PARKS FACILITIES

DECOMMISSIONING PLAN

REV. 1

May 23, 1997

70-364

B&W Nuclear Environmental Services, Inc.

a McDermott company

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ESH97-060
May 23, 1997

Mr. D.A. Orlando, Project Manager
Division of Low-Level Waste and
Decommissioning Projects Branch
Mail Stop T3F-37
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Subject: Parks Facilities Decommissioning Plan, Revision 1

Dear Mr. Orlando:

Enclosed please find seven copies of the Parks Facilities Decommissioning Plan, Revision 1, dated May 23, 1997. This revision incorporates changes as agreed upon by the NRC and B&W NESI staffs' since the issuance of Revision 0. A change bar in the right hand margin indicates changes. Revision 1 supercedes and replaces Revision O in its entirety.

B&W NESI is eager to proceed with decommissioning activities covered by the plan and therefore requests your expeditious review and approval. If you have any questions please contact me at (804)948-4733.

Sincerely,

Philip R. Rosenthal

Philip R. Rosenthal
Licensing and Special Projects

NMSS

cc: W/Enclosure
T. Jackson – NRC Region I
J. J. Matviya - PaDEP

TABLE OF CONTENTS

APPENDICES

LIST OF FIGURES

Figures are located at the end of the section in which they are referenced.

LIST OF TABLES

ACRONYMS AND ABBREVIATIONS

AEC	Atomic Energy Commission
ALARA	As Low As Reasonably Achievable
ANSI	American National Standards Institute
ASTM	American Society for Testing of Materials
B&W	The Babcock and Wilcox Company
B&W NESI	B&W Nuclear Environmental Services, Inc.
BWICO	The Babcock & Wilcox Investment Company
CAS	Central Alarm Station
CB	catch basin
CFR	Code of Federal Regulations
Ci	Curie
CO	clean out
cpm	counts per minute
CRGT	Control Rod Guide Tube
DOE	U.S. Department of Energy
EAP	Environmental Analytical Procedure
EDMS	Environmental Data Management System
EPA	U.S. Environmental Protection Agency
ER	Engineering Release
ES&H	B&W NESI, Environment, Safety and Health
Fab	A fabrication area in Building A
FFTF	The DOE's Fast Flux Test Facility
GP	General Procedure
H&S	Health and Safety (for the Parks Project)
HAZWOPER	Hazardous Waste Operations and Emergency Response
HEPA	High-Efficiency Particulate Air
HEU	high enriched uranium
HPP	Health Physics Procedure
HS&L	Health & Safety and Licensing (for the Parks Project)
HSI	Health and Safety Instruction (for the Parks Project)
HVAC	heating, ventilation and air conditioning
INPO	Institute of Nuclear Power Operations
K_d	distribution coefficient
KVWPCA	Kiski Valley Water Pollution Control Authority
LEU	low enriched uranium
LLD	Lower Limit of Detection
LLRW	Low Level Radioactive Waste
LSA	Low Specific Activity
LWD	Liquid Waste Discharge
M	monitoring line
MDA	Minimum Detectable Activity
MH	man hole
mrem	millirem
MW	monitoring well

NIST	National Institute of Science and Technology
NMC	Nuclear Material Control
NPDES	National Pollution Discharge Elimination System
NRC	U.S. Nuclear Regulatory Commission
NSC	B&W Nuclear Service Company
NUMEC	Nuclear Materials and Equipment Corporation
OI	Operation Instruction
OSHA	Occupational Safety and Health Act
PaDEP	Pennsylvania Department of Environmental Protection
PCB	polychlorinated biphenyl
pCi	picoCurie
PIC	Pressurized Ionization Chamber
PVC	polyvinyl chloride
PZ	piezometer
QA	Quality Assurance
QAPP	Quality Assurance Project Plan
QC	Quality Control
QIP	Quality Implementing Procedure
R	Roentgen
R&D	Research and Development
RCP	reinforced concrete pipe
rem	Roentgen equivalent man
RPP	Radiation Protection Program
RWP	Radiation Work Permit
SD	sanitation drain
SLDA	Shallow Land Disposal Area
SNM	Special Nuclear Material
SRI	Shipping and Receiving Instruction
ST	storm sewer
T-2	Type II
TCE	trichloroethylene
TCP	terra cotta pipe
TLD	thermoluminescent dosimeter
TP	Technical Procedure
TRU	transuranic
UAS	Uranium Analytical Services
ZPPR	Zero Power Plutonium Reactor

REV. 1
CHANGE SUMMARY

Several changes were made to Rev. 0 in creating Rev. 1. Wherever practical, the changes are identified by vertical bars in the right hand margins. Several additional changes made to text and figures are described below.

Text

A number of typographical errors in the text of Revision 0 were corrected in Revision 1 but not identified by vertical bars in the right hand margin if they had no significant impact on the understanding of the text (e.g., hyphenating a word, adding a comma, changing an upper case letter to a lower case letter, and changing tense). As is customary practice in license applications, text deletions were not marked in the right margin.

Although Project Unit F was described in the Parks Facilities Characterization Plan and Report, most of the land area within the Project Unit F boundary is contained within the boundary of the SLDA and is therefore regulated by license SNM-2001. To avoid confusion, all references to Project Unit F contained in Rev. 0 of the Parks Facilities Decommissioning Plan have been deleted in Rev. 1. The small amount of land area within Project Unit F that is not included within the boundary of the SLDA has been reassigned in Rev. 1 of the Parks Facilities Decommissioning Plan to Project Unit E. Most of these deletions, including the total deletion of Sections 2.1.6 and 2.2.6, are not identified by vertical bars in the right hand margin since there is no text to mark.

Figures

The horizontal axes in Figures 2-16 and 2-17 were split so that the relationship of the D-S-5 sampling location to Outfall 1 could be seen. Also, since additional surface and river water sample data is now available, the concentration data were removed from Figures 2-17 and 2-17, and placed in a new table identified as Table 2-4. Figure 2-18 in Rev. 0 was not included in Rev. 1 since it was a presentation of Project Unit F data. Figure 2-19 in Rev. 0 was renumbered as Figure 2-18 in Rev. 1. Figure 3-1 was revised to clarify what outside-the-fence work is authorized under the existing SNM-414 license. Figure 3-2 was revised to reflect the B&W NESI organizational changes which have occurred since Rev. 0 was submitted. Figure 3-3 was revised to reflect the current decommissioning schedule. A new Figure 5-1 was added to show the affected areas and unaffected areas, based on the information accumulated to-date. Finally, several figures were changed in Section 2, to remove the Project Unit F areas, which are part of the SLDA.

Tables

A new Table 2-4 containing the surface water concentration data was added. A new Table 4-1 was added to identify the environmental monitoring stations to remain in operation after NRC approval of this decommissioning plan. Finally, Table 2-3 was updated to include the groundwater data obtained since Rev. 0 of the Parks Facilities Decommissioning Plan was submitted in January 1996.

1.0 BACKGROUND

The Parks Project is designed to decontaminate and decommission the B&W Parks Facilities. Activities and property at the adjacent Shallow Land Disposal Area are covered under a separate NRC license, and hence are not included in this plan. The objective of this decommissioning plan is to remediate radiological constituents at the Parks Facilities to the extent required by applicable governmental directives, standards and regulations in order to allow the NRC to (a) release the property for unrestricted use and (b) terminate license SNM-414. In view of the results of the characterization of the Undeveloped Area (see Section 2.2.5), no radiological remediation is needed.

Submittal of this Parks Facilities Decommissioning Plan was preceded by more than eight months of planning and site characterization, budgeted in excess of $3 million. This effort significantly enhanced B&W's knowledge regarding conditions at the Parks Facilities. The field activity and laboratory analysis of the comprehensive radiological and chemical characterization is complete. The B&W NESI evaluation of the results was documented in a Site Characterization Report transmitted to the NRC and PaDEP on April 30, 1996. This decommissioning plan summarizes the complete set of radiological data from the historical characterization activities and the recently completed site characterization effort.

Planning and characterization also served to identify key issues which may affect the overall feasibility of the project. While these issues are outside of B&W's direct control, they must nevertheless be resolved under terms and conditions acceptable to B&W in order for the decommissioning effort to proceed. B&W is working towards resolution, and firmly believes that the following items will in fact be satisfactorily resolved, in which case B&W is committed to proceeding with decommissioning the Parks Facilities:

1. Envirocare of Utah can continue to dispose of Parks Facilities waste for the duration of the project;

2. Necessary permits and/or approvals for B&W's activities, including the residual acceptance criteria specified in the plan, are received from the appropriate agencies in a timely manner, and;

3. Waste materials continue to be classified as low-level radioactive waste, or if any of the materials are classified as mixed waste, an acceptable disposal option is available.

1.1 LICENSE INFORMATION

This Decommissioning Plan pertains to Nuclear Regulatory Commission (NRC) license number SNM-414, Docket No. 70-364. The name of the licensee is The Babcock & Wilcox Company (B&W). B&W is a subsidiary of The Babcock & Wilcox Investment Company (BWICO). B&W and BWICO have their principal offices at 1450 Poydras Street, New Orleans, LA 70112-6050. B&W Nuclear Environmental Services Inc. (B&W NESI), an affiliate of B&W and itself a subsidiary of BWICO, is responsible to B&W for site operations at the Parks Facilities. The full mailing address is Babcock & Wilcox, Pennsylvania Nuclear Service Operations, R.D.#1, Box 355, Vandergrift, PA, 15690.

B&W NESI recognizes that this Decommissioning Plan, when approved, will become an amendment to license SNM-414 and, as such, may change, delete, or be an addition to conditions specified by the license.

1.2 SITE AND FACILITY DESCRIPTION

B&W owns approximately 115 acres of land located in Parks Township, Armstrong County, Pennsylvania. The location of this land relative to surrounding features is shown in Figure 1-1. For purposes of decommissioning, the B&W Property is subdivided into three principal areas:

- an area known as the "Parks Facilities" where three major facilities that have been used for nuclear activities, known as Buildings A, B and C, are located;
- an area containing the "Shallow Land Disposal Area" (the SLDA, where low level waste from Apollo was buried), which is licensed separately under SNM-2001 (Docket No. 70-3085) and is not subject to license termination under this decommissioning plan; and,
- an "Undeveloped Area" where nuclear materials were never processed or stored.

The location of these three areas is shown in Figure 1-2. The balance of the property owned by B&W is discussed in Section 2 and shown on Figure 2-2 where it is identified as Project Unit D.

1.2.1 Site Description

The land around the B&W Property is a mixture of rough terrain (steep hills and narrow valleys) and flat rolling country, having trailing divides, flat saddles, and rounded hills. Ground surface elevations range from about 740 feet to 1,740 feet above mean sea level. The land generally slopes to the south and west.

The B&W Property adjoins the Kiskiminetas River about 7.7 miles from its confluence with the Allegheny River. These two major rivers drain Armstrong County. The Kiskiminetas River, which forms the County's southwestern boundary, is not currently being used for drinking or irrigation downstream from the Parks Facilities. Recreational use of the Kiskiminetas River for boating and fishing is increasing because of reduced drainage of coal mining waste which led to historically high acidity of the river.

The B&W Property is surrounded by a mix of small farms with croplands and pastures, idle farmland, forest lands, light industry, medium-sized residential communities, and individual rural residences, as shown in Figure 1-1. A restaurant is located adjacent to the property on the north side, and a small industrial complex is located within a mile. The nearest residence is located along Kiskimere Road,

about 150 feet from the property, and the closest community is Kiskimere. Based on 1990 U.S. Census figures, about 2,500 people reside within a one mile radius. The nearest population center is the incorporated borough of Leechburg (population 2,504), located one mile to the west and physically separated from the B&W Property by a loop in the Kiskiminetas River. The incorporated borough of Vandergrift (population 5,904) is located 1.2 miles to the south and across the river. The unincorporated communities of Hyde Park, Kepple Hill, Kiskimere, North Vandergrift, Pleasant View, West Leechburg, and West Vandergrift lie within a 2 mile radius of the property. The estimated population of each of these communities in 1990 was between 100 and 500 people (reference Finding of No Significant Impact and Environmental Assessment for Renewal of License SNM-414, NRC, October 28, 1993.)

A humid, continental climate prevails in this region of Pennsylvania. The average daily temperature ranges from 23°F to 84°F, and the average annual precipitation is 36 inches with only small monthly variations.

During site characterization, the soils surrounding the buildings were identified as primarily silty clay, about 10 feet thick. Alluvial deposits of clay, silt, fine-grained sand, and coarse gravel were found at depths of 10 to 20 feet below the soil overburden. Most of the area around Buildings A and B consists of fill, disturbed soil, impervious cover, or is parking area. The area of the site covered with pavement or building is about 6.6 acres.

Geologic cross-sections were developed from the materials found during well and soil boring in and around Building A. Significant geologic features include soft claystone found between 3 and 6 feet below ground surface, and a shaley sandstone underlain by a carbonaceous shale which was not fully penetrated. In the adjacent floodplain of the Kiskiminetas River, alluvium deposits of clay, silt, sand, and gravel were found overlying the bedrock. The clay is generally silty to sandy, the sand is medium grained and well sorted, and the gravel is subangular to rounded and ranges from about one to six inches in diameter. Particle size increases with depth as the clay grades into silt and sand which overlies gravel.

Two hydraulically connected zones of groundwater exist within the Parks Facilities boundary; (1) an unconfined water-bearing zone in the carbonaceous shale bedrock, and, (2) a water-bearing zone of alluvial deposits. Groundwater recharge to the alluvium occurs primarily from surface infiltration and from groundwater moving predominantly along the soil/bedrock interface and into the alluvium from regions which are topographically upgrade. The static groundwater level measured in July 1991 at wells installed into the unconfined bedrock zone ranged from approximately 4 to 26 feet below ground surface.

Dry Run (formerly known as the Unnamed Tributary) originates in the Undeveloped Area of the B&W Property, east of the SLDA and approximately 2,100 feet from the Building C location. Dry Run flows through the SLDA and back into the Undeveloped Area before it is collected into a culvert which discharges to the Kiskiminetas River. The river discharge is permitted under the National Pollutant Discharge Elimination System (NPDES) as Outfall 1. Dry Run is dry for much of the year. Flow occurs seasonally and following significant rainfall events. Except during periods of extreme storm runoff, the entire flow of Dry Run infiltrates into the mine backfill area of the SLDA. Much of the infiltrating water enters the mine workings south of this area of Dry Run. Mine drainage enters the mine fill in this area from north of Dry Run and comprises most of the water in Dry Run where it emerges from the mine fill. Therefore, only a small portion of the water in the upper reaches of Dry

Run is present in the lower reaches of Dry Run and flows to the Kiskiminetas River.

Additional site description details can be found in the 1995 Parks Facilities Characterization Plan, Revision 0, which was submitted to the NRC on March 13, 1995.

1.2.2 Facility Description

Nuclear Materials and Equipment Corporation (NUMEC) was the initial owner of the Parks Facilities. The stock of NUMEC was sold in 1967 to the Atlantic Richfield Company. NUMEC, as a wholly-owned subsidiary of ARCO, operated the Parks Facilities until late 1971. B&W purchased the stock of NUMEC in November 1971 and NUMEC operated as a wholly-owned subsidiary until 1974, when the operations were consolidated into a B&W operating division. B&W NESI, an affiliate of B&W, has been responsible to B&W for operation of the Parks Facilities since April 1, 1992.

The major buildings within the Parks Facilities included a former plutonium processing facility (Building A); a multi-purpose fabrication building (Building B); and, a former high-enriched uranium processing facility (Building C). At various times in the past, Building A has been known as the Plutonium Lab; Building B as a combination of the Metals Plant, Hafnium Facility, and Machine Shop; and Building C as the Type II or T-2 Facility. What is now identified as the Parks Facilities was identified as the NUMEC Advanced Materials Center in the 1960s and early 1970s. Nuclear materials were processed and stored in designated areas of Buildings A, B, and C. Nuclear materials were also stored in certain outdoor locations surrounding Buildings A and B during the early years of operation. No radioactive material was handled, stored or processed in the Undeveloped Area.

Building A

Building A was constructed in five major phases, beginning in 1959 and continuing until 1970. The original portion of Building A was designed as a plutonium laboratory to perform R&D leading to plutonium-based products for emerging nuclear businesses. Initial operations in Building A were authorized by the Atomic Energy Commission (AEC) in 1960. Many experimental fuel forms and compositions were produced in the 1960s, including oxides, carbides and metal alloys in the form of plates, powder, pellets and special shapes. Work with nuclear materials in Building A was conducted in fabrication areas designated as Fab 1 through 7 and Fab 9, and in several small laboratories adjacent to the Fab areas. The current layout of the Fab areas is shown in Figure 1-3. All significant work on nuclear fuel materials was done within containment systems such as radiochemical hoods and gloveboxes.

The two largest production runs of fuel were Zero Power Plutonium Reactor (ZPPR) fuel plates in the late 1960s, and Fast Flux Test Facility (FFTF) fuel rods in the 1970s and early 1980. More than 12,200 ZPPR fuel elements were produced under contract to Argonne National Laboratory using plutonium-uranium-molybdenum ternary alloy plates encapsulated in stainless steel. The plutonium content was primarily Pu-239, with 11,500 of the plates having 11.5% Pu-240 and the balance of the plates having 27% Pu-240. The uranium was depleted.

FFTF (the DOE's Fast Flux Test Facility) fuel was the largest order of fuel processed in Building A. More than 50,000 FFTF pins were made; portions of Cores 1 and 2, and the entire Cores 3 & 4. The FFTF fuel was a mixed oxide based on a 20:80 ratio by mass of plutonium dioxide (PuO_2) and uranium dioxide (UO_2). The plutonium isotopic content was approximately 86% Pu-239, 12% Pu-240, and 2%

Pu-241 with trace amounts of Pu-242 and Pu-238. The uranium was either natural or depleted, depending on the customer's specifications.

Plutonium scrap recovery was an integral part of Building A operations. Scrap recovery operations were conducted in Fab 5 until August 1, 1967. They were moved in 1968 to a much larger and improved operation in Fab 6, which operated throughout the 1970s and into 1980. The scrap was dissolved in concentrated nitric acid to which a small amount of hydrofluoric acid had been added. The valence of the plutonium ion in the impure nitrate solution was adjusted by the addition of small quantities of ferrous sulfamate and sodium nitrite. The plutonium nitrate solution was purified by passing through ion exchange columns. The purified solution was then concentrated by evaporation, put into bottles and stored for shipment to the customer or for conversion into plutonium oxide.

Conversion of plutonium nitrate to plutonium oxide was performed at the north end of Fab 1 inside HEPA filtered gloveboxes. The conversion process started with small batches of plutonium nitrate to which either oxalic acid or hydrogen peroxide was added. The same equipment could be used for either precipitation process. The filter cake from the precipitation and filtration steps was transferred to a muffle furnace for calcining to PuO_2. The PuO_2 was placed into metal cans and stored for shipment back to the customer or for use in the Building A fuel fabrication.

The chemical, physical, mechanical, and radiochemical properties of in-process fuel, finished fuel forms, and radiation sources were determined on small samples in several small laboratory rooms adjacent to the west side of Fabs 1, 2, 3, and 4. Separate laboratories existed for wet chemistry, metallography and mechanical properties, and radiochemistry. An analytical chemistry laboratory was also installed in Fab 5, after removal of the scrap recovery process equipment, but the Fab 5 lab only operated for about 6 months during 1979-1980. Only laboratory size quantities of reagent grade chemicals were used in these laboratories.

Alpha, neutron and thermal sources were also produced in Building A. The two most common neutron sources were double-encapsulated plutonium-beryllium metallic sources and compacted mixtures of americium oxide and beryllium metal powders. These neutron sources were made in the Fab-4 area. A standard alpha source was made which consisted of a plutonium oxide film deposited on one or both sides of a flat metal backing plate. Limited quantities of various other neutron, beta, and gamma sources were also made to specific customer specifications. Materials used in these specialty sources included polonium, plutonium, americium, iridium, cesium, cobalt, and beryllium. Source manufacturing always took place inside HEPA filtered gloveboxes, except for high activity sources which were fabricated in the Building A Hot Cell.

The north end of Building A was divided into two large rooms. The Hot Cell and the Cell Control Area occupied the east room, and the Hot Handling Facilities occupied the west room. The Hot Cell was a reinforced, high density concrete structure designed for shielding personnel from gamma radiation. The Cell Control Area contained a fumehood for mixing chemicals prior to inserting them into the cell, and a second fumehood over the fission gas analysis equipment. A metallographic cell was abutted to the west side of the Hot Cell, just north of the sliding doors. Two small, steel-walled hot cells were also located in the Hot Handling Facilities room. One cell was used as a dissolving cell and the other for storage of radioactive specimens.

The interior of the Hot Cell was at a lower pressure than the exterior to prevent radioactive materials from reaching the workers or the environment. Air from the Hot Cell passed through a HEPA filter

prior to reaching the stack. Two liner boxes were used in the cell for performing work on materials containing alpha emitters. Each box had inlet and output filters and the air exiting the boxes passed into the main cell exhaust system which was HEPA filtered. Two other ventilation systems served hot cell operations. One system exhausted the metallograph and dissolver cell in the Hot Handling Facilities room, and the fission gas fumehood in the Cell Control Area. The other system exhausted the chemical fumehood in the Cell Control Area.

Gamma sources of Ir-192 and Co-60, which required extensive shielding (i.e., a hot cell), and high yield neutron sources of Po-210/beryllium were fabricated in the Hot Cell . but the primary work performed in the Hot Cell was destructive post-irradiation examination of test capsules and fuel pins irradiated in research reactors.

Significant quantities of chemicals were not used in hot cell operations, although varied reagents were used for metallography and cleaning of sealed sources. Solid waste from inside the Hot Cell was packaged and disposed of at AEC/NRC-approved disposal sites. High activity liquid waste was solidified for disposal as solid radioactive waste. Low activity liquid waste, such as from washing the cell walls prior to a manned entry, was sent to an outside, underground tank. This tank was fed by two floor drains inside the Hot Cell and one floor drain in the Hot Handling Facilities room. The tank liquid was periodically pumped back into the Building A low level liquid waste discharge system. Eighteen dry storage units (five inch diameter aluminum pipes set in concrete) are located outside the north end of the building just west of the former Hot Cell underground tank. The dry storage units were used to temporarily store containers of radioactive material going into or out of the hot cells.

Fuel processing and source manufacturing in Building A required support from other systems such as: water heaters; HVAC; natural gas fired boiler; air compressor; emergency generator; and a cooling tower. A small supply room for chemicals was originally located near the metallographic room west of Fab 1, but was moved later to Fab 8. Large containers of chemicals (bulk chemicals) were stored in several locations including outside the building. Building A also housed a repair shop for non-contaminated equipment, a shipping and receiving area, administrative offices, and lunch room areas. Special Nuclear Material (SNM) was neither processed nor stored in these support areas. Routine repair and maintenance of contaminated equipment was performed in the glovebox or radiochemical fumehood where the equipment was located. More extensive repairs were performed in the Warm Maintenance Area which contained a series of ventilated, HEPA filtered gloveboxes containing a lathe, drill press and other required equipment. The Warm Maintenance Area was located near the east side of Fab 1. Most of the equipment committed to the gloveboxes and radiochemical fumehoods was modified prior to use to facilitate both maintenance and repair within the containments.

Waste management was particularly important during the days of fuel fabrication. Recoverable amounts of plutonium and uranium were returned to customers, the fuel plant in Apollo (uranium only), or to another AEC-approved site. Trace quantities of plutonium and other radioactive materials, in the form of equipment or material contamination, were not recoverable and were sent for disposal as radioactive solid waste. Acidic waste streams were neutralized, solidified and sent off-site for disposal.

Liquid wastes such as sink and shower water and water used to cool the process equipment were discharged into holding tanks for sampling and monitoring to assure compliance with Pennsylvania and AEC/NRC limits prior to discharge to the Kiskiminetas River. In 1977, these discharges were rerouted to the Kiski Valley Water Pollution Control Authority (KVWPCA) sanitary sewer. Stormwater was also discharged to the river and since 1994 has been discharged under a NPDES permit. Sanitary wastes

from six of the Building A rest rooms were originally discharged into three septic tanks and one septic field located between the building and Route 66. Sanitary wastes from a seventh rest room in Fab 9 discharged to a separate tank and septic field located to the rear of the building. All connections to the Building A septic systems were rerouted to the KVWPCA sanitary sewer in 1977, thereby eliminating use of the septic tanks and drain fields.

Air from the process areas of Building A was discharged via a system of roof stacks using one, two or three stages of HEPA filtration. The majority of the stacks vented the HEPA filtered gloveboxes and radiochemical fumehoods, while the balance vented the flue gases from the natural gas fired heating units or general area exhaust. Exhaust air was not HEPA filtered if it came from the office areas, the Fab 4 change room, and other areas of the plant where radioactive material was not handled.

All the plutonium glove boxes and fumehoods were removed from Building A during a 1981-1983 deactivation program. Most of the effluent streams which existed during the years of plutonium fuel production were thus eliminated. The workload in Building A then shifted to repair and refurbishment of contaminated equipment used at reactor sites, building decontamination, and Low Level Radioactive Waste volume reduction services for commercial customers. Although involving much smaller quantities of radioactive isotopes, these activities still generated radioactive contamination, so the building exhaust air continued to require HEPA filtration before exiting through roof stacks. This exhaust was monitored to assure compliance with existing regulations. As commercial work slowed in the mid-1990s, the pace of building decontamination increased.

Additional details of the processing history in the Fab areas of Building A can be found in the Parks Facilities Characterization Plan which was submitted to the NRC on March 13, 1995.

Building B

Building B was constructed in three stages, beginning in 1961 when the Hafnium Facility was built to produce crystal-bar hafnium. The second stage of construction occurred in 1963 when the Metals Plant was built to the east of the Hafnium Facility. The third and final stage of construction occurred in 1964, when the space between the Hafnium Facility and the Metals Plant was closed in to create the Machine Shop. Later in its life, the combined facility became known as the Metals Building, and then Building B. The layout of Building B is shown in Figure 1-4.

Depleted uranium was the primary radioactive material processed in Building B, although smaller quantities of natural uranium, thorium, and Pu-238 were also processed. The depleted uranium was primarily in the form of metal or metal alloy, and the processing consisted mostly of forming (rolling, etc.) and machining operations which do not generate significant airborne emissions. A limited amount of U_3O_8 powder products were produced at the northeast end of Building B. Pu-238 was processed in a room in the northwest corner of Building B. All Pu-238 work was performed within interconnected gloveboxes. Receiving and shipping operations were conducted in a chemical fumehood. Non-radioactive metals and alloys were also processed in significant quantities in Building B. The majority of the work was production of crystal bar zirconium and hafnium, and zirconium-beryllium alloys.

The chemicals used in Building B were those required to support the radioactive materials and specialty metals processing and manufacturing. This included the use of nitric and oxalic acids in Pu-238 processing, use of materials such as trichlorethylene (TCE), and use of iodine in crystal-bar production.

The Hafnium Facility

The original product from the Hafnium Facility was crystal-bar hafnium. Crystal-bar hafnium was produced by reacting hafnium sponge with iodine (non-radioactive) to form hafnium-iodide gas. The gas was introduced into a vessel containing a high purity hafnium wire. A reaction between the gas and the heated wire dissociated the gas and deposited the hafnium on the wire forming crystal-bar hafnium. After reaction, the iodine gas was condensed and cycled back through the operation. The hafnium bar was packaged and shipped to customers. Crystal-bar zirconium was also produced in the Hafnium Facility using a process similar to the crystal-bar hafnium process.

A specialty zirconium alloy product was produced by hydriding ingots of beryllium and zirconium with hydrogen gas in a furnace. The resulting hydride was ground into powder, heated under vacuum to dissociate the hydride, milled, and sieved. The dehydrided powder was blended with titanium powder to produce homogeneous lots of zirconium-beryllium-titanium alloy powder. The blended powder was pressed into solid rings, packaged and shipped. Metal powders of other alloys were also produced in the Metals Plant using an identical hydride-dehydride process.

Under contract with the Atomic Energy Commission, Pu-238 nitrate was converted into an oxide product in a room in the northwest corner of the Hafnium Facility known as the Plutonium Annex. The conversion process for the Pu-238 nitrate was very similar to the process used for converting Pu-239 nitrate into fuel products in Building A, except that only oxalate precipitation was used. The conversion was performed in eight HEPA-filtered gloveboxes. Both product and waste were shipped to government sites. Sink and shower water and waste water from the janitor sink were discharged into one of two interconnected 1,000 gallon underground concrete tanks. The tanks were sampled to verify the water met AEC and Pennsylvania discharge criteria prior to release to the Kiskiminetas River. After production was completed, the equipment was removed and boxed. The gloveboxes were partially decontaminated and the glove ports sealed. The boxes were filled with a fire retardant foam, placed in large diameter corrugated steel pipe and the pipe was filled with foam. The boxes and pipes were shipped to a licensed radioactive waste disposal site in New York. Following equipment and glovebox removal, the floor covering was removed and the room decontaminated. The underground tanks and associated piping which supported the work in the Plutonium Annex were not removed at the time the equipment was dismantled. The two concrete tanks and the piping from the building to the tanks and several feet of outlet pipe were removed in a remediation project in 1991 which will be discussed later in Section 1.3.

B&W NESI's Nuclear Environmental Laboratories - Parks Township Laboratory is currently operational along the west side of the Hafnium Facility. The lab was opened in 1991 and will continue operation in Building B until the building is ready for final decontamination. At that point in time, the lab equipment will be moved to a temporary on-site facility and will continue operation for the remainder of the remediation effort.

The Machine Shop

The Machine Shop, connecting the Hafnium Facility to the Metals Plant, was used to fabricate equipment and machine metals in support of the production lines at the Apollo and Parks Township sites. The equipment in the Machine Shop included drill presses, lathes, shears, formers, grinders, polishers, welders, sandblasting, degreasing and other associated metal working machinery. Machining of depleted uranium was performed in the Machine Shop. Additionally, the repair/refurbishment of

equipment from the Apollo and Parks facilities was performed. Some of this equipment contained levels of radioactivity that exceeded the then existing criteria for release for unrestricted use.

The machining operations all took place on the ground floor. The second floor contained primarily offices and a training room, although a small environmental laboratory was in use at the south end of the second floor until 1991. After 1991, most of the second floor was used as office space until decontamination operations started in Building B in late 1996.

The Metals Plant

The Metals Plant was built in 1963. The original layout of the first floor of the Metals Plant included a variety of equipment to: melt zirconium-beryllium rods; heat treat tantalum and zirconium billets or plates for drawing or rolling; extrude copper-clad zirconium and uranium billets; forge uranium and zirconium products; hot roll tantalum and boron containing stainless steels; cold roll magnesium, tantalum and zirconium; vacuum annealing of metals; drawing and rotary swaging zirconium and uranium products; blending zirconium-beryllium powders and pressing into rods for later electric arc melting; air induction melting of stainless steel billets containing boron; vacuum induction melting of depleted uranium-molybdenum ingots which were sent to Building A for remelting into Pu-U-Mo alloy fuel plates; centerless grinding of uranium and zirconium products; powder processing of depleted U_3O_8 compacts; electroplating copper, nickel or cadmium cladding onto depleted uranium products; manufacturing and encapsulating sodium carbonate wafers, and hafnium or boron containing stainless steel control rods; pickling metal products after vapor (TCE) degreasing, cleaning with nitric acid (occasionally with HNO_3-HF) and/or a caustic solution, and deionized water rinsing.

Metals production from the Metals Plant was small scale and intermittent. Most of the processing equipment was removed for resale or disposal in 1973-1974. During the mid-1970s, a portion of the high bay area was used to machine non-radioactive fan components.

The second floor of the Metals Plant initially contained only one office, but over the years other offices were added along with two physical and mechanical testing laboratories for quality control testing, and an Energy Conversion Lab (also called the R&D Lab) where R&D projects were performed such as the development of Pu-238 fueled heart pacemakers, under an AEC sealed source license.

Shower and sink water was sent to one of two 500-gallon tanks on the east side of the Metals Plant and sampled prior to release to the Kiskiminetas River through the Metals Plant sewer. The condensed steam from the cooling tower was discharged directly to the Kiskiminetas River through the Metals Plant sewer. The sanitary waste was sent to one of two septic tanks and distributed to a leach field located between Building B and Route 66. In 1977, the sanitary waste from Building B was connected to the KVWPCA sewage system.

As the original equipment in the Metals Plant was discarded, much of the building was converted to office space and continued in use until decontamination activities began in Building B.

Additional details of the processing history in each of the three building complexes can be found in the Parks Facilities Characterization Plan which was submitted to the NRC on March 13, 1995.

Building C

Combined with the general expansion of Building A in the 1969-1970 time period, a new building was erected to the east of Building A. The building sat unused until 1973 when B&W received a contract to fabricate a high-enriched uranium fuel called Type II fuel. The building became known as the Type II Plant or T-2 Plant, and processing of SNM in the building was authorized by the AEC as Amendment No. 83 to SNM-414. The layout of Building C when it was in a production mode is shown in Figure 1-5.

The processing of Type II fuel involved dissolving high enriched U_3O_8 in a solution of hydrochloric acid and hydrogen peroxide, then diluting with demineralized water. The diluted uranium solution was fed through dialysis columns and an electrolysis cell. The uranium solution was then passed through forming columns to create a solid fuel form. The solid fuel was rinsed, dried, and sintered in a furnace. The sintered fuel was placed into containers and stored prior to being shipped to another licensed site for finishing operations. The majority of the processing operations were conducted in gloveboxes, radiochemical fumehoods, or other ventilated, HEPA filtered enclosures. In addition, the room air from the building was exhausted through HEPA filters.

Type-II fuel processing produced several types of liquid wastes: process wastes, laboratory wastes, hexanol wastes, utilities and blow-down wastes, and sanitary wastes. Uranium-rich liquid process waste was concentrated in a boil-down unit and transported, along with solid waste containing recoverable amounts of uranium, to the Apollo facility for recovery.

Laboratory waste, primarily from sampling operations to determine the uranium concentration of solutions, was pumped to the evaporator-concentrator for boil-down.

Hexanol from the forming columns was recycled through both continuous and batch recovery systems. The continuous recovery system combined spent hexanol and a small amount of fresh hexanol from the storage tank, and then added small quantities of ammonia gas. The solution was fed to a wash column where contact with water removed the impurities in the hexanol. The hexanol was distilled to remove absorbed water before being returned to the forming columns. The water was sent to a 15,000 gallon holding tank for monitoring prior to pumping to the evaporator-concentrator. The bottoms from the evaporator-concentrator were pumped to one of two asphalt-lined holding ponds on the east side of Building C and the vapors passed through a scrubber where volatile chlorides were removed using a sodium hydroxide solution. The spent scrubber solution was also discharged to the holding ponds.

The batch recovery system was used to concentrate three hexanol-lean waste streams: small amounts generated when removing fuel from the forming columns; separation of fuel from hexanol in the collection vessel during the first step in the wash cycle; and, a side stream from the main hexanol stream going from the forming columns to the wash columns. Water from the batch process went to the 15,000 gallon holding tank for monitoring. Recovered hexanol was sent to the hexanol storage tank, and the bottoms were used to supplement the natural gas as fuel for the evaporator-concentrator.

Liquid from backwashing the deionizer units and blow-down from the boiler and cooling systems were sent to a lime treatment sump to neutralize the waste effluent, then were transferred to a sewer line which discharged into the Kiskiminetas River under a provisional permit from the Pennsylvania Bureau of Water Quality Management.

Shower and sink waste was piped to a holding tank for monitoring. The waste was piped to the septic tank if it was less than 1% of the uranium limits set in the then applicable 10 CFR 20 for liquid effluents to unrestricted areas. Waste which exceeded the administrative limit was pumped to an evaporator-concentrator for boil-down prior to recovery at the Apollo facility. Sanitary waste from commodes and urinals was piped to a septic tank which fed a 1,600 ft^2 leach field.

Gaseous effluent from the evaporator-concentrator was sent to a scrubber for treatment prior to release to the atmosphere. The gaseous effluent from the evaporator-concentrator consisted of air, carbon dioxide, nitrogen, and water vapor that was scrubbed with sodium hydroxide before being discharged to the environment. Flue gases were discharged directly to the atmosphere.

High enriched fuel was fabricated in Building C from 1973 until March 1978. Deactivation of Building C is discussed later in Section 1.3. Additional details of the SNM processing in Building C can be found in the Parks Facilities Characterization Plan which was submitted to the NRC on March 13, 1995.

The Undeveloped Area

There is no evidence of work with or storage of radioactive materials in the Undeveloped Area of the B&W Property, and no reason for radioactive materials to have migrated into the area.

1.3 DECONTAMINATION ACTIVITIES PERFORMED UNDER SNM-414

This subsection provides an overview of significant Parks Facilities deactivation, decontamination, and soil remediation projects which were performed over the past 25 years as authorized by SNM-414. It also discusses decontamination work, authorized by Condition 10 of SNM-414, which is on-going at the Parks Facilities, and is required as a precursor to final decommissioning of the site under a NRC-approved Decommissioning Plan.

Land Parcel Remediation and Sale

In early 1982, B&W received an offer to buy a 3.6 acre parcel of land in a corner of its property in Parks Township. This parcel is located to the north of the current B&W Property and approximately 100 feet east of Route 66. B&W performed a radiological survey of the parcel to determine if the area could be released for unrestricted use in accordance with the existing NRC criteria. During this radiological survey, plutonium and americium activity above the NRC guidelines was detected in soil on the eastern portion of the parcel. The soil with elevated levels of activity was excavated and moved to an area adjacent to and south of Fab 8. After the soil with elevated levels of activity was moved, B&W performed a final survey of the remaining soil in the parcel. The average concentrations of Pu-239 and Am-241 in the parcel had been reduced to 10 pCi/g and 6 pCi/g respectively. The NRC conducted a confirmatory survey of the parcel and released it for unrestricted use in 1982 (reference NRC Inspection Nos. 70-364/83-02, 70-364/82-03, 70-364/81-10 and 70-364/81-05). After the NRC release, the excavation was backfilled with off-site borrow soils and the parcel was sold in December, 1982.

Soil Mound Remediation

The soil removed during remediation of the parcel of land which was sold in December, 1982 became known as the Soil Mound. During the expansion of Building A in the mid-1980s to house the Volume

Reduction Service Center, the Soil Mound, which had been stored adjacent to Fab 8, was moved to the north side of Fab 9. The Soil Mound, after it was moved to the north side of Fab 9, contained approximately 40,000 cubic feet of soil. The entire above-grade portion of the Soil Mound was packaged for burial. The soil upon which the Soil Mound sat, was then characterized. Soil with alpha-emitting TRU concentrations >25 pCi/g was excavated, packaged, and sent to a LLRW disposal site in Richland, WA. The soil remaining in the bottom and sides of the excavation was sampled and found to have <25 pCi (alpha TRU)/g which met the radiological release criteria for unrestricted use applicable to soil at that time. However, a final survey could not be performed due to high background readings from inside the building.

Remediation of the Former Drum Storage Area

An outside Drum Storage Area was formerly located in the area where portions of Fabs 8 and 9 were constructed when Building A was expanded in 1969-70. The Drum Storage Area had been used for the storage of low-level radioactive waste materials, primarily ion-exchange raffinate from Building A scrap recovery operations, until the late 1960s when the area was remediated in preparation for constructing Fabs 8 and 9. Subsequent drum storage was transferred to an indoor location in Building A which was known as the Drum Warehouse.

Approximately 13,000 cubic feet of radiologically contaminated soil was removed from the location of the former Drum Storage Area and shipped to a Low Level Radioactive Waste (LLRW) facility for burial. Fabs 8 and 9 were subsequently constructed partially over the former Drum Storage Area.

Building A Process Equipment Removal

B&W decided in March 1980 to dismantle the fuel fabrication lines in Building A so those sections of the building could be put to alternate uses. Liquids and sludges from the scrap recovery lines were drummed and stabilized. The process equipment, analytical laboratory equipment, gloveboxes and hoods were partially decontaminated and sprayed with a fixative. Ninety-five gloveboxes and hoods were cut into pieces, packed in polyvinyl chloride (PVC) bags, and loaded into steel burial crates. The remainder of the equipment went into either steel drums or burial crates. Approximately 13,000 cubic feet of waste contaminated with transuranic (TRU) isotopes was sent to the DOE's Hanford Site in Richland, WA during the 1981-83 time period.

In addition to TRU contaminated waste, about 42,000 cubic feet of Low Specific Activity (LSA) waste was also generated during the glovebox removal campaign, including most of the equipment in the Fab 9 area. Waste meeting LSA limits was sent to a LLRW site for burial.

During the 1974-1979 period, preceding the dismantlement of the fuel line, smaller amounts of TRU contaminated waste were also shipped to a commercial LLRW disposal facility in Richland, WA.

Following process equipment deactivation, Building A was utilized by B&W for commercial decontamination and LLRW volume reduction operations until the late 1980s, at which time surplus equipment was either sent to another NRC licensed site or to a licensed LLRW disposal site.

Hot Cell Underground Tank Project

A 300 gallon steel underground tank servicing the Building A hot cell area was excavated in April 1990. The tank had accumulated liquids from two floor drains inside the Hot Cell and a floor drain from the adjacent Hot Handling Facility on the west side of the Hot Cell. The soil in the excavation was not examined by the NRC and there was no release for unrestricted use. The excavation was backfilled using soils that originally surrounded the tank. The excavation was then capped with limestone. This area is included under the Parks Facilities Characterization Plan for additional sampling and analysis.

Re-Roofing of the Fab 6 Area in Building A

In 1991, the roof over Fab 6 was replaced and the old roofing was shipped to a LLRW site in Richland, WA for burial.

Building B Process Equipment Removal

Processing of uranium in the Metals Plant portion of Building B ceased in the late 1960s. Contaminated equipment was sent to a licensed LLRW disposal site and the area converted to other uses.

The processing of Pu-238 in Building B ceased in 1962. The room was decontaminated in 1965-66. The gloveboxes were foamed in-place, transferred into corrugated culvert pipe, and the gap between the boxes and pipe was foamed. The loaded culverts were shipped to a LLRW site in West Valley, NY for burial.

Removal of Building B Plutonium Annex Tanks

Two underground 1,000-gallon concrete tanks which formerly serviced the Plutonium Annex in the northwest corner of Building B and other sinks and floor drains in the Hafnium Plant portion of Building B, were remediated during 1991. The Plutonium Annex operated during 1961 and 1962, and the tanks were used to temporarily store sink and shower water from this operation. The tank contents were routinely sampled and the water, if found to be within acceptable release limits, was pumped out of the tanks into a terra cotta pipe that led to a culvert which discharged to the Kiskiminetas River (Outfall # 4).

When the concrete tanks were uncovered in 1991, they were intact and about two-thirds filled with water and sludge. Both the water and sludge were sampled, and analyzed using alpha and gamma spectroscopy. Am-241 was detected in the sludge samples at 26 pCi/g, Pu-238 at 1,600 pCi/g, and Pu-241 at 1,400 pCi/g. The maximum total uranium concentration detected in the sludge samples was 105 pCi/g.

The water was pumped into 55 gallon drums and moved indoors for evaporation. The tanks were removed intact, then cut into sections inside Fab 6. The sludge was removed and placed in pans for drying. The piping from Building B to the tanks and a short portion leading to the outfall were also removed, packaged and shipped to a LLRW disposal site. Piping which was not removed was capped. The sludge, piping and the sectioned tanks were packaged and shipped to a LLRW disposal site in Richland, WA.

The soil beneath and around the Plutonium Annex Tanks was sampled for radionuclides. Only low levels of uranium, plutonium and Am-241 were detected. Following an NRC confirmatory survey in 1992, the excavation was backfilled since it met the NRC criteria for release for unrestricted use (ref. NRC Inspection Nos. 70-364/92-01 and 70-364/91-04).

Re-Roofing of the Metals Plant High Bay in Building B

In 1991, the roof over the high bay portion of the Metals Plant was replaced. A portion of the roofing was contaminated and approximately 5,000 ft^3 was shipped to a LLRW burial site in Richland, WA. The roof decking was surveyed and found to be uncontaminated and was shipped to a commercial landfill for disposal.

Remediation of the Building B Trash Burner

In 1991, B&W NESI characterized and removed a trash burner which was attached to the exterior wall along the east side of Building B. The trash burner was built in the early 1960s to burn non-contaminated materials. Low levels of activity were detected in the lower portions of the trash burner as it was being dismantled. All contaminated material was sent to a licensed LLRW disposal site.

Building B East Driveway Soil Remediation

A 0.6 acre area comprising the East Driveway of Building B was remediated during 1993. Excavated soil was formed into piles and sampled for hazardous chemicals and radioisotopes. The soil piles contained low levels of both uranium and polychlorinated biphenyls (PCBs). A total of 30,000 cubic feet of the excavated soil had releasable levels of uranium and PCBs and was sent to a residual waste landfill. As of December 1995, an additional 3,000 cubic feet of soil with higher concentrations of uranium and PCBs is awaiting the availability of an acceptable disposal option and is being stored indoors in containers. Systematic radiological soil sampling was conducted following on the East Driveway excavation. The analyses indicated that the residual radiological concentrations met the NRC release criteria for unrestricted use, although the area was never free released by the NRC. The excavation area was sampled as part of the 1995 site characterization project.

Removal of Building B Liquid Waste Discharge Tanks

Two 500-gallon underground concrete tanks, known as the Liquid Waste Discharge (LWD) Tanks, were located to the east of Building B. Prior to 1976, the LWD Tanks were used to collect liquid waste from the sinks and showers in Building B. The tank waste was sampled and monitored prior to release to Outfall # 4 which discharged into the Kiskiminetas River.

The LWD Tanks were removed and remediated during 1993 as part of the East Driveway Soil Remediation project described above. The sludge in the LWD Tanks was removed and sampled for hazardous chemicals and radioisotopes. Total uranium measured 3,200 pCi/g, Am-241 was 17 pCi/g, Th-232 was 3 pCi/g, and measurable concentrations of Co-60 and Cs-137 were detected. Alpha spectroscopy results showed an alpha-TRU concentration of 24 pCi/g. PCBs were also detected in the sludge at an average concentration of 363 ppm. The LWD Tank sludge is currently stored in Building A pending waste disposal. The concrete LWD Tanks were volume reduced, packaged and are stored in Building A awaiting shipment to a licensed LLRW disposal site. The excavation resulting from the LWD Tank removal was radiologically sampled in accordance with the statistical criteria in

NUREG/CR-5849 and meets the NRC criteria for release for unrestricted use.

Remediation of the Building C Holding Ponds

Two asphalt lined holding ponds, formerly located to the east of Building C, were remediated in the late 1970s. Each holding pond had a capacity of 45,000 gallons and measured 30 feet by 50 feet by 4 feet deep. These holding ponds collected process liquids which had been radiologically monitored and released from Building C. The initial step in pond remediation was to pump most of the liquid back into Building C where it was evaporated. A solidification vendor was then contracted to solidify the balance of the liquid and all of the sludge. The drums of solidified waste were shipped to a LLRW site in Barnwell, SC for disposal.

After removal of the liquid and sludge, the asphalt liners were sampled and analyzed. The liners were excavated along with 5,000 cubic feet of soil. Soil showing radioactivity levels higher than instrument background was packaged for burial along with the liner chunks. A total of about 17,500 cubic feet of solidified waste and soil was shipped to a LLRW site in Barnwell, SC for disposal.

Both B&W and the NRC sampled the remaining soil in the excavation. Although no specific criteria existed at the time for enriched uranium residual activity in soil, B&W judged the pond soils to have acceptable residual radioactivity level and indicated to the NRC that it planned to fill the voids left by the pond excavation by grading the elevated surface into the void. The soil in the elevated surface area had been previously analyzed by the Region I NRC inspectors and a statement of "No items of noncompliance were identified" was issued as Item 8 in Inspection Report 70-135/78-24 and 70-364/78-29. B&W subsequently graded and contoured the pond area to a final grade which is estimated to be 2 feet to 5 feet higher than the former pond bottoms.

Building C Process Equipment Removal and Building Decontamination

During 1978, the process equipment used in the production of the Type II fuel in Building C was sectioned into smaller pieces, decontaminated to less than 4 grams of SNM per piece, sealed into plastic bags, and transferred to burial containers. After removal of all the process equipment from Building C, the walls, floors and fixtures were washed with water and dried. Additional effort was made to decontaminate areas of high fixed activity such as the dissolver room. After the floor tiles were removed, the interior of the facility was painted to prevent the spread of contamination. The total volume of equipment, concrete, and cleaning waste shipped to a licensed LLRW burial site was 18,609 cubic feet.

Additional Remediation of Building C

In 1991, B&W conducted additional decontamination activities in Building C. Temporary plastic enclosures under negative pressure were used for both floor and wall remediation to control the spread of contamination. Small portions of the concrete floor and concrete blocks were broken into less than 4-inch chunks and collected into 6-gallon plastic bags for additional assaying. Small particles and debris were vacuumed into a critically safe container. Approximately 1,110 ft^3 of concrete floor, crushed block and other debris, containing 2,040 grams of U-235, was shipped to a LLRW site in Barnwell, SC.

Post-1991 Decontamination Work

Decontamination of portions of Building A has been ongoing since 1991 to provide additional space for contract work involving the repair and storage of equipment used in the commercial nuclear power plant service business. Interior walls were demolished in Fab 1 and the Hot Cell areas, and abandoned utility lines were removed from the walls. The wall debris was packaged as LLRW for later burial. Based on the nature of past operations and existing characterization data, scabbling the concrete floor and wall surfaces was selected as the optimum method of decontamination. A floor scabbler was purchased and modified for mounting on a fork lift truck to enable the concrete block walls to be scabbled up to a height of about 10 feet, at a relatively high rate. Scabbling dust was collected and packaged as LLRW for subsequent off-site disposal.

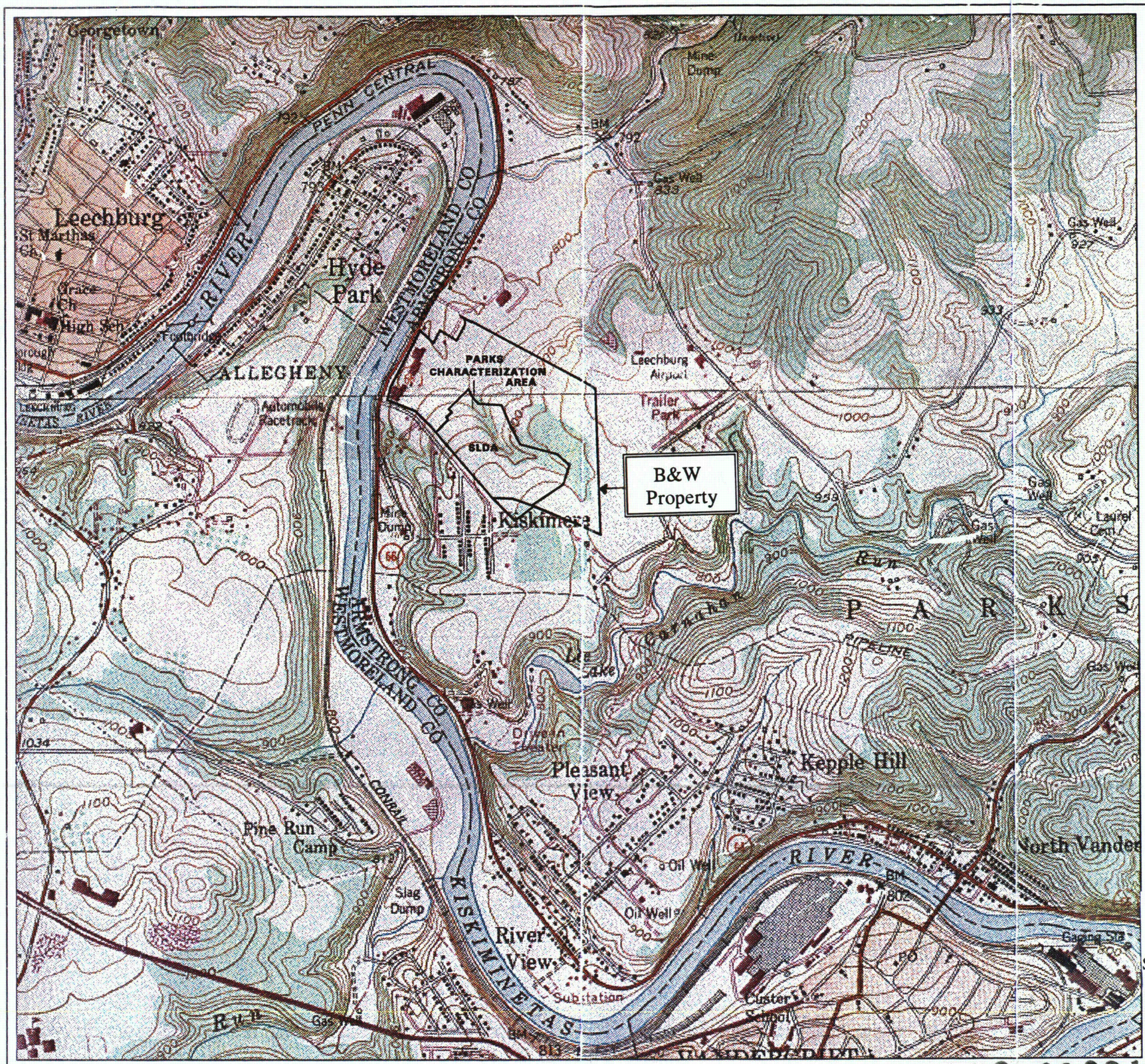
As the above decontamination effort was nearing completion, a conditional decision was made to continue the decontamination until the entire building structure had been decontaminated to levels meeting the NRC release criteria for unrestricted use. A Final Status Survey of the building will be performed according to the protocols in NUREG/CR-5849, and the final survey report submitted to the NRC. Building A will be demolished after the NRC has reviewed and approved the final survey report in accordance with license condition 11 in SNM-414.

A similar decontamination effort was started in Building C in early 1995. Utilities and other miscellaneous metallic materials were removed from the building, floors and walls were scabbled, and interior walls which could not be effectively scabbled were demolished and crushed. Contaminated scabbling dust and crushed block were packaged as LLRW for subsequent burial. As with Building A, it is currently anticipated that the building structure will be decontaminated to levels meeting the NRC release criteria for unrestricted use. A Final Status Survey of the building has been performed according to the protocols in NUREG/CR-5849, and the final survey report submitted to the NRC. Building C will be demolished after the NRC has reviewed and approved the final survey report in accordance with license condition 11 in SNM-414.

A similar decontamination effort is currently underway in Building B.

In all cases, the building surfaces are being decontaminated, as authorized in license condition 11 of SNM-414, to levels which meet the NRC criteria for surfaces for release for unrestricted use as stated in the April 1993 NRC document "Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of Licenses for Byproduct, Source, or Special Nuclear Material." These decontamination activities include removal and/or cleaning of surfaces such that the remaining cleaned surfaces can be surveyed, and released for unrestricted use after NRC review and approval. After such approval, the buildings are scheduled for demolition.

In a limited number of cases, it is not possible to monitor the surfaces of all items for activity without seriously compromising the integrity of the building structures. In that event, the surfaces of those items with inaccessible surfaces will be clearly identified both in a written list and by physically marking the surface near such items. The items so identified will require additional surface activity monitoring as the building is being demolished. Cases currently recognized as requiring this identification and subsequent monitoring include the corner grade beams in Building C and some of the bar joists in Buildings A and B which are set into the exterior walls.



REFERENCE:
USGS 7.5 MIN TOPOGRAPHIC QUADRANGLES
VANDERGRIFT, PA (Dated 1953, Photo Revised 1973)
LEECHBURG, PA (Dated 1954, Photo Revised 1969)

Figure 1-1, Rev. 1

Site Location Map - B&W Property

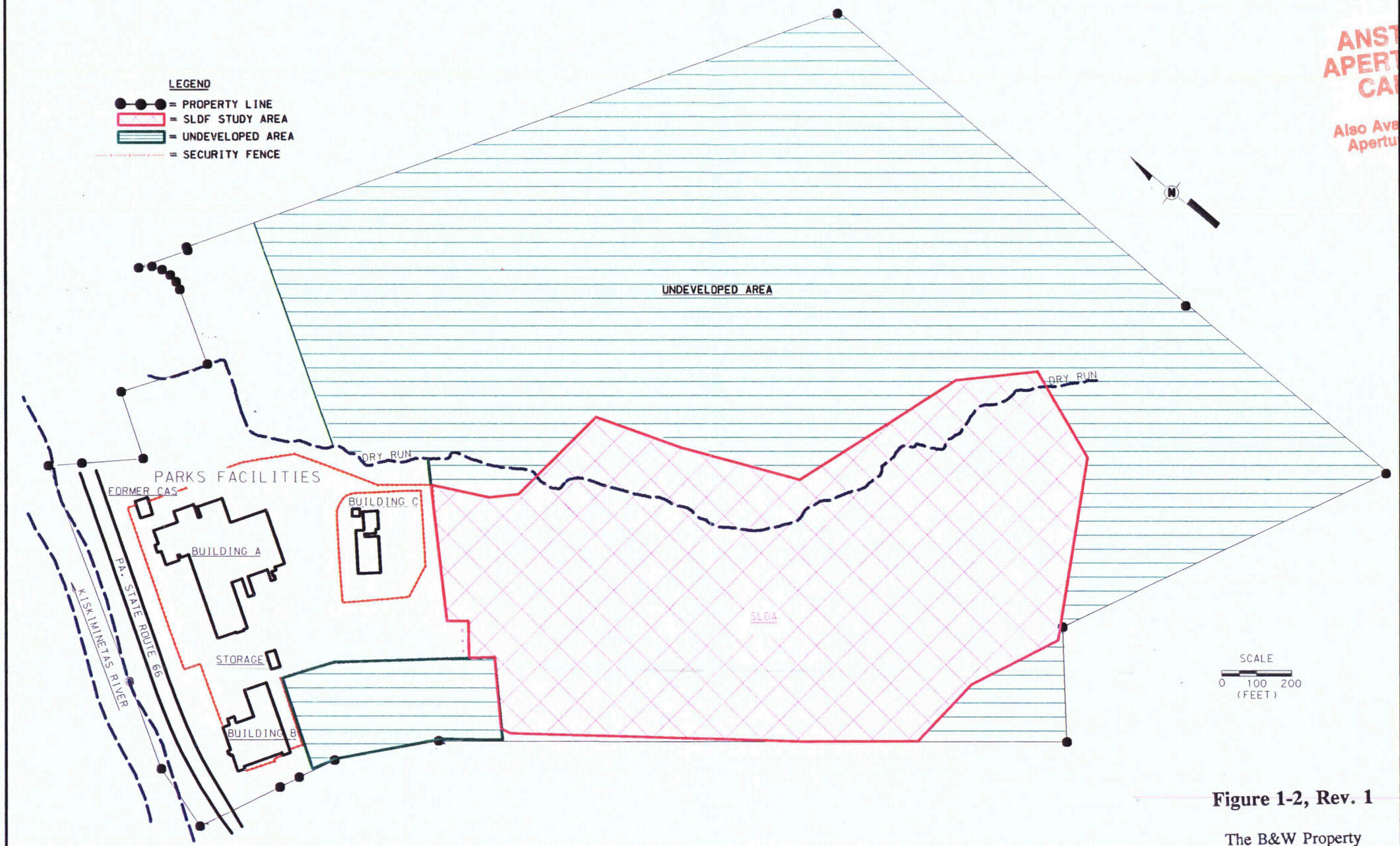


Figure 1-2, Rev. 1

The B&W Property

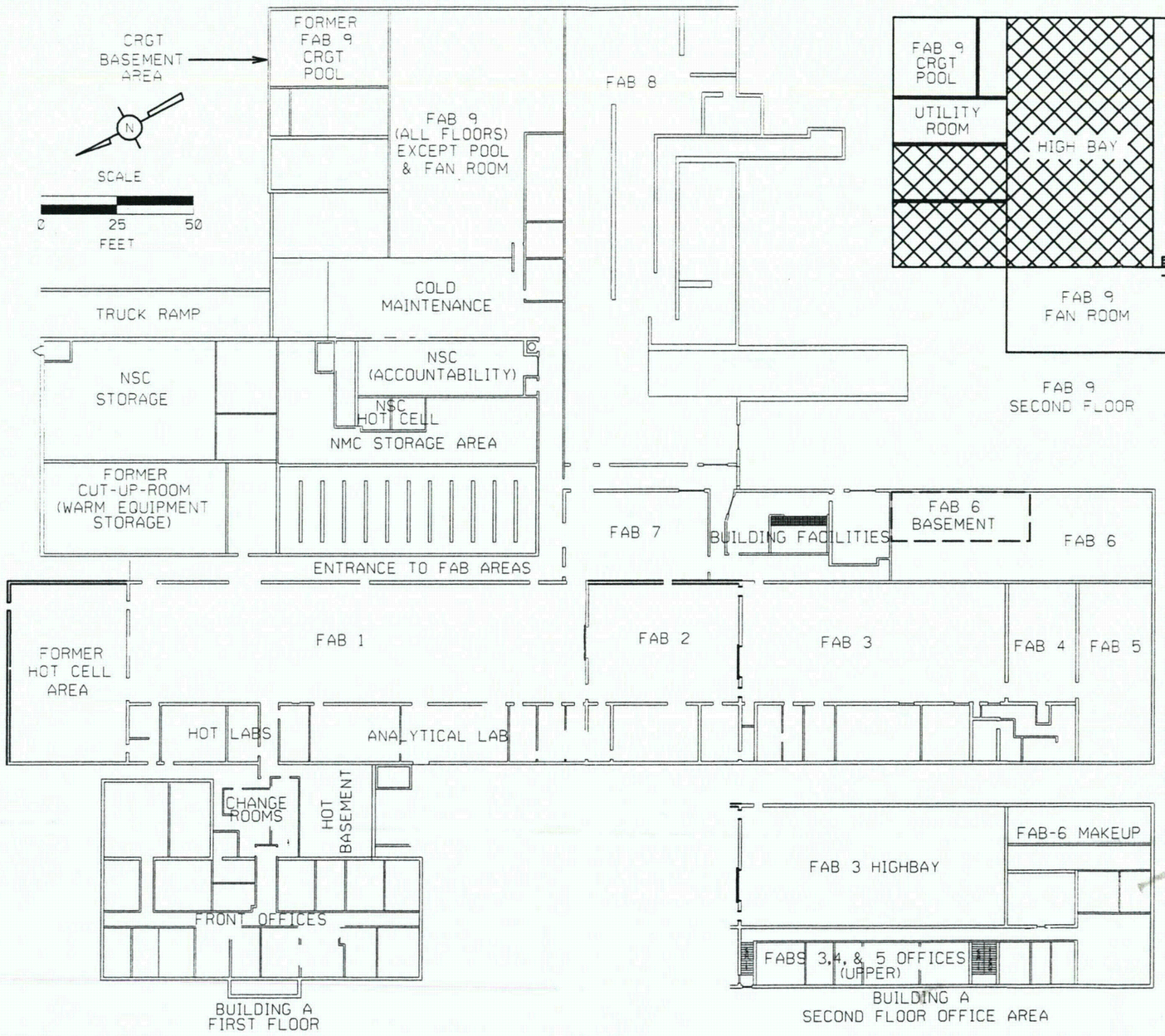
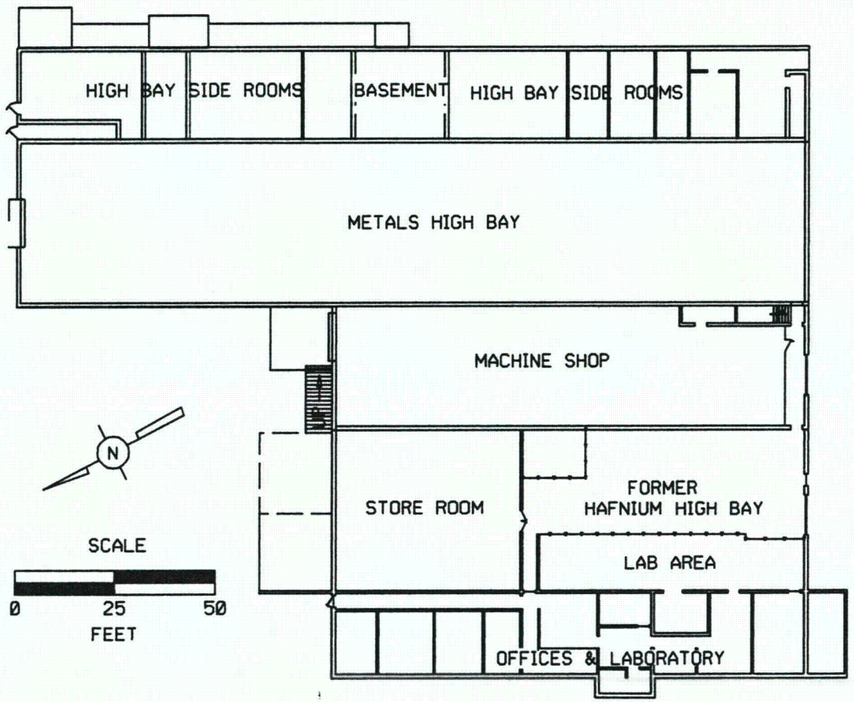
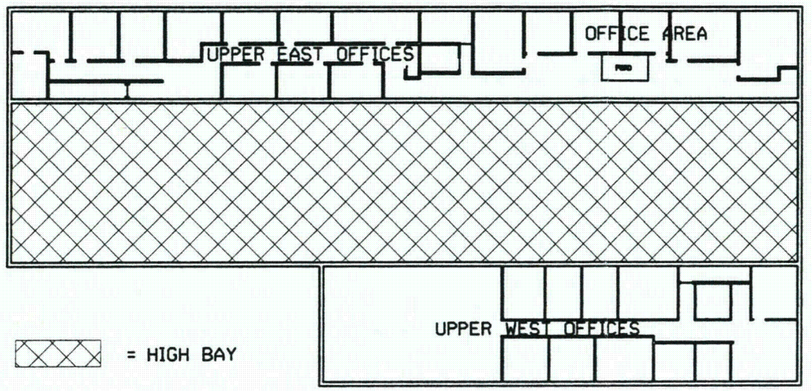


Figure 1-3, Rev. 1

Floor Plan of Building A



BUILDING B



SECOND FLOOR BUILDING B

Figure 1-4, Rev. 1

Floor Plan of Building B

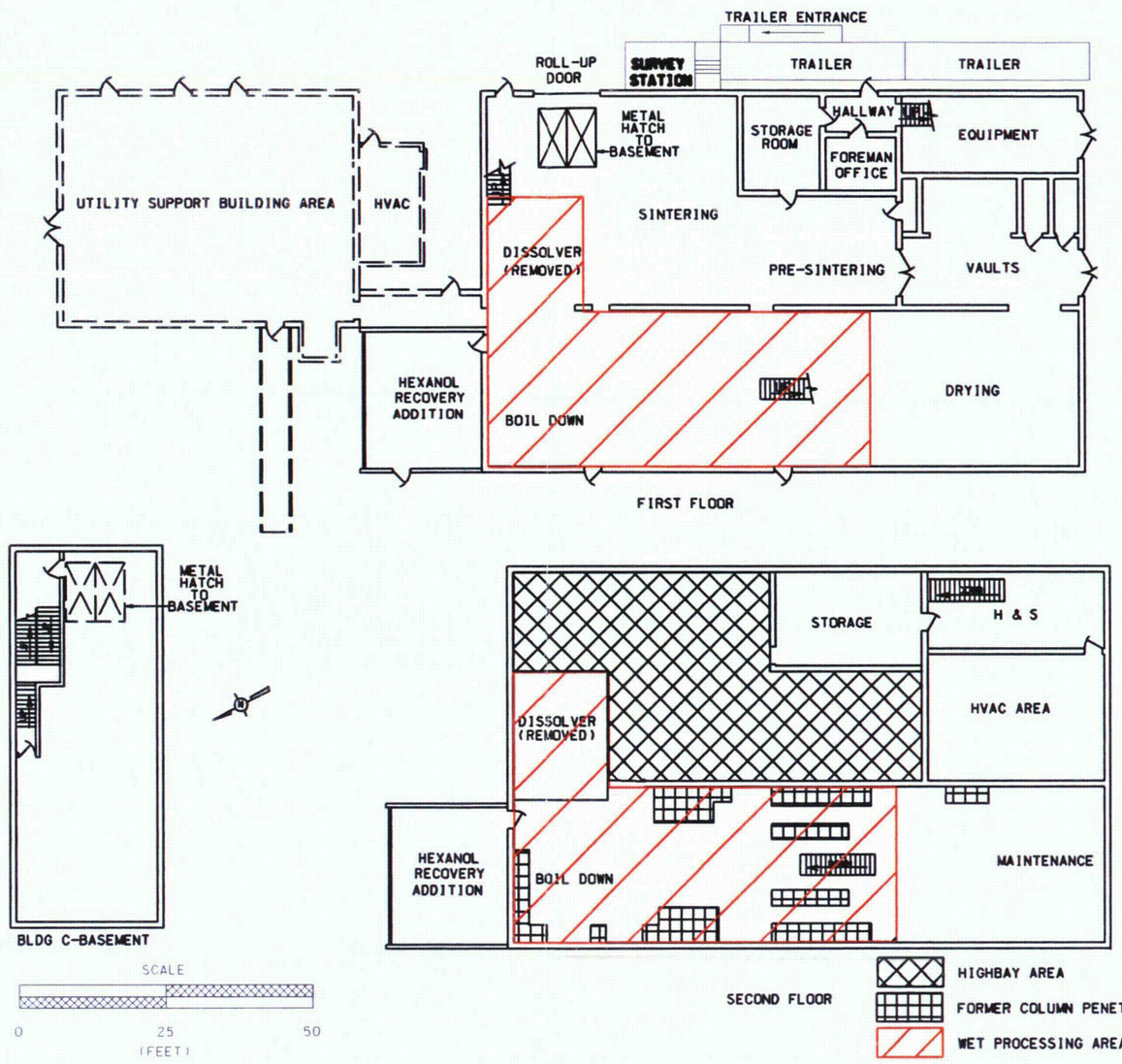


Figure 1-5, Rev. 1

Floor Plan of Building C

2.0 CURRENT RADIOLOGICAL CONDITIONS

The current radiological conditions of the Parks Facilities is based on historical characterization programs and the 1995 site characterization. In this section, a description of the Parks Facilities "Project Units" is presented followed by a summary of the radiological characterization results from both soil and water. The 1995 site characterization program was based on a system of Project Units to assist in the planning and execution of the site characterization.

2.1 PROJECT UNIT DESCRIPTION

The portion of the B&W Property being addressed in this section is referred to as the Parks Characterization Area, and includes the Parks Facilities area and the Undeveloped Area (see Figure 2-1). The Parks Characterization Area was further subdivided into five Project Units to facilitate the site characterization. The Project Unit boundaries were selected to encompass areas of the Parks Facilities where a specific but similar group of radionuclides were processed. Figure 2-2 depicts the boundaries of Project Units A, B, C, D, and E.

2.1.1 Project Unit A

Project Unit A is located near the northwestern corner of the B&W Property and includes Building A, the guard station, and the north parking lot. A total of approximately 10 acres of land comprise Project Unit A. Project Unit A is bounded by the B&W Property line to the north, Route 66 to the west, and Project Units B and C to the south and east, respectively. Dry Run flows through the northern portion of Project Unit A.

2.1.2 Project Unit B

Project Unit B is located near the southwestern corner of the B&W Property. A total of approximately 4 acres of land are included in Project Unit B which contains Building B, a small storage building (the white shed), and the south and west parking lots. Project Unit B is bounded to the north by Project Unit A, to the south by the B&W Property line (Kiskimere Road), to the east by Project Units C and E, and to the west by Route 66.

2.1.3 Project Unit C

Project Unit C is in the western portion of the B&W Property and consists of Building C and 5 acres of surrounding grounds. Project Unit C is bounded on the north and south by Project Unit E, on the east by the SLDA, and on the west by Project Units A and B. Dry Run crosses through the northern portion of Project Unit C.

2.1.4 Project Unit D

Project Unit D is located at the western edge of the B&W Property and consists of approximately 2.5 acres. The B&W Property line bounds the northern, western, and southern edges of Project Unit D. Project Units A and B adjoin Project Unit D to the east. Project Unit D is underlain by three Parks Facilities permitted outfalls (NPDES stormwater outfalls 2, 3, and 4) discharging to the Kiskiminetas River. Project Unit D does not contain any structures and has not been used for Parks Facilities

operations.

2.1.5 Project Unit E

Project Unit E consists of approximately 64 acres and is located in the eastern portion of the Parks Characterization Area and comprises over half of the B&W Property. Project Unit E is bounded to the north and east by the B&W Property line, and to the south and west by the SLDA and Project Units A and C. The only industrial activity that occurred in this Project Unit was the surface mining of the Upper Freeport Coal that outcrops in the area which is reported to have occurred in the 1920s.

2.2 RADIOLOGICAL CHARACTERIZATION

Numerous radiological characterization programs have been conducted at the Parks Facilities. The goal of these programs was to quantify and delineate the horizontal and vertical extent of radiological constituents in soils. Groundwater and surface water has also been investigated for radiological constituents. Characterization of building components such as slabs, footings, and drains is being conducted during the ongoing building decontamination of the Parks Facilities. The building characterization data is not presented in this Decommissioning Plan as the characterization is being performed to support work under the existing SNM-414 license. Any characterization and remediation of building footings and inaccessible areas of the building slabs will be completed during or after slab removal and will be part of the decommissioning process.

Sampling techniques primarily include split spoon sampling, hand augering, and monitoring well sampling. Sampling is performed in accordance with written procedures. Table 2-1 lists the major procedures used for sampling and analysis. The regulatory protocol for the collection of soil samples is based on guidance contained in NUREG/CR-5849, "Manual for Conducting Radiological Surveys in Support of License Termination", and the NRC "Branch Technical Position on Site Characterization for Decommissioning". Groundwater sampling is conducted in accordance with ASTM and EPA protocol.

Radiological samples were analyzed by gamma spectroscopy at the B&W NESI Nuclear Environmental Laboratory located at the Parks Facilities using written procedures. Selected samples were analyzed at off-site laboratories using alpha spectroscopy and beta liquid scintillation analysis to establish scaling factors for radionuclides which are difficult to detect and/or quantify using gamma spectroscopy (e.g., U-234, Pu-238, Pu-239, and Pu-241).

Historical characterization data obtained prior to 1995 was summarized in Section 4 of the Parks Facilities Characterization Plan, previously submitted to the NRC. During the summer of 1995, the extensive radiological and chemical characterization program outlined in the Parks Facilities Characterization Plan was implemented. The Parks Facilities Characterization Report, containing the radiological and chemical data, is currently being prepared and will soon be provided. The radiological information that follows is a summary of all data collection efforts conducted in the Parks Characterization Area.

Table 2-2 summarizes the radionuclides of interest in each Project Unit and their corresponding average concentrations in the soil. Table 2-3 presents the groundwater radionuclide characterization data collected to date. The figures referenced in the following sections generally display radiological concentrations on two separate drawings depicting zero to four feet (0′ - 4′) and greater than four foot (4′+) depth ranges. The depicted concentration ranges are based upon the guideline values in Section

3.2. A depth interval of zero to four feet was selected to facilitate the design of remediation activities. Generally, shoring and/or other side stabilization methods are not required for excavations less than four feet deep. Excavations deeper than four feet must incorporate appropriate trenching/shoring controls.

2.2.1 Project Unit A

Radiological sampling locations in Project Unit A are depicted in Figure 2-3. The primary radionuclides of concern were americium, uranium, plutonium, cobalt and cesium.

Am-241 was detected in concentrations between background (0.03 pCi/g; reference Section 5.5) and 1,562 pCi/g at depths ranging from the surface (0') to two feet.

Figure 2-4 indicates the extent of Am-241 concentrations greater than 2.2 pCi/g, to depth, across Project Unit A. An Am-241 concentration of 2.2 pCi/g correlates to a Pu-241 concentration of 62 pCi/g using scaling factors based on beta liquid scintillation analysis of numerous samples and the original isotopic ratios of the primary plutonium fuel product fabricated at Building A, decayed to-date. These scaling factors were used during the site characterization and will be used to guide soil remediation activities during decommissioning. Scaling factors to be used for the Final Status Surveys will be determined as discussed later in Section 5.6.3.

Total uranium was detected in concentrations between background (4.0 pCi/g; reference Section 5.5) and 58 pCi/g (detected at six inches below grade). Locations with concentration of total uranium greater than 30 pCi/g are depicted on Figure 2-6 at depths of zero to four feet and greater than four feet. Locations with concentrations of total uranium between 15 pCi/g and 30 pCi/g, which will affect remedial designs associated with overburden removal, are depicted in Figure 2-5.

Total uranium includes U-234, U-235, and U-238. U-235 and U-238 concentrations were determined via gamma spectroscopy. U-234 was determined from measured U-235 concentrations using scaling factors based on historical uranium alpha isotopic analyses conducted to support the decommissioning of B&W's former Apollo Uranium Fuel Manufacturing Facility. Uranium isotopic analyses of soil samples from Project Unit B, which were analyzed in 1993, were in general agreement with ratios used for the Apollo Project. The Apollo Project scaling factors for uranium were therefore considered acceptable for use during the site characterization and will be used to guide soil remediation activities during decommissioning in Project Units A, B and D. Scaling factors to be used for the Final Status Surveys will be determined as discussed later in Section 5.6.3.

Elevated levels of Co-60 and Cs-137 were detected in soils surrounding and beneath the Hot Cell area of Building A. The maximum concentrations of Co-60 and Cs-137 were 199 pCi/g and 581 pCi/g, respectively. Locations and depths of Co-60 and Cs-137 concentrations are shown on Figure 2-7.

2.2.2 Project Unit B

Americium, plutonium, and uranium are the radionuclides of interest in Project Unit B, although no significant radiological concentrations were found during the 1995 site characterization program.

Figure 2-8 shows the radiological soil sampling locations in Project Unit B. Am-241 and the plutonium isotopes (by use of scaling factors) were not detected in concentrations exceeding the guideline values in Section 3.2. An Am-241 concentration of 2.2 pCi/g correlates to a Pu-241 concentration of 62 pCi/g

using scaling factors based on beta liquid scintillation analysis of numerous samples and the original isotopic ratios of the primary plutonium fuel product fabricated at Building A, decayed to-date. These scaling factors were used during the site characterization and will be used to guide soil remediation activities during decommissioning. Scaling factors to be used for the Final Status Surveys will be determined as discussed later in Section 5.6.3.

Locations with concentrations of total uranium between 15 pCi/g and 30 pCi/g are shown on Figure 2-9. Locations with a concentration of total uranium in excess of 30 pCiU/g at depths of zero to four feet and greater than four feet are shown in Figure 2-10. Historical alpha spectroscopy analysis of soil samples from Project Unit B indicated the presence of both depleted and enriched uranium. Therefore, as a conservative measure, 30 pCi/g of total uranium concentration is being used as the guideline value for Project Unit B. The maximum concentration of total uranium detected in Project Unit B was 56 pCi/g at a depth of six inches.

2.2.3 Project Unit C

Project Unit C radiological sampling locations are shown in Figure 2-11. Uranium is the predominant radionuclide of interest in Project Unit C. Locations with total uranium concentrations greater than 15 pCi/g and less than 30 pCi/g are shown on Figure 2-12. Locations with total uranium concentrations greater than 30 pCi/g are shown in Figure 2-13 for depths of zero to four feet and greater than four feet. The maximum total uranium concentration detected was 919 pCi/g. Total uranium concentrations in excess of 30 pCi/g were generally found within ten feet of the perimeter of Building C, and in the vicinity of the former septic field and holding ponds. Localized total uranium concentrations greater than 30 pCi/g were also found at the northern boundary between Project Units C and E, where the outfalls of the drain lines from Building C emptied into the Dry Run tributary. Sampling continued near the outfalls until the extent of the uranium contamination was bounded. Based on the extent of uranium contamination found during site characterization, the boundary between Project Units C and E was revised (see Figure 2-11) to shift the Project Unit C boundary to the north and form a buffer zone of several new 10 m x 10 m grid blocks in Project Unit C to the north of the drain line outfalls. The purpose of the shift in the Project Unit boundary was to bring the contaminated area and a contiguous border of 10 m x 10 m grid blocks entirely within Project Unit C which already contains many affected area grid blocks. These newly relocated grid blocks will be sampled during the Final Status Survey of Project Unit C, after the contaminated areas are remediated.

Measured concentrations of U-235 and U-238 were combined with scaled U-234 concentrations and reported as the total uranium concentrations. A U-234 to U-235 scaling factor of 38.1:1, determined from isotopic ratios of uranium fuels produced in Building C during the late 1970s, was used for the characterization of Project Unit C. The mass spectrograph data used to calculate the isotopic ratios were submitted to the NRC on November 18, 1996 in the B&W NESI responses to the October 3, 1996 NRC comments on Rev. 0 of the Parks Facilities Decommissioning Plan.

Locations with elevated concentrations of Am-241 and Cs-137 are shown in Figure 2-14. Am-241 was detected in only seven samples with the maximum concentration being 13.34 pCi/g. Two of the seven samples contained Am-241 in concentrations greater than 2.2 pCi/g (2.34 pCi/g and 13.34 pCi/g) at a maximum depth of two feet. Co-60 was also detected in a limited number of samples in the immediate vicinity of Building C, but at a maximum concentration of 1.09 pCi/g which is less than the guideline value for Co-60.

2.2.4 Project Unit D

The radiological sampling locations in Project Unit D are shown in Figure 2-15. Americium and uranium were the primary radionuclides detected in Project Unit D soils, but only in isolated areas. Cobalt and cesium were also detected but are secondary radionuclides of interest.

Figure 2-16 shows the locations where elevated concentrations of Am-241, Co-60, Cs-137, and total uranium concentrations, to depth, were detected. Soil between zero and three foot in depth in the general vicinity of Outfall #3 contained the highest radionuclide concentrations in this Project Unit. Am-241 was detected at a maximum concentration of 1,532 pCi/g. The Pu-241 to Am-241 and Pu (alpha) to Am-241 concentration ratios for Project Unit D were determined to be 3.80 and 1.47, respectively. Co-60 and Cs-137 were detected at maximum concentrations of 1.51 pCi/g and 216.15 pCi/g, respectively. The maximum total uranium concentration was 35.14 pCi/g.

The area in the immediate vicinity of Outfall 3 (and a localized area of elevated activity at Outfall 2) were remediated in August 1996, with the approval of the NRC. This approval was granted by the NRC prior to approval of the Parks Facilities Decommissioning Plan due to the accessibility of the area to the general public. The August remediation consisted of removing approximately 500 cubic feet of soil and relocating it to a secure area between Buildings A and B. During the remediation work, additional soil samples were taken for alpha and beta analyses to establish the isotopic composition of the soil remaining at Outfall 3 and the soil that was excavated from Outfall 3.

During the remediation work, it was discovered that soil directly under the Outfall 3 pipe contains radionuclides in concentrations exceeding the guideline values listed in Section 3.2 of Rev. 0 of the Parks Facilities Decommissioning Plan. The cross-sectional area of the soil with elevated activity appears to be approximately twelve inches wide and six inches deep. However, the volume of soil which is affected is currently unknown because a complete data set is not available. Additional characterization is required to bound the extent of the affected soil under the pipe. The exposed soil under the Outfall 3 pipe has been stabilized with grout to prevent any migration into the area which was remediated in August. The soil under the pipe is not currently accessible and will be remediated when other general site soil remediation takes place. Final remediation of the soil under the Outfall 3 pipe will be performed under the Parks Facilities Decommissioning Plan after it is approved by the NRC. The history of Building A included the fabrication of americium-based neutron sources in the Fab 4 area. The concentration of plutonium isotopes in these neutron sources would have been relatively low. Additionally, the plutonium scrap recovery areas concentrated americium as the impurity in the raffinate stream. These activities could have resulted in different Pu-241/Am-241 ratios near Outfall 3 and other areas in Project Unit A, even though Outfall 3 drains a portion of Project Unit A. The Final Status Survey Report which includes the Outfall 3 area will discuss the difference in the Pu-241 to Am-241 ratio determined in the Outfall 3 area and in various portions of Project Unit A.

Radionuclide concentrations in excess of the guideline values in Section 3.2 were not detected in the vicinity of Outfalls 1, 2A, and 4. One surface sample in the vicinity of Outfall 2 contained Am-241 at a concentration of 45 pCi/g which exceeds the guideline value for Am-241.

2.2.5 Project Unit E

Project Unit E was classified as an unaffected area and subjected to NUREG/CR-5849 Unaffected Area characterization criterion, whereby random radiological surveying and sampling were conducted. Figure 2-17 shows the grid pattern, soil sample locations, and final walkover survey grids of Project Unit E. Eleven of the 105, 50 meter by 50 meter grids in this Project Unit (approximately 10%) were randomly selected for radiological characterization. Soil samples were collected from surface locations (i.e., a zero to two foot interval) from the 11 grids. Soil samples collected from the Project Unit E area did not contain radionuclide concentrations above the guideline values in Section 3.2.

In addition to the soil samples, a 100% walkover radiological survey, including fixed one meter exposure rate measurements, was conducted on the 11 grids. Existing procedures require surface locations with radiological surface readings exceeding two times background levels to be radiologically characterized through biased soil sampling. The radiological walkover survey did not identify any locations of Project Unit E exceeding twice background radiation levels. Based on the surveying and sampling results, Project Unit E meets the criteria for an unaffected area.

2.2.6 Groundwater

Groundwater sampling at the Parks Facilities was initiated in Project Unit A in the early 1990s. Historical groundwater sampling of the Project Unit A monitoring wells did not reveal elevated groundwater radionuclide concentrations in excess of the EPA point-of-reference values in Section 3.2. During the 1995 site characterization program, the groundwater monitoring network was significantly expanded to include Project Units B, C, and D. Currently, 34 monitoring wells and 6 piezometers are installed in the vicinity of the former processing buildings (see Figure 2-18). Sampling of the groundwater has been performed for four consecutive calendar quarters in accordance with the Parks Facilities Characterization Plan. Table 2-3 is a compilation of all existing groundwater radiological characterization data.

Five of the wells at the Parks Facilities have exhibit gross alpha concentrations in excess of 15 pCi/l in *one sampling event*, and one additional monitoring well has shown gross alpha concentrations in excess of 15 pCi/l in *more than one event*. B&W NESI believes that interpreting sampling data that is collected over a long period of time should be done with due consideration to the data set as a whole. Several factors can influence the results from one sampling event: naturally occurring radon and other radionuclides, seasonal variance, field sampling conditions, sample residue, laboratory analysis, etc. Part of the reason for conducting a long term monitoring program is to determine the average concentrations over a period of time. If one particular sampling event is much higher than the others that one set of sampling data should be considered suspect for any number of reasons.

B&W NESI's position is consistent with the promulgated EPA Regulation 40 CFR 141.25(d) and 40 CFR 141.26(a)(4). 40 CFR 141.25(d) states that the method of demonstrating compliance for gross alpha is based on the overall average concentration. 40 CFR 141.26(a)(4) states that annual averages are used for community water systems for demonstrating compliance. More recent EPA guidance (FR, July 18, 1991, pp 33102-33110) also demonstrates that B&W NESI's position remains consistent with current EPA strategy.

As previously stated, six out of thirty-six monitoring wells at one time or another have exhibited gross alpha readings of 15 pCi/l or greater: MW-10, MW-21, MW-40, MW-41, MW-48, and MW-49D. B&W NESI believes that these isolated and sporadic detections are not indicative of ground water conditions at the facility, but are anomalies. Each of these anomalies are explained in the following paragraphs.

MW-10, MW-40, and MW-41. These three wells had elevated gross alpha readings during the February 24, 1993 sampling event only. This immediately caused B&W NESI to question these results and resamples were collected on April 5, 1993 from these wells and two others (MW-31R and MW-42) for comparison. All of these sampling results were below 15 pCi/l. When looking at the long term monitoring results the following table can be derived:

Location	February 1993 Value	Average Using All Results	Standard Deviation Using All Results	Average without February 1993 Value	Std Dev without February 1993 Value
MW-10	16.07	2.99	4.54	1.69	1.98
MW-40	18.73	2.74	5.35	0.96	0.43
MW-41	81.48	9.19	24.10	1.16	0.54

EPA's method of determining compliance for gross alpha, radium, and uranium is based on data averages. 40 CFR 141.25(d) specifically states: "averages of data shall be used and shall be rounded to the same number of significant figures as the maximum contaminant level for the substance in question." The rounded average values for monitoring wells MW-10, MW-40, and MW-41 are 3, 3, and 9, respectively, when using the full data set. Therefore, these wells are in compliance.

Additionally, when comparing the February 1993 sampling event values with the averages and the expected error band (average plus/minus twice the standard deviation) for *either* the full data set *or* the data set without the February 1993 value, the February 1993 values fall outside the expected data range. Therefore the February 1993 sampling event data is suspect. Possible explanations for this data include field sampling conditions, field sampling equipment, sample residue, and laboratory analysis problems.

MW-49D. During the February 1996 groundwater sampling event, the initial results for MW-49D had gross alpha readings of 18.2 pCi/l. Subsequent reanalysis of this sample by gamma spectroscopy indicated only background levels of all radionuclides including uranium. The average concentration for this well, based on four quarterly sampling events, is 6.69 pCi/l (7 pCi/l) which is below the 15 pCi/l EPA gross alpha screening level. Therefore, this well is in compliance with 40 CFR 141.25(d)

MW-21. During the October 1995 sampling event, a sample was collected from MW-21 that indicated gross alpha of 92.81 pCi/l. This was the first time since the installation of this well that water was found in this well. It was also noted by both the samplers and the field engineer that the protective well cap on this well had been broken. It is unknown when the well cap was broken other than sometime between the November 1993 sampling event and the October 1995 sampling event. A replacement well cap was obtained and placed on MW-21. The sample collected from this well was difficult to obtain, observed to be dirty, and contained an inordinate amount of solid material. High residue was also

present in the laboratory analysis. The well did not recharge as would normally be expected from an undamaged monitoring well. Surface water from recent rainfall events was also noticed in the area.

Once the damaged well cap was replaced, no further water was obtained from this well. Monthly water level measurements indicate only minimal moisture (less than 0.5 feet) and often were dry. At no other time did the well contain sufficient water to sample. Therefore, these results are suspect due to the damaged well casing. The cause of this elevated gross alpha reading was most likely from the fines (sediments) in the water sample and from surface water run-off. The water in the well was most likely surface water and not groundwater since sampling has been attempted several other times following periods of high rainfall, but no water was available for sampling once the damaged well cap was replaced.

MW-48. MW-48 has had three of four sampling events with gross alpha greater than 15 pCi/l (21.19, 26.5, and 21.54 pCi/l). MW-48 is located immediately downgradient of the former holding ponds and immediately upgradient of Building C. After the gross alpha results were received, gamma spectroscopy was requested on the same samples to determine if the individual isotopes could be identified. Gamma spectroscopy results for this well indicate that radium-226 was detected at approximately 18 pCi/l. Additionally, these samples have high residue which bias the results upward.

Radium-226 is not a radionuclide of concern on this site since it was never processed here. The Ra-226 is a naturally occuring isotope and is considered part of the background for this well. If the total alpha activity in this well is reduced by the Ra-226 contribution of 18 pCi/l, the maximum values are reduced to 3.19, 8.5 and 3.54 (3, 9, and 4) pCi/l respectively. All of these values are below the EPA MCL of 15 pCi/l.

In summary, B&W NESI believes that the groundwater data collected to date demonstrates that groundwater quality is not an issue at the Parks Facilities.

2.2.7 River Water and Sediments

River (surface) water and river sediments from the Kiskiminetas River adjoining Project Unit D were characterized during the 1995 site characterization. The river water and sediment sampling locations are shown in Figure 2-15. Five grab samples of river water and five sediment samples were collected and analyzed for gross alpha and gross beta activity.

Gross alpha activity in the water samples ranged from 6.5 pCi/l at DS-2 (near Outfall #4) to 225 pCi/l at DS-5 (northern edge of B&W Property). Gross beta activity ranged from 8.3 pCi/l at DS-1 (southern or upstream location) to 2,490 pCi/l at DS-5. Subsequent analysis of the DS-5 water sample using gamma spectroscopy indicated a Cs-137 concentration of 2,320 pCi/l.

The DS-5 location was resampled in February, April and August 1996. No Cs-137 was detected in any of these sampling events. Additionally, the April and August 1996 samples were analyzed for gross alpha and gross beta. No concentrations of alpha or beta emitting radionuclides were detected above background levels. The gross alpha and gross beta results for all river water sampling events are presented in Table 2-4. Based on this series of results, B&W NESI concludes that the 1995 analytical result of 2,350 pCi/l of Cs-137 at location DS-5 is an anomaly, and was possibly the result of cross-contamination.

Sediment samples from the DS-1 through DS-5 locations contained total uranium at a maximum concentration of 4.63 pCi/g. All other sediment radionuclide concentrations were LLD.

2.2.8 Conclusion

Soil and groundwater in the Parks Characterization Area were subjected to comprehensive chemical, radiological, and physical characterization investigations. The chemical characterization program was performed to assess the distribution of chemical constituents in the Parks Characterization Area. The physical characterization program was conducted to assist in the development of migration, aquifer, risk assessment, and dose assessment mathematical models, if required. The results of the chemical and physical characterization methods will be described in the forthcoming Parks Facilities Characterization Report.

The site radiological characterization programs have delineated the nature and extent of soil and groundwater radiological conditions. Concentrations of radionuclides that exceed the guideline soil activity levels, as provided in Section 3.2, were detected in the soil under and external to Buildings A, B, and C, (Project Units A, B, and C, respectively) and at two localized areas on the riverbank (Project Unit D). No sample extracted during the sampling of Project Unit E exceeded the guideline soil activity levels. A walkover survey has been completed on Project Unit E and no elevated levels of radiation were detected, thus confirming the Project Unit E area is unaffected.

Generally, radiological constituents in the soil are limited to the top four feet, with very limited zones containing radioactivity that exceed four feet in depth. Based on the operating history of the facility and how the radiological materials were handled and processed (within gloveboxes and hoods, majority of materials as oxides or metals, extensive use of HEPA ventilation, etc.), only limited surface areas and minimal depths of soil were expected to contain levels of radioactivity above the guideline values in section 3.2. This essentially was confirmed by the 1995 site characterization program. Only three areas that were initially anticipated to be noncontaminated were identified during site characterization as containing radioactivity above the soil guideline values . These three areas were the two localized areas on the riverbank (Project Unit D) and the area in Project Unit C where the stormwater runoff from Building C discharges into Dry Run. These three areas will be included in the site remediation activities.

No elevated levels of radionuclides were detected during sampling of the groundwater in 1991, 1992, and 1993 from wells in and around Building A (Project Unit A). In addition, no elevated levels of radionuclides were detected during the sampling performed in 1995 and 1996 of either the existing wells or the new wells installed in Project Units A, B, C, and D. Based on the extensive groundwater sampling data that has been generated, the nuclear operations conducted at the Parks Facilities site have not negatively impacted the groundwater.

Table 2-1

SAMPLING AND ANALYSIS REFERENCES

B&W NESI Procedure	Title
GP-52	Chain of Custody Maintain sample possession history and records sample information such as location, time of collection, requested analysis, etc.
GP-82	Environmental Data Management System Provides guidelines for data entry, data management, and data maintenance in the Environmental Data Management System computerized multi-database system.
OI-146	Decontamination of Sampling Equipment Describes the decontamination techniques used on chemical and radiological sampling equipment.
OI-180	Liquids Sampling Describes the sampling of groundwater, surface water, and other miscellaneous liquids.
OI-181	Solids Sampling Describes the sampling of solid materials including soils, concrete, etc.
SRI-031	Shipment of Nonradioactive Samples Provides instructions for the shipment of samples to off-site laboratories.
RPP Manual	B&W NESI Radiation Protection Programs (RPP) Describes the general radiation protection program for the Parks Project.
HSI	Health & Safety Instructions A series of instructions describing generic radiological safety guidelines.
HPP	Operational Health & Safety Procedures Manual/ Health Physics Procedures (HPP) Describes the proper use of Health & Safety radiological survey equipment and techniques to be used for conducting radiological surveys.

Table 2-1 (continued)

SAMPLING AND ANALYSIS REFERENCES

B&W NESI Procedure	Title
TPs and RCPs	Technical Procedures (TPs) and Radiation Calibration Procedures (RCPs) Specialized procedures of the HPP program that provide instructions for activities such as final radiological surveying and radiological survey instrument calibration.
EAP-001 to EAP-012	Environmental Analytical Procedures (EAP) The Nuclear Environmental Laboratory (NEL) procedures covering environmental sample receipt, preparation, drying, measurement of pH and moisture content, standard preparation, and quality control samples.
UAS	Uranium Analytical Services (UAS) Procedures NEL procedures describing activities including gamma spectroscopy sample preparation, system efficiency calibrations, background checks, preparation of water samples for gross alpha and beta counting, and associated analysis procedures.
ER# GENS6003	Parks Facilities Characterization Engineering Release Describes the 1995 site characterization program requirements for B&W NESI and contracted field personnel.
ER# GENS6007	Parks Facilities Fourth Quarter 1995 Monitoring Well Sampling Provides guidance for B&W NESI field personnel for the sampling of the Parks Facilities groundwater monitoring wells.
Chap. 6	Parks Facilities Characterization Plan, Field Investigation Plan Contains the specific objectives, work scope, and procedures required for the 1995 Parks Facilities Characterization.

MISCELLANEOUS REFERENCES

NUREG/CR-5849, "Manual for Conducting Radiological Surveys in Support of License Termination" (Draft Report for Comment, June 1992)

NRC, "Branch Technical Position on Site Characterization for Decommissioning" (DRAFT, November 1994)

Table 2-2

RADIONUCLIDE DATA SUMMARY

Project Unit	Predominant Radionuclides of Interest	Average Radionuclide Concentration in the Soil* (pCi/g)
A	Am-241 Pu-241 Pu (alpha) Total uranium Co-60 Cs-137	10.5 294.8 33.6 8.1 6.1 5.1
B	Am-241 Pu-241 Pu (alpha) Total uranium	0.4 10.4 1.2 8.8
C	Total uranium	25.4
D	Am-241 Pu-241 Pu (alpha)	86.5 328.7 127.2
E	None	N.A.

* Average of the laboratory samples that exceeeded the Lower Limit of Detection. Laboratory samples were not used to determine this average concentration if they did not exceed the Lower Limit of Detection.

Table 2-3

GROUNDWATER RADIONUCLIDE CHARACTERIZATION DATA

Well Location	Radiation Type	7/17/91 Sampling pCi/liter	10/05/92 pCi/liter	02/24/93 Sampling pCi/liter	04/05/93 Sampling[4] pCi/liter
MW-04	alpha	6.63	1.04	4.31	NA
	beta	4.57	1.6	2.23 (4.61 LLD)	NA
MW-06	alpha	4.99	1.31 (2.04 LLD[3])	-0.86 (2.67 LLD)	NA
	beta	7.21	1.58 (2.96 LLD)	3.57	NA
MW-10	alpha	5.08	0.53 (0.66 LLD)	16.07	6.03
	beta	6.56	1.87	3.75	8.48
MW-21	alpha	NA	NA	NA	NA
	beta	NA	NA	NA	NA
MW-21R	alpha	3.76	0.02 (0.98 LLD)	0.08 (0.78 LLD)	NA
	beta	5.73	-1.60 (1.89 LLD)	1.5	NA
MW-31	alpha	NA	NA	NA	NA
	beta	NA	NA	NA	NA
MW-31R	alpha	12.62	0.04 (1.29 LLD)	0.03 (0.96 LLD)	1.63
	beta	19.89	2.62	2.46	4.96
MW-33	alpha	6.96	0.06 (0.86 LLD)	-0.70 (0.95 LLD)	NA
	beta	9.11	1.46	0.82 (1.11 LLD)	NA
MW-34	alpha	2.35	0.25 (0.87 LLD)	0.06 (1.04 LLD)	NA
	beta	5.92	0.68 (1.43 LLD)	2.04	NA
MW-37	alpha	4.77	1.09	0.87	NA
	beta	6.62	6.42	18.21	NA
MW-38	alpha	< 1.00	0.63 (0.78 LLD)	-0.01 (0.41 LLD)	NA
	beta	4.82	0.78 (1.77 LLD)	1.38	NA
MW-39	alpha	NA	1.61	0.31 (1.10 LLD)	NA
	beta	NA	3.06	3.22	NA
MW-39D[2]	alpha				
	beta				
MW-40	alpha	NA	0.45 (0.70 LLD)	18.73	0.36 (1.11 LLD)
	beta	NA	4.71	3.61	3.57
MW-41	alpha	NA	0.69 (0.83 LLD)	81.48	1.14 (1.53 LLD)
	beta	NA	2.36	7.72	7.48
MW-42[1]	alpha			1.16	1.09 (1.52 LLD)
	beta			6.26	12.94
MW-43[1]	alpha			0.93 (1.63 LLD)	NA
	beta			4.06	NA
MW-44[1]	alpha			-0.33 (0.74 LLD)	NA
	beta			1.65	NA

General Notes:

(a) Negative numbers denote values less than background and are an effect of the statistical deviation associated with counting background.

(b) NA denotes monitoring well was not sampled during that sampling event.

Table 2-3 (continued)

GROUNDWATER RADIONUCLIDE CARACTERIZATION DATA

Well Location	Radiation Type	05/10/93 Sampling pCi/liter	09/01/93 Sampling pCi/liter	11/30/93 Sampling pCi/liter
MW-04	alpha	0.36	1.24	1.28
	beta	1.645	3.58	2.92
MW-06	alpha	-0.43 (2.34 LLD)	0.00 (1.94 LLD)	4.23
	beta	-2.77 (2.90 LLD)	3.76	13.91
MW-10	alpha	0.08	0.15 (0.70 LLD)	1.13
	beta	2.32	1.53	4.75
MW-21	alpha	NA	NA	NA
	beta	NA	NA	NA
MW-21R	alpha	1.42	0.23 (0.74 LLD)	2.09
	beta	2.7	2.08	4.51
MW-31	alpha	NA	NA	NA
	beta	NA	NA	NA
MW-31R	alpha	-0.05 (0.84 LLD)	1.53	3.14
	beta	1.42	2.27	6.03
MW-33	alpha	0.54	-0.15(0.87 LLD)	0.96
	beta	2.39	2.04	5.62
MW-34	alpha	0.21	0.41 (0.94 LLD)	1.87
	beta	2.9	1.79	9.25
MW-37	alpha	0.57	-0.01(0.77 LLD)	1.6
	beta	6.58	4.67	8.5
MW-38	alpha	1.69	0.46 (0.63 LLD)	0.77
	beta	1.42	3.42	3.03
MW-39	alpha	-0.27 (1.19 LLD)	-0.12(1.02 LLD)	11.56
	beta	2.41	2.61	13.47
MW-39D[2]	alpha			
	beta			
MW-40	alpha	0.35	0.33 (0.84 LLD)	0.88
	beta	2.38	2.08	3.5
MW-41	alpha	0.71	0.38 (0.86 LLD)	1.85
	beta	2.79	2.13	5.42
MW-42[1]	alpha	3.23	-1.04(1.61 LLD)	2.26
	beta	4.7	4.63	6.62
MW-43[1]	alpha	0.68	0.40 (0.68 LLD)	2.8
	beta	5.7	4.78	22.66
MW-44[1]	alpha	0.46	0.24 (0.60 LLD)	1.1
	beta	1.34	2.25	3.2

Table 2-3 (continued)

GROUNDWATER RADIONUCLIDE CARACTERIZATION DATA

Well Location	Radiation Type	10/23/95 Sampling pCi/liter	2/27/96 Sampling pCi/liter	5/6/96 Sampling pCi/liter	8/5/96 Sampling pCi/liter
MW-04	alpha	0.97	0.12	0.17 (1.0 LLD)	2.79
	beta	1.4	1.21	1.54	15.94
MW-06	alpha	3.5	0.95	3.71	4.28
	beta	2.1	5.38	3.9	11.35
MW-10	alpha	1.01	0.35	0.49	1.34
	beta	1.68	1.59	1.71	3.89
MW-21	alpha	92.81	DRY	DRY	DRY
	beta	168.3			
MW-21R	alpha	0.1	0.56	0.75	0.15 (1.0 LLD)
	beta	1.9	9.14	2.92	3.01
MW-31	alpha	DRY	DRY	DRY	DRY
	beta				
MW-31R	alpha	1.78	1.13	0.63	2.86
	beta	0.9	2.54	3.63	3.50
MW-33	alpha	1.1	0.33	0.36 (1.0 LLD)	2.02
	beta	2.5	2.17	3.2	10.46
MW-34	alpha	1.5	0.64	1.16	2.61
	beta	2.3	2.46	3.16	5.10
MW-37	alpha	0.23	1.47	1.31	1.51
	beta	2.8	6.19	4.09	3.85
MW-38	alpha	0.82	0.66	0.21 (1.0 LLD)	2.80
	beta	2.2	2.54	2.13	15.99
MW-39	alpha	1.63 (2.00 LLD)	1.01	2.16	2.63
	beta	2.2	15.38	4.16	2.39
MW-39D[2]	alpha	7.43	6.24	4.54	14.56
	beta	8.25	5.37	10.21	4.21 (6.0 LLD)
MW-40	alpha	0.20 (1.00 LLD)	0.72	0.30 (1.0 LLD)	2.02
	beta	2.5	2.97	2.45	7.68
MW-41	alpha	2.1	0.44	0.73	1.41
	beta	2.1	1.23	2.06	10.84
MW-42[1]	alpha	0.75 (2.00 LLD)	0.82	1.88	1.62
	beta	7.6	5.44	15.33	7.67
MW-43[1]	alpha	0.35 (1.00 LLD)	0.67	1.51	1.22
	beta	3.8	6.32	4.79	4.75
MW-44[1]	alpha	0.87	0.96	0.68	3.53
	beta	1.1	3.51	2.21	15.88
MW-45[2]	alpha	0.81	3.43	1.07	1.17
	beta	2.3	4.66	3.12	2.54
MW-45D[2]	alpha	10.81	1.2	2.54 (8.0 LLD)	12.07 (13.0 LLD)
	beta	10.28	7.71	9.17	17.27
MW-46[2]	alpha	1.8	1.94	0.65	4.53
	beta	1.3	4.21	2.21	29.35

Table 2-3 (continued)

GROUNDWATER RADIONUCLIDE CARACTERIZATION DATA

Well Location	Radiation Type	10/23/95 Sampling pCi/liter	2/27/96 Sampling pCi/liter	5/6/96 Sampling pCi/liter	8/5/96 Sampling pCi/liter
MW-47[2]	alpha	3.6	0.84	0.07 (1.0 LLD)	0.93 (1.0 LLD)
	beta	2.5	2.15	2.32	3.08
MW-48[2]	alpha	5.84	21.19[5]	26.5[5]	21.54[6]
	beta	4.22	1.93	4.94	7.10
MW-49[2]	alpha	1	0.43	1.96	1.43
	beta	2.95	2.48	6.9	4.28
MW-49D[2]	alpha	1.6	18.2	0.35 (2.0 LLD)	4.95
	beta	0.51	9.01	2.9	5.33
MW-50[2]	alpha	1.36	1.56	0.98	2.40
	beta	0.77	2.18	2.34	3.62
MW-51[2]	alpha	1.21	1.9	-1.26 (2.6 LLD)	3.31
	beta	2.2	5.4	16.45	3.72
MW-52[2]	alpha	1.1	2.6	0.76	1.16
	beta	2.6	5.49	7.44	8.09
MW-52D[2]	alpha	1.74	-0.16 (1.09 LLD)	3.3	-2.92 (10.0 LLD)
	beta	0.89	2.45	5.65	5.17 (7.0 LLD)
MW-53[2]	alpha	1.61	2.71	0.94	3.15
	beta	2.98	4.66	4.1	6.48
MW-54[2]	alpha	1.6	1.25	0.04 (3.0 LLD)	3.14 (6.0 LLD)
	beta	2.2	14.04	3.88	46.62
MW-55[2]	alpha	4.6	0.98	-0.18 (3.0 LLD)	1.73 (4.0 LLD)
	beta	4.2	0.05 (0.92 LLD)	2.25	12.38
MW-56[2]	alpha	1.55	0.56	2.69	2.72 (3.0 LLD)
	beta	1.76	3.49	3.36	4.25
MW-57[2]	alpha	2.01	1.47	1	2.07
	beta	3.36	4.2	5.9	6.85
MW-58[2]	alpha		8.04	DRY	DRY
	beta		20.64		
MW-59[2]	alpha	2.75	0.33	-0.38 (1.0 LLD)	2.47
	beta	4.2	4.01	9.33	9.08

[1] Wells installed February 1993
[2] Wells installed during 1995 site characterization activities
[3] LLD is the Lower Limit of Detection
[4] Only MW-10, MW-31R, MW-41, and MW-42 were sampled on 4/5/93
[5] Sample was recounted. Only environmental levels of total uranium were detected.
[6] Sample being recounted to identify gross alpha

Table 2-4

SURFACE WATER RADIONUCLIDE CHARACTERIZATION DATA

River Location	Radiation Type	10/23/95 Sampling pCi/liter	2/27/96 Sampling pCi/liter	5/6/96 Sampling pCi/liter	8/5/96 Sampling pCi/liter
D-S-1	gross alpha	9.53	Not Sampled	Not Sampled	Not Sampled
	gross beta	8.38			
D-S-2	gross alpha	6.55	Not Sampled	Not Sampled	Not Sampled
	gross beta	9.75			
D-S-3	gross alpha	12.24	Not Sampled	Not Sampled	Not Sampled
	gross beta	101.10			
D-S-4	gross alpha	7.40	1.69	-0.23 (1.0 LLD)	1.97
	gross beta	55.30	3.58	2.65	6.22
D-S-5	gross alpha	224.80	1.07	0.09 (1.0 LLD)	0.73 (3.0 LLD)
	gross beta	2,489.70	3.25	2.10	23.65
	Cs-137 by gamma spectroscopy	2,320.00	Undetectable	Undetectable	Undetectable

Figure 2-1, Rev. 1

Parks Characterization Area

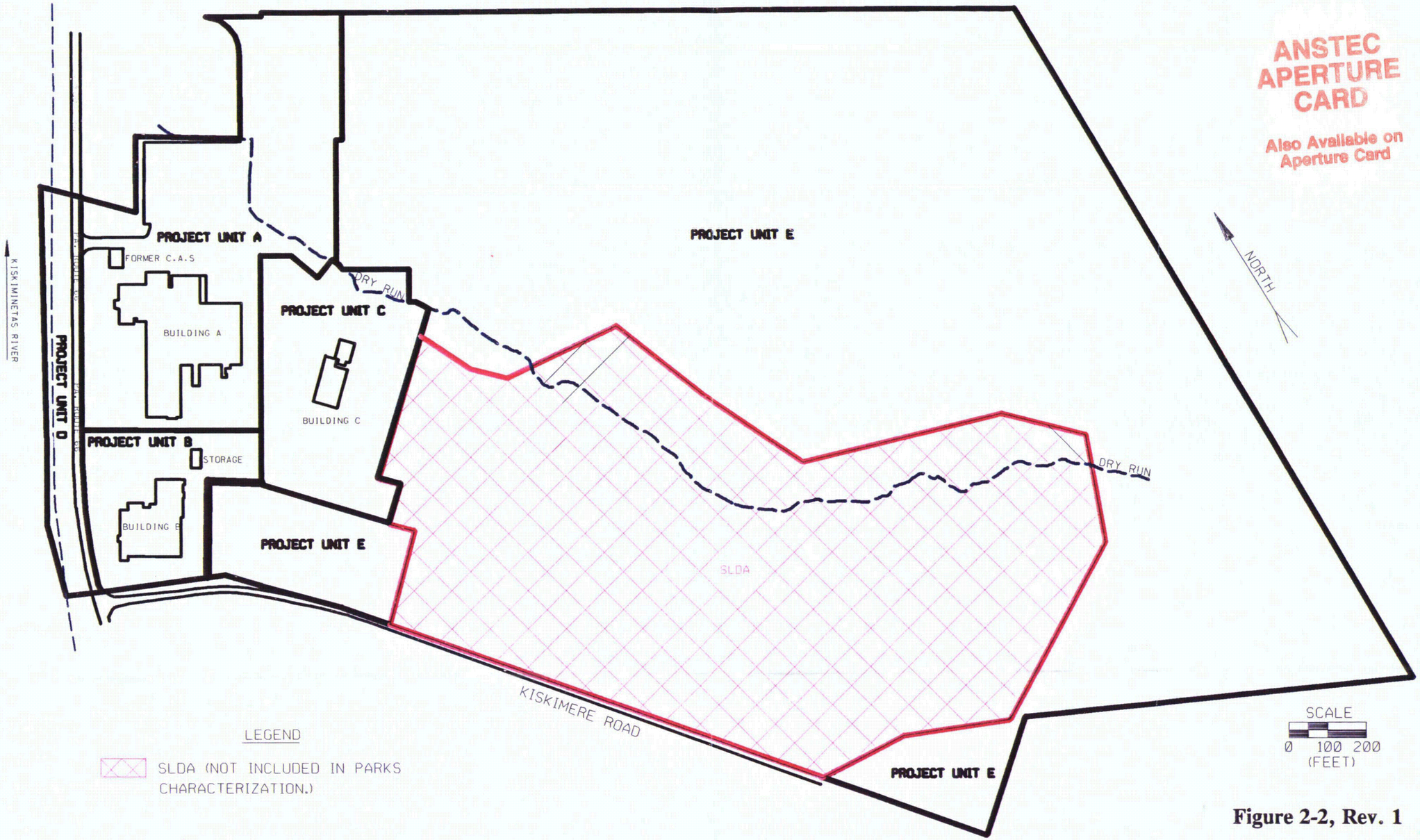


Figure 2-2, Rev. 1

Parks Characterization Area
Project Units

Figure 2-3, Rev. 1

Project Unit A - Radiological Sampling Locations

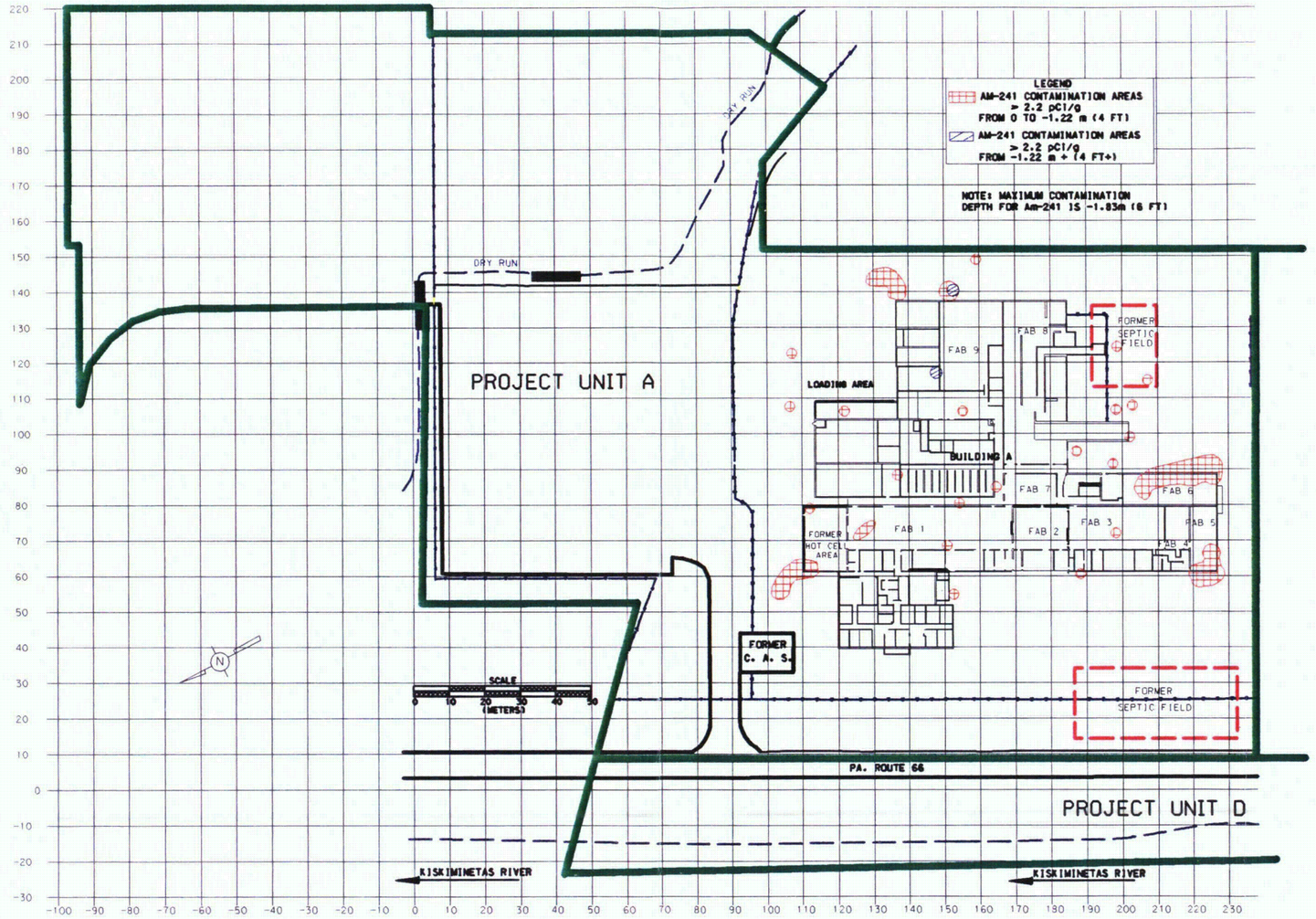


Figure 2-4, Rev. 1

Project Unit A -
Americium-241 Concentrations
(>2.2 pCi/g: 0′-4′ and 4′+)

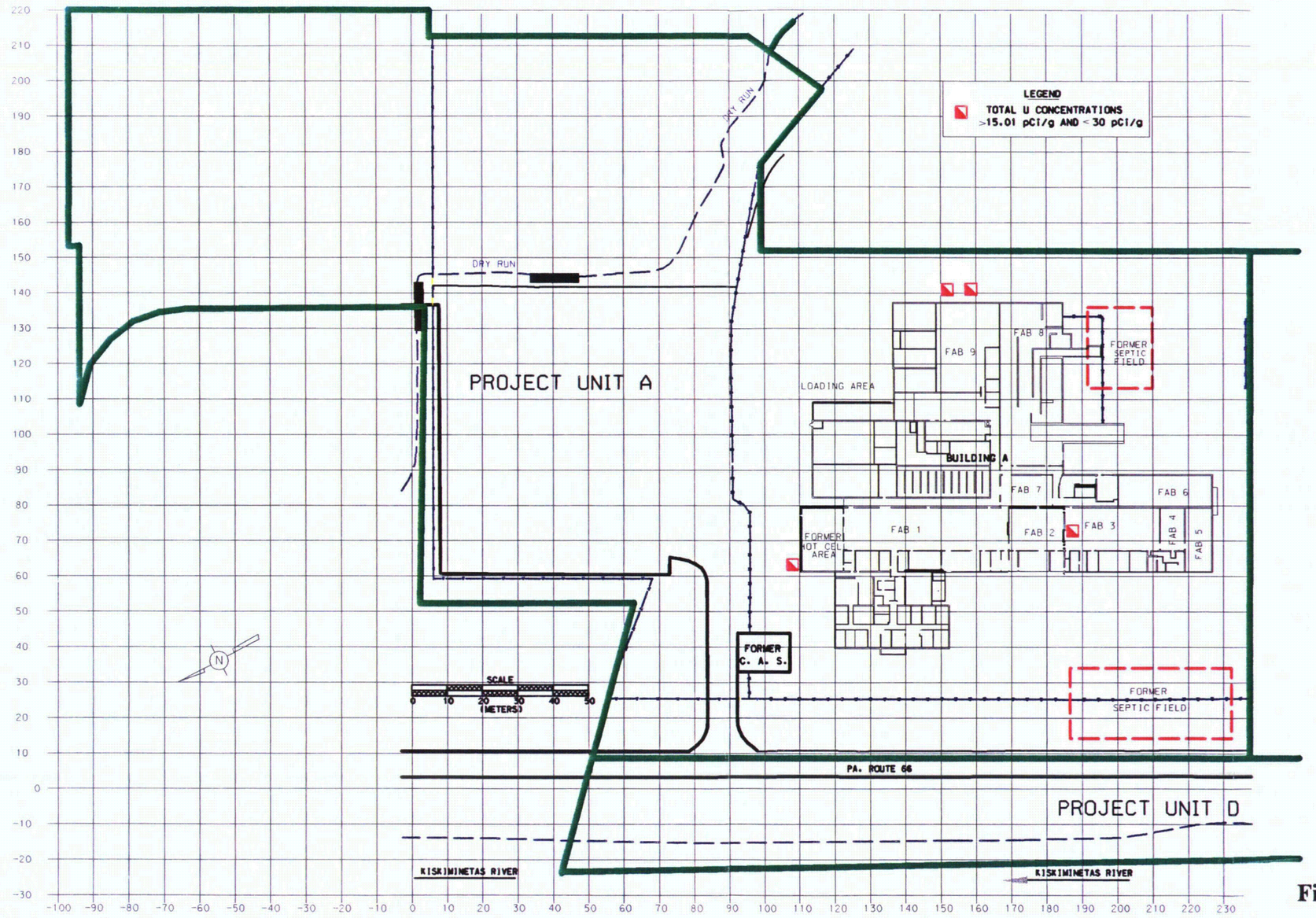


Figure 2-5, Rev. 1

Project Unit A -
Total Uranium Concentrations
(>15 pCi/g and <30 pCi/g)

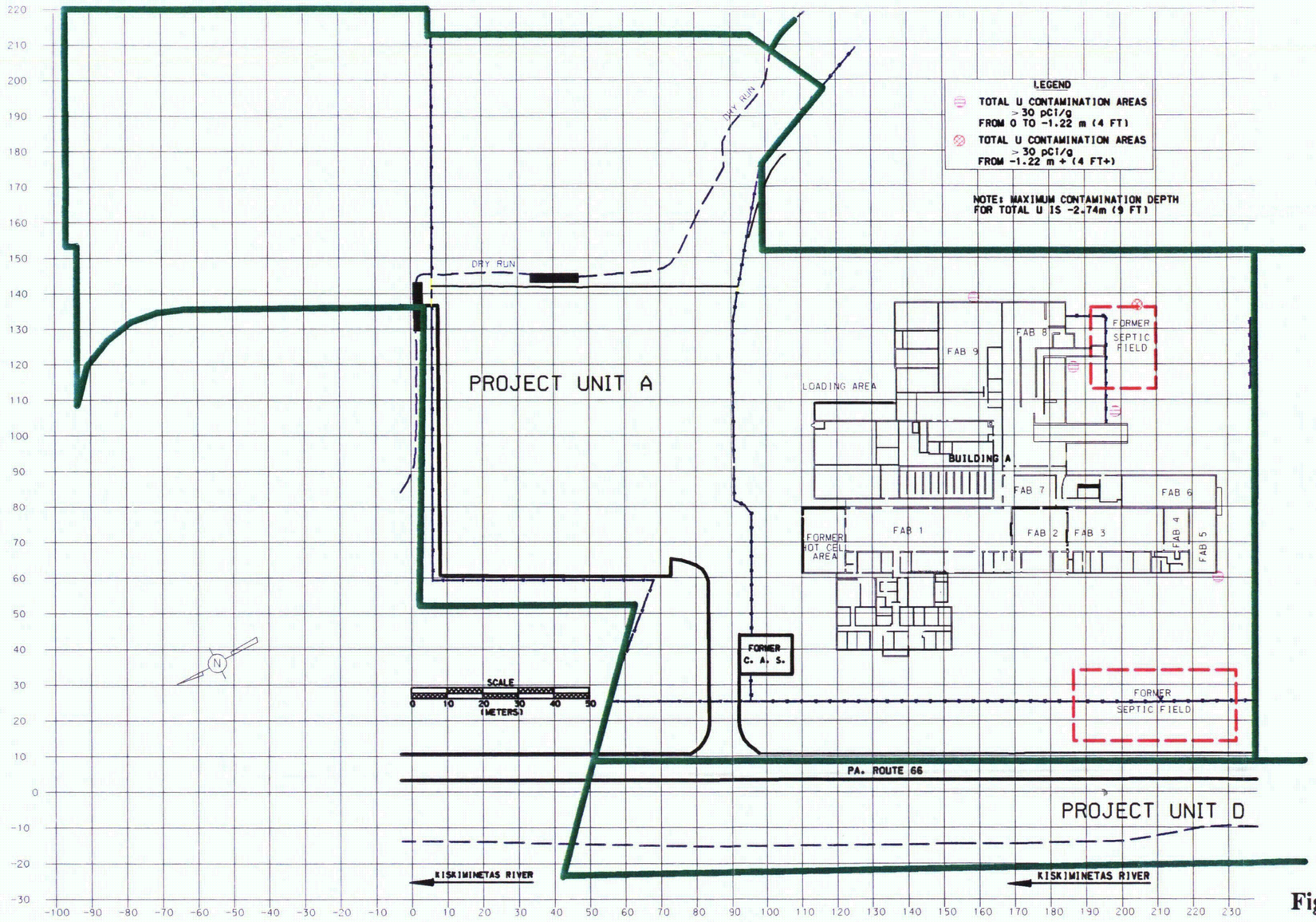


Figure 2-6, Rev. 1

Project Unit A -
Total Uranium Concentrations
(>30 pCi/g: 0′-4′ and 4′+)

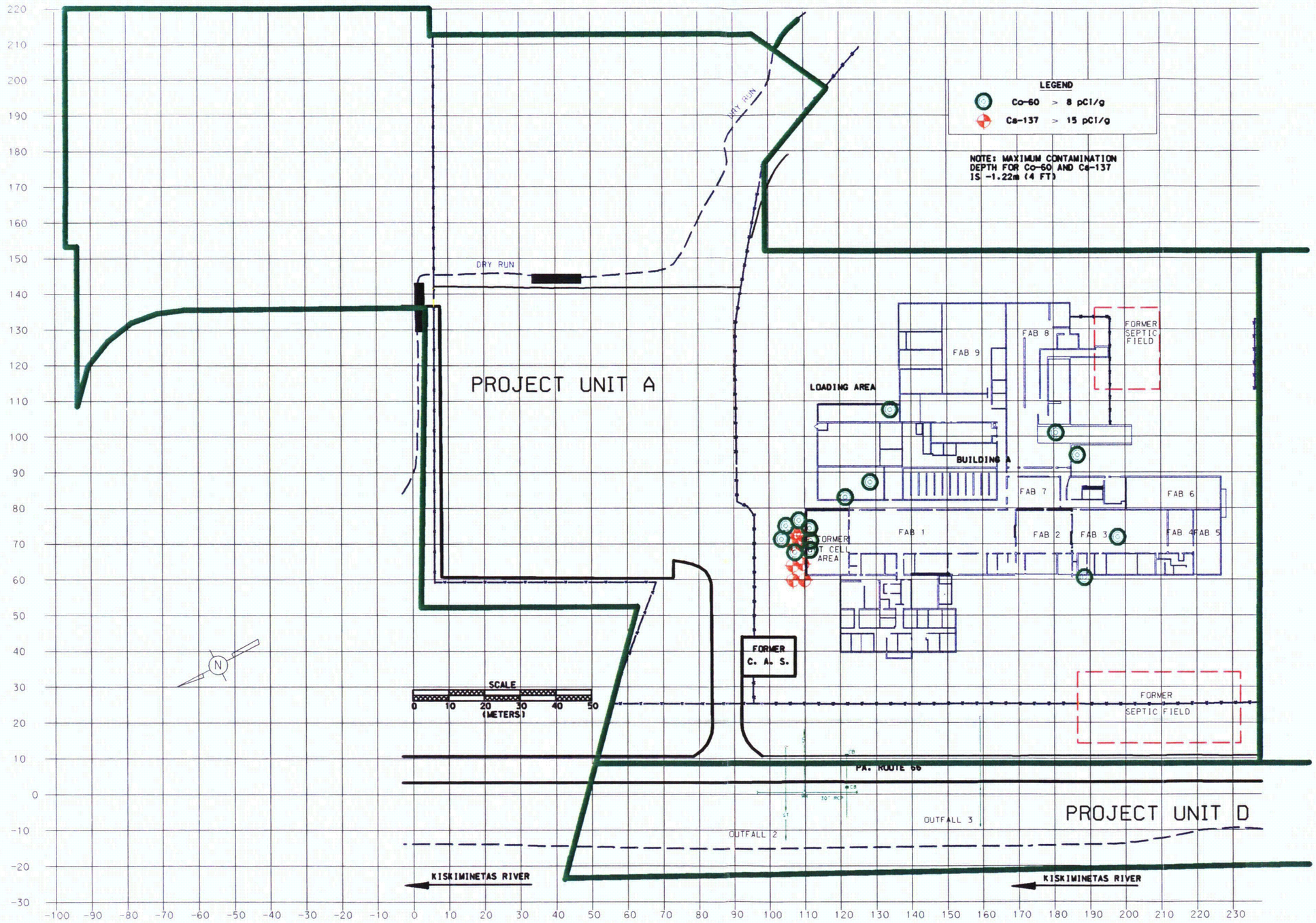


Figure 2-7, Rev. 1

Project Unit A -
Co-60 (>8 pCi/g) and Cs-137
(>15 pCi/g) Concentrations

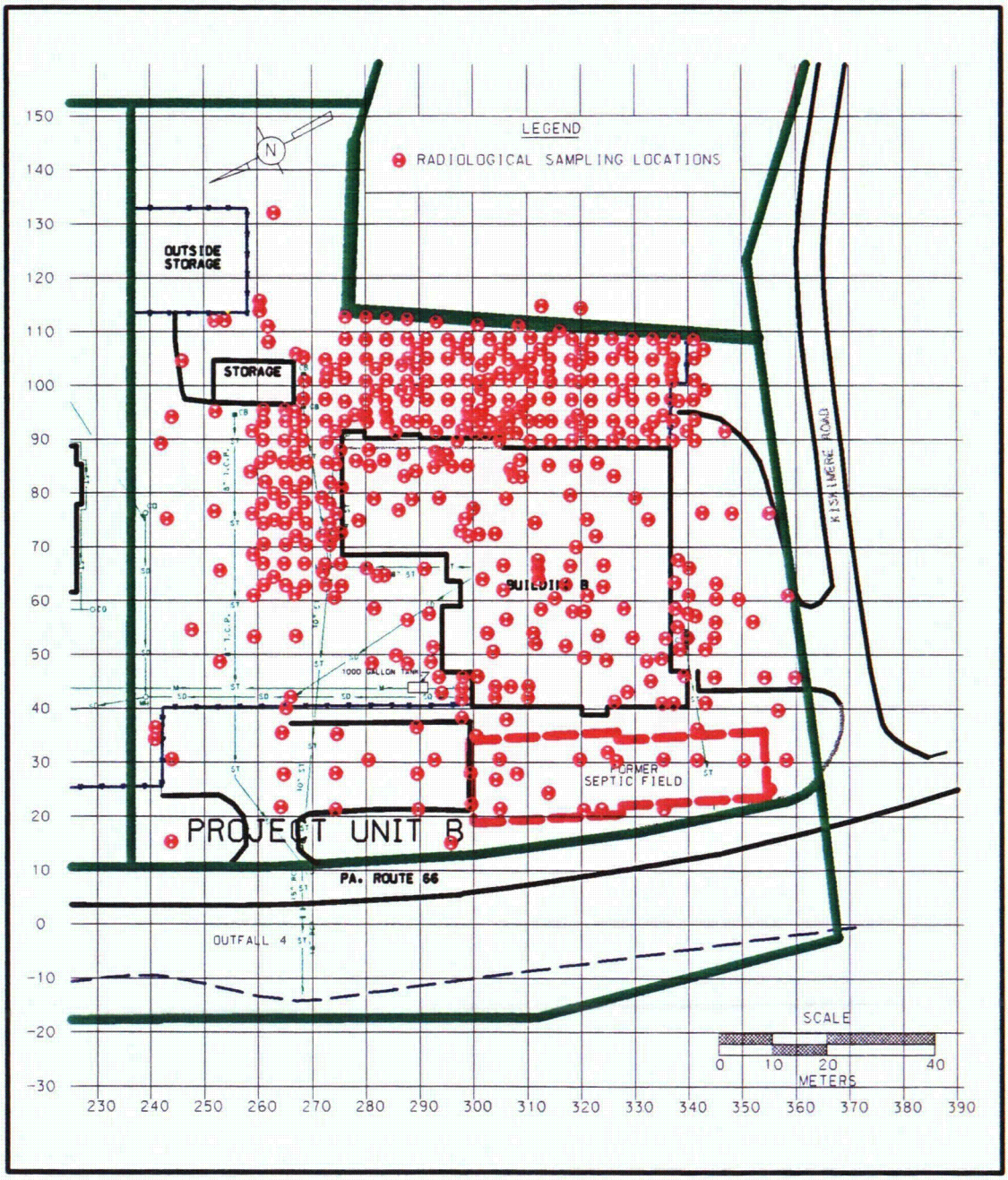


Figure 2-8, Rev. 1

Project Unit B -
Radiological Sampling Locations

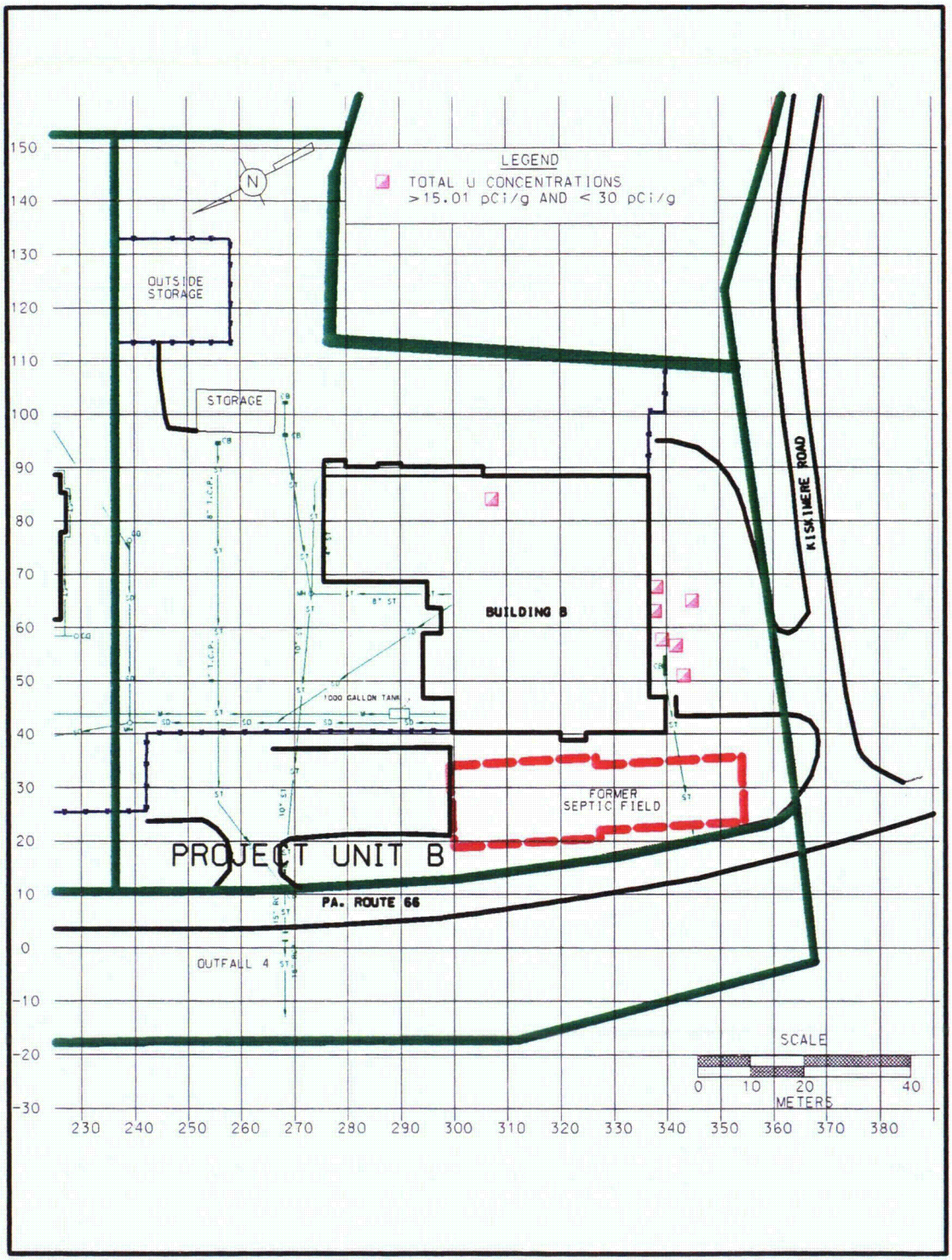


Figure 2-9, Rev. 1

Project Unit B -
Total Uranium Concentrations
(>15 pCi/g and <30 pCi/g)

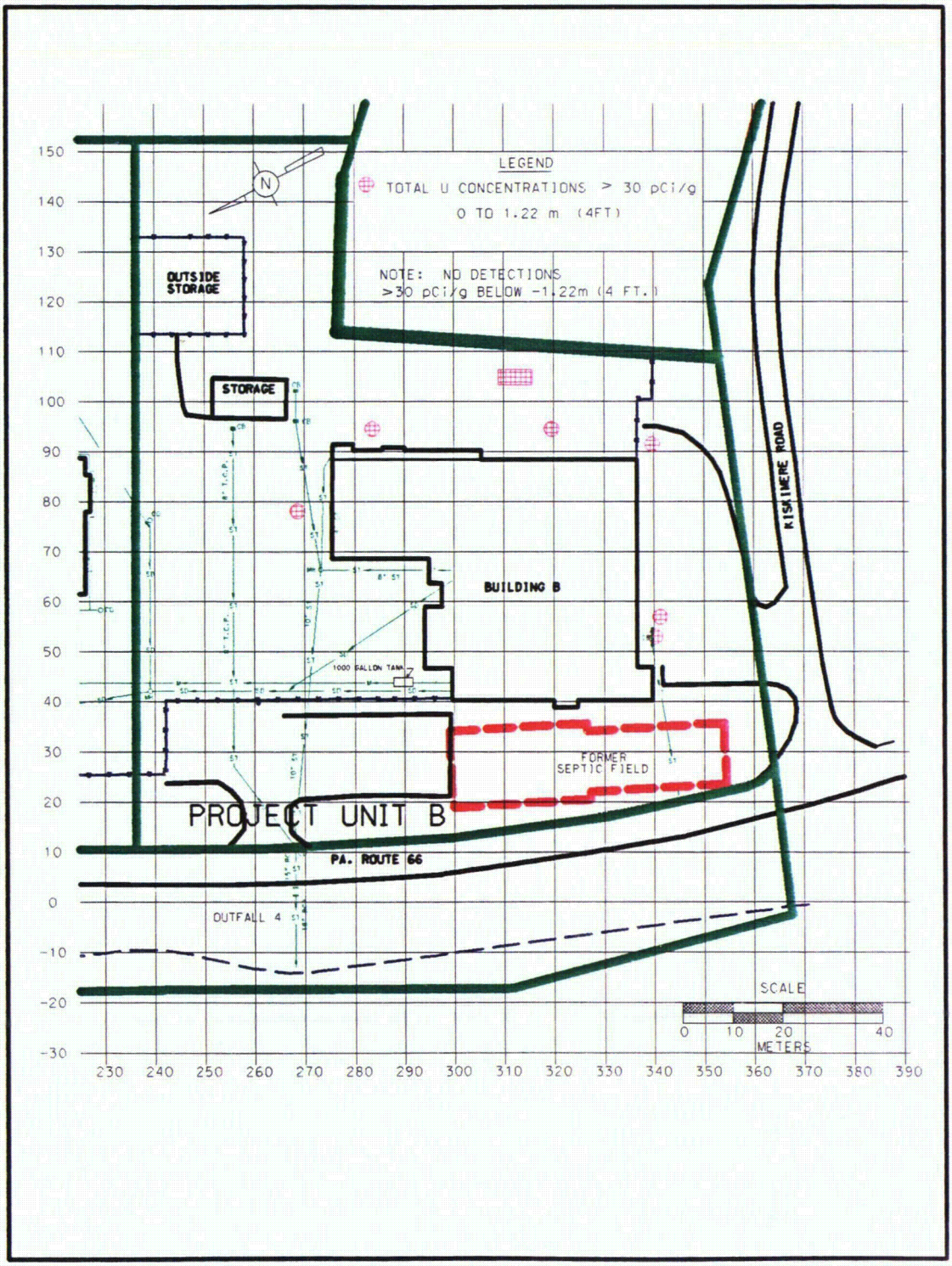


Figure 2-10, Rev. 1

Project Unit B -
Total Uranium Concentrations
(>30 pCi/g: 0′-4′ and 4′+)

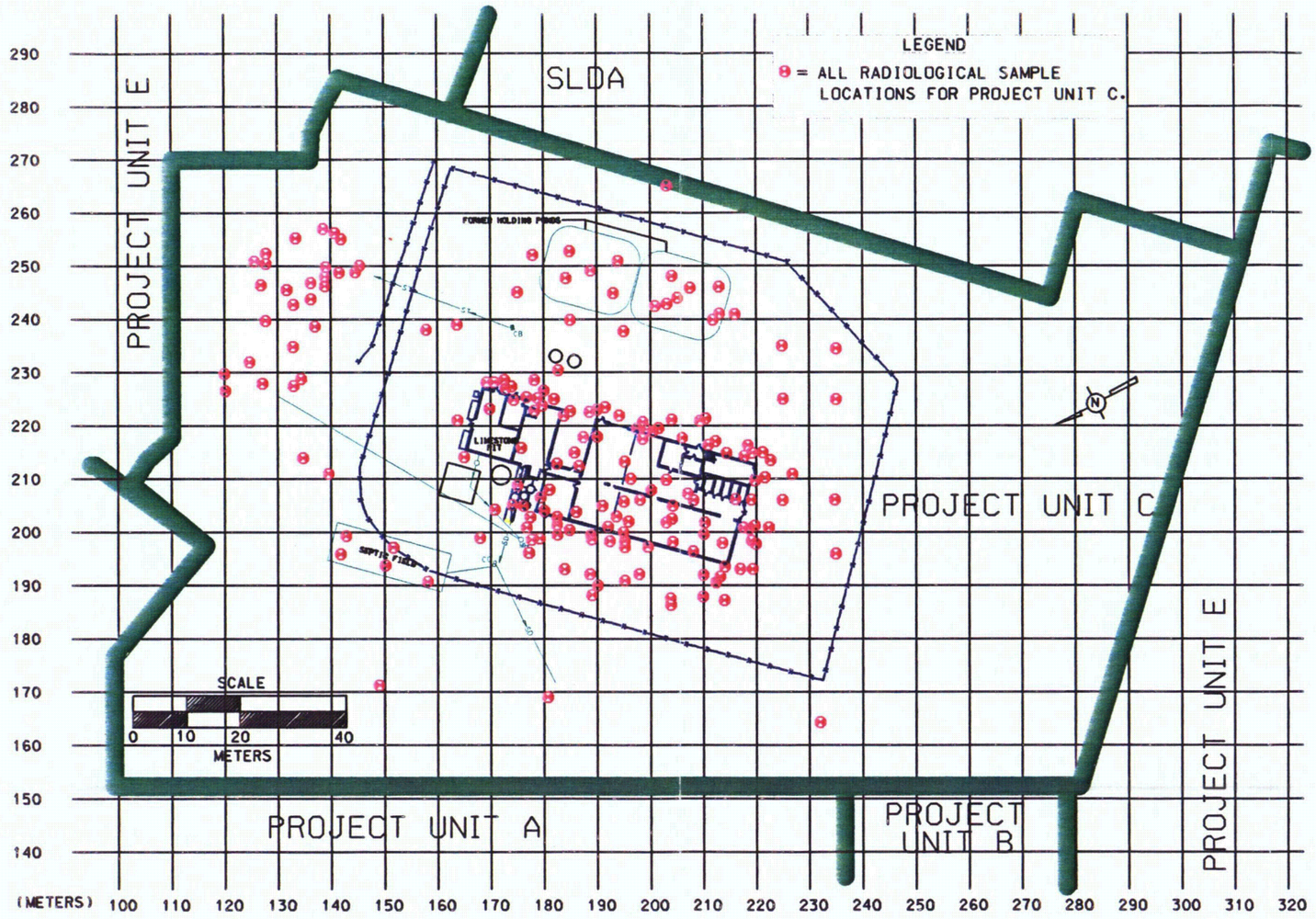


Figure 2-11, Rev. 1

Project Unit C -
Radiological Sampling Locations

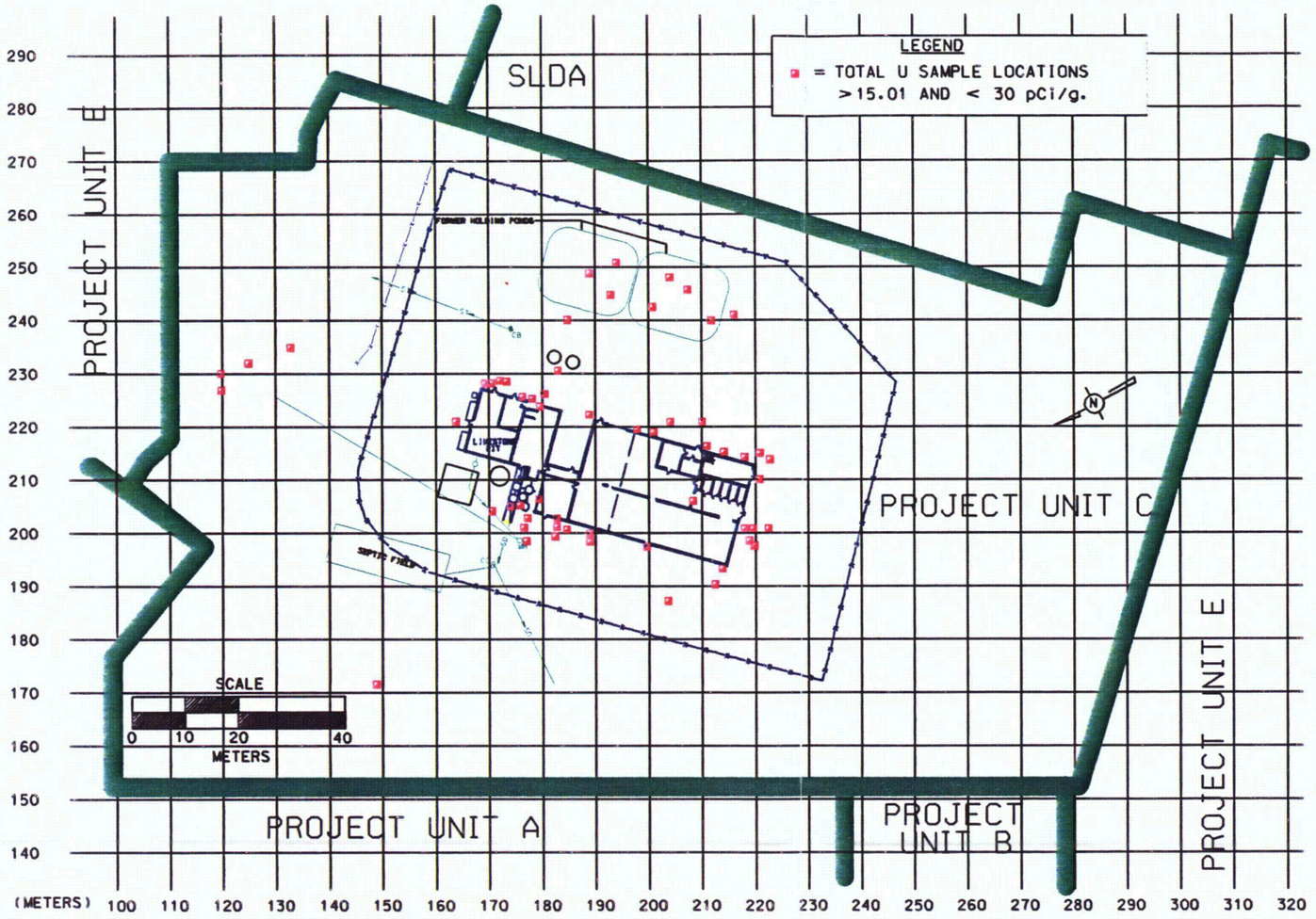


Figure 2-12, Rev. 1

Project Unit C -
Total Uranium Concentrations
(> 15 pCi/g and < 30 pCi/g)

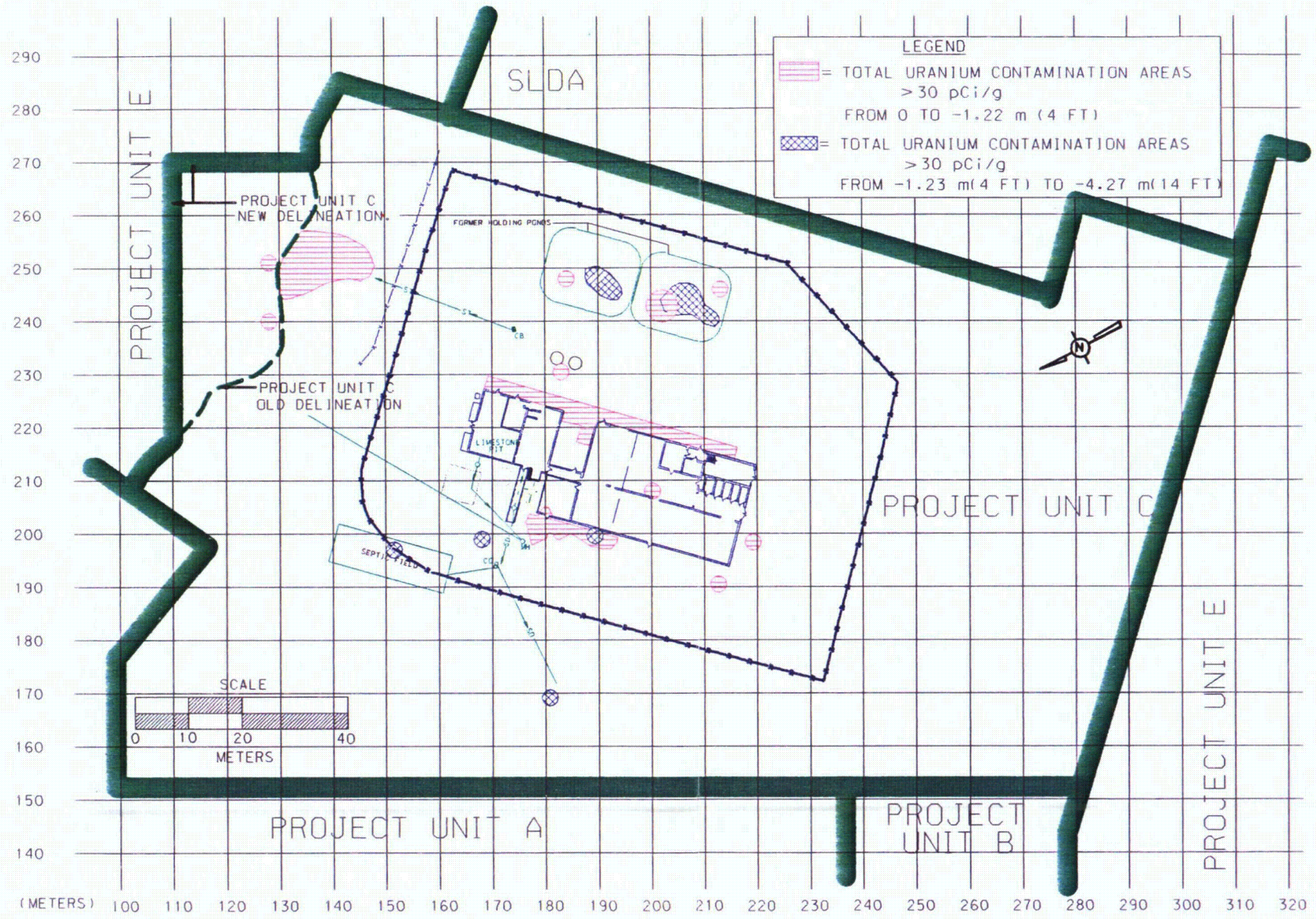


Figure 2-13, Rev. 1

Project Unit C -
Total Uranium Concentrations
(>30 pCi/g: 0'-4' and 4'+)

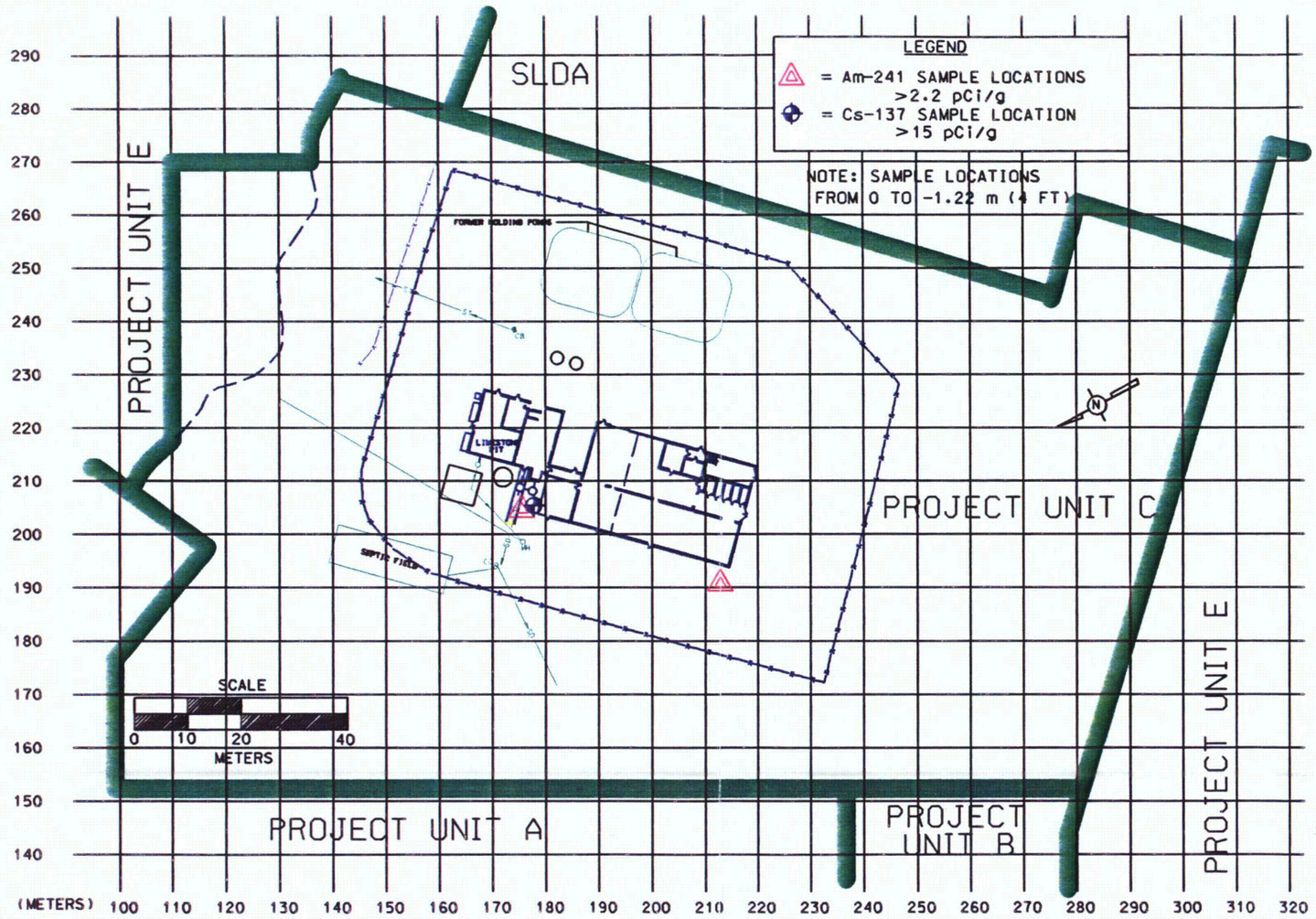


Figure 2-14, Rev. 1

Project Unit C - Am-241
(>2.2 pCi/g), Cs-137 (>15 pCi/g)
Concentrations

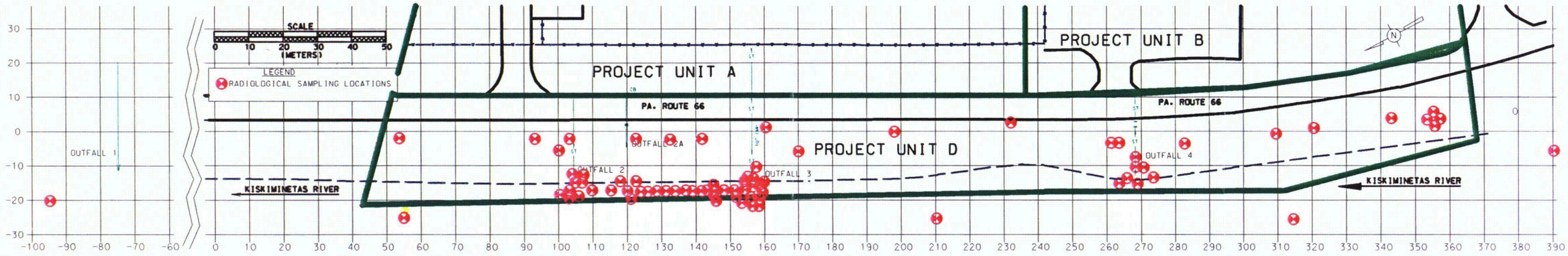


Figure 2-15, Rev. 1

Project Unit D -
Radiological Sampling Locations

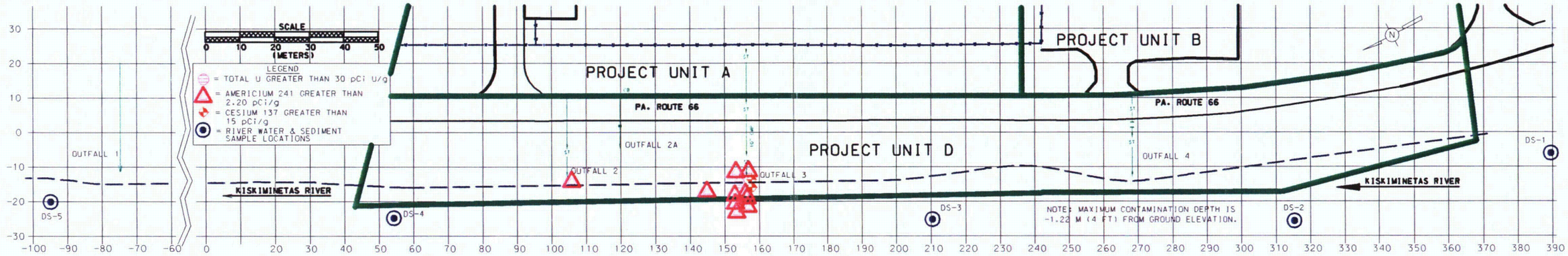


Figure 2-16, Rev. 1

Project Unit D - Am-241
(>2.2 pCi/g), Cs-137 (>15 pCi/g)
and Total Uranium (>30 pCi/g)
Concentrations

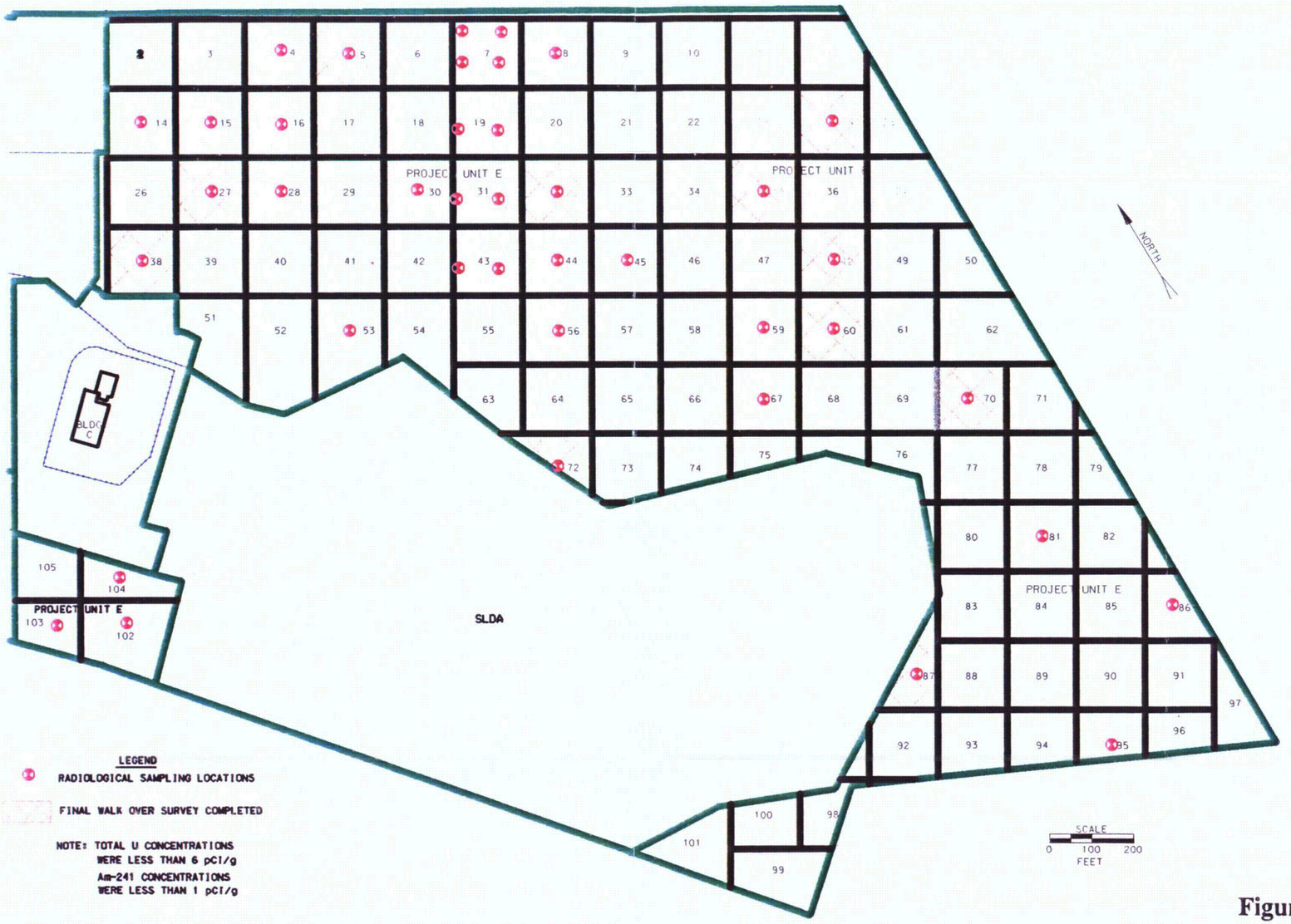


Figure 2-17, Rev. 1

Project Unit E - Radiological Sampling Locations and Final Walk-over Survey Grids

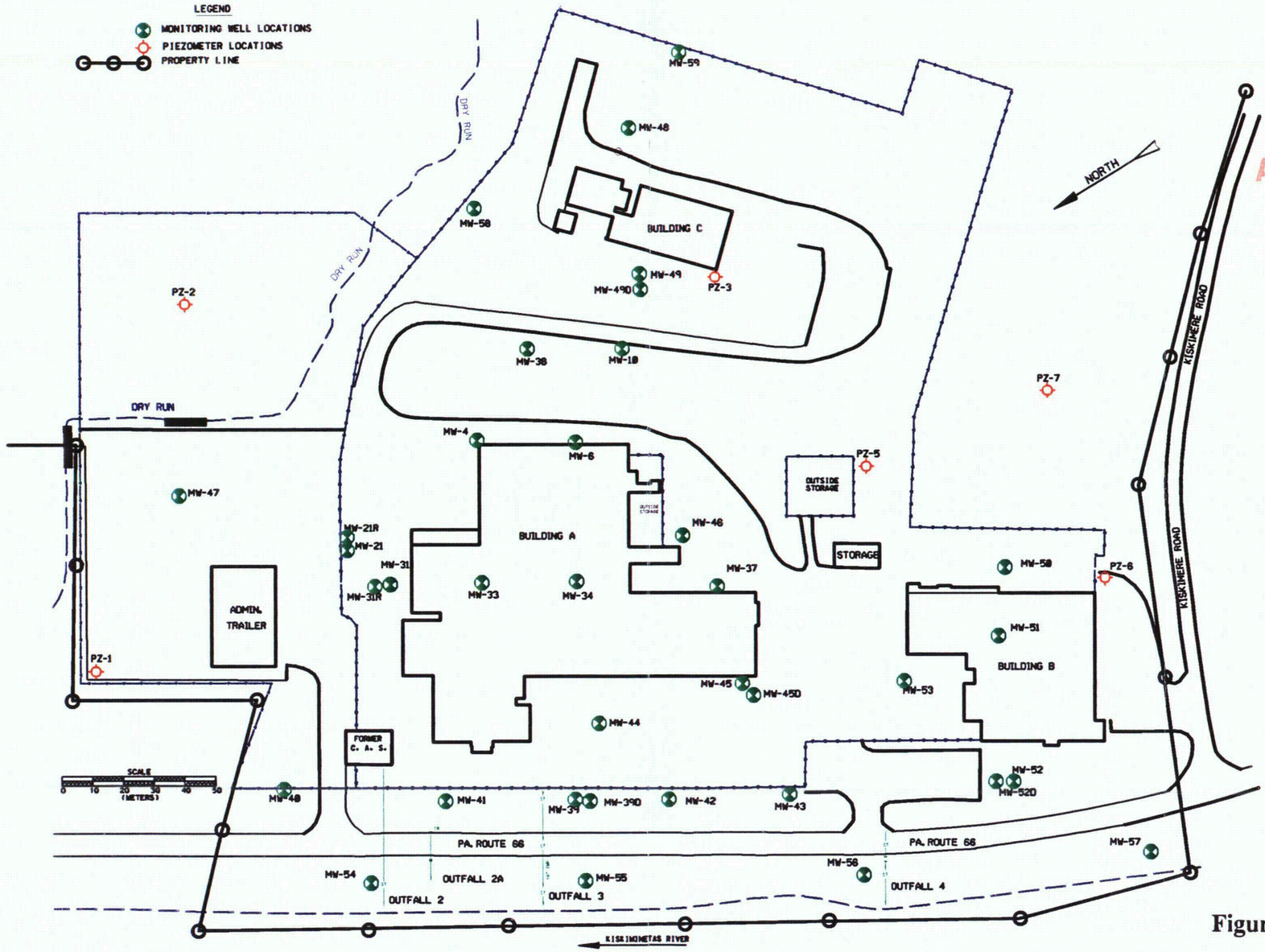


Figure 2-18, Rev. 1

Parks Facilities Groundwater Monitoring Wells

3.0 PLANNED DECOMMISSIONING ACTIVITIES

Decommissioning has been preceded by many individual characterization, deactivation, decontamination and remediation projects, as discussed in Section 1.3. Alternative decommissioning activities were also evaluated during preparation of this decommissioning plan, and analysis of the major alternative is included in Appendix A. While it is anticipated that most of the radioactive materials and buildings will have been removed from the site prior to approval of the Decommissioning Plan, the foundations, grade-level concrete floors and basements of the three major building complexes will still remain, as will most of the below-grade man-made structures including septic fields, septic tanks, distribution boxes, catch basins, storm sewer lines, water pipes, septic system piping, and underground electric, gas and telephone lines, and paved areas. There will also be regions of soil which were identified during the site characterization activities as containing radioactivity above the guideline values indicated in Section 3.2. These regions of soil with elevated radioactivity levels were previously discussed in Section 2.2.

B&W's decommissioning objective is stated in Section 3.1. The decommissioning criteria it will meet are described in Section 3.2. An overall view of the proposed decommissioning activities is presented in Section 3.3. Details of the major activities and tasks necessary to accomplish the objective is discussed in Section 3.4. The planned methodology to be followed during soil excavation is discussed in Section 3.5. The organization and control procedures necessary to safely accomplish the work are detailed in Section 3.6. The schedule for completing decommissioning activities is provided in Section 3.7. A discussion of radioactive waste management issues is provided in Section 3.8.

3.1 OBJECTIVE

B&W's decommissioning objective is to remediate the Parks Facilities to the extent required by applicable governmental directives, standards and regulations in order to allow the NRC to (a) release the property for unrestricted use, and (b) terminate license SNM-414. In view of the results of the characterization, no radiological remediation of the Undeveloped Area (see Section 2.2.5) is needed.

3.2 DECOMMISSIONING CRITERIA

The principal radiological constituents identified during site characterization or known to be present through knowledge of site history and processes are:

- Alpha emitting Pu isotopes
- Am-241
- Pu-241
- High Enriched Uranium (HEU)
- Depleted Uranium (DU)
- Fission and activation products, predominantly Cs-137 and Co-60

The radiological constituents will primarily exist in a dispersed form associated with soil, or the bulk material resulting from decommissioning activities. Smaller amounts may be contained on surfaces of grade level or below-grade man-made appurtenances. The residual radioactivity levels that will be considered acceptable for release of the facilities and site for unconditional use are given below in separate tables for bulk materials and surfaces. The limits or guideline values in the following tables will be applied independently except in areas with mixed radionuclides where the sum-of-ratios approach will be used as described in NUREG/CR-5849.

GUIDELINE SOIL AND BULK MATERIAL ACTIVITY LEVELS

Kind of Material	Maximum Soil Concentration (in pCi/g)	Reference
Plutonium compounds, (soluble and insoluble) (excluding Pu-241)	25	1
Am-241 compounds, (insoluble)	30	1
Pu-241	1,250	2
Enriched Uranium	30	1
Depleted Uranium	35	1
Co-60	8	3
Cs-137	15	3
Sr-90	5	4

References:

(1) "Policy and Guidance Directive FC 83-23: Termination of Byproduct, Source, and Special Nuclear Material Licenses", from Richard E. Cunningham to Regional Administrators, Branch Chiefs and Division of Fuel Cycle and Materials Safety, November 4, 1983

(2) See Appendix B

(3) "Medical, Academic, and Commercial Use Safety: Evaluation of Acceptability of Proposed Decommissioning Activities", memorandum from J. W. N. Hickey, Chief Operations Branch, Division of Fuel Cycle to W. E. Cline, Chief, Nuclear Materials Safety and Safeguards Branch, NRC, Region III, May, 6, 1987

(4) Memo from Mr. Jerry Swift (NRC Section Leader) to Mr. Berne Haertjens (B&W NESI), dated March 31, 1992, which included a table of maximum soil concentrations considered acceptable by the NRC for release for unrestricted use.

GUIDELINE SURFACE ACTIVITY LEVELS*

NUCLIDE [a]	AVERAGE [b c f]	MAXIMUM [b d f]	REMOVABLE [b e f]
^{nat}U, ^{235}U, ^{238}U, and associated decay products	5,000 dpmα/100 cm^2	15,000 dpmα/100 cm^2	1,000 dpmα/100 cm^2
Transuranics (excluding ^{241}Pu), ^{226}Ra, ^{228}Ra, ^{230}Th, ^{228}Th, ^{231}Pa, ^{227}Ac, ^{125}I, ^{129}I	100 dpm/100 cm^2	300 dpm/100 cm^2	20 dpm/100 cm^2
^{nat}Th, ^{232}Th, ^{90}Sr, ^{223}Ra, ^{224}Ra ^{232}U, ^{126}I, ^{131}I, ^{133}I	1,000 dpm/100 cm^2	3,000 dpm/100 cm^2	200 dpm/100 cm^2
Beta-gamma emitters (nuclides with decay modes other than alpha emission or spontaneous fission) except ^{90}Sr and others noted above, but including ^{241}Pu	15,000 dpm$\beta\gamma$/100 cm^2	15,000 dpm $\beta\gamma$/100 cm^2	1,000 dpm $\beta\gamma$/100 cm^2

[a] Where surface activity by both alpha- and beta-gamma-emitting nuclides exists, the limits established for alpha and beta-gamma emitting nuclides should apply independently.

[b] As used in this table, dpm (disintegrations per minute) means the rate of emission by radioactive material as determined by correcting the counts per minute observed by an appropriate detector for background, efficiency, and geometric factors associated with the instrumentation.

[c] Measurements of average activity should not be averaged over more than 1 square meter. For objects of less surface area, the average should be derived for each such object.

[d] The maximum activity level applies to an area of not more than 100 cm^2.

[e] The amount of removable radioactive material per 100 cm^2 of surface area should be determined by wiping that area with dry filter or soft absorbent paper, applying moderate pressure, and assessing the amount of radioactive material on the wipe with an appropriate instrument of known efficiency. When removable activity on objects of less surface area is determined, the pertinent levels should be reduced proportionally and the entire surface should be wiped.

[f] The average and maximum radiation levels associated with surface activity resulting from beta-gamma emitters should not exceed 0.2 mrad/hr at 1 cm and 10 mrad/hr at 1 cm, respectively, measured through not more than 7 milligrams per square centimeter of total absorber.

* From NRC "Policy and Guidance Directive FC 83-23: Termination of Byproduct, Source, and Special Nuclear Material Licenses", from Richard E. Cunningham to Regional Administrators, Branch Chiefs and Division of Fuel Cycle and Materials Safety, November 4, 1983

As previously discussed in Section 2.2.8, significant radioactivity is not expected in the groundwater based on the site characterization results, but a post-remediation sampling program from wells which are located upgradient, downgradient and within the boundaries of the Parks Facilities will be conducted to confirm this expectation. The EPA National Primary Drinking Water Regulations will be used as a point-of-reference against which groundwater sampling and analysis results will be compared.

POINT-OF-REFERENCE GROUNDWATER ACTIVITY LEVELS

Radionuclide	Concentration Level	Reference
Man-made beta-photon emitters	4 mrem per year	1
Gross alpha particle activity (including Ra-226 but excluding radon and uranium)	15 pCi/l	1
Combined Ra-226 and Ra-228	5 pCi/l	1
Uranium	20 μgrams/l	2

References:

(1) 40 CFR 141, "National Primary Drinking Water Regulations," 1976

(2) 40 CFR 141 and 142, "National Primary Drinking Water Regulations; Radionuclides; Proposed Rule," July 1991

3.3 OVERVIEW OF PROPOSED DECOMMISSIONING ACTIVITIES

The objective of the Parks Project is to decontaminate and decommission the Parks Facilities to permit release for unrestricted use and termination of NRC license SNM-414. To accomplish the goal, a decommissioning approach has been developed and integrated with ongoing decontamination activities which are authorized under the existing SNM-414 license. This integration supports the goal of releasing the Parks Facilities for unrestricted use in a timely and effective manner.

The distinction between decontamination activities being performed under the existing NRC license, SNM-414, and decommissioning activities to be authorized by NRC approval of the Parks Facilities Decommissioning Plan is briefly outlined below and shown graphically in Figure 3-1. A summary level schedule is provided in Section 3.7 of this plan showing the timing of the decommissioning activities.

Under the Existing NRC License SNM-414

The buildings will be decontaminated, and final surveys will be performed and documented. Following NRC review and approval of the final survey report for each building in accordance with license condition 11 of SNM-414, the buildings will be demolished down to, but excluding, the grade level concrete slabs and the basements.

Debris from decontamination of the buildings or building utility systems which exceeds the guideline values in Section 3.2 will be shipped to a licensed LLRW disposal site which can also accept whatever chemical constituents are contained in the waste.

Debris from decontamination of the buildings or building utility systems which is less than the guideline values in Section 3.2 will be interred at an approved landfill, if necessary due to chemical constituents, or retained on-site.

Localized areas of soil outside the security fence may be remediated as decontamination activities under the existing authority already granted in SNM-414 if proper notice is given to the NRC for their review prior to commencing remediation. At the time of submission of this revision to the Parks Facilities Decommissioning Plan, a localized area of soil contamination near Outfall 3 and an even smaller area near Outfall 2 are the only known sources of contamination outside the security fence. [B&W NESI had previously briefed the NRC staff regarding its findings and action plans for the limited area near Outfall 3, and agreement was reached that expedited work along the riverbank near Outfall 3 should be performed under the existing SNM-414 license.]

Under an Approved Decommissioning Plan

Building slabs, basements, and sub-surface utilities and structures will be removed.

Soil from under the buildings and other locations on the site will be excavated as required. Excavated soil which exceeds the guideline values in Section 3.2 will be shipped to a LLRW disposal site which can also accept whatever chemical constituents are contained in the waste. Excavations will be surveyed in accordance with NRC and PaDEP requirements and backfilled after concurrence from NRC and PaDEP.

A Final Status Survey of the site will be performed. A post-remediation groundwater monitoring program will be conducted in conformance with NRC and PaDEP requirements.

Dealing with Coexisting Chemical and Radiological Constituents

A detailed evaluation of the radiological and chemical data from a comprehensive radiological and chemical characterization of the Parks Facilities was performed, and documented in a Site Characterization Report that was transmitted to PaDEP and the NRC in April 1996. The radiological conditions at the Parks Facilities are summarized in Section 2.2 of this Decommissioning Plan.

The Site Characterization Report identified areas that may contain coexisting radiological and chemical constituents, and those areas where actions taken to remediate one type of constituent (i.e., radiological or chemical) may reasonably be anticipated to affect the other. Recognizing the potential for overlapping regulatory jurisdiction, those areas may require special consideration prior to initiating remedial action of those areas.

Based on the characterization data , areas requiring this special consideration are believed to be limited. However, prior to initiating remediation of such an area, B&W NESI will carefully evaluate the data and develop an approach for remediation based on that evaluation. In cases where it is impractical or impossible to fully comply with the regulations of both NRC and PaDEP, B&W NESI will propose a resolution. The time required to develop such a resolution and to achieve regulatory concurrence could impact the schedule provided in Section 3.7.

3.4 DECOMMISSIONING ACTIVITIES AND TASKS

The work required to decommission the Parks Facilities can be divided into six major activities. A brief description of the activities is provided below.

Activity 1 Removing portions of the building concrete slabs to expose inaccessible areas or to gain access to underslab drain lines and other utilities, including excavating and dispositioning the soil overburden and soil identified by in-process monitoring as containing radiological constituents above the guideline values in Section 3.2.

Description Several inaccessible areas below the top surface of the concrete floor slabs will need to be evaluated to determine if additional remediation is necessary. Some of these areas are crevices, such as the expansion joints in the concrete slabs and the wall-to-floor intersections. Other areas include below-grade utility services such as electrical conduit, floor drains, and sanitary lines, which were installed before the building slabs were poured.

These inaccessible areas will be made accessible by removing a portion of the floor slab to create a large enough opening to perform an adequate survey. The pieces of concrete slab will be surveyed after removal, and the soil in the exposed excavation will be surveyed and sampled. If the soil is found to have radioactivity above the release criteria, the soil will be excavated to a depth and areal extent whereby the remaining in-place soil meets the release criteria.

Activity 2 Excavating and dispositioning soil which contains or potentially contains radiological constituents above the guideline values in Section 3.2.

Description The remnants of the building slabs and the basement walls will be excavated using conventional techniques. Any soil identified during site characterization or by in-process sampling and analysis as having radioactivity exceeding the guideline values in Section 3.2 will be excavated. Soil will also be excavated to access man-made structures (such as piping leading to or from existing or former underground holdup/monitoring tanks, storm sewer lines, septic tanks and drain fields, catch basins, and piping connecting sanitary waste or process water lines) which appeared to exceed guideline values based on site characterization data. Structural components will be surveyed after they are removed from the ground to determine if they meet the guideline values for surfaces in Section 3.2. Soil excavation methodology is discussed in Section 3.5.

Activity 3 Surveying of exposed soil surfaces, including excavations, in the affected areas (see Section 5.1) and preparation of Final Status Survey Reports. Final grading of any excavations will occur following concurrence from NRC and PaDEP.

Description The bottom of each excavation will undergo a survey as described in Section 5.1.3. After concurrence from NRC and PaDEP, the excavations will be backfilled with clean soil meeting the sampling and analysis protocol described in Section 5.2. Access to the released areas will be controlled to prevent the influx of constituents from other site remediation activities. In addition, a site final radiological survey will be performed according to the protocols described in Section 5.1. The site will be divided into several survey units for the final survey and each such unit will be reported separately.

Activity 4 Final walkover survey of site.

Description After all excavations on the site have been backfilled and the final grading of the site completed, a walkover survey will be performed (excluding Project Unit E).

Activity 5 Quarterly groundwater sampling and reporting for one year.

Description A quarterly post-remediation ground water monitoring program for radiological constituents will be conducted for one year following completion of site remediation, using the protocols described in Section 5.3 of this Decommissioning Plan. The completion of site remediation is defined as that point in time when all radiologically contaminated soil has been packaged for disposal and all excavated areas have been backfilled. Quarterly Reports and one Final Report will be submitted to the NRC.

Activity 6 Preparing a Final Report to the NRC, summarizing the individual Final Status Survey Reports.

Description The final activity is preparing a Final Report and submitting it to the NRC along with a request for termination of License SNM-414. The Final Report will summarize the total residual activity remaining on-site, the findings in the individual Final Status Survey Reports, the final walkover survey, and the groundwater monitoring program.

3.5 SOIL EXCAVATION

The purpose of this section is to provide the methodologies to be used for (a) excavating, such that intermixing of soils having radioactivity above and below the Section 3.2 guideline levels is minimized, (b) surveying the bottom of each excavation, (c) dispositioning soil piles, and (d) backfilling of excavated areas.

3.5.1 Excavation Methodology

Soil excavation will be performed using conventional earth moving equipment. However, control over the excavation activity is designed not only to maximize removal of soil with radioactivity above the Section 3.2 guideline levels, but also to minimize intermixing of such soil with soil below the guideline levels. Due to (a) the inhomogeneity of soil at the site, (b) measurement uncertainties, and (c) the inherently non-surgical nature of excavation operations, a limited amount of intermixing is unavoidable.

Excavation will generally be performed in three phases: (1) removal of "overburden" containing radioactivity below the Section 3.2 guideline levels, (2) removal of soil containing radioactivity approximately three times the guideline levels, and (3) removal of soil containing radioactivity levels between those of phases 1 and 2. Soil from each of these three phases will be placed in a separate, identified pile. Excavation drawings based on the results of the site characterization program will be prepared to provide general guidance on the depth and areal extent of excavation required for each phase. However in-process measurements (see Section 5.4) will be used to more precisely define the end of each phase and, thus, to minimize intermixing.

3.5.2 Soil Pile Dispositioning

Each soil pile, including those containing "overburden," will be subjected to a volumetric survey as described in Section 5.2 under "Site Excavated Soils." Soil piles that meet the protocol requirements described in Section 5.2 and the chemical requirements established by PaDEP will be retained on-site for use as backfill or cover. Soil piles that do not meet these requirements will be either packaged and shipped to a LLRW disposal site or split into two or more smaller soil piles in an attempt to segregate the soil that contains radioactivity above the guideline values in Section 3.2 from the soil with lower radioactivity levels. All soil piles will be covered until they can be sampled and evaluated. The cover will be maintained until such time that: (a) the soil pile is determined to meet the criteria for unrestricted use; or (b) the soil in the pile is packaged for disposal as LLRW.

The volumetric survey data will be provided to the NRC for review. None of these soil piles will be used for backfill or cover until concurrence has been received from NRC and PaDEP.

3.5.3 Surveying of Excavations

Following the excavation of the contaminated area as described in Section 3.5.1, the "bottom of the hole" will undergo in-process sampling to verify that all soil above the acceptable soil guideline values in Section 3.2 has been excavated. Any additional soil with activity above the guideline values will be dispositioned as described in Section 3.5.2.

If an excavated area fails to meet the criteria listed in Sections 5.1.2 or 5.1.3 during the final status survey or during any NRC confirmatory survey, the area will be re-excavated and any resultant soil pile generated from the re-excavation will be dispositioned as explained in Section 3.5.2. The excavated area may be subdivided for remediation purposes as detailed in NUREG/CR-5849, especially if the final survey data indicates that the soil above the guideline values is localized.

3.5.4 Backfilling Excavations

Open excavation areas will be backfilled after receiving concurrence from NRC and PaDEP. The backfill material may originate from off-site and/or on-site sources; see Section 5.2 for characterization and data evaluation requirements. The backfilling operation will be performed using standard construction techniques and equipment.

3.6 PROJECT ORGANIZATION AND WORK CONTROL

This section describes the project organization that will become effective upon NRC's approval of the Decommissioning Plan in lieu of that specified in Sections 2 and 11 of SNM-414. As the project moves forward, changes to the project organization may be needed in response to the reduced level of site activities and reduced hazards. Effective with NRC's approval of this plan, the licensee may make changes to the organizational structure in accordance with the process described in Section 4 of this plan, provided the safety function maintains an independent reporting relationship from that of operations, and the positions responsible for the safety functions are held by individuals which satisfy the educational and experience qualifications described in Section 3.6.3 for such functions.

3.6.1 Project Organizational Structure

Overall program direction for the Parks Project, including cost and schedule control, is provided by a dedicated Project Manager. Functional area managers assist the Project Manager on technical matters, provide resources to the project from their staffs in response to tasks assigned by the Project Manager, and provide day-to-day management of the personnel. The Parks Project organization is illustrated in Figure 3-2. The manager of Health & Safety and Licensing reports to the B&W NESI Manager, Safety. Additional support may be provided by B&W NESI personnel from other sites.

Brief descriptions of the responsibilities of the major managerial positions is provided in Section 3.6.2. Section 3.6.3 identifies the minimum qualifications for the managers with safety-related responsibilities.

3.6.2 Managerial Responsibilities

Project Manager, Parks Project is responsible for the overall project planning and execution of all activities at the Parks Facilities in accordance with applicable health, safety, quality and technical requirements. He is the senior site manager and reports directly to the President, B&W NESI. The Project Manager has full authority to stop any activity when he believes these requirements are not being met.

General Manager, Environment, Safety and Health (ES&H) reports to the President, B&W NESI and is responsible for the establishing and ensuring implementation of the B&W NESI quality assurance, environmental and safety programs, and compliance assessment programs. He shall provide technical direction and approval of safety and environmental compliance programs and shall arrange for audits to ensure that project activities are conducted in full compliance with NRC and other applicable regulatory requirements.

Manager, Safety reports to the General Manager, ES&H and is responsible for safety and environmental programs performed at B&W NESI sites, including activities under SNM-414. The Manager, Safety and his subordinates provide technical support to the Manager, Health & Safety and Licensing at the Parks Facilities site.

Site Quality Assurance Engineer reports to the B&W NESI Quality Assurance Manager who, in turn, reports to the General Manager, ES&H. This relationship provides for independence of action. The site QA Engineer is responsible for implementation of the site-specific QA Project Plan and implementing procedures. When QA audits identify a deficiency in quality, the respective unit manager at the Parks Facilities is responsible for prompt correction of the deficiency.

Manager, Health & Safety and Licensing (HS&L) reports directly to the Manager, Safety and is functionally independent of Operations, thus assuring independence of action in matters pertaining to health and safety. The Manager, HS&L has authority to stop work on any decommissioning operation based on safety concerns. The Manager, HS&L is responsible for the implementation of technical ES&H matters established by the General Manager, ES&H, and is responsible for escalating ES&H matters that cannot be resolved at the site level to the General Manager, ES&H. The Manager, HS&L is also responsible for administering B&W's NRC license SNM-414 and is the designated contact point with the NRC. The Manager, HS&L provides technical guidance on all elements of radiological and occupational safety for the project and shall approve procedures and instructions implementing the safety programs. The Manager, HS&L is responsible for radiological and industrial safety training for the Parks Project.

Manager, Operations reports to the Project Manager, and receives program and task directives directly from the Project Manager. The Manager, Operations is responsible for nuclear material accountability, field engineering, transportation, daily work assignments for Health and Safety, and the physical execution of decontamination and decommissioning activities at the Parks Facilities.

Manager, Engineering reports to the Project Manager, and receives program and task directives directly from the Project Manager. The Manager, Engineering is responsible for establishing site characterization programs and for development of remedial designs for site environmental restoration. The Manager, Engineering is also responsible for Parks Facilities general engineering tasks and for site security.

3.6.3 Minimum Qualifications for Safety Related Positions

Project Manager, Parks Project must hold a baccalaureate degree and have a minimum of eight years of experience in the nuclear industry, including five years of project management experience.

Manager, Safety must hold a baccalaureate degree in science or engineering and have a minimum of eight years of experience including five years of supervisory experience in the nuclear industry.

General Manager, Environment, Safety and Health must hold a baccalaureate degree in engineering or science and have a minimum of twelve years experience including five years in nuclear safety, health physics, quality assurance, industrial safety, or environmental safety, and five years of management experience.

Quality Assurance Engineer must hold (a) a baccalaureate degree, or (b) a high school diploma with at least five years experience in quality assurance or quality control.

Manager, Safety and Health/Licensing must hold (a) a baccalaureate degree and have a minimum of two years experience in nuclear operations, or (b) a high school diploma with at least ten years experience in nuclear operations.

3.6.4 Work Control

Operations with nuclear materials at the Parks Facilities are performed in accordance with written instructions. Written instructions were used to safely control the previous decontamination, deactivation and remediation activities described in Section 1.3, and will continue to be used during the decommissioning activities described in Section 3.4. There are four general types of written instructions in use at the Parks Facilities: Programs, Procedures, Engineering Releases, and Radiation Work Permits. These written instructions are reviewed and approved by key management individuals in the Parks Project organization.

Programs are broad-based management policies affecting the health, safety and quality of work activities. Existing program documents include the Health and Safety Plan, ALARA Program, Industrial Safety Instructions, and the Quality Assurance Plan. These programs and plans are implemented by specific Procedures, Engineering Releases, and Radiation Work Permits, as discussed below.

Procedures are written instructions defining how to operate equipment, calibration methods, or guidance for completing routine work activities. General Procedure GP-61 defines how procedures are prepared and controlled to ensure work is performed using only approved procedures.

Engineering Releases (ERs) are the primary written instruction for both decontamination and decommissioning work at the Parks Facilities. ERs provide specific instructions in a logical and sequenced manner for one time or short duration activities requiring a disciplined approach to ensure that health and safety requirements are met. Quality Implementing procedure QIP-15 defines how ERs are prepared, implemented and closed-out. Quality Implementing procedure QIP-19 defines how interim changes to an ER are authorized pending formal revision of the ER.

Radiation Work Permits (RWPs) specify necessary radiation safety controls, including personnel monitoring, monitoring devices, protective clothing, respiratory protection equipment, special air sampling, and additional precautionary measures. RWPs are issued for non-routine activities where there is a need to prescribe the conditions under which the work may be done in order to assure adequate protection of workers and the public from the potential radiological hazards that may be encountered. RWPs required for decommissioning activities are usually identified during the preparation and review of ERs. Health and Safety personnel specify the necessary radiation safety controls and approve the RWP. The radiological safety evaluation of the RWP invokes use of the ALARA Plan when required. Information taken into account in issuing the RWP includes: type and location of work to be performed, radiation and contamination types and levels, and effects on work being performed simultaneously in other areas, including environmental effects. All RWPs have expiration dates, and the status of issued RWPs is reviewed on a routine basis by Health and Safety personnel. Upon completion of the work under the RWP, the requestor is responsible for ensuring that the RWP is terminated and that the work area is returned to acceptable conditions, as determined by Health and Safety personnel.

3.7 SCHEDULE

A comprehensive schedule has been prepared for the Parks Project. The schedule is fully integrated to effectively manage both the decontamination activity currently permitted under the existing SNM-414 NRC license and the planned decommissioning activities described in this Decommissioning Plan.

The establishment of a decommissioning approach was preceded by more than eight months of planning and characterization budgeted in excess of $3 million that resulted in a significantly enhanced perspective on conditions at the Parks Facilities.

Figure 3-3 depicts the summary level schedule for planned decommissioning activities. Decommissioning planning and Parks Facilities Characterization activities are shown in the schedule for information only and are not intended to represent decommissioning activities. The schedule shown in Figure 3-3, which is current as of the date of this submittal, represents best estimates of when scheduled activities will take place. Note that the schedule includes anticipated regulatory approval cycles in order to represent total calendar time for the project. Please also note that provision has not been made to account for all potential schedule perturbations, some of which may not be under the direct control of B&W NESI (for example, unavailability of disposal sites, unanticipated or extended delays in receiving necessary approvals from local, State and other Federal agencies, labor disputes, weather delays, equipment breakdown, etc.) Actual performance of the work may occur earlier or later than shown based on such factors, and the schedule will be revised accordingly. A current copy of the schedule

will be maintained at the work site, and will be available for NRC review.

3.8 RADIOACTIVE WASTE MANAGEMENT

Low Level Radioactive Waste

B&W NESI may decontaminate the surfaces of structures or structural components, to the extent practical, to reduce the volume of radioactive waste requiring disposal. Material that does not meet the guideline values in Section 3.2 will be transferred to a licensed Low Level Radioactive Waste (LLRW) disposal facility.

The table below provides a summary level breakdown of the estimated volume of low level radioactive waste that is expected to be generated during decommissioning the Parks Facilities. The table does not include LLRW generated during decontamination of the buildings, since that work is being performed under the existing SNM license and is not a decommissioning activity.

Estimated Low-Level Radioactive Waste Volume From Decommissioning the Parks Facilities
(volume in cubic feet)

Project Unit	Soil and Bulk Material Volume
A	23,300
B	4,200
C	16,300
Total	43,800

In general, soil that potentially exceeds the criteria for release for unrestricted use will be excavated and placed in covered piles. The piles will be sampled in accordance with Section 3.5.2. Soil from piles failing the requirements in Section 5.2 will be classified as LLRW and loaded into lined dump trailers, metal boxes, bags, triwall boxes, or other equivalent storage/shipping containers. After manifesting, the majority of this soil will be expediently shipped to a LLRW disposal site to minimize the amount of time it is stored on-site.

While decommissioning activities are in progress, LLRW will also be generated from decontamination activities conducted in Buildings A, B, and C. This decontamination waste will be placed into various sized metal boxes, bags, triwall boxes, or other equivalent storage/shipping containers, or loaded directly into seavans or lined dump trailers. Each radwaste container will be appropriately labeled in accordance with written procedures. The containers may be temporarily stored on-site, until the containers can be efficiently shipped to a LLRW disposal site. The short term, on-site storage will be within existing buildings, in designated outside storage areas, in trailers or seavans, or in an auxiliary storage facility to be erected in early 1997. The auxiliary storage facility will be a 40' x 80' x 16' high postframe building. The storage facility will be located in the parking lot to the north of Building A, and will comply with current regulations and guidance regarding storage of low level radioactive waste. The waste will only be stored until it can be efficiently transported to a LLRW disposal site.

Greater than Class C Radioactive Waste

It is anticipated that decontamination and decommissioning activities may identify small quantities of Greater than Class C radioactive waste. Disposal of Greater than Class C low-level radioactive waste is the responsibility of the U.S. Department of Energy (DOE). Greater than Class C waste generated during decommissioning of the Parks Facilities will be stored on-site in accordance with all applicable NRC requirements until such time as the DOE is prepared to accept the waste for disposal. If the DOE is not ready to accept the Greater than Class C waste by the time that B&W NESI completes the decommissioning activities, the waste will be transferred to another facility authorized to accept Greater than Class C material for interim storage.

Mixed Low Level Radioactive Waste

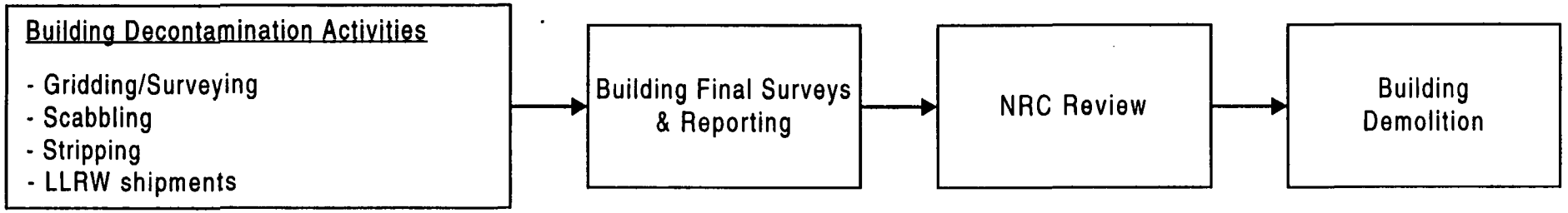
Based upon a preliminary evaluation of site characterization results, B&W NESI anticipates that a limited amount of soil containing both radiological and chemical constituents may be identified during decommissioning. Management and disposal of mixed waste generated during decommissioning the Parks Facilities will be performed in accordance with all applicable Federal and Commonwealth of Pennsylvania regulations. B&W NESI will pursue environmentally responsible management of such small quantities of mixed waste, and will explore viable treatment and disposal alternatives for mixed waste during the decommissioning period. (See EPA Policy Statement, "Extension of the Policy on Enforcement of RCRA Sec. 3004(j) Storage Prohibition at Facilities Generating Mixed Radioactive/Hazardous Waste")

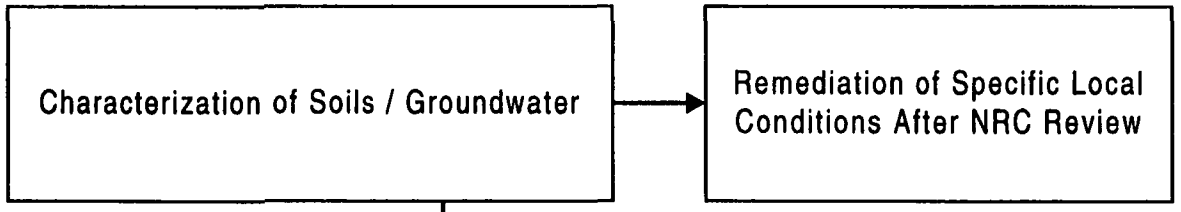
Two final disposal options for mixed waste generated during decommissioning currently exist: (1) stabilization followed by burial at a licensed and permitted mixed waste disposal site; or, (2) treatment at an authorized facility to destroy the hazardous component in the mixed waste, transforming it into a low level radioactive waste. B&W NESI will evaluate both options as more information becomes available on the exact content of the material expected to be mixed

waste. Mixed waste remaining on site at the time that B&W NESI has completed the decommissioning activities will be transferred to another facility authorized for interim storage of such material until a disposal option becomes available.

Adequate resources are available at the Parks Facilities to properly manage the mixed waste. These resources include: laborers, technicians, supervisors, engineers, and managers qualified as both Radiation Workers and Hazardous Waste Operations and Emergency Response (HAZWOPER) workers; routine use of surveillance equipment adequate to determine the presence of hazardous volatile materials, flammable materials, or harmful oxygen levels; knowledgeable engineering staff to write and revise work procedures to ensure proper work techniques when hazardous materials are expected; and, an adequate supply of personal protective equipment. In addition, B&W NESI currently works, and will continue to work during decommissioning, under control of our Hazardous Waste Manual. The B&W NESI Hazardous Waste Manual controls how hazardous wastes are identified, accumulated, and transported, and how the records are maintained.

Decontamination Activities





Decommissioning Activities

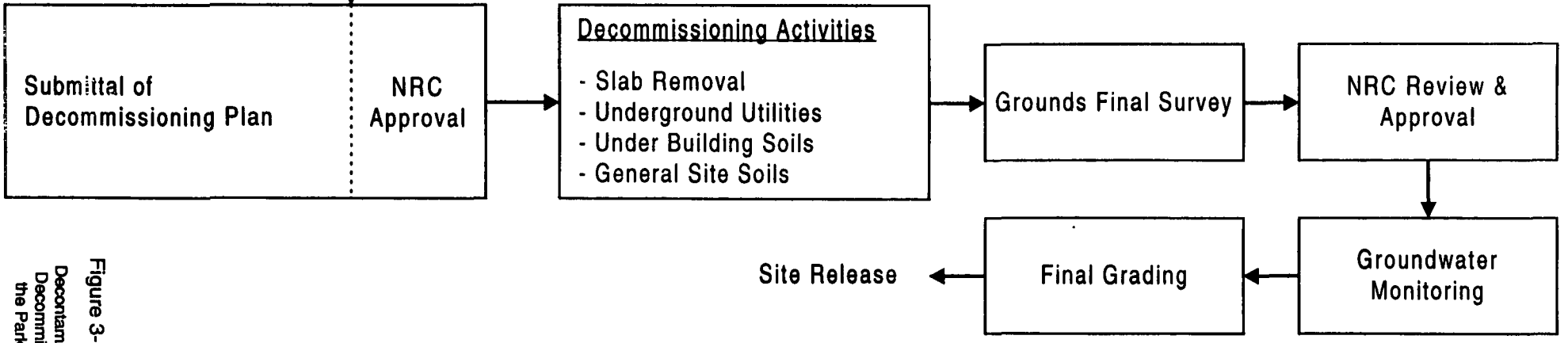
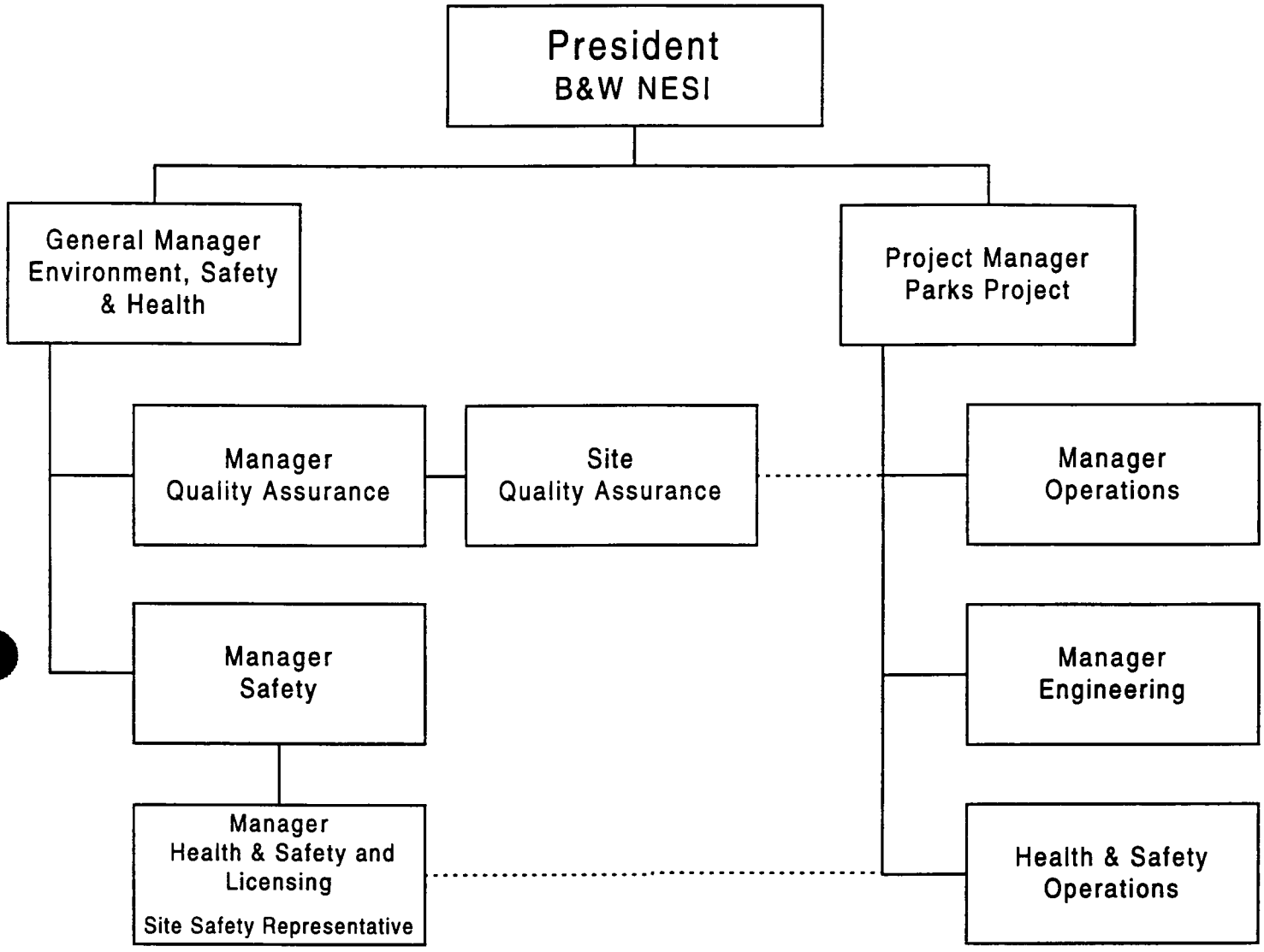
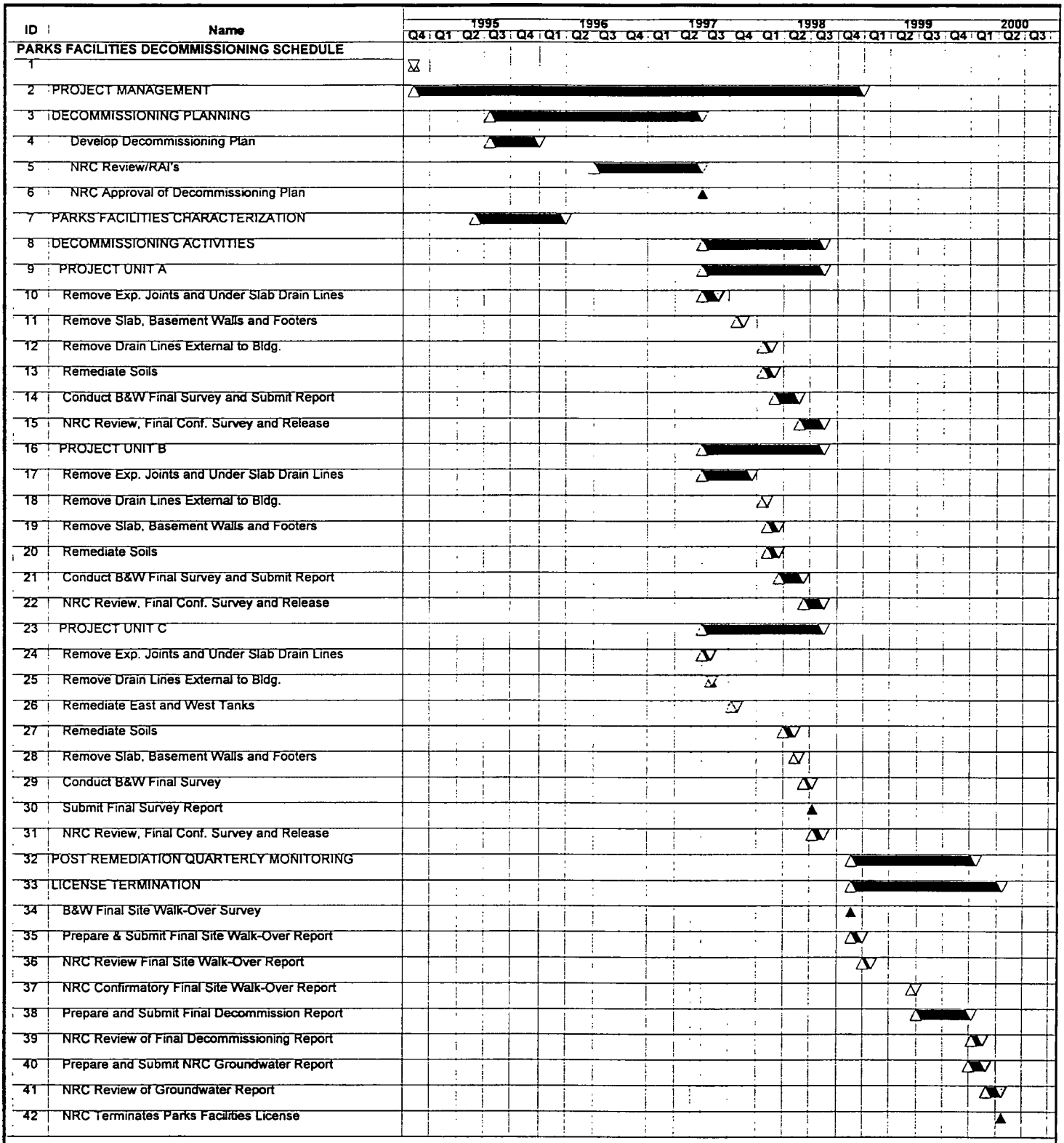


Figure 3-1, Rev. 1
Decontamination and Decommissioning of the Parks Facilities



NOTE: Solid lines represent relationships with administrative (hire/fire) authority. Dotted lines represent relationships which impose technical authority, require coordination or provide project direction.

Figure 3-2, Rev-1
Parks Project Organization



Project Start 31OCT94 Project Finish 16APR00 Data Date 31OCT94 Plot Date 23MAY97 © Primavera Systems, Inc.	Early Bar Progress Bar	PFD2	Sheet 1 of 1	

B&W NESI

Parks Facilities Decommissioning

Figure 3-3

4.0 HEALTH & SAFETY

B&W has maintained a Health & Safety program applicable to activities authorized under SNM-414 since 1971. The Health & Safety program is designed to ensure the safety and health of employees, visitors, and members of the public during all operations authorized under the license. Since 1971, the Health & Safety program has been revised from time to time with approval of the NRC to be commensurate with authorized activities in effect at the time. The effectiveness of the Health & Safety program, which includes a firm management commitment to ALARA, has been well demonstrated over the past 25 years.

4.1 RADIOLOGICAL SAFETY

To support development of this decommissioning plan, analyses were performed to assess the radiological impacts of performing the selected decommissioning activities on the workers and the public. These analyses included transportation impacts under both normal and accident conditions. These supporting analyses are included in Appendix C.

This decommissioning plan, when approved, authorizes the remediation of soil, groundwater, below-grade structures and building utilities such as retention tanks, buried pipes, etc. Upon approval of this plan, B&W NESI will use the existing Health & Safety program as described in SNM-414 License Renewal Application, Revision 6, dated March 17, 1995 and approved by an NRC Letter (Weber/Pierson) to B&W (Sgarlata), dated October 24, 1995. Also upon approval of this decommissioning plan, in recognition that both the amount of radioactivity and general safety hazards will be reduced, the Health & Safety program may be modified from time to time such that the Health & Safety program is maintained commensurate with the activities being performed.

The General Manager - Environment, Safety and Health (ES&H) may authorize modifications to the Health & Safety program under the following conditions:

1. The modifications or changes will not reduce the effectiveness of the Health & Safety program for the activities being performed.

2. The requirements of Chapter 4 of SNM-414 License Renewal Application, Revision 6, dated March 17, 1995 shall not be modified or changed without prior approval of the NRC.

3. A Safety Evaluation for the safety area to be modified or changed has been performed and documented with recommendations submitted to the General Manager ES&H. The General Manager ES&H may utilize site resources or qualified resources from other units of B&W NESI or its affiliate, The Babcock & Wilcox Company, to perform the Safety Evaluations.

4. The changes will satisfy the provisions of clauses (i) through (iv) of 10 CFR 51.22(c)(11).

5. Copies of the Safety Evaluations and safety program directives from the General Manager ES&H will be maintained on-site for review by representatives of the NRC.

With the approval of this decommissioning plan, the Safety Advisory Board is not required and approval authority for items previously addressed by the Safety Advisory Board is transferred to the General Manager ES&H.

4.2 INDUSTRIAL SAFETY

To support development of this decommissioning plan, analyses were performed to assess the non-radiological impact of performing the selected decommissioning activities. These supporting analyses are included in Appendix D.

It is recognized that the remediation of radionuclides from soil, groundwater, and below grade structures & services will require the use of construction equipment such as mechanical shovels, cranes, etc. B&W NESI maintains in effect an Industrial Safety program to ensure worker safety during construction type activities. This program is designed to meet the industrial and construction safety requirements of the Occupational Safety and Health Act (OSHA). The General Manager ES&H has the authority to modify or change the Industrial Safety program such that the requirements for this area of safety are commensurate with the activities being performed.

4.3 ENVIRONMENTAL MONITORING

B&W NESI presently maintains an Environmental Monitoring program for the Parks Facilities as described in SNM-414 License Renewal Application, Revision 6, dated March 17,1995. This program was designed to monitor air and water effluents during plant operations.

4.3.1 Program Changes to be Implemented After NRC Approval of the Parks Facilities Decommissioning Plan

With the approval of this decommissioning plan, some of the monitoring parameters and sampling points will no longer be needed since the site source term will have been greatly reduced. It is estimated that the current site source term is less than one percent of the source term at the time fuel was being produced at the Parks Facilities. In addition, the building exhausts and associated stacks will progressively be phased out, thereby eliminating a potential mechanism for airborne dispersal. Any future airborne releases (none are expected) will be at grade level. Because of these reasons, the only environmental monitoring stations that remain appropriate are Stations 7, 8 and T3, which are located near the fence line, and the background station, Station 5. B&W NESI will operate the four environmental monitoring stations shown in Table 4-1 after NRC approval of this decommissioning plan. In addition, the number of Kiskiminetas River grab samples will be reduced from three to two, with the remaining two taken from locations near the Vandergrift bridge and the Leechburg foot bridge.

4.3.2 Program Changes to be Implemented After the Final Site Survey is Completed

B&W NESI will terminate operation of Station 7 once the site-wide Final Status Survey is completed and no further soil remediation is anticipated. Stations 5, 8 and T3 will continue to be operated but without soil sampling or the use of thermoluminescent dosimeters. In addition, the quarterly sampling of Kiskiminetas River water will be changed to an annual event. Environmental monitoring will be continued at this reduced level until all activities at the Parks Facilities site are completed. At that time, with the concurrence of the NRC, the remaining environmental monitoring program will be terminated.

Table 4-1

ENVIRONMENTAL MONITORING STATION LOCATIONS

Monitoring Station Nomenclature	Location Description
Station 5*	4.4 miles northeast at Gum Corner
Station 7	50 feet south of Veado's restaurant
Station 8	Northeast corner of B&W fence line toward Cook Pacemaker
Station T3	Southeast corner of B&W property line at closest private residence, line-of-sight

*Background station

Note: These environmental monitoring locations can be found on the map shown as Figure 4-1, SNM-414, License Renewal Application, Revision 6, dated March 17, 1995.

5.0 FINAL STATUS SURVEYS

A series of Final Status Surveys is required to demonstrate that the site has been remediated and that the residual radioactivity is within the acceptable limits discussed in Section 3.2. These Final Status Surveys form the basis for Activity 3 in Section 3.4 of this decommissioning plan. The Final Status Surveys will be designed, conducted, and evaluated utilizing guidance provided in NUREG/CR-5849 titled "Manual for Conducting Radiological Surveys in Support of License Termination". This section describes the protocols to be used during Final Status Surveys.

5.1 SOIL SURVEYS AND SOIL ANALYSIS

A metric rectangular grid system shall be used to delineate grid blocks for the Final Status Surveys at the Parks Facilities site. The grid system shall be indexed to a U. S. Geological Survey benchmark to permit sample locations to be identified. All sample locations will be referenced to the site grid system.

5.1.1 Classification of Areas

All ground area at the Parks Facilities will be classified as either an affected area or an unaffected area in accordance with the following definitions of NUREG/CR-5849:

Affected areas are those areas that have potential radioactive contamination (based on plant operating history) or known radioactive contamination (based on past or preliminary radiological surveillance). This includes areas where radioactive materials were used and stored, where records indicate spills or other unusual occurrences that would have resulted in spread of contamination, and where radioactive materials were buried. Areas immediately surrounding or adjacent to locations where radioactive materials were used, stored, spilled or buried are included in this classification because of the potential for inadvertent spread of contamination.

Unaffected areas are those areas of the site which were not classified as affected areas. These areas are not expected to contain residual activity, based on knowledge of site history and previous survey information.

All available information was used to design the Project Units boundaries in the Parks Facilities Characterization Plan. This information included plant operating history, known radioactive spills or contamination incidents, and past characterization data. Section 4.3.1 of the Parks Facilities Characterization Plan reviewed the radiological characterization programs performed in the years prior to 1995, and Section 6.0 described the extensive sampling and analysis program which was implemented in 1995. The location and extent of radioactivity at the site, based on both historical and 1995 characterization results, were previously discussed in Section 2.2 of this Decommissioning Plan. The detailed 1995 site characterization data was presented in the Parks Facilities Characterization Report which was submitted to the NRC in April 1996.

For conducting the Final Status Surveys, Project Units A through E will be further subdivided into one or more survey units. Survey unit sizes will be adjusted as necessary in each Project Unit such that no affected area survey unit will be larger than 10,000 m^2. The initial classification of each survey unit will be based on plant operating history, known radioactive spills or contamination

incidents. The extensive amount of data obtained during the 1995 site characterization will be used to augment and validate the historical data. Additional characterization data obtained during site remediation will also be considered. Final classification of a survey unit as affected or unaffected shall include the full use of all characterization and site historical data. Based on this extensive informational database, each survey unit will be classified as either an affected area survey unit or an unaffected area survey unit, for purposes of conducting the final radiological surveys. In addition, the final setting of survey unit boundaries will reflect all available characterization and site history data.

The following table is the classification break-down of the five Project Units by area based on the current informational database. The stated areas are approximate and may change somewhat based on additional sampling and surveying during the remediation process. Any change in the classification of a grid block from one classification to the other will be explicitly explained in the Final Status Survey Report for the survey unit(s) that contained the reclassified grid block(s).

Project Unit	Affected Area* (m^2)	Unaffected Area (m^2)
A	15,800	30,100
B	6,800	6,600
C	8,800	12,600
D	600	8,900
E	0	243,300
Total	32,000	301,500

* Survey unit sizes will be adjusted as necessary in each Project Unit such that no affected area survey unit will be larger than 10,000 m^2.

Figure 5-1 shows the currently projected locations of the affected area grid blocks within the Project Units. The yellow colored grid blocks were classified as affected area grid blocks based on historical knowledge or pre-1995 characterization data. The blue colored grid blocks were classified as affected area grid blocks based on the 1995 site characterization data, and includes a sufficient number of adjacent grid blocks to create a buffer zone as required in NUREG/CR-5849. Project Unit E contains only unaffected area grid blocks while Project Units A, B, C and D contain both affected area and unaffected area grid blocks.

5.1.2 Soil and Paved Surface Scanning

The predominant radioactive constituents are isotopes of uranium, plutonium and americium, although there are limited areas where activation and fission products are present. TRU and uranium isotopes decay primarily by alpha emission with a few weak beta-gamma emissions. It is impossible to detect concentrations of these isotopes that approach the guideline values in section 3.2 with hand-held survey instruments commonly used for scanning. The purpose, then, of direct measurements is twofold: (1)

establish a record of the site background radiation dose, and (2) place an upper bound on the activity limits that could be present in non-sampled locations to demonstrate that the quantities of fission and activation products, where present, do not cause exposure rates in a grid block in excess of 10 μR/hr above background at 1 meter from the surface.

Gamma exposure rates will be measured approximately one meter above the ground surface using either a pressurized ionization chamber (PIC), a NaI (Tl) scintillation meter, or a μR-meter or equivalent gamma-scintillator instrument that has been cross-calibrated against a PIC at the site. Measurements will also be made in a systematic pattern at the following levels:

Affected areas - A 100% walkover survey will be done of each affected area grid block. Affected area grid blocks shall be 100 m^2 or less in area. The walkover survey shall be done using a NaI (Tl) scintillation meter or equivalent instrument to measure the radiation level at approximately 1 cm above the soil surface. In addition, a gamma measurement, using a PIC, μR-meter or equivalent, will be made above the locations where soil samples will be taken for final survey, and at any location where the walkover survey radiation level measured at 1 cm exceeded twice the background. These measurements will also be made at the bottom of excavated areas prior to the systematic soil sampling. Paved surfaces (not including the concrete building floor slabs) such as parking lots may be scanned as structural surfaces using alpha and beta monitoring equipment in lieu of samples. If the paved surface is covered in a manner that precludes the collection of valid data, samples will be taken for laboratory analysis. Direct surface activity measurements and removable activity measurements shall be taken at locations on a paved surface that a soil sample would normally be taken in an affected area grounds survey.

Any grid block containing a location with a 1 meter exposure rate exceeding 10 μR/hr above background during a final survey shall be remediated and resurveyed.

Unaffected areas - Measurements will be made in at least 30 randomly selected grid blocks throughout the unaffected area. The surface areas of these grid blocks will represent at least 10% of the unaffected area of the site. A 100% walkover will be done for each selected grid block using a NaI (Tl) scintillation meter or equivalent instrument to measure the radiation level at approximately 1 cm above the soil surface. In addition, a gamma measurement, using a PIC, μR-meter or equivalent, will be made approximately 1 meter above any location where a soil sample is taken and at any other locations where the radiation level measured at 1 cm exceeded twice the background.

Exterior paved surfaces such as parking lots may be scanned as structural surfaces using alpha and beta monitoring equipment in lieu of samples, if there is no covering over the paved surfaces that would prevent the collection of valid data. Direct surface activity measurements and removable activity measurements shall be taken at locations on a paved surface that a soil sample would be taken in an unaffected area grounds survey. If a 1 meter exposure rate of $>7.5\mu$R/hr (i.e., 75% of the NRC criteria for 1 meter direct readings) above background is detected, a soil sample, or direct and loose activity measurements on paved surfaces shall be taken at the location of the reading and the classification of the area as an unaffected area shall be re-evaluated.

5.1.3 Soil Sampling and Paved Surface Monitoring

Affected areas - Soil samples will be taken at the bottom of each excavation based upon a systematic grid pattern which has been projected from well-defined reference benchmarks located on the

unexcavated surface. Soil, as defined in 40 CFR 192.11, is all unconsolidated material normally found on or near the surface including, but not limited to, silt, sand, clay, and small rocks (nominally, ½ to 1 inch in diameter) or gravel. Samples will be collected at the center and at the locations within the grid block that are approximately equidistant from the center and each of the four corners of the grid block, for a total of five samples per grid block. The addition of the sample at the center of the grid block is an allowance for scanning sensitivity that was used in the sample problem of in Appendices C and D of NUREG/CR-5849. This sampling density of five samples per grid block meets the intent (when compared using a square survey unit with ten 100 m^2 grid blocks, or 10,000 m^2) of the EPA recommended sampling procedure (described on page 4.16 of NUREG/CR-5849) that uses a triangular grid with a sampling interval of 5 m on a side. Soil samples shall also be taken at any point identified in the walkover survey as being two or more times the background exposure rate at 1 cm from the surface of the ground. Each sample will be analyzed by gamma spectroscopy. Some individual samples or composite samples will be analyzed by alpha spectroscopy to confirm the relationship between isotopes that are readily detectable, such as Am-241 and U-235, and related radionuclides that are difficult to detect but were identified during site characterization. Composite samples are prepared by taking uniform amounts of the soil to be composited, homogenizing the samples by ball milling or similar methods, and then taking a representative sample for analysis. These composite samples will not be compared to any NRC criteria. They are used solely to determine the suite of isotopes present in those survey units to evaluate the validity of the scaling factors being used for the Final Status Surveys. Once a predictable relationship (i.e., scaling factor) has been established between the concentrations of two or more isotopes, measurements of the gamma emitting members of these groups of related nuclides will be used to determine the activity of the remaining radionuclides in the group.

Paved surface monitoring shall be done on the same systematic pattern as the soil sampling of grounds. Monitoring for direct and removable, alpha, beta and gamma activity shall be conducted at each systematic survey point.

If, as a result of a final or confirmatory survey, additional remediation (e.g., additional excavation) is required in a grid block, a new set of soil samples for final survey shall be collected after the additional remediation has been completed. Locations previously used for final survey sampling shall not be resampled as part of the systematic survey; instead, new systematic sample locations within the grid block shall be determined. The instrument survey shall be repeated, with the 1 meter exposure rate measurements being taken at the new final survey soil sampling locations.

If, as a result of a final or confirmatory survey, additional remediation is required in a paved surface grid block, a new set of direct and removable activity measurements for final survey shall be collected after the additional remediation has been completed. Locations previously used for final survey sampling shall not be remeasured as part of the systematic survey; instead new systematic survey locations within the grid block shall be determined. The 1 meter exposure rate measurements shall be taken at the new final survey systematic measurement locations.

Additional remediation will be required if a grid block or survey unit does not meet the requirements of Section 5.6 or if a soil sample or direct surface measurement exceeds three times a release limit or the removable activity exceeds the guideline values in Section 3.2. Section 5.6.4 addresses the treatment of "elevated activity areas", that are less than three times the applicable release limit.

If residual radioactive material, attributable to licensed operations, is identified during a final status survey, and the activity or concentration of this material is sufficient to require additional remedation,

an evaluation will be performed to determine:

1. the source of the contamination;

2. why the material was not identified and remediated prior to the final survey; and,

3. the effect that the identification of this material has on the conclusion that the facility is suitable for unrestricted use.

The results of this evaluation will be discussed with the NRC when the evaluation is completed. A discussion of the identification of additional areas requiring remedation and the evaluation discussed above will be included in the Final Status Survey Report

No excavation will be backfilled until quality control certifies the exposed surface meets the NRC criteria for release for unrestricted use and the NRC and PaDEP concur that the excavation may be backfilled. Material used to backfill excavations, or boreholes, will be sampled according to the protocols based on ASTM E105-58 (1989) and ASTM E122-89, as specified in Section 5.2. Each sample will be analyzed by gamma spectroscopy.

Unaffected areas - The grid blocks chosen for survey shall be selected on a random basis. Soil samples shall be taken at any point identified in the walkover survey as being two or more times the background exposure rate at 1 cm from the surface of the ground and at one or more locations within each grid block which had the elevated exposure rate. If a soil sample from such a grid block exceeds 75% of a release limit, the grid block shall be reclassified as an affected area grid block. Both this grid block and the contiguous grid blocks shall be surveyed and sampled, if they have not already been surveyed, to determine if additional remediation is warranted. Classification of the unaffected area, which contains the grid block shall be evaluated using the data analysis procedures described in Section 5.6.

Paved surface grids chosen for survey shall be selected on a random basis. Direct alpha and beta measurements, and removable activity measurements shall be taken at any point identified in the walkover survey as being two or more times the background exposure rate at 1 cm from the surface of the ground and at one or more locations within the each selected grid. If a direct measurement in a grid block exceeds 25% of a guideline value in Section 3.2, the grid block shall be reclassified as an affected area grid block and contiguous grid blocks shall be surveyed. Classification of the unaffected area which contains the grid block shall be evaluated using the data analysis procedures described in Section 5.6.

If an unaffected area of pavement or ground is re-classified as an affected area, the reasons for the re-classification, and the impact that the re-classification has on the bases for classifying the area as an unaffected area, will be evaluated. The NRC will be informed when an unaffected area is re-classified as an affected area, and a discussion of the evaluation will be included in the Final Status Survey Report.

5.1.4 Sub-Surface Sampling

Extensive sub-surface sampling was performed in the years prior to 1995, as described in Section 5.2.1 of the Parks Facilities Characterization Plan, and also during the site characterization performed in 1995, as described in the April 1996 Parks Facilities Characterization Report. At least one 1-meter deep sample will be taken per affected area survey unit during the Final Status Survey. The location of that

one (minimum) sample will be the grid block having the highest perceived potential for subsurface contamination.

A minimum of thirty such 1-meter deep samples will be taken across the Parks Facilities site, with at least one sample in each affected area survey unit, thereby meeting the intent of what is recommended in Section 4.2.4 of NUREG/CR-5849. The sample results will be evaluated in accordance with Sections 5.1.3 and 5.6. They will also be evaluated on a case-by-case basis to determine if subsurface contamination could be an issue, in which case follow-up sampling will be conducted.

5.1.5 Additional Remediation

Soil containing radionuclide concentrations above the guideline values, as determined during a Final Radiological Survey or NRC Confirmatory Survey, will be excavated to the extent required to assure compliance with the requirements of Sections 5.1 and 5.6. The completion of an excavation will be determined using in-process sampling and surveying. All grid blocks requiring such additional excavation will be resurveyed in accordance with Section 5.1.

5.2 VOLUMETRIC SURVEYS

Determination of bulk soil activity will be required for: fill of off-site origin, soil excavated from Parks Facilities unaffected areas, and soils excavated as part of the remediation process. The average activity levels of these bulk soils shall be determined through protocols based upon ASTM E105-58, (1989) and ASTM E122-89. Each sample will be analyzed by gamma spectroscopy, whether the soil originated on-site or off-site. Sampling requirements will differ with each class of soil because the intended use and potential radionuclide activity levels of each class of soil differ.

Soils of Off-site Origin - Off-site soils intended for use as on-site fill will be characterized in-place. The purpose of the sampling program is to establish the background radionuclide activity levels of the fill dirt for the record, and to confirm the assumption that the radionuclides and activity levels present are those typically present in the environment. The average activity levels for uranium will be determined to plus or minus 20% at the 95% confidence level, unless the activity is present at levels less than 10% of the applicable guideline value in Section 3.2. Stone, gravel and crushed rock obtained from local quarries and used on-site for backfilling of designated areas will not generally be radiologically sampled.

Soils of On-site Origin - Soil from unaffected areas of the site that were not used for site operations may be used as fill for site excavations. Soil from unaffected area to be used as fill will be 100% scanned and surveyed, and must satisfy the requirements for an unaffected area. The soil will then be characterized in place. The purpose of the sampling program is to establish the background radionuclide activity levels of the fill dirt for the record, and to confirm the assumption that the radionuclides and activity levels present are those typically present in the environment. The average activity levels for uranium will determined to plus or minus 20% at the 95% confidence level, unless it is present at levels less than 10% of the applicable guideline value in Section 3.2.

Site Excavated Soils - Soil excavated as part of the remediation effort or to gain access to areas requiring remediation will generally be segregated in separate piles as discussed in Section 3.5.2. Bulk soil will be sampled to determine the average radiological concentration prior to final dispositioning.

If the average radiological concentration is less than the applicable guideline value in Section 3.2, the soil can be retained on-site for use as fill, provided the protocol requirements described below are met.

- Core samples will be taken through the depth of the soil pile, or container, and at least one selected section, 2-3 feet in length, will be analyzed using gamma spectroscopy.

- The remaining portions of the core samples will be analyzed using in-process monitoring (see Section 5.4) to detect elevated activity areas. Core sections with radionuclide concentrations greater than the applicable guideline values, as determined during in-process monitoring, shall be analyzed by gamma spectroscopy. If any section of a core sample is above the applicable guideline values based on gamma spectroscopy, all of the core sections will be analyzed by gamma spectroscopy. The weighted average of the core, as determined in accordance with Section 5.6.5, shall be used in the determination of the average activity of the soil pile.

- A soil pile or container shown to contain an elevated activity area in excess of three times an applicable soil concentration guideline value shall either be removed from consideration for on-site retention, or remediated and resampled.

- A soil pile or container of soil is acceptable for on-site retention, if the soil piles or containers of soil have been statistically sampled and analyzed to ensure that the concentration of radionuclides does not exceed the guideline values in Section 3.2 at the 95% confidence level. Equation 5.5 in Section 5.6.6 will be used to evaluate the data. Soil with an acceptable value of μ_α will be retained on-site for use as backfill in excavated areas or as general site cover. Only excavated soils that fail this statistical acceptance criteria will be sent to a low-level radioactive waste disposal site.

5.3 WATER

The hydrogeologic features of a site significantly affect the design of a post-remediation groundwater monitoring program. A summary of the hydrogeology of the Parks Facilities site was presented earlier in Section 1.2.1. Details of the site hydrogeology were presented in the Parks Facilities Characterization Report transmitted to the NRC on April 30, 1996.

5.3.1 Post-Remediation Groundwater Monitoring

The post-remediation groundwater monitoring program is designed to confirm that there are no radionuclides in the shallow aquifer exceeding the point-of-reference values in Section 3.2. The monitoring program will be confined to the shallow aquifer. If post-closure concentrations of radionuclides in groundwater in the shallow aquifer are acceptably low, it will be assumed that the deeper aquifer will also be acceptably low. NUREG/CR-5512 Water-Use Model assumptions will be used in evaluating the results, as discussed later in Section 5.8. The plan for monitoring of groundwater at the Parks Facilities site is described below.

- **There will be at least three upgradient wells.** The existing wells remaining from the characterization effort will be used if they are usable following the remediation process and are suitably located.

- **There will be at least four downgradient wells.** These wells will be located outside the security fence near the Kiskiminetas riverbank. Four wells are currently installed in adequate locations; MW-54, MW-55, MW-56, and MW-57, as shown in Figure 2-18. Those four wells will be used for post-remediation groundwater monitoring if they remain in useable condition and are still judged to be in adequate downgradient locations after site remediation is complete.

- **There will be at least two wells located on the Parks Facilities site.** Existing wells from the site characterization will be used if they are usable following the remediation process and are in suitable locations.

- **Groundwater monitoring wells will be radiologically sampled each calendar quarter for a period of one year following remediation.** Monitoring of the wells for one year is considered adequate on the basis that the infiltration of any radionuclides from the soil into the shallow aquifer will have stabilized within this period and the sample data will be representative of the radionuclide concentrations that would be expected over a relatively long period of time. Also, taking quarterly samples will ensure obtaining seasonal data. The data analysis procedures, described in Section 5.8, will be used to demonstrate that the point-of-reference criteria are satisfied.

5.3.2 Distribution Coefficient (K_d) Evaluation

In addition to conducting the groundwater monitoring program described above, B&W NESI may perform studies to evaluate the distribution coefficient (K_d) for the remediated site and the principal isotopes. The evaluation would be based on ASTM Procedure D4319-93, "Standard Test Method for Distribution Ratios by the Short-Term Batch Method". Distribution coefficients measured for soils remaining on-site could be used to demonstrate that the rate of migration of isotopes at the site is sufficiently low such that the radionuclide concentration in groundwater will, in the distant future, remain below the point-of-reference values discussed in Section 3.2.

An alternative concept for assessing the availability of uranium compounds which could migrate to ground water is given in NUREG/CR-6232 "Assessing the Environmental Availability of Uranium in Soils and Sediments".

Determining the distribution coefficient or uranium environmental availability does not replace demonstrating that the site meets the decommissioning criteria defined in Section 3.2 of the Parks facilities Decommissioning Plan. B&W NESI will demonstrate that the site meets the decommissioning criteria in Section 3.2 for release of the site for unrestricted use, at the time of license termination. The possible evaluation of the distribution coefficient (K_d) or assessment of uranium compound environmental availability is intended solely to supplement the information gained from post-remediation groundwater monitoring which was described in Section 5.3.1.

5.4 IN-PROCESS MEASUREMENTS

Radiation survey instrument measurements, gamma and alpha spectroscopy and beta liquid scintillation counting may be augmented by in-process measurements. The in-process measurements will be performed using a NaI(Tl) scintillation counter to obtain approximate activity levels. These results will be cross-calibrated to gamma spectroscopy measurements performed in a laboratory to ensure that sufficient accuracy was obtained. In-process measurements may be used for:

- Tracking the progress of excavations to provide measurements will can result in more rapid decision making on (a) the need for and extent of continued excavation, and (b) how to minimize intermixing soils having radionuclide concentrations above and below the guideline values in Section 3.2.

- Establishing the lateral and vertical extent of elevated activity areas on soil surfaces or in soil piles, thereby providing an economical and rapid determination of whether a grid block or soil pile meets the concentration guideline values for the radioisotopes which are present.

- Detecting surface elevated activity area. Systematic surface sampling for the record may be augmented by either a systematic or random in-process sampling of a grid block or survey unit. Samples that are three or more times a guideline value will be analyzed using gamma spectroscopy unless additional remediation of the grid block or survey unit is performed.

- Volumetric elevated activity area detection. Soil pile core samples shall be subdivided into 2 to 3 foot lengths and each length shall be analyzed. Samples with in-process results exceeding a release limit will be analyzed using gamma spectroscopy unless the soil pile is remediated or disposed of as radioactive waste.

5.5 BACKGROUND

Grounds To determine background radioactivity levels, surface soil samples and available vegetation samples from twelve off-site locations were collected. The locations were on concentric rings from the site at radial distances of 0.5, 1.5 and 3.0 km. Locations on the inner ring were due north, south, east, and west of the site; locations on successive rings were offset 45 degrees from those of the previous ring. Specific locations were determined in the field by the sampling team according to the following criteria: sample areas should appear to have been undisturbed for several years; they should have moderately good permeability; they should not be near buildings, trees, or other sheltering structures; and, they should not be subject to fertilization. Permission was obtained from property owners prior to sampling.

Two 1 meter square areas were measured and marked, about 3 meters apart, at each of the twelve sampling locations. All vegetation was removed from these areas to a height of 10 to 20 cm above the soil and a portion was collected in a plastic bag for analysis. No vegetation was present at five of the locations, so vegetation samples could not be obtained from those locations. Soil plugs were taken at the center and corners of each pair of one meter square areas. These soil plugs were examined and described by a geologist and then composited to provide a sample at each location for analysis. Soil and vegetation results were analyzed by gamma spectroscopy. The average concentration of total uranium in the soil is 4.0 pCi/g, and the average concentration of Cs-137 in the soil is 0.2 pCi/g. The soil Co-60 and Am-241 activity levels did not exceed their respective Lower Limit of Detection (see Section 5.8.1 for LLD values). The vegetation samples did not exhibit any radionuclide concentrations above their respective Lower Limit of Detection.

Exposure rate measurements were taken at each location at one meter above the ground surface using a Reuter Stokes RSS-112 PIC, an Eberline PRM-6 rate meter, and a Victoreen NaI(Tl) scintillation detector. Readings from the PRM-6 and NasI(Tl) detector were cross-calibrated to the RSS-112 PIC. The average 1 meter exposure rate is 9.8 μR/hr.

The determination of background was conducted in accordance with NUREG/CR-5849.

Paved Surfaces The background radioactivity levels for paved surfaces shall be determined by direct instrument measurements of representative surfaces (e.g., steel, concrete, brick etc.), known to be free of contamination. Direct and removable alpha and beta measurements shall be taken using the instruments which are used for final surveys of structures. The minimum detectable activities (MDAs) for scanning shall be determined in accordance with NUREG/CR-5849 methodologies.

5.6 DATA INTERPRETATION

5.6.1 Data Presentation

All data will be presented in a format which provides the calculated activity, in the appropriate units for the measurement, and the estimated uncertainty of the measurements at the 95% confidence level. All sources of error affecting the data will be included. An error range may be specified for a table of data if it is unwieldy to calculate the error for each measurement.

5.6.2 Background Corrections

Final survey sample results will normally be corrected for background activity. Data which has not been corrected for background will be specifically identified in all reports.

Gross surface activity shall be corrected by subtracting appropriate background values, taken from similar structures and/or materials that contain only naturally occurring radionuclides. Gross soil activity and exposure rates will be corrected by subtracting appropriate background values. The methodology used to determine the background radioactivity at the Parks Facilities site was consistent with NUREG/CR-5849 guidelines, as discussed in Section 5.5.

5.6.3 Isotopic Ratios

Isotopes are present at the Parks Facilities site that cannot be directly detected by routine measurement methods such as gamma spectroscopy and field monitoring instruments. Alpha and gamma spectroscopy, mass spectroscopy, and beta liquid scintillation counting have been employed to determine the relationship of these isotopes to isotopes that are readily detectable by routine measurement methods and field monitoring instruments. These ratios, also known as scaling factors, are used to scale the actual measurements to determine the total activity and isotopic distribution. Knowledge of site history and use, together with the site characterization data, will be used to define areas with specific isotopic compositions, and area-specific isotopic ratios will be determined.

Scaling factors have been and will be used at the Parks Facilities to determine the concentrations of U-234, Pu-238, Pu-239, Pu-240, Pu-241, and Pu-242, from other radioisotopes which are more readily detectable. The data used to calculate the uranium and plutonium scaling factors currently in use at the Parks Facilities are primarily based on mass spectrographic analysis of fuel that was produced at the Parks Facilities. The vast majority of fuel production in Building A was mixed oxide FFTF fuel For the purposes of determining the scaling factors for the plutonium isotopes, B&W NESI used a 15 year decay of the original fuel composition, since it has been 16 years since facility shutdown and 36 years since the beginning of facility operations. The appropriateness of the decay period was confirmed by

review of the isotopic analysis data provided in a series of tables (Tables 6-3 through 6-8) in Rev. 0 of the Parks Facilities Characterization Report which was issued to the NRC on April 30, 1996. The review demonstrated that the currently used scaling factors are consistent with an effective date of the contaminant origin of approximately 1978. The date is consistent with the guidance on page 21 of Appendix E of NUREG/CR-0129 "Safety and Costs of Decommissioning a Reference Small Mixed Oxide Fuel Fabrication Plant," which states that the effective date of the site deposited mixed oxides is the shutdown date minus approximately 3 years. Fuel production in Building A was terminated in 1980, and removal of major equipment and inventory was completed in 1981. The use of a 15 year decay period, which assumes that all of the activity present dates from the end of 20 years of mixed oxide fuel operations, is therefore conservative. The primary contaminants from Building A operations cannot not be less than 16 years old and could be 36 years old.

The ratios of the plutonium isotopes to Am-241, the marker isotope, steadily decrease with time, due to ingrowth of Am-241 (from the decay of Pu-241), and the decay of Pu-238 and Pu-241. If soil contaminants date from an earlier time, the calculated plutonium activity will be in excess of the amount of residual plutonium actually present. The practice is reasonable and conservative as the effects of decay over time will inevitably decrease the actual ratios of Pu-241 and Pu-alpha to Am 241 from those presently determined and in use.

The initial sets of scaling factors for uranium isotopes in Project Units A and B, where depleted and low enriched uranium fuel or products were produced, are based on low enriched uranium scaling factors calculated from mass spectrographic analysis of the low enriched fuel produced at B&W's Apollo Fuel Plant. The use of these scaling factors is slightly conservative when applied to the depleted uranium product that was the primary product fabricated in Building B and in most of the mixed oxide, FFTF fuel produced in Building A.

The scaling factors for Project Unit C are based on mass spectrographic analysis of the single composition, high enriched fuel form processed in Building C. The detailed mass spectrographic data used to calculate the isotopic ratios for Project Unit C were submitted to the NRC on November 18, 1996 in the B&W NESI responses to the October 3, 1996 NRC comments on Rev. 0 of the Parks Facilities Decommissioning Plan.

The applicability, validity and conservatism of the scaling factors will be confirmed throughout the remediation process, by sampling and isotopic analysis. If scaling factors, that do not reflect the present data, and are higher than the present factors are found in any area, that area will be bounded, and the higher scaling factors will be applied to that area. No survey unit will contain areas with different scaling factors. This process shall be applied to all project units and sets of scaling factors including those for the high enriched uranium and depleted uranium areas. The isotopic data and the historical use data used to generate the scaling factors for the various survey units will be provided in the Final Status Survey Report for each survey unit.

5.6.4 Evaluation of Survey Results by Grid Block

Upon the completion of the surface activity measurements, survey results shall be evaluated on a grid block by grid block basis. In order for a grid block to be considered acceptable, the average of all of the measurements in the grid block shall be less than the applicable limits; no measurement shall exceed three times an applicable limit; and any measurement that is greater than one times and no more than three times an applicable limit shall be tested to see if it can be accepted as an elevated activity area

within the grid block using the formula:

$$(GA/A)^{0.5} = R \qquad \text{[Eq. 5.1]}$$

where GA = the area of the grid block,

A = the area with elevated activity, and

R = the ratio.

If the activity of the elevated area divided by the applicable limit is less than or equal to the ratio, R, the elevated activity area is acceptable. If the activity of the elevated area divided by the applicable limit is greater than R, the grid block shall be identified for additional remediation.

If activity levels in excess of 25% of an applicable limit are found in a paved surface classified as an unaffected area, the area shall be reclassified as an affected area and an affected area survey shall be performed. If activity levels in excess of 75% of an applicable limit are found in a soil survey, the area shall be reclassified as an affected area.

5.6.5 Determination of Grid Block Average Survey Results

Grid block average activity levels shall be calculated using data from systematic and random (if any) activity measurements and weighted activity measurements for areas where elevated activity is present as described below. This method is consistent with the guidance in Section 8.5.2 of NUREG/CR-5849. If the measurements do not exceed the applicable activity concentration limit, the grid block average shall be calculated using equation 5.2. If the measurements exceed the applicable activity concentration limit, the grid block average shall be calculated using equation 5.3. The grid block is acceptable if the grid block average net activity level (the actual measurement minus background) is less than the acceptable limits for each type of activity present; surface (removable alpha, beta and gamma, and direct alpha, beta and gamma), bulk material, or soil.

The grid block average 1 meter exposure rate levels shall be determined using equation 5.2. Exposure rate measurements are not required for all building surface grid blocks or measurement locations.

$$\bar{x} = \frac{1}{n_s} \sum_{i=1}^{n_s} x_i \qquad [Eq.5.2]$$

where $\bar{x}$ = mean of the measurements,

n_s = number of measurements, and

x_i = any particular measurement.

Weighted averages (as is necessary when an area of elevated activity is present) will be calculated using equation 5.3.

$$\overline{x_w} = \frac{1}{n_s} \sum_{i=1}^{n_s} x_i \left[1 - \sum_{k=1}^{n_k} A_k\right] + \sum_{k=1}^{n_k} y_k A_k \qquad [Eq.5.3]$$

where

x_w	=	weighted mean including elevated area(s)
x_i	=	systematic and random measurements at point i
n_s	=	number of systematic and random measurements
y_k	=	elevated area activity in area k
A_k	=	fraction of 100 m^2 grid blocks occupied by elevated area k
n_k	=	number of elevated areas

5.6.6 Evaluation of Activity Measurement Results by Survey Unit

When all grid blocks within a given survey unit have been found acceptable on a grid block by grid block basis, the activity measurements and exposure rate results for the survey unit will be evaluated. A survey unit will be considered to pass this step if: the average of all net activity level measurements in the area is less than the applicable limits at the 95% confidence level; no net 1 meter exposure measurement is greater than 10 μR/hr and removable activity does not exceed the guideline values in Section 3.2.

Survey unit activity level averages shall be calculated using equation 5.2. All measurements from systematic and random locations will be used to calculate the average activity level of a survey unit. In addition, an "extra sample/measurement" will be calculated for every 100 m^2 grid block that contained an area of elevated activity. The "extra sample/measurement" will be the grid block weighted average calculated using equation 5.3, and will be used as one of the systematic and random measurements in determining the average activity in that survey unit.

The survey unit 1 meter net exposure rate average shall be calculated using equation 5.2. All 1 meter exposure rate measurements made in the survey unit (systematic and biased) shall be used. The survey unit's net exposure rates are acceptable if no single net exposure rate measurement is greater than 10 μR/hr. The standard deviation of the measurements (s_x) is calculated using equation 5.4:

$$s_x = \sqrt{\frac{\sum_{i=1}^{n} (\bar{x} - x_i)^2}{n-1}} \qquad [Eq.5.4]$$

where $\bar{x}$ = the mean of the measurements,

x_i = any particular value, and

n = the number of measurements.

Demonstration that the survey unit meets the NRC criteria for release for unrestricted use shall be by the use of the equation 5.5 for all survey results except exposure rate results.

$$\mu_\alpha = \bar{x} + t_{1-\alpha,df} \frac{s_x}{\sqrt{n}} \qquad [Eq.5.5]$$

where μ_α = calculated parameter to compare to guideline value

$\bar{x}$ = mean of a set of values,

n = number of values measured or calculated,

x_i = any particular value,

S_x = standard deviation, and

$t_{1-\alpha,df}$ = the 95% confidence level obtained from the student's t-test with n-1 degrees of freedom (df) and α being the false positive probability (0.05 for the Parks Facilities).

In order for an area to be considered acceptable to pass this step, μ_α must be less than the guideline value.

5.6.7 Water

At the end of the one year radiological sampling period, the data from the wells will be analyzed and evaluated. If the results of this evaluation confirm that the site-wide

radionuclide concentrations do not exceed the point-of-reference values in Section 3.2, the program objective will have been satisfied and the wells will be sealed in accordance with applicable regulations.

If the point-of-reference concentration limits are not met, further investigatory work, including possible additional sampling, will be performed.

5.7 INSTRUMENTATION

Two categories of instrumentation will be used by B&W NESI in conducting final status surveys and sample analysis. They are direct measuring instruments and laboratory equipment. All instruments will be appropriate for the measurements being made. Typical instrumentation is listed in Tables 5-1 and 5-2.

Measurements of the gamma exposure rate over the Parks Facilities site will be made with μR-meters or other scintillation instruments. The instruments will be cross-calibrated at the site against a PIC to ensure that the instruments are calibrated for the gamma-emitting isotopes which are found on-site.

Surface exposure rate measurements will be used only as indicators of undiscovered radiological constituents. These measurements will not be used to demonstrate attainment of the site release criteria.

Direct surface measurements for gross alpha and beta activity levels will be performed using 100 cm^2 scintillation probes or gas proportional probes, such as the Bicron Surveyor M with A100 or B100, alpha or beta probes. Scanning shall be performed using scintillation probes or gas proportional probes, such as the Bicron Surveyor M with A100 or B100 probes, and Eberline gas proportional floor monitors for alpha and beta activity. Removable activity measurements shall be performed using a low background gas flow proportional counter such as the Tennelec LB 5100.

An appropriate, dedicated check sources will be read by each field instrument at the time of calibration and the instrument response recorded. Each day that an instrument is used, a calibration source will be read by the instrument to determine that the original response is duplicated. Daily checks will be logged for each instrument. If the response is not duplicated to within three standard deviations of the measurement, the instrument will be tagged and taken out of service pending recalibration. Instruments which are in continuous use during the day will be periodically exposed to a check source to be sure that the proper response is being obtained.

5.8 LABORATORY ANALYSIS

5.8.1 Soil

All soil samples will be analyzed by gamma spectroscopy using solid-state detectors. Each gamma spectrum will be reviewed by an experienced gamma spectroscopist to identify interferences or other artifacts not identified by the computer program. The lower limits of

detection (LLD) for critical isotopes are:

U-235	0.1	pCi/g
Am-241	0.06	pCi/g
Cs-137	0.04	pCi/g
Co-60	0.1	pCi/g

During previous site characterization activities, numerous representative samples from Project Units A, B, and D were analyzed for isotopic activity by alpha and gamma spectroscopy and beta liquid scintillation counting to determine the ratios of readily detectable isotopes such as U-235 and Am-241 to related isotopes that are not readily detectable. Historical isotopic data will be used for Project Unit C since isotopic distribution was a requirement of the Type II fuel specification. Prior to requesting a confirmatory survey, B&W NESI will provide the NRC with the applicable data.

5.8.2 Water

Each water sample will be analyzed for gross alpha, beta and gamma concentrations utilizing EPA method 900.0. Alpha and gamma spectroscopy and beta liquid scintillation counting will be performed using the assumption that the activity present is due to selected representative and conservative isotopes.

5.9 FINAL REPORT

The results of the final status surveys of the site (reference Activity 6 in Section 3.4) will be submitted to the NRC in a report that will be prepared in accordance with Chapter 4 of NUREG/CR-5849. The report will summarize the survey results and demonstrate that the site meets the NRC criteria for release for unrestricted release use with the requisite level of certainty. Copies or summaries of procedures used and supporting calculations and tables showing the average and maximum radionuclide concentrations in soil in each grid block and soil pile which was sampled will either be included in the report or a table will be provided indicating the letters in which the procedures, calculations, and data were previously submitted to the NRC. Similar data will be provided for the groundwater monitoring wells. The raw data will not be provided in the report because of the volume of this documentation. However, this information will be available for NRC review.

In cases where activity levels exceed a guideline value, appropriate alpha or beta isotopic analysis will be performed to determine the specific isotopic distribution to allow a detailed analysis in support of release.

Table 5-1

TYPICAL DIRECT MEASUREMENT INSTRUMENTS FOR PERFORMING FINAL RADIOLOGICAL SURVEYS AT THE PARKS FACILITIES

Instrument/Method	Radiation Type	Application	Sensitivity
End Window or Pancake Probe	Beta	Surface Surveying Scanning	500 dpm/ 100 cm^2
NaI(Tl) Scintillator (Eberline PRM6)	Gamma	Exposure Ratemeter	2-5 μR/hr
TLD	Gamma	Integral Dose	10 mrem
Pressurized Ion Chamber Reuter Stokes RSS-112	Gamma, X-ray	Exposure Rate <1 μR/hr. Integral	
ZnS Scintillator Bicron Surveyor M	Alpha	Static Count	54 dpm/100 cm^2
ZnS Scintillator Bicron Surveyor M	Alpha	Scanning	57 dpm/100 cm^2
ZnS Scintillator Bicron Surveyor M	Beta	Static Count	580 dpm/100 cm^2
ZnS Scintillator Bicron Surveyor M	Beta	Scanning	2500 dpm/100 cm^2
Eberline E600 Gas Proportional	Alpha	Static Count	14-40 dpm/100 cm^2
Eberline E600 Gas Proportional	Alpha	Static Count	14-40 dpm/100 cm^2
Eberline E600 Gas Proportional	Beta	Scanning	1350-4550 dpm/100 cm^2
Eberline E600 Gas Proportional	Beta	Static Count	200-400 dpm/100 cm^2

* The sensitivity of the Eberline E600 varies with material background and count time.

Table 5-2

TYPICAL LABORATORY INSTRUMENTS FOR PERFORMING FINAL RADIOLOGICAL SURVEYS AT THE PARKS FACILITIES

Instrument Method	Radiation Type	Application	Sensitivity
HPGe Spectrometer	Gamma	Sample Analysis	< 0.1 pCi/g*
Gas Proportional Counter	Beta, Alpha	Gross Radioactivity	1-3 dpm Beta or Alpha
NaI Scintillator	Gamma	Sample Analysis	Variable
Radiochemical Separations	Specific Radionuclides	Low Level Measurements	Variable

* For the majority of gamma emitting isotopes; e.g., the sensitivity for U-235 is 0.03, Am-241 is 0.06, and Cs-137 is 0.04 pCi/g.

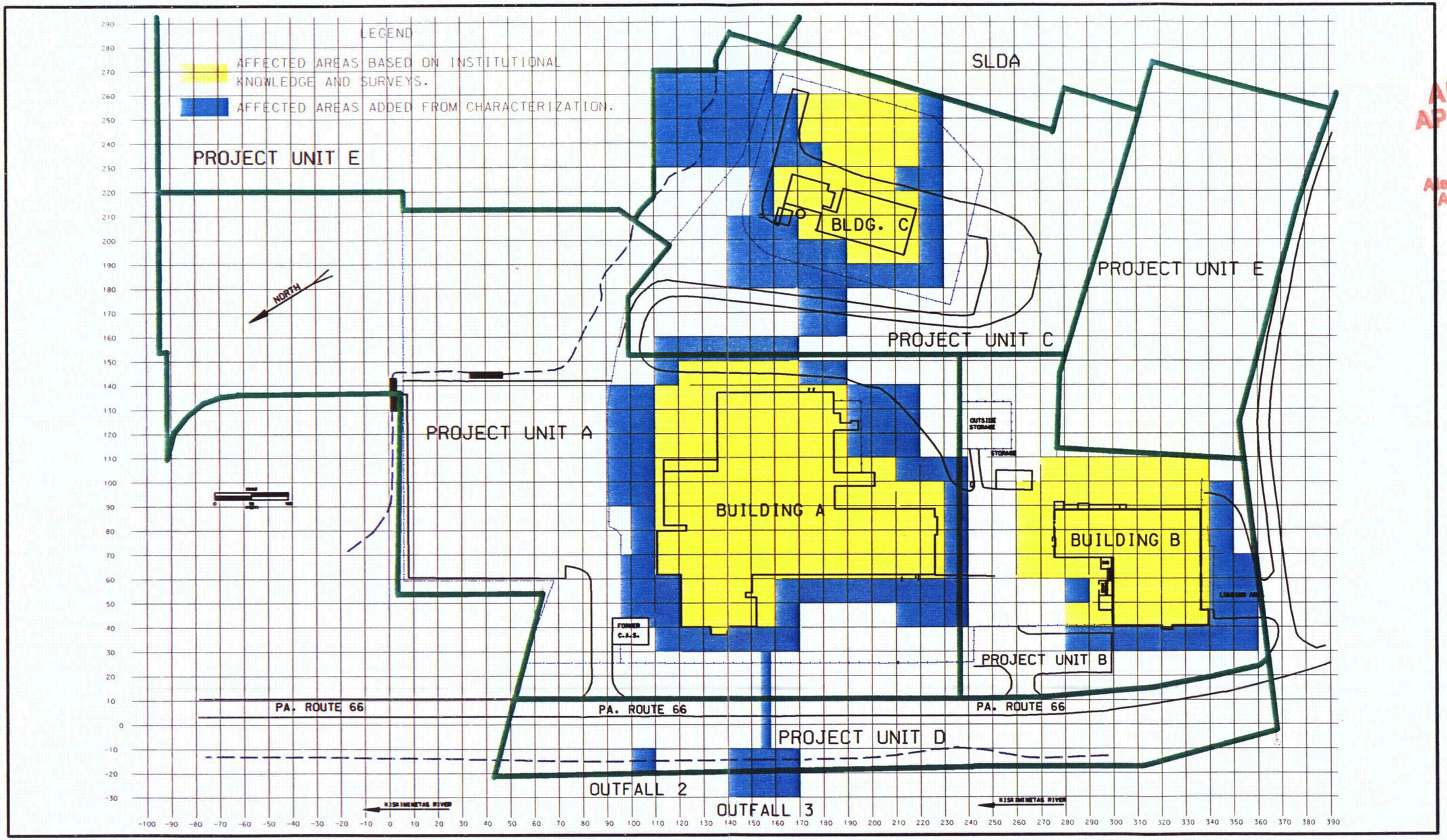


Figure 5-1, Rev. 1

Proposed Affected and Unaffected Area Grid Blocks for the Final Status Survey

6.0 FINANCIAL ASSURANCE

The work required to reduce the level of radiological materials at the Parks Facilities to the level at which the site can be released for unrestricted use and the NRC license terminated can be grouped into two categories: ***decontamination*** activities and ***decommissioning*** activities. Section 3.3 provided an overview of the two categories of activities, and they are summarized below.

- ***Decontamination*** activities are defined as those licensed activities that are currently authorized as specified in Condition 10 of SNM-414. The primary ***decontamination*** activities at the Parks Facilities involve the decontamination of the building surfaces, followed by final radiological surveys, NRC review and approval of the final survey report, and dismantlement of the buildings down to, but not including, the grade level floor slabs.

- ***Decommissioning*** activities are defined as those activities beyond decontamination that are described in this decommissioning plan. They cannot be performed until this decommissioning plan is approved by the NRC and license SNM-414 is amended to authorize the ***decommissioning*** activities. The primary ***decommissioning*** activites are removal of the build floor slabs, basements, below-grade drains and utiliites, excavation of the soil where needed, and final surveying of the site.

A summary of the cost to decommission the Parks Facilities, estimated in October 1996, is presented in the table below. The cost estimate includes all the activities directly associated with ***decommissioning*** (e.g., excavation and final surveys) and prorates those activities which support both ***decommissioning*** and ***decontamination*** (e.g., project management, regulatory interface, and engineering). Detailed decommisioning financial data to support this summary cost estimate was transmitted under separate cover to the NRC, since this data is considered proprietary to The Babcock and Wilcox Company and not available for public access in accordance with 10 CFR 2.790.

	Labor	Material	Subcontractor	Transportation	Burial	Totals
Activity 1. Inaccessible Area Evalaution and Decontamination	74,569	0	252	0	0	74,821
Activity 2. Soil Excavation and Floor Slab Removal	505,003	0	349,214	382,434	1,614,591	2,851,242
Activity 3. Soil Surveys and Individual Reports	131,878	0	85,575	0	0	217,453
Activity 4. Final Walkover of Site	4,609	0	0	0	0	4,609
Activity 5. Quarterly Groundwater Monitoring	17,378	0	213,143	0	0	230,521
Activity 6. Final Survey Report	190,663	0	764,358	0	0	955,021
Project Management	900,054	119,046	132,730	6,743	0	1,158,573
Regulatory Interface	319,667	4,224	29,015	0	0	352,906
General	162,271	622,123	43,849	0	0	828,243
Totals	2,306,092	745,393	1,618,136	389,177	1,614,591	6,673,388

The NRC renewed SNM-414 in October 1995 and The Babcock and Wilcox Company placed into effect financial assurance in the amount of $2,000,000. The total cost of decommissioning is now estimated (October 1996) at $6,673,388, as shown in the table.

The Babcock and Wilcox Company will increase the total decommissioning amount to $8,000,000 to provide approximately 20% contingency. The Babcock and Wilcox Company will then increase the financial assurance currently in effect, by obtaining an additional line of credit for $6,000,000 to meet the higher cost, including contingency, estimated for decommissioning.

7.0 QUALITY ASSURANCE

Because the purpose of decommissioning and the final radiological survey is to demonstrate that the facility meets the established release criteria, activities will be performed in a manner that assures the results are accurate and that uncertainties have been adequately considered. The quality assurance program will operate in all stages of decommissioning through the final survey, validation of the data, and the interpretation of the results.

Persons or organizations responsible for assuring that the quality assurance program has been established and verifying that activities affecting quality have been correctly performed will have sufficient authority, access to work areas, and organizational freedom to:

- identify quality problems;
- initiate, recommend, or provide solutions to quality problems through designated channels;
- verify implementation of solutions; and
- assure that further decommissioning activities are controlled until proper disposition of a nonconformance or deficiency has occurred.

Such persons or organizations will have direct access to responsible management at a level where appropriate action can be effected. Such persons or organizations will report to a management level such that required authority and organizational freedom are provided, including sufficient independence from cost and schedule considerations (see Section 3.6 for additional organizational details).

The major aspects of the quality assurance program for the decommissioning activities are discussed in the following sections.

7.1 QUALITY ASSURANCE PROJECT PLAN

For execution of decommissioning activities at the Parks Facilities, a Quality Assurance Project Plan (QAPP), consistent with ANSI/ASME NQA-1, "Quality Assurance Program Requirements for Nuclear Facilities" will be developed. The QAPP will also meet the general intent of NUREG/CR - 5849, "Manual for Conducting Radiological Surveys in Support of License Termination". The objective of the QAPP is to ensure confidence in the sampling, analysis, interpretation and use of radiological data generated during the decommissioning project.

The QAPP will ensure collection of reliable data by serving as the instrument of control for field and analytical activities associated with the project. Stated within the QAPP are the quality assurance policies, quality control criteria, and reporting requirements that must be followed by all site and contractor personnel when carrying out their assigned responsibilities on this project. The QAPP describes the functional activities and quality assurance/quality control (QA/QC) protocols necessary to collect data of adequate quality.

7.2 PROCEDURES

Supporting Quality Implementing Procedures (QIPs) will provide step-by-step details for complying with project requirements. The final radiological survey, including sampling plans, direct measurements, sample analysis, instrument calibration, daily functional checks of instruments, and sampling methods will be performed according to written procedures. These written procedures will be reviewed and approved by the appropriate site managers.

7.3 SUBCONTRACTORS

The activities to be conducted during decommissioning may require the services of various specialty subcontractors, such as a qualified, competent drilling contractor or a licensed surveyor. Subcontractor activities will be under the direct supervision of B&W NESI personnel during the site decommissioning and in accordance with the QAPP. Vendors providing quality related goods or services for this project will be selected from an Approved Suppliers List maintained by Quality Assurance.

7.4 LABORATORY SERVICES

The radiological analytical laboratory services for the project will be primarily performed by the B&W NESI Nuclear Environmental Laboratory. The laboratory will be responsible for all bench level QA/QC, data reduction, data reporting, and analytical performance monitoring. Laboratory accuracy will be evaluated by the analysis of blank and spiked samples. Sample handling protocols, analytical procedures, and reporting procedures employed by the analytical laboratory will be described in the laboratory's Quality Assurance Plan.

The Director of the laboratory is responsible for assuring that all laboratory managers are thoroughly familiar with the Quality Assurance Project Plan and good laboratory practices, and that all laboratory personnel meet the requisite qualifications for their positions within the laboratory. The Director, or his representative, shall review and approve all reports. The Director is also responsible for assuring laboratory personnel have appropriate training to perform assigned responsibilities, and for daily management of the laboratory and its staff.

The laboratory will have a QA Administrator who is responsible for assuring that the QA/QC requirements of the QAPP, the laboratory Quality Assurance Plan, and its associated operating procedures are strictly followed. The QA Administrator is responsible for review of data, alerting the Project Manager of the need for corrective action (when necessary), performing internal audits as specified by the QAPP, and maintenance of the QC records. The QA Administrator is also responsible for preparing project specific QA/QC plans as necessary.

7.5 SURVEYS AND SAMPLING ACTIVITIES

Surveys will be performed by trained individuals following written procedures, and using properly calibrated instruments. The custody of samples will be tracked from collection to analysis. Final survey data will be retained for a minimum of five years. A split sample will be collected when desired by the NRC to obtain samples that are duplicates of those to be analyzed by B&W NESI. When this operation is performed, the procedure for obtaining duplicate samples will be followed.

QC hold points will be utilized as necessary to ensure quality of surveys and sampling. Hold points will also be used to ensure that soil is moved only after QA has verified that the proper sampling and survey information for the soil in question has been obtained.

7.6 DOCUMENTATION

Data will be recorded in the Environmental Data Management System (EDMS). Entries will include the location of the survey or sampling point on the site three-dimensional grid. The EDMS personnel will also ensure that chain-of-custody and data management procedures are followed for decommissioning-related samples. In addition, B&W NESI procedures for the proper handling, shipping and storage of samples will be used.

The Parks Facilities site will be accurately mapped in relation to the surrounding areas. Direct measurements and analytical results will be documented. The results for each survey and sample analysis will be placed on the site map at the appropriate grid block location and also be listed in tabular form (result versus sample or survey location).

Data will be recorded in an orderly and verifiable way and reviewed for accuracy and consistency. Every step of the decommissioning process, from training personnel to calculating and interpreting the data, shall be documented in a way that lends itself to audit. Records of training to demonstrate qualification will also be maintained.

7.7 EQUIPMENT MAINTENANCE AND CALIBRATION

Measuring equipment will be maintained, calibrated, and tested according to Regulatory Guides 4.15 and 4.16 recommendations. Further, the procedures, responsibilities, and schedules for calibrating and testing equipment will be documented. Procedures will meet the requirements of ANSI N323-1978. Calibration and maintenance of laboratory instrumentation will also meet the requirements of INPO 83-016.

Proper maintenance of equipment varies, but maintenance information and use limitations are provided in the vendor documentation. Measuring and analyzing equipment will be tested and calibrated before initial use and will be recalibrated if maintenance or modifications could invalidate earlier calibrations. Field and laboratory equipment, specifically used for obtaining final radiological survey data, will be calibrated based on standards traceable to the National Institute of Science and Technology (NIST). In those cases where NIST-traceable standards are not available, standards of an industry-recognized organization (for example, the New Brunswick Laboratory for various uranium standards) will be used. Minimum frequencies for calibrating equipment will be established and documented.

Measuring equipment will be tested at least once on each day the equipment is used. Test results will be recorded in tabular or graphic form and compared to predetermined, acceptable performance ranges. Equipment that does not conform to the performance criteria will be promptly removed from service until the deficiencies can be resolved.

7.8 DATA MANAGEMENT

The generation, handling, computations, evaluation and reporting of final radiological survey data will be as specified in B&W NESI procedures. Included in these procedures will be a system of data review and validation to ensure consistency, thoroughness and acceptability. Qualified personnel from HS&L, Operations, and Engineering will review and evaluate survey data.

Data reduction, QC review, and reporting will be the responsibility of the analytical laboratory. Data reduction includes all automated and manual processes for reducing or organizing raw data generated by the laboratory. The laboratory will provide a data package for analyses which will include a copy of the raw data, and any other information needed to check and recalculate the analytical results.

Once a data package is received from the laboratory, the analytical results and pertinent QA/QC data will be compiled onto standardized data spreadsheets. The spreadsheets will serve as basic reference sheets for data validation, as well as for project data use.

Prior to releasing data for use by project staff, selected data will undergo data evaluation based on intended end use of the data. Data points chosen for evaluation will be examined to determine laboratory compliance with QA requirements and other factors that determine the quality of the data.

If sample analytical data are rejected or data omissions are identified during the data validation, this data will be evaluated to judge the impact on the project. Other corrective action may include resampling and analyzing, evaluating and amending sampling and analytical procedures and accepting data acknowledging the level of uncertainty.

7.9 SAMPLE CHAIN-OF-CUSTODY

One of the most important aspects of sample management is to ensure that the integrity of the sample is maintained; that is, that there is an accurate record of sample collection, transport, analysis, and disposal. This ensures that samples are neither lost nor tampered with and that the sample analyzed in the laboratory is actually and verifiably the sample taken from a specific location in the field.

Sample custody will be assigned to one individual at a time. This will prevent confusion of responsibility. Custody is maintained when (1) the sample is under direct surveillance by the assigned individual, (2) the sample is maintained in a tamper-free container, or (3) the sample is within a controlled-access facility.

A chain-of-custody record (a standard form) will be initiated by the individual collecting or overseeing the collection of samples. A copy of this form will accompany the samples throughout transportation and analyses; and any breach in custody or evidence of tampering will be documented.

7.10 AUDITS

Periodic audits will be performed to verify that decommissioning activities comply with established procedures and other aspects of the QAPP and to evaluate the overall effectiveness of the QA program. The Manager, Quality Assurance and the Manager, HS&L will ensure that qualified personnel conduct audits on at least a quarterly basis to ensure that applicable procedures are followed. The audits will

be conducted in accordance with written guidelines or checklists. HS&L personnel will also conduct semiannual audits. External program audits may also be used at the discretion of management. Audit results will be reported to responsible management in writing, and actions to resolve identified deficiencies will be tracked and appropriately documented.

APPENDIX A

ANALYSIS OF DECOMMISSIONING ALTERNATIVES

The major alternative considered was to install a crushing plant on site, demolish the building and process the building rubble through the crushing plant. This alternative was similar to an operation successfully performed during the decommissioning of the Apollo, PA site under NRC License SNM-145. The crushed rubble would have been sampled as it came out of the plant, any material that exceeded the current release criteria would have been shipped to a LLRW burial site (Envirocare). Material below the release criteria would have remained on site and used as fill material after the soil exceeding the release criteria had been removed and shipped for LLRW burial.

This alternative was abandoned for several reasons. The crushed rubble remaining on site may have increased the radiological dose to members of the public; the cost of this alternative far exceeded the cost of what is proposed in the current submittal; and the overall decommissioning schedule would have been negatively impacted.

APPENDIX B

PARKS FACILITIES PU-241 SOIL RELEASE CRITERION

1.0 INTRODUCTION

The purpose of this report is to document justification for a concentration limit of 1,250 picocuries per gram for plutonium-241 (Pu-241) in soil and other bulk material released for unrestricted use. The analysis demonstrates that the dose from Pu-241 at 1,250 picocuries per gram would be below approximately 30 millirem per year and would be "as low as reasonably achievable" (ALARA). The specified numerical dose limit applies only for the purpose of determining a concentration limit for Pu-241 and does not apply to other residual radioactive material at the site. (The Pu-241 concentration limit so derived would be used in conjunction with FC 83-23 limits for other nuclides and the sum-of-the-fractions rule in demonstrating compliance with release limits for soils with mixtures of nuclides.)

The report first describes a screening dose assessment for soil containing 1,250 picocuries per gram of Pu-241. The report then describes an analysis demonstrating that concentration limit of 1,250 picocuries per gram for Pu-241 in soil is ALARA. The screening dose assessment and ALARA assessment are presented in Sections 2 and 3 of this report, respectively. Conclusions from these assessments are summarized in Section 4.

2.0 PU-241 SCREENING DOSE ASSESSMENT

A screening dose assessment was performed to calculate the maximum annual dose that might be received by a member of the public from exposure to soil containing Pu-241 at a concentration limit of 1,250 picocuries per gram. The assessment was designed to meet the following design criteria:

- Use the computer code RESRAD, Version 5.62.
- Except as specified below, use default parameter values from NRC's Policy and Guidance Directive PG-8-08 (NRC, 1994) for the resident-farmer scenario.
- For values of K_d (soil/water distribution ratio) for plutonium and americium in the contaminated zone and unsaturated zones, use values in the lower 95th percentile of the loam soil distribution based on reported literature values.
- For values of K_d (soil/water distribution ratio) for plutonium and americium in the saturated zone, use values in the lower 95th percentile of the sand soil distribution based on reported literature values.
- Provide all information showing that the various K_d values used are in the lower 95th percentile of the distributions based on literature values.
- Provide all RESRAD summary output information.

Taken together, the assumptions about exposure scenario and the assumptions regarding parameter values tend to increase the calculated dose relative to the dose that might be calculated for a more likely set of exposure scenario and parameter value assumptions. It is unlikely that important aspects

of the resident-farmer scenario specified in PG-8-08 would ever occur at the Parks site. Consider, for example, the potential for use of shallow groundwater for domestic consumption, crop irrigation, and cattle watering, as assumed in the PG-8-08 resident-farmer scenario. The site is currently served by a reliable municipal water supply that draws from a surface water source. Given the population density in the locale, loss of this source must be considered unlikely. Indeed, it is difficult to imagine how it loss of this source without replacement might be possible without substantial modification of the current social and political conditions in the locale. Furthermore, in the event of loss of this source, the Kiskiminetas River, which flows along one border of the site, would almost certainly serve as the substitute water source.

Except for K_d values, PG-8-08 default parameter values are documented thoroughly in PG-8-08. Therefore, PG-8-08 default parameter values, except for K_d values, will not be discussed in detail in this report. The summary output from RESRAD, provided at the end of this report, lists on pages 4 through 7, in side-by-side format, both RESRAD default parameter values and values input by the user. Except for K_d values, which are discussed below, the listed user input values that differ from the RESRAD default values were drawn from PG-8-08.

Values for plutonium and americium K_d were derived from the work of Sheppard and Thibault (Sheppard, 1990). Sheppard and Thibault have reviewed literature reports of K_d values, have summarized their results statistically, and have produced a compendium of K_d values for use in dose assessment . This compendium is cited as a source for K_d values in Appendix A of PG-8-08. This compendium is also cited in NUREG/CR-5512 (Kennedy, 1992), and, along with other references, in supporting documentation for the RESRAD code.

Sheppard and Thibault have summarized their results in terms of log-normal distributions with parameters, μ_g (the mean of the natural logarithms) and σ_g (the standard deviation of the natural logarithms). The authors note that the K_d distributions for plutonium and americium distributions are based on empirical K_d determinations rather than derivations from plant/soil concentration ratios used for a number of other elements. Typically, only the geometric means from the distribution for each soil type are cited in other works. But the Sheppard and Thibault distribution parameter values can be used to derive K_d values for any chosen percentile:

$$K_d = \exp(\mu_g + z\,\sigma_g)$$

where z is the value of the standard normal distribution statistic for the percentile of interest. For the 5th percentile (lower 95th percentile), the value of z is -1.645. Sheppard and Thibault where z is the value of the standard normal distribution statistic for the percentile of interest. For the 5th percentile (lower 95th percentile), the value of z is -1.645. Sheppard and Thibault distribution parameter values and 5th percentile K_d values calculated from them are shown below for plutonium and americium in loam and sand soils:

K_d Data for Plutonium and Americium in Loam and Sand Soils

Soil Type K_d Distribution Data	Plutonium	Americium
Loam Soil		
μ_g	7.1	9.2
σ_g	1.2	1.4
K_d (5^{th} percentile), ml/g	167	982
K_d Used, ml/g	170	700
Sand Soil		
μ_g	6.3	7.6
σ_g	1.7	2.6
K_d (5^{th} percentile), ml/g	33	27
K_d Used, ml/g	6.6	27

The 5^{th} percentile K_d values are the values exceeded in their respective distributions with a frequency of 95%. Lower K_d values are exceeded with a frequency higher than 95%. For reasons described below, some K_d values different from the 5^{th} percentile values were used in the RESRAD analysis. The values used in the RESRAD run at the end of this report are also listed in the table above. It is important to note that all of the K_d values used in the analysis are exceeded in their respective distributions with a frequency equal to or greater than 95%.

Test runs of RESRAD with input parameter values as described above (including 5^{th} percentile K_d values) produced unexpectedly high calculated doses late in the 1,000-year period of interest. Americium-241 in the groundwater ingestion pathway (Am-241) was found to be the major contributor to the high calculated doses. Bounding calculations performed by hand revealed that the calculated RESRAD results were too high to be physically possible. Additional test runs of RESRAD with minor perturbations in K_d values and values for other parameters produced unpredictable and questionable results. These results indicated a possible error in the RESRAD code. Investigation by the author of the RESRAD code (Yu, 1997) found no coding error, but revealed an undocumented, implicit calculational assumption in the code that was violated by using the 5^{th} percentile K_d values. The assumption implicit in the code is that while K_d values may be assumed to change from one soil zone to another, the ratio of parent to daughter K_d remains constant across all zones (Yu, 1997.). Violation of this assumption by using K_d values that alter this ratio can result in unpredictable results that can be seriously in error.

This limitation in the code required the use of some K_d values that were lower than the calculated 5th percentile value. The K_d values for americium in the contaminated zone and uncontaminated, unsaturated zones, both of which are loam soils, were reduced somewhat from the 5th percentile values to bring them closer to the 5th percentile values for plutonium. This adjustment is conservative (*i.e.*, can lead only to a higher calculated dose). The adjustment was made to reduce the ratio of the americium K_d value to plutonium K_d value. Minimizing this ratio permits use of more nearly equal K_d values for americium and plutonium in the saturated zone, which more closely approximates the relationship between the 5th percentile K_d values for americium and plutonium in that zone.

The K_d value for plutonium in the saturated zone, assumed to be sand, was also reduced from the 5th percentile value. This was done to maintain the same K_d ratio as in the upper zones while using the 5th percentile K_d value for americium in the saturated zone. Theoretically, this adjustment is not conservative. Although it increases the migration rate of Pu-241 in the saturated zone, Pu-241 contributes little to dose. Furthermore, more rapid migration of Pu-241 through the saturated zone reduces the decay of Pu-241 to Am-241 in that zone, thereby reducing the potential dose from Am-241 produced in that zone. However, examination of the detailed RESRAD output indicated that, because of its short half-life of 13.7 years, and its slow rate of migration downward toward the saturated zone, Pu-241 decays to inconsequential levels before entering the saturated zone. This means that the potential for buildup of Am-241 in the saturated zone is inconsequential in any case.

Results of the RESRAD run are included in the RESRAD output at the end of this report and are summarized in Figure 1. The maximum annual radiation dose from all pathways calculated in the RESRAD run from 1,250 pCi/g for Pu-241 in soil is just below 31 millirem per year. The pathways contributing most of the radiation dose at the maximum level are inhalation of resuspended soil and ingestion of plant food containing nuclides taken up from soil or deposited from settling of resuspended soil.

The maximum calculated annual dose of 31 millirem per year is approximately 30 millirem per year. This calculated dose is well below the 10 CFR Part 20 limit of 100 millirem per year. As noted, this calculated dose is based on a screening dose assessment that incorporates conservative assumptions in the definition of exposure scenarios and in the selection of parameter values. The actual highest annual dose to members of the public would likely be lower that the maximum dose calculated in this screening assessment.

3.0 ALARA ASSESSMENT

The principle that radiation doses should be kept as low as reasonably achievable (ALARA) has been applied for many years in radiation protection. In conjunction with dose limits for workers and members of the public, application of the ALARA principal is an important element in the NRC standards for radiation protection (10 CFR Part 20). This section of the report describes an analysis designed to determine whether reduction of the concentration of Pu-241 in soils below 1,250 picocuries per gram would be warranted by the ALARA principle.

Elements of ALARA Analysis

In the context of soil remediation, ALARA analysis is fundamentally a balancing of the value of

remedial action against its cost. The value of remedial action is the value of the radiation dose expected to be saved by the action. If the expected value of the dose reduction exceeds the cost of remediation required to achieve the dose reduction, the action is warranted. The test is applied successively in a way that implements the most effective actions first. When no further actions can be found warranted by the ALARA test, remediation has reached the ALARA condition. The potential radiation dose has been reduced to a level as low as reasonably achievable.

Rigorous ALARA analysis can be complex, but ALARA analysis for soil remediation can be simplified greatly if the value of dose saved can be estimated on the conservatively high side and the cost of remediation can be estimated on the conservatively low side. If, in spite of such conservative assumptions, the cost of any proposed remediation exceeds the value of the dose expected to be saved, the ALARA condition has already been reached and no further dose reduction is warranted. If, on the other hand, the conservatively high estimated value of the dose expected to be saved exceeds the conservatively low estimate of the cost of any proposed remediation, the proposed action may be warranted. At a minimum, more rigorous analysis would be necessary to demonstrate that the ALARA point has been reached and no further dose reduction is warranted.

In the case at hand, a limit of 1,250 picocuries per gram for Pu-241 in soil released for unrestricted use is to be tested. In Section 2 of this report this concentration has been shown to result in a calculated maximum annual dose to a member of the public of approximately 30 millirem per year. The question to be answered by ALARA analysis is whether additional soil cleanup of Pu-241 to levels below 1,250 picocuries per gram (*i.e.*, reduction of the potential dose from Pu-241 to some level below 30 millirem per year) would be warranted by the ALARA principle. Thus, the analysis must balance the value of the dose saved by reducing the dose from Pu-241 to levels below 30 millirem per year against the cost of the required cleanup.

Value of Dose Saved

In determining the value of dose saved, the radiation dose quantity of interest is population dose, which can be thought of as an aggregate dose. It is the sum, over the future time period of interest and over the entire exposed population, of all of the individual annual doses received by each member of the exposed population. A population dose is expressed in units of person-rem. For example, ten people, each receiving 0.1 rem per year for a period of 20 years would result in a population dose of 20 person-rem.

The population dose depends upon the duration of the exposure period, the annual dose received by each person exposed, and the total number of people exposed each year. Each of these factors is examined further below.

The maximum time period of interest is fixed by guidance in PG-8-08 at 1,000 years. Shorter time periods can be considered more appropriate, and have been used in NRC environmental analyses, but, for purposes of conservatism, shorter periods are not considered in this analysis.

As can be seen from the results in Section 2, the annual dose received by an exposed person can vary with time. However, the analysis can be simplified by conservatively assuming that the annual dose is constant with time at the maximum calculated in the 1,000-year period of interest, 31 millirem per

year for a Pu-241 soil concentration of 1,250 picocuries per gram..

The total number of people exposed depends upon the population density in the area and the area of the zone containing the radioactive materials of interest. Reasonably conservative estimates of the population density in the area can be derived from consideration of likely future land uses that are consistent with exposure scenario assumptions. For example, a population of 4 persons per acre would appear to be reasonably consistent with current low-density residential land use in the immediate vicinity and would be conservatively high for agricultural use of the land, which is assumed in the resident-farmer scenario. This population density can be conservatively assumed to be constant with time. The area of the zone containing radioactive materials of interest can be established reasonably accurately from site characterization data. However, as described below, both the value of the dose saved and the cost of the remedial action can be determined on a unit area basis, which makes the actual area of the zone containing radioactive materials relatively unimportant in this analysis.

The dose saved by a remedial action is the difference between two population doses--the population dose without the proposed remedial action less the population dose residual after implementation of the remedial action. The analysis can be simplified greatly if the population dose after remedial action is conservatively assumed to be zero (i.e., the remedial action is assumed to be entirely effective in eliminating the potential for radiation exposure). This assumption results in the maximum possible dose savings. Any more realistic estimate of potential dose savings from any remedial action can only be less, and, consequently, its value can only be less. With this simplification, it is possible to derive a conservatively high estimate of the expected dose to be saved from further remedial action by calculating only one population dose--the population dose based on the assumption that no further remedial action occurs.

The discussion of the benefit of remedial action has thus far focused on the dose saved. However, for ALARA analysis, the value of dose saved and the cost of remedial action must be expressed the same units--monetary units. NRC has provided guidance for estimating the monetary value of population dose saved (NRC, 1995a and NRC, 1995b). These documents establish the value of a person-rem for purposes of ALARA analysis at $2,000, and provide guidance for accommodating the differences in the time distributions of benefits realized from dose savings and costs incurred in remedial action.

In the context of this analysis, in which the value of dose saving is realized at a relatively low rate over a large portion of the time period of interest and the costs of remedial action are incurred entirely at the beginning of the time period, NRC guidance recommends consideration of the use of the present value of dose savings in the ALARA balance against remedial action costs. For periods of interest less than about 100 years, NRC recommends use of a 7% per year discount rate in valuing future dose savings. For longer periods, NRC recommends two approaches: (1) calculation of the value of dose savings on a present worth basis using a discount rate of 3% per year, and (2) displaying benefits and costs at the time they occur, with no present value conversion. For a time period of 1,000 years and a constant annual dose, the first approach is equivalent to using an undiscounted value of a person-rem of approximately $70. Figure 1 can be used to assess the time pattern of the realization of the value of dose savings. However, for the conservative assumption, noted above, of a constant annual dose with time, the realization of the value of dose savings can be considered to occur at a rate constant with time.

The above discussion leads to a simple algorithm for deriving a conservatively high estimate of the value of dose savings from reducing the concentration of Pu-241 in soil at the Parks Facilities site below 1,250 picocuries per gram (i.e., reducing the annual dose to a level lower than 30 millirem). The value estimate is the product of the area of the zone containing radioactive material, the population density (4 persons per acre), the maximum annual dose without further remedial action (i.e., 30 millirem), the time period of interest (1,000 years), the monetary value of a person-rem ($2,000 if discounting is ignored, or $70 if the effect of a 3% per year discount rate is to be included), and factors to provide consistency in units.

The algorithm is simplified further by dropping the area of the zone containing radioactive material from the algorithm above so that the value of dose savings is calculated on a unit area basis. This is done only for convenience of calculation and expression. The maximum calculated annual dose used in this simplified algorithm must still be derived by assuming a realistic or conservatively high estimate of the area of the zone containing radioactive material, as was done in Section 2. In addition, remediation, if warranted, must be conducted throughout the entire zone containing radioactive material.

Cost of Remedial Action

The only practical remedial action to reduce the concentration of Pu-241 in soil to levels below 1,250 picocuries per gram is excavation and shipment of soil to a licensed disposal facility. The cost of soil remediation by this method tends to scale to volume. Indeed, the charge for the major component of the estimated soil remediation cost for the Parks site is assessed on a volume basis. However, the other important cost components, including soil excavation, sampling and analysis, packaging, and truck shipment, also scale to volume. Estimates of the cost of all of these items, developed in planning the Parks Facilities decommissioning, total approximately $70 per cubic foot. (No costs for building removal or slab demolition are included in these costs.) Over half of this cost is the fee for burial. Consequently, the minimum remediation cost per unit volume cannot be much less than estimated total cost of $70 per cubic foot.

To develop an estimate of cost comparable to the estimate of the value of dose savings per unit area, derived as described above, the volumetric cost must be converted to an areal cost. This is done by assuming a minimum practical excavation thickness for remedial action. For remediation of substantial areas, it seems likely that the minimum excavation thickness achievable using heavy equipment would be at least 6". Control of excavation to thinner zones with consistency would be impractical. (The distribution of Pu-241 with depth may exceed 6", which would require excavation to a depth greater than 6". This possibility is ignored in this analysis because the intent is to derive a conservatively low estimate of remedial action cost to balance against a conservatively high estimate of the value of dose savings.) Thus, the remedial action cost per unit area can be calculated using the volumetric unit cost of $70 per cubic foot and a minimum thickness of 6" in estimating the minimum soil volume remediated per unit area.

Analysis and Conclusions

ALARA analyses performed as described above are documented in Tables 1 and 2. calculated. The first analysis, in Table 1, incorporates the effect of discounting the value of dose savings at a rate of

3% per year. As noted above, this analysis is one of two recommended by NRC for long periods of interest. The value of the dose savings calculated in this way is $2 per square meter remediated below 1,250 picocuries per gram of Pu-241. The cost of remediation is $377 per square meter remediated. This analysis shows that the cost of remediation would exceed the value of dose savings by an extremely large margin, even though the simplifications in the analysis skew the results substantially in favor of the value of dose savings. By this analysis, reducing the Pu-241 concentration to a level below 1,250 picocuries per gram would clearly be unwarranted by the ALARA principle.
The analysis in Table 2 is identical to the analysis in Table 1, except that a value of $2,000 per person-rem is used. This constitutes an extremely conservative case that departs markedly from NRC guidance described above. This case effectively ignores discounting and treats the value of dose savings as though it would be realized immediately. This treatment effectively increases the value of dose savings to $59 per square meter remediated to a Pu-241 level lower than 1,250 picocuries per gram. However, even in this case, the cost, which remains at $377 per square meter remediated, far exceeds the value of the dose savings. The analysis shows that even in this extreme case, remediation below 1,250 picocuries per gram is unwarranted by the ALARA principle.

The analysis in Table 2 was conducted to derive an estimate of the value of the dose savings and the costs of remedial action at the time they occur, with no present value conversion. As noted above, this approach is the second of two approaches recommended in NRC guidance for evaluation of situations with long periods of interest. The cost of remedial action, for which the conservative low estimate is $377 per square meter remediated, would be incurred in one lump at the time of decommissioning. The undiscounted value of the dose savings, $59 per square meter remediated, would be realized at a uniform rate of $0.06 per square meter remediated in each year of the 1,000-year period of interest. This analysis also shows that the cost of remedial action would far exceed the value of dose savings.

This simplified but conservative ALARA assessment demonstrates that a limit of 1,250 pCi/g for Pu-241 in soil and other bulk material released for unrestricted use, which corresponds to a maximum calculated dose of approximately 30 millirem per year, is as low as reasonably achievable (ALARA) by a substantial margin. Any lower level would be achieved only at a cost that far exceeds the value of any resulting dose savings.

4.0 CONCLUSIONS

The conclusions from these assessments are as follows:

- A limit of 1,250 pCi/g for Pu-241 in soil and other bulk material released for unrestricted use would result in a calculated maximum annual dose to members of the public of about 31 millirem per year, well below the 10 CFR Part 20 limit of 100 millirem per year.
- This calculated dose is based on a screening dose assessment that incorporates conservative assumptions in the definition of exposure scenarios and in the selection of parameter values. The actual highest annual dose to members of the public would likely be lower that the dose calculated in this screening assessment.
- A limit of 1,250 pCi/g for Pu-241 in soil and other bulk material released for unrestricted use is as low as reasonably achievable (ALARA).
- A limit lower than 1,250 pCi/g for Pu-241 in soil and other bulk material released for

unrestricted use would be achieved only at a cost that would far exceed the value of any resulting dose savings.

5.0 REFERENCES

Kennedy, 1992. "Residual Radioactive Contamination from Decommissioning: Volume 1, Technical Basis for Translating Contamination Levels to Annual Total Effective Dose Equivalent," Kennedy, W. E. Jr., and Strenge, D. L., NUREG/CR-5512, Pacific Northwest Laboratory, September, 1992.

NRC, 1994. "Scenarios for Assessing Potential Doses Associated with Residual Radioactivity," Policy and Guidance Directive PG-8-08, Division of Waste Management, Office of Nuclear Material Safety and Safeguards, U.S. Nuclear Regulatory Commission, May, 1994.

NRC, 1995a. "Reassessment of NRC's Dollar Per Person-Rem Conversion Factor Policy," NUREG-1530, Office of Nuclear Regulatory Research, U.S. Nuclear Regulatory Commission, December, 1995.

NRC, 1995b. "Regulatory Analysis Guidelines of the U.S. Nuclear Regulatory Commission," NUREG/BR-0058 Revision 2, U.S. Nuclear Regulatory Commission, November, 1995.

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Yu, 1997. Personal communication from C. Yu, Argonne National Laboratory, February 18, 1997.

TABLE 1
ALARA ANALYSIS FOR PU-241 AT 1,250 PCI/G
$2,000 PER PERSON-REM, 3% PER YEAR DISCOUNTING

USER INPUT:	
PD, POPULATION DENSITY, persons/acre	4
D, CONSTANT DOSE RATE, mrem/y-person	30
T, TIME FOR AGGREGATION OF DOSE, years	1000
V, VALUE OF 1 PERSON-REM, $/person-rem	70
TH, THICKNESS OF ZONE TO BE REMEDIATED, ft	0.5
UC, REMEDIATION COST PER UNIT VOLUME, $/ft3	70
CALCULATED OUTPUT:	
B, BENEFIT OF DOSE SAVED PER M2 REMEDIATED, $	2
B=PD/4047*D/1000*T*V (Constants: 4047 m2/acre: 1000 mrem/rem)	
C, COST PER M2 REMEDIATED, $	377
C=3.28*3.28*TH*UC (Constant: 3.28 ft/m)	

C > B. No further remedial action is warranted.

Notes:

The value of $70 per person-rem used for V is the undiscounted value per person-rem that is equivalent to $2,000 per person-rem for a constant annual dose each year for 1,000 years, discounted to present value at a rate of 3% per year.

The asterisks in the equations for B and C indicate multiplication.

TABLE 2
ALARA ANALYSIS FOR PU-241 AT 1,250 PCI/G
$2,000 PER PERSON-REM, NO DISCOUNTING

USER INPUT:	
PD, POPULATION DENSITY, persons/acre	4
D, CONSTANT DOSE RATE, mrem/y-person	30
T, TIME FOR AGGREGATION OF DOSE, years	1000
V, VALUE OF 1 PERSON-REM, $/person-rem	2000
TH, THICKNESS OF ZONE TO BE REMEDIATED, ft	0.5
UC, REMEDIATION COST PER UNIT VOLUME, $/ft3	70
CALCULATED OUTPUT:	
B, BENEFIT OF DOSE SAVED PER M2 REMEDIATED, $	59
B=PD/4047*D/1000*T*V (Constants: 4047 m2/acre; 1000 mrem/rem)	
C, COST PER M2 REMEDIATED, $	377
C=3.28*3.28*TH*UC (Constant: 3.28 ft/m)	

C > B. No further remedial action is warranted.

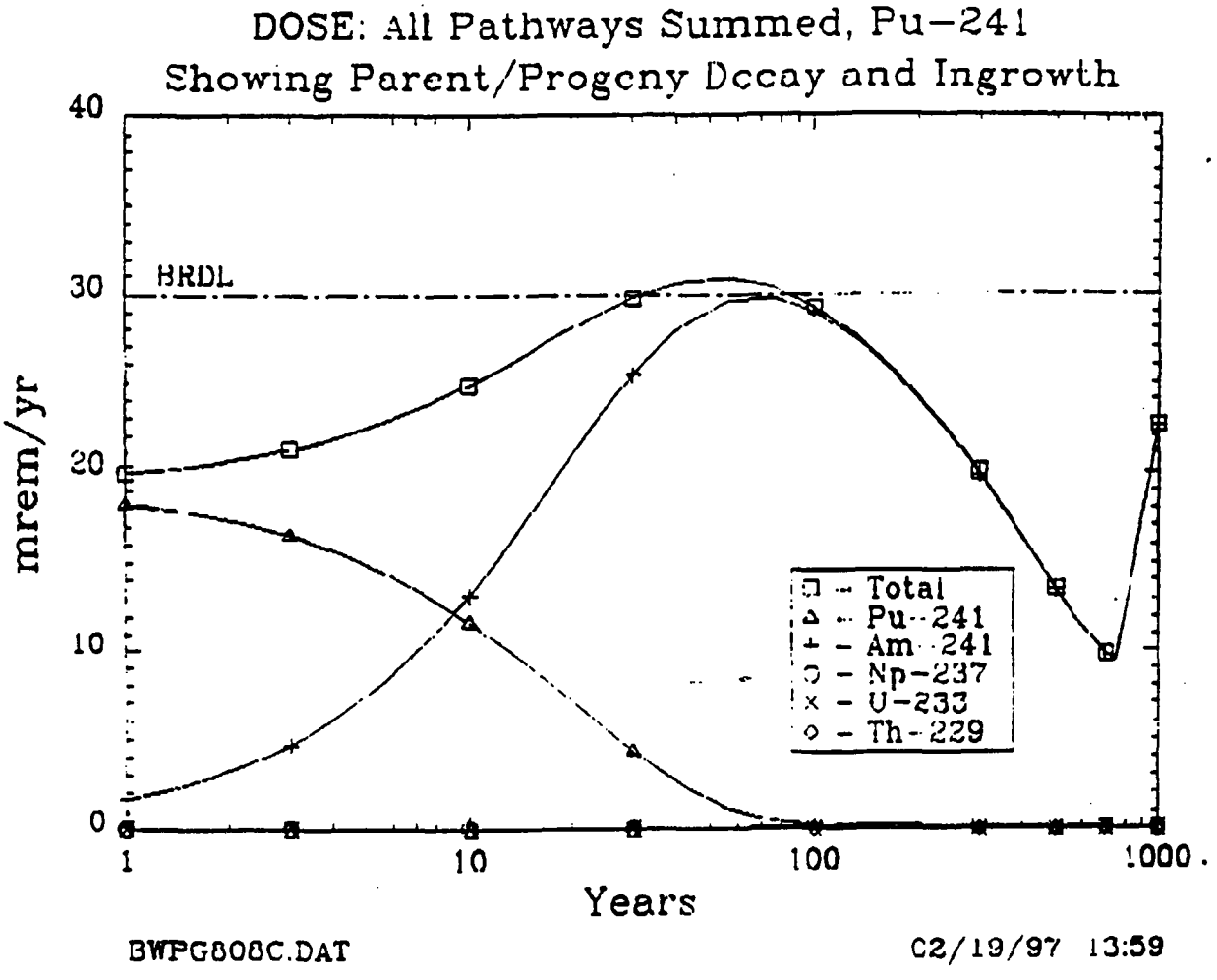
Notes:

The remediation cost of $377 per square meter remediated would be expended entirely at the very beginning of the 1,000-year period of interest. The total undiscounted benefit of $59 per square meter remediated would be realized at an approximately constant rate of $0.06 per year per square meter remediated for each year of the 1,000-year period of interest.

The asterisks in the equations for B and C indicate multiplication.

FIGURE 1

GRAPHICAL PRESENTATION OF RESRAD RESULTS



Summary : BW PG-8-08 SCENARIO C-RESIDENT FARMER-PU-241-SPECIAL Kd
File : BWPG808C.DAT

Table of Contents

Part I: Mixture Sums and Single Radionuclide Guidelines

Dose Conversion Factor (and Related) Parameter Summary
File: DOSFAC.BIN

0 Menu	Parameter	Current Value	Default	Parameter Name
B-1	Dose conversion factors for inhalation, mrem/pCi:			
B-1	Am-241	4.440E-01	4.440E-01	DCF2(1)
B-1	Np-237+D	5.400E-01	5.400E-01	DCF2(2)
B-1	Pu-241+D	8.250E-03	8.250E-03	DCF2(3)
B-1	Th-229+D	2.160E+00	2.160E+00	DCF2(5)
B-1	U-233	1.350E-01	1.350E-01	DCF2(6)
D-1	Dose conversion factors for ingestion, mrem/pCi:			
D-1	Am-241	3.640E-03	3.640E-03	DCF3(1)
D-1	Np-237+D	4.440E-03	4.440E-03	DCF3(2)
D-1	Pu-241+D	6.850E-05	6.850E-05	DCF3(3)
D-1	Th-229+D	4.030E-03	4.030E-03	DCF3(5)
D-1	U-233	2.890E-04	2.890E-04	DCF3(6)
D-34	Food transfer factors:			
D-34	Am-241 , plant/soil concentration ratio, dimensionless	1.000E-03	1.000E-03	RTF(1,1)
D-34	Am-241 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	5.000E-05	5.000E-05	RTF(1,2)
D-34	Am-241 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	2.000E-06	2.000E-06	RTF(1,3)
D-34				
D-34	Np-237+D , plant/soil concentration ratio, dimensionless	2.000E-02	2.000E-02	RTF(2,1)
D-34	Np-237+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-03	1.000E-03	RTF(2,2)
D-34	Np-237+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	5.000E-06	5.000E-06	RTF(2,3)
D-34				
D-34	Pu-241+D , plant/soil concentration ratio, dimensionless	1.000E-03	1.000E-03	RTF(3,1)
D-34	Pu-241+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-04	1.000E-04	RTF(3,2)
D-34	Pu-241+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	1.000E-06	1.000E-06	RTF(3,3)
D-34				
D-34	Th-229+D , plant/soil concentration ratio, dimensionless	1.000E-03	1.000E-03	RTF(5,1)
D-34	Th-229+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-04	1.000E-04	RTF(5,2)
D-34	Th-229+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	5.000E-06	5.000E-06	RTF(5,3)
D-34				
D-34	U-233 , plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF(6,1)
D-34	U-233 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	3.400E-04	3.400E-04	RTF(6,2)
D-34	U-233 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	6.000E-04	6.000E-04	RTF(6,3)
D-5	Bioaccumulation factors, fresh water, L/kg:			
D-5	Am-241 , fish	3.000E+01	3.000E+01	BIOFAC(1,1)
D-5	Am-241 , crustacea and mollusks	1.000E+03	1.000E+03	BIOFAC(1,2)
D-5				
D-5	Np-237+D , fish	3.000E+01	3.000E+01	BIOFAC(2,1)
D-5	Np-237+D , crustacea and mollusks	4.000E+02	4.000E+02	BIOFAC(2,2)
D-5				
D-5	Pu-241+D , fish	3.000E+01	3.000E+01	BIOFAC(3,1)
D-5	Pu-241+D , crustacea and mollusks	1.000E+02	1.000E+02	BIOFAC(3,2)
D-5				
D-5	Th-229+D , fish	1.000E+02	1.000E+02	BIOFAC(5,1)
D-5	Th-229+D , crustacea and mollusks	5.000E+02	5.000E+02	BIOFAC(5,2)
D-5				

Dose Conversion Factor (and Related) Parameter Summary (continued)
File: DOSFAC.BIN

0 Menu	Parameter	Current Value	Default	Parameter Name
D-5	U-233 , fish	1.000E+01	1.000E+01	BIOFAC(6,1)
D-5	U-233 , crustacea and mollusks	6.000E+01	6.000E+01	BIOFAC(6,2)

Site-Specific Parameter Summary

0 Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R011	Area of contaminated zone (m**2)	1.000E+04	1.000E+04	---	AREA
R011	Thickness of contaminated zone (m)	2.000E+00	2.000E+00	---	THICKO
R011	Length parallel to aquifer flow (m)	1.000E+02	1.000E+02	---	LCZPAQ
R011	Basic radiation dose limit (mrem/yr)	3.000E+01	3.000E+01	---	BRDL
R011	Time since placement of material (yr)	0.000E+00	0.000E+00	---	TI
R011	Times for calculations (yr)	1.000E+00	1.000E+00	---	T(2)
R011	Times for calculations (yr)	3.000E+00	3.000E+00	---	T(3)
R011	Times for calculations (yr)	1.000E+01	1.000E+01	---	T(4)
R011	Times for calculations (yr)	3.000E+01	3.000E+01	---	T(5)
R011	Times for calculations (yr)	1.000E+02	1.000E+02	---	T(6)
R011	Times for calculations (yr)	3.000E+02	3.000E+02	---	T(7)
R011	Times for calculations (yr)	5.000E+02	1.000E+03	---	T(8)
R011	Times for calculations (yr)	7.000E+02	0.000E+00	---	T(9)
R011	Times for calculations (yr)	1.000E+03	0.000E+00	---	T(10)
R012	Initial principal radionuclide (pCi/g): Pu-241	1.250E+03	0.000E+00	---	S1(3)
R012	Concentration in groundwater (pCi/L): Pu-241	not used	0.000E+00	---	W1(3)
R013	Cover depth (m)	0.000E+00	0.000E+00	---	COVERO
R013	Density of cover material (g/cm**3)	not used	1.500E+00	---	DENSCV
R013	Cover depth erosion rate (m/yr)	not used	1.000E-03	---	VCV
R013	Density of contaminated zone (g/cm**3)	1.630E+00	1.500E+00	---	DENSCZ
R013	Contaminated zone erosion rate (m/yr)	1.000E-03	1.000E-03	---	VCZ
R013	Contaminated zone total porosity	3.000E-01	4.000E-01	---	TPCZ
R013	Contaminated zone effective porosity	2.000E-01	2.000E-01	---	EPCZ
R013	Contaminated zone hydraulic conductivity (m/yr)	1.000E+01	1.000E+01	---	HCCZ
R013	Contaminated zone b parameter	5.300E+00	5.300E+00	---	BCZ
R013	Humidity in air (g/cm**3)	not used	8.000E+00	---	HUMID
R013	Evapotranspiration coefficient	5.000E-01	5.000E-01	---	EVAPTR
R013	Precipitation (m/yr)	1.000E+00	1.000E+00	---	PRECIP
R013	Irrigation (m/yr)	7.600E-01	2.000E-01	---	RI
R013	Irrigation mode	overhead	overhead	---	IDITCH
R013	Runoff coefficient	2.000E-01	2.000E-01	---	RUNOFF
R013	Watershed area for nearby stream or pond (m**2)	1.000E+06	1.000E+06	---	WAREA
R013	Accuracy for water/soil computations	1.000E-03	1.000E-03	---	EPS
R014	Density of saturated zone (g/cm**3)	1.630E+00	1.500E+00	---	DENSAQ
R014	Saturated zone total porosity	3.000E-01	4.000E-01	---	TPSZ
R014	Saturated zone effective porosity	2.000E-01	2.000E-01	---	EPSZ
R014	Saturated zone hydraulic conductivity (m/yr)	1.000E+02	1.000E+02	---	HCSZ
R014	Saturated zone hydraulic gradient	2.000E-02	2.000E-02	---	HGWT
R014	Saturated zone b parameter	5.300E+00	5.300E+00	---	BSZ
R014	Water table drop rate (m/yr)	0.000E+00	1.000E-03	---	VWT
R014	Well pump intake depth (m below water table)	1.000E+01	1.000E+01	---	DWIBWT
R014	Model: Nondispersion (ND) or Mass-Balance (MB)	ND	ND	---	MODEL
R014	Well pumping rate (m**3/yr)	2.500E+02	2.500E+02	---	UW
R015	Number of unsaturated zone strata	1	1	---	NS

Site-Specific Parameter Summary (continued)

0 Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R015	Unsat. zone 1, thickness (m)	1.000E+00	4.000E+00	---	H(1)
R015	Unsat. zone 1, soil density (g/cm**3)	1.500E+00	1.500E+00	---	DENSUZ(1)
R015	Unsat. zone 1, total porosity	3.000E-01	4.000E-01	---	TPUZ(1)
R015	Unsat. zone 1, effective porosity	2.000E-01	2.000E-01	---	EPUZ(1)
R015	Unsat. zone 1, soil-specific b parameter	5.300E+00	5.300E+00	---	BUZ(1)
R015	Unsat. zone 1, hydraulic conductivity (m/yr)	1.000E+01	1.000E+01	---	HCUZ(1)
R016	Distribution coefficients for Pu-241				
R016	Contaminated zone (cm**3/g)	1.700E+02	2.000E+03	---	DCNUCC(3)
R016	Unsaturated zone 1 (cm**3/g)	1.700E+02	2.000E+03	---	DCNUCU(3,1)
R016	Saturated zone (cm**3/g)	6.600E+00	2.000E+03	---	DCNUCS(3)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.406E-03	ALEACH(3)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(3)
R016	Distribution coefficients for daughter Am-241				
R016	Contaminated zone (cm**3/g)	7.000E+02	2.000E+01	---	DCNUCC(1)
R016	Unsaturated zone 1 (cm**3/g)	7.000E+02	2.000E+01	---	DCNUCU(1,1)
R016	Saturated zone (cm**3/g)	2.700E+01	2.000E+01	---	DCNUCS(1)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	3.417E-04	ALEACH(1)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(1)
R016	Distribution coefficients for daughter Np-237				
R016	Contaminated zone (cm**3/g)	1.000E+01	-1.000E+00	---	DCNUCC(2)
R016	Unsaturated zone 1 (cm**3/g)	1.000E+01	-1.000E+00	---	DCNUCU(2,1)
R016	Saturated zone (cm**3/g)	3.800E-01	-1.000E+00	---	DCNUCS(2)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	2.357E-02	ALEACH(2)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(2)
R016	Distribution coefficients for daughter Th-229				
R016	Contaminated zone (cm**3/g)	6.000E+04	6.000E+04	---	DCNUCC(5)
R016	Unsaturated zone 1 (cm**3/g)	6.000E+04	6.000E+04	---	DCNUCU(5,1)
R016	Saturated zone (cm**3/g)	2.300E+03	6.000E+04	---	DCNUCS(5)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	3.988E-06	ALEACH(5)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(5)
R016	Distribution coefficients for daughter U-233				
R016	Contaminated zone (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCC(6)
R016	Unsaturated zone 1 (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCU(6,1)
R016	Saturated zone (cm**3/g)	1.900E+00	5.000E+01	---	DCNUCS(6)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	4.771E-03	ALEACH(6)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(6)
R017	Inhalation rate (m**3/yr)	1.051E+04	8.400E+03	---	INHALR
R017	Mass loading for inhalation (g/m**3)	2.000E-04	2.000E-04	---	MLINH
R017	Dilution length for airborne dust, inhalation (m)	3.000E+00	3.000E+00	---	LM
R017	Exposure duration	3.000E+01	3.000E+01	---	ED
R017	Shielding factor, inhalation	5.000E-01	4.000E-01	---	SHF3
R017	Shielding factor, external gamma	6.700E-01	7.000E-01	---	SHF1
R017	Fraction of time spent indoors	5.500E-01	5.000E-01	---	FIND
R017	Fraction of time spent outdoors (on site)	2.100E-01	2.500E-01	---	FOTD

Site-Specific Parameter Summary (continued)

0 Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R017	Shape factor flag, external gamma	1.000E+00	1.000E+00	1 shows circular AREA.	FS
R017	Radii of shape factor array (used if FS = -1):				
R017	Outer annular radius (m), ring 1:	not used	5.000E+01	---	RAD_SHAPE(1)
R017	Outer annular radius (m), ring 2:	not used	7.071E+01	---	RAD_SHAPE(2)
R017	Outer annular radius (m), ring 3:	not used	0.000E+00	---	RAD_SHAPE(3)
R017	Outer annular radius (m), ring 4:	not used	0.000E+00	---	RAD_SHAPE(4)
R017	Outer annular radius (m), ring 5:	not used	0.000E+00	---	RAD_SHAPE(5)
R017	Outer annular radius (m), ring 6:	not used	0.000E+00	---	RAD_SHAPE(6)
R017	Outer annular radius (m), ring 7:	not used	0.000E+00	---	RAD_SHAPE(7)
R017	Outer annular radius (m), ring 8:	not used	0.000E+00	---	RAD_SHAPE(8)
R017	Outer annular radius (m), ring 9:	not used	0.000E+00	---	RAD_SHAPE(9)
R017	Outer annular radius (m), ring 10:	not used	0.000E+00	---	RAD_SHAPE(10)
R017	Outer annular radius (m), ring 11:	not used	0.000E+00	---	RAD_SHAPE(11)
R017	Outer annular radius (m), ring 12:	not used	0.000E+00	---	RAD_SHAPE(12)
R017	Fractions of annular areas within AREA:				
R017	Ring 1	not used	1.000E+00	---	FRACA(1)
R017	Ring 2	not used	2.732E-01	---	FRACA(2)
R017	Ring 3	not used	0.000E+00	---	FRACA(3)
R017	Ring 4	not used	0.000E+00	---	FRACA(4)
R017	Ring 5	not used	0.000E+00	---	FRACA(5)
R017	Ring 6	not used	0.000E+00	---	FRACA(6)
R017	Ring 7	not used	0.000E+00	---	FRACA(7)
R017	Ring 8	not used	0.000E+00	---	FRACA(8)
R017	Ring 9	not used	0.000E+00	---	FRACA(9)
R017	Ring 10	not used	0.000E+00	---	FRACA(10)
R017	Ring 11	not used	0.000E+00	---	FRACA(11)
R017	Ring 12	not used	0.000E+00	---	FRACA(12)
R018	Fruits, vegetables and grain consumption (kg/yr)	1.660E+02	1.600E+02	---	DIET(1)
R018	Leafy vegetable consumption (kg/yr)	1.100E+01	1.400E+01	---	DIET(2)
R018	Milk consumption (L/yr)	1.000E+02	9.200E+01	---	DIET(3)
R018	Meat and poultry consumption (kg/yr)	6.300E+01	6.300E+01	---	DIET(4)
R018	Fish consumption (kg/yr)	5.400E+00	5.400E+00	---	DIET(5)
R018	Other seafood consumption (kg/yr)	9.000E-01	9.000E-01	---	DIET(6)
R018	Soil ingestion rate (g/yr)	1.825E+01	3.650E+01	---	SOIL
R018	Drinking water intake (L/yr)	7.300E+02	5.100E+02	---	DWI
R018	Contamination fraction of drinking water	1.000E+00	1.000E+00	---	FDW
R018	Contamination fraction of household water	not used	1.000E+00	---	FHHW
R018	Contamination fraction of livestock water	1.000E+00	1.000E+00	---	FLW
R018	Contamination fraction of irrigation water	1.000E+00	1.000E+00	---	FIRW
R018	Contamination fraction of aquatic food	5.000E-01	5.000E-01	---	FR9
R018	Contamination fraction of plant food	-1	-1	0.500E+00	FPLANT
R018	Contamination fraction of meat	-1	-1	0.500E+00	FMEAT
R018	Contamination fraction of milk	-1	-1	0.500E+00	FMILK
R019	Livestock fodder intake for meat (kg/day)	6.800E+01	6.800E+01	---	LFI5
R019	Livestock fodder intake for milk (kg/day)	5.500E+01	5.500E+01	---	LFI6
R019	Livestock water intake for meat (L/day)	5.000E+01	5.000E+01	---	LWI5
R019	Livestock water intake for milk (L/day)	1.600E+02	1.600E+02	---	LWI6

Site-Specific Parameter Summary (continued)

0 Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R019	Livestock soil intake (kg/day)	5.000E-01	5.000E-01	---	LSI
R019	Mass loading for foliar deposition (g/m**3)	1.000E-04	1.000E-04	---	MLFD
R019	Depth of soil mixing layer (m)	1.500E-01	1.500E-01	---	DH
R019	Depth of roots (m)	9.000E-01	9.000E-01	---	DROOT
R019	Drinking water fraction from ground water	1.000E+00	1.000E+00	---	FGWDW
R019	Household water fraction from ground water	1.000E+00	1.000E+00	---	FGWHH
R019	Livestock water fraction from ground water	not used	1.000E+00	---	FGWLW
R019	Irrigation fraction from ground water	1.000E+00	1.000E+00	---	FGWIR
C14	C-12 concentration in water (g/cm**3)	not used	2.000E-05	---	C12WTR
C14	C-12 concentration in contaminated soil (g/g)	not used	3.000E-02	---	C12CZ
C14	Fraction of vegetation carbon from soil	not used	2.000E-02	---	CSOIL
C14	Fraction of vegetation carbon from air	not used	9.800E-01	---	CAIR
C14	C-14 evasion layer thickness in soil (m)	not used	3.000E-01	---	DMC
C14	C-14 evasion flux rate from soil (1/sec)	not used	7.000E-07	---	EVSN
C14	C-12 evasion flux rate from soil (1/sec)	not used	1.000E-10	---	REVSN
C14	Fraction of grain in beef cattle feed	not used	8.000E-01	---	AVFG4
C14	Fraction of grain in milk cow feed	not used	2.000E-01	---	AVFG5
STOR	Storage times of contaminated foodstuffs (days):				
STOR	Fruits, non-leafy vegetables, and grain	1.400E+01	1.400E+01	---	STOR_T(1)
STOR	Leafy vegetables	1.000E+00	1.000E+00	---	STOR_T(2)
STOR	Milk	1.000E+00	1.000E+00	---	STOR_T(3)
STOR	Meat and poultry	2.000E+01	2.000E+01	---	STOR_T(4)
STOR	Fish	7.000E+00	7.000E+00	---	STOR_T(5)
STOR	Crustacea and mollusks	7.000E+00	7.000E+00	---	STOR_T(6)
STOR	Well water	1.000E+00	1.000E+00	---	STOR_T(7)
STOR	Surface water	1.000E+00	1.000E+00	---	STOR_T(8)
STOR	Livestock fodder	4.500E+01	4.500E+01	---	STOR_T(9)
R021	Thickness of building foundation (m)	not used	1.500E-01	---	FLOOR
R021	Bulk density of building foundation (g/cm**3)	not used	2.400E+00	---	DENSFL
R021	Total porosity of the cover material	not used	4.000E-01	---	TPCV
R021	Total porosity of the building foundation	not used	1.000E-01	---	TPFL
R021	Volumetric water content of the cover material	not used	5.000E-02	---	PH2OCV
R021	Volumetric water content of the foundation	not used	3.000E-02	---	PH2OFL
R021	Diffusion coefficient for radon gas (m/sec):				
R021	in cover material	not used	2.000E-06	---	DIFCV
R021	in foundation material	not used	3.000E-07	---	DIFFL
R021	in contaminated zone soil	not used	2.000E-06	---	DIFCZ
R021	Radon vertical dimension of mixing (m)	not used	2.000E+00	---	HMIX
R021	Average annual wind speed (m/sec)	not used	2.000E+00	---	WIND
R021	Average building air exchange rate (1/hr)	not used	5.000E-01	---	REXG
R021	Height of the building (room) (m)	not used	2.500E+00	---	HRM
R021	Building interior area factor	not used	0.000E+00	---	FAI
R021	Building depth below ground surface (m)	not used	-1.000E+00	---	DMFL
R021	Emanating power of Rn-222 gas	not used	2.500E-01	---	EMANA(1)
R021	Emanating power of Rn-220 gas	not used	1.500E-01	---	EMANA(2)

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	active
7 -- drinking water	active
8 -- soil ingestion	active
9 -- radon	suppressed

Contaminated Zone Dimensions		Initial Soil Concentrations, pCi/g	
Area:	10000.00 square meters	Pu-241	1.250E+03
Thickness:	2.00 meters		
Cover Depth:	0.00 meters		

0

Total Dose TDOSE(t), mrem/yr
Basic Radiation Dose Limit = 30 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	5.000E+02	7.000E+02	1.000E+03
TDOSE(t):	1.918E+01	1.992E+01	2.124E+01	2.487E+01	2.980E+01	2.924E+01	1.993E+01	1.355E+01	9.766E+00	2.259E+01
M(t):	6.393E-01	6.640E-01	7.081E-01	8.292E-01	9.933E-01	9.748E-01	6.645E-01	4.515E-01	3.255E-01	7.532E-01

0Maximum TDOSE(t): 3.090E+01 mrem/yr at t = 52.51 ± 0.05 years

0

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 52.51 years

0
0 Water Independent Pathways (Inhalation excludes radon)

Radio-Nuclide	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.
Pu-241	8.574E-01	0.0278	1.610E+01	0.5210	0.000E+00	0.0000	1.189E+01	0.3847	1.255E-01	0.0041	7.248E-03	0.0002	1.850E+00	0.0599
Total	8.574E-01	0.0278	1.610E+01	0.5210	0.000E+00	0.0000	1.189E+01	0.3847	1.255E-01	0.0041	7.248E-03	0.0002	1.850E+00	0.0599

0

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 52.51 years

0
0 Water Dependent Pathways

Radio-Nuclide	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Pu-241	6.014E-02	0.0019	2.150E-04	0.0000	0.000E+00	0.0000	1.188E-02	0.0004	1.347E-03	0.0000	1.111E-05	0.0000	3.090E+01	1.0000
Total	6.014E-02	0.0019	2.150E-04	0.0000	0.000E+00	0.0000	1.188E-02	0.0004	1.347E-03	0.0000	1.111E-05	0.0000	3.090E+01	1.0000

0*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 = 0.000E+00 years
Water Independent Pathways (Inhalation excludes radon)

Radio-Nuclide	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.
Pu-241	1.308E-02	0.0007	1.021E+01	0.5322	0.000E+00	0.0000	7.614E+00	0.3970	1.532E-01	0.0080	2.381E-03	0.0001	1.188E+00	0.0619
Total	1.308E-02	0.0007	1.021E+01	0.5322	0.000E+00	0.0000	7.614E+00	0.3970	1.532E-01	0.0080	2.381E-03	0.0001	1.188E+00	0.0619

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

Radio-Nuclide	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Pu-241	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	1.918E+01	1.0000
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	1.918E+01	1.0000

*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)

Radio-Nuclide	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.
Pu-241	6.038E-02	0.0030	1.057E+01	0.5308	0.000E+00	0.0000	7.902E+00	0.3967	1.529E-01	0.0077	2.667E-03	0.0001	1.229E+00	0.0617
Total	6.038E-02	0.0030	1.057E+01	0.5308	0.000E+00	0.0000	7.902E+00	0.3967	1.529E-01	0.0077	2.667E-03	0.0001	1.229E+00	0.0617

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

Radio-Nuclide	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Pu-241	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	1.992E+01	1.0000
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	1.992E+01	1.0000

*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)

Radio-Nuclide	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.
Pu-241	1.480E-01	0.0070	1.125E+01	0.5294	0.000E+00	0.0000	8.389E+00	0.3949	1.509E-01	0.0071	3.186E-03	0.0001	1.305E+00	0.0614
Total	1.480E-01	0.0070	1.125E+01	0.5294	0.000E+00	0.0000	8.389E+00	0.3949	1.509E-01	0.0071	3.186E-03	0.0001	1.305E+00	0.0614

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

Radio-Nuclide	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Pu-241	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	2.124E+01	1.0000
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	2.124E+01	1.0000

*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)

Radio-Nuclide	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.
Pu-241	3.918E-01	0.0157	1.309E+01	0.5264	0.000E+00	0.0000	9.726E+00	0.3910	1.450E-01	0.0058	4.623E-03	0.0002	1.513E+00	0.0608
Total	3.918E-01	0.0157	1.309E+01	0.5264	0.000E+00	0.0000	9.726E+00	0.3910	1.450E-01	0.0058	4.623E-03	0.0002	1.513E+00	0.0608

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

Radio-Nuclide	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Pu-241	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	2.487E+01	1.0000
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	2.487E+01	1.0000

*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+01 years
Water Independent Pathways (Inhalation excludes radon)

Radio-Nuclide	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.
Pu-241	7.440E-01	0.0250	1.558E+01	0.5229	0.000E+00	0.0000	1.152E+01	0.3867	1.335E-01	0.0045	6.658E-03	0.0002	1.793E+00	0.0602
Total	7.440E-01	0.0250	1.558E+01	0.5229	0.000E+00	0.0000	1.152E+01	0.3867	1.335E-01	0.0045	6.658E-03	0.0002	1.793E+00	0.0602

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

Radio-Nuclide	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Pu-241	1.393E-02	0.0005	4.982E-05	0.0000	0.000E+00	0.0000	2.753E-03	0.0001	3.120E-04	0.0000	2.574E-06	0.0000	2.980E+01	1.0000
Total	1.393E-02	0.0005	4.982E-05	0.0000	0.000E+00	0.0000	2.753E-03	0.0001	3.120E-04	0.0000	2.574E-06	0.0000	2.980E+01	1.0000

*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+02 years
Water Independent Pathways (inhalation excludes radon)

Radio-Nuclide	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.
Pu-241	8.437E-01	0.0289	1.518E+01	0.5191	0.000E+00	0.0000	1.120E+01	0.3831	1.135E-01	0.0039	6.981E-03	0.0002	1.744E+00	0.0596
Total	8.437E-01	0.0289	1.518E+01	0.5191	0.000E+00	0.0000	1.120E+01	0.3831	1.135E-01	0.0039	6.981E-03	0.0002	1.744E+00	0.0596

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

Radio-Nuclide	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Pu-241	1.254E-01	0.0043	4.485E-04	0.0000	0.000E+00	0.0000	2.478E-02	0.0008	2.809E-03	0.0001	2.318E-05	0.0000	2.924E+01	1.0000
Total	1.254E-01	0.0043	4.485E-04	0.0000	0.000E+00	0.0000	2.478E-02	0.0008	2.809E-03	0.0001	2.318E-05	0.0000	2.924E+01	1.0000

*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)

Radio-Nuclide	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.
Pu-241	5.766E-01	0.0289	1.033E+01	0.5180	0.000E+00	0.0000	7.621E+00	0.3823	7.685E-02	0.0039	4.760E-03	0.0002	1.186E+00	0.0595
Total	5.766E-01	0.0289	1.033E+01	0.5180	0.000E+00	0.0000	7.621E+00	0.3823	7.685E-02	0.0039	4.760E-03	0.0002	1.186E+00	0.0595

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

Radio-Nuclide	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Pu-241	1.169E-01	0.0059	4.259E-04	0.0000	0.000E+00	0.0000	2.309E-02	0.0012	2.567E-03	0.0001	2.135E-05	0.0000	1.993E+01	1.0000
Total	1.169E-01	0.0059	4.259E-04	0.0000	0.000E+00	0.0000	2.309E-02	0.0012	2.567E-03	0.0001	2.135E-05	0.0000	1.993E+01	1.0000

*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 = 5.000E+02 years
Water Independent Pathways (Inhalation excludes radon)

Radio-Nuclide	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.
Pu-241	3.908E-01	0.0288	6.997E+00	0.5166	0.000E+00	0.0000	5.164E+00	0.3812	5.208E-02	0.0038	3.226E-03	0.0002	8.039E-01	0.0593
Total	3.908E-01	0.0288	6.997E+00	0.5166	0.000E+00	0.0000	5.164E+00	0.3812	5.208E-02	0.0038	3.226E-03	0.0002	8.039E-01	0.0593

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 5.000E+02 years
Water Dependent Pathways

Radio-Nuclide	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Pu-241	1.103E-01	0.0081	5.218E-04	0.0000	0.000E+00	0.0000	2.176E-02	0.0016	1.738E-03	0.0001	1.659E-05	0.0000	1.355E+01	1.0000
Total	1.103E-01	0.0081	5.218E-04	0.0000	0.000E+00	0.0000	2.176E-02	0.0016	1.738E-03	0.0001	1.659E-05	0.0000	1.355E+01	1.0000

*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 = 7.000E+02 years
Water Independent Pathways (Inhalation excludes radon)

Radio-Nuclide	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.
Pu-241	2.648E-01	0.0271	4.742E+00	0.4856	0.000E+00	0.0000	3.500E+00	0.3584	3.529E-02	0.0036	2.186E-03	0.0002	5.448E-01	0.0558
Total	2.648E-01	0.0271	4.742E+00	0.4856	0.000E+00	0.0000	3.500E+00	0.3584	3.529E-02	0.0036	2.186E-03	0.0002	5.448E-01	0.0558

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 7.000E+02 years
Water Dependent Pathways

Radio-Nuclide	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Pu-241	5.610E-01	0.0574	3.896E-03	0.0004	0.000E+00	0.0000	1.103E-01	0.0113	1.689E-03	0.0002	4.697E-05	0.0000	9.766E+00	1.0000
Total	5.610E-01	0.0574	3.896E-03	0.0004	0.000E+00	0.0000	1.103E-01	0.0113	1.689E-03	0.0002	4.697E-05	0.0000	9.766E+00	1.0000

*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+03 years
Water Independent Pathways (Inhalation excludes radon)

Radio-Nuclide	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.
Pu-241	1.477E-01	0.0065	2.645E+00	0.1171	0.000E+00	0.0000	1.952E+00	0.0864	1.969E-02	0.0009	1.220E-03	0.0001	3.039E-01	0.0135
Total	1.477E-01	0.0065	2.645E+00	0.1171	0.000E+00	0.0000	1.952E+00	0.0864	1.969E-02	0.0009	1.220E-03	0.0001	3.039E-01	0.0135

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

Radio-Nuclide	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Pu-241	1.454E+01	0.6436	1.057E-01	0.0047	0.000E+00	0.0000	2.859E+00	0.1265	1.681E-02	0.0007	1.077E-03	0.0000	2.259E+01	1.0000
Total	1.454E+01	0.6436	1.057E-01	0.0047	0.000E+00	0.0000	2.859E+00	0.1265	1.681E-02	0.0007	1.077E-03	0.0000	2.259E+01	1.0000

*Sum of all water independent and dependent pathways.

Dose/Source Ratios Summed Over All Pathways
Parent and Progeny Principal Radionuclide Contributions Indicated
DSR(j,t) (mrem/yr)/(pCi/g)

OParent (i)	Product (j)	Branch Fraction	t= 0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	5.000E+02	7.000E+02	1.000E+03
Pu-241	Pu-241	1.000E+00	1.534E-02	1.460E-02	1.322E-02	9.348E-03	3.471E-03	1.082E-04	1.567E-07	8.177E-12	3.623E-16	1.037E-22
Pu-241	Am-241	1.000E+00	0.000E+00	1.335E-03	3.771E-03	1.055E-02	2.035E-02	2.316E-02	1.583E-02	1.076E-02	7.763E-03	1.805E-02
Pu-241	Np-237	1.000E+00	0.000E+00	2.370E-09	2.025E-08	1.895E-07	1.469E-05	1.259E-04	1.147E-04	7.609E-05	5.003E-05	2.563E-05
Pu-241	U-233	1.000E+00	0.000E+00	1.014E-16	2.224E-15	6.727E-14	9.756E-12	5.256E-10	1.542E-09	1.359E-09	9.555E-10	4.697E-10
Pu-241	Th-229	1.000E+00	0.000E+00	3.026E-20	2.408E-18	2.636E-16	1.812E-14	8.213E-13	1.101E-11	2.485E-11	3.668E-11	4.856E-11
Pu-241	ΣDSR(j)		1.534E-02	1.594E-02	1.699E-02	1.990E-02	2.384E-02	2.339E-02	1.595E-02	1.084E-02	7.813E-03	1.808E-02
OPu-241	Pu-241	2.450E-05	3.759E-07	3.577E-07	3.240E-07	2.290E-07	8.503E-08	2.652E-09	3.839E-12	2.003E-16	8.877E-21	2.541E-27
Pu-241	Np-237	2.450E-05	0.000E+00	7.145E-11	1.990E-10	5.148E-10	2.718E-08	1.486E-08	1.325E-10	1.053E-12	8.232E-15	5.442E-18
Pu-241	U-233	2.450E-05	0.000E+00	4.260E-18	3.234E-17	2.875E-16	2.181E-14	1.777E-13	6.805E-14	2.331E-14	7.873E-15	1.486E-15
Pu-241	Th-229	2.450E-05	0.000E+00	1.841E-21	4.782E-20	1.554E-18	2.964E-17	3.804E-16	1.364E-15	1.752E-15	1.879E-15	1.898E-15
Pu-241	ΣDSR(j)		3.759E-07	3.578E-07	3.242E-07	2.295E-07	1.122E-07	1.751E-08	1.364E-10	1.079E-12	1.798E-14	3.390E-15

Branch Fraction is the cumulative factor for the j'th principal radionuclide daughter: CUMBRF(j) = BRF(1)*BRF(2)* ... BRF(j).
The DSR includes contributions from associated (half-life ≤ 0.5 yr) daughters.

0

Single Radionuclide Soil Guidelines G(i,t) in pCi/g
Basic Radiation Dose Limit = 30 mrem/yr

ONuclide (i)	t= 0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	5.000E+02	7.000E+02	1.000E+03
Pu-241	1.955E+03	1.883E+03	1.765E+03	1.508E+03	1.258E+03	1.282E+03	1.881E+03	2.768E+03	3.840E+03	1.660E+03

0

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 = 52.51 ± 0.05 years

ONuclide (i)	Initial pCi/g	tmin (years)	DSR(i,tmin)	G(i,tmin) (pCi/g)	DSR(i,tmax)	G(i,tmax) (pCi/g)
Pu-241	1.250E+03	52.56 ± 0.05	2.472E-02	1.214E+03	2.472E-02	1.214E+03

Individual Nuclide Dose Summed Over All Pathways
Parent Nuclide and Branch Fraction Indicated
DOSE(j,t), mrem/yr

ONuclide (j)	Parent (i)	BRF(i)	t= 0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	5.000E+02	7.000E+02	1.000E+03
Pu-241	Pu-241	1.000E+00	1.918E+01	1.825E+01	1.653E+01	1.168E+01	4.338E+00	1.353E-01	1.959E-04	1.022E-08	4.529E-13	1.297E-19
Pu-241	Pu-241	2.450E-05	4.698E-04	4.471E-04	4.050E-04	2.863E-04	1.063E-04	3.314E-06	4.799E-09	2.504E-13	1.110E-17	3.175E-24
Pu-241	ΣDOSE(j):		1.918E+01	1.825E+01	1.653E+01	1.169E+01	4.338E+00	1.353E-01	1.959E-04	1.022E-08	4.529E-13	1.297E-19
OAm-241	Pu-241	1.000E+00	0.000E+00	1.669E+00	4.713E+00	1.319E+01	2.544E+01	2.895E+01	1.979E+01	1.345E+01	9.703E+00	2.256E+01
ONp-237	Pu-241	1.000E+00	0.000E+00	2.962E-06	2.531E-05	2.369E-04	1.836E-02	1.574E-01	1.434E-01	9.511E-02	6.254E-02	3.204E-02
Np-237	Pu-241	2.450E-05	0.000E+00	8.931E-08	2.488E-07	6.435E-07	3.397E-05	1.857E-05	1.656E-07	1.317E-09	1.029E-11	6.802E-15
Np-237	ΣDOSE(j):		0.000E+00	3.051E-06	2.556E-05	2.375E-04	1.839E-02	1.574E-01	1.434E-01	9.511E-02	6.254E-02	3.204E-02
OU-233	Pu-241	1.000E+00	0.000E+00	1.268E-13	2.780E-12	8.409E-11	1.220E-08	6.570E-07	1.927E-06	1.698E-06	1.194E-06	5.871E-07
U-233	Pu-241	2.450E-05	0.000E+00	5.325E-15	4.042E-14	3.594E-13	2.726E-11	2.221E-10	8.506E-11	2.914E-11	9.841E-12	1.858E-12
U-233	ΣDOSE(j):		0.000E+00	1.321E-13	2.821E-12	8.445E-11	1.222E-08	6.572E-07	1.927E-06	1.698E-06	1.194E-06	5.871E-07
OTh-229	Pu-241	1.000E+00	0.000E+00	3.782E-17	3.010E-15	3.295E-13	2.264E-11	1.027E-09	1.376E-08	3.106E-08	4.584E-08	6.070E-08
Th-229	Pu-241	2.450E-05	0.000E+00	2.301E-18	5.977E-17	1.943E-15	3.705E-14	4.755E-13	1.706E-12	2.190E-12	2.349E-12	2.373E-12
Th-229	ΣDOSE(j):		0.000E+00	4.012E-17	3.070E-15	3.314E-13	2.268E-11	1.027E-09	1.376E-08	3.106E-08	4.585E-08	6.070E-08

BRF(i) is the branch fraction of the parent nuclide.

Individual Nuclide Soil Concentration
Parent Nuclide and Branch Fraction Indicated
S(j,t), pCi/g

ONuclide (j)	Parent (i)	BRF(i)	t= 0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	5.000E+02	7.000E+02	1.000E+03
Pu-241	Pu-241	1.000E+00	1.250E+03	1.190E+03	1.077E+03	7.616E+02	2.828E+02	8.817E+00	4.388E-04	2.183E-08	1.086E-12	3.814E-19
Pu-241	Pu-241	2.450E-05	3.062E-02	2.914E-02	2.640E-02	1.866E-02	6.928E-03	2.160E-04	1.075E-08	5.349E-13	2.662E-17	9.344E-24
Pu-241	ΣS(j):		1.250E+03	1.190E+03	1.077E+03	7.616E+02	2.828E+02	8.818E+00	4.388E-04	2.183E-08	1.086E-12	3.814E-19
OAm-241	Pu-241	1.000E+00	0.000E+00	1.954E+00	5.572E+00	1.564E+01	3.020E+01	3.437E+01	2.350E+01	1.592E+01	1.079E+01	6.019E+00
ONp-237	Pu-241	1.000E+00	0.000E+00	3.166E-07	2.712E-06	2.540E-05	1.439E-04	4.136E-04	3.510E-04	2.385E-04	1.616E-04	9.017E-05
Np-237	Pu-241	2.450E-05	0.000E+00	9.564E-09	2.667E-08	6.902E-08	1.019E-07	3.348E-08	3.245E-10	2.913E-12	2.615E-14	2.223E-17
Np-237	ΣS(j):		0.000E+00	3.262E-07	2.738E-06	2.547E-05	1.440E-04	4.136E-04	3.510E-04	2.385E-04	1.616E-04	9.017E-05
OU-233	Pu-241	1.000E+00	0.000E+00	4.639E-13	1.204E-11	3.890E-10	7.244E-09	8.789E-08	2.595E-07	2.591E-07	2.077E-07	1.293E-07
U-233	Pu-241	2.450E-05	0.000E+00	2.113E-14	1.806E-13	1.680E-12	9.299E-12	2.383E-11	1.223E-11	4.736E-12	1.823E-12	4.351E-13
U-233	ΣS(j):		0.000E+00	4.851E-13	1.222E-11	3.907E-10	7.253E-09	8.791E-08	2.595E-07	2.591E-07	2.077E-07	1.293E-07
OTh-229	Pu-241	1.000E+00	0.000E+00	1.100E-17	8.629E-16	9.550E-14	5.745E-12	2.895E-10	3.911E-09	8.833E-09	1.305E-08	1.732E-08
Th-229	Pu-241	2.450E-05	0.000E+00	6.696E-19	1.739E-17	5.639E-16	1.061E-14	1.350E-13	4.847E-13	6.230E-13	6.678E-13	6.753E-13
Th-229	ΣS(j):		0.000E+00	1.167E-17	8.802E-16	9.606E-14	5.756E-12	2.897E-10	3.911E-09	8.834E-09	1.305E-08	1.732E-08

BRF(i) is the branch fraction of the parent nuclide.

APPENDIX C

RADIOLOGICAL ANALYSES SUPPORTING DECOMMISSIONING ACTIVITIES

Analysis of the Radiological Impacts to the Public and Workers from Decommissioning Activities, Including Transportation of the Waste from Decommissioning Activities

The Nuclear Regulatory Commission issued an Environmental Assessment (EA) and a Finding of No Significant Impact (FONSI) on October 28, 1993, in conjunction with its renewal of Materials License SNM-414. Activities approved under that license included decontamination of facilities formerly used for plutonium and uranium processing, the volume reduction of low-level radioactive waste, and other activities. The inventories of radioactive material utilized for these activities represent a conservative upper bound for radiation exposure to workers and the public. Activities proposed under the Decommissioning Plan are designed to cleanup floor slabs and contaminated site soils remaining after the decontamination work being performed under the existing license. Therefore, radiological impacts that might be expected from activities conducted under the Decommissioning Plan are clearly lower than those observed or estimated for activities under the current license. Analyses in the NRC 1993 EA of potential doses to workers and the public from those operations found those impacts to be insignificant.

The results are presented in abbreviated form in Tables 1 through 4. The annual dose calculated using COMPLY code Level 2 for an annual ground level release of 1 microcurie of a nuclide was 0.016 millirem per year for Pu-239, 0.017 millirem per year for Am-241, 0.00032 millirem per year for Pu-241, and 0.0042 millirem per year for U-234. These results can be considered dose factors (millirem per microcurie) that can be multiplied by annual release quantities, developed above, to calculate dose.

Doses calculated in this manner, using release quantities developed above, were 0.022 millirem per year for Pu-239240, 0.0073 millirem per year for Am-241, 0.024 millirem per year for U-234, and 0.0039 millirem per year for Pu-241. The total calculated annual dose from all nuclides combined is 0.037 millirem per year. Despite the many conservative assumptions in the COMPLY methodology, the dose calculated using that methodology is nearly a factor of 10 lower than the dose calculated for the maximum exposed individual in the 1993 EA for the current license. It would be reasonable to assume that the population dose that might be calculated for the Parks Facilities decommissioning would also be nearly a factor of 10 lower than the population dose calculated in the 1993 EA for the current license. Because the doses calculated in the 1993 EA for the current license were sufficiently low to support a finding of no significant impact, the much lower doses calculated for the Parks Site decommissioning should also support a finding of no significant impact.

Exposure of Workers

We will demonstrate in the following paragraphs, using the 1993 EA, significant reductions in dose and risks from decommissioning activities. The maximum external dose to a worker should be substantially less than 0.7 rem and the population dose to the worker population should be

substantially less than the 49 person-rem, as estimated in the 1993 EA for operations under the current license. (Internal exposure has been and can be expected to continue to be negligibly low.) The dose from decommissioning activities would be substantially less at the much lower soil radiological concentrations than currently allowed by licensing activities.

In the 1993 EA for operations under the current license, the maximum annual external dose to a worker was estimated to be 0.7 rem and the annual population dose to the worker population was estimated to be 49 person-rem. Those estimates are based on measurements of external exposure to workers during earlier operations at the plant. Internal doses were negligible in comparison. Operations under the current license have involved refurbishing of equipment containing multi-curie quantities of byproduct materials. Radiation exposure rates on the order of up to 1 R/hour were associated with some of this equipment. The fission product nuclides also were potential internal exposure hazards. Operations also included decontamination of facilities containing quantities of alpha-emitting plutonium on the order of 1 curie and quantities of uranium on the order of 0.01 curie. Radiation exposure (external) rates from these nuclides were negligibly low. This was primarily because the rates of emission of penetrating radiation from these nuclides are low, but in part because these nuclides existed in dilute form mixed in with building materials and, to a lesser extent, soils. These nuclides remained potential internal hazards, primarily through the inhalation pathway; however, the potential for internal exposure was also limited by the dilute concentrations in which they existed. This characteristic, together with the engineering controls and other protective measures applied during decontamination explain the negligibly low internal exposures associated with these decontamination activities.

For activities covered under the Decommissioning Plan, external exposures will be negligible because the inventory of byproduct materials will have been reduced by activities conducted under the current license to microcurie levels--a reduction of 6 orders of magnitude or more--prior to beginning Decommissioning Plan activities. This would effectively eliminate all potential external radiation sources of any significance. The inventory of uranium, plutonium, and americium nuclides will also have been reduced greatly (probably by roughly one order of magnitude) during decontamination activities conducted under the current license. Nuclides to be handled during the activities described in the Decommissioning Plan would still be distributed in dilute form in the concrete in floor slabs and, to a lesser extent, in soils, which would continue to limit the potential for internal exposure. Application of standard radiation protection measures would also continue as necessary to limit radiation exposure of workers. As a practical matter, these measures would be applied if the airborne nuclide concentration potential approaches about 10% of the 10 CFR Part 20 derived air concentration (DAC) for workers. Because the maximum concentration would usually be well less than 10% of the DAC, the actual average concentration to which a relatively highly exposed worker would be exposed on a long term basis would probably be substantially lower than the maximum--probably by a factor at least as high as 3. Because the DAC for workers is equivalent to 5 rem per year , the likely inhalation dose to a relatively highly exposed worker from one year of exposure would be less than about 0.2 rem. This dose is far below the 10 CFR 20 limit of 5 rem, and is lower than the maximum external dose of 0.7 rem in the 1993 EA for the current license. The worker population dose could also be expected to be correspondingly lower. Because the doses calculated in the 1993 EA for operations under the current license were sufficiently low to support a finding of no significant impact, the lower doses estimated for the Parks Site decommissioning should also support a finding of no significant impact.

Exposure of the public

Similarly, the dose to the public from radioactive material releases to the environment can be expected to be much lower than the maximum dose to an individual of 0.34 millirem per year and the population dose of 0.22 person-rem per year estimated in the 1993 EA. The dose from decommissioning activities would be substantially less at the much lower soil radiological concentrations than currently allowed by licensing activities.

In the 1993 EA for operations under the current license, the maximum annual dose to a member of the public (at the nearest residence located approximately 220 m SSW) was estimated to be 0.34 millirem and the dose to the population within 50 miles was estimated to be 0.22 person-rem. For the same reasons discussed above in connection with doses to workers, doses to members of the public can be expected to be lower that the doses estimated in the 1993 EA.

Potential releases of nuclides to air can be assumed to be the dominant contributor to dose to members of the public from operations described in the Decommissioning Plan because there will be no discharges of liquid effluents. A conservative estimate of the potential airborne nuclide annual release quantity can be made from an estimate of the average nuclide concentration in materials to be handled during the decommissioning and an estimate of the fugitive dust emission rate.

A site-specific estimate of the potential fugitive dust emission rate for the Parks decommissioning is not yet complete. However, an approximate estimate can be derived from the emission rate calculated for the decommissioning of the B&W Apollo facility. That fugitive dust release limit was estimated to be 0.05 g/s (Air Quality Plan Approval, Permit No. 03-399-008, Pennsylvania Department of environmental Resources, Air Quality Control, Fugitive Dust Emission Controls, February 7, 1992). The scale of activity in the Apollo decommissioning was much greater than the scale anticipated for the Parks Site. The quantity of soils and crushed building rubble handled at Apollo was about a factor of 10 higher than that anticipated at the Parks Site. Large-scale subsurface excavation was conducted in the Apollo decommissioning, whereas little is anticipated for the Parks Site. Overall, it would be reasonable to assume that fugitive dust emissions for the Parks Site decommissioning can be expected to be roughly an order of magnitude less, or about 0.005 g/s. The emissions of interest from the standpoint of potential airborne releases would be those associated with soil remediation and building slab removal. According to the schedule in Figure 3-3 of the Parks Decommissioning Plan, these activities would be conducted over a period of about 15 months, during which about 3 months would be required for Project Unit A (primarily plutonium and americium), about 2 months for Project Unit C (uranium), and about 4 months for Project Unit B (uranium). For purposes of estimating annual average nuclide releases, the effective annual average fugitive dust emission rate is estimated to be 0.001 g/s for Pu and Am and 0.002 g/s for uranium.

Average nuclide concentrations in bulk materials to be removed during decommissioning can be estimated from data in the Parks Facilities Characterization Report. For Project Unit A, the average concentrations for nuclides of interest are approximately 60 pCi/g for Am-241, 190 pCi/g for Pu-239240, and 1700 pCi/g for Pu-241. For Project Units B and C, average uranium concentrations were not computed, but can be seen by inspection to be below 40 and 400 pCi/g, respectively. To simplify the calculation, it was assumed that the average uranium concentration in both project units is 400 pCi/g. Annual average airborne nuclide release rates, calculated

from these concentrations, fugitive dust emission rates developed above, and an operating period of 2000 hr/y are 0.43 microcuries Am-241, 1.4 microcuries Pu-239240, 12 microcuries Pu-241, and 5.8 microcuries U-234.

A conservative assessment of annual dose to a nearby resident can be estimated using the release estimates derived above in a simple screening dose calculation using the USEPA COMPLY code ("A Guide for Determining Compliance with the Clean Air Act Standards for Radionuclide Emissions from NRC-Licensed and Non-DOE Federal Facilities," EPA 520/1-9-002 (Rev 2), U.S. Environmental Protection Agency, Office of Radiation and Indoor Air, October, 1989). The COMPLY code computes dose using one of four approaches of increasing complexity. The simplest approach that accounts for atmospheric dispersion between the source and the receptor is Level 2. However, important conservative assumptions remain. For example, in the Level 2 approach it is conservatively assumed that the wind blows toward the receptor 25% of the time at a default speed of 2 m/s. It is also assumed that the receptor is exposed to the maximum extent possible (100% outdoor occupancy, entire diet produced at residence, etc.) through the inhalation, ground, and food pathways. (The calculated dose for ground and food pathways is based on an assumption that releases continue over a period of 30 years to reflect ongoing operation of a facility. That assumption causes the calculated doses from those pathways to be overestimated for an operation like the Parks Site decommissioning, for which the bulk of the radioactive material handling will be completed in little more than one year.) Because of these and other conservative assumptions, results from the COMPLY code must be considered conservative upper estimates of dose from the Parks Site decommissioning.

The COMPLY code was run for unit release quantities for the location of the resident nearest the releases. for purpose of evaluation , the releases were assumed to emanate from a single point at the southeast corner of Building A.

The nearest resident is located 220 meters SSW of the point (1993 EA, p.A-8). Almost all of the radioactive material that might be released during decommissioning would be released from locations near Buildings A and C. The locations are at least 220 meters from the nearest resident. The results are presented in abbreviated form in Tables 1 through 4. The annual dose calculated using COMPLY code Level 2 for an annual ground level release of 1 microcurie of a nuclide was 0.016 millirem per year for Pu-239, 0.017 millirem per year for Am-241, 0.00032 millirem per year for Pu-241, and 0.0042 millirem per year for U-234. These results can be considered dose factors (millirem per microcurie) that can be multiplied by annual release quantities, developed above, to calculate dose.

Finally, the radiation dose to the public from routine transportation of radioactive materials should be much less than those calculated in the 1993 EA. In the 1993 EA, a dose of 0.084 millirem per year was calculated for the maximum exposed individual. That individual was assumed to be exposed to 200 shipments per year, each registering 40 millirem per hour at 1 meter. (Radiation levels from shipments under the Parks Facilities DP are estimated to be orders of magnitude less.) The population dose calculated in the 1993 EA for transportation was less than 0.02 person-rem. For shipments under the Parks Facilities DP, the population dose would also be much less than the population dose calculated in the 1993 EA. There are 102 shipments planned for the entire decommissioning period, each registering a dose of <1.0 millirem per hour at 1 meter . Hence, the dose from decommissioning activities would be substantially less at the much lower soil radiological concentrations than currently allowed by

licensing activities.

Radiological Accident Analysis for both Decommissioning Activities and the Transportation of Radioactive Waste to the Disposal Facility.

The 1993 EA described above also included evaluation of a spectrum of potential accidents involving release of radioactive materials. These included transportation accidents. Potential doses from all of these postulated accidents were below the EPA Protective Action Guidelines (PAGs) for whole-body exposure of 1 rem and were also below the 1.0 rem dose threshold identified in 10 CFR Part 70.22 as the threshold for the preparation of an emergency plan. For operations proposed under the DP, radioactive material inventories will be much lower than in operations considered in the 1993 EA. Furthermore, the form of the radioactive material (low concentrations in soil and concrete) make the material less mobile. For example, in the 1993 EA for the current license, the highest calculated dose from an accident was from a postulated outdoor fire in stored flammable materials containing plutonium-239 from building and equipment decontamination operations. It was assumed that these materials were packaged in a 100 cubic foot metal burial box. The plutonium concentration in the decontamination materials was assumed to be 10,000 pCi/g. The dose calculated for this postulated accident was 0.26 rem. A similar accident was postulated as a transportation accident with similar results. As indicated above in the response to Item 3, the nuclides to be handled in the decommissioning are present in dilute form in building material and soil, which are generally not flammable. Furthermore, as indicated in the response to Item 3, the average nuclide concentrations in those materials are far lower than assumed in the accident analyses in the 1993 EA for the current license. Thus, the nuclide concentrations available for release and the potential for release per unit concentration available are both substantially lower in the activities proposed in the Parks Facilities Decommissioning Plan than under the current license. Therefore, the dose from an accident associated with work under the Decommissioning Plan can only be substantially less than the maximum calculated in the 1993 EA for current operations. Consequently, the impacts of accidents from operations under the DP should be far less than those previously evaluated in the 1993 EA and found to be insignificant.

TABLE 1
COMPLY OUTPUT FOR PU-239

COMPLY: V1.5d. 3/26/97 8:20

BW PTS DP PU239

SCREENING LEVEL 2

DATA ENTERED:

Nuclide		Release Rate (curies/YEAR)
PU-239	W	1.000E-06

Distance from the source to the receptor is 220 meters.

Default mean wind speed used (2.0 m/sec).

NOTES:

Input parameters outside the "normal" range:

None.

RESULTS:

Effective dose equivalent: 1.6E-02 mrem/yr.

TABLE 2
COMPLY OUTPUT FOR AM-241

COMPLY: V1.5d. 3/26/97 8:34

BW PTS DP AM241

SCREENING LEVEL 2

DATA ENTERED:

Nuclide		Release Rate (curies/YEAR)
AM-241	W	1.000E-06

Distance from the source to the receptor is 220 meters.

Default mean wind speed used (2.0 m/sec).

NOTES:

Input parameters outside the "normal" range:

None.

RESULTS:

Effective dose equivalent: 1.7E-02 mrem/yr.

TABLE 3
COMPLY OUTPUT FOR PU-241

COMPLY: V1.5d. 3/26/97 8:36

BW PTS DP PU241

SCREENING LEVEL 2

DATA ENTERED:

Nuclide		Release Rate (curies/YEAR)
PU-241	W	1.000E-06

Distance from the source to the receptor is 220 meters.

Default mean wind speed used (2.0 m/sec).

NOTES:

Input parameters outside the "normal" range:

None.

RESULTS:

Effective dose equivalent: 3.2E-04 mrem/yr.

TABLE 4
COMPLY OUTPUT FOR U-234

COMPLY: V1.5d. 3/26/97 8:38

BW PTS DP U-234

SCREENING LEVEL 2

DATA ENTERED:

Nuclide		Release Rate (curies/YEAR)
U-234	Y	1.000E-06

Distance from the source to the receptor is 220 meters.

Default mean wind speed used (2.0 m/sec).

NOTES:

Input parameters outside the "normal" range:

None.

RESULTS:

Effective dose equivalent: 4.2E-03 mrem/yr.

APPENDIX D

ANALYSIS OF THE NON-RADIOLOGICAL IMPACTS OF DECOMMISSIONING ACTIVITIES

Decommissioning of the Parks Township facility as presented in the Decommissioning Plan is unlikely to result in any non-radiological impacts to the human environment. There is no planned use of chemicals in the decommissioning activities, only excavation of soil and removal of concrete floors that exceed current radiological release criteria. B&W has committed to conducting decommissioning activities in compliance with PADEP and EPA regulations. Based on the small releases expected from above described activities, and B&W's commitment to comply with the applicable regulations, no measurable impact is expected as a result of chemical releases to the atmosphere.

The only operations which have the potential to affect the terrestrial environment are soil excavation and concrete slab removal. These are being carefully planned and will be conducted so as to avoid the release of contaminants through soil erosion or airborne particulate. Further, the areas of soil disturbance are typically small. Operations will be conducted within PADEP limits ensuring that effluents will not affect man or terrestrial biota.

Without control, stormwater runoff from paved surfaces and areas of soil removed may contain small amounts of material that could be carried into the adjacent river. No significant contamination is expected in the site runoff. However, samples will be collected and the analytical results will be supplied to PADEP as part of the Parks Township stormwater permit.

Without control, small quantities of chemical materials may reach to the Kiskiminetas River as a result of decommissioning operations. Chemical effluents are controlled by applying release limits established by DEP. Decommissioning of the Parks Township facility within these limits will preclude any significant impacts on the aquatic environment in the vicinity of Parks Township.

Groundwater monitoring has shown low level organics near some of the buildings. The site hydrologic conditions are such that no significant off-site concentration or impact is expected.

Decommissioning of the site will mean loss of jobs which may be offset by the release of the property for unrestricted use, allowing for possible expansion by the existing industrial complex immediately north of the site. Hence there should be no significant net socioeconomic impacts as a result of decommissioning.

The potential non-radiological impacts associated with normal, transport from the Parks Township facility would consist of long-term health effects caused by the inhalation of vehicle exhaust and normal transport incidents due to increased traffic on the shipping routes. The approximate 100 shipments would not significantly affect the life of the highway system in the area, nor would the noise generated by the shipments have a significant impact on the ambient noise levels in the area.

The likelihood and magnitude of non-radiological impacts that may result from waste and product shipments to and from the Parks Township facility are irrespective of the radioactive nature of the load. These impacts are simply the potential increased number of traffic-related injuries associated with the

increased traffic flow. The impacts of normal transport are estimated on the basis of health effects expected to result from increased exhaust emissions, while accident impacts consist of potential collision-induced injuries and deaths.