review. No response by IDEQ within thirty (30) days following receipt of such notice shall constitute concurrence. IDEQ concurrence is not required for generally exempted material as set forth in Table C.4a.

Based on categories of waste described in the waste acceptance criteria, the concentration of the various radionuclides in the conveyance (e.g., rail car gondola, other container etc.) shall not exceed the concentration limits established in the WAC without the specific written approval of the IDEQ unless generally exempted as set forth in Table C.4a. Radiological surveys will be performed as outlined in ERMP-01 to verify compliance with the WAC. If individual "pockets" of activity are detected indicating the limits may be exceeded, the RSO or RPS shall investigate the discrepancy and estimate the extent or volume of the material with the potentially elevated

radiation levels. The RPS or RSO shall then make a determination on the compliance of the entire conveyance load with the appropriate WAC limits. If the conveyance is determined not to meet the limits, USEI will notify IDEQ's RCRA Program Manager within 24 hours of a concentration based exceedance of the facility WAC to evaluate and discuss management options. The findings and resolution actions shall then be documented and submitted to the IDEQ.

The radioactive material waste acceptance criteria, when used in conjunction with an effective radiation monitoring and protection program as defined in the USEI *Radioactive Material Health and Safety Plan* and *Exempt Radioactive Materials Procedures* provides adequate protection of human health and the environment. Included within this manual are requirements for USEI to submit a written summary report of Table C.1 through C.2 radioactive material waste receipts showing volumes and radionuclide concentrations disposed at the USEI site on a quarterly basis. USEI will also submit a Table C.3 through C.4b annual report of exempted products devices, materials or items within 60 (sixty) days of year end (December 31st). The annual report will provide total volumes or mass of isotopes and total activity by isotope listing the activity of each radionuclide disposed during the preceding year, and the cumulative total of activity for each radionuclide disposed at the facility. The report will include an updated analysis of the impact on the facility performance assessment.

These criteria and procedures are designed to assure that the highest potential dose to a worker handling radioactive material at USEI shall not exceed 400 mrem/year TEDE dose, and that no member of the public is calculated to receive a potential dose exceeding 15 mrem/year TEDE dose, from the USEI program. TEDE is defined as the "Total Effective Dose Equivalent", which equals the sum of external and internal exposures. The public dose limit during operation activities is limited to 100 mrem/yr TEDE dose. An annual summary report of environmental monitoring results will be submitted to IDEQ by June 1st for the preceding year.

Materials that have a radioactive component that meets the criteria described in Tables C.1 through C.4b and are RCRA regulated material will be managed as described within this WAP for the RCRA regulated constituents.

Table C.1: Unimportant Quantities of Source Material Uniformly Dispersed* in Soil or Other Media**

	Status of Equilibrium	Maximum Concentration of Source Material	Sum of Concentrations Parent(s) and all progeny present***
a	Natural uranium in equilibrium with progeny	<500 ppm / 167 pCi/g (²³⁸ U activity)	≤ 3000 pCi/g
	Refined natural uranium (²³⁸ U, ²³⁵ U, ²³⁴ U, ²³⁴ Th, ^{234m} Pa, ²³¹ Th)	<500 ppm / 333 pCi/g	≤ 2000 pCi/g
	Depleted Uranium (^{234Th} , ^{234m} Pa)	<500 ppm / 169 pCi/g	≤ 2000 pCi/g
b	Natural thorium (²³² Th + ²²⁸ Th)	<500 ppm / 110 pCi/g	≤ 2000 pCi/g
	²³⁰ Th in equilibrium with progeny	<0.01 ppm / 200 pCi/g	≤2000 pCi/g
	²³⁰ Th (with no progeny)	0.1 ppm / ≤2000 pCi/g	
	Any mixture of Thorium and Uranium	Sum of ratios ≤ 1****	≤2000 pCi/g

Table C.2: Naturally Occurring Radioactive Material Other Than Uranium and Thorium Uniformly Dispersed* in Soil or Other Media**

	Status of Equilibrium	Maximum Concentration of Parent Nuclide	Sum of Concentrations of Parent and All Progeny Present***
a	²²⁶ Ra or ²²⁸ Ra with progeny in bulk form ¹	500 pCi/g	≤ 4500 pCi/g
b	²²⁶ Ra or ²²⁸ Ra with progeny in reinforced IP-1 containers ¹	1500 pCi/g	13,500 pCi/g
c	²¹⁰ Pb with progeny(Bi & ²¹⁰ Po)	1500 pCi/g	4500 pCi/g
	⁴⁰ K	818 pCi/g	N/A
	Any other NORM		≤3000 pCi/g

¹ Any material containing ²²⁶Ra greater than 222 pCi/g shall be disposed at least 6 meters from the external point on the completed cell.

Table C.3: Non-Production Particle Accelerator Produced Radioactive Material*****

Acceptable Material	Activity or Concentration
Any non-production particle accelerator produced radionuclide.	All materials shall be packaged in accordance with USDOT packaging requirements. Any packages containing iodine or volatile radionuclides will have lids or covers sealed to the container with gaskets. Contamination levels on the surface of the packages shall not exceed those allowed at point of receipt by USDOT rules. Gamma or x-ray radiation levels may not exceed 10 millirem per hour anywhere on the surface of the package. All packages received shall be directly disposed in the active cell. All containers shall be certified to be 90% full.

*Average over conveyance or container. The use of the phrase "over the conveyance or container is meant to reflect the variability on the generator side. The concentration limit is the primary acceptance criteria.

**Unless otherwise authorized by IDEQ, other Media does not include radioactively contaminated liquid (except for incidental liquids in materials). See radioactive contaminated liquid definition (definition section of Part B permit).

*** Diffuse waste with a total concentration (sum of concentrations of all radionuclides present) which is 2000 pCi/g or less may be accepted at the site (i.e., the controlling limit is 2000 pCi/g).

$$**** \frac{\text{Conc. of U in sample}}{\text{Allowable conc. of U}} + \frac{\text{Conc. of Th in Sample}}{\text{Allowable conc. of Th}} \leq 1$$

***** Any material that has been made radioactive by use of a non-production particle accelerator as set forth in Federal Register, Vol. 72, No. 189, Monday October 1, 2007, page 55868.

Table C.4a: NRC Exempted Products, Devices or Items

Exemption 10 CFR Part*	Product, Device or Item	Isotope, Activity or Concentration
30.15	As listed in the regulation	Various isotopes and activities as set forth in 30.15
30.14, 30.18	Other materials, products or devices specifically exempted from regulation by rule, order, license, license condition, concurrence, or letter of interpretation	Radionuclides in concentrations consistent with the exemption
30.19	Self-luminous products containing tritium, ⁸⁵ Kr, ³ H or ¹⁴⁷ Pm	Activity by Manufacturing license
30.20	Gas and aerosol detectors for protection of life and property from fire	Isotope and activity by Manufacturing license
30.21	Capsules containing ¹⁴ C urea for <i>in vivo</i> diagnosis of humans	¹⁴ C, one µCi per capsule
40.13(a)	Unimportant quantity of source material: see table above	≤0.05% by weight source material
40.13(b)	Unrefined and unprocessed ore containing source material	As set forth in rule
40.13(c)(1)	Source material in incandescent gas mantles, vacuum tubes, welding rods, electric lamps for illumination	Thorium and uranium, various amounts or concentrations, see rules
40.13(c)(2)	(i) Source material in glazed ceramic tableware (ii) Piezoelectric ceramic (iii) Glassware not including glass brick, pane glass, ceramic tile, or other glass or ceramic used in construction	≤20% by weight ≤2% by weight ≤10% by weight
40.13(c)(3)	Photographic film, negatives or prints	Uranium or Thorium
40.13(c)(4)	Finished product or part fabricated of or containing tungsten or magnesium-thorium alloys. Cannot treat or process chemically, metallurgically, or physically.	≤4% by weight thorium content.
40.13(c)(5)	Uranium contained in counterweights installed in aircraft, rockets, projectiles and missiles or stored or handled in connection with installation or removal of such counterweights.	Per stated conditions in rule.
40.13(c)(6)	Uranium used as shielding in shipping containers if conspicuously and legibly impressed with legend "CAUTION RADIOACTIVE SHIELDING – URANIUM" and uranium incased in at least 1/8 inch thick steel or fire resistant metal.	Depleted Uranium
40.13(c)(7)	Thorium contained in finished optical lenses	≤30% by weight thorium, per conditions in rule.
40.13(c)(8)	Thorium contained in any finished aircraft engine part containing nickel-thoria alloy.	≤4% by weight thorium, per conditions in rule.

**Table C.4b: Materials Specifically Exempted by the NRC
Or NRC Agreement State**

Exemption	Materials	Isotope, Activity or Concentration*
10 CFR 30.11***	Byproduct material including production particle accelerator material exempted from NRC or Agreement State regulation by rule, order, license, license condition or letter of interpretation may be accepted as determined by specific NRC or Agreement State exemption.****	Byproduct material at concentrations consistent with the exemption**
10 CFR 40.14***	Source material exempted from NRC or Agreement State regulation by rule, order, license, license condition or letter of interpretation may be accepted as determined by specific NRC or Agreement State exemption.****	Source material at concentrations consistent with the exemption.
10 CFR 70.17	Special Nuclear Material (SNM) exempted from NRC regulation by rule, order, license, license condition or letter of interpretation may be accepted as determined by specific NRC or Agreement State exemption.****	SNM at concentrations consistent with the exemption.

*Sum of all isotopes up to a maximum concentration of 3,000 pCi/gm.

**Specifically exempted production beam accelerator may be received under Table C.3 provisions [10 CFR 20.2008 (b)]

***Also includes equivalent Agreement State regulation where applicable.

**** Similar material not regulated or licensed by the NRC may also be accepted. Sum of all isotopes up to a maximum concentration of 3,000 pCi/gm. IDEQ shall be notified prior to the receipt of Special Nuclear Material not regulated or licensed by the NRC.

Additional Information for USEI's Waste Analysis Plan

1. US Ecology Idaho, Inc. (USEI) may receive contaminated materials or other materials as described in Tables C.1 - C.4b above. USEI may not accept for disposal any material that by its possession would require USEI to have a radioactive material license from the Nuclear Regulatory Commission (NRC).
2. Unless approved in advance by USEI and IDEQ, average activity concentrations may not exceed those concentrations enumerated in Tables C.1 and C.2. Additionally, for Tables C.1 and C.2, individual pockets of material may exceed the WAC for the radionuclides present as long as the average concentration of all radionuclides within the package or conveyance remains at or below the WAC and the highest dose rate measured on the outside of the unshielded package or conveyance does not exceed those action levels enumerated in ERMP-01.
3. Other items, devices or materials listed in Table C.4a, which are exempted in accordance with 10 CFR Parts 30, 40 or equivalent Agreement State regulations or 10 CFR Part 70 may be accepted at or below the activities (per device or item) or concentrations specified in those exemptions.
4. The generator of the exempted or non-production particle accelerator produced waste must specify that the waste meets applicable acceptance criteria and/or exemption requirements.
5. In accordance with permit requirements, notification of any exceedance of the WAC will be provided to the RCRA Program Manager within 24 hours, in accordance with the permit.

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Dose Conversion Factor (and Related) Parameter Summary

Dose Library: FGR 11

u	Parameter	Current Value#	Base Case*	Parameter Name
.	DCF's for external ground radiation, (mrem/yr)/(pCi/g)			
.	C-14 (Source: FGR 12)	1.345E-05	1.345E-05	DCF1(1)
.	Dose conversion factors for inhalation, mrem/pCi:			
.	C-14 (Class: ORGANIC)	2.090E-06	2.090E-06	DCF2(1)
.	C-14 (Class: CO2)	2.350E-08	2.350E-08	C14InhDCF
.	Dose conversion factors for ingestion, mrem/pCi:			
.	C-14	2.090E-06	2.090E-06	DCF3(1)
14	Food transfer factors:			
14	C-14 , plant/soil concentration ratio, dimensionless	5.500E+00	5.500E+00	RTF(1,1)
14	C-14 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	3.100E-02	3.100E-02	RTF(1,2)
14	C-14 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	1.200E-02	1.200E-02	RTF(1,3)
i	Bioaccumulation factors, fresh water, L/kg:			
i	C-14 , fish	5.000E+04	5.000E+04	BIOFAC(1,1)
i	C-14 , crustacea and mollusks	9.100E+03	9.100E+03	BIOFAC(1,2)

or DCF1(xxx) only, factors are for infinite depth & area. See ETEG table in Ground Pathway of Detailed Report.

Case means Default.Lib w/o Associate Nuclide contributions.

Site-Specific Parameter Summary

id	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
1	Area of contaminated zone (m**2)	8.822E+04	1.000E+04	---	AREA
1	Thickness of contaminated zone (m)	3.360E+01	2.000E+00	---	THICK0
1	Length parallel to aquifer flow (m)	5.820E+02	1.000E+02	---	LCZPAQ
1	Basic radiation dose limit (mrem/yr)	2.500E+01	3.000E+01	---	BRDL
1	Time since placement of material (yr)	0.000E+00	0.000E+00	---	TI
1	Times for calculations (yr)	1.000E+00	1.000E+00	---	T(2)
1	Times for calculations (yr)	3.000E+00	3.000E+00	---	T(3)
1	Times for calculations (yr)	1.000E+01	1.000E+01	---	T(4)
1	Times for calculations (yr)	3.000E+01	3.000E+01	---	T(5)
1	Times for calculations (yr)	1.000E+02	1.000E+02	---	T(6)
1	Times for calculations (yr)	3.000E+02	3.000E+02	---	T(7)
1	Times for calculations (yr)	1.000E+03	1.000E+03	---	T(8)
1	Times for calculations (yr)	not used	0.000E+00	---	T(9)
1	Times for calculations (yr)	not used	0.000E+00	---	T(10)
2	Initial principal radionuclide (pCi/g): C-14	1.300E-01	0.000E+00	---	S1(1)
2	Concentration in groundwater (pCi/L): C-14	not used	0.000E+00	---	W1(1)
.3	Cover depth (m)	3.600E+00	0.000E+00	---	COVER0
.3	Density of cover material (g/cm**3)	1.780E+00	1.500E+00	---	DENSCV
.3	Cover depth erosion rate (m/yr)	1.000E-04	1.000E-03	---	VCV
.3	Density of contaminated zone (g/cm**3)	1.500E+00	1.500E+00	---	DENSCZ
.3	Contaminated zone erosion rate (m/yr)	1.000E-03	1.000E-03	---	VCZ
.3	Contaminated zone total porosity	4.000E-01	4.000E-01	---	TPCZ
.3	Contaminated zone field capacity	2.000E-01	2.000E-01	---	FCCZ
.3	Contaminated zone hydraulic conductivity (m/yr)	5.000E+01	1.000E+01	---	HCCZ
.3	Contaminated zone b parameter	5.300E+00	5.300E+00	---	BCZ
.3	Average annual wind speed (m/sec)	2.000E+00	2.000E+00	---	WIND
.3	Humidity in air (g/m**3)	not used	8.000E+00	---	HUMID
.3	Evapotranspiration coefficient	7.500E-01	5.000E-01	---	EVAPTR
.3	Precipitation (m/yr)	1.840E-01	1.000E+00	---	PRECIP
.3	Irrigation (m/yr)	2.000E-01	2.000E-01	---	RI
.3	Irrigation mode	overhead	overhead	---	IDITCH
.3	Runoff coefficient	2.000E-01	2.000E-01	---	RUNOFF
.3	Watershed area for nearby stream or pond (m**2)	1.000E+06	1.000E+06	---	WAREA
.3	Accuracy for water/soil computations	1.000E-03	1.000E-03	---	EPS
.4	Density of saturated zone (g/cm**3)	1.500E+00	1.500E+00	---	DENSAQ
.4	Saturated zone total porosity	4.300E-01	4.000E-01	---	TPSZ
.4	Saturated zone effective porosity	4.000E-01	2.000E-01	---	EPSZ
.4	Saturated zone field capacity	4.000E-01	2.000E-01	---	FCSZ
.4	Saturated zone hydraulic conductivity (m/yr)	2.500E+01	1.000E+02	---	HCSZ
.4	Saturated zone hydraulic gradient	1.000E-02	2.000E-02	---	HGWT
.4	Saturated zone b parameter	5.000E+00	5.300E+00	---	BSZ
.4	Water table drop rate (m/yr)	1.000E-03	1.000E-03	---	VWT
.4	Well pump intake depth (m below water table)	1.000E+01	1.000E+01	---	DWIBWT
.4	Model: Nondispersion (ND) or Mass-Balance (MB)	ND	ND	---	MODEL
.4	Well pumping rate (m**3/yr)	2.500E+02	2.500E+02	---	UW
.5	Number of unsaturated zone strata	5	1	---	NS

Site-Specific Parameter Summary (continued)

ID	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
.5	Unsat. zone 1, thickness (m)	1.000E+00	4.000E+00	---	H(1)
.5	Unsat. zone 1, soil density (g/cm**3)	1.630E+00	1.500E+00	---	DENSUZ(1)
.5	Unsat. zone 1, total porosity	5.200E-01	4.000E-01	---	TPUZ(1)
.5	Unsat. zone 1, effective porosity	1.000E-01	2.000E-01	---	EPUZ(1)
.5	Unsat. zone 1, field capacity	4.500E-01	2.000E-01	---	FCUZ(1)
.5	Unsat. zone 1, soil-specific b parameter	1.100E+01	5.300E+00	---	BUZ(1)
.5	Unsat. zone 1, hydraulic conductivity (m/yr)	1.500E-02	1.000E+01	---	HCUZ(1)
.5	Unsat. zone 2, thickness (m)	4.600E+00	0.000E+00	---	H(2)
.5	Unsat. zone 2, soil density (g/cm**3)	1.690E+00	1.500E+00	---	DENSUZ(2)
.5	Unsat. zone 2, total porosity	3.400E-01	4.000E-01	---	TPUZ(2)
.5	Unsat. zone 2, effective porosity	3.300E-01	2.000E-01	---	EPUZ(2)
.5	Unsat. zone 2, field capacity	7.000E-02	2.000E-01	---	FCUZ(2)
.5	Unsat. zone 2, soil-specific b parameter	2.000E+00	5.300E+00	---	BUZ(2)
.5	Unsat. zone 2, hydraulic conductivity (m/yr)	2.200E+03	1.000E+01	---	HCUZ(2)
.5	Unsat. zone 3, thickness (m)	2.130E+01	0.000E+00	---	H(3)
.5	Unsat. zone 3, soil density (g/cm**3)	1.300E+00	1.500E+00	---	DENSUZ(3)
.5	Unsat. zone 3, total porosity	5.200E-01	4.000E-01	---	TPUZ(3)
.5	Unsat. zone 3, effective porosity	4.000E-01	2.000E-01	---	EPUZ(3)
.5	Unsat. zone 3, field capacity	4.900E-01	2.000E-01	---	FCUZ(3)
.5	Unsat. zone 3, soil-specific b parameter	3.000E+00	5.300E+00	---	BUZ(3)
.5	Unsat. zone 3, hydraulic conductivity (m/yr)	9.000E+02	1.000E+01	---	HCUZ(3)
.5	Unsat. zone 4, thickness (m)	1.680E+01	0.000E+00	---	H(4)
.5	Unsat. zone 4, soil density (g/cm**3)	1.310E+00	1.500E+00	---	DENSUZ(4)
.5	Unsat. zone 4, total porosity	4.900E-01	4.000E-01	---	TPUZ(4)
.5	Unsat. zone 4, effective porosity	4.300E-01	2.000E-01	---	EPUZ(4)
.5	Unsat. zone 4, field capacity	4.800E-01	2.000E-01	---	FCUZ(4)
.5	Unsat. zone 4, soil-specific b parameter	5.000E+00	5.300E+00	---	BUZ(4)
.5	Unsat. zone 4, hydraulic conductivity (m/yr)	6.000E+01	1.000E+01	---	HCUZ(4)
.5	Unsat. zone 5, thickness (m)	1.220E+01	0.000E+00	---	H(5)
.5	Unsat. zone 5, soil density (g/cm**3)	1.500E+00	1.500E+00	---	DENSUZ(5)
.5	Unsat. zone 5, total porosity	5.200E-01	4.000E-01	---	TPUZ(5)
.5	Unsat. zone 5, effective porosity	1.500E-01	2.000E-01	---	EPUZ(5)
.5	Unsat. zone 5, field capacity	3.200E-01	2.000E-01	---	FCUZ(5)
.5	Unsat. zone 5, soil-specific b parameter	8.000E+00	5.300E+00	---	BUZ(5)
.5	Unsat. zone 5, hydraulic conductivity (m/yr)	1.000E-01	1.000E+01	---	HCUZ(5)
.6	Distribution coefficients for C-14				
.6	Contaminated zone (cm**3/g)	5.000E+00	0.000E+00	---	DCNUCC(1)
.6	Unsaturated zone 1 (cm**3/g)	1.000E+00	0.000E+00	---	DCNUCU(1,1)
.6	Unsaturated zone 2 (cm**3/g)	1.000E+00	0.000E+00	---	DCNUCU(1,2)
.6	Unsaturated zone 3 (cm**3/g)	1.000E+00	0.000E+00	---	DCNUCU(1,3)
.6	Unsaturated zone 4 (cm**3/g)	1.000E+00	0.000E+00	---	DCNUCU(1,4)
.6	Unsaturated zone 5 (cm**3/g)	1.000E+00	0.000E+00	---	DCNUCU(1,5)
.6	Saturated zone (cm**3/g)	1.000E+00	0.000E+00	---	DCNUCS(1)
.6	Leach rate (/yr)	0.000E+00	0.000E+00	3.333E-04	ALEACH(1)
.6	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(1)

Site-Specific Parameter Summary (continued)

Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
.7 Inhalation rate (m**3/yr)	8.400E+03	8.400E+03	---	INHALR
.7 Mass loading for inhalation (g/m**3)	1.000E-04	1.000E-04	---	MLINH
.7 Exposure duration	3.000E+01	3.000E+01	---	ED
.7 Shielding factor, inhalation	4.000E-01	4.000E-01	---	SHF3
.7 Shielding factor, external gamma	7.000E-01	7.000E-01	---	SHF1
.7 Fraction of time spent indoors	5.000E-01	5.000E-01	---	FIND
.7 Fraction of time spent outdoors (on site)	2.500E-01	2.500E-01	---	FOTD
.7 Shape factor flag, external gamma	1.000E+00	1.000E+00	>0 shows circular AREA.	FS
.7 Radii of shape factor array (used if FS = -1):				
.7 Outer annular radius (m), ring 1:	not used	5.000E+01	---	RAD_SHAPE(1)
.7 Outer annular radius (m), ring 2:	not used	7.071E+01	---	RAD_SHAPE(2)
.7 Outer annular radius (m), ring 3:	not used	0.000E+00	---	RAD_SHAPE(3)
.7 Outer annular radius (m), ring 4:	not used	0.000E+00	---	RAD_SHAPE(4)
.7 Outer annular radius (m), ring 5:	not used	0.000E+00	---	RAD_SHAPE(5)
.7 Outer annular radius (m), ring 6:	not used	0.000E+00	---	RAD_SHAPE(6)
.7 Outer annular radius (m), ring 7:	not used	0.000E+00	---	RAD_SHAPE(7)
.7 Outer annular radius (m), ring 8:	not used	0.000E+00	---	RAD_SHAPE(8)
.7 Outer annular radius (m), ring 9:	not used	0.000E+00	---	RAD_SHAPE(9)
.7 Outer annular radius (m), ring 10:	not used	0.000E+00	---	RAD_SHAPE(10)
.7 Outer annular radius (m), ring 11:	not used	0.000E+00	---	RAD_SHAPE(11)
.7 Outer annular radius (m), ring 12:	not used	0.000E+00	---	RAD_SHAPE(12)
Fractions of annular areas within AREA:				
.7 Ring 1	not used	1.000E+00	---	FRACA(1)
.7 Ring 2	not used	2.732E-01	---	FRACA(2)
.7 Ring 3	not used	0.000E+00	---	FRACA(3)
.7 Ring 4	not used	0.000E+00	---	FRACA(4)
.7 Ring 5	not used	0.000E+00	---	FRACA(5)
.7 Ring 6	not used	0.000E+00	---	FRACA(6)
.7 Ring 7	not used	0.000E+00	---	FRACA(7)
.7 Ring 8	not used	0.000E+00	---	FRACA(8)
.7 Ring 9	not used	0.000E+00	---	FRACA(9)
.7 Ring 10	not used	0.000E+00	---	FRACA(10)
.7 Ring 11	not used	0.000E+00	---	FRACA(11)
.7 Ring 12	not used	0.000E+00	---	FRACA(12)
8 Fruits, vegetables and grain consumption (kg/yr)	1.600E+02	1.600E+02	---	DIET(1)
8 Leafy vegetable consumption (kg/yr)	1.400E+01	1.400E+01	---	DIET(2)
8 Milk consumption (L/yr)	9.200E+01	9.200E+01	---	DIET(3)
8 Meat and poultry consumption (kg/yr)	6.300E+01	6.300E+01	---	DIET(4)
8 Fish consumption (kg/yr)	not used	5.400E+00	---	DIET(5)
8 Other seafood consumption (kg/yr)	not used	9.000E-01	---	DIET(6)
8 Soil ingestion rate (g/yr)	3.650E+01	3.650E+01	---	SOIL
8 Drinking water intake (L/yr)	5.100E+02	5.100E+02	---	DWI
8 Contamination fraction of drinking water	1.000E+00	1.000E+00	---	FDW
8 Contamination fraction of household water	not used	1.000E+00	---	FHHW
8 Contamination fraction of livestock water	1.000E+00	1.000E+00	---	FLW
8 Contamination fraction of irrigation water	1.000E+00	1.000E+00	---	FIRW
8 Contamination fraction of aquatic food	not used	5.000E-01	---	FR9
8 Contamination fraction of plant food	-1	-1	0.500E+00	FPLANT

Site-Specific Parameter Summary (continued)

Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
Contamination fraction of meat	-1	-1	0.100E+01	FMEAT
Contamination fraction of milk	-1	-1	0.100E+01	FMILK
Livestock fodder intake for meat (kg/day)	6.800E+01	6.800E+01	---	LFI5
Livestock fodder intake for milk (kg/day)	5.500E+01	5.500E+01	---	LFI6
Livestock water intake for meat (L/day)	5.000E+01	5.000E+01	---	LWI5
Livestock water intake for milk (L/day)	1.600E+02	1.600E+02	---	LWI6
Livestock soil intake (kg/day)	5.000E-01	5.000E-01	---	LSI
Mass loading for foliar deposition (g/m**3)	1.000E-04	1.000E-04	---	MLFD
Depth of soil mixing layer (m)	1.500E-01	1.500E-01	---	DM
Depth of roots (m)	9.000E-01	9.000E-01	---	DROOT
Drinking water fraction from ground water	1.000E+00	1.000E+00	---	FGWDW
Household water fraction from ground water	not used	1.000E+00	---	FGWHH
Livestock water fraction from ground water	1.000E+00	1.000E+00	---	FGWLW
Irrigation fraction from ground water	1.000E+00	1.000E+00	---	FGWIR
Wet weight crop yield for Non-Leafy (kg/m**2)	7.000E-01	7.000E-01	---	YV(1)
Wet weight crop yield for Leafy (kg/m**2)	1.500E+00	1.500E+00	---	YV(2)
Wet weight crop yield for Fodder (kg/m**2)	1.100E+00	1.100E+00	---	YV(3)
Growing Season for Non-Leafy (years)	1.700E-01	1.700E-01	---	TE(1)
Growing Season for Leafy (years)	2.500E-01	2.500E-01	---	TE(2)
Growing Season for Fodder (years)	8.000E-02	8.000E-02	---	TE(3)
Translocation Factor for Non-Leafy	1.000E-01	1.000E-01	---	TIV(1)
Translocation Factor for Leafy	1.000E+00	1.000E+00	---	TIV(2)
Translocation Factor for Fodder	1.000E+00	1.000E+00	---	TIV(3)
Dry Foliar Interception Fraction for Non-Leafy	2.500E-01	2.500E-01	---	RDRY(1)
Dry Foliar Interception Fraction for Leafy	2.500E-01	2.500E-01	---	RDRY(2)
Dry Foliar Interception Fraction for Fodder	2.500E-01	2.500E-01	---	RDRY(3)
Wet Foliar Interception Fraction for Non-Leafy	2.500E-01	2.500E-01	---	RWET(1)
Wet Foliar Interception Fraction for Leafy	2.500E-01	2.500E-01	---	RWET(2)
Wet Foliar Interception Fraction for Fodder	2.500E-01	2.500E-01	---	RWET(3)
Weathering Removal Constant for Vegetation	2.000E+01	2.000E+01	---	WLAM
C-12 concentration in water (g/cm**3)	2.000E-05	2.000E-05	---	C12WTR
C-12 concentration in contaminated soil (g/g)	3.000E-02	3.000E-02	---	C12CZ
Fraction of vegetation carbon from soil	2.000E-02	2.000E-02	---	CSOIL
Fraction of vegetation carbon from air	9.800E-01	9.800E-01	---	CAIR
C-14 evasion layer thickness in soil (m)	3.000E-01	3.000E-01	---	DMC
C-14 evasion flux rate from soil (1/sec)	7.000E-07	7.000E-07	---	EVSN
C-12 evasion flux rate from soil (1/sec)	1.000E-10	1.000E-10	---	REVSN
Fraction of grain in beef cattle feed	8.000E-01	8.000E-01	---	AVFG4
Fraction of grain in milk cow feed	2.000E-01	2.000E-01	---	AVFG5
Storage times of contaminated foodstuffs (days):				
Fruits, non-leafy vegetables, and grain	1.400E+01	1.400E+01	---	STOR_T(1)
Leafy vegetables	1.000E+00	1.000E+00	---	STOR_T(2)
Milk	1.000E+00	1.000E+00	---	STOR_T(3)
Meat and poultry	2.000E+01	2.000E+01	---	STOR_T(4)
Fish	7.000E+00	7.000E+00	---	STOR_T(5)
Crustacea and mollusks	7.000E+00	7.000E+00	---	STOR_T(6)

Site-Specific Parameter Summary (continued)

Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
Well water	1.000E+00	1.000E+00	---	STOR_T(7)
Surface water	1.000E+00	1.000E+00	---	STOR_T(8)
Livestock fodder	4.500E+01	4.500E+01	---	STOR_T(9)
Thickness of building foundation (m)	not used	1.500E-01	---	FLOOR1
Bulk density of building foundation (g/cm*3)	not used	2.400E+00	---	DENSFL
Total porosity of the cover material	not used	4.000E-01	---	TPCV
Total porosity of the building foundation	not used	1.000E-01	---	TPFL
Volumetric water content of the cover material	not used	5.000E-02	---	PH2OCV
Volumetric water content of the foundation	not used	3.000E-02	---	PH2OFL
Diffusion coefficient for radon gas (m/sec):				
in cover material	not used	2.000E-06	---	DIFCV
in foundation material	not used	3.000E-07	---	DIFFL
in contaminated zone soil	not used	2.000E-06	---	DIFCZ
Radon vertical dimension of mixing (m)	not used	2.000E+00	---	HMIX
Average building air exchange rate (1/hr)	not used	5.000E-01	---	REXG
Height of the building (room) (m)	not used	2.500E+00	---	HRM
Building interior area factor	not used	0.000E+00	---	FAI
Building depth below ground surface (m)	not used	-1.000E+00	---	DMFL
Emanating power of Rn-222 gas	not used	2.500E-01	---	EMANA(1)
Emanating power of Rn-220 gas	not used	1.500E-01	---	EMANA(2)
Number of graphical time points	512	---	---	NPTS
Maximum number of integration points for dose	17	---	---	LYMAX
Maximum number of integration points for risk	1	---	---	KYMAX

Summary of Pathway Selections

Pathway	User Selection
1 -- external gamma	active
2 -- inhalation (w/o radon)	active
3 -- plant ingestion	active
4 -- meat ingestion	active
5 -- milk ingestion	active
6 -- aquatic foods	suppressed
7 -- drinking water	active
8 -- soil ingestion	active
9 -- radon	suppressed
Find peak pathway doses	active

Summary : EGL Vadose Zone Analysis

File : C:\RESRAD_FAMILY\RESRAD\ABC CONTAM SOIL C-14.RAD

Contaminated Zone Dimensions

Initial Soil Concentrations, pCi/g

Area: 88221.00 square meters
Thickness: 33.60 meters
Screen Depth: 3.60 meters

C-14 1.300E-01

Total Dose TDOSE(t), mrem/yr

Basic Radiation Dose Limit = 2.500E+01 mrem/yr

Total Mixture Sum M(t) = Fraction of Basic Dose Limit Received at Time (t)

t (years):	0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03
TDOSE(t):	0.000E+00	5.281E-02						
M(t):	0.000E+00	2.112E-03						

Minimum TDOSE(t): 5.281E-02 mrem/yr at t = 1.000E+03 years

Summary : EGL Vadose Zone Analysis

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Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 0.000E+00 years

Water Independent Pathways (Inhalation excludes radon)

Radionuclide	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
4	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 0.000E+00 years

Water Dependent Pathways

Radionuclide	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
	mrem/yr	fract.	mrem/yr	fract.										
4	0.000E+00	0.0000	0.000E+00	0.0000										
Total	0.000E+00	0.0000	0.000E+00	0.0000										

Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)

As mrem/yr and Fraction of Total Dose At t = 1.000E+00 years

Water Independent Pathways (Inhalation excludes radon)

Radionuclide	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
4	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)

As mrem/yr and Fraction of Total Dose At t = 1.000E+00 years

Water Dependent Pathways

Radionuclide	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
	mrem/yr	fract.	mrem/yr	fract.										
4	0.000E+00	0.0000	0.000E+00	0.0000										
Total	0.000E+00	0.0000	0.000E+00	0.0000										

Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
 As mrem/yr and Fraction of Total Dose At t = 3.000E+00 years

Water Independent Pathways (Inhalation excludes radon)

Radionuclide	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
4	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
 As mrem/yr and Fraction of Total Dose At t = 3.000E+00 years

Water Dependent Pathways

Radionuclide	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
	mrem/yr	fract.	mrem/yr	fract.										
4	0.000E+00	0.0000	0.000E+00	0.0000										
Total	0.000E+00	0.0000	0.000E+00	0.0000										

Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+01 years

Water Independent Pathways (Inhalation excludes radon)

Radionuclide	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
4	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+01 years

Water Dependent Pathways

Radionuclide	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
	mrem/yr	fract.	mrem/yr	fract.										
4	0.000E+00	0.0000	0.000E+00	0.0000										
Total	0.000E+00	0.0000	0.000E+00	0.0000										

* Sum of all water independent and dependent pathways.

Summary : EGL Vadose Zone Analysis

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Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+01 years

Water Independent Pathways (Inhalation excludes radon)

Radionuclide	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
4	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+01 years

Water Dependent Pathways

Radionuclide	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
	mrem/yr	fract.	mrem/yr	fract.										
4	0.000E+00	0.0000	0.000E+00	0.0000										
Total	0.000E+00	0.0000	0.000E+00	0.0000										

Sum of all water independent and dependent pathways.

Summary : EGL Vadose Zone Analysis

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Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
 As mrem/yr and Fraction of Total Dose At t = 1.000E+02 years

Water Independent Pathways (Inhalation excludes radon)

Radionuclide	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
4	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
 As mrem/yr and Fraction of Total Dose At t = 1.000E+02 years

Water Dependent Pathways

Radionuclide	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
	mrem/yr	fract.	mrem/yr	fract.										
4	0.000E+00	0.0000	0.000E+00	0.0000										
Total	0.000E+00	0.0000	0.000E+00	0.0000										

Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
 As mrem/yr and Fraction of Total Dose At t = 3.000E+02 years

Water Independent Pathways (Inhalation excludes radon)

Radioisotope	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
4	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
 As mrem/yr and Fraction of Total Dose At t = 3.000E+02 years

Water Dependent Pathways

Radioisotope	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
	mrem/yr	fract.	mrem/yr	fract.										
4	0.000E+00	0.0000	0.000E+00	0.0000										
Total	0.000E+00	0.0000	0.000E+00	0.0000										

*Sum of all water independent and dependent pathways.

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Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+03 years

Water Independent Pathways (Inhalation excludes radon)

Radionuclide	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
4	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
al	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+03 years

Water Dependent Pathways

Radionuclide	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
	mrem/yr	fract.	mrem/yr	fract.										
4	1.797E-02	0.3403	0.000E+00	0.0000	0.000E+00	0.0000	2.245E-02	0.4251	5.996E-03	0.1135	6.392E-03	0.1210	5.281E-02	1.0000
	1.797E-02	0.3403	0.000E+00	0.0000	0.000E+00	0.0000	2.245E-02	0.4251	5.996E-03	0.1135	6.392E-03	0.1210	5.281E-02	1.0000

Sum of all water independent and dependent pathways.

Summary : EGL Vadose Zone Analysis

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Dose/Source Ratios Summed Over All Pathways

Parent and Progeny Principal Radionuclide Contributions Indicated

Parent (i)	Product (j)	Thread Fraction	DSR(j,t) At Time in Years (mrem/yr)/(pCi/g)								
			0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03	
.4	C-14	1.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	4.062E-01

DSR includes contributions from associated (half-life ≤ 180 days) daughters.

Single Radionuclide Soil Guidelines G(i,t) in pCi/g

Basic Radiation Dose Limit = 2.500E+01 mrem/yr

Slide (i)	t=	0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03
.4	*	4.455E+12	6.155E+01						

specific activity limit

Summed Dose/Source Ratios DSR(i,t) in (mrem/yr)/(pCi/g)

and Single Radionuclide Soil Guidelines G(i,t) in pCi/g

at tmin = time of minimum single radionuclide soil guideline

and at tmax = time of maximum total dose = 1.000E+03 years

Slide (i)	Initial (pCi/g)	tmin (years)	DSR(i,tmin)	G(i,tmin) (pCi/g)	DSR(i,tmax)	G(i,tmax) (pCi/g)
.4	1.300E-01	1.000E+03	4.062E-01	6.155E+01	4.062E-01	6.155E+01

Individual Nuclide Dose Summed Over All Pathways
Parent Nuclide and Branch Fraction Indicated

Nuclide (j)	Parent (i)	THF(i)	DOSE(j,t), mrem/yr									
			t= 0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03		
4	C-14	1.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	5.281E-02

THF(i) is the thread fraction of the parent nuclide.

Individual Nuclide Soil Concentration
Parent Nuclide and Branch Fraction Indicated

Nuclide (j)	Parent (i)	THF(i)	S(j,t), pCi/g								
			t= 0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03	
4	C-14	1.000E+00	1.300E-01	1.299E-01	1.298E-01	1.294E-01	1.282E-01	1.242E-01	1.134E-01	8.254E-02	

THF(i) is the thread fraction of the parent nuclide.

CALC.EXE execution time = 0.51 seconds

GENERAL DESCRIPTION (IDAPA 58.01.05.012 & 40 CFR 270.14(B)(1))

US Ecology Idaho (USEI) owns and operates an approximately 160-acre RCRA Subtitle C Treatment, Storage and Disposal Facility (TSDF). This facility is located at the end of Lemley Road approximately 10½ miles west of the town of Grand View, Owyhee County, Idaho.

The site had previously operated as a waste storage and landfill disposal facility by a different owner from 1973 to 1981. Current activities at this facility include storage, treatment, and disposal at an on-site landfill(s) of industrial, toxic and hazardous wastes and certain low activity radioactive materials. USEI serves multiple industries including chemical, manufacturing, steel, petroleum and pharmaceutical industries as well as the federal government. Wastes are generated on-site from various site activities. These activities include leachate generation from landfills, liquids collected from various containment areas/systems and other waste streams generated during the operation of various on-site waste management units including the Stabilization Facility, Stabilization Building, Containment Building, various container management units, landfill(s), surface impoundments, and other existing hazardous waste management units and support facilities.

The active disposal portion of the facility is comprised of two (2) active landfill disposal cells, designated as Cells 14 and 15 and four (4) surface impoundment disposal units, designated as the Evaporation Pond and Collection Pond #'s 1, 2 and 3. Additionally, there are two landfill disposal units, Trenches 10 and 11, which completed a five year evaporative cap performance demonstration which began during the year 2000 and are now closed. Former Trench 5 has also been closed using a standard RCRA facility cap.

Historically, the site was primarily used for management of non-hazardous and hazardous wastes, and PCB under a separate TSCA permit. Throughout the 1970's, the facility was operated by Wes-Con, Inc. as an industrial waste landfill and received wastes for disposal in the abandoned on-site Titan missile silos and then active chemical waste landfill. In 1980 Wes-Con, Inc. (Now operated by USEI) obtained interim status under RCRA for management of hazardous wastes, including treatment, storage and disposal of approved hazardous wastes. USEI received a "Hazardous Waste Treatment, Storage and Disposal Facility Permit" from U.S. EPA and IDEQ on December 15, 1988.

The Grand View, Idaho waste management facility has been in operation since 1973. Prior to the purchase of the facility by USEI, portions of the Titan missile silo complex were used for waste disposal in addition to the on-site trenches. Because of the timing of the USEI purchase of the site and the promulgation of current environmental regulations, the only information available regarding past disposal practices is the records that were maintained at the facility by previous owners and information that USEI has been able to obtain from past owners and long-term employees at the site.

In recent years, the facility has accepted large volumes of low activity radioactive material from the federal government's Formerly Utilized Site Remedial Action Program (FUSRAP), other federal agencies, and private entities including NRC and Agreement State licensees. These materials include naturally occurring and accelerator produced radioactive material in low concentrations, as well as source and byproduct material generally or specifically exempted from regulation under the Atomic Energy Act for disposal purposes.

General Hydrogeologic Information

Regional Setting

Introduction

The following is a summary of the Physiographic Setting and Regional Hydrogeology of USEI Site B presented in the 1986 Site Characterization Report (CH2M HILL, February 1986). This information has been assembled pursuant to IDAPA 58.01.05.012 (40 CFR 270.14(c)(2)).

Physiography

USEI Site B is situated in the western portion of a 20,000-square-mile physiographic unit known as the Snake River Plain. The plain extends from the vicinity of Ashton, Idaho, to north of Ontario, Oregon. The Snake River Plain is approximately 350 miles in length and varies in width from 25 to 75 miles. USEI Site B lies within the lowland area of the Owyhee subunit of the Snake River Plain at an elevation of between 2,525 ft. and 2,635 ft.

The Snake River, which flows to the northwest, lies approximately three (3) miles east of the site and is the most prominent water resource of the area. The site is approximately 250 ft. higher than the Snake River flood plain, which locally extends outward up to one mile along either side of the river. Castle Creek, a perennial stream that flows northward to the Snake River, lies approximately one mile west of Site B. Cloudburst Wash, a small ephemeral (intermittent) stream, lies about two (2) miles to the east of Site B and also empties into the Snake River. The facility straddles the Castle Creek and Cloudburst Wash drainage basins. However, since the facility contains all runoff from active areas, it does not contribute runoff to either drainage. The area is characterized by badlands-type topography and exhibits varied relief. Major topographic features of the area include several prominent buttes, remnant basaltic cinder cones, and canyons cut by the Snake River. Vegetation in the area is typical of a semiarid environment. The lowland area within which the site is located is inhabited by low brush and grasses, including sagebrush, rabbit brush, wheat grass, and cheat grass. Land use in the area consists of undeveloped rangeland and some limited irrigated agriculture. Irrigation water in the area is derived from the Snake River, Castle Creek, and from the deep, regionally extensive, geothermal groundwater system. The area is sparsely populated with isolated farms and ranches being the dominant habitation.

Climate

The semiarid western portion of the Snake River Plain has one of the highest annual average temperatures in the state. For a 64-year period (1933 to 1996) at the Grand View U.S. Weather Bureau Station, located ten (10) miles east of the site, the average temperature was 52.2 degrees Fahrenheit (EarthInfo, Inc., 1997). The range in temperature during the winter

months of December through February was -1 degree Fahrenheit to 58 degrees Fahrenheit. From March to November, the temperatures ranged from 12 degrees Fahrenheit to 101 degrees Fahrenheit.

The site is influenced by prevailing westerly maritime winds via the Columbia River and Snake River valleys; consequently, most precipitation falls during the winter. Over the same 64-year period at the Grand View U.S. Weather Bureau Station, the average annual total precipitation was 7.1 inches. The precipitation in this area is evenly distributed from November through June, with only a minor amount falling during the summer, usually associated with isolated thunderstorms. The mean annual pan evaporation for the Grand View area is approximately 53 inches (U.S. Weather Bureau, 1959).

Regional Well Inventory

A records search of the well log files at the Idaho Department of Water Resources (IDWR) in March 2003 turned up 26 logs for wells installed within a 3-mile radius of Section 19. There were no new wells drilled in this search area between the 1998 and current submittals of this permit application document. Note that the test well LP-40 discussed previously was not included in this summary.

Figure E-6 shows the approximate location of the wells based on the location information included on the log. Included in Figure E-6 is a table showing the well depth, date drilled, and stated use. Four (4) of the well logs were for USEI monitoring wells and there were two duplicate logs filed for the same well (well No. 13). The plugged and abandoned water well exploratory well drilled west of Site B by USEI to a depth of 800 ft. is shown as well No. 18 and the plugged and abandoned deep artesian well drilled by the U.S. Air Force in 1958 is shown as well No. 14. Appendix E.1 provides copies of the well logs as filed with IDWR.

There are five existing wells in the immediate vicinity of Site B that are of interest because they may be hydraulically downgradient of the facility. Four of these wells, Nos. 12, 13, 21, and 22, are domestic wells that probably cannot be impacted by shallow groundwater at Site B because they are deep artesian wells (greater than 600 ft. deep) and either flow at the surface or have very shallow static water levels (less than 12 ft. bgs). The fifth well, No. 23, was drilled for stock watering and draws water from sands and gravels with a reported yield of over 50 gallons per minute. The location provided on the Well Drillers Report places this well about 1.5 miles west of the Snake River (one mile east of Site B) in an area where saturated gravel deposits are not expected. However, in a telephone interview with the owner of the well, the actual location of the well is approximately ½ mile west of the Snake River and 50 ft. northwest of the Grand View Irrigation Canal. This places the well approximately 2.0 miles east of Site B in the NW ¼ NE ¼ of Section 21 as shown in Figure E-6, not NW ¼ NE ¼ of Section 20 as stated on the Well Driller's Report. Based on well No. 23's proximity to the Snake River and the irrigation canal, and the lithology provided in the Well Drillers Report, this well apparently draws water from saturated gravels that are recharged by the Snake River and possibly the canal. Thus, well No. 24 will not likely be impacted by shallow groundwater at Site B.

Regional Geology

Several investigators have been active in the delineation of the geology of the area at the regional scale. Malde and Powers (1962), Littleton and Crosthwaite (1957), Anderson (1965), and Ralston and Chapman (1969) have all contributed to establishing the geology of southwestern Idaho, including the general area of Site B. The information from these researchers is

summarized and synthesized in this section to provide an overview of the geologic setting. The intent of this section is not to provide a definitive and detailed examination of the geology of the area, but only to place the site in the regional geologic framework as a basis for the detailed site geology and hydrogeology.

Stratigraphy

The regional stratigraphy of the area is dominated by the Idaho Group of Miocene to Pleistocene Age. This depositional sequence consists of up to 5,000 ft. of sedimentary and interspersed basaltic lava deposits that accumulated in the Snake River Plain over a basement of thick, older silicic volcanic rocks, primarily rhyolites.

The sedimentary deposits of the Idaho Group were laid down under three distinct episodes of lava damming (and subsequent dam breaking) of the ancestral Snake River. These episodes resulted in the formation of large lakes across the region. Fine-grained (silt and clay) lacustrine (lake bed) deposits are frequently intertongued with coarser-grained (silt and sand) of fluvial (river) and flood plain deposits throughout the area. These discontinuous and interbedded sand, silt, and clay beds form complex stratigraphic relationships on a regional scale. As a general rule, the deposits are unconsolidated except for some minor sandstone and freshwater limestone and localized, discontinuous, basaltic lava beds. Generally, however, the lacustrine deposits predominate and form the most contiguous sedimentary beds across the Snake River Plain and the Site B area. The lacustrine and fluvial sediments of the Glens Ferry Formation of the Idaho Group are the primary strata of concern at Site B.

The several-hundred-foot-thick Snake River Basalt forms a cap rock over the Idaho Group sediments throughout much of the area and is the youngest formation in the regional sequence. Locally, the Snake River has eroded through the Snake River Basalt and into the underlying Idaho Group sediments. The Idaho Group sediments north of the Snake River, north of Site B, are capped by the resistant Snake River Basalt that forms steep cliffs adjacent to the river. The Idaho Group sediments south of the river (and within the vicinity of Site B) generally lack the protective basalt cap and have been eroded, forming the badlands topography characteristic of the area.

Structure

The Snake River Plain appears to be a downdrop fault-block basin, or graben, bounded by normal faults to the northeast and the southwest. Subsidence in the center of the basin was greatest and, consequently, the Idaho Group sediments are thickest near the center. The regional dips (angle from horizontal that the strata slopes) of the Idaho Group sediments range from near horizontal near the center of the basin to a maximum of about ten (10) degrees toward the margins of the basin. In the vicinity of Site B, regional dips of 2 to 4 degrees have been reported, with strike directions (perpendicular to direction of dip) approximately north 70 degrees west.

As a result of the structural attitude (dip) of the Idaho Group strata, older units tend to be exposed at a considerable distance south of the Snake River, with younger units exposed progressively nearer the river. Faults are apparent throughout the region because of differential settlement of sedimentary beds and movements along the principal regional faults that border the Snake River Plain. Minor faults locally cut older units of the Idaho Group; the younger units, however, are generally unaffected since they were deposited after the faulting occurred. The faults typically parallel the plain; faulting transverse to the plain is not common.

Local Geology

This section focuses on the characteristics of the Idaho Group sediments present in the vicinity of Site B.

Local Stratigraphy

In ascending order (deepest and oldest first), the localized formations are the Poison Creek (600+ feet thick); the Banbury Basalt (200+ feet thick); the Chalk Hills (200+ feet thick); the Glens Ferry (1,500+ feet thick); and the Bruneau (0 to 100+ feet thick). A detailed stratigraphic column prepared from the driller's log for the artesian well drilled in 1958 at Site B illustrates the stratigraphic sequence at Site B.

The Chalk Hills and Poison Creek Formations represent two individual lacustrine periods affecting the central and western portions, respectively, of the Snake River Plain. In some reports, particularly in many of the older geologic reports concerning the area and on numerous deep-drilling logs, the Poison Creek Formation is shown as occurring stratigraphically above the Banbury Basalt. This is due to lithologic similarities between the Chalk Hills and Poison Creek Formations and the volcanism responsible for the deposition of Banbury Basalt into the lacustrine environments present.

The Glens Ferry and Bruneau Formations are of prime interest to the site; the Glens Ferry is the unit where groundwater is first encountered and the Bruneau forms the uppermost geologic unit beneath Site B. Together, these two units form a composite thickness of about 1,600 ft. The deeper Banbury Basalt and Poison Creek Formations are of secondary importance to site-scale hydrogeology only because of their depth. However, these formations provide a regional source of deep-flowing artesian groundwater, generally obtained from depths in excess of 2,000 ft. to 3,000 ft. beneath Site B. The artesian aquifer discussion is provided below. Because of the importance of the Bruneau and Glens Ferry Formations to the Site B characterization, these units are discussed in detail below.

Glens Ferry Formation

The Glens Ferry Formation is of interest since the uppermost zone of saturation beneath Site B exists within the upper portions of this formation. Although the Glens Ferry Formation is approximately 1,500 ft. thick in the site area, the following discussion focuses on roughly the upper 800 ft. The Glens Ferry Formation was deposited in the area under three ancestral depositional environments: lacustrine, fluvial, and flood plain. The three stratigraphic facies, each representing a different energy of deposition that is reflected in the typical grain size of the sediments, differ from one another in lithologic composition and areal persistence and tend to grade vertically from one facies to the next. The overall sedimentary pattern in the upper few hundred feet of the Glens Ferry Formation is of upward coarsening, reflecting the climate and drainage pattern changes that ultimately led to the complete disappearance of the Glens Ferry lake.

For discussion purposes, the Glens Ferry Formation has been divided into two units. The lower unit of the Glens Ferry Formation consists of a lower lacustrine facies that upwardly becomes increasingly interbedded with fine-grained fluvial sands. The upper unit of the Glens Ferry Formation consists of predominantly fluvial sands grading vertically into flood plain facies. The lacustrine facies is the most extensive and areally persistent sedimentary body in the Glens Ferry Formation. Because of the structural dip of the beds in the Snake River Plain, all three facies are exposed at the land surface within the general area.

The extensive lacustrine facies consists of a thick-bedded, silty clay to clayey silt that grades with depth into a massive clay. Within the lacustrine facies are discrete intervals of thin lenses of very fine, tuffaceous sand interbedded with thicker, clayey, silt beds. These intervals represent periods of unstable lake margins. As water levels fluctuated, lake margin and fluvial sands were deposited farther into the lake. When the lake levels rose again, the sand lenses were covered with additional fine-grained lacustrine sediments. Where these sand zones are saturated, they represent the water-bearing portions of the lacustrine facies of the Glenns Ferry Formation. The water-bearing zones being monitored at Site B consist of two groups of these thin sand beds sand beds interbedded in the lacustrine sediments. At some exposures, the thick-bedded silt unit is overlain by several feet of very fine sand, alternately interbedded with additional silt. In many exposures, the fine sands are cross-bedded and show the presence of ripple marks. The fine sands generally denote the regional top of the lacustrine facies.

A less extensive fluvial facies overlies the lacustrine deposits, and generally consists of a fine- to medium-grained sand reaching a thickness of about 60 ft. Frequently, a 1" thick, tuffaceous, fine-grained sandstone is found at the top of the fluvial sand. Some cross-bedding is evident in the fluvial facies and, on a local scale, the sand unit intertongues laterally with the lacustrine facies.

The flood plain facies, where present, overlies the fluvial facies and denotes the top of the Glenns Ferry Formation; it consists of an interbedded sequence of clay, silt, and sand. sand beds. Individual beds vary in thickness from about two (2) to four ft. (4') in the general area and laterally persist for several hundred feet. The flood plain sediments are areally discontinuous, however, and range from being absent to about 200 ft. thick. Plant fragments and other detritus are evident in the flood plain facies. Texturally, the flood plain deposits appear banded (that is, possessing thin, laminae-like alternating beds) compared to the more homogeneous underlying fluvial and overlying Bruneau Formation sediments.

Bruneau Formation

The Bruneau Formation consists of a variety of lithologic types ranging from unconsolidated lake deposits that contain basalt flows and tuff beds to high energy river gravels. In the vicinity of Site B, the formation is approximately 100 ft. thick, but the thickness varies greatly and the formation is absent in some locations. The Bruneau Formation is generally more coarse-grained than the underlying Glenns Ferry Formation and has been divided regionally into a basal gravel unit (approximately 40 ft. thick), an overlying lower unit (approximately 70 ft. thick), followed by an upper unit (approximately 20 ft. thick). A 10- to 15-foot tuff layer separates the upper and lower units.

The basal gravel unit is composed of rounded pebbles, cobbles, and coarse-grained, cross-bedded sand lenses. The origin of the unit is interpreted as a river and beach deposits of ancestral Lake Bruneau. The lower unit, which overlies the basal gravel, consists of a thin, basaltic, cinder bed, an intervening mottled clay, and a fine-grained tuffaceous sand. The upper unit of the Bruneau is lithologically similar to the lower unit, but regionally occurs above the 10- to 15-foot-thick tuff layer. Locally, the thicknesses and lithologic characteristics of the Bruneau units can vary considerably. Only the basal gravel unit of the Bruneau Formation is present at USEI Site B.

Minor recent and Pleistocene surficial deposits are also intermittently present in the local area and consist of Snake River terrace gravels, colluvium, and stream alluvium. The stream alluvium exists along the margins of permanent drainages, and the colluvium consists of random slope debris. These minor deposits are difficult to distinguish from the unconsolidated coarse-grained Bruneau Formation deposits on a local scale. For purposes of classification in this report, all

surficial deposits in the vicinity of Site B are considered to be part of the Bruneau Formation, even though they may be of more recent geologic origin.

Regional Hydrogeology

The groundwater resources of the area have been examined at the regional scale by several investigators. Mundorff, Crosthwaite, and Kilburn (1964) prepared a report on the occurrence of groundwater within the entire Snake River Plain. Ralston and Chapman (1969) investigated the groundwater resources of northern Owyhee County, and Young and Lewis (1982) examined the hydrology of deep thermal groundwater in southwestern Idaho. Several other groundwater availability and geothermal resource studies have been performed in the region, most notably by Brott, Blackwell, and Mitchell (1978) and Young, Lewis, and Bracken (1979). On the basis of these principal research studies, an overview of the groundwater resources of the region is presented in the following sections.

Principal Groundwater Systems

The regional studies indicate that three groundwater systems are present in the area of Site B. These systems are as follows:

1. A deep groundwater system found primarily within the silicic volcanics, Banbury Basalt and the Poison Creek Formation. Groundwater is found at depths ranging from 600 to more than 3,000 ft. in this system. Water in this system is under considerable artesian pressure and geothermally heated. Many wells tapping the aquifer are capable of flowing at the land surface. Several flowing geothermal wells in the Castle Creek drainage are used for irrigation and contribute to the general water resources available in that area. In the 3,000-foot-deep water supply well drilled by the U.S. Air Force (USAF) at Site B, the first significant water was encountered at 2,980 ft. The USAF test well flowed at over 300 gpm at a temperature of 170 degrees Fahrenheit. The USAF geothermal well was plugged and abandoned in 1986 by USEI (CH2M HILL, June 1986). The geothermal aquifer system, herein referred to as the deep artesian aquifer, is the most important groundwater resource in the area. Recharge to the deep artesian system in the area is believed to originate in the Owyhee Mountains, where precipitation exceeds 50" annually.
2. A local veneer of saturated alluvium exists along Castle Creek. The alluvium and the creek are reported to be hydraulically connected. Some shallow domestic wells have been installed in the alluvium, generally to depths not exceeding 50 ft. Most of this alluvial system development occurs approximately eight (8) miles southwest and upstream of Site B (Ralston and Chapman, 1969). As Castle Creek flows northeastward from this area to the Snake River, it passes to within one (1) mile of Site B. It can reasonably be assumed that a veneer of saturated alluvium exists along Castle Creek in this downstream area as well. Recharge to this system is primarily by surface water runoff derived locally from precipitation and from the Owyhee Mountains.
3. Groundwater is found within the fine-grained sand beds and interbedded silts of the upper parts of the Glens Ferry Formation at depths on the order of 140 to 350 ft. below ground level. Well yields and water quality in this system vary greatly. The Glens Ferry Formation provides water to scattered low-yielding stock watering and domestic wells in the general vicinity of the site. In the area of the town of Oreana, seven (7) miles southwest of Site B, numerous wells provide groundwater for small irrigation and domestic uses from the Glens Ferry Formation (Ralston and Chapman, 1969). In this area, local leakage from the Catherine Creek alluvial system probably contributes significantly to the recharge and well yields from the Glens Ferry Formation. Recharge to the shallow Glens Ferry aquifer

comes from direct precipitation on exposed permeable beds, infiltration where the formation is exposed to surface water sources, and by vertical leakage from underlying artesian zones on a broad regional scale. The potential for recharge to the Glenns Ferry Formation from Site B is minimal because all site runoff is directed to lined collection ponds.

The water-bearing intervals being monitored at USEI Site B are in the upper portion of the shallow Glenns Ferry Formation. At Site B, however, the formation is not very permeable and most wells yield less than 0.5 gallon per minute. The shallow Glenns Ferry aquifer as it exists at Site B is not a true aquifer in the context of water resources because of low yield. The detailed characterization of the water-bearing properties and geochemical properties of the shallow Glenns Ferry system beneath Site B is provided in Section E.3.c.

Regional Flow Characteristics

Deep Artesian System

Groundwater in the deep artesian system generally moves from the mountains toward the Snake River, which is the regional hydrologic base level and therefore the likely discharge point for at least a portion of the groundwater in the deep artesian system. The observed northeast direction of flow in this system is consistent with the generalized orientation of the landscape, the trend of regional surface water drainages, and the regional trend of the Owyhee Mountains relative to the position of the Snake River. Strong upward gradients exist between the deep artesian system and shallower systems over most of the area. Where intervening confining strata are thin, more permeable, or breached by faults or wells, the deep artesian system also has a vertical flow pattern and contributes water to shallower systems. This is particularly noted to be occurring in the Castle Creek drainage area southwest of Site B where uncased or uncontrolled artesian wells are contributing to the base flow of Castle Creek and therefore also to the localized alluvial groundwater system in communication with the creek.

Shallow Glenns Ferry Groundwater

Because of the remoteness and sparsely populated nature of the area, coupled with the limited and sporadic groundwater resource potential of the Glenns Ferry Formation, there is insufficient information available to make definitive regional interpretation of flow directions and rates for the Shallow Glenns Ferry system. In general, the shallow groundwater system flows toward, and probably discharges into, the Snake River. However, smaller scale flow directions are expected to be highly variable because of localized points of recharge from surface waters and vertical leakage from the deeper system, and from localized discharge points such as wells and natural drainages. Locally, southeasterly, northeasterly, and easterly flow directions have been identified in the shallow Glenns Ferry groundwater system at Site B. All of these flow directions are generally toward the Snake River where it either discharges directly or enters the local alluvial groundwater system along the Snake River.

Relationship of the Deep Artesian System to Site B

A deep artesian well was drilled on Site B by the USAF in 1958 as a water supply well (Shannon and Wilson, 1959). The artesian well was plugged and abandoned by USEI in 1986 (CH2M HILL, June 1986). The well abandonment was completed methodically and thoroughly using oil-field cementing techniques and cementing service contractors. There have been no data suggesting any vertical leakage from the deep artesian well, either before or after plugging. Although the well was abandoned, because of the location of the artesian well in the center of Site B and

because much of the understanding of the deeper geologic formations beneath Site B came from the artesian well records, it is appropriate to preserve the documentation of the well in this application. Pertinent information regarding the deep artesian well is summarized below. In addition, important information on the nature of the deep regional flow system can be gained by a review of the characteristics of this well.

The geologic section beneath Site B is dominated by blue clays and shales. The aquifers of interest at Site B occupy a very small portion of the uppermost geologic formation.

The shut-in pressure of 70 psi at the wellhead reported in 1958 was confirmed in 1986 prior to well abandonment. This value represents a head approximately 160 ft. above the land surface at Site B and approximately 335 ft. above the heads observed in the shallow Glenns Ferry Formation at Site B. These data confirm that a strong upward hydraulic gradient exists between the deep artesian system and the shallow Glenns Ferry system immediately beneath Site B. The drillers log of the artesian well did not report any major aquifer zones between the shallow Glenns Ferry system and the deep artesian zone, spanning an interval of several thousand feet. This was confirmed at the 800-foot-deep exploratory borehole that was drilled by USEI as an exploratory water well west of the site in 1984. Drilling logs from this well indicate that strata below 300 ft. are predominantly blue clay and shale, which is consistent with the drillers log recorded for the artesian well. This hydrogeologic setting and head relationship indicates it is not possible for waste constituents from the site to migrate downward to the deep artesian aquifer. Therefore, the shallow water-bearing zones within the Glenns Ferry Formation are the primary "aquifers" of interest in this Document, and the remainder of this section is devoted to describing, in detail, the characteristics of these two groundwater systems.

Site Hydrogeologic Characteristics

Introduction

In this section, the results of the site-specific hydrogeologic investigations conducted at Site B are presented in detail. The goal of the hydrogeologic investigations to date has been to characterize the geologic and hydrogeologic properties of the uppermost aquifer and any aquifer hydraulically connected to it. At Site B this involved a detailed investigation of the upper 400 ft. of unconsolidated sediments beneath the site. This information has been assembled pursuant to IDAPA 58.01.05.012 (40 CFR 270.14(c)(2)).

The uppermost water-bearing zone beneath Site B actually consists of two discrete, low-yielding, finely bedded sand zones that are separated by a 20- to 30-foot-thick confining clay bed. Under the nomenclature used in this report, these two zones are called the Upper and Lower Aquifers, respectively. Both zones occur in the Glenns Ferry Formation.

An unsaturated zone, ranging from 140 ft. to 200 ft. in thickness, overlies the uppermost aquifer and consists of silts and clays of the Glenns Ferry Formation overlain by coarser-grained sands, silty sands, dense clay beds, and sandy gravels of the Bruneau Formation.

The following sections develop in detail the generalized concepts presented above. A description of the site-specific subsurface geology is provided, followed by a detailed examination of the hydraulic and hydrochemical aspects of the uppermost aquifer system. The system is complex as a result of subtle stratigraphic differences within the Glenns Ferry Formation and the effect of

dipping strata. To orient the reader, an overview of the uppermost aquifer concept is presented in Section E.3.c.(3), following the site-specific geology discussion below.

Site Geology

Formation Identification

Quaternary and Tertiary sediments of the Bruneau and Glens Ferry Formations directly underlie the site. The veneer of surficial gravels present over much of the site is interpreted as basal conglomerate of the Pleistocene-Age Bruneau Formation (Benfer, 1984). Fine-grained sediments of the Pliocene- to Pleistocene-Age Glens Ferry Formation underlie the Bruneau Formation gravels. The Glens Ferry then persists throughout the remaining depth of the investigation.

Stratigraphy

Throughout the remainder of this section, references will be made to the observed thicknesses of various geologic strata penetrated. Qualitative descriptive terms have been numerically classified according to Krumbein and Sloss (1963).

Geologic and geophysical logs have been used to construct several geologic cross sections depicting the stratigraphy at USEI Site B. Previous reports and submittals on file with DEQ contain these large cross section plates which are not reproduced in this application.

With two minor exceptions, the basal gravels of the Bruneau overlie the entire site. The exceptions are where the basal gravels are thinly covered by recent soil or ash layers, or where they have been removed by site construction activities. Typically, the gravels are present only to about 50 ft. bgs but were found to extend to approximately 100 ft. in the southeast and northeast corners of the site.

The Glens Ferry is present beneath the Bruneau gravels and represents sedimentary deposition in a large lake system with peripheral and capping fluvial and flood plain facies (Smith et al., 1982). As such, the Glens Ferry consists of lake-margin deposits containing fluvial deposits (stream and beach shoreline sands and near-shore silts). Underlying the fluvial deposits are the lacustrine facies (lake deposits) of the Glens Ferry. The entire sequence exhibits upward coarsening (finer grained with depth). As such, this represents a period of lake regression (a lowering of the water level in the ancient lake [Selley, 1972]). Lithologic and facies contacts are gradual and are controlled by the predominance of grain size and bedding.

The upper (fluvial) sequence of the Glens Ferry Formation contains very thick-bedded (greater than ten (10) ft.) fine sands and silts containing a few clay seams. Typically, the sands are well sorted, moderately indurated, and thickly bedded. Calcite cementing predominates. The clay seams distributed within the sand are generally thin-bedded (several inches to one (1) ft. thick) and are plastic (soft and moldable). Near the base of the sequence, thin-bedded carbonates (limestone) occur. These sedimentary sequences are representative of lake margin environments (Selley, 1972). This section persists to approximately 130 ft. in depth at the center of the site, where the finer grain size and thinner bedding exists. Where the predominance of finer grain size and thinner bedding exists, this facies change is interpreted as the bottom contact of the fluvial facies overlying lacustrine sediments of the Glens Ferry Formation.

The lacustrine facies consists of thick-bedded clays and silts containing very thin beds of silt, sand (generally less than one ft. (1) thick), and sand-silt lamina. The sequence expresses cyclic

sedimentation for the depth investigated. The formation transcends through thick-bedded sequences of clay and silts containing discrete, thinly bedded sands (one ft. (1) thick or less) and reflects deposition representative of a lacustrine environment as the lake waters rose and fell. The sands and silts (linear and lense-like in form) represent near-shore and shoreline deposits. Portions of this sequence are deltaic in nature and contain abundant plant debris. Sheet-like clay and finer silts are representative of offshore and deeper lacustrine deposition.

The first sequence of shoreline and near-shore deposits underlying the fluvial facies occurs at an approximate depth of 160 ft. at the center of the site. In the northwest portion of the site, the sequence contains numerous thin-bedded silty sands and lamina that are separated by thin- to thick-bedded silts and clays. These sand beds appear to pinch and thin toward the south and east, forming thickly bedded clay and silt in those directions. Although a continuous zone exists, individual sand beds appear discontinuous across the site. This may indicate that the source of the sands was from the northwest, where increased bedding and coarser grain sizes would be expected. This may also be a result of a lateral facies change, such as a transition to a flood plain or deltaic sequence, occurring within the northern portion of the site, or may represent younger deposition upon paleo-erosional surfaces. It is this zone of thin, discontinuous, and laterally variable sands and silts that represents the Upper Aquifer. Within the upper portion of the sequence, the unit changes color from brown to gray, which may represent a change from oxidizing to reducing conditions at the time of deposition.

These near-shore deposits transcend downward into offshore (deep lake) deposits consisting of thickly bedded clay containing silt. This clay unit is approximately 20 ft. thick at the center of the site, extending to a depth of approximately 230 ft. This zone thickens from approximately 20 ft. thick in the northwest portion of the site to more than 30 ft. thick in the southeast portion of the site. This unit is the confining bed separating the Upper and Lower Aquifers.

This offshore deposit transcends into another shoreline and near-shore sequence, generally comprising thick-bedded silt and thin-bedded clay that contains thin-bedded sands and sand lamina. This zone (the Lower Aquifer) is continuous across the site, although individual sand beds gradually thin and pinch out. This unit extends to a depth of approximately 250 ft., where again, deposition transcends into deeper offshore deposits of thick-bedded clay and fine silt, which provide the basal confinement of the Lower Aquifer. It appears from the limited information and from the deep borings that this facies again transcends into another sequence of near-shore sands and silts at approximately 290 ft. in depth. These sands are very thin-bedded and have not been investigated.

The drilling logs of the deep artesian well onsite and the 800-foot-deep exploratory water well (WWI) west of the site indicate that the strata below 300 ft. are predominantly blue clay and shale to at least 1,770 ft.

Structure

Units of the Glenns Ferry Formation at the site strike north 69 degrees west, and dip approximately 3.5 degrees to the northeast. Gradual differences have been noted within the formation and reflect changes in depositional environment reflective of lacustrine sedimentation and Snake River Plain downwarping. The upper near-shore sequence (i.e., the Upper Aquifer measured at its base) strikes north 70 degrees west and dips 1.8 degrees northeast. The next near-shore sequence (i.e., the Lower Aquifer measured at its center) strikes north 70 degrees west and dips 2.4 degrees northeast, as measured from Coreholes D-32, D-22, and D-21.

No evidence of faulting exists within the depths of the investigation at the site as determined by surface mapping of existing trenches and analysis of geologic cores. Units can be traced across

the site using geophysical logs and direct core logs, all of which conform to measured strike and dips. No indications of faulting (such as displacement, associated fracturing, or alteration) have been witnessed throughout the entire geologic section investigated.

Site Hydrostratigraphy

This section will describe in detail the hydrologic and hydrochemical properties of two interbedded sand zones that have been defined as uppermost aquifer(s) beneath the site pursuant to IDAPA 58.01.05.012 (40 CFR 270.14(c)(2)).

Overview

Two low-yielding, water-bearing zones denoted as the Upper and Lower Aquifers have been identified within the shallow Glenns Ferry Formation beneath Site B. Although neither zone would be classified as an aquifer for water resources development because of the definition of the uppermost aquifer in the regulatory context, they represent the uppermost aquifer(s) of concern for groundwater monitoring purposes. The Upper Aquifer at Site B consists of finely bedded, fine, silty sand in 80 ft. to 90 ft. of silt and clay. The top of the Upper Aquifer sequence is a gradational contact with the overlying fluvial facies of the Glenns Ferry Formation. The top of the Upper Aquifer section is 120 to 160 ft. below ground level. A massive clay, 20' to 30 ft. thick, hydraulically separates the Upper Aquifer from another group of fine, silty, and clayey sands referred to as the Lower Aquifer. The top of the Lower Aquifer is 220 ft. to 275 ft. below ground level and the aquifer section is 30 ft. to 40 ft. thick. Because of structural dip, both aquifers slope to the northeast at approximately 2 to 4 degrees.

As a result of the northeasterly structural dip, the Upper Aquifer sands gradually emerge out of the water from north to south across the site. The entire Upper Aquifer becomes unsaturated along a general east-west trend that crosses the south-central portion of the site. South of this emergence, the sands comprising the Upper Aquifer are present but they are above the potentiometric surface and are not saturated. Conversely, the saturated thickness of the Upper Aquifer increases from south to north as more sands become saturated.

The potentiometric surface of the Upper Aquifer varies from 140 ft. to about 200 ft. below ground level. Groundwater in the Upper Aquifer flows into the site all along the northern border, but most enters from the northwest corner. Flow in the Upper Aquifer is to the east and southeast. The permeabilities of the Upper Aquifer are low, and sustained well yields are generally less than 1.0 gpm.

The Lower Aquifer consists of two (2') ft. to nine (9') ft. of thinly bedded, very fine sand and silty sand seams in a 30- to 40-foot-thick section of silts and clays. Most sand beds are found within a 15-foot-thick interval. The Lower Aquifer is saturated beneath the entire site. The permeabilities of the Lower Aquifer are low, and well yields are generally less than 0.5 gpm. Water in the Lower Aquifer is under moderate artesian pressure. Along the northern edge of the site, water levels rise 60 ft. to 80 ft. above the top of the aquifer. Groundwater in the Lower Aquifer flows to the northeast.

Upper Aquifer

The Upper Aquifer sequence consists of thinly bedded sands and sand lamina separated by thin- to thick-bedded silts and clays. The individual sand seams range from less than 1.5 ft. thick to partings less than 1/16 of an inch thick. Most are between 0.5ft. and 0.1 ft. thick and consist of

very fine-grained, silty sand. Lateral continuity of individual sands is difficult to demonstrate, but the aquifer sequence is present across the entire site. The total cumulative thickness of the sand beds changes laterally east and west because of depositional variations.

In the northwest portion of the site, the cumulative thickness of saturated sand beds in the Upper Aquifer ranges from about eight ft. (8) ft. to 36 ft., occurring over approximately 70 ft. of fine- to thick-bedded silts and clays. The individual sand beds thin and pinch-out toward the east and south. Therefore, the Upper Aquifer contains less sands and therefore does not yield as much water to the east and south. The cumulative thickness of bedded sands underlying the water table in the eastern portion of the site is approximately two (2') ft. to 12 ft., occurring over approximately 20 ft. to 50 ft. of fine- to thick-bedded silts and clays.

The bottom of the aquifer sequence is represented by a relatively rapid gradational change from bedded silts and silty clay to the massive silty clay and clay of the underlying confining bed. The bottom of the Upper Aquifer section ranges from 185 ft. to 250 ft. below ground level.

The top of the Upper Aquifer is also a gradational contact. As discussed earlier, the Upper Aquifer is developed in the lacustrine facies of the Glenns Ferry Formation. The contact between the lacustrine and overlying fluvial sediments is a gradational facies change represented by a thinning of beds and dominance of silts and clays from fluvial to lacustrine. The top of the lacustrine facies (top of the Upper Aquifer sequence) ranges from 120 ft. below ground level in the northwest corner to about 160 ft. below ground level in the northeast corner; across the central portion and eastern sides it is 120 ft. to 140 ft. below ground level. Thickness of the sequence ranges from 80 ft. to 90 ft.

The top of the saturated water-bearing portion of the Upper Aquifer is a function of the intersection of the dipping stratigraphic sequence and the potentiometric surface. Because of the dip, the section rises above the potentiometric surface and becomes unsaturated across the southern portion of the site. From south to north, the dip causes progressively more sand seams to intercept the potentiometric surface and become saturated. Consequently, the saturated thickness of the aquifer increases to the north and the top of saturation is found progressively higher in the geologic section comprising the Upper Aquifer.

Each individual saturated sand seam is probably under confined conditions as a result of the adjacent silt and clay beds. Given the scale of the bedding, it is impossible to isolate individual sand seams to verify this assumption. Taken as a whole, however, there appears to be little evidence of vertical gradient within the Upper Aquifer section, and, therefore, the aquifer is considered to be unconfined.

Intermediate Clay Bed

The inner confining clay between the Upper and Lower Aquifers ranges from 20 ft. to 30 ft. thick across the site. As discussed in the previous section, the top of the inner confining clay is gradational with the silts of the bottom of the Upper Aquifer. A similar transitional contact exists between the bottom of the confining clay and the top of the Lower Aquifer. In both cases, the gradational contact occurs within about five ft. (5). This clay consists of blue-gray, massive to thickly bedded clay. In Corehole D-23, in the northwest corner, there are seven (7) to ten (10) silty sand lamina (less than 1/8" thick) within the 20 ft. thick clay, while along the east side, no sand lamina are found in the entire 20 ft. thick section.

This clay unit is persistent and consistent across the site and hydraulically separates the Upper and Lower Aquifers. This hydraulic separation is evidenced by differences in water level, flow

directions, and water chemistry between the Upper and Lower Aquifers. These indicators of hydraulic separation are discussed in more detail in subsequent sections.

Lower Aquifer

The Lower Aquifer is a sand sequence within silts and clays of the Glens Ferry Formation. Although the persistence and thickness of individual thinly bedded sands varies laterally, the aquifer is present and saturated everywhere beneath the site.

The bedded sands occur within a 30 ft. to 40 ft. thick sequence of thick-bedded silts and clays. The majority of sands occur within a 10 ft. to 15 ft. interval. Coreholes and geophysical logs of borings indicate that the bedded sands pinch and thin toward the west and south, forming very thin-bedded sands and sand lamina less than ¼" thick. Some sands are discontinuous and pinch out. The total cumulative thickness of bedded sands in the western portion of the site is less than four (4) ft.

Along the east side of the site, the individual beds range from sand lamina (less than ¼ inch thick) to one ft. (1) thick bedded sands, the latter consisting of fine- to very fine-grained silty sand. Most of the water is probably being carried in the upper portion of the sequence, where greater sand thickness and persistence exist. The total cumulative thickness of bedded sands in the Lower Aquifer along the eastern side is less than nine ft. (9) The top of the Lower Aquifer section is 205 ft to 275 ft. below ground level, and the bottom is 305 ft. to 250 ft. below ground level. The Lower Aquifer section generally ranges from 30 ft. to 40 ft. thick.

Basal Confining Clay

Underlying the Lower Aquifer is a massive to thickly bedded clay at least 25 ft. thick. This clay was penetrated in only a few borings, and it has not been tested extensively. Visual descriptions indicate it to be massive (does not contain sand lamina) and "fat," having high plasticity. Properties of this clay are expected to be similar to the inner confining clay.

Hydraulic Properties

Introduction

Pursuant to IDAPA 58.01.05.012 (40 CFR 270.14(c)(2)), the hydrogeologic regime at USEI Site B was characterized as part of the initial permit application process (CH2M HILL, February 1986). Subsequent to the issuance of the permit, considerable additional information has been developed on the hydraulic properties of the Upper and Lower Aquifers at Site B. This portion presents a complete reexamination of the hydrologic properties of Site B, using both previously presented information and new information. The objectives of the hydrologic characterization program were to 1) examine the factors that influence the rate and direction of groundwater movement; 2) evaluate overall groundwater availability; 3) evaluate the degree of hydraulic separation of the Upper and Lower Aquifers; and 4) estimate the degree of containment afforded by the clays and other sediments found above, below, and between the aquifers.

Information from the available data were used individually and conjunctively to determine the hydraulic characteristics that define the groundwater flow properties at USEI Site B. The aquifers at Site B consist of finely bedded, fine sand and silt beds in a predominantly silty clay matrix. Because most groundwater flow, and therefore most of the potential contaminant migration, would occur in the sand beds, the ultimate aquifer property being sought from the aquifer test

data was the hydraulic conductivity (K) of the sand beds, as opposed to a composite hydraulic conductivity of the entire saturated thickness. Most of the test data available, however, provided either an estimate of the composite K or the transmissivity (T) of the entire saturated thickness of the aquifer.

To estimate the K of the sand beds, the T and/or K values from the aquifer tests were adjusted to reflect only the cumulative thickness of sand beds identified in the wells as estimated from review of the geologic and geophysical logs for each well. Once a K was determined, an estimated groundwater velocity was calculated. Aquifer transmissivities were also used to compare the relative water flux across the site through and between aquifers.

To evaluate the degree of containment afforded by the clays and other sediments found above, below, and between the aquifers, laboratory testing was performed on soils collected from the Upper and Lower Aquifers and the inner and lower confining units. Grain-size analyses and permeability testing were performed on 79 samples of materials from three (3) borings, D-21, D-22, and D-23, at the USEI site. These data were previously reported in CH2M HILL (February 1986) as part of USEI's 1985 Part B permit application.

Results

Usable data are not available on all wells but the large amount of data that was available provides valuable information on both aquifers beneath all portions of the site. Soil hydraulics testing data are presented in CH2M HILL (February 1986).

In Section E.3.b., a transmissivity value was estimated for each pumping and recovery test, slug test, and specific capacity test (Table E-9). Based on the individual tests, an average T value for each well was calculated as shown in Table E-9. The average T value is the average of all aquifer tests performed over the lifespan of the well. Additionally, if an individual test was analyzed by more than one analytical technique and more than one analytical technique provided a valid solution, then all valid solutions are included in the calculation of the average T value.

K values were calculated from the average transmissivity data through the relationship $K = T/b$ where b = the saturated aquifer thickness. Representative thickness values were obtained for 22 of 28 test wells in the Upper Aquifer and 14 of 15 test wells in the Lower Aquifer where successful transmissivity values were obtained. Representative thickness values were determined via an interpretation of subsurface conditions at each respective test site. Information from all geologic and geophysical logs were used to estimate the actual thickness of sandbeds present within each test interval. This was done to adjust the aquifer test results under the premise that most of the aquifer response during the tests occurs from the sandier aquifer zones, and not the adjacent confining zones, a portion of which is generally included in the test interval. This resulted in a conservative reduction in the thickness values and an associated conservative increase in hydraulic conductivities.

As a supplement to the in situ determination of hydraulic conductivity provided by the aquifer tests, hydraulic conductivity values were also calculated from grain-size distribution information by the Hazen Method. Thirteen (13) of the 79 samples had grain-size analysis performed on the most permeable beds in the Upper and Lower Aquifers. Table E-11 summarizes the calculated hydraulic conductivity estimates for these 13 soil samples based on the Hazen Method. The Hazen Method is one of several predictive equations that relate hydraulic conductivity values to the grain-size distribution of representative aquifer materials. The techniques are approximation methods, but generally provide useful estimates of hydraulic conductivity (Freeze and Cherry, 1979). Todd (1980) cautions that the empirical formulas may not give reliable results because of

the difficulty of including all possible variables in porous media. Therefore, field and laboratory methods are preferable as a general rule.

The Hazen Method estimates K through the following relationship (Equation E.3-2):

$$K = A (d_{10})^2$$

where:

K is the hydraulic conductivity, A is a conversion factor (equal to 1.0 when K is reported in cm/sec and grain size in millimeters [mm]), and d_{10} is the grain-size diameter at which ten (10) percent by weight of the particles are finer.

Upper Aquifer

For the Upper Aquifer, transmissivity values were obtained from 28 test wells. Average T values ranged from a low of 0.1 ft²/day for U-26 to a high of 51.1 ft²/day for D-18 (abandoned). The mean transmissivity for the Upper Aquifer is 7.0 ft²/day, based on an average of the average T values. Figure E-12 denotes the average transmissivity values obtained for each Upper Aquifer test site. Figure E-12 also shows the distribution of T values in the Upper Aquifer. In Figure E-12, T values are grouped into ranges of α 0.1 ft²/day, 0.1 to 2.0 ft²/day, 2.0 to 5.0 ft²/day, and > 5.0 ft²/day. The highest T values of the Upper Aquifer occur beneath the north/northwest portions of the facility and generally decrease toward the south and east.

To understand the significance of these transmissivity values, they can be compared to minimum values required for a domestic water supply. The U.S. Bureau of Reclamation (USBR) has investigated and published the transmissivity values necessary for water supply development purposes (USBR, 1977). Transmissivity values below one (1) ft²/day are considered infeasible for domestic well purposes, while transmissivity values between one (1) ft²/day and 10 ft²/day are considered poor. Fair well potential can be achieved with transmissivity values between 10 and 100 ft²/day. Thus, the transmissivity values obtained for the test sites are generally in the infeasible to poor well potential range, with only five (5) average T values of the Upper Aquifer test locations falling in the fair range. As shown in Figure E-12, the five higher-yielding wells are located in the north/northwest portion of the Upper Aquifer.

The calculated hydraulic conductivity values derived from the average T for the Upper Aquifer materials range from a minimum of 4.0 x 10⁻² ft/day (1.4 x 10⁻⁵ cm/sec) at U-26 to a maximum of 4.2 ft/day (1.5 x 10⁻³ cm/sec) at UP-7. These values are representative of very fine sands and mixtures of sand, silt, and clay, which are reported to have conductivity values ranging from 10⁻³ cm/sec to 10⁻⁶ cm/sec (Todd, 1980). Consistent results were observed between the geologic classification of subsurface materials and their calculated conductivity values. From Table E-11 it can be seen that the range of empirically derived hydraulic conductivity values (Hazen Method) in the Upper Aquifer is significantly lower than the range determined with the pump tests. For the Upper Aquifer, empirically derived hydraulic conductivity values ranged from 2.6 x 10⁻² ft/day (9.0 x 10⁻⁶ cm/sec) to 0.5 ft/day (1.69 x 10⁻⁴ cm/sec). The hydraulic conductivity values obtained from the grain-size analyses may include finer-grained materials from the confining zones that are adjacent to the sandier aquifer zones. This could account for the somewhat lower values observed. It is important to note that the hydraulic conductivity values obtained from the grain-size analyses were not used in the computation of groundwater velocities. Rather, they have been included for exemplary purposes and as an additional check on pumping test-derived hydraulic conductivities.

Lower Aquifer

For the Lower Aquifer, transmissivity values were obtained from 15 test wells. Average T values ranged from a low of 0.4 ft²/day for MW-6 (abandoned) to a high of 3.3 ft²/day for MW-5 (abandoned). The mean transmissivity for the Lower Aquifer is 1.0 ft²/day, based on an average of the average T values. T values in the Lower Aquifer are low and do not appear to follow a discernible distribution pattern. Based on the USBR criteria discussed above, the transmissivity values obtained from the Lower Aquifer test sites are in the infeasible to poor well potential range for a domestic water supply.

The calculated hydraulic conductivity of the Lower Upper Aquifer materials range from a minimum of 6.9×10^{-2} ft/day (2.4×10^{-5} cm/sec) at L-38 to a maximum of 8.3×10^{-1} ft/day (2.9×10^{-4} cm/sec) at MW-5 (abandoned). Similar to the Upper Aquifer, these values are representative of very fine sands and mixtures of sand, silt, and clay, which are reported to have conductivity values ranging from 10^{-3} cm/sec to 10^{-6} cm/sec.

The range of empirically derived hydraulic conductivity values (Hazen Method) in the Lower Aquifer is lower than the range determined with the pump tests. For the Lower Aquifer, empirically derived hydraulic conductivity values ranged from 2.8×10^{-3} ft/day (1.0×10^{-6} cm/sec) to 0.6 ft/day (1.96×10^{-4} cm/sec). As noted above, the hydraulic conductivity values obtained from the grain-size analyses may include materials from the confining zones that are adjacent to the sandier aquifer zones. This could account for the somewhat lower values observed. It is important to note that the hydraulic conductivity values obtained from the grain-size analyses were not used in the computation of groundwater velocities. Rather, they have been included for exemplary purposes and as an additional check on pumping test-derived hydraulic conductivities.

Intermediate (Inner) and Basal Confining Layers

Soil samples collected from D-21, D-22, and D-23 that represent the inner and basal confining zones are identified in Table E-10. The vertical coefficient of permeability was determined for ten (10) of the confining material samples. The range in vertical permeabilities for the two confining zones was 1.1×10^{-4} to 1.4×10^{-1} ft/day (4×10^{-8} to 5.0×10^{-5} cm/sec). The single sample (boring D-22, sample S-31) with the 5.0×10^{-5} cm/sec value is probably due to bedding fractures within the clay as noted on the well log (CH2M HILL, February 1986) or may represent a silty or sandy seam in the confining bed. Without including this sample, the vertical conductivity of the confining beds ranges from 5.7×10^{-3} ft/day (2×10^{-6} cm/sec) to 1.1×10^{-4} ft/day (4×10^{-8} cm/sec) and the mean value is 2.8×10^{-4} ft/day (1×10^{-7} cm/sec).

As shown in Table E-10, the moisture content for the soil samples collected from the inner and lower confining zones ranged from 23.0 % to 31.0 % and averaged 28.1 %, and the degree saturation ranged from 89.4 % to 98.7 % and averaged 93.7 %. These data indicate that moisture was present in the confining zones at near-saturated field conditions. According to the field drilling logs, the moisture content within the inner and upper confining zones ranged from dry to moist, supporting the presence of some moisture in the soils in the confining zones. However, the moisture content in soils below 100 ft. may have been affected by water used in rotary drilling.

Groundwater Flow Properties

Water Level and Hydraulic Gradient

Depth to Water Level Measurement Corrections

The results of gyroscopic surveys at piezometers U-26, UP-28, and UP-29 and monitoring well L-28 indicate that UP-28, UP-29, and L-28 significantly deviate from vertical, and U-26 does not significantly deviate from vertical. As a result, the depth to water measurements at UP-28, UP-29, and L-28 have been corrected based on regression analysis.

Based on the corrected depth to water measurements, the water level elevation anomaly indicated on potentiometric surface maps of the Upper Aquifer in the vicinity of UP-28 does not appear to be directly associated with the inclination of the piezometer off of vertical. However, the water level elevation anomaly indicated on potentiometric surface maps of the Lower Aquifer in the vicinity of UP-28 does not appear to be directly associated with the inclination of the piezometer off of vertical.

Potentiometric Data

Groundwater levels at USEI Site B are measured semiannually in the monitoring wells and piezometers included in the permitted Detection and Compliance Monitoring Systems. The period of record for each well varies according to when the individual well was installed. Some of the wells in the groundwater monitoring system were installed as test wells for site characterization prior to USEI receiving the permit. Consequently, they have periods of record extending back to 1984. Most of the active monitoring wells were installed after the Part B permit was issued and, therefore, the effective period of record begins in 1989

The pre-1989 data sets tend to have more scatter than the post-1989 wells for several reasons: 1) insufficient water level re-equilibration time between frequent sampling and testing activities; 2) variable wellhead configurations and therefore various measure points between wells and over time for the same well; and 3) non-standardized equipment. As the new and existing wells were brought into the permitted Detection Monitoring System, wellheads and measuring points were standardized, dedicated water level probes were used and written field procedures and data recording formats were adopted. These measures significantly reduced the data scatter in these records.

Water level data and hydrographs for the pre-1989 period are presented in CH2M HILL (February 1986). Appendix E.6 includes the tabulated data and hydrographs for all 50 wells in the current groundwater monitoring system for the period from April 1989 through April 2001. As discussed in the next section, water levels have been rising at Site B. In 1999 a Rising Groundwater Study was completed (CH2M HILL, 1999b). In 2001, as required by DEQ, the rising groundwater was re-evaluated (CH2M Hill 2001). The 2001 re-evaluation report provides updated hydrographs through April 2001. The next scheduled re-evaluation of the rising groundwater at Site B will be completed in Fall 2003. The rising groundwater study is further discussed in the next section.

From April 1989 through the October 1996 sampling event, all water levels were measured with the same water-level probe. Prior to the October 1997 water-level measurements, however, the original probe failed and could not be repaired. Consequently, a new water meter was used for the October 1997 water-level data set. Calibrating the new probe or establishing a measurement

offset by collecting comparison water levels from several wells using both probes could not be completed before the old probe failed.

In comparing the October 1996 to October 1997 water levels, many wells exhibited a significant decline in recorded water-level elevations between the two events. Because a correlation could not be established between the two probes, the observed declines in water levels between the successive October water levels are not considered reliable.

Water levels are tabulated after each sampling event and included in the sampling reports contained in the operating record. These reports document the water level data collected between April 2001 and October 2002. The October 2002 water levels are included on Table E-13 and the period of water level record from October 1989 to October 2002 is used in this section to describe the water level trends, potentiometric surfaces, hydraulic gradients, groundwater velocities, and the groundwater flux and water balance for the Upper and Lower Aquifers at Site B.

Water Level Trends

Water levels in the monitoring wells and piezometers at Site B have been generally rising over the period of record. The rate of rise for each well is variable and not consistent between wells or over the period of record for any individual well.

In 1999 a rising groundwater study was completed (CH2M HILL, 1999b). This study examined flow paths, water chemistry and age dating in an effort to determine the source of the rising groundwater. The rising groundwater study determined that the water in the Lower Aquifer and eastern portions of the Upper Aquifer were of similar ages but that the water in the Upper Aquifer in the extreme northwest corner of the site was much younger. This suggests that the water coming into the site in the Upper Aquifer was being recharged by Castle Creek about one (1) mile to the west. This incoming water is displacing the older water in the Upper Aquifer. The rising hydraulic head in the Upper Aquifer is also affecting the pressure head in the Lower Aquifer, especially where the two aquifers overlap. Because of the potential impacts of rising water levels on groundwater flow rates and directions, monitoring well screen placement and concerns over possible impacts to water quality as the rising groundwater encounters vapors or the missile silos, DEQ requires the rising groundwater trends to be re-evaluated every two years. The first re-evaluation was completed in August 2001 and the next one scheduled for Fall 2003.

The 2001 re-evaluation report used regression analysis to predict future water level elevations based on the assumption that the rising water level trends continue at current rates. In summary, these projections indicate the Upper Aquifer water levels will contact the bottom of the missile silos in 36 to 53 years (year 2039 to 2056), again, assuming past trends continue unchanged into the future. In many wells the hydrographs show an initial steeper trend followed by a distinct flattening trend beginning in about 1993 so these predictions must be used with caution. The re-evaluation report also concluded that rising water would not seriously impact well construction or placement as the groundwater flow directions have not changed.

The maximum change has been an increase of 10.71 ft. in piezometer UP-4 and the minimum rise is 3.35 ft. in piezometer UP-7. In general, water levels in the Upper Aquifer on the east side of the site have risen faster than those on the west side. This has resulted in a gradual decrease in the west-to-east gradients across the site, although groundwater flow paths have not significantly changed. A contour map showing the change in water levels in the Upper Aquifer between October 1989 and October 2002 is provided in Figure E-14.

Water levels in the Lower Aquifer wells have also risen over this same period. The average rise in the Lower Aquifer is 4.7 ft. and the range is from 0.42 ft. in well L-35 to 8.26 ft. in well LP-15. In general the wells with the highest water level change, are overlain by the Upper Aquifer. Since the Lower Aquifer is confined, the water levels in these wells are believed to be responding primarily to the increase in loading from the water level rise in the Upper Aquifer.

Well L-38 in the extreme southwest part of the study area experienced a sudden water level increase of approximately ten ft. (10) in 1993 that is believed to be caused by surface loading of earth materials stockpiled in the vicinity during the excavation of Cell 14. Since 1993, the water level has been gradually declining back to the trend line that existed prior to the "spike." Similar, but smaller, spikes occurred in wells L-35 and LP-14 during this same time. These wells are also near the soil stockpile area. Well L-36, in contrast, experienced a drop of approximately three ft. (3) in the water level during this same time, apparently in response to the decrease in loading as the nearby Cell 14 trench was excavated. Since 1993, the water level in L-36 has been gradually rising back to the trend line that existed before the sudden drop in water levels. Water level changes in the Lower Aquifer have not significantly affected the groundwater flow paths.

Potentiometric Surface

Lower Aquifer.

There has been little change in the direction of groundwater flow over the period between October 1989 and October 2002. Groundwater in the Lower Aquifer moves into the site from the southwest and flows northeasterly across the southern end of the site. The equipotential lines on the figures are equally spaced and trend uniformly northwest-southeast. The consistency of the equipotential lines is also another indication that geologic matrix and hydraulic properties of the Lower Aquifer of the site are uniform across the southern and southwestern portions of the site. This uniform flow field characteristic is consistent with the geologic descriptions and hydraulic property characterization data presented earlier in this section.

The potentiometric surface in the Lower Aquifer changes character radically northeast of Cell 14. Because the piezometers in this area are linearly aligned along the northeastern side of the site (LP-12, LP-13 and LP-15), it is difficult to determine true flow patterns. However, the data suggest that groundwater flow in the Lower Aquifer changes to an easterly direction and that the gradients flatten out in this area.

Geologic coring, hydraulic property testing, and geophysical logging of the Lower Aquifer sediments in this area do not indicate any changes in the geologic framework or hydrogeologic properties that would account for these flow direction changes. The apparent distortion of the consistent northeasterly flow pattern exhibited by the Lower Aquifer to the southwest appears to be coincidental with the southern limit of saturation in the overlying Upper Aquifer. These data indicate the potentiometric head in the Lower Aquifer is influenced by the overlying Upper Aquifer. This influence is believed to be primarily related to hydraulic pressure, as opposed to leakage. The hydraulic communication between the Upper and Lower Aquifer is discussed in more detail below.

Based on the October 2002 potentiometric map, horizontal gradients in the southern part of the Lower Aquifer (that portion not overlain by the Upper Aquifer) range from 0.0110 to 0.0440 ft/ft and average 0.0261. It is not possible to establish a gradient for the Lower Aquifer north of the Cell 14 monitoring wells (where it is overlain by the Upper Aquifer) because of insufficient data points.

Upper Aquifer

Water table maps for the Upper Aquifer for the October 1989 and October 2002 periods are provided in Figures E-16 and E-19. Although, as discussed previously, water levels in the Upper Aquifer wells have risen 3.3 ft. to 10.7 ft. over the 1989 to 2002 time period, the overall pattern of groundwater flow has not changed. Water in the Upper Aquifer flows across the site from northwest to southeast. Water also flows into the site all along the northern boundary. This water flows diagonally across the northeastern corner and exits the site along the eastern boundary.

The additional water level data provided by wells UP-28 and UP-29, installed in 1993 along the west central side of the site, suggests a radical and unexplained gradient change in this area as shown on the October 2002 potentiometric map. The data from these wells indicate that along the west central side of the site, water in the Upper Aquifer is flowing from southwest to northeast, which is almost perpendicular to the predominant flow direction in the Upper Aquifer. However, the groundwater flowing from the area of UP-28 and UP-29 eventually converges upon and joins the rest of the system. Detailed site characterization efforts in this area, including a discussion of the high water levels in wells UP-28 and UP-29, are reported in CH2M HILL (June 1993).

Well UP-28 was drilled into the Lower Aquifer to verify the stratigraphy prior to well construction. Although the Lower part of the borehole was plugged with bentonite grout prior to installing the well, upward leakage of Lower Aquifer water cannot be ruled out. It is unlikely, however, that the high water level at UP-28 represents a mounding effect since the Upper Aquifer sediments should be able to accommodate any minimal leakage past the bentonite seal that could be occurring. There are insignificant chemistry differences between the Lower part of the Upper Aquifer and the Lower Aquifer; therefore, there is not a distinctive chemistry profile that can be used to determine if the high water levels represent leakage up the borehole (see Section E.3.c.(6)). Well UP-29 was not drilled into the Lower Aquifer, yet water levels in this well are also higher than expected. This suggests a natural cause for the elevated heads that cannot be explained by the existing data. At this point, the water levels in well UP-28, and to a lesser extent in UP-29, represent the only deviation in the overall northwest-southeast flow direction in the Upper Aquifer.

The irregular spacing and curved equipotential lines for the Upper Aquifer are an indication of the variable Aquifer hydraulic properties of the Upper Aquifer as described previously in Section E.3.c.(4). There are two hydrologic gradient regimes in the Upper Aquifer, illustrated by the distinct spacing of the equipotential lines in Figure E-19. The western 1/2 of the aquifer displays gradients in the range of 0.0049 to 0.0089 ft/ft. The eastern 1/2 has much steeper gradients that range from 0.0140 to 0.0235 ft/ft. The demarcation between the two gradient regimes appears to extend from slightly west of U-26 on the southern extent of the aquifer to between U-5 and UP-7 on the northern site boundary. The area of low gradients in the north and northwest parts of the site coincides with the areas of high hydraulic conductivity and transmissivity. Aquifer properties and well yields are Lower along the eastern side and southern extent of the aquifer. The pattern of hydraulic gradients illustrated in Figure E-19 mirrors and supports the distribution of aquifer properties.

Groundwater Flux and Velocities

Lower Aquifer

The cluster of sand and silty sand seams comprising the Lower Aquifer occurs over an interval 20 ft. to 40 ft. thick. Recalling that aquifer transmissivity, T , is defined as the hydraulic conductivity times saturated thickness, groundwater flux, or the volume of groundwater moving with time

through the Lower Aquifer beneath the southern portion of the site, can be estimated by $Q = T \times l \times \text{width}$, where T = the average aquifer transmissivity, l = the average horizontal gradient, and width is the width of the aquifer parallel to the equipotential lines. The average T for the Lower Aquifer determined in wells around Cell 14 is 1.0 ft/d (Table E-9). The average gradient for the southern portion of the site using the October 2002 water level data is 0.0261 ft/ft as discussed previously. The cross-sectional width of the aquifer beneath Cell 14 is approximately 2,000 ft. Based on these variables, there is about 57 cubic feet (ft³) per day or 20,958 ft³/year of water moving through the entire width and thickness of the Lower Aquifer. To put this flow rate in perspective, a typical household uses 400 gallons per day or 19,600 ft³/year. Because the cross-sectional area, hydraulic conductivity, and hydraulic gradient in the Lower Aquifer do not change significantly across the site, flux into the site from the west side and flux leaving the site on the east side are approximately equal.

Most groundwater movement and, therefore, contaminant transport, will occur through the sand seams making up the aquifer. Groundwater velocities for the sand seams can be estimated by $\text{Velocity} = (K \times l) / n_e$, where K is the hydraulic conductivity, l is the gradient, and n_e is the effective porosity. Effective porosity is defined as that portion of the total porosity through which flow occurs. Effective porosity is almost impossible to determine because of the difficulty in obtaining undisturbed samples. The average porosity of the fine sands in the Upper and Lower Aquifers at Site B was 0.43. Also, as discussed in the 1986 Section E, researchers have concluded that for groundwater flow through granular media, the total porosity can be used in the velocity calculation with little effect. Therefore, velocity calculations for Site B made since 1986 have used the porosity value of 0.43. The K and porosity of the sand beds, as discussed in the Aquifer Properties section, were used in the velocity calculations. Calculated seepage velocities for the Lower Aquifer range from 2.6 ft. per year to 11.2 ft. per year and average 5.2 ft. per year. Calculated velocities vary with the K and l at each well.

Upper Aquifer

Flux calculations for the Upper Aquifer are more complicated than for the Lower Aquifer because the Upper Aquifer is unconfined, the gradients across the site are highly variable, and the saturated thickness varies from about 70 ft. along the north facility boundary to zero feet across the northern edge of Cell 14 where the last of the aquifer sediments emerge. Consequently, a wedge-shaped, cross-sectional area was used to compute the flux, and separate fluxes were calculated for the west and east sides.

From this exercise, the estimated flux into the site from the west is about 43,122 cubic feet (ft³) per year and the flux leaving the east side of the site is 5,193 cubic feet (ft³) per year. The difference between the two values is a net inflow of 37,929 cubic feet (ft³) per year that must be accounted for. These issues are presented in the Water Balance section (Section E.3.c.(5)(d)), which follows the Upper Aquifer groundwater velocity discussion.

The same approach and assumptions presented earlier for the Lower Aquifer were also used to estimate velocities in the Upper Aquifer sand beds. Calculated seepage velocities for the Upper Aquifer range from 0.2 ft. per year at well U-2 to 81.6 ft. per year at well UP-7. The average for all Upper Aquifer wells is 8.3 ft. per year.

Calculated velocities vary with the K and l at each well. Table E-9 provides the calculated velocity at each Upper Aquifer well for which a K and l value have been determined. Although the composite hydraulic conductivities on the east side of the site are lower than those for the northwest corner, the gradients are higher. Therefore, there are no large and consistent east-west differences in the calculated groundwater velocities in the Upper Aquifer across the site.

However the three wells with the highest velocities (UP-7, UP-5 and U-6) are all located in the northeast corner of the site.

Vertical Gradients and Flux

Separating the two aquifers is the inner confining bed, a strata of clay and silty clay 20 ft. to 40 ft. thick. The hydraulic head relationship between the Upper and Lower Aquifers across the inner confining bed varies across the site. Near the southern limit of saturation in the Upper Aquifer north of Cell 14, the hydraulic head in the Lower Aquifer is higher than the water table in the overlying Upper Aquifer. Across a narrow band in the middle of the site there is no significant head difference between the two aquifers, and across the northern 1/2 of the site water levels in the Upper Aquifer are higher than the head in the Lower Aquifer.

Using the October 2002 water level data, there are five Upper Aquifer-Lower Aquifer well pairs available to quantify the gradient across the inner confining bed. The upward gradient, as measured in two well pairs (U-26/L-33 and UP-26/LP-27) averages 0.0378 ft/ft with .77 ft. to 1.5. ft. of actual water level difference. There are much greater water level differences between the Upper and Lower Aquifers across the northeast side of the site. Downward gradients in the three well pairs in this area (U-7/LP-13, UP-4/LP-12, and U-12/LP-15) average 0.1231, with actual water level differences ranging from 1.63 ft. at U-12/LP-15 to 6.77 ft. at U-7/LP-13.

Laboratory tests conducted on geologic cores of the inner confining bed and from similar formations within and beneath the Lower Aquifer provided estimates of vertical hydraulic conductivities of 1×10^{-7} to 1×10^{-8} cm/sec. (CH2M HILL, February 1986). Vertical flow occurs across strata, as opposed to along strata for horizontal flow. Therefore, it is appropriate to assume that in a bedded sedimentary sequence, vertical movement will be controlled by the material having the lowest hydraulic conductivity. To evaluate leakage between the Upper and Lower Aquifers, a vertical conductivity of 10^{-8} cm/sec was used.

Applying Darcy's law and using an average vertical hydraulic conductivity of 10^{-8} cm/sec, the gradients discussed previously, and an upward gradient zone 500 ft. wide by the width of the site (2,000 ft.) results in a flux of 391 cubic feet (ft^3) of water per year moving from the Lower to the Upper Aquifer in the southern part of the site. Doing the same calculation for the area with downward gradients across the northern part of the site indicates a downward flux of 3,822 cubic feet (ft^3) per year moving from the Upper Aquifer to the Lower Aquifer.

Comparing the calculated vertical flux into the Lower Aquifer beneath the northern part of the site to the horizontal flux in the Lower Aquifer south of the area overlain by the Upper Aquifer indicates that about 1/4 as much water is moving vertically into the Lower Aquifer as is coming in horizontally from the southwest. As discussed previously, the horizontal gradients in the Lower Aquifer beneath the northern part of the site appear to flatten and change directions to roughly parallel that in the Upper Aquifer. This gradient change is probably due to a combination of the flux of water coming vertically into the Lower Aquifer and the effect of the hydraulic head imposed by the overlying Upper Aquifer.

There are distinct water chemistry differences between the Upper Aquifer and the Lower Aquifer wells in the northern parts of the site. If leakage from the Upper Aquifer is a significant source of water for the Lower Aquifer as the Darcy flux indicates, then the Lower Aquifer water chemistry beneath the northern part of the site should also reflect the influx of Upper Aquifer water.

In summary, although there are strong downward gradients and therefore by Darcy's law a calculable net flux of water from the Upper Aquifer into the Lower Aquifer, water chemistry data suggest that the actual flow is much less than the calculations indicate.

Water Balance Calculation

To synthesize the elements affecting the movement of water through the Upper Aquifer at USEI Site B, a water balance was prepared. One of the most significant benefits of conducting a water balance analysis is to check the validity of the estimated physical and hydrogeologic characteristics of the aquifer and the overall conceptual model of the system. If it is impossible to achieve an approximate level of water balance by applying the site characterization data, then either the characteristics are not correct or the conceptual model is not correct. As will be presented in the following section, the water balance for the Upper Aquifer at Site B indicates that the site characterization data are both correct and reasonable and that the overall conceptual model is correct.

The elements of a water balance for the Upper Aquifer are: lateral inflow, lateral outflow, vertical inflow from the Lower Aquifer, vertical outflow to the Lower Aquifer, infiltration of precipitation, groundwater pumpage, and change in storage. To examine the water balance at Site B, the 13-year period from October 1989 to October 2002 was used. Each of the elements of the water balance discussed independently in the preceding sections is briefly presented below.

Lateral Inflow and Outflow in the Upper Aquifer

As mentioned previously, in the Upper Aquifer there is approximately 43,122 cubic feet (ft³) per year coming into the site from the northwest and 5,193 cubic feet (ft³) per year leaving along the eastern side. This results in a net influx of 37,929 cubic feet (ft³) per year or a total net gain of approximately 498,265 cubic feet (ft³) over the 1989 to 2002 period.

Vertical Inflow from the Lower Aquifer

The vertical flux calculations provided above account for an influx of 391 cubic feet (ft³) per year from the Lower Aquifer to the Upper Aquifer over the southern portion of the Upper Aquifer. From 1989 to 2002, this added approximately 5,089 cubic feet (ft³) of water to the Upper Aquifer.

Vertical Outflow to the Lower Aquifer

Over the northern portion of the Upper Aquifer, the calculated flux from the Upper Aquifer to the Lower Aquifer was about 3,822 cubic feet (ft³) per year, or 49,683 cubic feet (ft³) over the 1989-2002 period.

Precipitation Infiltration

There is no direct evidence of the infiltration of precipitation at Site B. In fact, the only hard evidence, very dry moisture contents in the vadose zone determined during the vadose zone characterization, suggests no infiltration is occurring. However, infiltration of precipitation occurs under very arid conditions given the right set of circumstances. Therefore, an infiltration component was included. The percentage of annual precipitation that actually infiltrates and reaches the groundwater is highly speculative and in arid ranges may range from essentially zero to about two percent (2 %) of annual precipitation. An infiltration rate of 0.05 inches per year (0.7 % of annual precipitation) was applied to the total square footage of the Upper Aquifer

(about 4,000,000) and equates to about 16,667 cubic feet (ft³) per year, or 216,967 cubic feet (ft³) from 1989 to 2002. This calculated amount is intuitively much too large for Site B, especially given the dry vadose sediments present. At Site B where compacted clayey surface soils are prevalent and surface water runoff is channeled into lined ponds, infiltration rates are expected to be very low. The rising groundwater study conducted in 1999 (CH2M HILL, 199b) found no evidence of recent precipitation water in the Upper Aquifer through either water chemistry or tritium age dating and it probable that the effective recharge from precipitation is essentially zero at this site. However, for the purposes of the water balance, a low infiltration rate was used. The conclusions of the water balance evaluation are not affected by the inclusion, or exclusion, of precipitation.

Vadose Zone Drilling and Sampling

Two boreholes, D-33 and D-34, were drilled as part of the vadose zone drilling and sampling program.

Laboratory analyses were performed on 40 vadose zone soil samples from D-33 and D-34. The laboratory data were also grouped by geologic formation to determine the average properties of the different soil types encountered in the two boreholes. A total of seven soil types are identified: the Bruneau Formation soils, Glenns Ferry fluvial facies sand/silty sand soils, Glenns Ferry fluvial facies clayey silt soils, Glenns Ferry sandy silt soils, Glenns Ferry lacustrine sand/silty sand soils, Glenns Ferry lacustrine clayey silt soils, and Glenns Ferry blue-gray clayey silt soils.

Two geologic cross sections of the vadose zone at Site B were prepared from available soil boring logs. Cross section K-K' runs north to south along the eastern edge of the site. Cross section L-L' cuts diagonally across the site from the northeast to the southwest corner. Both cross sections show the interpreted locations of geologic formations and facies beneath the site. It should be noted that these cross sections have a large vertical exaggeration and the actual dip of the various geologic units if drawn to scale would appear almost horizontal.

The following is a summary of the results of the vadose zone drilling and sampling program.

1. Auger drilling and continuous sampling provide effective methods for obtaining detailed stratigraphic information on the vadose zone at Site B to depths of approximately 150 ft.
2. Laboratory data indicate the presence of four distinct soil types: 1) sands and gravels of the Bruneau Formation; 2) sands/silty sands of the fluvial and lacustrine facies of the Glenns Ferry Formation; 3) sandy silts of the fluvial and lacustrine facies of the Glenns Ferry; and 4) clayey silts of the fluvial and lacustrine facies of the Glenns Ferry Formation.
3. Saturated hydraulic conductivities of Bruneau Formation soils show the largest variation and range from 10^{-5} to 10^{-2} cm/sec. Saturated hydraulic conductivities of the Glenns Ferry fluvial and lacustrine sand/silty sand soils are on the order of 10^{-3} cm/sec. Saturated hydraulic conductivities of the Glenns Ferry clayey silt soils are on the order of 10^{-6} cm/sec. Saturated hydraulic conductivities of Glenns Ferry soils at the site differ by three to four orders of magnitude between the sand/silty sand and the clayey silt soils.
4. Cross sections prepared with existing soil boring logs and correlations with grain-size distribution data from Shannon and Wilson indicate that the geologic facies described in D-33 and D-34 are horizontally continuous beneath the site. The ranges of hydraulic conductivity found for soil types in D-33 and D-34 describe the range of hydraulic conductivity for similar soil types at the site.

5. Vadose zone strata dip to the north-northeast between 1.5 and 3.4 degrees. The north-northeast dip direction is consistent with the dip of deeper formations in the area that are known to dip toward the Snake River.
6. The most prominent stratigraphic marker in the vadose zone at Site B is the blue-gray clayey silt layer shown in the cross sections in Figures E-22 and E-23. The change from a light brown to blue-gray color is interpreted as a transition from oxidizing to reducing conditions within the soils. The blue-gray color contact does not parallel the present day potentiometric surface in the uppermost aquifer. Instead, the blue gray contact is located between 11 ft. and 75 ft. above the potentiometric surface and appears to parallel the strata in the vadose zone. This indicates the contact may be due to a change in the depositional environment as, or soon after, the sediments were deposited or is related to a paleo-potentiometric surface in the area.
7. Based on soil boring logs from D-33 and D-34, clayey silt layers comprise 8.6 to 11.0 % (6.5 ft. to 9.4 ft.) of the Glenns Ferry fluvial facies section. Clayey silt layers comprise 67.5 to 75.6 % (28.7 ft. to 36.9 ft.) of the Glenns Ferry lacustrine facies section. The total accumulated thickness of clayey silt layers in D-33 was 43.4 ft. over 155 ft. of borehole. The total thickness of clayey silt layers in D-34 was 38.2 ft. over 153.5 ft.

In situ moisture contents for Site B soils at depths less than 30 ft. are very low and are probably close to the residual value. At these moisture contents, the unsaturated hydraulic conductivity of these soils is also very low, indicating there is a low potential for infiltration and moisture recharge via precipitation at the site.

Computer Modeling

Computer modeling (CH2M HILL, December 1987) was conducted to simulate a release from the bottom of a disposal unit and the movement of a hypothetical leachate plume through the unsaturated zone at Site B. The emphasis was on examining the amount of vertical and lateral movement of leachate through the unsaturated zone. The modeling effort also provided insight into the question of potential leachate plume widths and therefore appropriate monitoring well spacing.

The model SUTRA (Saturated and Unsaturated Transport), developed by the U.S. Geological Survey (Voss, 1984), was used to simulate quasi-3D vertical plume migration in the unsaturated zone. Hydraulic properties of the unsaturated strata underlying Site B used in these simulations were determined in the laboratory on samples collected by continuous coring during the vadose zone drilling and sampling investigation, as described above. The model included 43 separate layers consisting of nine (9) different lithologies based on the cores and vadose zone hydraulic properties analysis.

Simulations were conducted to analyze the effect of both "falling head" (catastrophic release) and "continuous leak for two (2) years" (slow leak based on infiltrating precipitation). The effect on plume spreading of variable leachate source depths and dimensions was also examined. The following represent the relevant conclusions that can be drawn from the simulation results:

1. The results from both simulated scenarios indicate that the unsaturated subsurface beneath Site B acts to completely halt the downward migration of large volumes of source fluid before it can reach the water table. This occurs primarily because the unsaturated zone is thick, relatively dry, and comprised of many low-permeability stratigraphic units that tend to retard and spread out the infiltrating liquids.
2. Simulated dissolved-solute contaminant releases from trenches at Site B, as large as 300,000 gallons and released over a period of two (2) years at a depth of 40 ft., did not

reach the water table. A steady-state distribution of concentration for this particular scenario was reached in 15,000 years. At that point in elapsed time, the maximum depth of infiltration was about 130 ft., roughly 50 ft. above the water table.

3. The scale of the leak discussed in item 2 above is the largest leak considered likely to occur through the particular source-area diameter selected (10 ft.). However, should this scale of leak underestimate the size of potential contaminant sources, the results imply that for contamination to reach the water table, and to do so in less than 100 years, it would have to originate from a substantially larger source than the volume of the largest scenario simulated in this investigation.
4. Monitoring well spacing cannot be based solely on the simulation results because the hypothetical plume did not reach the depth of the Upper Aquifer at Site B. Therefore, other criteria must be used to establish appropriate monitoring well spacing and locations. These include location of waste disposal units and aquifer flow rates and flow directions.

Site-Specific RESRAD Water Pathway Parameters for the Contaminated Soil, Vadose Zone, and Saturated Zone

US Ecology
Grand View, Idaho

April 7, 2005



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Executive Summary

This report documents the site-specific hydrogeologic, waste-cell properties and conditions that are required in the RESRAD model to assess the reasonably conservative estimate of the expected dose from radiation exposure to hypothetical individuals from soil contamination. The soil contamination used in these analyses is the reasonably anticipated wastes containing exempt radioactive waste that will be disposed at the existing US Ecology Idaho (USEI) facility near Grand View Idaho. These wastes will be co-disposed with other, non-radioactive waste at the USEI facility in disposal cells that extend approximately 15 meters below grade, and which contain synthetic membrane liners emplaced over a one-meter thick layer of low-permeability compacted clay.

The site-specific hydrogeologic properties and conditions used in the RESRAD analysis were determined using the extensive site-specific information available from numerous characterization reports previously submitted to the Idaho Department of Environmental Quality (IDEQ). This is the same information used to support the existing approved RCRA permit for the USEI facility. Specifically, hydrogeologic conditions in both the vadose and saturated zones from these reports were used to develop the necessary input parameters for RESRAD.

Site-specific conditions in the waste disposal cell needed for the RESRAD analysis were determined using information provided by USEI on the anticipated wastes regarding waste forms, volumes, concentrations of radionuclides, co-disposed waste forms and volumes, waste emplacement and stabilization methods, and waste cover operations.

A reference case RESRAD analysis was performed using the site specific vadose zone, saturated zone, and waste cell conditions. Additionally, a sensitivity analyses was performed to determine the parameters to which the estimated dose was the most sensitive. These parameters were the distribution coefficients (K_D) for ^{14}C , ^{129}I , and ^{99}Tc the hydraulic conductivity of the contaminated zone, and the hydraulic conductivity of the saturated zone.

The results of the reference case show that the maximum reasonably conservative expected dose within the 1000-year analysis period was always less than 9.6 mrem/yr from all pathways, and was always less than 7.3 mrem/yr from the water-borne pathways. The results of sensitivity analyses show that the maximum reasonably conservative expected dose allowing for uncertainties in K_D values in the contaminated zone, the hydraulic conductivity of the saturated zone, and the hydraulic conductivity of the contaminated zone was always less than 11.9 mrem/yr from all pathways, and always less than 9.6 mrem/yr from the water-borne pathways. Essentially, the entire simulated dose from the non-waterborne pathway computed with RESRAD is from radon. RESRAD radon pathway variables and conditions are discussed elsewhere in this submittal.

1. Introduction

With this submittal, USEI proposes to use the same RESRAD model with more realistic and site specific parameters into its permit. USEI believes that these improvements, based on site-specific hydrogeologic information better represent the site's behavior and factors that better represent potential exposure scenarios. This use of site-specific information and more realistic exposure scenarios is encouraged in the RESRAD Version 6 documentation.

1.1. Purpose

This report documents the site-specific hydrogeologic and waste-cell properties and conditions that are required in the RESRAD model to assess the reasonably conservative estimate of the expected dose from radiation exposure to hypothetical individuals from soil contamination. The soil contamination used in this analysis is the reasonably anticipated wastes containing exempt radioactive waste that will be disposed at the existing US Ecology Idaho (USEI) facility near Grand View Idaho. These wastes will be co-disposed with other, non-radioactive waste at the USEI facility in disposal cells that extend approximately 15 meters below grade, and which contain synthetic membrane liners emplaced over a one-meter thick layer of low-permeability compacted clay. The synthetic membrane liner is overlain by a one-foot layer of compacted clayey soil having a slightly higher permeability than the compacted clay beneath the membranes¹.

1.2. Disclaimer

Some analyses contained in this report relied upon data and information provided by others. Eagle Resources P.A. makes no representations regarding the completeness, accuracy and reliability of that data and information.

¹USEI Cell 15 design, construction, operation, monitoring, and closure requirements, Appendix B, Section 02288.

2. Analysis

RESRAD Pathways analyzed for this report are summarized in the following figure:

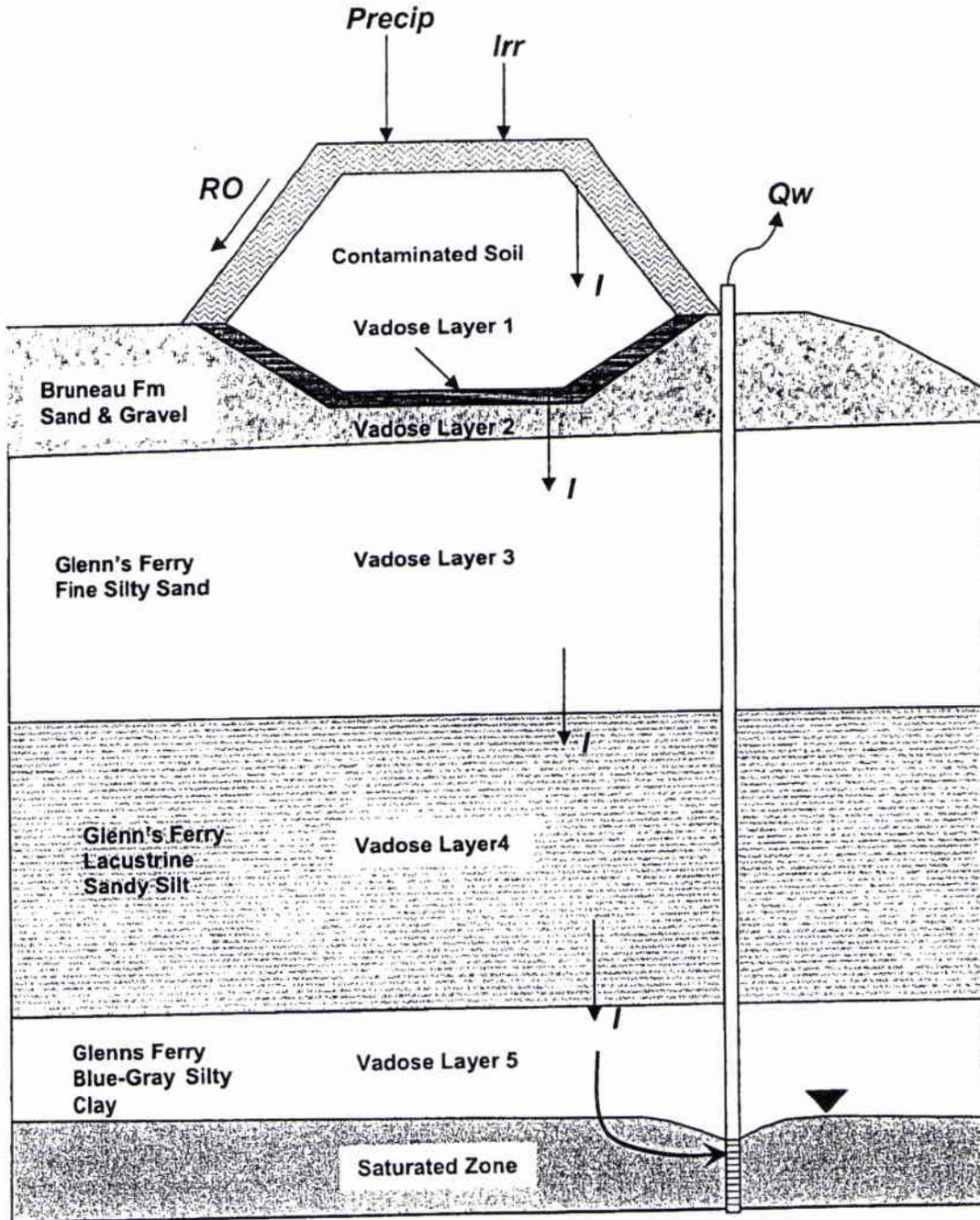


Figure 1.--RESRAD subsurface water pathways.

2.1. Approach

The findings of this report were developed using the following approach:

- Obtain the previous USEI RESRAD modeling that has been updated to include radionuclides and their respective activities in the anticipated wastes that are and will be received at the USEI facility;
- Assign additional vadose zones that correspond with the lithology and hydraulic properties documented in previous site studies;
- Review reasonableness of default values for the fate and transport parameters and conditions and assign site specific values to the parameters if a more reasonably conservative value can be developed from measurements or literature values;
- Identify waste characteristics, characteristics of co-disposed wastes, and waste stabilization and emplacement methods that will serve to reduce activities in leachate that may move out of the disposal cell into the vadose zone; and
- Use sensitivity analyses to assess the effect of reasonable variations in fate and transport parameters for the disposal cell, vadose zone, and saturated zone to which total dose from all pathways and from water pathway are sensitive.

2.1.1. Updated RESRAD Model

USEI provided an updated version of the RESRAD dataset that included the concentrations of radionuclides and their respective activities in the anticipated wastes. These radionuclides and activities as well as the other parameters reviewed for this report are shown in the RESRAD report included elsewhere in this submittal by USEI.

2.1.2. Site-Specific Vadose Zone and Saturated Zone Properties

The RESRAD Vadose zone model component was updated to include five zones that correspond to the low permeability waste disposal cell liner and four zones corresponding to lithologies identified in the CH2MHill Vadose zone Modeling Report^{2,3}.

The RESRAD Saturated zone was updated using hydraulic conductivities determined as the geometric mean of values for the conductive sands from 25 aquifer tests performed in the shallowest permanent aquifer beneath the site (Upper Aquifer)⁴. The hydraulic gradient of 0.011 was also taken from the same reference table.

²CH2MHill, 1987. Computer modeling results for the Part B Permit Application, ESII Site B Grand View Idaho.

³CH2MHill, 1987. 6.CH2MHill, 1986. Vadose Zone Characteristics at ESII Site B Grand View Idaho

⁴Appendix E Groundwater Monitoring, RCRA Part B Application, Table E-2.

2.1.2.1. Hydraulic properties

The site specific RESRAD hydraulic properties assigned to the vadose zone and the saturated zone are shown in Table 1.

Table 1 . Contaminated Zone, Vadose Zone, and Saturated Zone Site-Specific Properties.

Material-->	Contaminated Zone	Vadose Zone					Saturated Zone
		USZ(1)	USZ(2)	USZ(3)	USZ(4)	USZ(5)	
	Compacted Waste	Compacted Clay	Glenns Ferry Fluvial Sand	Glenns Ferry Clayey Silt	Glenns Ferry Lacustrine Clayey Silt	Lacustrine Blue-Gray Clay	Silty Sand
Data Source-->	USEI ⁵	USEI ¹	CH2MHill Soil 2 ²	CH2MHill Soil 3 ²	CH2MHill Soil 4 ²	CH2MHill ²	4/
Thickness, M-->	33.60	1.00	4.60	21.30	16.80	12.20	N/A
Density, gm/cm ³ -->	1.50	1.63	1.69	1.30	1.31	1.50	1.50
Total Porosity-->	0.40	0.52	0.51	0.52	0.51	0.52	0.40
Effective Porosity-->	N/A	0.10	0.33	0.40	0.43	0.15	0.20
Field Capacity-->	0.20	0.45	0.07	0.49	0.48	0.32	0.25
Hyd. Conductivity, Myr	50	0.015	2200	900	60	0.1	25
Campbell b	5	11	2	3	5	8	5

The CH2MHill Vadose Modeling Report for the site² provides the parameters N and α of the vanGenuchten/Mualem model for the functional relationship between relative saturation and relative unsaturated hydraulic conductivity ($K_R = K(R_S)/K_{SAT}$). RESRAD uses the simpler Campbell model based upon the work of Clapp and Hornberger (Reference RESRAD manual) that uses the single parameter, b . Because these two models use different numbers of parameters it was not possible to solve for b in terms of N and α . Consequently values of b for RESRAD have been taken from the RESRAD manual⁶ for each soil type in the contaminated soil, vadose zone, and saturated zone.

The waste cell liner corresponds to vadose zone layer 1 for the RESRAD analyses. Material obtained from the USEI on-site Ketterling Clay Borrow Pit has been and is used at the USEI site to construct low permeability liner of the waste cells. The Ketterling Clay exhibits the following typical physical strength properties and characteristics shown in Table 2. Layer 1 of the RESRAD Vadose Zone is assigned a thickness of one (1) meter, and a saturated hydraulic conductivity of 0.02m/yr (6×10^{-8} cm/sec). The assigned hydraulic conductivity takes no additional credit for the artificial membrane liner which has a permeability of 3.2×10^{-4} m/yr (1.0×10^{-9} cm/sec)¹.

⁵Simon Bell, US Ecology Idaho, personal communication

¹ibid.

²ibid Table 2.

⁴ibid

⁶C. Yu, A.J. Zielen, J.-J. Cheng, D.J. LePoire, E. Gnanapragasam, S. Kamboj, J. Arnish, A. Wallo III, W.A. Williams, and H. Peterson, July 2001. User's Manual for RESRAD Version 6 ANL/EAD-4 Environmental Assessment Division Argonne National Laboratory, 9700 South Cass Avenue, Argonne, Illinois 60439

Table 2.-- Properties of the low permeability clay used for the waste disposal cell liner ¹.

Property	Value
Engineering Classification	CL, CH
PI	14.6 to 26.5
LL	37.4 to 51.7
Maximum Density by D698	97.9 to 104.5 pcf
Optimum Moisture Content by D698	20.0 to 22.8%
In situ Dry Density	93.9 to 103.4 pcf
In situ Water Content	2.8 to 3.4%
Lab K_s	1×10^{-7} to 2×10^{-8} cm/s
% Standard Proctor Achieved	95 to 105
Drained Strength:	
ϕ	22°
c	0 psf
Undrained Strength:	
ϕ	0°
c	3000 psf

This material is applied over a prepared sub-grade in lifts that are compacted to near optimal moisture content to achieve the minimum K_{sat} . The maximum compacted lift thickness is six (6) inches. The value of 0.02 m/yr used RESRAD analyses is equal to 6.0×10^{-8} cm/sec.

The low permeability liner is protected from freezing by requiring that sufficient protective fill and or waste are emplaced over the liner prior to the onset of the frost-penetration season (USEI Operating Manual, Section 2.6.C).

The compacted density of the liner for RESRAD analyses is 1.63 gm/cm^3 , or 105 lb.ft^3 (pcf).

Other RESRAD parameters for the liner layer were taken from the literature for compacted clays using the material property database EnvirobaseTM ⁷.

2.1.2.2. Site-Specific Distribution Coefficients (K_D s)

Site-specific distribution coefficients for the radionuclides shown in Attachment A were assigned for the contaminated zone, the five vadose zone layers, and the saturated zone. The following preference order was used to assign these values for each combination of material type and radionuclide:

1. Literature values based upon measured values, if available
2. Literature values based upon models (i.e. plant uptake models), if available
3. RESRAD default values

The assigned site-specific K_D values and the source used for their selection are shown in Table 3. Additional considerations used to assign the K_D values to the contaminated zone (waste disposal cell) are given in the following section.

¹ibid.

⁷Waterloo Hydrogeologic, 2003. 10.EnvirobaseTM Material and Chemical Environmental Fate Database.

2.1.3. Disposal Cell (Contaminated Zone) Characteristics

The characteristics of the disposal cell that are addressed in this report that support the RESRAD analyses are:

- Past and anticipated future radioactive waste
 - Physical form
 - Anticipated daily disposal volume
 - Concentration (Activity) of the radioactive isotopes
- Co-disposed non-radioactive waste
 - Physical form
 - Anticipated daily disposal volume
 - Stabilization methods and materials

The radionuclides that contribute the largest water pathway component of total dose within the 5000 year analysis period are ^{129}I , ^{14}C , and ^{99}Tc . This section assesses the likely sorption mechanisms for these isotopes on materials and conditions expected in the waste disposal cell.

2.1.3.1. Anticipated Waste Form and Compounds Likely to Contain ^{14}C

The potential for attenuation of ^{14}C by sorption and/or chemical reaction(s) in the contaminated zone depends upon the chemical compound present in the waste that is contaminated with ^{14}C and upon the physical form of waste containing these contaminated compounds. Based upon information provided by USEI, the typical physical form of the waste will be flooring materials, concrete, rebar, roofing materials, structural steel, soils associated with digging up foundations, and concrete and/or pavement or other similar solid materials. Material sizes will range from individual sand grains to monoliths with volumes of several cubic feet. The waste will contain no free liquids or chelating agents.

2.1.3.2. Chemical Compounds Likely to Contain ^{14}C

^{14}C will most likely be present in the form of carbonates and/or bicarbonates ($^{14}\text{CO}_3^{2-}$ or $\text{H}^{14}\text{CO}_3^-$) in the concrete waste from certain parts of buildings to be demolished and disposed at USEI. The mechanism for the presence of these carbonates and bicarbonates is carbonation of cement occurs when concrete is exposed to air containing CO_2 or water containing carbonates or bicarbonates⁸ during the life of the facility prior to demolition. The depth of such carbonation into concrete surfaces is dependent upon the porosity of the cement, and the time of exposure⁸.

Information provided by USEI, the wastes may also contain some amounts of organic compounds that contain ^{14}C -compounds from flooring (vinyl tile), adhesives, concrete floor and wall sealants, and asphalt.

⁸Campbell, D.H, R.D. Sturm, and S.H. Kosmatka, 1991. Detecting Carbonation: Concrete Technology Today, v.12, no. 1. Portland Cement Association.

2.1.3.3. Adsorption Sites or Sinks for ¹⁴C-carbonate Species in Disposed Concrete Waste

Carbonation decreases the pH of the cement, and may render it more likely to leach constituents, including the carbonates deposited during the carbonation process⁸. However, the disposed wastes will in part be likely broken up, exposing concrete that has not been carbonated during the life of the facility. This should create an additional 'sink' for ¹⁴C-containing carbonates leached from previously carbonated concrete and may offset the leaching and migration within the contaminated zone.

Concrete waste present in co-disposed waste that has been broken up to expose material that had not been previously carbonated should provide additional carbonation sinks for ¹⁴C-containing carbonates leached from the anticipated waste. These materials should also provide additional carbonation sinks for ¹⁴C leached from the organic compounds that may be present in the waste.

Native site soils and material excavated from the waste cell are assumed to be present in the contaminated zone as it is assumed that they generally are emplaced over and around the disposed waste as part of daily disposal operations. When used, these materials should provide additional sorption sites for ¹⁴C-containing compounds dissolved in soil moisture within the contaminated zone. These backfill and cover materials contain sand and silt sized grains that were derived from silicic volcanic materials present in the Bruneau Formation present at the site⁵. It is assumed that quartz sand and granite are reasonable analogs to these materials for purposes of assessing the likely sorption of ¹⁴C-compounds.

2.1.3.4. Adsorption Sites in Co-disposed waste

The anticipated radionuclide-containing waste will be co-disposed with other hazardous and non-hazardous waste. Information provided by USEI⁹ based on historical waste receipts, shows that approximately 60% of waste receipts are NORM/TENROM, 25% are RCRA (typically requires treatment) and 15% are other non-hazardous waste. The majority (over 50%) of the RCRA material is made up of EPA waste code K061 which is "electric arc furnace, bag house dust". K061 contains heavy metals such as zinc, lead, cadmium, chromium, etc. K061 made up approximately 50,000 tons of the 381,000 total tons disposed in 2004. The treatment of K061 typically requires 5% lime (by weight) and 10% ferrous sulfate (by weight). The other 40,000 tons of material were a mix of non-RCRA and RCRA, which is also commingled and compacted with the NORM/FUSRAP wastes. RCRA wastes that excluded K061 were stabilized with an additional 3,500 tons of lime.

⁸ibid.

⁹CH2MHill, February 1986. ESII Site B Site Characterization and Groundwater Monitoring Program, EnviroSAFE Services of Idaho, Inc., Grand View, ID. U.S. EPA I.D. No. IDD073114654. Boise, ID.

⁵Simon Bell, 2005, Personal Communication

The lime used for stabilization adds a significant volume of additional material that can serve as adsorption sites for both ^{14}C and ^{99}Tc as shown by the measured K_D values for these species on carbonates in the next section. ^{99}Tc is most likely present in the anticipated waste as pertechnetate form ($^{99}\text{Tc}(\text{VII})\text{O}_4^-$)¹¹ which as an anion is not adsorbed to negatively charged sorption sites in waste or soils. In addition, the reducing agent (ferrous sulfate) should result in a reducing environment which will promote the formation of lower valence-state $^{99}\text{Tc}(\text{IV})$ complexes and compounds that would be expected to form both discrete solid phases as well as complexes with mineral surfaces. All of these should result in the likely removal of Tc from solution and immobilization within sediments within the disposal cell.^{11, 12}

2.1.3.5. K_D Values for Contaminated Zone Materials

This analysis assumes that literature values can be used to provide reasonable, conservative values of K_D for carbon-containing compounds in the contaminated zone. It is further assumed that the use of measured K_D s from the literature to estimate attenuation in the contaminated zone is an adequate and conservative surrogate for more complex chemical reactions such as carbonation of concrete.

Measured K_D values for ^{14}C and ^{99}Tc on concrete for this analysis are taken from Szántó, et. al.¹³ and are shown in the following table:

Material	K_d , cm ³ /g	
	^{99}Tc	^{14}C
Granite	4.2	2.4
Carbonate	46	4.4
Chlorite	21	2.6
Na-bentonite	19	1
Quartz	28	2.3
Concrete	2.1	4

The values of K_D for ^{14}C on Granite and Quartz shown in this table are also assumed to be applicable to backfill materials used at the USEI facility as they should represent reasonable analogs for the mineralogy of the materials from the Bruneau Formation used for such purposes.

¹¹ Shuh, D.k, W.W. Lukens, and C.J. Burnes, 2003. Research Program to Investigate the Fundamental Geochemistry of Technetium: Final Report. U.S. Department of Energy Project Number: EMSP-73778.

¹² J. R. Lloyd, V.A. Sole, C.V.G. vanPraagh, and D.R. Lovley.2003. Direct and Fe(II)-Mediated Reduction of Technetium by Fe(III)-Reducing Bacteria: Applied and Environmental Microbiology. Sept. 2000, p. 3743-3749.

¹³ Zs. Szántó, E. Hertelendi, M. Molnár and L. Palcsu, 1999. The Interaction of Trace Levels of ^3H , ^{99}Tc , ^{63}Ni , and ^{14}C with Granite, Concrete, Carbonate, Chlorite, Quartz, and Na-Bentonite: <http://www.atomki.hu/ar98/e/e05/e05.html>.

Sheppard and Thibault^{6,14} provide the following values for K_D for C, Tc, and I. Their values for sand, Loam, and Clay should be applicable for the backfill materials used in disposal operations for the contaminated zone:

Material	¹⁴ C K_D cm ³ /g	¹²⁹ I K_D cm ³ /g	⁹⁹ Tc K_D cm ³ /g
Sand	5	1	0.1
Loam	<i>20</i>	5	0.1
Clay	<i>1</i>	21	1
Organic Soil	<i>70</i>	5	1

Note that Sheppard and Thibault report K_D values in L/Kg. The table above has used the assumption that the density of water equals 1 Kg/L.

The values in bold italics in the table above reported by Sheppard and Thibault for ¹⁴C were computed using soil to plant concentration ratios from modeling and were not measured using batch sorption or column tests. The probabilistic version of RESRAD uses a default mean K_D of 11 cm³/g¹⁵.

From this analysis, we conclude that reasonable, supportable K_D values for the ¹⁴C-compounds likely to be present in waste disposal cell are between 2 cm³/g and 10 cm³/g.

Values for K_D assigned to each the contaminated zone, the five vadose zone layers, and the saturated zone are shown in Table 3.

⁶ibid.

¹⁴Sheppard, M.I, and D.H. Thibault, 1990. Default Soil/Liquid Partition Coefficients, Kds, for Four Major Soil Types: A Compendium: Health Physics, v. 59, no. 4, pp 471-482, Table 1.

¹⁵ C. Yu, D. LePoire, E. Gnanapragasam, J. Arnish, S. Kamboj, B.M. Biwer, J.-J. Cheng, A. Zielen, and S.Y. Chen. November 2000: Development of Probabilistic RESRAD 6.0 and RESRAD-BUILD 3.0 Computer Codes. U.S. Nuclear Regulatory Commission. Office of Nuclear Regulatory Research Radiation Protection, Environmental Risk and Waste Management Branch. NUREG/CR-6697 (Table 3.9, P. 3-30)

Table 3.-- Site-specific Kd values assigned to the RESRAD zones

Species	Conc. pCi/g	Contaminated Zone		USZ(1)		USZ(2)		USZ(3)		USZ(4)		USZ(5)		Sat. Zone	
		Kd cm ³ /gm	Data Source	Kd cm ³ /gm	Data Source	Kd cm ³ /gm	Data Source	Kd cm ³ /gm	Data Source	Kd cm ³ /gm	Data Source	Kd cm ³ /gm	Data Source	Kd cm ³ /gm	Data Source
²²⁷ Ac	3.2	450	ST (Sand)	2400	ST (Clay)	450	ST (Sand)								
¹⁰⁸ Ag ¹¹⁰ Ag	10	90	ST (Sand)	180	ST (Clay)	90	ST (Sand)								
²⁴¹ Am ²⁴³ Am	0.1	1900	ST (Sand)	8400	ST (Clay)	1900	ST (Sand)								
¹⁹⁵ Au	100	0	RR-D	0	RR-D	0	RR-D	0	RR-D	0	RR-D	0	RR-D	0	RR-D
¹³³ Ba	25	50	RR-D	50	RR-D	50	RR-D	50	RR-D	50	RR-D	50	RR-D	50	RR-D
¹⁴ C	10	5	SHMP (Concrete)	1	Less than ST										
⁴¹ Ca	25	5	ST (Sand)	50	ST (Clay)	5	ST (Sand)								
¹⁰⁹ Cd	100	11	DJTM (Sand)	560	ST (Clay)	11	DJTM (Sand)								
¹⁴⁴ Ce	100	500	ST (Sand)	20000	ST (Clay)	500	ST (Sand)								
²⁵² Cf	0.1	0.1	RR-D	0.1	RR-D	0.1	RR-D	0.1	RR-D	0.1	RR-D	0.1	RR-D	0.1	RR-D
²⁴³ Cm ²⁴⁴ Cm ²⁴⁵ Cm ²⁴⁶ Cm ²⁴⁷ Cm ²⁴⁸ Cm	0.1	0.1	RR-D	0.1	RR-D	0.1	RR-D	0.1	RR-D	0.1	RR-D	0.1	RR-D	0.1	RR-D
⁵⁷ Co ⁶⁰ Co	10, 25	60	ST (Sand)	550	ST (Clay)	60	ST (Sand)								
¹³⁴ Cs ¹³⁵ Cs ¹³⁷ Cs	25, 25, 25	280	ST (Sand)	500	ST (Clay)	280	ST (Sand)								
¹⁵² Eu ¹⁵⁴ Eu ¹⁵⁵ Eu	10, 10, 25	0.1	RR-D	0.1	RR-D	0.1	RR-D	0.1	RR-D	0.1	RR-D	0.1	RR-D	0.1	RR-D
⁵⁵ Fe	100	220	ST (Sand)	165	ST (Clay)	220	ST (Sand)								
¹⁵² Gd ¹⁵³ Gd	100, 10	0.1	RR-D	0.1	RR-D	0.1	RR-D	0.1	RR-D	0.1	RR-D	0.1	RR-D	0.1	RR-D
⁶⁸ Ge	100, 10	0	RR-D	0	RR-D	0	RR-D	0	RR-D	0	RR-D	0	RR-D	0	RR-D
³ H	1000	0	RR-D	0	RR-D	0	RR-D	0	RR-D	0	RR-D	0	RR-D	0	RR-D
¹²⁹ I	0.01	0.2	< ST	0.1	RR-D										
⁴⁰ K	100	15	ST (Sand)	75	ST (Clay)	15	ST (Sand)								
⁵⁴ Mn	10	50	ST (Sand)	180	ST (Clay)	50	ST (Sand)								
²² Na	10	10	RR-D	10	RR-D	10	RR-D	10	RR-D	10	RR-D	10	RR-D	10	RR-D
⁹⁴ Nb ^{93m} Nb	100	160	ST (Sand)	900	ST (Clay)	160	ST (Sand)								
⁵⁹ Ni ⁶³ Ni	100	400	ST (Sand)	650	ST (Clay)	400	ST (Sand)								
²³⁷ Np	0.1	0.1	RR-D	0.1	RR-D	0.1	RR-D	0.1	RR-D	0.1	RR-D	0.1	RR-D	0.1	RR-D

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Table 3 (concluded).-- Site-specific Kd values assigned to the RESRAD zones.

Species	Conc. pCi/g	Contaminated Zone		USZ(1)		USZ(2)		USZ(3)		USZ(4)		USZ(5)	
		Kd cm ³ /gm	Data Source										
²³¹ Pa	3.2	550	ST (Sand)	2700	ST (Clay)	550	ST (Sand)						
²¹⁰ Pb	333	270	ST (Sand)	550	ST (Clay)	270	ST (Sand)						
¹⁴⁷ Pm	100	0.1	RR-D										
²³⁸ Pu ²³⁹ Pu ²⁴⁰ Pu ²⁴¹ Pu ²⁴² Pu ²⁴⁴ Pu	0.1	550	ST (Sand)	5500	ST (Clay)	550	ST (Sand)						
²²⁶ Ra ²²⁸ Ra	112, 28	70	RR-D										
¹⁰⁶ Ru	25	55	ST (Sand)	800	ST (Clay)	55	ST (Sand)						
¹²⁵ Sb	100	45	ST (Sand)	250	ST (Clay)	45	ST (Sand)						
¹⁴⁷ Sm ¹⁵¹ Sm	10 100	0.1	RR-D										
⁹⁰ Sr	100	15	ST (Sand)	110	ST (Clay)	15	ST (Sand)						
⁹⁹ Tc	1	0	RR-D										
²⁰⁴ Tl	100	0	RR-D										
²²⁸ Th ²²⁹ Th ²³⁰ Th ²³² Th	28, 28 83, 28	3200	ST (Sand)	5800	ST (Clay)	3200	ST (Sand)						
²³³ U ²³⁴ U ²³⁵ U ²³⁶ U ²³⁸ U	3.2, 83, 3.2, 3.2 83	35	ST (Sand)	1600	ST (Clay)	35	ST (Sand)						
⁶⁵ Zn	10	200	ST (Sand)	2400	ST (Clay)	200	ST (Sand)						

Notes: ST: Shepard and Thiebault¹⁴, RR-D: RESRAD Default⁶, SHMP: Szanto, et. al¹³, DJTM: Dunnivant, et.al.¹⁶

¹⁴ibid.

⁶ibid.

¹³ibid.

¹⁶ Dunnivant, F.M., P.M. Jardine, D.L. Taylor and J.F. McCarthy, Co-transport of cadmium and hexachlorobiphenyl by dissolved or columns containing aquifer material, Environ. Science and Technology., 26, 360-368, 1992 (Cited in Envirobase™.)

A sensitivity analysis was conducted to assess uncertainty in the total dose computed with RESRAD for water-pathways for the USEI facility caused by uncertainty in the following parameters:

- K_D values in the contaminated zone for ^{14}C , ^{129}I , and ^{99}Tc ;
- Hydraulic conductivity of the contaminated zone (waste disposal cell)
- Hydraulic Conductivity of the Saturated Zone

The sensitivity analyses results are shown in Table 4, and show that RESRAD simulated the maximum water-pathway dose within 1000 years using reasonably conservative uncertainties in the sensitivity parameters is always less than 9.6 mrem/yr.

Table 4.-- Summary of sensitivity Analyses

Run	Analysis Description	Sensitivity Parameter		Max Total Dose All Pathways mrem/yr	Max Total Dose Water Pathway mrem/yr
		Value	Units		
2	^{14}C K_D in Waste Cell Sensitivity	2	cm^3/gm	11.90	9.60
2	^{14}C K_D in Waste Cell Reference Case	5	cm^3/gm	9.60	7.30
3	^{14}C K_D in Waste Cell Sensitivity	7	cm^3/gm	9.50	7.20
4	^{14}C K_D in Waste Cell Sensitivity	10	cm^3/gm	9.50	7.20
5	^{129}I K_D in Waste Cell Sensitivity	0.1	cm^3/gm	11.10	8.80
2	^{129}I K_D in Waste Cell Reference Case	0.2	cm^3/gm	9.60	7.30
7	^{129}I K_D in Waste Cell Sensitivity	0.5	cm^3/gm	7.40	5.10
8	^{129}I K_D in Waste Cell Sensitivity	1	cm^3/gm	7.10	4.80
2	^{99}Tc K_D in Waste Cell Sensitivity	0	cm^3/gm	9.60	7.30
9	^{99}Tc K_D in Waste Cell Sensitivity	0.1	cm^3/gm	9.40	7.10
10	^{99}Tc K_D in Waste Cell Sensitivity	0.5	cm^3/gm	8.70	6.40
2	Ksat of Waste Cell Reference Case	10	m/yr	9.60	7.30
11	Ksat of Waste Cell Sensitivity	50	m/yr	9.90	7.60
12	Ksat of Waste Cell Sensitivity	100	m/yr	10.00	7.70
13	Ksat of Saturated Zone Sensitivity	15	m/yr	8.90	6.60
14	Ksat of Saturated Zone Sensitivity	20	m/yr	9.60	7.30
2	Ksat of Saturated Zone Reference Case	25	m/yr	9.60	7.30
15	Ksat of Saturated Zone Sensitivity	50	m/yr	9.60	7.30
Reference Case					

A large amount of available site-specific data was used for the reference case RESRAD analysis. In particular, the thickness, zonation, and hydraulic properties of the vadose zone, the characteristics of the waste-disposal cell and low-permeability clay liner, and the Upper Aquifer that underlies the site have been assigned based upon site specific measurements. In addition, information provided by USEI on the characteristics of the anticipated wastes and the methods by which it will be co-disposed with other waste was used to assign site-specific values to contaminated zone RESRAD parameters.

The results of the reference case show that the reasonable and conservative expected dose within the 1000-year analysis period was always less than 9.6 mrem/yr from all pathways, and was always less than 7.3 mrem/yr from the water-born pathways. The results of sensitivity analyses show that the maximum reasonably conservative expected dose allowing for uncertainties in K_D values in the contaminated zone, the hydraulic conductivity of the saturated zone, and the hydraulic conductivity of the contaminated zone was always less than 11.9 mrem/yr from all pathways, and always less than 9.6 mrem/yr from the water-born pathways. Essentially the entire simulated dose from the non-waterborne pathway computed with RESRAD, is from radon. RESRAD radon pathway variables and conditions are discussed elsewhere in this submittal.



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QUALIFICATIONS AND EXPERIENCE

Mr. Lappala has over 32 years of professional consulting in the Environmental, Water Resources Development, Hazardous Waste, and Radioactive Waste fields. As a professional consultant, Mr. Lappala has led and managed teams to successfully integrate technical, regulatory and economic factors into clients' business strategies. He has provided these services for over 60 Fortune® 500 companies representing the following industry groups: Aerospace, Chemicals, Electronics, Food & Beverage Processing, Forest & Paper Products, Manufacturing, Metal Products, Oil and Gas, Pharmaceuticals, Telecommunications, Transportation, Utilities, and Waste Management and the U.S. Departments of Defense and Energy. These services include:

- Assessment, development and management of ground water and surface-water supply systems for agricultural, municipal, and industrial users;
- Permitting and compliance assistance for land application systems for treated wastewater and biosolids;
- Investigation and remediation of contaminated sites regulated under CERCLA, RCRA, and numerous State Voluntary Cleanup Programs;
- Development and implementation of multi-site, multi-company environmental liability management programs;
- Investigation, permitting, and licensing of hazardous and low-level radioactive waste disposal facilities;
- Litigation support and expert witness services in the areas of hydrogeology, contaminant transport, and waste site development; and
- Development of Environmental Management Systems and Environmental Information Management Systems to enhance regulatory compliance at operating plants and facilities.

Mr. Lappala has represented hundreds of clients in public hearings, regulatory agency meetings, court proceedings, and legislative committees. He is a licensed Professional Engineer and a Certified Remedial Site Manger in North Carolina.

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Radioactive Waste Projects

Central Interstate Compact Proposed Low Level Radioactive Waste Disposal Facility, Boyd County, NE.

Principal hydrogeologic consultant and expert witness for the State of Nebraska in litigation regarding the denial of the license application. Responsible for: Developing independent conceptual and simulation models of the occurrence and movement of groundwater in the vadose and saturated zones; Documenting and simulation of recharge at the site using fine-time-scale modeling of the vadose zone; Documenting and demonstrating the presence and frequency of occurrence of the watertable relative to disposal facility components; Documenting and demonstrating the occurrence of groundwater discharge from shallow groundwater systems within the disposal facility boundary; Assessing the adequacy with which the applicant integrated site characterization and performance assessment modeling; Assessing the adequacy with which the applicant considered reasonable hydrologic and hydrogeologic bounding case scenarios for performance assessment'; Developed and presented time-lapse visualizations of groundwater discharge on a weekly basis for the eight year period of record using water level observations in piezometers and monitoring wells; prepared expert reports; and presented testimony in open court regarding these issues.

North Carolina Low-Level Radioactive Waste Disposal Facility, Wake County, NC.

Principal technical consultant responsible for assessing past unsuccessful technical and regulatory negotiation approaches to licensing a disposal site for low-level radioactive waste in North Carolina under their obligation to the Southeast Compact Commission. Recommended that significant changes be made to previous version of technical approach, project management, and regulatory negotiation strategy. Assigned to lead a multi-consultant team responsible for implementing these recommendations and negotiating a consensus work plan with the regulatory body charged with licensing the disposal facility. Successfully negotiated the consensus work plan and developed a revised project management approach (and management team) to implement the plan. All parties acknowledge this approach to be the best, most cost-effective method ever developed to prepare this complex License Application. Client: North Carolina Low-Level Radioactive Waste Management Authority. Client: State of Nebraska

Ward Valley Site License, California.

Principal technical consultant for the site selection, characterization and preparation of license application for the California Low Level Radioactive Waste Disposal Facility. One of the principal architects of the approach assisted with site selection, characterization, and the required monitoring vadose zone monitoring plan. Prepared numerous technical position papers during the project, and provided testimony to technical review panels and the California Legislature. Designed and supervised tasks including detailed characterization and modeling of the potential transport of radionuclide species in the vadose and saturated zones, gas phase transport, and field demonstrations of transport processes. Client: U.S. Ecology

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Ward Valley California National Academy of Science Hearings.

Prepared and presented testimony on four of the seven issues evaluated by the NAS panel: Potential transfer of contaminants through the unsaturated zone and potential for contamination of groundwater; Potential infiltration from the repository trenches by shallow subsurface flow; Potential for hydrologic connection between the site and the Colorado River; and The need for monitoring plans for groundwater and the unsaturated zone downgradient of the site. Client: US Ecology.

Invited Participant in Symposium: Recent developments in modeling unsaturated flow and transport.

Battelle Northwest Laboratories conference, Battelle Conference Center, Seattle, Washington. Presented review paper on the state of the practice of modeling unsaturated flow and transport and recommendations for future research needs. Client: U.S. Geological Survey.

Nation-wide Low-Level Radioactive Waste Disposal Facilities.

Provided consultation and review of experiments, and reports, on low-level radioactive waste disposal sites including Beatty, Nevada; Sheffield, Illinois; Maxey Flats, Kentucky; West Valley, New York; and Barnwell, South Carolina. Client: U.S. Geological Survey.

High Level Civilian Nuclear Waste Disposal Program.

Responsible for review of all hydrological studies and reports for evaluation of suitability of area for high-level radioactive waste disposal at Gulf Coast Salt Domes and Atlantic Coast Piedmont granitic plutons locations. Evaluated and redirected computer modeling studies of regional, near-field, and repository-scale hydrological transport systems. Client: U.S. Department of Energy.

Fate and Transport Research.

As research hydrologist, performed basic and applied research relating to occurrence and movement of water, solutes, and heat in unsaturated zone. Activities included: (1) computer modeling of multidimensional systems to describe simultaneous movement of water, heat, and solutes in variably saturated systems; (2) design and execution of laboratory and field experiments for heat and moisture movement relating to problems of radioactive waste disposal and groundwater recharge in arid and semiarid areas; (3) writing and documenting computer program for automatic identification of aquifer contaminant transport parameters from single-well tracer tests; (4) computer modeling and field measurements of evapotranspiration from shallow water tables; and (5) direct measurement and modeling of recharge under different vegetation types. Client: U.S. Geological Survey

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Litigation Consulting and Testimony

Denial of License for the Central Interstate Compact Proposed Low Level Radioactive Waste Disposal Facility, Boyd County, NE.

Principal hydrogeologic consultant and expert witness for the State of Nebraska in litigation regarding the denial of the license application. Responsible for: Developing independent conceptual and simulation models of the occurrence and movement of groundwater in the vadose and saturated zones; Documenting and demonstrating the presence and frequency of occurrence of the watertable relative to disposal facility components; Documenting and demonstrating the occurrence of groundwater discharge from shallow groundwater systems within the disposal facility boundary; Assessing the adequacy with which the applicant integrated site characterization and performance assessment modeling; Assessing the adequacy with which the applicant considered reasonable hydrologic and hydrogeologic bounding case scenarios for performance assessment'; Developed and presented time-lapse visualizations of groundwater discharge on a weekly basis for the eight year period of record using water level observations in piezometers and monitoring wells; prepared expert reports; and presented testimony in open court regarding these issues.

Cost Allocation Testimony, Clare, Michigan Site.

Provided expert testimony in case involving multiple potential sources of groundwater contamination of a municipal well field. Preparation for testimony included extensive review of existing data collected by multiple consultants to the parties, integration of that information using a Geographic Information System, and three-dimensional groundwater flow and flowpath modeling. The GIS was successfully used in live testimony to respond to answers from the judge and from counsel representing all parties to the action. Client: Illinois Tool Works.

Waste Disposal Facility Siting License, Louisiana.

Testified as a qualified expert witness on issues of groundwater flow and chemical transport. Successfully demonstrated that the site as designed would not result in any adverse impacts on groundwater or surface water. Site is located behind levees in the floodplain of the Mississippi River at an elevation lower than the mean river stage. Site operating license was issued as a result of this testimony. Client: Genstar-Briscoe-Maphis.

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Wastewater Permitting and Compliance Projects

Modeling of Nitrate Loading to Neuse River from Past Biosolids Application, North Carolina. Principal investigator for modeling of nitrate loading to the Neuse River via groundwater and surface water discharge from biosolids application to fields near the City of Raleigh's Neuse River Waste Water Treatment Plant. Loading from groundwater discharge is being assessed using a three-dimensional flow and transport model integrated with ArcGIS™. Loading from surface water is being assessed using the USDA Surface Water Assessment Tool (SWAT) integrated with ArcView™. Client: City of Raleigh Public Works Department.

Response to Notice of Violation, Municipal Spray Irrigation Facility, North Carolina. Principal investigator for responding to NOV from the North Carolina Division of Water Quality for alleged impacts to groundwater at the Elm City Wastewater Spray Irrigation Facility. Used existing data, new field tests and measurements, and modeling to demonstrate that spray field operations were not the source of levels of nitrates in monitoring wells in excess of NC groundwater standards. The most likely source was shown to be previous agricultural operations on the property and adjacent properties. Client: Town of Elm City.

Permitting application of spray irrigation of combined industrial and municipal wastewater effluent, North Carolina.

Principal investigator for site characterization, modeling, and monitoring in support of a permit for the disposal of treated effluent from combined municipal and industrial waste water plants. Disposal fields comprise shallow soils overlying fractured rocks of the Carolina Slate Belt. Client: Sheaffer International.

Permitting for new spray irrigation facility, food processing plant, North Carolina.

Principal investigator for conducting modeling of the hydrologic fate and transport of constituents in effluent from food processing plants that is applied using spray irrigation. Constructed and applied models of vadose zone and saturated zone groundwater flow and transport. Made extensive use of sensitivity analyses to successfully demonstrate to the permitting agency that the site would conform to regulatory requirements, eliminating the need for additional extensive and exhaustive site investigation. Client: Bruce Foods.

Natural Attenuation Projects

Natural Attenuation Decision, Industrial Site, North Carolina.

Served as the principal technical reviewer for project that was successful in obtaining Monitored Natural Attenuation as the approved remedy at a complex site in Research Triangle Park. Site strategy included demonstrating through extensive data analysis and visualization methods that attenuation was being accomplished as a result of the combination of restricted flow paths in fractured, Triassic rocks and a series of reductive de-halogenation processes. Client: Bristol Meyers-Squibb.

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Nitrate Contamination Assessment.

Project leader for transport modeling feasibility study covering a 1,300-square-mile area in Nebraska. Objective was to evaluate locations with high nitrate concentrations in groundwater. Conducted and analyzed tracer tests to determine contaminant parameters for conservative tracers. Client: Central Platte Natural Resources District.

Artificial Recharge Projects.

Co-investigator on several Nebraska projects involving recharge through wells and spreading including: field, laboratory, and model studies of flow and transport in unsaturated zones; design and installation of recharge wells; and injection tests performed for periods up to 2 years. Recharge was successful. Client: Central Platte Natural Resources District.

Water Resources Development and Management Modeling.

At two areas in southwest Nebraska (3,500 square miles and 300 square miles, respectively) and a 400-square-mile area in northeast Nebraska, served as project leader for groundwater/surface-water modeling studies. Developed methodology for combined modeling of soil zone and groundwater systems, and incorporated interdisciplinary methodologies in developing quantitative descriptions of hydrological systems, including complex multi-aquifer systems. Client: Upper Republican and Middle Republican Natural Resource Districts.

Groundwater Supply Assessment.

Principal investigator for quantitative groundwater study conducted over a 4,000-square-mile area in northeastern New Mexico. Project involved geologic mapping, aquifer performance tests, mapping of hydrostratigraphic units, and modeling Client: U.S. Geological Survey

Integrated Water Development Project Assessment.

Developed and applied digital modeling techniques for stream-aquifer studies for the entire Platte River Basin in Nebraska to evaluate the impacts on groundwater and surface water systems from the combined development of publicly and privately funded projects. Client: Missouri River Basin Commission.

Water Supply Options Assessment.

Served as ad hoc committee member to develop interdisciplinary study to evaluate the replacement of groundwater in response to excessive irrigation pumping from the Ogallala aquifer in western Texas. Client: High Plains Water Management District.

Major Hydrogeologic Investigations

Semiconductor manufacturer, Mountain View, California.

Project manager for remedial investigation at a semiconductor-manufacturing site in Mountain View, California. The project included a soil gas investigation; underground tank, sump, and pipeline evaluations; installation of multiple-level monitoring wells; borings; chemical analysis; and contaminant hydrogeologic analysis. Client: Confidential

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Project manager for remedial investigation/reasoning study in Santa Clara County, California. Project included a soil gas investigation, the installation of monitoring wells, an aquifer simulation, a contaminant hydrogeologic analysis, and design of groundwater control and treatment systems. Client: Confidential

Landfill Investigations, Pima County Arizona.

At two landfills in Pima County, Arizona, managed groundwater study to determine relative contributions of three sources of pollution and to recommend cleanup procedures. Client: Pima County, Arizona

California Groundwater Contamination Sites.

Defined extent of contamination, evaluated present and future movement, and designed and implemented methods to clean up aquifers at various California sites contaminated by volatile and semi-volatile compounds. Clients: Confidential

Cost Allocation Modeling.

Provided guidance using a quasi-three-dimensional finite element flow and transport model to design most economically efficient aquifer restoration programs for an industrial site in Santa Clara County, California. Performed analytical and numerical modeling to demonstrate relative contribution from multiple parties contributing to a complex, multi-aquifer groundwater contamination site. Client: Raytheon Semiconductor

Multi-site, Multi-Company Regulatory Compliance

Enterprise-Wide Compliance Management Program.

As client manager to a large industrial client, responsible for providing appropriate company resources to manage and implement a system that encompassed environmental matters resulting from regulatory actions at the state and federal level, from property transactions, and from other corporate-wide environmental management programs. Implemented a system of management controls, information management, and communications that has provided the client with consistent technical, cost, and regulatory strategy approaches. This system is used on over 20 sites across the U.S., and is served by project managers and resources drawn from company offices nationwide. Client: Allegheny-Teledyne, Inc.

Development of corporate-wide Environmental Management System.

Principal consultant for a large, multi-company, multi-site manufacturing client. Developed the initial planning tools and approaches used with the client to create an Environmental Management approach tailored to meet the needs and requirements of the corporation, division, company, and plant. Working with the client, Mr. Lappala developed an approach and systems to capture the following information: baseline waste generation, waste characterization, waste emission, and regulatory compliance requirements. This system serves is now being used across all business lines and corporate levels to minimize environmental costs and manage change in products, processes, and regulatory requirements. Client: Confidential.

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Principal consultant for the evaluation of the presence of and consequences of heavy metal contamination for over 400 industrial and other facilities throughout North America and Europe. Designed the approach used to minimize financial and regulatory exposure impacts on company operations. Client: Confidential.

Regulatory Strategy and Response Program.

In support of programs involving divestiture and regulatory compliance at multiple facilities across the U.S., Mr. Lappala served as principal consultant for the management of environmental evaluations and investigations. Responsible for the approaches and consulting services for projects ranging from short-notice due diligence evaluations to those implemented under CERCLA and RCRA. Client: Confidential.

Superfund Projects

Mr. Lappala has worked at more than 25 Superfund sites including: Woodlands; Tucson International Airport Area; Advanced Micro Devices; Fairchild; GATX Annex Terminal; IBM; Intel; Moffett Naval Air Station; McKesson Chemical; Purity Oil Sales; Raytheon; Signetics; Stringfellow; Teledyne Semiconductor; TRW Microwave, Inc.; United Heckathorn Co.; Lowry Landfill; Marshall Landfill; Rocky Mountain Arsenal; Woodbury Chemical; Acme Solvents; Kane and Lombard Street; Times Beach; Chemsol; South Valley; and Wasatch Chemical (Lot 6).

The following project descriptions provide examples of Mr. Lappala's Superfund site experience:

Rocky Mountain Arsenal, Denver, Colorado.

Co-investigator for construction, calibration, and use of finite element groundwater flow and contaminant transport models. Project manager for design and implementation of groundwater sampling protocol and monitoring programs. As the principal investigator, assisted in developing model of groundwater system. Consultant on problems related to offsite migration of pesticides and products related to chemical weapons manufacture. Managed 3-year project defining contaminant sources in support of litigation and remedial action planning. Client: U.S. Army.

Semiconductor facility, Mountain View, California.

Project manager for remedial investigation and operable unit feasibility studies at 100-acre site with multiple contamination sources, plumes, and aquifers. Client: The MEW RI/FS Group.

Boulder-Marshall Landfill, Colorado.

Project manager for development of work plan and review and oversight of EPA contractors for remedial investigation/feasibility study. Client: Confidential.

Times Beach, Missouri.

Project manager for hydrogeologic and geotechnical investigation of dioxin contamination. Client: CH2M Hill.

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Project manager for investigation of former Manufactured Gas Plant site, including sampling waste, groundwater, and surface water. Client: CH2M Hill.

Petroleum facility, Fresno, California.

Project manager for remedial investigation at Purity Oil Sales, Inc., site. Client: California Department of Health Services.

South Valley, Albuquerque, New Mexico.

Consultant for hydrogeology and modeling for solvent-contaminated groundwater to assess impacts on Municipal well fields. Client: van Waters & Rogers.

Acme Solvents, Rockford, Illinois.

Consultant for initial hydrogeology, field investigations and evaluation of interim remedial measures. Client: Acme Solvents Steering Committee.

Lowry Landfill, Colorado.

Technical consultant for a remedial investigation/endorsement assessment/feasibility study at the Lowry Landfill. Responsibilities included design and consulting on groundwater and contaminant transport modeling. Client: The Lowry Coalition.

RCRA Projects

RCRA Facility Investigation, Calvert City Kentucky.

Provided site investigation and remediation strategy for one of the largest RCRA RFI sites in the county at a chemical manufacturing facility in Kentucky. Responsibilities included formulating site conceptual models and designing data collection programs to confirm these models. RFI activities were designed to consolidate as many RCRA SWMUs as possible under the CAMU concept to minimize site investigation and remedial costs. Client: Elf Atochem.

RFI, Electrical Equipment Manufacturer Raleigh, NC.

Provided technical strategy and implementation planning for a site with multiple SWMUs involving soil and groundwater contamination. Client: Square D Company.

Nationwide TSD Facility Audit Program.

Technical consultant and investigator for a nationwide program of periodic audits of RCRA-permitted TSD Facilities to assure industrial clients that these facilities were operating and had operated in a manner that did not result in risk to generators from disposal of their regulated wastes. Clients: Confidential.

Regulatory Program Assistance.

Provided technical consulting and review to EPA for implementation of Resource Conservation and Recovery Act (RCRA). Work involved review of applications for variances to requirements for groundwater monitoring and technical changes to regulations. Client: A.T. Kearney.

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Technical reviewer to assess the adequacy of the petition in addressing groundwater transport pathways as well as gas generation from mixed radioactive and hazardous waste proposed for disposal at the facility. Client: A.T. Kearney.

State-Lead Regulatory Programs

Negotiation of Favorable Administrative Order on Consent, Pennsylvania.

Project manager and client advocate for the successful negotiation of a AOC that codified the results of a successful limited-scope investigation for a site contaminated with chlorinated solvents in fractured bedrock to depths of 400 feet, the presence of NAPLs, and contamination of an adjacent stream. Site investigation and negotiation successfully integrated the requirement to coordinate and manage stream channel improvements performed by a contractor to the local municipality because the stream sediments were impacted by groundwater discharge from the site. Client: Allegheny Teledyne Inc.

Major Utility Compliance Project.

Technical consultant for project planning and review to help major California utility achieve regulatory compliance. Work included vadose zone and groundwater investigations to evaluate integrity of ponds. Client: Southern California Edison

Major Petroleum Refinery.

Provided technical consulting services to bring major southern California petroleum refinery into compliance with regulations. Project involved evaluation of leakage from raw crude and refined product storage tanks and distribution systems. Client: Mobil Oil Company.

Underground Tank Regulation Consulting.

Prepared alternative regulations for vadose zone and groundwater monitoring for Assembly Bill 1362 (Sher Bill) and presented them to California Regional Water Quality Control Board. Project involved evaluation of technical feasibility of proposed regulations, and produced more economical monitoring methods for vadose and saturated zones. Client: Western Oil and Gas Association

Water Supply Development Projects

Central Coastal Plain Supplemental Water Supply.

As president of Eagle Water Company, Mr., Lappala manages all aspects of a proposed water development project that is designed to use under-utilized groundwater from the Castle-Hayne Formation to provide supplemental water supplies to municipalities and public utilities in the Central Coastal Plain Capacity Use Area as designated by the North Carolina Environmental Management Commission. Key Project components include: Assurance of water supplies that are of adequate quality and sustainable for greater than 50 years; Contracting with an adequate customer base to make the project economically viable; Design, Engineering, and Construction of a pumping and transmission system of as much as 75 miles in length to multiple customers; and obtaining Project Financing. Client: Eagle Water Company.

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Information Technology and Geographic Information Management Systems

Development of Data Management Hydraulic Modeling and Geographic Information Management Systems for a Phosphate mining and manufacturing complex.

Developed a system for the integrated management of mining, surveying, utility, process water flow, and environmental compliance information for the largest phosphate fertilizer mining and manufacturing complex in North America. Integrated legacy databases and flat files into a SQL server environment. Integrated SQL database with ArcView™ and prepared over 100 interactive gridded datasets for mine development and management. Developed custom GIS query and reporting tools using MapObjects™ and Visual Basic™ for real time monitoring of the flow and chemical content for the no-discharge recycling process water system. Developed and demonstrated a prototype for deployment over client's intranet using Microsoft .NET™ technologies. Client: PCS Phosphate

Development of a compliance management plan for groundwater contamination at a major pharmaceutical manufacturing facility North Carolina.

Developed a database-GIS system by integrated large volumes of legacy data from a variety of formats. Completed system is a tool for client to use in demonstrating compliance with environmental regulations, for demonstrating the basis for locations where monitoring is no longer needed, and as a tool for guiding additional site investigations. Client: Confidential

Teaching and Training

Introduction to Modeling of Hydrologic Systems: Online Distance Learning Course.

Developed and serve as the instructor for the first distance learning course offered by the American Water Resources Association. The course provides water resources professionals with an understanding of the concepts of hydrologic systems modeling, and is based upon Mr. Lappala's more than 30 years of practical modeling experience.

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PROFESSIONAL EXPERIENCE

EAGLE RESOURCES, P.A.

1999 - Present
Raleigh, NC
President

Independent consultant providing services to industrial clients in the areas of Water and Wastewater permitting and compliance, Environmental Liability Management, Water Resources Development, Siting and Permitting Waste disposal and Management Facilities, Environmental Litigation Support, and Environmental Due Diligence.

HARDING LAWSON ASSOCIATES

1983 - 1999
Senior Vice President

1996 - 1999 Raleigh, NC
1989 - 1996 Princeton, NJ
1983 - 1989 Novato, CA

- Managed and developed the company's largest three private sector accounts for a consecutive 4-year period. Assisted clients with regulatory strategy and planning, technical advice, oversight of other consultants, and regulatory negotiation.
- Managed all company-wide private sector business development.
- Managed all company-wide federal sector business development, contract compliance, and project implementation
- Responsible for starting offices in Tucson, Denver, Princeton, and Raleigh.
- Standing member of senior management team reporting to the CEO and President.
- Actively participated in the team that launched a successful IPO in 1987.

THE EARTH TECHNOLOGY COMPANY

1981 - 1983 Long Beach, CA
Associate Hydrogeologist and Group Manager

U.S. GEOLOGICAL SURVEY

1968 - 1981
Research Hydrologist Denver, CO
Hydrologist Lincoln, NE, Albuquerque, NM

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EDUCATION

BS in Watershed Management, Colorado State University, 1968

MS in Civil Engineering, Water Resources Development, University of Nebraska, 1977

Over 60 quarter-hours of continuing professional education in engineering, geology, information management, business management, and environmental sciences

REGISTRATIONS AND CERTIFICATIONS

Licensed Professional Engineer North Carolina, No. 026990

Certified Professional Hydrogeologist, No. 319, American Institute of Hydrology

Registered Site Manger, NC Inactive Hazardous Sites Cleanup Program.

PROFESSIONAL MEMBERSHIPS AND POSITIONS

American Institute of Hydrology

National Association of Groundwater Scientists and Engineers

American Water Resources Association

American Chemical Society

American Water Works Association

American Consulting Engineers Council: Chairman of Environmental Committee, 1991-1993

REFERENCES

A list of references will be provided upon request.

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Mr. Lappala is the author of over 40 publications, hundreds of consulting reports and presentations. He was the principal author of the computer program VS2D, which is widely used in the environmental industry to analyze problems of water and contaminant transport in the vadose zone. Representative publications include the following.

2002. Introduction to Modeling of Hydrologic Systems: Internet interactive learning course: American Water Resources Association.
1992. Computer Models for Subsurface Water. *in* Handbook of Hydrology (with M.P. Anderson, D.S. Ward, and T.A. Prickett). *Ed.* David R. Maidment. McGraw-Hill, Inc.
1991. Field measurements and modeling as applied to estimating recharge rates and potential radionuclide migration, California Low Level Radioactive Waste Disposal Facility, Ward Valley, California, Symposium-Recharge in Arid and Semi-Arid Regions, 83rd Annual Meeting, Soil Science Society of America, October.
1989. Status of performance assessment, California low-level radioactive waste disposal facility. Paper presented at Focus 89 - Nuclear Waste Isolation in the Unsaturated Zone; Las Vegas, Nevada, September 18-21 (with J.L. Grant and S.A. Romano). *In Proceedings* from symposium.
1988. Soil Venting of Volatile Organic Compounds from Low Permeability Soil at a site in Santa Clara County, California. Paper presented at the American Institute of Chemical Engineers Conference, Denver, Colorado, and August 21-24.
1984. Detection of soil and groundwater contamination by shallow soil gas sampling. Paper presented at Hazardous Materials Control Research Institute's Fifth National Conference on Management of Uncontrolled Hazardous Waste Sites, November, Washington, D.C. (with G. M. Thompson).
1983. Evaluation of *in-situ* natural clay layer for the containment of coal fired power plant wastes at the Intermountain Power Project, Lynndyl, Utah. Consulting report.
1983. Two-dimensional fluid flow in variably saturated porous media with nonlinear source terms and boundary conditions, computer program documentation. U.S. Geological Survey, Open-File Report, Menlo Park, California.
1982. Simulating the effects of organic leachates on clay liners. *In Proceedings*, Symposium on the Role of Unsaturated Zones in Hazardous and Radioactive Waste Disposal, Spring Annual Meeting, Philadelphia, Pennsylvania, American Geophysical Union, Washington, D.C.
1982. Recent developments in modeling unsaturated flow and transport. *In Proceedings*, jointly sponsored NCS/Battelle Northwest Laboratories conference, Battelle Conference Center, Seattle, Washington.
1982. Evaluation of the exploratory stage of the U.S. Army Toxic and Hazardous Materials Agency contamination survey at Tooele Army Depot, Tooele, Utah. Consulting report prepared under U.S. Army contract DAAG49-81-C-0192.
1981. Experimental determination of coupled heat and moisture movement in unsaturated sand. Abstract of paper presented at John Ferris Symposium on Groundwater Hydraulics, Spring Annual Meeting, Baltimore, Maryland, American Geophysical Union, Washington, D.C. (with D. I. Stannard).
1980. Documentation of programs for the solution of the dispersion-convection equation with linear adsorption and kinetics in radial coordinates with automatic parameter identification. Water Resources Investigations, U.S. Geological Survey, Menlo Park, California.

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- Management, Denver, Colorado.
1979. Factors involved in movement of water through the unsaturated zone. In *Proceedings*, meeting of the Groundwater Management Districts Association, Colorado Springs, Colorado.
1979. Simulated changes in groundwater levels and streamflow resulting from future development (1970-2020) in the Platte River Basin, Nebraska. Open File Report 79-26, Water Resources Investigations, U.S. Geological Survey, Menlo Park, California (with P. A. Emery and F. J. Otradovsky).
1979. The simulation of solute and heat transport to evaluate aquifer parameters. In *Proceedings*, Symposium on Trace Element Migration by Fluid Flow, Fall Annual Meeting, San Francisco, American Geophysical Union, Washington, D.C.
1978. Predictive analyses of groundwater discharges in the Willow Creek Watershed, Northeast Nebraska. Water Resources Investigations 78-67, U.S. Geological Survey, Menlo Park, California (with J. T. Dugan).
1978. Groundwater availability in the Hitchcock-Red Willow, Frenchman Valley and Meeker Driftwood Irrigation Districts, Southwest Nebraska. Open File Report 76-461, U.S. Geological Survey, Menlo Park, California (with P. F. Hemphill and R. E. Booker).
1977. Coupled models at the soil and saturated zones for use as a water management tool. In *Proceedings*, Symposium on Unified Studies of the Saturated-Unsaturated Zones, American Geophysical Union, Spring Annual Meeting, Washington, D.C.
1977. Quantitative hydrogeology of the Upper Republican Natural Resources District, Southwest Nebraska. Water Resources Investigations 78-38, U.S. Geological Survey, Menlo Park, California.
1976. Changes in the water supply in the Upper Republican Natural Resources District, Southwest Nebraska, from 1952-75. Open File Report 76-498, U.S. Geological Survey, Menlo Park, California.
1975. Review of hydrologic data and interpretations, Nebraska Midstate Diversion, Pick-Sloan Missouri Basin program. Administrative report prepared for the U.S. Department of the Interior, U.S. Geological Survey, Menlo Park, California (with E. P. Weeks and V. B. Sauer).
1975. Stream-aquifer hydrology. Technical report, Missouri River Basin Commission, State of Missouri.
1974. Calibration of regional groundwater flow models in the absence of time-dependent system response. In *Proceedings*, Symposium on the Groundwater/Surface-Water Interface, Fall Annual Meeting, San Francisco, California, American Geophysical Union, Washington, D.C.
1974. Groundwater hydrology of the northern high plains of New Mexico. New Mexico State Engineer Technical Report.
1972. Groundwater resources of Mora River drainage basin, western Mora County, New Mexico. New Mexico State Engineer, Technical Report 37 (with J. W. Mercer).
1972. Erwin-1 Production Well, City of Gallup, McKinley County, New Mexico. Open File Report, U.S. Geological Survey, Menlo Park, California (with J. W. Mercer).
1971. Drilling and testing of Well 69, Fort Wingate Army Depot, McKinley County, New Mexico. Open File Report, U.S. Geological Survey, Menlo Park, California (with J. W. Mercer).
1970. A geophysical study of alluvial valleys in western Mora County, New Mexico. Open File Report, U.S. Geological Survey, Menlo Park, California (with J. W. Mercer).

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ATTACHMENT VI

FINAL STATUS SURVEY PLAN

**Includes DCGL report, Sensitivity Analysis, ALARA Analysis
Evaluation and VSP Hot Spot Detection**

Final Status Survey Plan
Partial Site Release
Sanitary Lagoon(s) and Drain Field(s) – SLDF
Analytical Bio-Chemistry Laboratories

Analytical Bio-Chemistry Laboratories
7200 East ABC Lane
Columbia, MO

Prepared by Safety and Ecology Corporation

October 15, 2009

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Attachments

A	DCGL Derivation and Dose Assessment Report
B	Dose Assessment Sensitivity Analysis
C	ALARA Analysis
D	Site Figure/Survey Units
E	VSP – Sample Grid
F	VSP – Minimum Number of Samples

1.0 Facility Final Status Survey Plan

1.1 Introduction

This Final Status Survey Plan specifies the methodologies and protocols to be implemented while performing radiological sampling and surveys in support of the unconditional, partial site release (PSR) of the Analytical Bio-Chemistry (ABC) Laboratories, Inc. site Sanitary Lagoon and Drain-Field(s). ABC Laboratories, Inc. is located at 7200 East ABC Lane, in Columbia, MO. This plan was developed using the guidance provided in NUREG 1757 Volume 2, *Consolidated NMSS Decommissioning Guidance* and NUREG 1575, *Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM)*. It provides the approach, methods, and techniques for the design and performance of final status surveys. FSSs are designed to implement the protocols and guidance provided in NUREG 1757 Volume 2 and MARSSIM to demonstrate compliance with the established release criteria. These methods ensure technically defensible data is generated to aid in determining whether or not the facility meet the release criteria for unrestricted use.

1.2 Release Criteria

The residual C-14 activity within the ABC Labs Sanitary Lagoon and Drain Field (SLDF) is the result of discharged license limits of C-14 and H-3 conveyed from laboratory facilities by a PVC sewer line. The site will be remediated in accordance with decommissioning criteria of Subpart E, Radiological Criteria for License Termination of 10 CFR Part 20, Standards for Protection Against Radiation. Specifically, Subpart E, 10 CFR 20.1402, Radiological Criteria for Unrestricted Use, allows release of a site for unrestricted use if the residual radioactivity distinguishable from background results in a TEDE to an average member of the critical group not exceeding 25 mrem/yr, and the residual radioactivity has been reduced to levels that are ALARA.

1.3 Soil Release Criteria

Attachment A presents the results of a dose assessment for the ABC Labs site area associated with the Sanitary Lagoon(s) and Drain-Field(s) (SLDF). A radionuclide-specific DCGL_w value corresponding to the radiological criteria of 10 CFR 20 Subpart E has been derived using version 6.4 of the RESidual RADioactivity (RESRAD) computer code (deterministic mode). The DCGL_w value was derived for 25 mrem/yr total effective dose equivalent (TEDE) for the resident farmer scenario and is 210.3 pCi/g for C-14 based on 40,000 m² of potentially impacted soil area. The supporting sensitivity analysis and ALARA evaluations are presented in Attachments B and C respectively. Attachment D contains a figure of the ABC Labs site.

1.3.1 DCGL_{EMC}

Area factors have been developed to be used for elevated measurement comparisons (EMC) and to determine sampling requirements for C-14 which cannot be reliably detected in moist, disturbed, outdoor soil by field instrumentation. The appropriate DCGL_{EMC} values are calculated by multiplying the appropriate DCGL_w by the area factors presented below.

$$DCGL_{EMC} = \text{Area Factor} * DCGL_w$$

Table 1 Area Factors

Area:	20 m²	85 m²	100 m²	500 m²	1,000 m²	10,000 m²	20,000 m²	30,000 m²
AF:	3,776	507.8	403	39.2	14.1	2.8	1.4	1.2
DCGL _{EMC} (pCi/g):	794,200	106,800	84,790	8,239	2,972	596.2	296.4	242.5

1.4 Characterization Surveys

Biased radiological sampling of the Sanitary Lagoon(s) and Drain-Field(s) (SLDF) at the site was performed in 2007. Concentrations of C-14 ranged from less than 1 to a maximum of 3,570 pCi/g. The 2007 sampling data for the Sanitary Lagoon and Drain Field are presented in Tables 2 and 3 below.

Table 2 Sanitary Lagoon Soil Sampling Data (pCi/g)

Sample	Activity 0-6 inch	Sample	Activity 0-6 inch	Sample	Activity 0-6 inch
ABC-SL-01	1438.1	ABC-SL-24	1204.4	ABC-SL-47	-22.6
ABC-SL-02	27.6	ABC-SL-25	639.5	ABC-SL-48	-28.4
ABC-SL-03	765.0	ABC-SL-26	1020.6	ABC-SL-49	-20.1
ABC-SL-04	796.0	ABC-SL-27	1261.5	ABC-SL-50	-22.0
ABC-SL-05	182.4	ABC-SL-28	1178.0	ABC-SL-51	-15.4
ABC-SL-06	89.2	ABC-SL-29	1448.1	ABC-SL-52	2.3
ABC-SL-07	1817.1	ABC-SL-30	980.8	ABC-SL-53	-15.5
ABC-SL-08	706.9	ABC-SL-31	395.2	ABC-SL-54	-15.4
ABC-SL-09	855.9	ABC-SL-32	342.3	ABC-SL-55	-16.8
ABC-SL-10	2177.8	ABC-SL-33	1027.5	ABC-SL-56	-23.5
ABC-SL-11	36.8	ABC-SL-34	882.1	ABC-SL-57	-15.0
ABC-SL-12	13.2	ABC-SL-35	1154.7	ABC-SL-58	-22.4

Sample	Activity 0-6 inch	Sample	Activity 0-6 inch	Sample	Activity 0-6 inch
ABC-SL-13	3570.6	ABC-SL-B-36	507.9	ABC-SL-59	-25.4
ABC-SL-14	2134.3	ABC-SL-B-37	440.7	ABC-SL-60	-24.8
ABC-SL-15	57.0	ABC-SL-B-38	2937.1	ABC-SL-61	-21.0
ABC-SL-16	168.7	ABC-SL-39	-19.3	ABC-SL-62	-18.5
ABC-SL-17	489.0	ABC-SL-40	-20.9	ABC-SL-63	-18.1
ABC-SL-18	2173.3	ABC-SL-41	-19.2	ABC-SL-64	-13.1
ABC-SL-19	50.4	ABC-SL-42	-21.7	ABC-SL-65	-12.1
ABC-SL-20	1478.5	ABC-SL-43	-25.7	ABC-SL-66	-19.5
ABC-SL-21	977.3	ABC-SL-44	-17.2	ABC-SL-67	-18.5
ABC-SL-22	2566.1	ABC-SL-45	-14.3	ABC-SL-68	-23.2
ABC-SL-23	398.2	ABC-SL-46	-13.6		

Table 3 Drain Field Soil Sampling Data (pCi/g)

Sample	Activity 0-6 inch	Sample	Activity 0-6 inch	Sample	Activity 0-6 inch
ABC-DF-01	43.8	ABC-DF-12	8.5	ABC-DF-23	26.3
ABC-DF-02	9.4	ABC-DF-13	-13.2	ABC-DF-24	-11.8
ABC-DF-03	8.9	ABC-DF-14	-15.5	ABC-DF-25	-11.8
ABC-DF-04	-4.1	ABC-DF-15	4.3	ABC-DF-26	-21.0
ABC-DF-05	180.9	ABC-DF-16	76.7	ABC-DF-27	-18.6
ABC-DF-06	206.7	ABC-DF-17	7.6	ABC-DF-28	-20.3
ABC-DF-07	143.6	ABC-DF-18	19.6	ABC-DF-29	-13.8
ABC-DF-08	247.9	ABC-DF-19	9.1	ABC-DF-30	-15.1
ABC-DF-09	-10.4	ABC-DF-20	43.1	ABC-DF-31	46.4
ABC-DF-10	6.0	ABC-DF-21	104.5	ABC-DF-32	-21.8
ABC-DF-11	-2.5	ABC-DF-22	-2.0		

1.4.1 Land Area Classification

NUREG-1575 (MARSSIM) defines areas that have no reasonable potential for residual contamination as “non-impacted.” These areas have no radiological impact from site operations. Areas with some potential for residual contamination are defined as “impacted.” Impacted areas are further divided into Class 1, 2, or 3 areas based on the potential for contamination as shown below.

1.4.1.1 Definitions

Class	Definition	Survey Unit Size
1 Land Areas	Areas known or expected to have radionuclide concentrations above the DCGL _w	Up to 2,000 m ²
2 Land Areas	Areas known or expected to have radionuclide concentrations above normal background concentrations but that are not expected to be above the DCGL _w	2,000 to 10,000 m ²
3 Land Areas	Areas that are not expected to have radionuclide concentrations above normal background concentrations	No limit

As shown on the ABC Labs site figure in Attachment D, the Sanitary Lagoon and near Drain Field/Discharge area are classified as a Class 1 areas. These areas have the highest potential for contamination based on historical process operations. They are surrounded by Class 2 areas. The remaining portions of the site are Class 3 areas. Table 4 below provides a description of each survey unit. Note that a small fraction (<20,000 m²) of Class 3 survey unit number 4 area is expected to be impacted and require sampling.

Table 4 Land Area Survey Unit Classifications

Survey Unit Number	Class	Description	Length (feet)	Width (feet)	Survey Unit Size (m²)
1	1	Lagoon	150	200	2,787
2	1	Discharge Area	100	100	929
3	2	Area surrounding Lagoon and Discharge Areas	330	600	18,401
4	3	Remaining Site Area			69,247

1.5 Remedial Action Support Surveys

1.5.1 Open Land Areas Survey Instrumentation

C-14 does not emit high-energy photons that are easily detected using survey instruments equipped with NaI scintillation crystal detectors. Instead C-14 emits beta particles averaging 156 keV of energy. Scanning for gross beta activity will not be used as part of the FSS of open land areas.

1.6 Class 1 and Class 2 Land Area FSS Design

As previously stated, scanning site soils for residual C-14 activity will not be used as part of the FSS of open land areas; consequently, Visual Sample Plan (VSP) version 5.4.1 has been used to calculate the sample density (grid spacing) required to detect an area of 85 m² which corresponds with a DCGL_{EMC} of 106,800 pCi/g of C-14 or an area factor of 507.8 (see Table 1). A concentration of 106,800 pCi/g of C-14 is 29.9 times higher than any of the previous sampling results presented in Tables 2 and 3 above. A 90% probability of not missing a 85 m² elliptical “hot spot” was used in the VSP program to determine a triangular grid spacing between samples of 33 feet or 10 meters as shown in Attachment E. A random starting point within the contiguous Class 1 and Class 2 survey units will be chosen for the first sampling point within the triangular systematic grid. Samples will be obtained at a density of 22 samples per 2,000 m² within both Class 1 and Class 2 survey units shown in Table 4 above. Note that the total number of samples (sample area) and cost for sample analysis shown in Attachment E are very likely over estimates (place holders) and include the cost for both H-3 and C-14 analysis.

1.7 Class 3 Land Area FSS Design

Following completion of Class 1 and Class 2 area sampling and delineation, Class 3 areas will be sampled in accordance with standard MARSSIM protocols. This section describes the process for determining the number of survey measurements necessary to ensure that a data set is sufficient for statistical analysis. Sample size is based on the relative shift, the Type I and II errors, and the specific statistical test used to evaluate the data.

1.7.1 Nonparametric Statistical Test

The Sign Test is a one-sample statistical tests used for situations in which the radionuclide of concern is not present in background, or is present at negligible fractions compared to the DCGL such as C-14. The advantage to a nonparametric test is that it does not require assumptions about the data distribution (e.g., normal, log-normal).

1.7.2 Null Hypothesis

The null hypothesis (H_0) to be tested is that the residual contamination is equal to or greater than the acceptance criteria (210.3 pCi/g) and the alternative hypothesis (H_A) is that the residual contamination is less than the acceptance criteria.

1.7.3 Decision Error Rates

A decision error is the probability of making an error in the decision on whether a survey unit either passing when it should fail or failing a survey unit when it should pass. The first decision error, passing a survey unit that should fail, is referred to as a false positive or TYPE I decision error. The probability of making this error is denoted by " α ". Setting a high value for α results in a higher risk of passing a survey unit that should fail. Setting a low value for α lowers the risk of passing a survey unit that should fail. The α for the ABC Labs land areas will be set at 0.05 as shown in Table 5 below.

The second decision error, failing a survey unit that should pass, is referred to as a false negative or TYPE II decision error and is denoted by " β ". A high value for β results in a higher risk of failing a survey unit that should pass. Selecting a low value for β lowers the risk and minimizes investigations undertaken when a survey unit fails. The β for ABC Labs land areas will initially be set at 0.10, or 10 percent probability.

Table 5 Survey Unit Decision Errors
DECISION/OUTCOME OF STATISTICAL TEST

		Reject H_0	Accept H_0
TRUE CONDITION OF SURVEY UNIT	Survey results meet (less than) the acceptance criteria	No decision error (probability = $1 - \alpha$)	Incorrectly fail to release survey unit Type II error (probability = β)
	Survey results exceed (equal to or greater than) the acceptance criteria	Incorrectly release survey unit Type I error (probability = α)	No decision error (probability = $1 - \beta$)

1.7.4 Sampling Measurements

The results of discrete sampling will be used to verify that the average soil concentration in each survey unit is less than the DCGL_w. The number of measurements needed depends on the ratio of the radionuclide concentration to be measured relative to the variability in the concentration. This ratio is called the relative shift (Δ / σ) and is calculated as follows:

$$\frac{\Delta}{\sigma} = \frac{(DCGL_w - LBGR)}{\sigma}$$

Where: Delta (Δ) = DCGL_w minus the Lower Boundary of the Gray Region (LBGR)

Sigma (σ) = Standard deviation of contaminant measurements collected within the survey unit

LBGR = Lower Boundary of the Gray Region is the concentration at which the Type II (β) error applies. Its value is chosen so that the relative shift is between 1 and 3 in accordance with MARSSIM recommendations.

Sampling data for the Sanitary Lagoon and Drain Field are presented in Tables 2 and 3 above. For the purpose of calculating the number of statistically required samples, concentration levels greater than 90 pCi/g are assumed to be remediated to 90 pCi/g. The sample standard deviation (σ) associated with the Lagoon (53) has been conservatively over estimated to a value of 70 to ensure that the number of sampling locations is sufficient to meet the required statistical criteria. This standard deviation of 70 has been used to determine the number of sampling locations in the Class 3 portions ABC Labs land areas. A value of 105.3 pCi/g has been chosen for the lower bound of the gray region (LBGR) so that Δ/σ is 1.5. The number of sampling locations is 15 from NUREG-1575, Table 5.5. Visual Sample Plan (VSP) version 5.4.1 has also been used to calculate the number of samples required (15) for a 2,000 m² example area as shown in Attachment F.

Measurements locations in Class 3 survey units are taken in random locations. Random means that each measurement location in the survey unit has an equal probability of being selected. The random selection process uses random numbers that correspond to a survey unit's reference coordinate system to establish the measurement locations within the survey unit. The random numbers are generated using a random

number generator. Measurement locations selected that do not fall within the survey unit area or cannot be surveyed due to site conditions may be replaced using the same random process.

1.7.5 Investigation Levels

An investigation level is established to flag sample locations that require additional attention to ensure that they are properly classified and delineated. Final status survey investigations for Class 1 and Class 2 survey units will be performed whenever sampling data indicate the potential for contamination exceeding the DCGLW (210.3 pCi/g). For class 3 survey units, investigations will be initiated whenever a sample result exceeds 10% of the DCGLw or 21 pCi/g. These investigation levels were determined based on knowing that compliance with the site release criteria may require the following inequality to be satisfied:

$$\frac{\delta}{\text{DCGLw} + \frac{\text{Average concentration in elevated area} - \delta}{\text{Area factor for elevated area(s)} \times \text{DCGLw}}} < 1$$

Where:

δ = Average of measurements outside the elevated area.

1.7.6 Open Land Area Soil Sample Laboratory Analysis

Final survey samples are planned to be sent to Eberline in Oak Ridge, TN for analysis. Below is a brief description of Eberline procedures for counting the final survey samples to demonstrate compliance with stated goals.

- Eberline is a National Environmental Laboratory Accredited Program, (NELAP), certified in TN, UT, SC, NJ, NY, ND, CA, TX, & NV, (RCRA & SDWA required program) Primary certification is with the State of Utah.
- DOE CAP approved, (Department of Energy Consolidate Audit Program)
- USDA Approved Laboratory

The laboratory analyzes Carbon-14 and Tritium in solids using the high temperature oxidization technique. Samples aliquots are placed into porcelain boats, slightly wetted with deionized water and then high temperature oxidized using a Harvey oxidizer. Tritium in the sample is converted to water vapor and captured in scintillation cocktail via the water trap on the Harvey oxidizer. Carbon-14 is converted to carbon dioxide via the high temperature oxidization process and then captured in selective Carbsorb cocktail within the Carbon-14 trap of the Harvey oxidizer. Samples are then counted by liquid scintillation using energy selective windows for both Carbon-14 and Tritium. Effective separation of the Tritium and Carbon-14 occurs as a result of this process. Tritium and Carbon-14 samples are counted independently and results are derived using scintillation cocktail specific quench curves. Carbon-14 results are corrected for carbon dioxide conversion using a known recovery spike. Typical counting times are dependent upon required quantification limits.

Instruments include the following:

- Harvey Oxidizer, Model 0X700,
- Packard Liquid Scintillation Counters, (LSC) Model Tri-Carb 3100R

Typical Sensitivities are shown below:

Carbon-14	Solid	<5.0 pCi/g
Tritium	Solid	<10 pCi/g
Carbon-14	Liquid	<50 pCi/l
Tritium	Liquid	<100 pCi/l

Calibration are done via cocktail specific quench curves using an appropriate quenching agent. This information can be provided with data if necessary.

Tritium & Carbon-14 in water:

Water samples are analyzed for Tritium by the distillation technique. Samples are placed into a 250 ml distillation flask and attached to a cold water condenser. Samples are then brought to a boil and distillate condensates are captured. Aliquots of the condensate are placed into scintillation vials, scintillation

cocktail is added and then samples are counted by beta liquid scintillation using energy specific window settings. Results are calculated using current cocktail specific quench curves.

Water samples analyzed for Carbon-14 are aliquoted into appropriate sized beakers, a standard carbonate solution is added and then samples are oxidized using potassium permanganate for at least 24 hours. After complete oxidization of any carbon to the carbonate state, carbon dioxide is evolved by acid addition in a sealed bubbler flask. Carbon dioxide, (Carbon-14) is then captured in selective scintillation cocktail, (Carbsorb). Samples are counted by beta liquid scintillation using energy specific window settings. Results are calculated using current cocktail specific quench curves. A recovery known recovery spike is also analyzed for recovery corrections

1.8 Data Collection, Recording, Assessment and Reporting

Samples will be collected in the field and assigned a unique identification number which will correspond to a grid location identified on a corresponding map. Control of samples will be accomplished with a chain of custody document. A GPS system may be utilized for mapping purposes.

A chain-of-custody record will accompany each sample from the point of collection through obtaining the final results from an approved laboratory to ensure the validity of the sample data. Chain-of-custody records are controlled and maintained in accordance with applicable procedures. Each survey unit's data will be controlled in accordance with approved procedures. These procedures address the design and field implementation of the survey requirements. Survey unit records are quality records. Measurement results stored as FSS data constitute the Final Survey of Record and are included in the data set for each survey unit used for determining compliance with the site-release criteria. Measurements are recorded in units appropriate for conversion and subsequent comparison to the release criteria in section. The recording units for soil concentration are pCi/g for activity concentrations. Numeric values, including negative numbers, are recorded.

FSS data will be reviewed and validated before data assessment to ensure that they are complete, fully documented, and technically acceptable. The review criteria for data acceptability will include at a minimum, the following items:

- Compliance with survey instructions as specified in the survey package including the number, location, and survey unit variability (σ) of measurements.

- The instrumentation MDC was below the administrative criteria (89.4 pCi/g) specified in Attachment A.
- The chain-of-custody was tracked from the point of sample collection to the point of obtaining results from an approved laboratory.
- The data set is comprised of qualified measurement results collected in accordance with the survey design, which accurately reflects the radiological status of the facility.
- The data has been properly recorded.

If the data review criteria were not met, the discrepancy will be reviewed and the decision to accept or reject the data will be documented.

1.9 FSS Report

The FSS Report will provide a summary of the survey results and the overall conclusions, which demonstrate that the ABC Labs PSR land area meets the radiological criteria. Information such as the number and type of measurements, basic statistical quantities, and statistical analysis results are included in the report. The level of detail is sufficient to clearly describe the FSS program and to certify the results. The report will include information concerning the following:

- An overview of the results of the survey.
- A discussion of any changes that were made in the survey from what was proposed in the Soil Remediation Plan.
- A description of the method by which the number of samples was determined for each survey unit.
- A summary of the values used to determine the number of samples and justification for these values.
- The survey results for each survey unit including the following:
 - The number of samples taken for the survey unit.
 - A map or drawing of the survey unit showing the reference system and random-start systematic sample locations.
 - The measured sample concentrations.
 - The statistical evaluation of measured concentrations.
 - Judgmental and miscellaneous sample data sets reported separately from those samples collected for performing the statistical evaluation.

- A discussion of anomalous data including any areas exceeding the investigation level or measurement locations in excess of the DCGL_w.
- A statement that a given survey unit satisfied the DCGL_w and the elevated measurement comparison, if any sample points exceeded the DCGL_w.
- A description of any changes in initial survey unit assumptions relative to the extent of residual radioactivity.
- If a survey unit fails, a description of the investigation conducted to ascertain the reason for the failure and a discussion of the impact that the failure has on the conclusion that the facility is ready for final radiological surveys.
- If a survey unit fails, a discussion of the impact that the reason for the failure has on other survey unit information.

2.0 References

- (1) USEPA, et. al. 2001. *Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM)*. NUREG-1575, 402-R-97-016, DOE/EH-0624.

ATTACHMENT A

Derived Concentration Guideline Values for Analytical Bio-Chemistry Laboratories

Resident Farmer Exposure Scenario/Critical Group

Analytical Bio-Chemistry Laboratories
7200 East ABC Lane
Columbia, MO

Prepared by Safety and Ecology Corporation

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1 Introduction

This document has been prepared by Safety and Ecology Corporation (SEC) on behalf of Bionomics, to document the derivation of Derived Concentration Guideline Values (DCGLs) for the unrestricted release of the Analytical Bio-Chemistry (ABC) Laboratories Sanitary Lagoon(s) and Drain-Field(s) (SLDF) in Columbia, Missouri, post remediation.

A dose model was used to derive DCGLs that would result in a dose (total effective dose equivalent or TEDE) to the critical group below the selected standard. The DCGL values are used to plan remediation activities and to demonstrate compliance with the selected standard at the completion of remediation. The cleanup standards and methodology found in 10 Code of Federal Regulations (CFR) 20.1402 "Radiological Criteria for Unrestricted Use". The DCGLs, were developed in accordance with 10 CFR 20.1402, which states:

"A site will be considered acceptable for unrestricted use if the residual radioactivity that is distinguishable from background radiation results in a TEDE to an average member of the critical group that does not exceed 25 mrem (0.25 mSv) per year, including that from groundwater sources of drinking water, and the residual radioactivity has been reduced to levels that are as low as reasonably achievable (ALARA)."

The scenario, the critical group, and the exposure pathways define a dose model. The Resident Farmer Scenario was selected to model exposure from the SLDF area for the next 1000 years. The Resident Farmer Scenario includes exposure from the following exposure pathways:

- Direct exposure to external radiation from the contaminated soil material;
- Internal dose from inhalation of airborne radionuclides, excluding radon progeny; and
- Internal dose from ingestion of
 - Plant foods grown in the contaminated soil and irrigated with contaminated water,
 - Meat and milk from livestock fed with contaminated fodder and water,
 - Drinking water from a contaminated well or pond,
 - Fish from a contaminated pond, and
 - Contaminated soil.

The RESidual RADioactivity (RESRAD) code was selected for modeling the resident farmer scenario. The deterministic mode of RESRAD Version 6.4 was used for the calculation of TEDEs and DCGLs for the resident farmer.

Site specific input parameter values were used where available. For the majority of additional inputs for which no site specific value was available, the default (conservative) value was used.

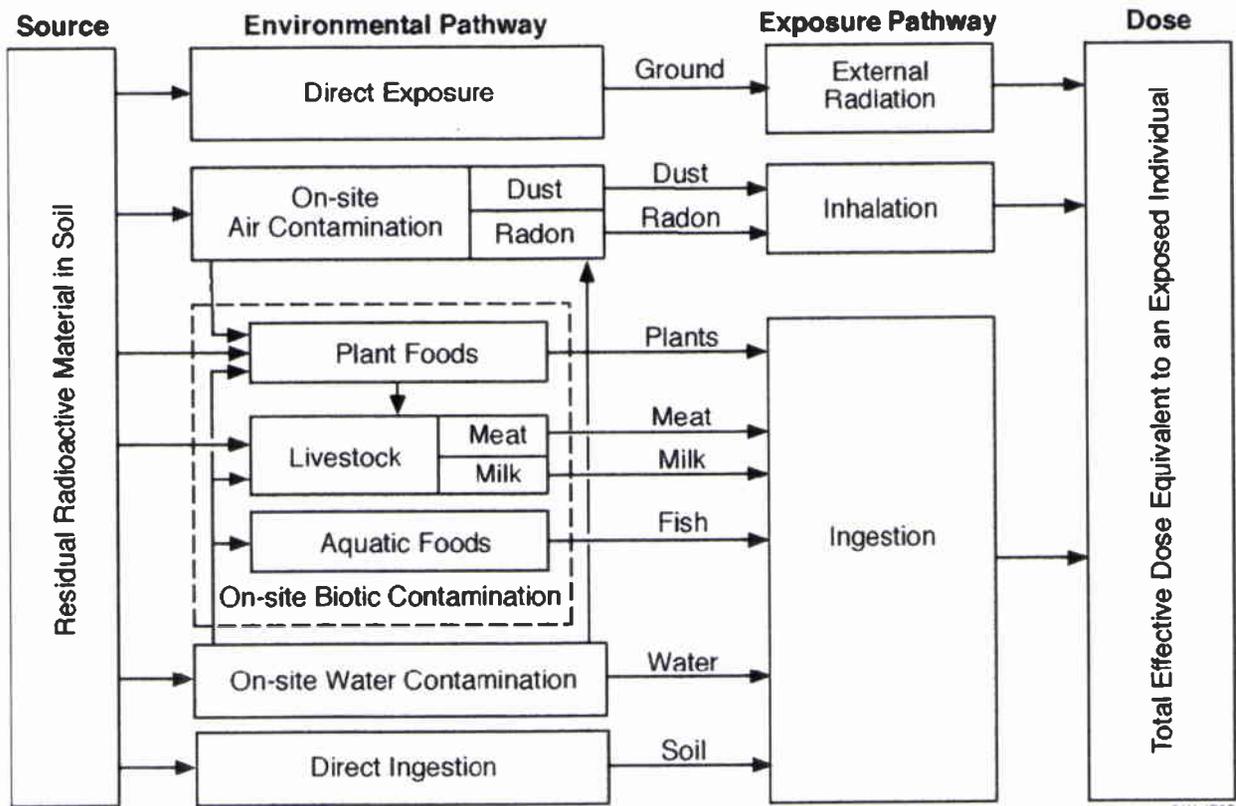
The remainder of this report is structured as follows: Chapter 2 provides the details of the assumptions and the non-default RESRAD input parameter values used, Chapter 3 provides a summary table of all of the RESRAD input parameters, Chapter 4 presents a summary of the dose assessment results, Chapter 5 presents supporting documentation including RESRAD output files and graphs and Chapter 6 references.

2 Assumptions and Input Parameter Values

2.1 Dose Assessment

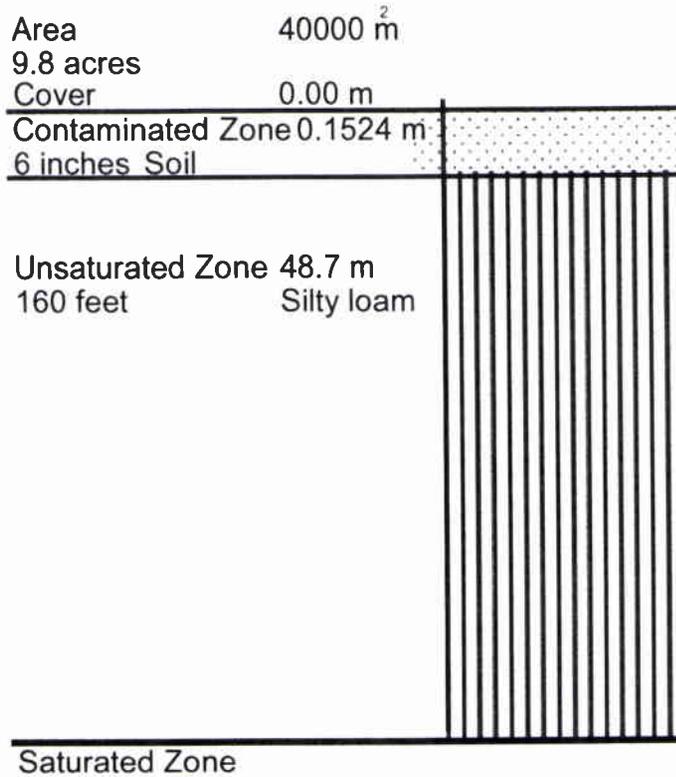
The RESRAD code with the resident farmer scenario was selected with all environmental and exposure pathways active, except radon. Figure 1 illustrates the exposure pathways. Figure 2 is an illustration of the RESRAD model cover, contaminated zone, unsaturated zone, and saturated zone strata post remediation.

Figure 1 – RESRAD Environmental and Exposure Pathways – SLDF excludes Radon



CYA4725

Figure 2 – Dose Assessment As-Left Strata



Note:
 The figure is not to scale.

2.2 DCGL Derivation Dose Assessment

The DCGL values are derived from the dose based standard of the USNRC (10CFR20.1402), mainly the radiological criteria for unrestricted use as follows:

“A site will be considered acceptable for unrestricted use if the residual radioactivity that is distinguishable from background radiation results in a TEDE to an average member of the critical group that does not exceed 25 mrem (0.25 mSv) per year.”

Therefore, the dose resulting from projected as-left condition post remediation goal were derived and the results were then used to determine limiting DCGLs values as appropriate.

As-Left Sanitary Lagoon(s) and Drain Field(s) – SLDF

The as-left condition of the site (SLDF), i.e., the condition of the site post remediation, is defined by the following:

- Contaminated zone area = 40,000 m²

- Contaminated zone depth = 0.152 m (6-inch surface layer based on the characterization data for the site).
- Cover depth = 0.000 m (i.e., there is no cover. The contaminated zone is on the surface).
- The unsaturated zone (the depth of soil between the contaminated zone and the saturated (groundwater bearing zone) zone = 47.8 m based on the MEGA 2007 Missouri Environmental Geology Atlas and USGS internet site (References 6 and 7 below).
- The length parallel to aquifer flow (303 m) is assumed to be the longest dimension (diagonal) in the rectangular impacted area of approximately 153 m by 261 m).

DCGLs based on the projected as-left condition of the site are presented in Section 4.

2.3 Site Specific Non-Default Input Parameter Values

Table 1 Site Specific Non-Default Parameters for As-Left

Parameter Name ¹	Unit	Default Value	Site Specific	Remarks
Area of contaminated zone	m ²	10,000	40,000	Potentially Impacted Site Area
Thickness of contaminated zone	m	2	0.1524	Average contaminated zone thickness 6 inches
Initial principal radionuclides	pCi/g	-	C-14 210.3	DCGLw for the ABC Labs potentially impacted site area
Unsaturated zone thickness	m	4.00	48.7	Unsaturated zone – 160 feet (References 7 and 8)
Distribution coefficient for C-14 in the contaminated, unsaturated and saturated zones	cm ³ /g	0	4.3	NUREG/CR- 5512, Vol.3 Table 6.92
Unsaturated zone soil density	g/cm ³	1.5	1.28	Dry density for silt loam DCH – Table 2.1
Unsaturated zone total porosity	-	0.4	0.45	Representative Porosity Value for silt DCH – Table 3.2
Unsaturated zone Hydraulic conductivity	m/yr	10	227	Representative Value of Saturated Hydraulic Conductivity for Silty loam DCH – Table 5.2
Length parallel to aquifer flow	m	100	303	The longest dimension (diagonal) in the rectangular impacted area of approximately 153 m by 261 m

DCH – Data Collection Handbook to Support Modeling Impacts of Radioactive Material in Soil Environmental Assessment and Information Sciences Division Argonne National Laboratory, April 1993

3 Input Parameter Assignments Summary

Table 2 – Input Parameters

RESRAD Input Parameter Assignments				
Screen	Name	Value	Units	Description
R016	ALEACH(i)	0	/yr	Input Leach Rate
R011	AREA	Refer to Table 1	m ²	Area of Contaminated Zone
R013	BCZ	5.30	--	Contaminated Zone Exponential <i>b</i> Parameter
R011	BRDL	25	mrem/yr	Radiation Dose Limit
R014	BSZ	5.30	--	Saturated Zone Exponential <i>b</i> Parameter
R015	BUZ(1)	5.30	--	Unsaturated Zone Exponential <i>b</i> Parameter
R013	COVER0	0	m	Cover Depth
R016	DCNUCC, DCNUCU, DCNUCS	Refer to Table 1	cm ³ /g	Distribution Coefficient for C-14 in the Contaminated, Unsaturated and Saturated Zones
R014	DENSAQ	1.50	g/cm ³	Default Density of Saturated Zone
R015	DENSUZ(1)	Refer to Table 1	g/cm ³	Unsaturated Zone Soil Density
R013	DENSCZ(1)	1.50	g/cm ³	Density of Contaminated Zone
R018	DIET(1)	160	kg/yr	Fruit, Vegetable, and Grain Consumption
R018	DIET(2)	14	kg/yr	Leafy Vegetable Consumption
R018	DIET(3)	92	L/yr	Milk Consumption
R018	DIET(4)	63	kg/yr	Meat and Poultry Consumption
R018	DIET(5)	5.4	kg/yr	Fish Consumption
R018	DIET(6)	0.90	kg/yr	Other Seafood Consumption
R019	DM	0.15	m	Depth of soil mixing layer
R019	DROOT	0.9	m	Depth of Roots
R018	DWI	510	L/yr	Drinking Water Intake
R014	DWIBWT	10	m	Well Pump Intake Depth Below Water Table
R017	ED	30	yr	Exposure Duration
R014	EPSZ	0.2	d.d.f.	Saturated Zone Effective Porosity
R015	EPUZ	0.2	d.d.f.	Unsaturated Zone Effective Porosity
R013	EVAPTR	0.5	d.d.f.	Evapotranspiration Coefficient
R018	FDW	1	d.d.f.	Contaminated Fraction of Drinking Water
R019	FGWDW	1	d.d.f.	Drinking Water Fraction from Groundwater
R019	FGWIR	1	d.d.f.	Irrigation Fraction From Groundwater
R019	FGWLW	1	d.d.f.	Livestock Water Fraction From Groundwater
R018	FLW	1	d.d.f.	Contaminated Fraction of Livestock Water

RESRAD Input Parameter Assignments				
Screen	Name	Value	Units	Description
R017	FIND	0.5	d.d.f.	Fraction of Time Spent Indoors Onsite
R018	FIRW	1.0	d.d.f.	Contaminated Fraction of Irrigation Water
R018	FMEAT	-1	d.d.f.	Contaminated Fraction of Meat (calculated by RESRAD)
R018	FMILK	-1	d.d.f.	Contaminated Fraction of Milk (calculated by RESRAD)
R017	FOTD	.25	d.d.f.	Fraction of Time Spent Outdoors Onsite
R018	FPLANT	-1	d.d.f.	Contaminated Fraction of Plant Food (calculated by RESRAD)
R017	FR9	0.50	d.d.f.	Contaminated Fraction of Aquatic Food
R015	H(1)	Refer to Table 1	m	Unsaturated Zone Thickness
R013	HCCZ	10	m/yr	Contaminated Zone Hydraulic Conductivity
R014	HCSZ	100	m/yr	Saturated Zone Hydraulic Conductivity
R015	HCUZ(1)	Refer to Table 1	m/y	Unsaturated Zone Hydraulic Conductivity
R014	HGWT	0.02	d.d.f.	Saturated Zone Hydraulic Gradient
R013	IDITCH	Overhead	--	Irrigation Mode
R017	INHALR	8,400	m ³ /y	Inhalation Rate
R013	KPS	0.001	--	Accuracy for Water/Soil Computations
R011	LCZPAQ	Refer to Table 1	m	Length of Contaminated Zone Parallel to Aquifer Flow
R019	LFI5	68	kg/d	Livestock Fodder Intake for Meat
R019	LFI6	55	kg/d	Livestock Fodder Intake for Milk
R019	LWI5	50	L/day	Livestock Water Intake for Meat
R019	LWI6	160	L/day	Livestock Water Intake for Milk
R019	LSI	0.5	kg/d	Livestock Soil Intake
R019	MLFD	0.0001	g/m ³	Mass Loading for Foliar Deposition
R017	MLINH	0.0001	g/m ³	Mass Loading for Inhalation
R014	MODEL	ND	--	Model: Nondispersion (ND)
R013	PRECIP	1	m/yr	Annual Precipitation
R013	RI	0.2	m/yr	Irrigation
R013	RUNOFF	0.2	d.d.f.	Default Runoff Coefficient
R012	S1	210.3	pCi/g	Initial Concentration of C-14 and C-14 DCGL
R017	SHF1	0.7	d.d.f.	Shielding Factor – External Gamma Radiation
R017	SHF3	0.4	d.d.f.	Shielding Factor – Inhalation
R018	SOIL	36.5	g/yr	Default Soil Ingestion Rate
R011	T(2-10)	0.2, 1, 10, 300, 1000	yr	Calculation Times For Dose
R011 R013	THICK0	Refer to Table 1	m	Thickness of Contaminated Zone
	TPCZ	0.4	d.d.f.	Contaminated Zone Total Porosity
R017	TPSZ	0.4	d.d.f.	Saturated Zone Total Porosity

RESRAD Input Parameter Assignments

Screen	Name	Value	Units	Description
R015	TPUZ	Refer to Table 1	d.d.f.	Unsaturated Zone Total Porosity
R014	UW	250	m ³ /yr	Well Pumping Rate
R013	VCZ	.001	m/yr	Contaminated Zone Erosion Raye
R014	VWT	0.001	m/yr	Water Table Drop Rate
R013	WAREA	1000000	m ²	Watershed Area for Nearby Stream or Pond
R013	WIND	2	m/s	Average Annual Wind Speed
C14	C12WTR	2.0E-5	g/cm ³	C12 Concentration in water
C14	C12CZ	0.03	g	C12 Concentration in contaminated soil
C14	CSOIL	0.02	d.d.f.	Fraction of vegetation carbon from soil
C14	CAIR	0.98	d.d.f.	Fraction of vegetation carbon from air
C14	DMC	0.30	m	C14 Evasion layer thickness in soil
C14	KVSN	7.0E-07	1/sec	C14 Evasion flux rate from soil
C14	REVSN	1.0E-10	1/sec	C12 Evasion flux rate from soil
C14	AVFG4	0.80	d.d.f.	Fraction of grain in beef cattle feed
C14	AVFG5	0.20	d.d.f.	Fraction of grain in milk cow feed

a - d.d.f. = dimensionless decimal fraction

4 Dose Assessment/DCGL Determination Summary

4.1 10CFR20.1402 DCGLs

Summary results of the C-14 remediation goal dose assessment are presented in the following tables. Figure 3 presents a graphical illustration of dose by pathway with increasing time.

Table 3 – Dose Assessment Summary

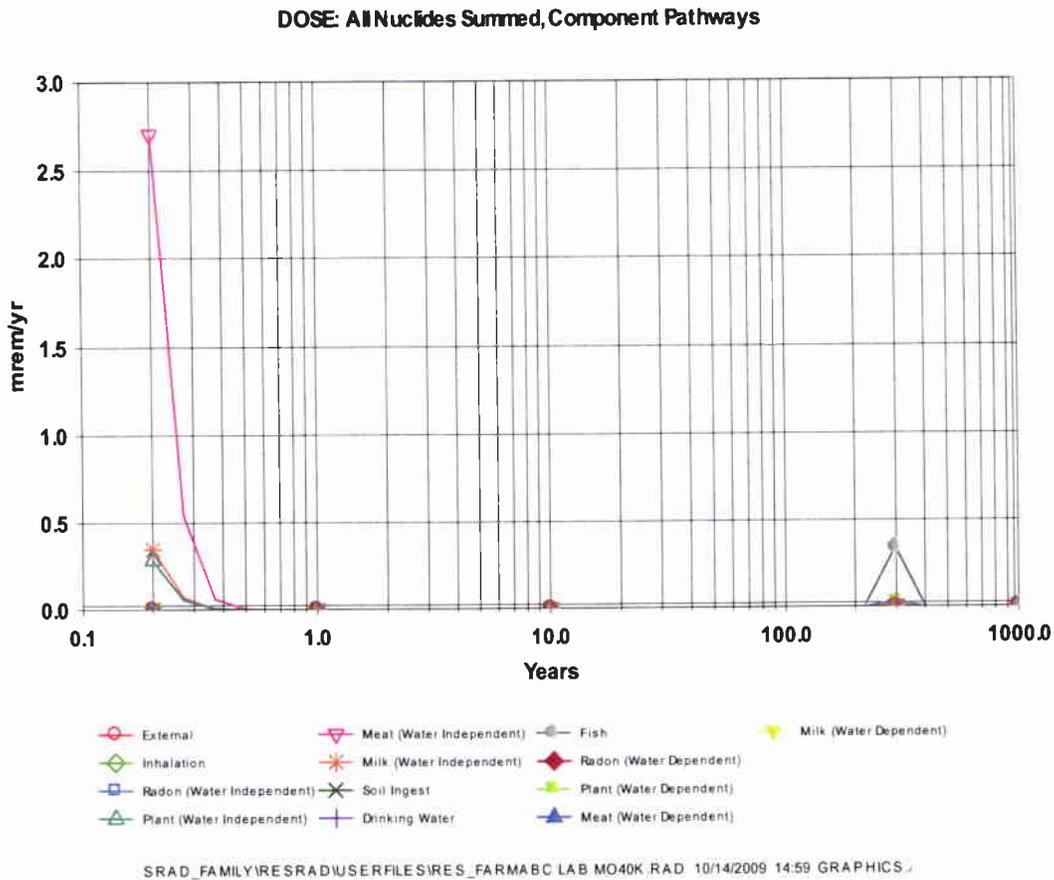
Assessment	Max TDOSE(t) for Soil at the Remediation Goal (mrem/yr)	t_{\max} (years)	Soil Administrative Limit (pCi/g)	Max TDOSE(t) DCGL _w of 210.3 pCi/g (mrem/yr)
ABC Labs Sanitary Lagoon and Drain Field	10.6	0	89.40	25

Table 4 – Area Factors and DCGL_{EMC} Values

Contaminated Area (m ²)	30,000	20,000	10,000	1,000	500	100	85	20
Area Factor	1.2	1.4	2.8	14.1	39.2	403	507.8	3776
DCGL _{EMC} (pCi/g):	242.5	296.4	596.2	2972	8239	84790	106,800	794,200

In conclusion, the DCGL value based on 25 mrem in the maximum year of exposure (first year) is 210.3 pCi/g. An administrative limit of 89.4 pCi/g (corresponding to 10.6 mrem in the first year) will be used during implementation of the remedial action.

Figure 3



4.2 Summary of Results

As shown in Figure 3 above, the dose due to residual C-14 activity at the DCGL_w of 210.3 pCi/g over an area of 40,000 m² results in an annual dose of less than 5 mrem within 2.4 months after the final survey. Remediation of the ABC Labs soil is anticipated to result in a lower dose as shown in Table 3 above.

5 Attachments

5.1 RESRAD Output File and Graphs (refer to table)

RESRAD File Name	RESRAD File Description
ABC Labs Sanitary Lagoon and Drain Field	ABC Labs DCGL Derivation
ABC Labs 40K, 30K, 20K, 10K, 1K, 500, 100, 85, 20	ABC Labs Area Factor Derivation

6 References

1. 10CFR20.1402
2. RESRAD Computer Code 6.4 – Environmental Assessment Division of Argonne National Laboratory, August 25, 2005
3. User's Manual for RESRAD Version 6 – Environmental Assessment Division of Argonne National Laboratory, July 2001
4. Data Collection Handbook to Support Modeling Impacts of Radioactive Material in Soil – Environmental Assessment and Information Sciences Division of Argonne National Laboratory, April 1993
5. NUREG/CR-5512, Vol. 3, Residual Radioactive Contamination From Decommissioning. Parameter Analysis. Draft Report for Comment, NRC, October 1999
6. MEGA 2007 Missouri Environmental Geology Atlas, Missouri Department of Natural Resources, Division of Geology and Land Surveys
7. USGS internet site
http://waterdata.usgs.gov/nwis/uv?cb_all_72019=on&cb_72019=on&format=gif_stats&period=60&site_no=385718092234201 accessed October 14, 2009

ATTACHMENT B

Sensitivity Analysis for Analytical Bio-Chemistry Laboratories

Resident Farmer Exposure Scenario/Critical Group

Analytical Bio-Chemistry Laboratories
7200 East ABC Lane
Columbia, MO

Prepared by Safety and Ecology Corporation

October 15, 2009

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1 Introduction

This document has been prepared by Safety and Ecology Corporation (SEC) on behalf of Bionomics, to document a sensitivity analysis performed for the derivation of Derived Concentration Guideline Value (DCGL) for the unrestricted release of the Analytical Bio-Chemistry (ABC) Laboratories Sanitary Lagoon(s) and Drain-Field(s) (SLDF) in Columbia, Missouri. The deterministic mode of the RESidual RADioactivity (RESRAD) code (version 6.4) was used to derive the 210.3 pCi/g DCGL for ¹⁴C that would result in a 25 mrem (0.25 mSv) dose (total effective dose equivalent or TEDE) to the critical group under a Resident Farmer Scenario.

2 Baseline Input Parameter Values

The RESRAD code with the resident farmer scenario was selected with all environmental and exposure pathways active, except radon. Figure 1 is an illustration of the baseline RESRAD model cover, contaminated zone, unsaturated zone, and saturated zone strata post remediation. Table 1 presents the site-specific non-default parameters used in the baseline case. Figure 2 presents a graphical illustration of dose by pathway with increasing time. As shown in Figure 2, the TEDE decreases from 25 mrem (primarily from plant, meat and milk consumption) to 0 mrem within six months following the final status survey. At approximately 300 years, the dose begins to rise from 0 after the residual radioactivity reaches the saturated zone and peaks at approximately 0.40 mrem (primarily from fish consumption from a hypothetical pond) and drops to 0 at approximately 400 years.

Figure 1 – Dose Assessment As-Left Strata

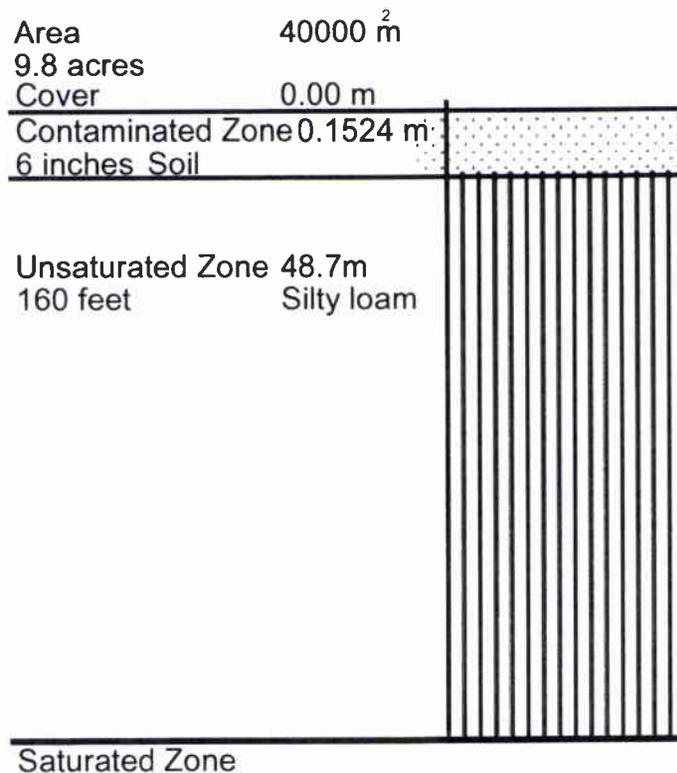
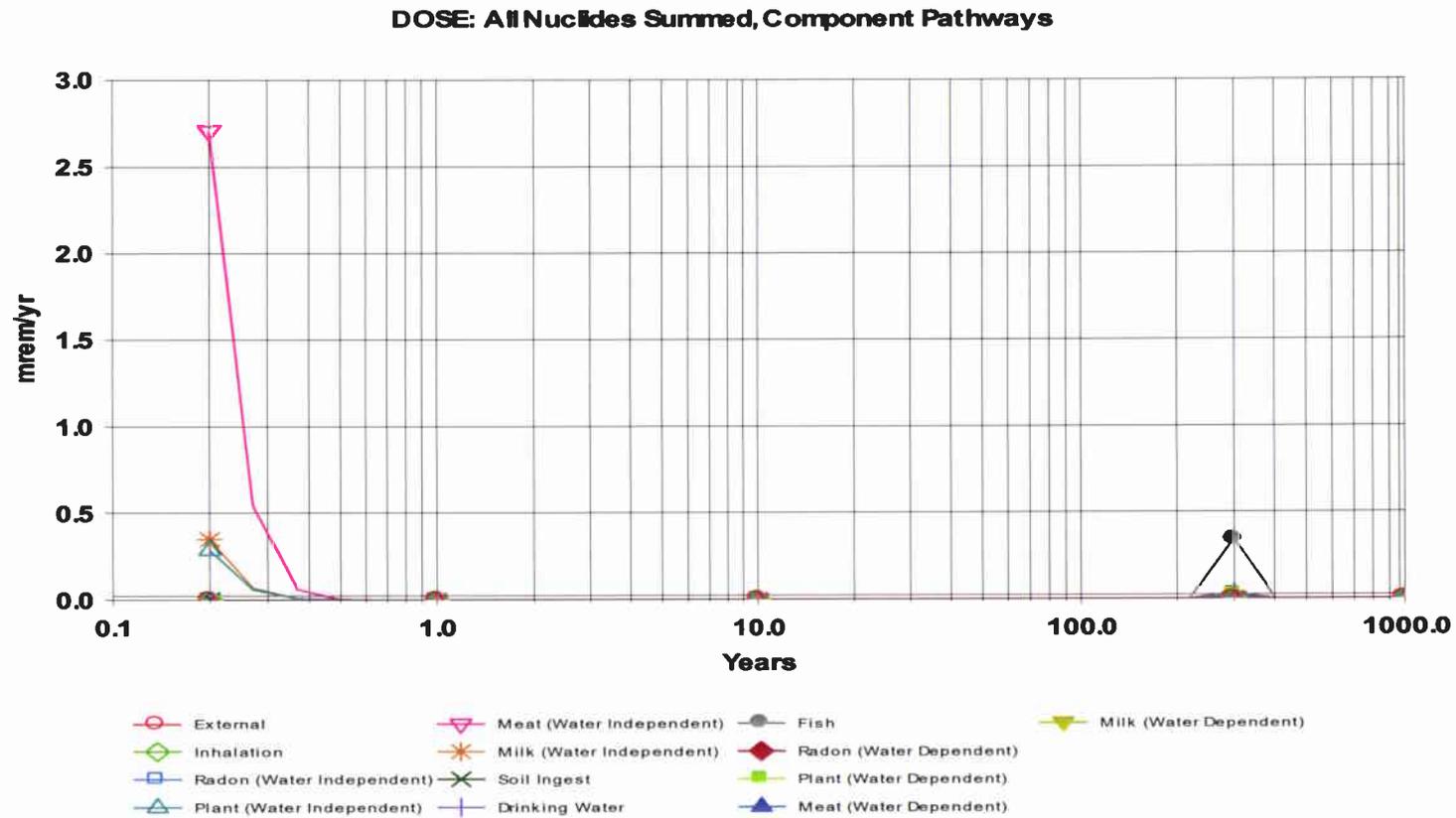


Table 1- Site Specific Non-Default Parameters for As-Left

Parameter Name¹	Unit	Default Value	Site Specific	Remarks
Area of contaminated zone	m ²	10,000	40,000	Potentially Impacted Site Area
Thickness of contaminated zone	m	2	0.1524	Average contaminated zone thickness 6 inches
Initial principal radionuclides	pCi/g	-	C-14 210.3	DCGLw for the ABC Labs potentially impacted site area
Unsaturated zone thickness	m	4.00	3.505	Unsaturated zone – 11.5 feet (State of Missouri)
Distribution coefficient for C-14 in the contaminated, unsaturated and saturated zones	cm ³ /g	0	4.3	NUREG/CR- 5512, Vol.3 Table 6.92
Unsaturated zone soil density	g/cm ³	1.5	1.28	Dry density for silt loam DCH – Table 2.1
Unsaturated zone total porosity	-	0.4	0.45	Representative Porosity Value for silt DCH – Table 3.2
Unsaturated zone Hydraulic conductivity	m/yr	10	227	Representative Value of Saturated Hydraulic Conductivity for Silty loam DCH – Table 5.2
Length parallel to aquifer flow	m	100	303	The longest dimension (diagonal) in the rectangular potentially impacted area of approximately 153 m by 261 m

DCH – Data Collection Handbook to Support Modeling Impacts of Radioactive Material in Soil,
Environmental Assessment and Information Sciences Division, Argonne National Laboratory, April 1993

Figure 2



SRAD_FAMILY\RESRAD\USERFILES\RES_FARMABC LAB MO40K.RAD 10/14/2009 14:59 GRAPHICS..

3 Sensitivity Analysis Results

Table 2 below presents the site-specific non-default parameters for which the NRC requested a sensitivity analysis be performed as well as the results of the analyses. The range of each parameter value is based on estimated uncertainty in the "as left" conditions following remediation or the range of values based on a literature review. The distribution coefficient (K_d) range for ^{14}C in the contaminated, unsaturated and saturated zones is based on Sheppard and Thibault¹. The probabilistic version of RESRAD uses a default, mean K_d of $11 \text{ cm}^3/\text{g}^2$. The graphical results for the sensitivity analysis for each parameter are presented in Figures 3 through 8 below.

Table 2 Sensitivity Analysis Parameters and Results

Parameter Name	Baseline Parameter Value	Upper and Lower Parameter Values	Dose Increase with Increase or Decrease in Parameter Value	Results/Comments
Contaminated Zone Thickness (m)	0.1524	0.229/0.1016	Increase	51% increase in peak dose compared to baseline
Unsaturated Zone Thickness (m)	48.7	779/3.04	No Change	No change in peak dose compared to baseline
Distribution coefficient (K_d) for the contaminated, zone (cm^3/g)	4.3	18.49/1.0	Increase	1.4% increase in peak dose compared to baseline
Distribution coefficient (K_d) for the unsaturated zone (cm^3/g)	4.3	18.49/1.0	No Change	No change in peak dose compared to baseline
Distribution coefficient (K_d) for the saturated zone (cm^3/g)	4.3	18.49/1.0	No Change	No change in peak dose compared to baseline
Unsaturated Zone Hydraulic Conductivity (m/y)	227	1135/45.4	No Change	No change in peak dose compared to baseline

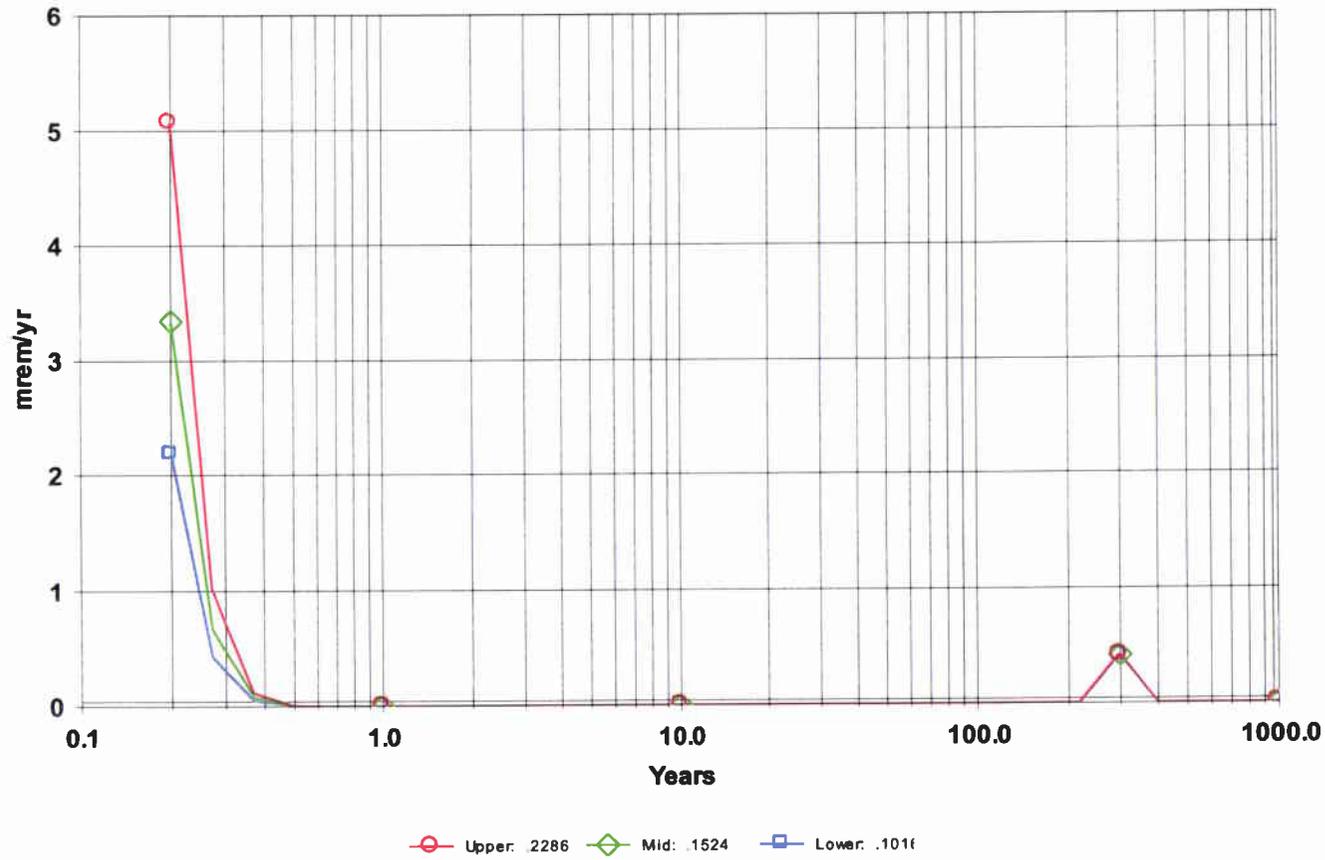
The only parameter to which the peak dose is very sensitive is the contaminated zone thickness; however, the TEDE decreases from 37.7 mrem to less than 1 mrem within 0.4 years following the final survey when licensee control of the site will still be maintained. Changes in the other parameter values have very little or no effect on the peak dose and only a minimal effect on the magnitude of future doses (primarily from fish consumption from a hypothetical pond).

¹ Sheppard, M.I, and D.H. Thibault, 1990. Default Soil/Liquid Partition Coefficients, K_d s, for Four Major Soil Types: A Compendium: Health Physics, v. 59, no. 4, pp 471-482, Table 1.

² C. Yu, D. LePoire, E. Gnanapragasam, J. Arnish, S. Kamboj, B.M. Biber, J.J. Cheng, A. Zielen, and S.Y. Chen. November 2000: Development of Probabilistic RESRAD 6.0 and RESRAD-BUILD 3.0 Computer Codes. U.S. Nuclear Regulatory Commission. NUREG/CR-6697 (Table 3.9, p. 3-30)

Figure 3

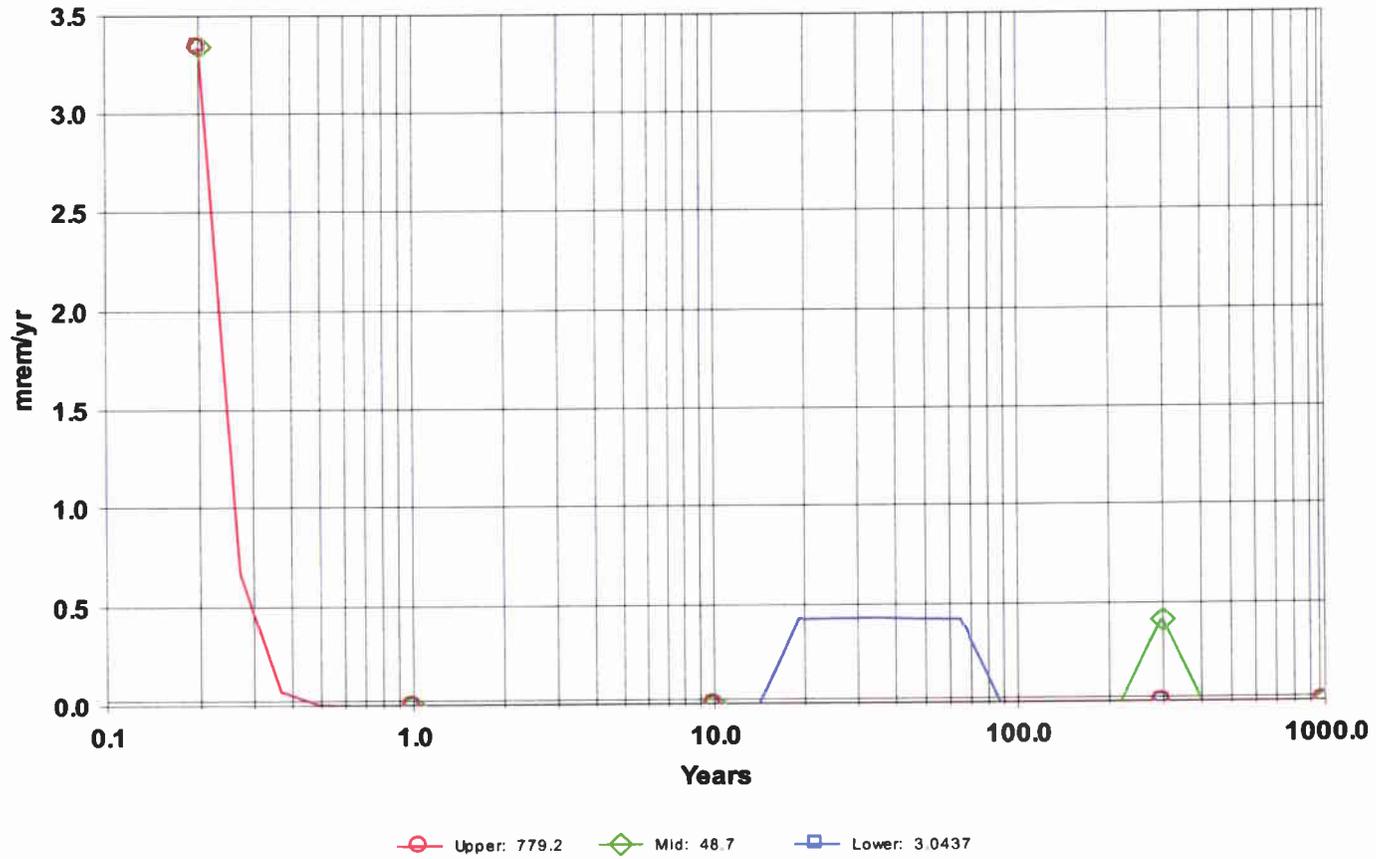
DOSE: All Nuclides Summed, All Pathways Summed With SA on Thickness of contaminated zone



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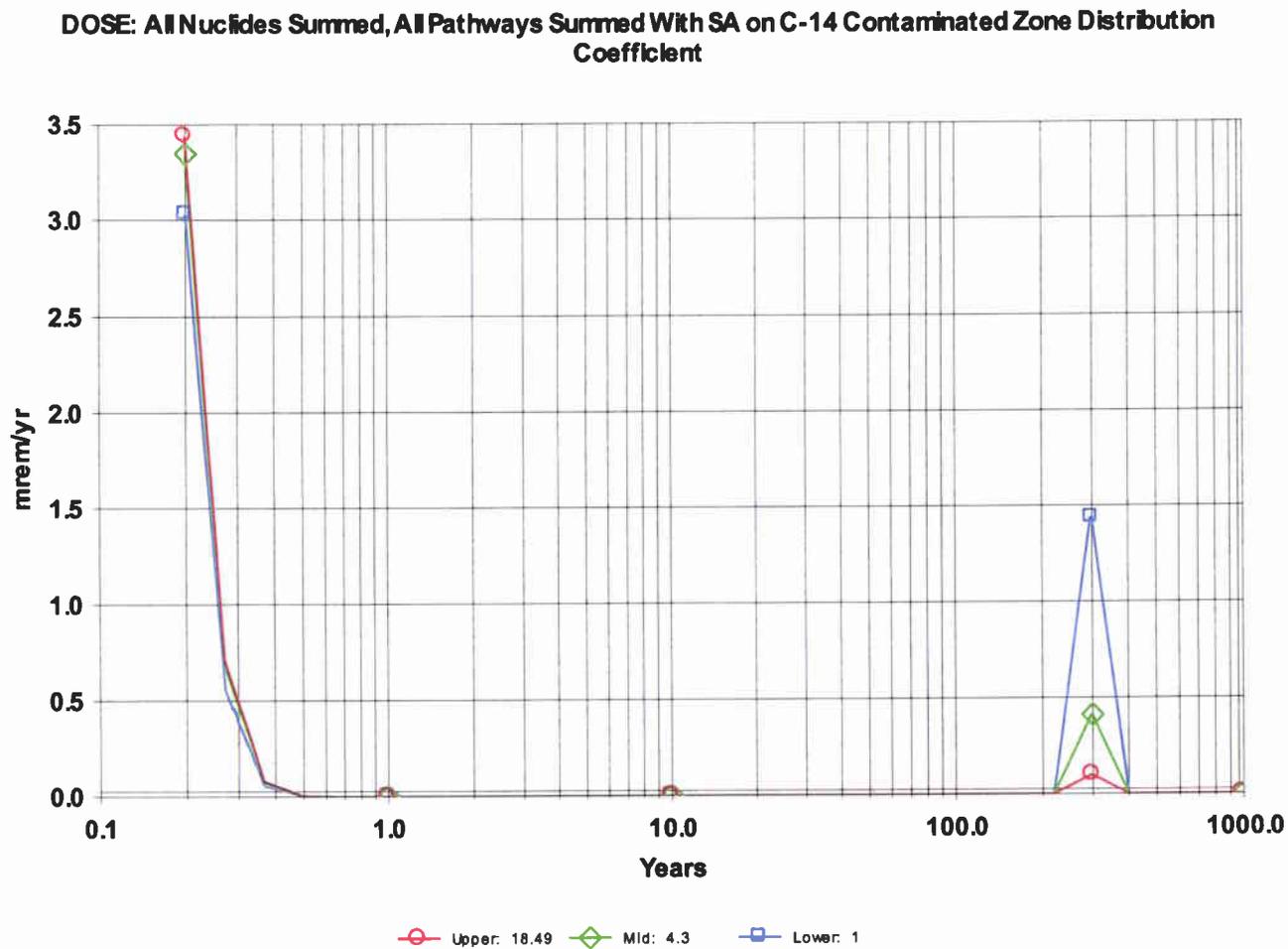
Figure 4

DOSE: All Nuclides Summed, All Pathways Summed With SA on Thickness of Unsaturated Zone 1



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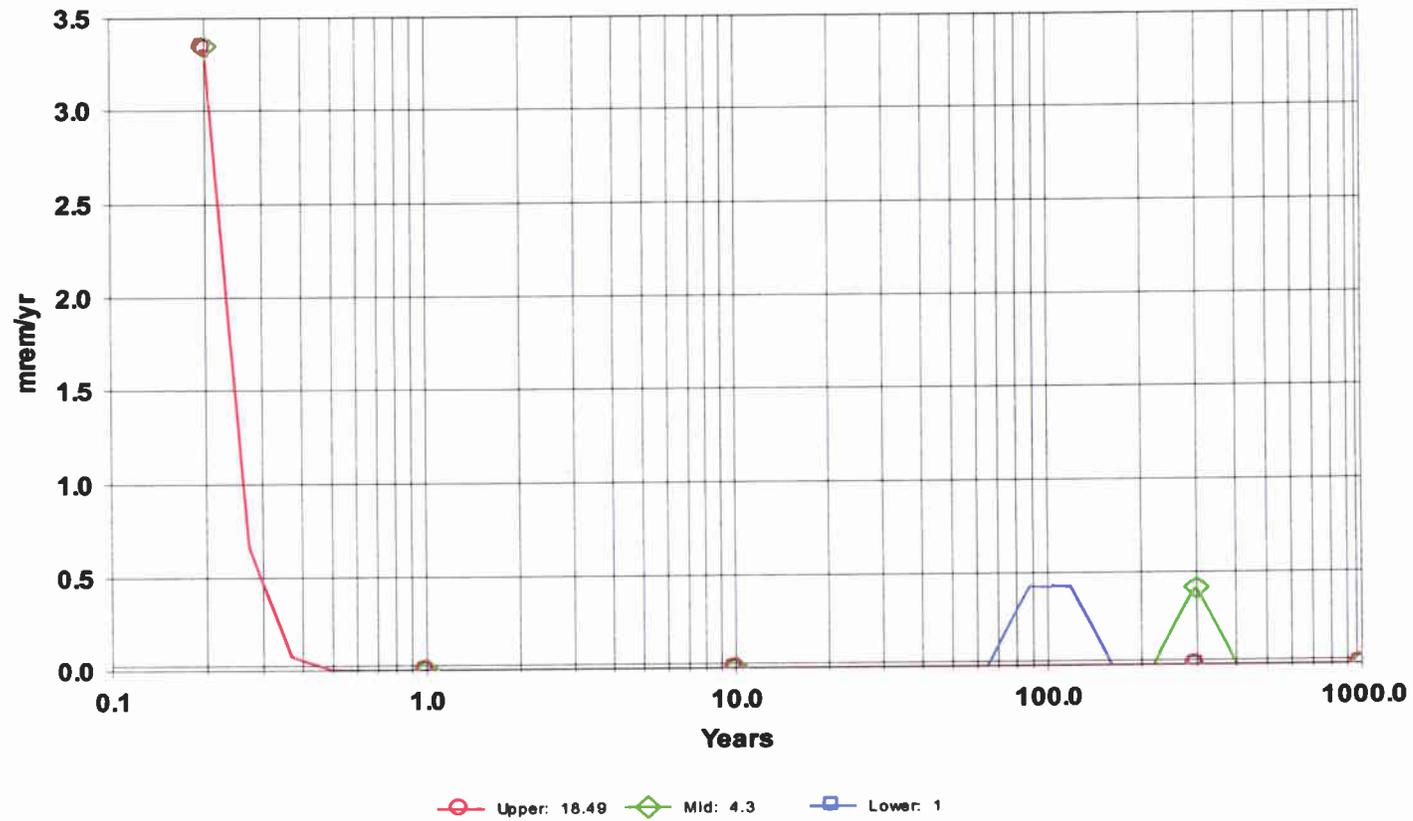
Figure 5



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Figure 6

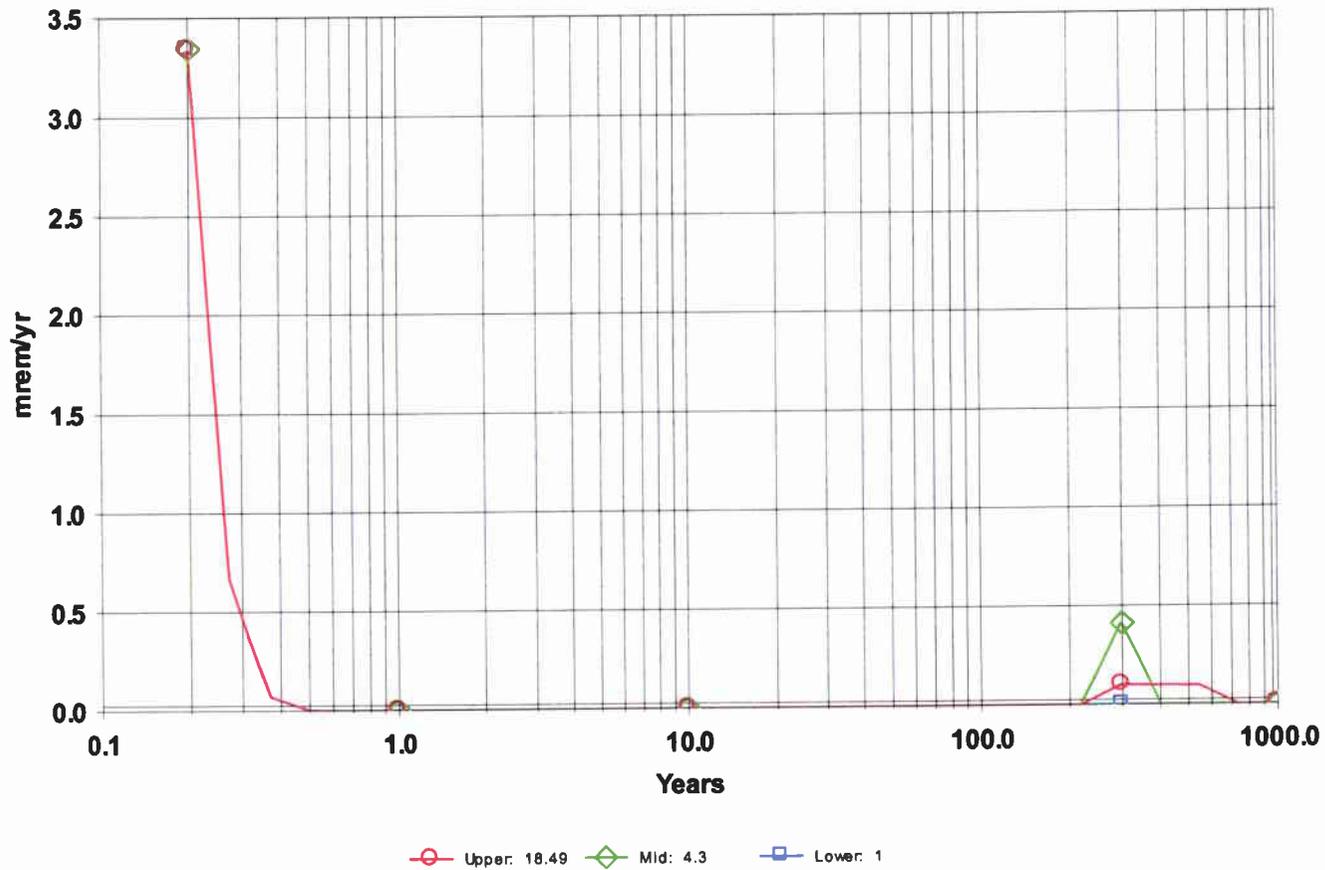
DOSE: All Nuclides Summed, All Pathways Summed With SA on C-14 Unsaturated Zone Distribution Coefficient



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Figure 7

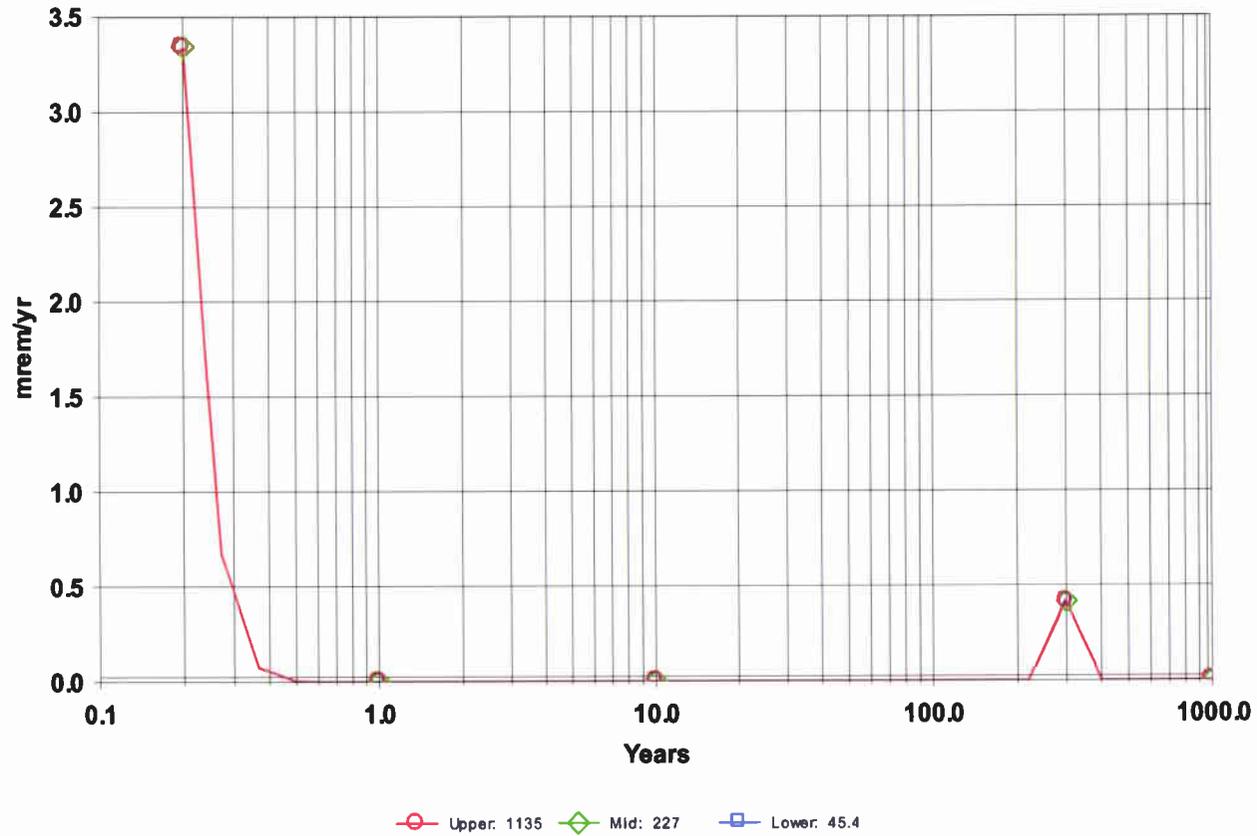
DOSE: All Nuclides Summed, All Pathways Summed With SA on C-14 Saturated Zone Distribution Coefficient



;\RAD_FAMILY\RESRAD\USERFILES\RES_FARMABC LAB MO40K.RAD 10/14/2009 17:27 GRAPHICS.ASC Includes All Pa

Figure 8

DOSE: All Nuclides Summed, All Pathways Summed With SA on Hydraulic Conductivity of Unsaturated Zone 1



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ABC LABS Remediation ALARA Analysis Evaluation

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ABC LABS Remediation ALARA Analysis Evaluation

1.0 Remediation ALARA Analysis Evaluation

The information presented below describes how ABC Labs has demonstrated that doses to the average member of the critical group are As Low as Reasonably Achievable (ALARA) following implementation of the preferred decommissioning option for unrestricted use, as required by 10 CFR 20.1402. This ALARA evaluation addresses the following:

- Cost-benefit analysis of the preferred option postulated to reduce residual radioactivity to levels no greater than the radiological criteria for unrestricted use (25 mrem TEDE per year).
- The predetermined method for showing compliance with the ALARA requirement at the time decommissioning is completed.

The remediation ALARA analysis is an optimization technique separate from the operational ALARA, but uses the same underlying principle to seek the proper balance of remediation costs and benefits below the 10 CFR 20.1402 radiological criteria:

“Reasonably achievable” is judged by considering the state of technology and the economics of improvements in relation to all the benefits from these improvements. Determination of the ALARA level will consider any detriments, such as deaths from transportation accidents, expected to potentially result from remediation and waste disposal. However, a comprehensive consideration of risks and benefits will include risks from non-radiological hazards. An action taken to reduce radiation risks should not result in a significantly larger risk from other hazards.

ABC Labs has elected to decommission a portion of their Columbia, Missouri site for unrestricted use under the assumption that the critical group is an onsite resident farmer. Accordingly, ABC Labs has performed an ALARA analysis to establish a remediation goal for decommissioning under the soil remediation or soil removal option. For compliance with 10 CFR 20.1403(a), one acceptable method of compliance is to demonstrate that cleanup to the unrestricted release criteria is beyond ALARA considerations.

When the beneficial effects (“benefits”) of remediation exceed their undesirable effects (“costs”), the remediation is deemed cost effective and implementable. Conversely, if costs outweigh benefits, the existing residual radioactivity is ALARA and the remediation is not considered cost effective. The

ABC LABS Remediation ALARA Analysis Evaluation

ultimate comparison of interest is the incremental difference in benefits and costs. Wherever possible, benefits and costs have been described in monetary (dollar) amounts.

1.1 Calculation of Benefits

In Appendix N to NUREG-1757, Volume 2, the NRC identified four possible benefits associated with decommissioning: (1) collective dose averted, (2) regulatory costs avoided, (3) changes in land values, and (4) aesthetics/reduction in public opposition. Numerical benefit estimates are typically calculable only for the first three benefits, however, making description of the last benefit possible in semiquantitative or qualitative terms only. The approach that ABC Labs has used to determine the value of these benefits is discussed below.

1.1.1. Collective Dose Averted

2. Using the simplest benefit analysis, the only benefit estimated from a reduction in the level of residual radioactivity is the monetary value of the collective averted dose to future occupants of the site. The collective averted dose is based on the same exposure scenario used for the compliance calculation or the onsite resident farmer scenario.
3. The benefit from collective averted dose, B_{AD} , is calculated by determining the present worth of the future collective averted dose and multiplying it by a factor to convert the dose to monetary value::
4. value::

$$5. B_{AD} = 2,000PW(AD_{Collective})$$

6. where:

- 6.1.1. B_{AD} = benefit from averted dose for a remediation action, \$;
- 6.1.2. 2,000 = monetary value of collective dose averted, \$/person-rem; and
- 6.1.3. $PW(AD_{collective})$ = present worth of future collective averted dose.

7. According to Appendix N to NUREG-1757, Volume 2, for doses averted within 1000 years, a discount rate of 7 % should be used for soil.
8. For simple situations, Appendix N to NUREG-1757, Volume 2 recommends that the present worth of the future collective averted dose be estimated from the following equation:

ABC LABS Remediation ALARA Analysis Evaluation

$$9. \quad PW(AD_{\text{collective}}) = 0.025 P_D A F \left(\frac{Conc}{DCGL_w} \right) \frac{1 - e^{-(r+\lambda)N}}{r + \lambda}$$

10. where:

10.1.1. 0.025 = annual TEDE dose to an average member of the critical group from residual radioactivity at the Derived Concentration Guideline Level (DCGL_w) concentration;

10.1.2. P_D = population density for the critical group or 0.0004 persons/m² (open land);

10.1.3. A = area being evaluated, 40,000 m²;

10.1.4. F = fraction of the residual radioactivity removed by the remediation or 1;

10.1.5. Conc = average concentration of residual radioactivity in the area being evaluated;

10.1.6. DCGL_w = derived concentration guideline equivalent to the average concentration of residual radioactivity that would give a dose of 25 mrem/year to the average member of the critical group, or 210.3 pCi/g;

10.1.7. r = monetary discount rate, 7 % yr⁻¹ for 1000 years is used;

11. = radiological decay constant for the radionuclide (C-14), 0.000121 yr⁻¹; and

11.1.1. N = collective dose delivery duration or 1000 years.

12. The present worth of the benefit calculated above assumes that the peak dose occurs in the first year of the modeling horizon.

1.1.1 Regulatory Costs Avoided

This benefit has not been calculated.

1.1.2 Changes in Land Values

This benefit has not been calculated.

1.1.3 Aesthetics and Reduction in Stakeholder Opposition

This benefit has not been calculated.

ABC LABS Remediation ALARA Analysis Evaluation

1.2 Calculation of Costs

The remediation costs generally included are the monetary costs of: (1) remediation planning, execution, and management; (2) waste packaging, transportation, and disposal (T&D); (3) T&D conveyance incidents; (4) workplace incidents; (5) remediation workforce radiological doses; and (6) radiological dose to members of the public. The cost estimate presented here does not include the costs associated with T&D conveyance incidents, workplace incidents, remediation workforce radiological doses or radiological doses to members of the public which are all expected to be relatively minor.

The total cost, C_T , to be balanced against accrued benefits for the remediation has several components as shown below:

$$C_T = C_R + C_{T\&D} + C_{T\&Dinc} + C_{Winc} + C_{Wdose} + C_{Pdose} + C_{Other}$$

where:

- C_R = monetary cost of the remediation action including mobilization and demobilization;
- $C_{T\&D}$ = monetary cost for waste packaging, transport, and disposal;
- $C_{T\&Dinc}$ = monetary cost of T&D incidents resulting in fatalities;
- C_{Winc} = monetary cost of worker occupational safety incidents resulting in fatalities;
- C_{Wdose} = monetary cost of the dose delivered to workers;
- C_{Pdose} = monetary cost of the dose delivered to members of the public from on-site activities; and
- C_{Other} = other applicable or relevant and appropriate costs.

All the cost terms defined above do not necessarily have to be calculated. For example, if any of the terms exceeds the benefit, the remediation alternative/option will have been shown to be unnecessary without calculating other costs.

The costs associated with the packaging, transport and disposal of soil containing C-14 at the DCGL level alone are estimated to be \$800,000.

1.3 The ALARA Residual Radioactivity Level

The residual radioactivity level that is ALARA is the concentration, $Conc$, at which the remediation benefit equals the remediation cost. After equating the total cost, C_T , with the present worth of future averted collective dose, PW_{CAD} , the concentration ratio, $Conc:DCGL_W$, is solved as follows:

ABC LABS Remediation ALARA Analysis Evaluation

$$\frac{Conc}{DCGL_w} = \frac{C_T}{2,000P_D 0.025FA} \left(\frac{r + \lambda}{1 - e^{-(r+\lambda)N}} \right)$$

Using the parameter values specified in Sections 7.1.1 and 7.2.1 above results in a (Conc:DCGL_w) ratio of 70 or an ALARA concentration of 14,725 pCi/g which is well above the DCGL value of 210.3 pCi/g. Consequently, remediation to the DCGL level is already ALARA.

**Final Status Survey Plan
Partial Site Release
Sanitary Lagoon(s) and Drain Field(s) – SLDF
Analytical Bio-Chemistry Laboratories**

Attachment D

ABC Labs Map

**Final Status Survey Plan
Partial Site Release
Sanitary Lagoon(s) and Drain Field(s) – SLDF
Analytical Bio-Chemistry Laboratories**

Attachment E

VSP Hot Spot Detection

Systematic sampling locations for detecting an area of elevated values (hot spot)

This report summarizes the sampling design used, associated statistical assumptions, as well as general guidelines for conducting post-sampling data analysis. Sampling plan components presented here include how many sampling locations to choose and where within the sampling area to collect those samples. The type of medium to sample (i.e., soil, groundwater, etc.) and how to analyze the samples (in-situ, fixed laboratory, etc.) are addressed in other sections of the sampling plan.

The following table summarizes the sampling design developed. A figure that shows sampling locations in the field is also provided below.

SUMMARY OF SAMPLING DESIGN	
Primary Objective of Design	Detect the presence of a hot spot that has a specified size and shape
Type of Sampling Design	Hot spot
Sample Placement (Location) in the Field	Systematic (Hot Spot) with a random start location
Formula for calculating number of sampling locations	Singer and Wickman algorithm
Calculated total number of samples	442
Type of samples	Point Samples
Number of samples on map ^a	421
Number of selected sample areas ^b	1
Specified sampling area ^c	429712.00 ft ²
Grid pattern	Triangular
Size of grid / Area of grid ^d	33.5332 feet / 973.825 ft ²
Total cost of sampling ^e	\$155,700.00

^a This number may differ from the calculated number because of 1) grid edge effects, 2) adding judgment samples, or 3) selecting or unselecting sample areas.

^b The number of selected sample areas is the number of colored areas on the map of the site. These sample areas contain the locations where samples are collected.

^c The sampling area is the total surface area of the selected colored sample areas on the map of the site.

^d Size of grid / Area of grid gives the linear and square dimensions of the grid spacing used to systematically place samples.

^e Including measurement analyses and fixed overhead costs. See the Cost of Sampling section for an explanation of the costs presented here.



Primary Sampling Objective

The primary purpose of sampling at this site is to detect "hot spots" (local areas of elevated concentration) of a given size and shape with a specified probability, $1-\beta$

Selected Sampling Approach

This sampling approach requires systematic grid sampling with a random start. If a systematic grid is not used, the probability of detecting a hot spot of a given size and shape will be different than desired or calculated.

Number of Total Samples: Calculation Equation and Inputs

The algorithm used to calculate the grid size (and hence, the number of samples) is based on work by Singer and Wickman for locating geologic deposits [see Singer and Wickman (1969) and Hassig et al. (2004) for details]. Inputs to the algorithm include the size, shape, and orientation of a hot spot of interest, an acceptable probability of finding a hot spot, the desired type of sampling grid, and the sampling budget. For this design, the grid size was calculated based on the given hot spot size and other parameters.

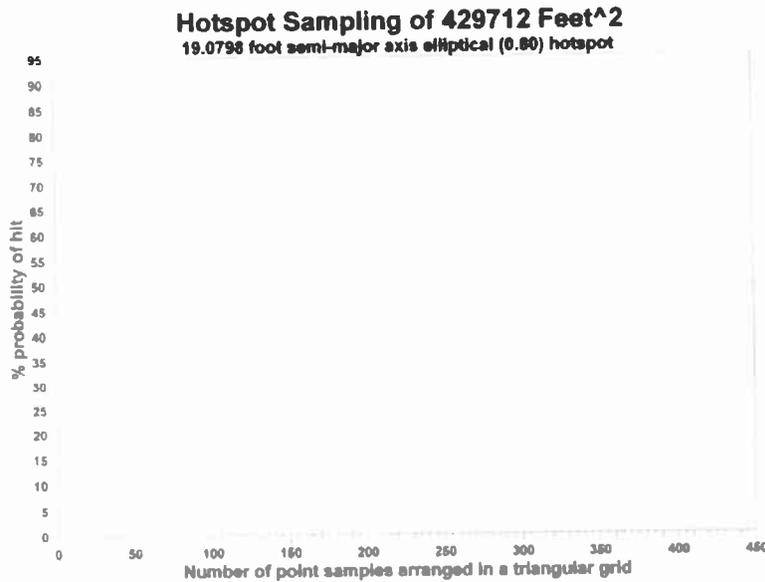
The inputs to the algorithm that result in the grid size are:

Parameter	Description	Value
Inputs		
$1-\beta$	Probability of detection	90%
Grid Type	Grid pattern (Square, Triangular or Rectangular)	Triangular
Sample Type	Point samples or square cells	Points
Hot Spot Shape	Hot spot height to width ratio	0.8
Hot Spot Size	Length of hot spot semi-major axis	19,079.8 feet
Hot Spot Area ^a	Area of hot spot (Length ² * Shape * π)	914.93 ft ²
Angle	Angle of orientation between hot spot and grid	Random
Sampling Area	Total area to sample	429,712.00 ft ²
Outputs		
Grid Size	Spacing between samples	33,533.2 feet
Grid Area	Area represented by one grid	973,825 ft ²

Samples^b Optimum number of samples 441 262
 Cost Total cost of sampling \$155,700.00

^a Length of semi-major axis is used by Singer-Wickman algorithm. Hot spot area is provided for informational purposes.
^b The optimum number of samples is calculated by dividing the sampling area by the grid area.

The following graph shows the relationship between the number of samples and the probability of finding the hot spot. The dashed blue line shows the actual number of samples for this design (which may differ from the optimum number of samples because of edge effects).



Assumptions that Underlie the VSP Locating a Hot Spot Design Method

- 1 The shape of the hot spot of concern is circular or elliptical.
- 2 The level of contamination that defines a hot spot is well defined.
- 3 The location of the hot spot is unknown, and if a hot spot is present, all locations within the sampling area are equally likely to contain the hot spot.
- 4 Samples are taken on a square, rectangular or triangular grid pattern.
- 5 Each sample is collected, handled, measured or inspected using approved methods that yield unbiased and sufficiently precise measurements.
- 6 A very small proportion of the surface being studied will be sampled (the sample is much smaller than the hot spot of interest).
- 7 Sample locations are independent of the measurement process.
- 8 The systematic grid is placed at a randomly determined starting place to cover the surface area of interest.
- 9 There are no classification errors (if a hot spot is sampled, it is not mistakenly overlooked or an area is not mistakenly identified as a hot spot).

Sensitivity Analysis

The sensitivity of the calculation of number of samples was explored by varying the probability of hit (%), hot spot shape (height to width ratio) and hot spot size (length of semi-major axis). The following table shows the results of this analysis

Number of Samples

**Final Status Survey Plan
Partial Site Release
Sanitary Lagoon(s) and Drain Field(s) – SLDF
Analytical Bio-Chemistry Laboratories**

Attachment F

VSP Sign Test Samples

Systematic sampling locations for comparing a median with a fixed threshold (nonparametric - MARSSIM)

Summary

This report summarizes the sampling design used, associated statistical assumptions, as well as general guidelines for conducting post-sampling data analysis. Sampling plan components presented here include how many sampling locations to choose and where within the sampling area to collect those samples. The type of medium to sample (i.e., soil, groundwater, etc.) and how to analyze the samples (in-situ, fixed laboratory, etc.) are addressed in other sections of the sampling plan.

The following table summarizes the sampling design developed. A figure that shows sampling locations in the field and a table that lists sampling location coordinates are also provided below.

SUMMARY OF SAMPLING DESIGN

Primary Objective of Design	Compare a site mean or median to a fixed threshold
Type of Sampling Design	Nonparametric
Sample Placement (Location) in the Field	Systematic with a random start location
Working (Null) Hypothesis	The median(mean) value at the site exceeds the threshold
Formula for calculating number of sampling locations	Sign Test - MARSSIM version
Calculated total number of samples	15
Number of samples on map ^a	16
Number of selected sample areas ^b	1
Specified sampling area ^c	21520.89 ft ²
Size of grid / Area of grid cell ^d	39.7828 feet / 1370.63 ft ²
Grid pattern	Triangular
Total cost of sampling ^e	\$6,250.00

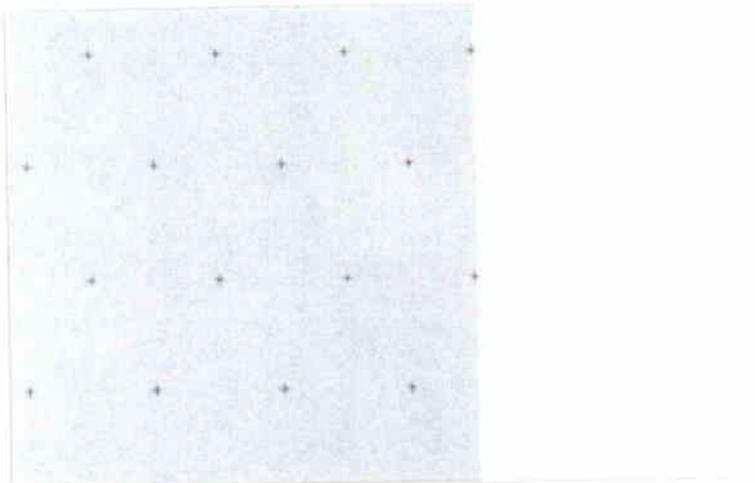
^a This number may differ from the calculated number because of 1) grid edge effects, 2) adding judgment samples, or 3) selecting or unselecting sample areas.

^b The number of selected sample areas is the number of colored areas on the map of the site. These sample areas contain the locations where samples are collected.

^c The sampling area is the total surface area of the selected colored sample areas on the map of the site.

^d Size of grid / Area of grid cell gives the linear and square dimensions of the grid used to systematically place samples.

^e Including measurement analyses and fixed overhead costs. See the Cost of Sampling section for an explanation of the costs presented here.



Area: Area 1

X Coord	Y Coord	Label Value	Type	Historical
6.3327	29.1018		0 Systematic	
46.1154	29.1018		0 Systematic	
85.8982	29.1018		0 Systematic	
125.6809	29.1018		0 Systematic	
26.2241	63.5547		0 Systematic	
66.0068	63.5547		0 Systematic	
105.7896	63.5547		0 Systematic	
145.5723	63.5547		0 Systematic	
6.3327	98.0075		0 Systematic	
46.1154	98.0075		0 Systematic	
85.8982	98.0075		0 Systematic	
125.6809	98.0075		0 Systematic	
26.2241	132.4604		0 Systematic	
66.0068	132.4604		0 Systematic	
105.7896	132.4604		0 Systematic	
145.5723	132.4604		0 Systematic	

Primary Sampling Objective

The primary purpose of sampling at this site is to compare a site median or mean value with a fixed threshold. The working hypothesis (or 'null hypothesis) is that the median(mean) value at the site is equal to or exceeds the threshold. The alternative hypothesis is that the median(mean) value is less than the threshold. VSP calculates the number of samples required to reject the null hypothesis in favor of the alternative one, given a selected sampling approach and inputs to the associated equation.

Selected Sampling Approach

A nonparametric systematic sampling approach with a random start was used to determine the number of samples and to

specify sampling locations. A nonparametric formula was chosen because the conceptual model and historical information (e.g., historical data from this site or a very similar site) indicate that typical parametric assumptions may not be true.

Both parametric and non-parametric equations rely on assumptions about the population. Typically, however, non-parametric equations require fewer assumptions and allow for more uncertainty about the statistical distribution of values at the site. The trade-off is that if the parametric assumptions are valid, the required number of samples is usually less than if a non-parametric equation was used.

Locating the sample points over a systematic grid with a random start ensures spatial coverage of the site. Statistical analyses of systematically collected data are valid if a random start to the grid is used. One disadvantage of systematically collected samples is that spatial variability or patterns may not be discovered if the grid spacing is large relative to the spatial patterns.

Number of Total Samples: Calculation Equation and Inputs

The equation used to calculate the number of samples is based on a Sign test (see PNNL 13450 for discussion). For this site, the null hypothesis is rejected in favor of the alternative one if the median(mean) is sufficiently smaller than the threshold. The number of samples to collect is calculated so that if the inputs to the equation are true, the calculated number of samples will cause the null hypothesis to be rejected.

The formula used to calculate the number of samples is

$$n = \frac{(Z_{1-\alpha} + Z_{1-\beta})^2}{4(\text{Sign}P - 0.5)^2}$$

where

$$\text{Sign}P = \Phi\left(\frac{\Delta}{s_{total}}\right)$$

$\Phi(z)$ is the cumulative standard normal distribution on $(-\infty, z)$ (see PNNL-13450 for details).

n is the number of samples.

s_{total} is the estimated standard deviation of the measured values including analytical error.

Δ is the width of the gray region.

α is the acceptable probability of incorrectly concluding the site median(mean) is less than the threshold.

β is the acceptable probability of incorrectly concluding the site median(mean) exceeds the threshold.

$Z_{1-\alpha}$ is the value of the standard normal distribution such that the proportion of the distribution less than $Z_{1-\alpha}$ is $1-\alpha$.

$Z_{1-\beta}$ is the value of the standard normal distribution such that the proportion of the distribution less than $Z_{1-\beta}$ is $1-\beta$.

Note: MARSSIM suggests that the number of samples should be increased by at least 20% to account for missing or unusable data and uncertainty in the calculated value of n . VSP allows a user-supplied percent coverage as discussed in MARSSIM (EPA 2000, p. 5-33).

The values of these inputs that result in the calculated number of sampling locations are

Analyte	n ^a	Parameter					
		S	Δ	α	β	$Z_{1-\alpha}$ ^b	$Z_{1-\beta}$ ^c
Analyte 1	15	70	105	0.05	0.1	1.64485	1.28155

^a The final number of samples has been increased by the MARSSIM Overage of 20%.

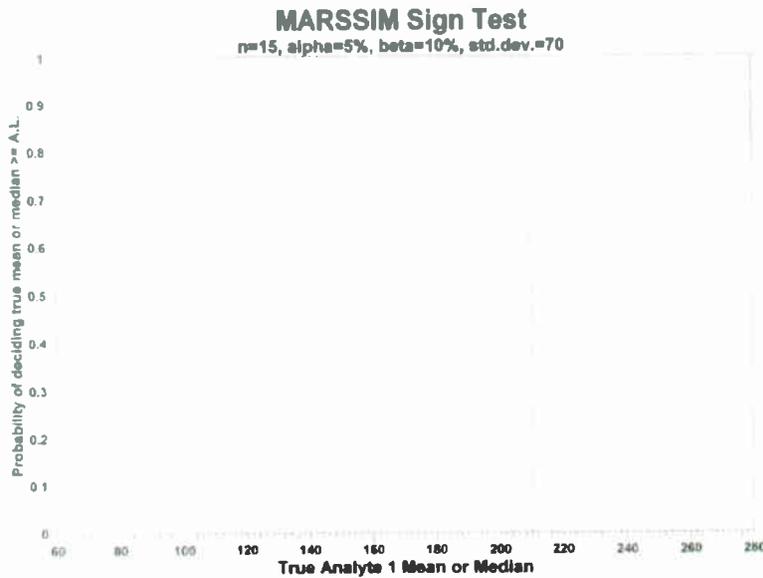
^b This value is automatically calculated by VSP based upon the user defined value of α .

^c This value is automatically calculated by VSP based upon the user defined value of β .

The following figure is a performance goal diagram, described in EPA's QA/G-4 guidance (EPA, 2000). It shows the probability of concluding the sample area is dirty on the vertical axis versus a range of possible true median(mean) values for the site on the horizontal axis. This graph contains all of the inputs to the number of samples equation and pictorially represents the calculation.

The red vertical line is shown at the threshold (action limit) on the horizontal axis. The width of the gray shaded area is

equal to Δ the upper horizontal dashed blue line is positioned at $1-\alpha$ on the vertical axis, the lower horizontal dashed blue line is positioned at β on the vertical axis. The vertical green line is positioned at one standard deviation below the threshold. The shape of the red curve corresponds to the estimates of variability. The calculated number of samples results in the curve that passes through the lower bound of Δ at β and the upper bound of Δ at $1-\alpha$. If any of the inputs change, the number of samples that result in the correct curve changes.



Statistical Assumptions

The assumptions associated with the formulas for computing the number of samples are:

- 1 the computed sign test statistic is normally distributed.
- 2 the variance estimate, S^2 , is reasonable and representative of the population being sampled.
- 3 the population values are not spatially or temporally correlated, and
- 4 the sampling locations will be selected probabilistically.

The first three assumptions will be assessed in a post data collection analysis. The last assumption is valid because the gridded sample locations were selected based on a random start.

Sensitivity Analysis

The sensitivity of the calculation of number of samples was explored by varying the standard deviation, lower bound of gray region (% of action level), beta (%), probability of mistakenly concluding that $\mu >$ action level and alpha (%), probability of mistakenly concluding that $\mu <$ action level. The following table shows the results of this analysis.

		Number of Samples					
		$\alpha=5$		$\alpha=10$		$\alpha=15$	
		$s=140$	$s=70$	$s=140$	$s=70$	$s=140$	$s=70$
AL=210.3	$\beta=5$	912	234	722	185	606	155
	$\beta=10$	722	185	554	142	453	117
	$\beta=15$	606	155	453	117	363	94
LBGR=90	$\beta=5$	234	64	185	51	155	44
	$\beta=10$	185	51	142	40	117	33

	Size=9.5399	Size=19.0798	Size=28.6197
Shp=0.7	1930	483	215
1- β =85 Shp=0.8	1630	408	182
Shp=0.9	1428	357	159
Shp=0.7	2114	529	235
1- β =90 Shp=0.8	1766	442	197
Shp=0.9	1529	383	170
Shp=0.7	2348	587	261
1- β =95 Shp=0.8	1936	484	216
Shp=0.9	1662	416	185

1- β = Probability of Hit (%)
 Shp = Hot Spot Shape (Height to Width Ratio)
 Size = Hot Spot Size (Length of Semi-major Axis)

Cost of Sampling

The total cost of the completed sampling program depends on several cost inputs, some of which are fixed, and others that are based on the number of samples collected and measured. Based on the numbers of samples determined above, the estimated total cost of sampling and analysis at this site is \$155,700.00, which averages out to a per sample cost of \$352.26. The following table summarizes the inputs and resulting cost estimates.

COST INFORMATION			
Cost Details	Per Analysis	Per Sample	442 Samples
Field collection costs		\$100.00	\$44,200.00
Analytical costs	\$250.00	\$250.00	\$110,500.00
Sum of Field & Analytical costs		\$350.00	\$154,700.00
Fixed planning and validation costs			\$1,000.00
Total cost			\$155,700.00

Recommended Data Analysis Activities

Post data collection activities generally follow those outlined in EPA's Guidance for Data Quality Assessment (EPA, 2006). The data analysts will become familiar with the context of the problem and goals for data collection and assessment. The data will be verified and validated before being subjected to statistical or other analyses. Graphical and analytical tools will be used to verify to the extent possible the assumptions of any statistical analyses that are performed as well as to achieve a general understanding of the data. The data will be assessed to determine whether they are adequate in both quality and quantity to support the primary objective of sampling.

A map of the actual sample locations will be generated so that the sampling plan and the field implementation may be compared. Deviations from planned sample locations due to topographic, vegetative, or other features will be noted. Their impacts will be qualitatively assessed. If a hot spot is discovered, additional sampling may be performed to determine its size and shape. In which case, the initial assumptions of the sampling design may then be assessed and/or reconsidered.

References

EPA 2006. *Data Quality Assessment: Statistical Methods for Practitioners* EPA QA/G-9S, EPA/240/B-06/003. U.S. Environmental Protection Agency, Office of Environmental Information, Washington DC.

Gilbert, R.O. 1987. *Statistical Methods for Environmental Pollution Monitoring*. Wiley & Sons, Inc., New York, NY.

Hassig, N.L., J.E. Wilson, R.O. Gilbert and B.A. Puspipher. 2004. *Visual Sample Plan Version 3.0 User's Guide* PNLI-14970. Pacific Northwest National Laboratory, Richland, WA, December 2004.

Singer, D.A. and J.E. Wickman. 1969. *Probability Tables for Locating Elliptical Targets with Square, Rectangular, and Hexagonal Point Nets*. Pennsylvania State University, University Park, Pennsylvania. Special Publication 1-69.

This report was automatically produced* by Visual Sample Plan (VSP) software version: 5.4.1
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* The report contents may have been modified or reformatted by end-user of software

ATTACHMENT VII

**ABC AUDIT CHECKLIST
OF DECOMMISSIONING ACTIVITIES**

FOR REVIEW ONLY

Audit Checklist

Audit Report No.

License No.

Audit of activities at (Address/Facility):

Contact at Audit Location:

Date of this Audit:

Summary of Findings and Action:

No deficiencies

Deficiencies

Inadequate action on previous deficiencies

Corrective Action Required and implemented.

Recommendations:

AUDIT CHECKLIST

1. RADIOACTIVE MATERIALS LICENSE FOR SEC			
a. Does SEC have a license for performing decommissioning	Yes	No	
b. Is the license valid	Yes	No	
2. RADIATION WORKER TRAINING, QUALIFICATIONS, AND INSTRUCTION TO WORKERS			
a. Are training and qualifications of all personnel verified before being allowed to perform assigned duties	Yes	No	
b. If training is needed, is it given before being allowed to perform duties	Yes	No	
c. Are instructions given to workers outlining the scope of work to be performed	Yes	No	
3. INTERNAL DOSIMETRY PROGRAM (SEC-RP-002, Rev 1)			
a. Are there internal dosimetry program requirements for this project	Yes	No	N/A
b. Are they included in the appropriate Radiological Work Permits	Yes	No	
c. Is the bioassay schedule appropriate	Yes	No	
d. Are the bioassay dose results reviewed for correctness	Yes	No	
4. PREGNANCY DECLARATION FOR RADIOLOGICAL WORKER (SEC-RP-003, Rev 0)			
a. Has a declaration of pregnancy been made by a pregnant worker	Yes	No	N/A
b. Has the declaration of pregnancy been given in writing	Yes	No	
c. Has a determination of the occupational exposure that the embryo/fetus been performed	Yes	No	
5. PERSONNEL CONTAMINATION EVENT (SEC-RP-005, REV 0)			
a. Is there proper survey equipment to detect contamination on personnel	Yes	No	
b. Are there written procedures available to assist in the performance of a decontamination on a contaminated worker	Yes	No	
c. Are the proper supplies available to perform a decontamination	Yes	No	
d. Are the forms available to document the decontamination procedure	Yes	No	
6. CONTROLLING RADIOACTIVE SOURCES (SEC-RP-007, REV 0)			
a. Are sealed sources properly stored when not in use	Yes	No	N/A
b. Is a "Radioactive Source Check Out Log" maintained	Yes	No	
7. ALARA EVALUATIONS (SEC-RP-008)			
a. Has an ALARA Evaluation been completed for this project	Yes	No	
b. Have the members of the project team reviewed the ALARA evaluation	Yes	No	

8. LAPEL AIR SAMPLING (SEC-RP-009)	Yes	No	N/A
a. Has the worker(s) wearing a lapel air sampler been briefed on the care to be exercised while working	Yes	No	
b. Has the starting time and initial flow rate been recorded	Yes	No	
c. Has the stop time and final sample flow rate been recorded	Yes	No	
d. Were the proper calculations performed to record the results	Yes	No	
9. DESIGNING AND CONTROLLING RADIOACTIVE MATERIAL AREAS (SEC-RP-010)			
a. Has a location and custodian been selected for RMSA	Yes	No	
b. Has a request for the RMSA been given to the RCS	Yes	No	
c. Has the proper signs and identifying information been posted	Yes	No	
d. Has an inventory been started by the RMSA Custodian and updated as new materials are placed in the RMSA	Yes	No	
10. RADIATION WORK PERMITS (SEC-RP-012, REV 0)			
a. Have Radiation Work Permits been prepared	Yes	No	
b. Do they contain sufficient detail to inform workers of the radiological conditions and protective measures required to perform work in a radiologically safe manner	Yes	No	
c. Was a Hazardous Work Permit and/or Job Safety Analysis developed before the RWP	Yes	No	
d. Was an ALARA review completed	Yes	No	
e. If revisions were made, was the proper revision number included	Yes	No	
11. RESPIRATORY PROTECTION PROGRAM (SEC-RP-014, REV 1)			
a. Has a RWP determined that respiratory protection is required	Yes	No	
b. Has a RWP listed which type of respiratory equipment is required	Yes	No	
c. Has the proper training been given and documented for the workers required to wear the respiratory equipment	Yes	No	
d. Has the respiratory equipment been inspected before use	Yes	No	
12. CONTAMINATION SURVEYS (SEC-RP-016, REV 1)			
a. Are there the appropriate equipments for the type, level and energy range of the radiation to be detected being used for the contamination surveys	Yes	No	
b. Are personnel trained in how to properly perform contaminations surveys	Yes	No	
c. Have a sufficient number of smear/swipe samples been taken for the areas requiring contamination surveys	Yes	No	
d. Are surveys being done at the appropriate times	Yes	No	
e. Are the appropriate survey forms being filled out with all required information (i.e., Name of person conducting the survey, date, time, purpose of survey, locations model, serial number and cal. due date of instruments, type of radiation)	Yes	No	

f. Is equipment and machinery swiped for contamination at the end of the work day	Yes	No	
13. ALARA PROGRAM (SEC-RP-113, REV 0)			
a. Is there an established ALARA Program	Yes	No	
b. Are there administrative control levels used	Yes	No	
14. ACCESS CONTROL (SEC-RP-115)			
a. Are there entry and exits locations designated for the radiation area	Yes	No	
b. Are the following requirements verified before personnel enter radiological areas:			
1. Site-specific training	Yes	No	
2. Submittal of bioassay sample	Yes	No	
3. PPE worn correctly	Yes	No	
15. PPE USE-INSPECTION-SURVEYS (SEC-RP-118, REV 0)			
a. Has the types of personal protective equipment been determined and listed on the RWP	Yes	No	
b. Do the workers know the proper sequence for donning and removing the PPE	Yes	No	
16. AIR MONITORING AND SAMPLING (SEC-RP-122, REV 1)			
a. Have the use of air monitors been determined and the if so listed on the appropriate RWP's	Yes	No	N/A
b. Have the appropriate type and number of air samplers been deployed in and around the radiation area	Yes	No	
c. Is the required information entered on the filter envelope at the end of the day for each air monitor	Yes	No	
17. AREA AIR PARTICULATE MONITORING (SEC-RP-123, REV 1)			
a. Have the use of air monitors for air particulates been determined and if so listed on the appropriate RWP's	Yes	No	N/A
b. Have the appropriate type and number of air samplers been deployed in and around the radiation area	Yes	No	
c. Is the required information entered on the filter envelope at the beginning of the day for each air monitor (Worker(s) name, HWP Number, Sample Model and Serial Number, ON Date, time and flow rate, ON BY (RCTs initial)	Yes	No	
d. Is the required information entered on the filter envelope and the was care taken to not cross contaminate the filter (Off Date, Time, Flow, Technician's name stopping air monitor)	Yes	No	
e. Was the required information entered on the air sample analysis envelope (Site Name & Project Number, Detector type and Serial Number, Detector Background In cpm, Detector Efficiency, Date counted, Signature of person who performed the count)	Yes	No	

18. UNRESTRICTED RELEASE OF EQUIPMENT AND MATERIALS (SEC-RP-130, REV 3)			
a. Has an area been set up to check equipment for contamination at the end of each work day	Yes	No	
b. At the end of the project are all pieces of equipment scanned for removable contamination by scanning first and then performing smears if needed	Yes	No	
c. If survey results indicate item is below acceptable contamination level, is the material immediately located to an area that eliminates the possibility of future contamination	Yes	No	
d. If survey results indicate the item is above releasable levels, is the item recleaned and resurveyed	Yes	No	
19. ENVIRONMENTAL AIR PARTICULATE MONITORING (SEC-RP-131, REV 1)	Yes	No	N/A
a. Has the site been evaluated to determine if there is a potential to exceed the effluent limit	Yes	No	
b. If needed, are the sampling pumps located between four-and-six-feet above ground level and easily accessible for changing filters and servicing	Yes	No	
20. CALCULATING DETECTION SENSITIVITY (SEC-IO-702, REV 0)			
a. Has the MDA been calculated for the meters	Yes	No	
21. SURFACE SCANNING (SEC-IO-704, REV 0)			
a. Are the areas that were found to be hot from the core samples taken earlier resurveyed for verification of location	Yes	No	
b. Once the contaminated soil is removed, is the area resurveyed to ensure that all contaminated soil has been removed	Yes	No	
22. DIRECT SURFACE ACTIVITY MEASUREMENT (SEC-IO-706)	Yes	No	N/A
a. Do survey team members understand this procedure	Yes	No	
b. Are the appropriate survey meters used for this procedure (Ludlum 44-9 with a pancake probe, or Ludlum 43-68 Gas Proportional	Yes	No	
c. If an area is located that has an elevated direct surface radiation level, is it recorded on the appropriate form	Yes	No	
23. OPERATING INSTRUCTIONS FOR THE LUDLUM MODEL 2221 (SEC-IO-723, REV 0)			
a. Is the calibration sticker current	Yes	No	
b. Has the daily quality control checks been completed	Yes	No	
24. TRANSPORTATION (10 CFR 71.5(a) and 49 CFR			
a. Licensee shipments are:	Yes	No	
Delivered to common carriers	Yes	No	
Transported in licensee's own private vehicle	Yes	No	
b. Packages			
Authorized packages used [173.415, 416(b)]	Yes	No	

	Closed and sealed during transport [173.475(f)]	Yes	No
	Properly labeled and marked [173.441, 172.302]	Yes	No
c.	Shipping Papers		
	Prepared and used [172.200]	Yes	No
	Proper {Shipping Name, Hazard Class, UN Number, Quantity, Package	Yes	No
	Type, Nuclide, RQ, Radioactive Material, Physical and Chemical Form,	Yes	No
	Activity, Category of Label, TI, Shipper's Name, Certification and Signature,		
	Emergency Response Phone Number, Readily accessible during transport	Yes	No
d.	Vehicles		
	Cargo blocked and braced [177.842(d)]	Yes	No
	Placarded, if needed [172.504]	Yes	No
e.	HAZMAT training per 172.700-704	Yes	No

25. PERSONNEL RADIATION PROTECTION

a.	ALARA considerations are incorporated into the Radiation Protection Program [20.1101(b)]	Yes	No	
b.	Adequate documentation Of determination that unmonitored occupationally individuals are not likely to receive >10% of allowable limit [20.1502(a)]	Yes	No	
c.	External dosimetry required and used	Yes	No	N/A
	Supplier: Frequency:			
	Supplier is NVLAP-approved [20.1501(c)]	Yes	No	
	Dosimeters exchanged at required frequency [I IC]	Yes	No	
d.	Occupational intake monitored and assessed [20.1502(b)]	Yes	No	N/A
e.	NRC Forms or equivalent [20.2104(d), 20.2106(c)]: NRC-4 "Cumulative Occupational Exposure History" Complete:	Yes	No	
f.	NRC-5 "Occupational Exposure Record (or a Monitoring Period" Complete:	Yes	No	
g.	Worker declared her pregnancy in writing during audit period (review records)	Yes	No	
	If yes, determine compliance with [20.1208]	Yes	No	
	and check for records per [20.2106(e)]	Yes	No	
h.	Records of exposures, surveys, monitoring, and evaluations maintained [20.2102, 20.2103, 20.2106, L/C]	Yes	No	
i.	Pocket dosimeters and/or alarming rate meters [L/C]:	Yes	No	
	Possessed and used as required	Yes	No	
	Operable and calibrated/checked at required frequency	Yes	No	
	Records maintained	Yes	No	
j.	Safety interlocks, area monitors and alarms [L/C]:			
	Found operational	Yes	No	
	Tested at required frequency	Yes	No	
	Records maintained	Yes	No	

Remarks:

26. AUDITOR'S INDEPENDENT MEASUREMENTS (IF MADE)

Survey instrument:	Serial No.:	Last calibration:		
Auditor's measurements compared to licensee's			Yes	No
Describe the type, location, and results of measurements:				

27. RADIOACTIVE EFFLUENTS, WASTE MANAGEMENT, AND DISPOSAL

- | | | | | |
|----|--|-----|----|--|
| a. | Disposal by DIS in accordance with L/C | Yes | No | |
| b. | Licensee in compliance with 20.1501 and 20.1904(b) | Yes | No | |
| c. | Records maintained [20.2103(a), L/C] | Yes | No | |

Remarks:

- | | | | | |
|----|--|-----|----|-----|
| d. | Licensed material released into sanitary sewerage: | Yes | No | N/A |
| | Material is readily soluble (or is readily dispersible biological material) in Water [20.2003(a)(1)] | Yes | No | |
| | Monthly average release concentrations do not exceed Appendix B values [20.2003(a)(2,3)] | Yes | No | |
| | No more than 5 curies of tritium, 1 curie of carbon-14 and 1 curie of all other radionuclides combined were released in a year [20.2003(a)(4)] | Yes | No | |

Remarks:

- | | | | | |
|----|---|-----|----|-----|
| e. | Transfers for disposal at land disposal facilities | Yes | No | N/A |
| | Waste transferred to person specifically licensed to receive waste | Yes | No | |
| | Each shipment accompanied by a shipment manifest prepared as specified in Procedure BIO-001 | Yes | No | |
| | Shipment manifests complete and certified as specified [61.56(b)] | Yes | No | |
| | Waste packages labeled to identify their proper class | Yes | No | |
| | Licensee conducts a QC program to ensure compliance with 61.55 and 61.56, and which includes management evaluation of audits [App. F.III.A.3] | Yes | No | |
| | For shipments not acknowledged by recipient within 20 days after transfer, incident investigated and reported | Yes | No | |

- | | | | | |
|----|---|-----|----|--|
| f. | Waste staging/storage areas: | Yes | No | |
| | Adequate control of waste in storage [20.1801] | Yes | No | |
| | Containers properly labeled and area properly posted [20.1902, 20.1904] | Yes | No | |
| | Package integrity adequately maintained [I IC] | Yes | No | |
| | Adequate records of surveys and material accountability are maintained [20.2103, 20.2108] | Yes | No | |

28. NOTIFICATION AND REPORTS

Yes No N/A

- a. Licensee in compliance with [19.13, 30.50] (reports to individuals, public and occupational, monitored to show compliance with Part 20) Yes No
- b. Licensee in compliance with [20.2201, 30.50] (theft or loss) Yes No
- c. Licensee in compliance with [20.2202, 30.50] (incidents) Yes No
- d. Licensee in compliance with [20.2203, 30.50] (overexposures and high radiation levels) Yes No
- e. Licensee aware of telephone number for NRC Emergency Operations Center
[(301) 816-5100] Yes No

29. POSTING AND LABELING

Yes No N/A

- a. NRC Form 3 "Notice to Workers" is posted [19.11] Yes No
- b. Parts 19, 20, 21, Section 206 of Energy Reorganization Act, procedures adopted pursuant to Part 21, and license documents are posted, or a notice indicating where documents can be examined is posted [19.11, 21.6] Yes No
- c. Other posting and labeling per [20.1902, 1904] and the licensee is not exempted by [20.1903, 1905] Yes No
Remarks:

30. RECORDKEEPING FOR DECOMMISSIONING

Yes No N/A

- a. Records of information important to the safe and effective decommissioning of the facility maintained in an independent and identifiable location until license termination Yes No

31. SPECIAL LICENSE CONDITIONS OR ISSUES

Yes No N/A

- a. Review special license conditions, site-specific procedures or safety issues or other issues, and describe findings:
- b. Problems/deficiencies identified:
- c. Evaluation of compliance:

32. CONTINUATION OF REPORT ITEMS

(If more space is needed, use separate sheets and attach to report.)

Yes No N/A

33. PROBLEMS OR DEFICIENCIES NOTED AND RECOMMENDATIONS

Yes No N/A

Note: Briefly state (1) the requirement and (2) how and when violated. Provide recommendations for improvement.

34. EVALUATION OF OTHER FACTORS

- a. ABC and SEC Senior licensee management is appropriately involved with the radiation safety program and/or Radiation Safety Officer (RSO) oversight Yes No
- b. RSO has sufficient time to perform his/her radiation safety duties and is not too busy with other assignments Yes No
- c. Licensee has sufficient staff Yes No

35. CORRECTIVE ACTIONS

Yes No

Date of This Audit _____ Date of Last Audit _____

Next Audit Date _____

Auditor _____ Date _____
(Signature)

Management Review _____ Date _____
(Signature)

ATTACHMENT VIII

**BIONOMICS, INC.
PROCEDURE BIO-01
EXCAVATION, PACKAGING AND TRANSPORTATION OF
REMEDiated SOIL FROM ABC LABS LAGOON PROJECT**

BIONOMICS PROCEDURE

**TITLE – EXCAVATION, PACKAGING AND
TRANSPORTATION OF REMEDIATED SOIL
FROM ABC LABS LAGOON PROJECT**

PROCEDURE NUMBER BIO-01 Rev. 0

Effective Date: 10/15/2009

FOR REVIEW ONLY

Prepared by: _____
Paul Nipper / BIONOMICS
PROJECT MGR.

Date: _____

Reviewed by: _____
Andy Lombardo / SEC CHP

Date: _____

Approved by: _____
Sheila Hecht / RSO ABC LABS

Date: _____

FOR REVIEW ONLY

BIO-01 CHANGE RECORD

SECTION AFFECTED	APPROVED BY:	DATE:	

I. PURPOSE

This procedure provides guidelines and instructions for the safe excavation, packaging and transportation of remediated material from the ABC lagoon decommissioning by Bionomics, Inc. personnel.

II. SCOPE

This procedure applies to the remediation of radioactive contaminated soils and materials involved in the decommissioning of the ABC Labs lagoon, drain field and application area. The objective of this project is to remove identified areas of contamination to achieve unrestricted release of the identified area.

III. RESPONSIBILITIES

A. Bionomics, Inc. Personnel

Bionomics' personnel are responsible for adherence to this procedure as well as all applicable SEC License, Health & Safety and ABC License requirements as well as the overall conduct of excavation, packaging and transportation activities.

B. SEC Personnel

1. On-site training requirements.
2. Health and Safety support
3. Radiological Surveys.
4. Generate Radiation Work Permits
5. Identify and mark work zones.

C. ABC Labs Personnel

1. Provide any site specific training.
2. Provide Liquid Scintillation Counter and supplies to obtain samples.
3. Perform audits.

IV. PRE REQUISITES

- A. All SEC and Bionomics, Inc. personnel involved with remediation activities shall be trained commensurate with their job duties.
- B. All equipment, tools and packaging supplies will be available to support this operation.
- C. Underground Utilities assessment shall have been performed.

V. CONTROLLING DOCUMENTS AND REGULATIONS

- A. SEC Procedures
- B. ABC RAM License
- C. Decommissioning Plan
- D. US Ecology Grandview Waste Acceptance Criteria
- E. Title 49 CFR
- F. Disposal Package Checklist (See Attached)
- G. Operating Instructions for Pactec Inc. Lift Pac (See Attached)

VI. PROCEDURE

A. Prior to the start of excavation, local utilities will be contacted to assure the absence of underground utilities. Note: There are no utilities identified on site maps that would be affected during excavation. Depth of excavation is anticipated to be no more than six to eight inches and should not affect underground lines if present. Mechanical equipment shall be inspected prior to use to assure leakage of fluids is not a concern. Equipment found to be leaking fluids (hydraulic, oil, diesel, etc.) shall be repaired prior to use. Any leaks that require cleanup will be remediated.

B. Remediation Phases

1. Phase One

Phase One consists of removing soils at northern discharge point of drain field piping system and selected areas in the application field. Material will be excavated by mechanical means (machinery or hand tools) and placed in lagoon for temporary containment. Contamination control procedures will be implemented to avoid the spread of contamination during all phases of excavation and packaging activities. Remedial Action Support Surveys shall be conducted to determine remediation effectiveness.

2. Phase Two

Phase Two consists of removing soil from the lagoon and packaging for transport. Material will be loaded into suitable packages that meet D.O.T. and disposal site requirements. This material is currently classified as NRC and D.O.T. exempt material based on waste characterization data. Additional sampling will be performed to assure compliance.

3. Phase Three

The final phase will involve the loading and shipping of packaged material for disposal. Qualified packages will be loaded on transport vehicles for transport to rail facility. The attached container checklist shall be used.

C. Packaging

1. All packages shall be inspected prior to loading with remediated material to assure packages meet "strong tight" conditions.
2. The Pactec instructions shall be used for loading operations.
3. After the package has been prepared for acceptance of material, the material will be removed from the lagoon area and deposited in the Pactec package by mechanical means such as backhoe, bobcat, etc.
4. Additional sampling will be performed prior to sealing package.
5. The filled package shall be assigned a unique identification number.
6. Filled packages shall be sealed per Pactec instructions.

D. Material Staging

Filled packages shall be staged in the designated posted area.

E. Shipment Preparation

Qualified packages shall be manifested for delivery to the rail facility. The packages will be consolidated for shipment in gondola cars and shipping papers generated. Appropriate shipping papers shall be prepared and reviewed prior to shipment.

F. House Keeping

Bionomics, Inc. is responsible for maintaining good housekeeping practices. The work area and equipment should be cleaned as needed, and at a minimum at the end of each day's activities. Radiological surveys shall be performed on equipment, tools at the end of each shift. Equipment found to have contamination present will be assessed prior to determining if decontamination is warranted.

DISPOSAL PACKAGE CHECKLIST

Package ID and Weight	Loaded:	Sampled:	Sample Results: pCi/g	Package Survey:	Loaded for transport:	Shipping Papers Prepared:

INITIAL AND DATE FOR EACH PACKAGE



12365 Haynes St., P.O. Box 8069, Clinton, LA 70722
225-683-8602 1-800-272-2832 Fax: 225-683-8711

OPERATING INSTRUCTIONS FOR PACTEC INC. LIFT PAC

Introduction

The PacTec, Inc. Lift Pac™ is a (4) sided bag with a flat bottom and zippered top. The top is hinged on one side and closes by means of a continuous zipper on the other three. The Lift Pac consists of an outer bag made of woven polypropylene, and may have an inner bag made of non-woven polypropylene (IP-2 version). On the IP-2 version, both the inner and outer bags close by means of a zipper. The inner and outer bags close from opposing edges. On both IP-1 and IP-2 LiftPac products, the bags have an interior duffle which is draped over the outside walls of the LiftPac and cover the Loading Frame during the loading process. This design protects the closure zippers and minimizes potential contamination during loading. When the LiftPac has been filled and is ready for closure, the duffle is pulled up and over the top of the loaded material, gathered and tied prior to sealing the LiftPac. The LiftPac is lifted with fourteen (14) integral lifting straps, which connect to two (2) support ropes positioned on the bottom of the bag. The lift straps are held in position by forty-two (42) elastic guide loops affixed to the sides and bottom of the LiftPac.

Installation Procedures

1. Place Loading Frame into position on level surface. The Loading Frame sidewalls should be in the closed and ready to load position.
2. Remove one LiftPac from pallet and partially unfold LiftPac to 8' x 7'2" footprint.
3. Holding top corners of LiftPac, drop LiftPac into Loading Frame making sure that the LiftPac is properly aligned with the corresponding length of sidewalls of the Loading Frame. The 96" side of the LiftPac should align with the 96" side of the Loading Frame.
4. Align the four bottom and top corners of LiftPac with the bottom and top corners of the Loading Frame.
5. In an upward motion, pull all four sidewalls of LiftPac tight against the interior sidewalls of the Loading Frame making the fabric as smooth as possible.
6. Check the position of the 14 lift straps to ensure that all lifting straps are draped over the outer top edge of the Loading Frame. Lift straps should be flat with no twists or folds, and positioned from the bottom of the LiftPac, up the sidewalls and attached at the top edge of the LiftPac with Velcro to the elastic guide loops. **CAUTION: IF A LIFT**

STRAP IN NOT IN PLACE, IT MUST BE LOCATED AND PULLED OVER THE OUTER WALL OF THE LOADING FRAME IN ORDER TO FOLLOWING THE PACTEC, INC LIFTING PROCEDURES WHICH REQUIRES THE USE OF ALL 14 LIFTING STRAPS.

7. The LiftPac may be secured in position by attaching rope or bungees to the lift straps lifting loops and attaching the rope or bungees to the exterior of the Loading Frame.
8. Once LiftPac is in place and secured, unzip the inner and outer top flaps of LiftPac and drape top flaps over the top edge of the Loading Frame.
9. Pull interior duffle up and out to drape over the sidewalls of the Loading Frame. Note: Zipper should be entirely covered by the duffle for protection.
10. The LiftPac is now ready for effective loading. Please refer to PacTec, Inc. recommended standard operating procedures for loading the LiftPac.

"Providing Solutions for the Environment"

Express

From: Origin ID: COUA (573) 777-6340
James Tatters
ABC Labs
4780 Discovery Drive
Columbia, MO 65201



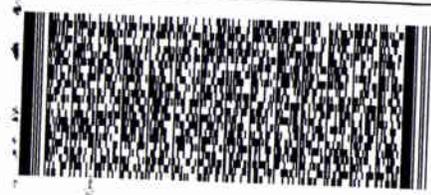
Ship Date: 20OCT09
ActWgt: 8.0 LB
CAD: 2281399/NET9090
Account#: S*****

Delivery Address Bar Code



Ref # Sheila Hecht
Invoice #
PO #
Dept # 710

SHIP TO: (830) 829-9854 BILL SENDER
George McCann
Nuclear Regulatory Commission
2443 WARRENVILLE RD STE 210
REGION 3
LISLE, IL 60532



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