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02-043

Director
Office of Nuclear Material Safety
and Safeguards.
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

Reference: License SNM-42, Docket 70-27

Subject: Industrial Waste Landfill No. 1, Decommissioning Plan and Final Status Survey Plan. (TAC No. L21642)

Gentlemen:

By letter dated December 4, 2001, BWX Technologies (BWXT) requested NRC to discontinue review of the Decommissioning Plan and Final Status Survey Plan for Industrial Waste Landfill No. 1. This request was made because of the discovery of trench material outside of the area of previously identified trenches.

BWXT characterized the newly identified trench areas consistent with the previously approved Final Status Survey Plan for the Industrial Waste Landfills. This additional characterization effort identified two new trenches (Trenches 7 and 8) containing an estimated 2,160 Ft^3 of additional waste material. Analysis of the waste material in these two trenches found no higher contamination level than 6 pCi/g total uranium. The average total uranium concentration in Trench 7 is 1.64 pCi/g and the average in Trench 8 is 2.32 pCi/g. The stated analytical results are not exclusive of background which has been established as 2.12 ±0.67 pCi/g uranium on average for soil at the site. It is apparent that the uranium contained in sludge waste material in these trenches is not significantly different from background soil. As such, no significant changes to the Decommissioning Plan and Final Status Survey Plan were made other than to incorporate the information on the two additional trenches. All applicable analytical results, including those associated with the most recent characterization effort, are reported in the Final Status Survey Report for Industrial Waste Landfill No. 1 in accordance with the Decommissioning Plan for Industrial Waste Landfill No. 1 that are enclosed with this letter.

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If there are questions in this regard, please contact us.

Arne F. Olsen
Licensing Officer

Enclosures (2)

cc: U.S. Nuclear Regulatory Commission
Region II

NRC Resident Inspector

BWX TECHNOLOGIES, INC.

NUCLEAR PRODUCTS DIVISION

FINAL STATUS SURVEY PLAN FOR THE INDUSTRIAL WASTE LANDFILL NO. 1

TAC NO. L21642

SPECIAL NUCLEAR MATERIALS LICENSE, SNM-42

REVISION 2, JULY 01, 2002

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FINAL STATUS SURVEY PLAN
INDUSTRIAL WASTE LANDFILLS AT
BWXT, NUCLEAR FUEL DIVISION

1.0 Executive Summary

From 1972 until 1990, BWX Technologies, Inc. (BWXT), formerly Babcock and Wilcox, operated two industrial waste landfills (IWLs) at the . The landfills were operated under permits issued by the Commonwealth of Virginia (VA #202 and VA #217). The landfills are located west and northwest of the Waste Treatment Facility. The BWXT site as well as the locations of the landfills are displayed on Figure 1 (Appendix A).

During an internal investigation in 1990, it was determined that the facility recycle water system had been introducing low levels of radioactive contamination into the "cold" pickle acid waste stream, as well as the waste neutralization process. Subsequent to the investigation, the USNRC issued a violation for onsite disposal of radioactive material in 1991.

In response to the violation committed to submitting a survey plan or "characterization plan" to the NRC for the industrial waste landfills. Following the completion of the characterization, BWXT's intention was to request permission to leave the contaminated material in place, as scoping surveys indicated that the criteria for unrestricted release could be demonstrated.

The basis of the survey plan was a random sampling of the landfills. The rationale for the random sampling was the documentation of the levels of radioactivity in the source of the contamination, described later in this report. Survey units were established for periods of time in which similar levels of radioactivity existed in the source term. Initial sampling was performed in the most recently used section of the landfill. The results of these samples were used to determine the number of samples required to be taken from the remaining landfill sections.

During the approval process for the *Characterization Plan*, meetings were held with the NRC and responses were provided to formal comments on the plan. One of the comments included discussion of the validity of a random sampling plan. responded that the end product of the plan would be the ability to determine the total quantity of radioactive material buried in the landfills within a certain degree of confidence. This same approach was used by and approved by the NRC to release other contaminated material during this period.

The Characterization Plan (NRC 1993) was approved by the NRC in 1993. The plan was implemented during 1994. Due to the change in decommissioning criteria published after the plan was approved, BWXT submitted a Decommissioning Plan (BWXT, 1997) describing actions that had already taken place. This plan was approved by the NRC on February 25, 1998.

The sampling performed in 1994 was analyzed and compared to the recycle water activity for equivalent time periods. A correlation between the data sets was proven. This indicates that the random survey performed in accordance with the NRC approved sampling plan properly characterized the landfills. There are, however, some areas of the landfills for which no correlation could be performed because no data for the recycle water system was available during these time periods. These areas have been identified and will require additional sampling as described in this plan.

Following approval and execution of the Final Status Survey Plan (FSSP), a Final Status Survey Report was submitted in December 1999 to demonstrate that the IWLs 1, 2A and 2B met the criteria for unrestricted release. Approval was granted for release of IWLs 2A and 2B however release of IWL 1 was not approved and excavation was requested for Trench 2 and a portion of Trench 3 of IWL 1. A revised FSSP for IWL 1 was submitted in conjunction with a revised Decommissioning Plan on July 31, 2001.

In November 2001, crews installing environmental monitoring wells near IWL 1 encountered additional waste material outside the landfills previously identified boundaries. Sampling was again performed consistent with the previously approved FSSP for this newly identified area. Two additional trenches were identified and the NRC notified to discontinue review of the submitted FSSP and Decommissioning Plan for IWL 1 until BWXT could revise and resubmit these documents after incorporating the new information. This FSSP and related Decommissioning Plan provide incorporate this new information as well as information regarding IWLs 2A and 2B in order to provide consistency with previously submitted documents.

2.0 Background Information

2.1 Description of the Waste Materials

The waste materials buried in the landfills included filter cake from the pickle acid treatment system, solids from the Imhoff settling system, prescreened material from the sanitary waste treatment system, and zirconium chips and fines.

Filter cake was generated from the non-radioactive pickle acid waste stream. The waste stream consisted of mixtures of spent hydrofluoric and nitric acids (5% HF, 30% HNO_3) used for pickling and dissolving various alloys. Discharges from fume scrubbers servicing pickling operations also discharged to this system.

The pH of the waste typically ranged from 2-3. The acidic wastes were neutralized with hydrated lime. The neutralized solution was then passed through a filter press following the addition of an anionic flocculating agent to aid in dewatering. The solids removed by the filters (filter cake) consisted of calcium fluoride, calcium hydroxide, and hydroxides of zirconium, iron, copper, and aluminum. The filter cake had a nominal moisture content of 50% at the time of burial. An average of approximately 50-100 cubic feet of filter cake was generated per day and placed in the landfills. The water supply for the fume scrubbers, as well as the source of make-up water for the lime slurry, were later found to be radioactively contaminated.

The Imhoff settling system collected solids from grit blast operations; blow down from precipitators and sand filters used to treat river water; backwash from softeners, demineralizers, and sand filters used to treat well water; and other non-acidic industrial waste streams. The Imhoff system became contaminated through contact with the recycle water system. The Imhoff settling pits were cleaned twice per year. Approximately 4,000–5,000 cubic feet of clean out solids were buried in the landfills each year.

Small amounts of prescreened material from the sanitary waste treatment system, sand from filtering systems as well as zirconium chips were also buried in the landfills. The prescreened sanitary material was contaminated, due to direct contact with the recycle water system. The filter sand was also contaminated from contact with the recycle water system. The zirconium chips were generated as a result of machining operations. The chips or turnings were not contaminated with radioactive material and do not pose a safety hazard. The amount of these materials buried in the landfills is estimated to be approximately 3,000 – 4,000 cubic feet per year.

A diagram of the waste streams is provided as Figure 2. Available data on the volumes of each waste stream input is provided in Table 1.

2.2 *Description of the Landfill No. 1*

Landfill #1 was used from 1972 until 1976. Landfill #2 was used in two sections. The first section (landfill section 2A) operated from 1977 until 1988; the second section (landfill section 2B) operated from 1989 until 1990. Use of the landfills was discontinued after June 1990, because the filter cake material was found to contain low levels of radioactive contamination.

Both landfills were operated in a relatively similar manner. Filter cake material was placed in a series of parallel trenches. Each trench was excavated; sludge material was transported to the trench and dumped by roto-hopper in piles until the area within the trench was full. Successive piles of filter cake material placed in the trenches was mounded above ground level. The volume of the filter cake placed in the trenches was reduced by approximately 30% by allowing it to dry, resulting in the mound above ground level settling below grade. Material from the excavation of the next trench was used as a cover of top soil. The top soil cover is approximately two feet in depth. The surface was then allowed to vegetate naturally.

In 1992, IT Corporation performed a geophysical investigation of the landfill areas (IT 1992) to try and outline the size and locations of the trenches in each area. Non-intrusive electromagnetic induction surveys were performed over each of the landfill areas using a Geonics EM-31DL terrain conductivity meter equipped with a digital data logger. Measurements of electrical conductivity were recorded at 5 foot intervals in a westerly direction, along survey lines 12.5 feet apart.

The survey revealed most of the trench locations in areas 2A and 2B. The survey of landfill 1 identified the boundaries of the landfill, but was not able to identify individual trench locations.

Soil conductivity measurements at landfill area 1 exhibited parallel northeast-southwest trends that indicated the presence of trenches. However, the boundaries and dimensions of individual trenches could not be resolved. Figure 3 depicts the findings of the IT measurements.

The burial of metal pieces in some areas of the landfills impeded the conductivity measurements. Periodically zirconium machined chips were buried in the landfills. The zirc chips were generated from machining operations of non-contaminated metal.

During 1998/1999/2001 sampling efforts, the trenches were defined in IWL 1 and Table 2 summarizes the characteristics of the trenches.

The trench sizes varied from one landfill area to another. The trenches used in landfill 1 (1972 to 1976) cover an area of less than 1 acre. The size of the trenches vary from approximately 5 to 20 feet wide, 45-135 feet long and 6-12 feet deep. The trenches are approximately 5 to 8 feet apart. There are 8 trenches in this area. The bottoms were excavated with a slope of approximately 3 percent. The cover of top soil in this area ranges from 1 to 7 feet in depth. The actual sludge height (depth excluding the soil cap) ranges from 1 to 9 feet.

2.3 *Description of the Source of Radioactive Contamination*

Until 1990, BWXT believed the waste materials being buried in the landfills to be non-radioactive. In 1990, BWXT discovered the waste materials were being radioactively contaminated by two plant water systems known as the recycle water system and the re-circulated water system.

When the [facility was built, a closed loop recycle water system was installed to provide water for non-contact cooling of various plant equipment, the fire protection system, and the sanitary waste system. The water was also used in grit blast operations, acid fume scrubbers, and pickling acid treatment. To replace evaporative and other losses from the recycle system, makeup water was provided from the James River and from the collection of rain water from roof runoff drains and storm sewer drains. Ex 4

Since its installation, the entire recycle water system had been contaminated with enriched uranium. The primary source was the airborne effluent discharged from the ventilation system which served uranium recovery operations. The airborne effluent settled on facility roofs and ground areas and entered the recycle water system in rain water from roof runoff and storm water drains. This effluent was moist, acidic, and contained soluble, highly enriched uranium compounds. In addition, some operations using recycle water as non-contact cooling in uranium recovery periodically leaked causing additional contamination of the system.

The recycle water system was known to contain low levels of radioactivity and was routinely sampled from 1979 to 1990 after use of IWL 1 was terminated.

During a 1989-1990 review of the recycled and re-circulated water usages [determined that waste materials being buried in the landfills contained low levels of enriched uranium. Consequently, all landfill burials were terminated in June 1990. A more detailed description of activities is discussed in NRC inspection report 70-27/90-19 (NRC 1990). Ex 4

Table 3 details the chronology of events for the Industrial Waste Landfills (IWLs).

3.0 Site Information

3.1 Site Description

The [facility is located on a 448 acre site in the northeastern corner of Campbell County, approximately 5 miles east of Lynchburg, Virginia. The site is located in a generally rural area, consisting primarily of rolling hills with gentle slopes, farm land, and woodlands. The main manufacturing facilities are centrally located on the site, with the manufacturing area contained in an approximately 19 acre protected area. The Waste Treatment Facilities (WTF) are located northeast of the main plant, approximately 600 feet from the James River. Landfill 1 is located approximately 1200 feet northwest of the WTF. Ex 4

The BWXT site can be reached from State Route 726 which connects to U.S. Route 460. U.S. Route 460 is a major link between the Lynchburg/Roanoke area and the eastern portion of the state. The [redacted] site is also serviced by a spur of the CSX Railroad which runs through BWXT property. Ex 4

The site is bordered by an oxbow of the James River from the southwestern to the northeastern side. On the south, the site is bordered by a large iron foundry. To the east is the Framatome-Cogema Fuels Company.

The site elevation ranges from 470 feet above mean sea level (MSL) at the James River, to 693 feet above MSL at the crest of a hill south of the main facility. The waste treatment facility and IWL 1 are located in the 100 year flood plain (NRC 1991).

3.2 *Site Conditions at Time of Final Survey*

Operations continue to be conducted at [redacted]. As the [redacted] it is likely operations will continue well into the future. Ex 4

4.0 Final Status Survey Overview

4.1 Survey Objectives

The purpose of this Final Status Survey Plan (FSSP) is to demonstrate that the level of radioactive contamination in the Industrial Waste Landfills at BWXT [redacted], following excavation of Trench 2 and a portion of Trench 3, satisfies NRC guidelines for unrestricted release. Ex 4

The specific objectives of the survey are to demonstrate that the residual contamination in the IWL#1, Trenches 2 and 3, meet the criteria for release under either option 1 or option 2 of the Branch Technical Position "Disposal or Onsite Storage of Thorium or Uranium Wastes from Past Operations", SECY 81-576 (NRC 1981), and that the environmental impact of any contamination above background poses no significant risk to the environment or to the general public.

Following approval of the Final Status Survey Report, Trench 2 and Trench 3 will be backfilled and the IWL 1 areas will be capped as described by the specifications set forth in the Decommissioning Plan (DP).

4.2 Identity of Contaminants

4.2.1 Estimate of the Volume of Material Buried

Since 1976, records of the quantities of sludge buried in the landfills for each month were maintained. While this was valuable data for IWLs 2A and 2B, IWL 1 was used from 1972 to 1976 and records were not available for that landfill. Therefore the volume estimate of buried material is based on the number of trenches and trench sizes determined during 1998/1999/2001 sampling events. It is estimated that 22,860 cubic feet of waste are buried in IWL 1.

4.2.2 Recycle Water System Activity

Recycle water was the primary source of contamination of the "cold" pickle acid system. From 1972 through 1990 recycle water contaminated the waste stream feeding the nonradioactive acid neutralization process (refer to Figure 2). The quantity of recycle water was small compared to the volume of the waste stream. Data is not available earlier than 1979 for the activity in the recycle water.

As stated earlier, the source of the contamination in the recycle water system was the uranium recovery operation, which processed primarily [ ] enriched uranium [ ] from 1972 to 1990. Ex4

4.2.3 Scoping Surveys

Scoping surveys of the landfills were performed in 1990. In addition, samples of pickle acid sludge were taken prior to burial during the investigation into whether the sludge contained radioactivity. The samples were analyzed by gamma spectroscopy (for U-235 and U-238). The lack of information for U-234 hampered the ability to make any assumptions on the enrichment of the uranium contamination at the time of sampling.

As a part of the internal investigation into the impact of the contamination of the recycle water system, samples of pickle acid sludge were taken at the time of generation from October 1989 through May 1990. The activity in many of the samples taken was not discernible from the natural uranium activity in the lime used for neutralization.

By assuming that the uranium was [ ] enriched, the U-234 content could be estimated. Typical U-234:U-235 activity ratios for HEU are 20:1. Ex4

Using this ratio, the scoping surveys indicated that the average concentration of total uranium was less than 30 pCi/g.

4.2.4 Activity Profile

Based on knowledge of the source of contamination, as well as scoping survey information, the radioactive contaminant present in the IWL is [ ]enriched uranium. The anticipated activity fractions are presented in Table 4. Ex 4

The quantity of fission products is insignificant*. Table 5 summarizes the quantity of other isotopes detected in the IWL scoping surveys.

* - Using NRC Guidance in PG-8-08 (NRC 1994B) and site specific RESRAD parameters, the dose rate estimated using RESRAD from the non-uranium isotopes at 1% of the uranium activity (assumed to be 30 pCi/g) is less than 3% of the maximum dose rate from the uranium contamination.

4.2.5 Environmental Availability of Uranium

Release of contaminated material under Option 2 of the BTP requires that the soluble and insoluble fractions of uranium in the soil be determined. Samples of the landfills taken in 1994 as a part of the first phase of the sampling plan were archived. From the archived samples, a composite sample representing each landfill area was created for analysis. The determination of the soluble fraction of uranium was based on the sequential extraction approach as described in NUREG/CR 6232, "Assessing the Environmental Availability of Uranium in Soils and Sediments" (NRC 1994A). The method described in Appendix C of NUREG/CR 6232, for estimating the quantities of total uranium and total available uranium was performed to determine the environmental availability of the uranium. These values were then applied to the guideline value criteria. The averaged IWL results indicate that the uranium consists of 52% soluble and 48% insoluble uranium compounds. Table 6 provides the analytical results for the environmental availability analysis.

4.2.6 Concentration Guideline Values

Under option 1 of the BTP, the guideline value (GV) for highly enriched uranium is 30 pCi/g of total uranium. Under option 2, the guideline value depends on the amount of soluble and insoluble uranium present. For option 2, the GV is determined by using the following formula:

$$\text{Guideline Value (pCi/g)} = \frac{1}{\dfrac{\textit{Insoluble Fraction}}{250\ \text{pCi/g}} + \dfrac{\textit{SolubleFraction}}{100\ \text{pCi/g}}}$$

Where the soluble fraction is equivalent to the total available uranium as determined by the methodology described in 4.2.5. The insoluble fraction consists of the total uranium, less the amount of soluble uranium.

Based on the analysis performed as described in 4.2.5, the guideline value for the industrial waste landfills is 140 pCi/g, total uranium activity.

Individual areas of residual activity exceeding the guideline value, known as elevated areas, may be acceptable provided they meet the conditions in 4.2.7.

4.2.7 Areas of Elevated Activity

Methods for determining acceptable concentrations for smaller, elevated areas of contamination for subsurface contamination are not discussed in NUREG/CR-5849 (NRC 1992). A method developed by the NRC for use in connection with the AAR "Site Remediation Plan for the Former Brooks and Perkins, Inc. Site" (NRC 1997) was used as reference for the BWXT application. This method uses simple scenarios to predict how subsurface contaminants may become surface contaminants. The dose from the excavated sub-surface contaminants is then estimated to determine the criteria of acceptable volumes of elevated activity.

The method uses RESRAD (DOE 1993) to set guideline values for smaller areas of elevated contamination. The RESRAD software is run for several scenarios with varying sizes of contaminated areas, which are contaminated to the applicable release limit. The exposures from these areas are then compared to the exposure for the default size area of 10,000 m^2. The following formula is used to determine the elevated area criteria:

$$\frac{\text{Dose from ScenarioX}}{\text{Dose from Default Area}} * \text{Release Limit} = \begin{matrix}\text{Acceptable Average Concentration}\\ \text{for Area X}\end{matrix}$$

The five scenarios are:

1) One excavation equipment bucket of soil (1 m^3)
2) Soil from a 1 m x 1m x 10 m (10 m^3) long footer excavation for a house without a basement
3) Soil from a 3m x 2.5 m x 10m (75 m^3) excavation for a house with a partial basement

4) Soil from a 1m x 10m x 10 m (100 m^3) excavation for a house with no basement
5) Soil from a 3m x 10m x 10m (300 m^3) excavation for a house with a full basement

It is assumed that the excavated soil is uniformly blended and spread out over an area at a thickness of 1 foot (0.3 m). The calculated doses are estimated using the resident farmer scenario and input parameters from Policy and Guidance Directive, PG-8-08 "Scenarios for Assessing Potential Doses Associated with Residual Radioactivity" (NRC 1994B). Table 7 summarizes the results of the elevated area analysis.

Following the implementation of the Decommissioning Plan, the IWL will be capped by four feet of soil (as required by the burial conditions under option 2 of the BTP). Using the above scenarios, no contaminated material would be exhumed, only clean earthen cap. Even after 1,000 years, the RESRAD default value for erosion (0.001 m/year) would postulate that 1 foot of cover will remain.

Because the IWL are currently capped by 2 feet (0.6 m) of clean soil, the volume of non-contaminated soil that would be blended with the excavated, contaminated material will be taken into account. For purposes of this evaluation, the conservative value of 2 feet will be used. The Branch Technical Position on Screening Methodology for Assessing Prior Land Burials of Radioactive Waste Authorized Under Former 10CFR20.304 and 20.302 (NRC 1996), allows a dilution factor of four for exhumed materials. This value was adopted from NUREG-0782. Using the existing cap of 2 feet will effectively provide a dilution factor of 2.5.

Example: Using Scenario 2, assuming the contamination level of the subsurface soil is 131.6 pCi/g ^{234}U, 7.0 pCi/g ^{235}U and 1.4 pCi/g ^{238}U, for a total U concentration of 140 pCi/g;

The volume of excavated soil (10 m^3) would include 0.6 m of non-radioactive soil and 0.4 m of contaminated soil for a total of 6 m^3 of clean soil and 4 m^3 of contaminated soil. This soil is spread over a 1 foot depth, creating a contaminated area of 30 m^2 (at 56 pCi/g, total U after mixing with clean soil).

RESRAD is run for a 30 m^2 area, at 56 pCi/g U_{total}. The maximum annual dose from this scenario is 5.5 mrem/yr.

RESRAD is then run for a 10,000 m^2 area at 140 pCi/g U_{total}. The maximum dose from this scenario is 24.7 mrem/yr.

The ratio between the runs is calculated (4.5) and multiplied by the unrestricted release limit (140 pCi/g), which results in an acceptable average concentration of 630 pCi/g for a 30 m^2 area or 10 m^3 volume.

The NRC paper (NRC 1997) states that:

> *"This concentration is considered acceptable since the dose from the elevated area containing this concentration will deliver the same dose as a large area contaminated at the unrestricted use level."*

An area of elevated activity, in excess of the appropriate release guideline value will be compared to the corresponding value calculated using the above method. If an area exceeds the elevated activity criteria, then additional samples will be taken to further define the size of the area. It is not anticipated that any remediation will be necessary.

4.2.8 Groundwater Monitoring and Migration Potential

Groundwater monitoring has been performed in the area of the landfills since 1982. These wells are sampled for radioactivity on an annual basis. The monitoring results demonstrate that there has been no migration of contamination into the groundwater. Table 8 provides the groundwater monitoring data and a description of the well locations relative to the landfills.

As a part of previous sampling events, samples of soil in areas adjacent to the landfills were taken. Samples were taken up gradient, as well as down gradient of each landfill area. A comparison of the activity in the soil between the up gradient and down gradient samples demonstrates that there has not been any migration of radioactivity from the filter cake. The data is provided in Table 9.

4.3 Organization and Responsibilities

The responsibilities for performing radiation surveys shall be as described in Chapter 2 of SNM-42.

4.4 Training

Training shall be as described in section 3.2 of SNM-42. These requirements apply to all individuals including contractors.

4.5 *Laboratory Services*

It is currently anticipated that Analytical services will be provided by BWXT Services, Inc.-Nuclear Environmental Operations-Nuclear Environmental Laboratory Services (NELS). Services will include sample analysis by alpha spectroscopy. The samples will be handled in accordance with NELS QA/QC plans, using chain of custody protocol. Analyses will be performed in accordance with NELS approved procedures based on accepted industry standards.

4.6 *General Survey Plan*

The proposed survey will utilize a combination of data from previous sampling events and sampling upon completion of excavation and removal of contaminated waste from Trenches 2 and 3 of IWL #1.

4.6.1 Previous Sampling Under NRC Approved Plans

Part of the data related to IWL #1 was developed through activities approved by the NRC in November of 1993 (NRC 1993). The survey plans were developed prior to the existence of Draft NUREG/CR-5849 (NRC 1992), however, it was based upon the same methodology and used many of the same references as Draft NUREG/CR-5849. The sampling conducted under the Characterization Plan (NRC 1993) was based on a random sampling of the landfill areas. The landfills were separated into five distinct survey units based on the levels of contamination in the source term at the time the waste material was buried. Each survey unit was randomly sampled. The radiological sampling and analysis of the landfills was completed in 1994.

Additional sampling of the industrial waste landfills was conducted in 1998-1999 in accordance with the FSSP for the IWLs approved by the NRC in correspondance dated May 12, 1998 (TAC No. L21642) and submitted in a FSSR to the NRC dated September 29, 1999.

The same sampling strategy as performed in 1998-1999 was imposed when additional sampling was needed in 2001 to delineate additional waste trenches in IWL 1. Data from these previous sampling events will be excluded if exhumation activities associated with waste removal from trenches 2 and 3 impact the areas from which the data were obtained.

4.6.2 Comparison of Sample Activity and Recycle Water Activity

Using the estimated dates of burial for each trench, the average sludge activity for each time period was compared to the average recycle water for each time period. Recycle water was the only source of contamination used in the comparison because it was the primary source of contamination. It was the only source of contamination from 1976-1984, and the primary source, based on total volume from 1976-1990. The ratios of activity contributed from each source are not known, however, the recycle water made the largest contribution of contamination.

Using the annual averages for each data set, a correlation analysis tool was used to determine whether any correlation between the two sets existed. The analysis tool and its formulas measure the relationship between two data sets that are scaled to be independent of the unit of measurement. The population correlation calculation returns the covariance of two data sets divided by the product of their standard deviations:

$$\rho_{X,Y} = \frac{\text{covariance}(X,Y)}{\sigma_X \bullet \sigma_Y}$$

Positive correlation is demonstrated by a positive number. A value returned of 1.0 indicates perfect correlation. The correlation demonstrated for the landfill data resulted in a value of 0.23. This indicates that the samples taken of the landfill are representative of the activity contributed by the source of contamination, and that the random sampling was appropriate.

4.6.3 Survey of IWL #1 Trenches 2 and 3 Excavation

Upon completing the remediation of the trenches, it is expected that the excavation will be shored on the northwestern and southeastern sides and the "clean" soil overburden and dividing barrier between the trenches removed for future backfill. The excavation should be sloped for access on the northeastern and southwestern faces. There may be some standing water present in the excavation.

A scanning survey of the accessible areas of the excavation, as well as any surrounding "affected" areas impacted by the exhumation activities, will be conducted using a 2" x 2" NaI detector, or equivalent. Identified elevations will be either exhumed for disposal as waste or flagged for additional sampling.

The floor and accessible walls of the excavation, and the surrounding area, will be gridded into 10m x 10m reference grids. The excavation and any surrounding affected grids will be sampled at the center of the grid and at the 4 points equidistant between the center and the four grid corners. A 2 meter deep "ring" surrounding the excavation will be sampled at a density of one sample every 5 meters at a distance of one meter from the lip of the excavation. Samples will be taken of the surface soil (<6" depth) at all locations unless there is reason to suspect subsurface contamination.

In addition, not more than 2 additional samples per grid may be obtained from the areas flagged during the scanning survey. All sampling data will be compiled and compared to the guidelines listed in Sections 4.2.7 and 4.2.8.

4.7 Schedule

The survey of IWL #1 Trenches 2 and 3 will be conducted pending approval of this survey plan. The time periods reflected in the schedule below are not tied to a specific start date at this time. The start date will be within one year following NRC approval.

Months	0	24	26	28	30	32	34	36	42	48
NRC Approval of FSSP	♦									
Preparation	■	■								
Excavation of waste		■	■							
Scanning Survey			■							
Collection of Samples			■	■						
Analysis of Samples				■	■					
Evaluation of Data					■	■				
Additional Sampling (Hot Spots)							■			
Analysis of Samples							■			
Evaluation of Data								■		
Preparation of FSSR								■	■	
Submit FSSR to NRC									♦	
NRC Approval										♦
Backfilling of excavation										→

4.8 Survey Report

The Final Status Survey Report (FSSR) will include the survey results and an analysis of the survey results. An environmental assessment of the impact of leaving the material in place (for Trenches 1, 4, 5, 6, 7, & 8), including the impact on groundwater, will be prepared and submitted to the NRC.

The FSSR format and content will be based on the recommendations in draft NUREG/CR 5849 (NRC 1992).

5.0 Survey Plan and Procedures

5.1 General

The survey is, by nature, a surface survey. The contaminated filter cake in Trenches 2 and 3, and the interspersing soil barrier, will be removed leaving only the surrounding soil. As discussed in 4.6, this survey will consist of systematic sampling of the excavation and any surrounding impacted area.

5.2 Equipment

The following equipment has been/will be used in sampling the IWL:

- Stainless steel scoops or shovels to collect soil.
- sampling containers (plastic bags and bottles)
- deionized water
- containers to collect rinsate
- containers to perform decontamination of sampling equipment

5.3 Instrumentation

Scanning will be performed using a 2" x 2" NaI detector, or equivalent, with coupled meter such as Eberline's SPA-3 and E-600, or equivalent.

Exposure rates will be measured using an Eberline Micro-R/hr Meter, model PRM-7 or equivalent.

Laboratory equipment will consist of alpha spectroscopy instrumentation. Typical minimum detectable activities for uranium activity by alpha spectroscopy is 0.1 pCi/g for each isotope.

5.4 Survey Plan

5.4.1 <u>Area Classification</u>

The exposed soil in the IWL #1, Trenches 2 and 3 excavation will be classified as an "affected area." Contamination is known to be present in the filter cake material buried in the trenches as described throughout the FSSP. An area surrounding the trench excavation of 2 meter depth will also be considered affected. In addition, any area which was impacted during the exhumation of waste will be classified as affected.

Areas of the IWL #1 outside of the affected areas will be considered unaffected.

5.4.2 Reference Grids

A 10m x 10m reference grid will be established over the IWL #1 area, excluding the excavation of Trenches 2 and 3. This grid will have its origin (0,0) at the origin indicated on Figure 4 which also identifies the 1993 sampling locations.

Reference grids for the trench excavation will be established in a 10m x 10m pattern with the origin (0,0) being at the lower left hand corner of a trench "wall" (as you would be looking at it from the floor of the trench) and the southwesternmost corner of the "floor."

5.4.3 Sampling Areas of Elevated Activity

The criteria for areas of elevated activity (4.2.7) will be applied to any sample result exceeding the GV. The size of the "hot spot" will be assumed as that area bounded by adjoining samples below the GV. The area between the bounding samples will determine the allowable level of activity. If the sample activity exceeds this level, additional samples will be taken to further define the area of elevated activity.

5.4.4 Surface Scans

As stated in section 2.2 a geophysical investigation of the IWL was performed in October of 1992.

In addition, surface scans of exposed trench surfaces in IWL #1, Trench 2 and 3, and surrounding areas impacted by exhumation activities, will be conducted using a 2" x 2" NaI detector, or equivalent. The detector will be held within 6 cm of the surface while moving at a rate of approximately 0.5 m/s in a "S" pattern. General paths will be followed that are not more than 1 meter apart so that approximately 100% of the surface will be scanned. If necessary to maintain clearance from the trench walls, the detector will be attached to a pole or stick.

5.4.5 Surface Activity Measurements

Surface activity measurements will not be performed because the contamination is limited to volumetrically contaminated soil and filter cake.

5.4.6 Exposure Rate Measurements

The contaminant [ ] enriched uranium, is primarily an alpha emitter. Exposure rates from low concentrations of [ ] enriched uranium contamination are difficult to discern from natural background. Background exposure rates around the NNFD site typically range from 5 to 8 micro-R/hr. If measurements exceeding twice background are considered detectable, then the detection limit for [ ] enriched uranium would be approximately 6,000 pCi/g for a large area uniformly contaminated to this level.

Exposure rate measurements will be performed using a micro-R/hour meter. One measurement will be made at a height of one meter in the approximate center of the IWL #1 trenches and in the trench 2 and 3 excavation. If a measurement exceeds two times the background level, the surface of the trench will be scanned. Any elevated areas will be exhumed and disposed as waste. Approved procedures for operation of the micro-R/hour meter will be followed.

5.4.7 Surface Sampling

Samples will be obtained from the trench excavation at the center point of each grid and at four points equidistant between the center and the grid corners. Samples will be obtained from any "affected" grid outside the excavation in the same manner. Samples will be taken from a 2 meter deep "ring" surrounding the excavation every 5 meters at a distance of one meter from the lip of the excavation. Existing sampling data will be utilized for unaffected areas in IWL #1 outside the excavation.

Stainless steel scoops or shovels will be used to obtain material from the uppermost 2" of soil at each sampling point. Large rocks or vegetation will be removed from the sample as it is placed into a container labeled with the sample number. Approximately 500 ml of material will be obtained as the sample.

Sampling tools will be rinsed and wiped clean before sampling at the next location.

5.4.8 Special Measurements & Samples

To ensure that radioactive material was not migrating from the trenches, soil samples were taken from the soil around the landfills at both up gradient and down gradient locations. Samples were taken at 3-4 feet, 6-8 feet, and 9-10 feet depths. The samples were analyzed for isotopic uranium by alpha spectroscopy (described in section 4.2.8).

Groundwater monitoring has been and will continue to be performed in the area. No migration of material from the trenches has been identified.

5.5 Background Level Determinations

During the initial phase of a Resource Conservation Recovery Act Facility Investigation on the [ ] site during 1993, 159 soil samples were taken and analyzed for isotopic uranium. From these, thirty background samples were selected to determine natural background uranium levels on site. Ex4

Background samples were identified by comparing the ratio of ^{234}U to ^{238}U activity. For natural uranium, the activities of the two isotopes should be roughly equivalent (ratio $^{234}U{:}^{238}U = 1$). Any contamination from [ ] operations would be easily identifiable because this ratio is extremely large for high enriched uranium (>30). Samples taken in or near contaminated areas were not used as a part of the selection. Ex4

Thirty samples with ^{234}U to ^{238}U activity ratios close to one were chosen randomly. The thirty samples were averaged yielding a mean activity of 2.12 pCi/g. According to draft NUREG/CR 5849, the background level is insignificant relative to the guideline value if it is less than 10% of the guideline value. The background level on site is less than 10% of the option 1 guideline value.

The number of samples used to determine the background was sufficient. Using formula 8-22 from draft NUREG/CR 5849, the number of background measurements needed to satisfy the objective was deemed adequate. Table 10 summarizes the BWXT site background measurements. The formula for determining the required number of measurements is:

$$n_B = \left[\frac{t_{95.5\%, df} * s_x}{0.2 * \bar{x}_B} \right]^2$$

where: n_B - number of background measurements required

$\bar{x}_B$ - mean of the initial background measurements

s_x - standard deviation of initial background measurements

$t_{95.5\%, df}$ - t statistic for 95.5% confidence and 30 degrees of freedom

5.6 Sample Analysis

The samples will be analyzed for isotopic uranium by alpha spectroscopy. Standard operating procedures will be used to perform these analyses.

Chain of custody protocol will be followed for handling all of the samples.

6.0 Data Interpretation

Analysis data will be reported in units of pCi/g. Values will be adjusted for contributions from natural background. The following calculations will be performed:

- Mean radioactivity concentration
- Standard deviation of measurements
- Comparison against the guideline value
- Comparison of individual measurements against elevated activity area criteria (4.2.8)
- Testing against the confidence level objective

In addition, the total site radionuclide inventory will be estimated. Draft NUREG/CR 5849 will be used as guidance for calculations.

7.0 Final Status Survey Report

A Final Status Survey Report will be prepared and submitted to the NRC. Data will be summarized in tables. Sampling locations will be shown on drawings.

8.0 References

BWXT 1997 *Industrial Waste Landfills Decommissioning Plan,* Revision 0.1, April 1997.

BWXT 1999 *Final Status Survey Report for the Industrial Waste Landfills,* Revision 0, September 1999.

DOE 1993 *Manual for Implementing Residual Radioactive Material Guidelines Using RESRAD, Version 5.0,* September 1993.

EPA 1989 Environmental Protection Agency, *Methods for Evaluating the Attainment of Cleanup Standards Volume 1: Soils and Solid Media,* EPA 230/02-89-042, 1989.

IT 1992 IT Corporation, *Geophysical Investigation Results RCRA Facility Investigation,* December 1992.

NRC 1981 USNRC Branch Technical Position, *Disposal or Onsite Storage of Residual Thorium or Uranium (Either as Natural Ores or Without Daughters Present) From Past Operations* (SECY 81-576), October 5, 1981.

NRC 1990 USNRC Inspection Report 70-27/90-19, September 1990.

NRC 1991 *Environmental Assessment for Renewal of Special Nuclear Material License No. SNM-42, docket No. 70-27, Babcock & Wilcox Company, Lynchburg, Virginia*, USNRC, August 1991.

NRC 1992 NUREG/CR-5849, *Manual for Conducting Radiological Surveys in Support of License Termination, Draft Report for Comment*, June 1992.

NRC 1993 U.S. Nuclear Regulatory Commission Radionuclide Characterization Plan (TAC No. L21642), November 15, 1993.

NRC 1994A U.S. Nuclear Regulatory Commission NUREG/CR-6232, *Assessing the Environmental Availability of Uranium in Soils and Sediments*, June 1994.

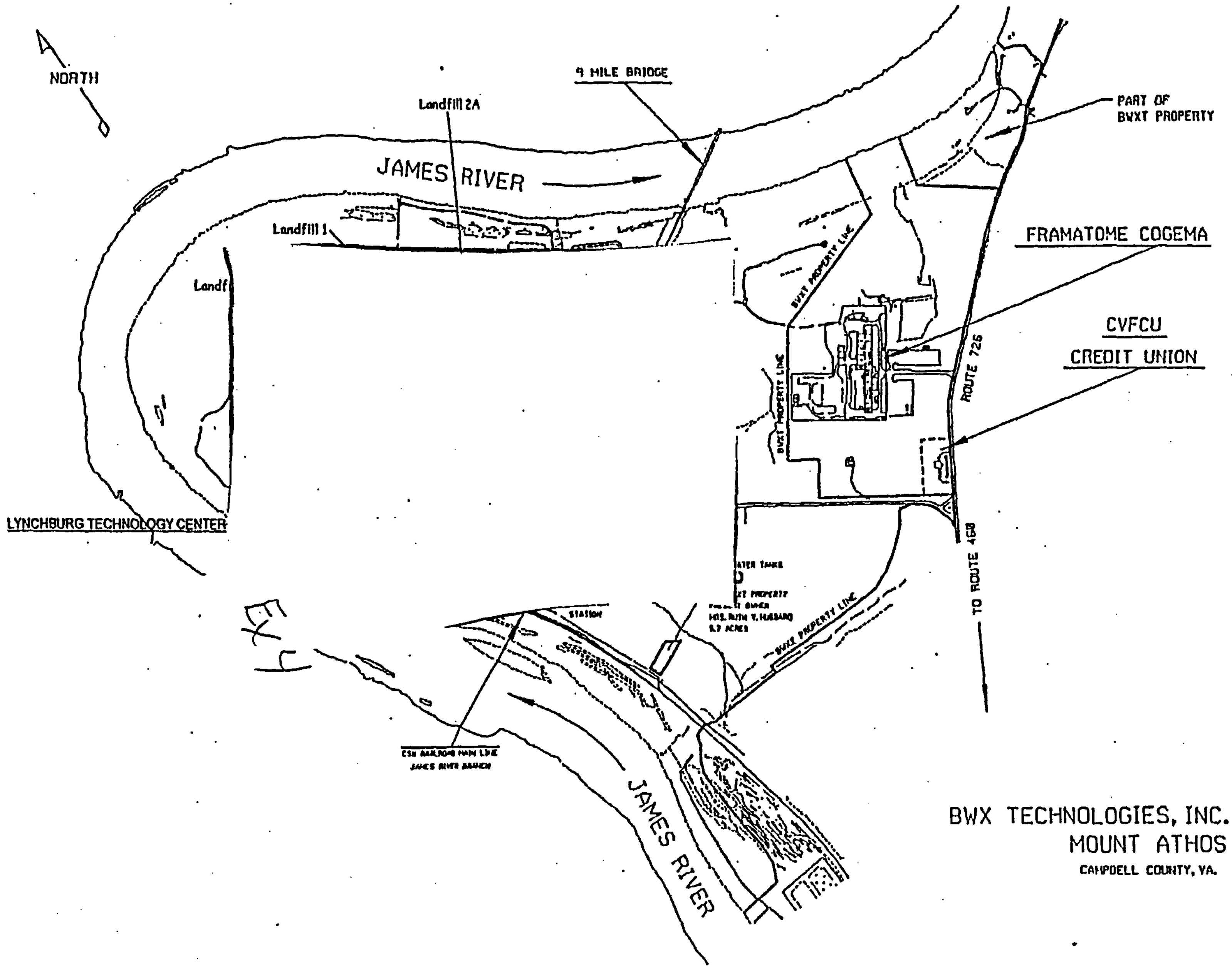
NRC 1994B USNRC Policy and Guidance Directive PG-8-08 "*Scenarios for Assessing Potential Doses Associated with Residual Radioactivity*", May 1994.

NRC 1996 USNRC Branch Technical Position on *Screening Methodology for Assessing Prior Landfills of Radioactive Waste Authorized Under Former 10 CFR 20.304 and 20.302*, November 1996

NRC 1997 USNRC, *Method for Surveying and Averaging Concentrations of Thorium in Contaminated Subsurface Soil*, prepared by NRC staff in connection with the review of the AAR "Site Remediation Plan for the Former Brooks and Perkins, Inc. Site", Docket #040-00235, received by BWXT, 1997.

Appendix A, Figures

Figure 1, NPD Site Map and Locations of Industrial Waste Landfills



Date: 07/21/97

Figure 3, Geophysical Survey Results for Landfill 1

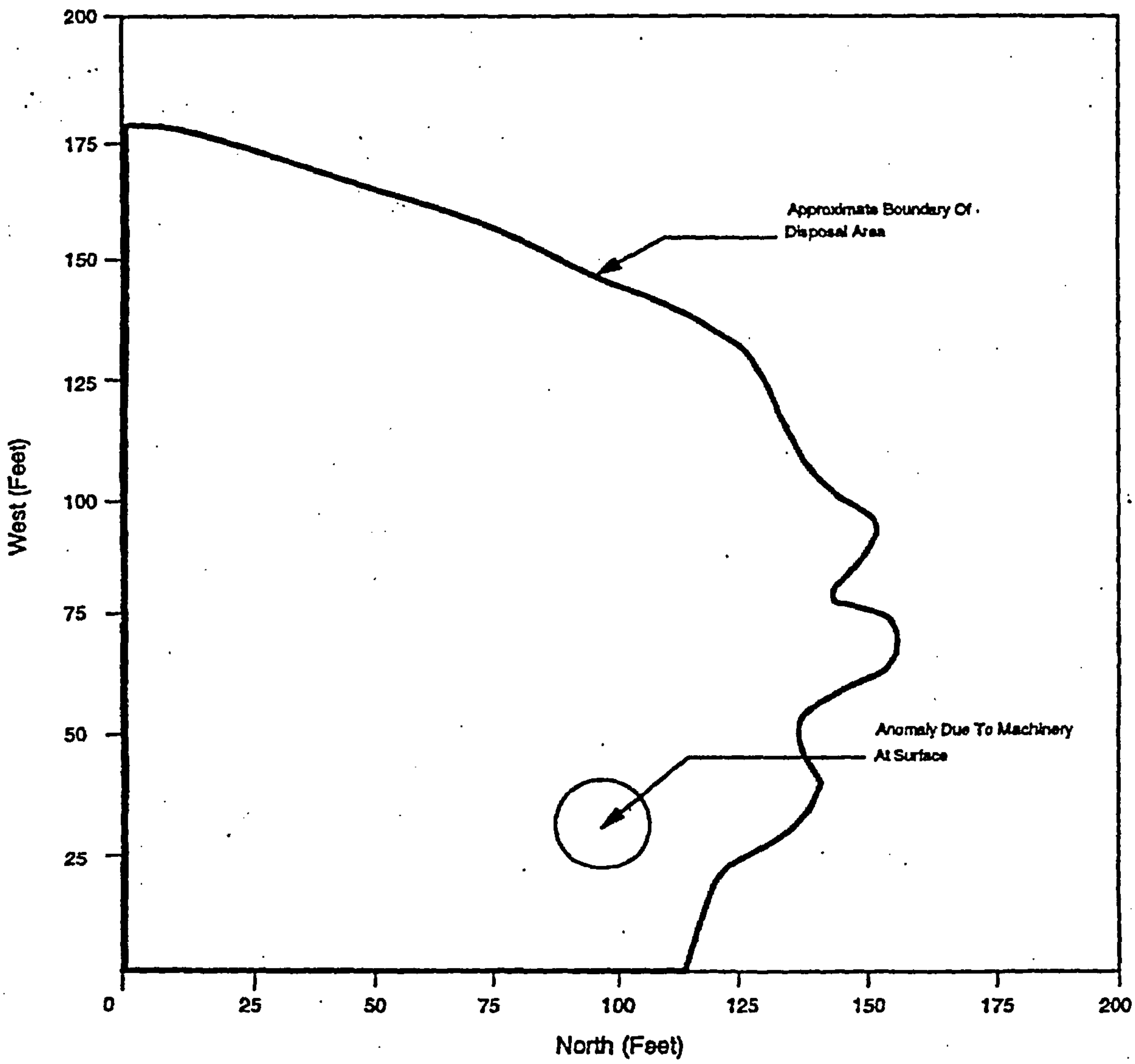
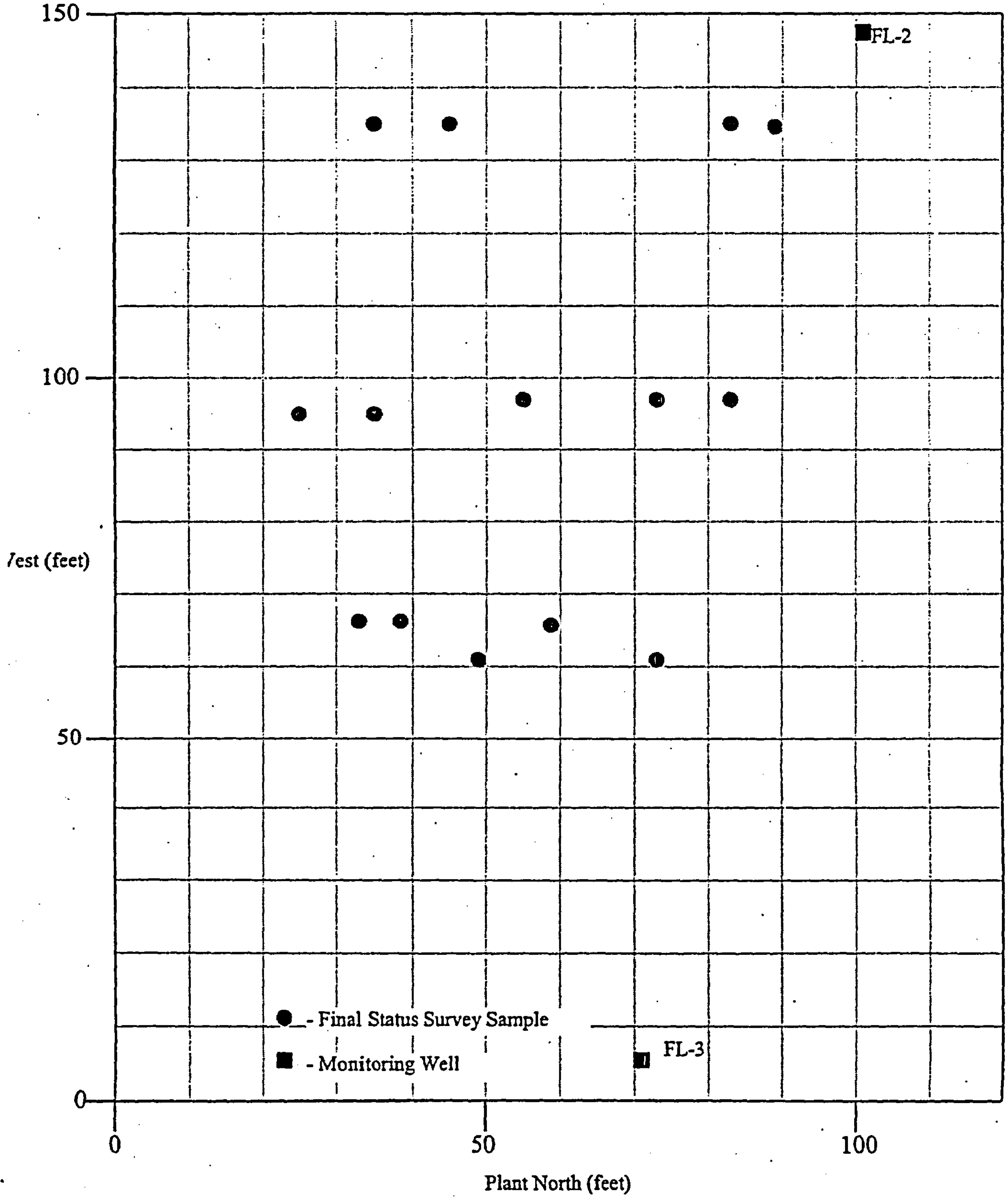


Figure 4, 1993 Sampling Event Locations for Landfill 1



Appendix B Tables

Table 1, Characteristics of Waste Streams

Waste Stream	Average Annual Volume	Source of Data
Non-radioactive Pickling Operations	62.9×10^6 liters	Records (1976-1990)
Pickling Operation Fume Scrubber Discharge (*recycle water*)	8×10^6 liters	Daily average
Lime Slurry Makeup Water Source (radioactive and non-radioactive combined), *recycle or recirculated water*	10×10^6 liters*	1984 & 1985 daily averages
Imhoff Settling Solids and Sanitary prescreened, etc	0.2×10^6 liters	Estimate
Filter Cake Sludge	0.9×10^6 liters	Records (1976-1990)

* - it is estimated that the "cold" system used 70% of the lime slurry

Table 2, Trench Characteristics

Landfill Area	Trench #	Trench Dimensions (feet)			Trench Volume (ft³)	Volume Buried* (ft³)
		Length	Width	Height		
1	1	75	10	3	2,250	2,925
	2	75	10	3	2,250	2,925
	3	135	10	3	4,050	5,265
	4	135	10	3	4,050	5,265
	5	135	10	3	4,050	5,265
	6	135	10	3	4,050	5,265
	7	44	5	3	660	858
	8	50	10	3	1,500	1,950

* - estimated to be 30% more than the volume of the trench

Table 3, Chronology of Significant Events for the Industrial Waste Landfills

Date	Event
1972	Use of Landfill 1 begins
1976	Burials in Landfill 1 are terminated
1977	Use of area A of Landfill 2 begins
1984	Waste Treatment Operations begin using the "recirculated" water system for lime slurry make-up
1988	Burials in section A of Landfill 2 are terminated
1989	Use of area B of Landfill 2 begins
October 1989	A comprehensive review of plant water systems and their uses identifies possibility that the pickle acid sludge may be contaminated
Oct. – Nov. 1989	Samples of "in-process" pickle acid sludge taken
January 1990	Sample results received, low levels, may be attributable to natural uranium in lime
April 1990	Samples of material buried in landfill taken
April 22, 1990	Use of Re-circulated water for lime slurry make-up terminated
June 1, 1990	Landfill samples indicate enriched uranium contamination, use of Landfill 2 terminated
October 1990	BWXT receives violation for unauthorized burial of licensed material
February 1991	BWXT, supplemental reply to violation; BWXT commits to characterization of landfills **with the intent *to request permission to leave the material in place following the characterization***
September 1991	EPA issues consent order requiring non-radioactive characterization of landfills
March 1992	BWXT submits Characterization Plan (CP) to NRC
June 1992	NUREG/CR-5849, "Manual for Conducting Radiological Surveys in Support of License Termination", Draft Report, published
November 1992	Revised CP submitted
November 1993	NRC approves CP
June 1994	Phase I sampling of landfill begins
August 1994	10CFR70.38, "Timeliness in Decommissioning Rule" becomes effective
September 1994	Phase I sampling of the landfills completed
December 1994	BWXT submits results of characterization to NRC
June 1995	NRC informs BWXT that the "Timeliness in Decommissioning Rule" applies, requests information on decommissioning
October 1995	BWXT requests delay in decommissioning
November 1995	Soil samples surrounding trenches taken, confirm no migration of activity has occurred
May 1996	BWXT re-requests delay
November 1996	BWXT submits Decommissioning Plan (DP) and requests delay if exhumation is required
January 1997	NRC states that BWXT should submit a Final Status Survey Plan and comments on DP
February 1998	NRC Approves Decommissioning Plan
April 1998	BWXT submits Final Status Survey Plan
September 1999	BWXT submits Final Status Survey Report for IW Landfills
May 2000	NRC requests IWL #1 Trench 2 and Trench 3 be remediated
August 2000	BWXT proposes revising FSSR to address 2A/2B only and revise DP and FSSP to address IWL #1 only.
November 2000	NRC accepts proposal to revise FSSR for landfills 2A/2B and DP/FSSP for IWL 1.
December 2000	BWXT requests delay in decommissioning IWL #1 until waste is delisted or 5 years.
December 2000	BWXT submits FSSR addressing IW Landfill 2A/2B
February 2001	NRC ammends SNM-42 (license condition S-13) to allow BWXT to submit the FSSR for IWL #1 by May 2006 and submittal of revised DP and FSSP for IWL by July 31, 2001
May 2001	NRC accepts/approves revised FSSR for IWLs 2A and 2B (license condition S-14).
July 2001	BWXT submits revised DP and FSSP for IWL #1 only
November 2001	Waste material identified outside the IWL defined boundaries
December 2001	Sampling performed to redefine the boundaries of IWL 1
July 2002	BWXT submits revised FSSP and Decommissioning Plan for IWL 1

Table 4, Anticipated Activity Fractions

Isotope	% Activity
U-234	~94%
U-235	~5%
U-238	~1%

Table 5, Fission Product Activity in Pickle Acid Sludge

	^{58}Co	^{60}Co	^{109}Cd	^{134}Cs	^{137}Cs
Maximum Activity (pCi/g)	0.01	0.09	0.009	0.02	0.03
No. of Detects	2/23	19/23	1/23	4/23	11/23
Maximum Dose Rate using RESRAD*	0.002	0.6	0.05	0.08	0.05

* - the maximum dose rate for HEU at 30 pCi/g using PG-8-08 & RESRAD defaults is 33 mrem/yr

Table 6, Environmental Availability of Uranium Analysis Results

Composite	Isotope	Total Uranium (pCi/g)	Total Available Uranium (pCi/g)	Soluble Fraction
	U-234	63.6	27.29	
	U-235	1.66	< 0.34	
	U-238	1.21	0.25	
A Landfill 1	Total U	66.47	27.54	0.41
	U-234	42.0	25.33	
	U-235	1.04	0.77	
	U-238	1.0	0.52	
B Landfill 2A	Total U	44.04	26.62	0.61
	U-234	23.5	12.56	
	U-235	0.52	0.28	
	U-238	1.32	0.58	
C Landfill 2B	Total U	25.34	13.42	0.53
Overall Average				0.52

Table 7, Acceptable Sub-surface Elevated Areas for Options 1 and 2 Guideline Values

Scenario No.	Volume (m^3)	Option 1 Guideline Value (pCi/g)	Acceptable Sub-surface Elevated Area Concentration (pCi/g)	Option 2 Guideline Value (pCi/g)	Acceptable Sub-surface Elevated Area Concentration (pCi/g)
1	1	30	402	140	1170
2	10	30	183	140	630
3	75	30	126	140	540
4	100	30	126	140	520
5	300	30	96	140	450

Table 8, Groundwater Monitoring Results
(alpha activity pCi/l)

Year	FL-2
<1995	ND
1995	0.13
1996	1.80
1997	8.89
1998	1.13
1999	1.14
2000	2.84
2001	1.02

Well No.	Location
FL-2	Approximately 15 feet north (down gradient) of landfill area 1

ND - No Data

NOTE: Monitoring well FL-2 was installed as a part of a RCRA Facility Investigation (RFI) conducted under approval by the EPA. The design and installation of these wells was approved by the EPA as a part of the RFI work plan.

Table 9, Landfill Migration Samples

Sample Location (up/down gradient)	Depth (feet)	Uranium Activity U-234 (pCi/g)	U-235 (pCi/g)	U-238 (pCi/g)	Total U (pCi/g)
1 Up	3-4	0.89	< 0.09	0.95	1.84
	6-8	1.10	<0.03	1.01	2.11
	9-10	1.42	0.05	1.43	2.90
4 Up	3-4	1.36	<0.04	1.24	2.60
	3-4 Dup	1.36	<0.25	1.27	2.64
	6-8	1.32	<0.25	1.21	2.53
	9-10	1.14	<0.05	1.08	2.22
	9-10 Dup	1.24	0.07	1.10	2.42
6 Up	3-4	1.21	<0.03	1.15	2.37
	6-8	0.94	<0.10	0.89	1.83
	9-10	0.97	<0.14	0.95	1.92
2 Down	3-4	1.11	0.06	0.77	1.95
	6-8	1.16	0.03	0.93	2.12
	9-10	1.46	<0.03	1.04	2.51
3 Down	3-4	1.22	0.09	1.10	2.42
	6-8	0.98	0.05	1.15	2.18
	9-10	2.55	0.16	1.49	4.20
5 Down	3-4	1.14	<0.10	1.23	2.37
	6-8	1.34	0.20	1.13	2.68
	9-10	1.14	0.04	1.15	2.34

	Down Gradient Samples	Up Gradient Samples
Average (pCi/g)	2.31	2.53
Std Dev (pCi/g)	0.35	0.66
$T_{(1-\alpha)}$	1.729	1.729
n	11	9
μ_α	**2.49**	**2.91**

Table 10, Summary of BWXT Site Background Measurements

Parameter	Value
$\bar{x}_{B\ (Total\ U)}$	2.12 pCi/g
s_x	0.67 pCi/g
$t_{95.5\%,\ df}$	2.042
n_B	10

BWX TECHNOLOGIES, INC.

NUCLEAR PRODUCTS DIVISION

DECOMMISSIONING PLAN FOR THE INDUSTRIAL WASTE LANDFILL NO. 1

TAC NO. L21642

SPECIAL NUCLEAR MATERIALS LICENSE, SNM-42

REVISION 3, JULY 01, 2002

1.0 GENERAL INFORMATION

1.1 Name, Address, and Corporate Information

1.1.1 Name

The BWX Technologies, Inc.
Nuclear Products Division

1.1.2 Address

BWX Technologies, Inc.
Nuclear Products Division
P. O. Box 785
Lynchburg, Virginia 24505-0785

1.1.3 Corporate Information

The licensee is BWX Technologies, Inc. (BWXT), a Delaware Corporation which is a wholly owned subsidiary of Babcock & Wilcox Investment Company, Inc., a Delaware Corporation. Babcock & Wilcox Investment Company, Inc. is a wholly owned subsidiary of McDermott Incorporated, also a Delaware Corporation. McDermott Incorporated is a wholly owned subsidiary of McDermott International, Inc. a Panama Corporation, which is a publicly traded company on the New York Stock Exchange. The principle offices of BWXT are located at:

1450 Poydras Street
New Orleans, LA 70112--6058

1.2 Affected Licenses

This decommissioning plan was developed in response to 10CFR70.38 "Expiration and Termination of Licenses and Decommissioning of Sites and Separate Buildings or Outdoor Areas" and NRC Letter 01-021 (dated 2/26/01) to address decommissioning of the Industrial Waste Landfill (IWL) #1 located at the Nuclear Products Division facility. The plan will be executed under license SNM-42 and will terminate license consideration of IWL #1. The plan does not otherwise affect the status of SNM-42.

2.0 DESCRIPTION OF PLANNED DECOMMISSIONING ACTIVITIES

2.1 Decommissioning Objective, Activities, Tasks and Schedules

2.1.1 Decommissioning Objective

This plan was developed in accordance with Regulatory Guide 3.65, "Standard Format and Content of Decommissioning Plans for Licensees Under 10 CFR Parts 30, 40, and 70" (NRC 1989), and draft NUREG/CR 5849, "Manual for Conducting Radiological Surveys in Support of License Termination" (NRC 1992), with the ultimate objective of:

1. Demonstrating through characterization of the landfill, or portions thereof, that the average contamination levels meet the criteria of Option 1 of the Branch Technical Position (NRC 1981). This will be referred to as Option 1 throughout this plan.
   OR

2. Demonstrating through characterization of the landfill that the average contamination levels, the characteristics of the material buried, and the site characteristics, meet the criteria of Option 2 of the Branch Technical Position (NRC 1981). This will be referred to as Option 2 throughout this plan.

For those areas decommissioned under Option 2, capping of the landfill will be necessary to assure the minimum burial depth.

Note that the Final Status Survey Report (FSSR) for IWLs 2A and 2B was submitted to the NRC in Dec., 2000 with conditional release of these landfills granted in May, 2001. The IWL 2A/2B FSSR was written based on the previous revision of the Decommissioning Plan (DP) and Final Status Survey Plan (FSSP). Consequently, this DP and the associated FSSP address only IWL #1.

The IWL #1 was characterized as described in the FSSR submitted Sept 1999. NRC responded to that FSSR in NRC Letter 00-043 (dated May 19, 2000), stating that Trench 2 and a portion of Trench 3 should be remediated. Excavation of IWL #1 Trench 2 and a portion of Trench 3 will be required before Option 2 of the Branch Technical Position can exercised for IWL #1. Additional information was gathered on two additional trenches discovered in 2001. That data is incorporated into the data already presented and is not expected to change current instructions or positions regarding IWL #1.

2.1.2 Description

2.1.2.1 Background

Landfills

From 1972 until 1990, BWXT operated two industrial waste landfills at the [redacted] (see Figure 1 for approximate locations). The first landfill was used from 1972 until 1976. The second landfill was used in two sections. The first section operated from 1977 until 1988; the second section operated from 1989 until 1990. Use of the landfills was discontinued after June 1990, because the filter cake material was found to contain low levels of radioactive contamination. Ex 4

Both landfills were operated in a relatively similar manner. Filter cake material was placed in a series of parallel trenches. Each trench was excavated; sludge material was transported to the trench at one end and dumped by roto-hopper in piles until this area within the trench was full. Successive piles of filter cake material placed in the trenches were mounded above ground level. The volume of the filter cake placed in the trenches was reduced by approximately 35% after allowing it to dry, resulting in the mound above ground settling below grade. Excavated material from the trench was used as a cover of top soil approximately two feet in depth. The surface was then allowed to vegetate naturally.

Based on Geoprobe® sampling conducted at IWL #1, eight trenches were identified. Trenches vary from approximately 5 to 10 feet wide with a landfill material thickness of about 3 feet. Four of the six trenches are 135 feet long, two trenches are 75 feet long, and the other two are less than 50 feet long. Table 1 summarizes the different trench characteristics for IWL #1.

Table 1, IWL #1 Trench Characteristics

Trench Number	Trench Dimensions (feet)			Trench Volume (ft^3)	Volume Buried (ft^3)
	Length	Width	Height		
1	75	10	3	2,250	2,925
2	75	10	3	2,250	2,925
3	135	10	3	4,050	5,265
4	135	10	3	4,050	5,265
5	135	10	3	4,050	5,265
6	135	10	3	4,050	5,265
7	44	5	3	660	858
8	50	10	3	1,500	1,950

Waste Materials

The waste materials buried in the landfill included filter cake from the pickling acid treatment system, solids from the Imhoff settling system, prescreened material from the sanitary waste treatment system, and zirconium chips and fines. The pickling acid treatment system was used to treat acidic wastes from various processes. The acidic wastes were neutralized with hydrated lime and passed through a filter press. An anionic flocculating agent was added to the suspended solids, prior to filtering, to aid in dewatering. The resulting filter cake consisted of calcium fluoride, calcium hydroxide, and hydroxides of zirconium, iron, copper, and aluminum. The filter cake had a nominal moisture content of 50% at the time of burial. Approximately 60-90 cubic feet per day were generated and placed in the landfills.

The Imhoff system collected solids from grit blast operations; blow down from precipitators and sand filters used to treat river water; backwash from softeners, demineralizers, and sand filters used to treat well water; and other non-acid industrial waste streams. The Imhoff settling pits were cleaned twice per year. Approximately 160-200 cubic yards of cleanout solids were buried in the landfills each year.

Radioactive Contamination Pathway

Until 1990, BWXT considered the waste materials being buried in the landfills to be non-radioactive. In 1990, BWXT discovered the waste materials were being radioactively contaminated by two plant water systems known as the recycle water system and the re-circulated water system.

Ex 4

When the [redacted] facility was built, a closed loop recycle water system was installed to provide water for non-contact cooling of various plant equipment, the fire protection system, and the sanitary waste system. The water was also used in grit blast operations, acid fume scrubbers, and pickling acid treatment. To replace evaporative and other losses from the recycle system, makeup water was provided from the James River and from the collection of rain water from roof runoff drains and storm sewer drains.

Since its installation, the entire recycle water system had been contaminated with enriched uranium from the airborne effluent discharged from the ventilation system which served uranium processing operations. The airborne effluent settled on facility roofs and ground areas and entered the recycle water system in rain water from roof runoff and storm water drains. The primary source of contamination was airborne effluent from the Uranium Recovery operations. This effluent was moist, acidic, and contained soluble uranium compounds.

The recycle water system was known to contain low levels of radioactivity and was routinely sampled. Data from 1979 to 1990, indicated the action level of 50 pCi/liter was exceeded only six times. Two of those exceeded levels were caused by contamination which entered the recycle water system from the rupture of a radioactive waste line in 1981.

In 1984, a piping system was installed to use a portion of the liquid effluent discharging into the James River. This effluent contained radioactivity from the treatment of radioactive liquid wastes. The effluent was re-circulated for use in waste treatment operations including pickling acid treatment. This system, which was known as the re-circulated water system, contained higher levels of radioactivity than the recycle water system, but the routine levels were less than one percent of the maximum permissible concentration specified in 10 CFR 20 Appendix B.

Investigation

During a 1989-1990 review of the recycled and re-circulated water usages, BWXT determined that waste materials being buried in the landfills contained low levels of enriched uranium. Consequently, all landfill burials were terminated in June 1990. A more detailed description of activities is discussed in NRC inspection report 70-27/90-19 (NRC 1990).

2.1.2.2 Site Characterization

In order to use Option 2, characteristics of the site must be described. The following descriptions of the site were originally reported in an investigation submitted to the Environmental Protection Agency (IT 1992).

Physiography

The dominant topographic features at BWXT are a hill located on the southern boundary of the property and a large 100-year flood plain located on the northern boundaries of the property. The crest of the hill rises 68 meters (m) (226 feet) above the James River, which is approximately 143 m (470 feet) above mean sea level (msl). Looking east toward the site, the area is somewhat wedge-shaped, with the southwest boundary of the site steeply sloping from the hill to the river and the northerly flood plain edges have 2- to 3-m high scarps. Most of the site has a northern exposure. Within the 525-acre site, 39 acres are fenced for the facility and an additional 55 acres (approximately) are covered with buildings, reservoirs, roads, and parking lots. A railroad line, owned by the CSX Railroad, follows the James River along the western boundaries of the site.

Climate

The Lynchburg area is influenced by cold and dry polar continental air masses in the winter and warm and humid gulf air masses in the summer. Extremes in weather conditions are rare. Mean temperature is approximately 13.7 degrees Celsius (°C) (56.7 degrees Fahrenheit [°F]) with normal average temperatures ranging from 24.6°C (76.3°F) in July to 3.6°C (38.5°F) in December. Rainfall amounts at Lynchburg average 102.4 centimeters (cm) (40.4 inches) in any given year, with monthly precipitation rates nearly uniform, although they are slightly higher during the summer months. Snowfall in the Lynchburg area generally occurs between the months of December and March, with a mean yearly snowfall total of 49.3 cm (19.4 inches). Monthly mean relative humidity values in Lynchburg at 7:00 a.m., 1:00 p.m., and 7:00 p.m. are 78.1 percent, 51.0 percent, and 62.0 percent, respectively.

Regional Geology

The BWXT Mt. Athos site is located in the western part of the Piedmont Geomorphic Province. The Piedmont Province is underlain by Precambrian and Paleozoic metamorphic and igneous rocks, Triassic sedimentary rocks, and erratic basaltic sills and dikes. The rock types at the facility consist of lustrous, gray-green phyllite, and fine- to coarse-grained schist, and mica quartzite members of the Lower Paleozoic Chandler Formation, which is part of the oldest member of the Evington Group. The metamorphism of these rock types is the result of folding and faulting associated with the Appalachian Orogeny in the James River Synchlinorium. The bedrock beneath the site is overlain by Quaternary alluvium and terrace deposits consisting of gravel, sand, silt, and clay materials typically found in fluvial depositional environments.

Site Geology

The subsurface beneath the landfill area is characterized by sands, silts, and clays along with alluvial pebbles, cobbles, and boulders, which are typically found in fluvial depositional environments. Bedrock is generally found 15 to 20 feet below ground surface (bgs). Monitoring wells installed in the vicinity encountered bedrock ranging from a brown and brownish-gray to a gray and bluish-gray micaceous schist with mafic minerals, probably from secondary mineralization, in trace amounts. Pyrite crystals of 3 to 5 millimeters were recovered from the cuttings during the drilling of one of the monitoring wells. There was little evidence of local structural features of the bedrock and bedrock weathering was confined to the first 3 feet.

Surficial geology in the area is composed mainly of Quaternary-age alluviam and Quaternary or older terrace gravel. Below the 100-year flood plain, surficial deposits above bedrock are characterized by sands, silts, and clays in various percentages, along with alluvial pebbles, cobbles, and boulders typically found in fluvial depositional environments. Above the 100-year flood plain, the clay-rich soils found are typical of in situ weathering of limestone bedrock. Borings and excavations at the BWXT site itself have confirmed that the site is blanketed by a layer of dark-brown, sandy-clay topsoil that contains extensive root structures. The topsoil is 13 to 40 cm (6 to 18 in) thick and is underlain by strata of firm, primarily cohesive soils such as clay and silt loam.

Mineral deposits located within the area are manganese, iron, and barite. Nearly all of these minerals have been found in or near beds of the Mt. Athos formation.

Surface Water Hydrology

The James River flow generally east-southeast from the Valley and Ridge Physiographic Province to the Atlantic Ocean through Hampton Roads and the Chesapeake Bay. However, next to the BWXT facility, it is flowing northwest. The river is formed approximately 154 kilometers (km) (96 miles) upstream of BWXT by the confluence of the Jackson and Cowpasture Rivers, and bends around three sides of BWXT. Based on data from U.S. Geological Survey (USGS) gauging stations, the average annual flow rate adjacent to BWXT has been estimated to be 110 cubic meters per second (m^3/s) (3900 cubic feet per second [ft^3/s]).Water quality of the James River is classified by the Commonwealth of Virginia as suitable for drinking water purposes.

There are no natural ponds or lakes on the BWXT facility and the only permanently pooled surface waters are man-made impoundments, all of which are involved in some manner with either plant operations or storm water surface drainage. Most surface water flow is drainage from buildings and parking lots or runoff from rain events. Perennial and intermittent streams and groundwater seeps or springs also contribute to surface flows. Perennial streams are spring-fed from groundwater and do not pool before traveling down gradient.

Surface water drainage on the BWXT site generally flows north and northeast into the James River at three outfalls. The first is a modified creek (ditch) in the [redacted] area that accommodates Ex4 runoff from the [redacted] facility. This creek has been diverted and impounded below the facility to provide flood control. Slightly downstream of the diversion, the impoundment discharges back into the creek at a Virginia Pollution Discharge Elimination System (VPDES)-permitted outfall. The second and third outfalls are also stream/ditch systems.

Groundwater Hydrology

Groundwater elevations in the James River flood plain range from approximately 0.3 m (1 foot) below ground surface to approximately 2.1 m (7 feet) bgs. At higher elevations, groundwater levels are approximately 6.1 to 9.1 m (20 to 30 feet) below grade. Groundwater elevation contours mirror surface to topographic contours and groundwater flow is perpendicular to the contour lines, toward the James River. The surficial aquifer is relatively porous, and shallow monitoring wells were able to sustain short-term pumping rates of 1.5 to 5 gallons per minute (gpm). A comparison of shallow and deep monitoring well levels shows the flood plain adjacent to the James River to be a groundwater discharge area. Groundwater also emerges at a number of seeps at or below the 152-m (500-foot) contour.

The average groundwater depths in the area of the IWL's, are 2.6 to 4.1 feet bgs, depending on the time of year. Most shallow monitoring wells in the immediate areas were pumped at a rate of 3.5 to 5.0 gpm; deep wells maintained a rate of 0.5 gpm.

Calculated horizontal hydraulic gradients from the main plant area to the flood plain area where IWL's 2A and 2B are located, is 0.064 foot per foot (/foot/foot), with the gradient from the flood plain area towards the James River decreasing to 0.029 foot/foot, near the area where IWL 1 is located.

All the wells emplaced during the RFI conducted by IT Corporation (IT) were tested for in situ permeability by a slug test method. The permeability values range from 1.7 x 10^{-3} to 8.9 x 10^{-5} centimeters per second (cm/s) (4.7 to 0.25 feet per day) for a mean of 9.42 x 10^{-3} cm/s (2.67 feet per day). Calculated average groundwater flow rate for the landfill areas based on an estimated porosity of 30 percent is 0.26 foot per day.

Current and Future Land Use

Current land use in the area of the Mt. Athos site is mixed. Industrial users include the BWXT, Framatome-Cogema Fuels (formerly B&W Fuel Company), and the Intermet Foundry (formerly the Lynchburg Foundry Company). At least nine residential properties and nine farms are located in the vicinity. BWXT is the sole source supplier of [redacted] a technology that is expected to continue well into the future. Accordingly, the Mt. Athos site proper is unlikely to be used for purposes other than industrial in the foreseeable future. In addition, the land is posted with no trespassing signs; patrols maintain the security on the site; and certain areas, such as the Final Effluent Ponds, are fenced, greatly restricting access

Ex 4

by unauthorized users, such as hunters and fishermen.

2.1.2.3 Characterization of the Material Buried (Solubility)

The landfills were used to dispose of filter cake solids generated from the neutralization of acidic waste from various processes. The resulting filter cake consisted of 55% calcium fluoride and 45% zirconium hydroxide, plus small quantities of other metal hydroxides (i.e., iron, copper, aluminum, and uranium).

In 1979, BWXT evaluated the leachability of enriched uranium from CaF_2 solids generated in the treatment of Low Level Radioactive waste (LLR) solutions. Three tests, a Soxhlet leach test, a static migration test, and a long-term leach test were performed as part of the evaluation. These tests concluded, based on evidence that there was no migration or transport of the uranium from the filter cake, that the CaF_2 filter cake is insoluble. In addition, since the tests were very aggressive relative to the conditions expected in a LLR Waste Disposal Facility, the study concluded that the filter cake was a very stable material suitable for burial as LLR waste.

The Radionuclide Characterization Plan (NRC 1993), required sampling of the soil at three depths down gradient of each landfill. A total of twenty samples were pulled at nominal depths of three, six, and nine feet. The down gradient samples were compared to up gradient samples. Based on the soil monitoring results, there is no evidence of migration of activity from the landfills into the soil.

All three leach tests demonstrate the buried material is insoluble and the groundwater monitoring and soil sampling demonstrate that there is no evidence of migration from the burial sites.

Samples of the landfill taken in 1994 as a part of the Characterization Plan (NRC 1993) were archived. From the archived samples, a random sample from each landfill was chosen for analysis. The determination of the soluble fraction of uranium was based on a sequential extraction approach as described in NUREG/CR 6232, "Assessing the Environmental Availability of Uranium in Soils and Sediments" (NRC 1994). The method described in Appendix C of NUREG/CR 6232, for estimating the quantities of total uranium, readily available uranium, slowly available uranium and very slowly available uranium was used to define the environmental availability of the uranium. The results of this test indicate that the uranium material consists of 52% soluble and 48% insoluble uranium compounds.

2.1.2.4 Excavation of Trench 2 and a Portion of Trench 3

Eight samples in IWL #1 exceeded the initial Option 2 calculated Guideline Value of 140 pCi/g, as described in the FSSR submitted December, 1999. These areas will be excavated and the landfill waste disposed of as radioactive waste. All of Trench 2 and a portion of Trench 3 will be excavated based on the elevated samples. Refer to Figure 2 for the estimated areas needing excavation. Post-excavation sampling will determine if sufficient excavation has occurred.

2.1.2.5 Capping and Covering of the Landfills

Option 2 requires the landfill be covered by at least 4 feet of soil. The soil covering the buried material that will not be excavated is nominally 2 feet. Therefore, the trench areas of IWL #1 that are left in place will require capping and covering to meet option 2.

The basic plan for closure at this facility for the remaining landfill would be a generally impermeable cap to inhibit infiltration of surface water (precipitation) through the 2 feet of cover which has already been applied by BWXT. This cap would be continuous cover over all trenches, including up to 5 feet beyond the outermost trenches on the site. The cap would then be covered to support growth of vegetation.

Capping: It is proposed that the cap have a permeability of less than or equal to 10^{-7}cm/sec. The 525 acre Babcock and Wilcox site has an abundance of suitable material on site. The USDA soil mapping for Campbell County indicates that the Babcock and Wilcox property has soil units having clayey subsoils including: Tatum loam, Turbeville fine sandy loam and Himassee loam. More than 50 acres of these soil units occur in undeveloped areas on the facility that can be set aside for use as borrow areas. Due to the short distance between the potential borrow areas and the landfill, the material can be excavated and imported to the landfill site and placed in layers and compacted so that the required degree of impermeability can be achieved.

Covering: A 0.5 ft. Layer of topsoil (a sandy loam soil which easily supports vegetative growth) is proposed. This material is also available on site. The surface sediments and the filled part of the landfill which has been filled and covered by the native materials have been readily vegetated by colonizing plants indigenous to the area; indicating the value of these soils is suitable to support vegetation to be planted for stabilization purposes. Availability and abundance of this type material appears to be of no concern. The area will be seeded, fertilized, limed, and mulched to promote vegetative growth and stabilize the soil to minimize erosion. Fertilization will be applied according to soil tests of the material. Prior to seeding, the surface will be smoothed and formed with a "cultipaker" or similar equipment. The seed mixture will be applied uniformly by hydro-seeding or equivalent. Grass and legume seeds would be mulched according to SCS specification. Final seed mixture will be determined with the assistance of the local conservation district representative.

2.1.2.6 Groundwater Monitoring

Groundwater monitoring has been performed extensively both up and down gradient of landfills 1 and 2 since 1994. A total of 84 samples have been analyzed with the average of all samples being less than 4.5 pCi/l. There has been no evidence of enriched uranium from any of the groundwater monitoring wells. Results from the well nearest to the landfills are summarized in Table 2-2.

Table 2-2, Radioactivity in Groundwater (pCi/L)

Monitoring Well		1995	1996	1997	1998	1999	2000	2001
FL-2	alpha	0.13	1.80	8.89	1.13	1.14	2.84	1.02
	beta	0.61	3.98	13.7	2.82	1.16	3.46	1.46
FL-2 is ~ 15 ft north of IWL #1 and down gradient towards river								

The sample data demonstrates that there is currently no evidence of migration of uranium from IWL #1.

The Final Status Survey Report will include an assessment of the potential groundwater impacts from leaving the material in place to demonstrate no significant risk to the public from drinking water and adequate protection of the groundwater aquifer.

2.1.2.7 Closure

The IWL's currently contain material that is a listed hazardous waste (F006). BWXT will continue to pursue a petition to EPA requesting delisting of the material and will provide an annual summary of progress towards delisting as described in license SNM-42 condition S-13.

2.1.3 Procedures

Section 2.7 of SNM-42 describes procedures used at [redacted] These procedures include the Radiation Protection Manual, and the Industrial Health and Safety Manual. The requirements of this section will be applied to all activities under this plan where there is a potential for exposure to radioactive material or where the execution of the task is essential to meeting the criteria. Ex 4

2.1.4 Schedules

The scheduler milestones for completion of decommissioning are as follows. NRC will be notified of any significant changes in this schedule.

Milestone	Completion Date
Submit initial Decommissioning Plan	4/24/97
Submit initial Final Status Survey Plan	4/24/98
Submit initial Final Status Survey Report	9/29/99
Submit revised Decommissioning Plan	7/31/01
Submit revised Final Status Survey Plan	7/31/01
Submit revised Decommissioning Plan	7/01/02
Submit revised Final Status Survey Plan	7/01/02
Obtain cost estimates for excavation	9/1/2004
Begin partial excavation of IWL #1	5/1/2005
Complete partial excavation of IWL #1 and properly dispose of wastes	5/1/2006
Submit Final Status Survey Report	7/1/2006
Obtain cost estimates for capping and covering	7/1/2006
Begin capping and covering	9/1/2006
Complete Capping and Covering and Complete	5/1/2007

2.2 Decommissioning Organization and Responsibilities

The organization for decommissioning shall be as described in Chapter 2 of SNM-42. The following responsibilities supplement those described in Chapter 2 and are specifically related to decommissioning.

Manager, Waste Operations

The Manager, Waste Operations, shall be responsible for overseeing operations at the Industrial Waste Landfills. He shall be responsible for assuring that applicable safety limits, controls, and procedures are followed. He shall be responsible for all contractors working on the IWL's.

2.3 Training

Training shall be as described in Section 3.2 of SNM-42. These training requirements apply to all individuals including contractors.

2.4 Contractor Assistance

Many of the activities associated with excavation and remediation, and capping and covering the landfills will be conducted by contractors. All contractors shall work under the authority of the Manager, Waste Operations. Contractors will not perform work with radioactive materials under this plan, therefore, no special training outside that described above will be required. Contractors will, however, be trained in procedures for performing the task. These procedures will contain safety precautions, as appropriate, as well as controls to assure the criteria is met (e.g., capping material and depth).

3.0 DESCRIPTION OF METHODS USED FOR PROTECTION OF OCCUPATIONAL AND PUBLIC HEALTH AND SAFETY

3.1 Facility Radiological History Information

The areas to be decommissioned have been fully described and characterized. Only IWL #1 will be impacted by this decommissioning event. Other landfill areas (2A and 2B) are in close proximity to IWL #1 but were released by the NRC in correspondence dated May 2001 (NRC 2001B)

3.2 Ensuring Occupational Radiation Exposures are ALARA

BWXT will operate according to Chapter 3 of SNM-42 which prescribes methods for maintaining exposures below limits specified in 10 CFR 20 and keeping exposures ALARA.

3.3 Radiation Protection Program

The Radiation Protection Program shall be in accordance with that described in

SNM-42.

3.4 Contractor Personnel

All requirements of sections 3.2 and 3.3 of this plan shall apply to contractor personnel. It shall be the responsibility of the Manager, Waste Operations to oversee contractor personnel to assure they operate in accordance with these requirements.

3.5 Radioactive Waste Management

The excavated radioactive waste will be handled in accordance with Section 3.4.1 of SNM-42 which authorizes disposal. As stated in Section 2.1.3 of this plan, this will be done according to approved procedures.

4.0 PLANNED FINAL RADIATION SURVEY

A radiation survey of the landfills was completed in 1994. The survey was performed according to a plan which was developed prior to the existence of Draft NUREG/CR 5849 (NRC 1992), however, the plan was based upon similar methodology and used many of the same references as Draft NUREG/CR 5849. This plan was developed by BWXT (B&W 1992) and approved by NRC in November of 1993 (NRC 1993), prior to initiation of sampling. The intent of the plan, once the evaluations were complete, was to ask for approval to leave the material in place (BWXT 1991).

The survey plan was based on a random sampling of the landfill areas. The landfills were separated into five distinct survey units based on the levels of contamination in the source term at the time the waste material was generated. Each survey unit was randomly sampled. The premise for the sampling plan was based on the fact that the source of contamination (primarily the recycle water system) was well characterized and relatively uniform. Periods of higher activity were delineated from periods of lower activity by separating the affected landfill sections into survey units based on the time periods that filter cake was generated and the corresponding activity in the source term (recycle water system).

An initial Final Status Survey Plan (FSSP) was developed in 1997 to demonstrate the acceptibility of the survey already performed and to identify additional survey requirements. This plan was submitted to NRC for review and approval.

A revised FSSP is being submitted in conjunction with this plan. Following submittal, approval, and execution of the revised FSSP; a revised Final Status Survey Report (FSSR) will be submitted to NRC to demonstrate the acceptability of the area for unrestricted release. The FSSR will include the survey results, an analysis of the survey results, and an assessment of the impact of leaving the material in place on the environment, including the impact on groundwater. The FSSR format and content will be based on the recommendations in draft NUREG/CR 5849 (NRC 1992).

5.0 FUNDING

This plan does not address termination of the license (SNM-42) and will be performed under existing license and accounting requirements o[redacted]. A cost estimate is, therefore, not necessary for this plan. Ex 4

6.0 PHYSICAL SECURITY PLAN

A physical security plan is not required for this plan.

7.0 REFERENCES

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NRC 1981 USNRC Branch Technical Position, *Disposal or Onsite Storage of Residual Thorium or Uranium (Either as Natural Ores or Without Daughters Present) From Past Operations* (SECY 81-576), October 5, 1981.

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NRC 1989 Regulatory Guide 3.65, "Standard Format and Content of Decommissioning Plans for Licensees Under 10 CFR Parts 30, 40, and 70"

NRC 1990 USNRC Inspection Report 70-27/90-19, September 1990

NRC 1991 *Environmental Assessment for Renewal of Special Nuclear Material License No. SNM-42, docket No. 70-27, Babcock & Wilcox Company,* [redacted] *Lynchburg, Virginia*, USNRC, August 1991 Ex.4

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NRC1994B USNRC Policy and Guidance Directive PG-8-08 "*Scenarios for Assessing Potential Doses Associated with Residual Radioactivity*", May 1994

NRC 1997 USNRC, *Method for Surveying and Averaging Concentrations of Thorium in Contaminated Subsurface Soil*, prepared by NRC staff in connection with the review of the AAR "Site Remediation Plan for the Former Brooks and Perkins, Inc. Site", Docket #040-00235, received by BWXT, 1997

NRC 1998 *Industrial Waste Landfills Final Status Survey Plan (TAC NO. L21642),* May, 1998, Letter to BWXT

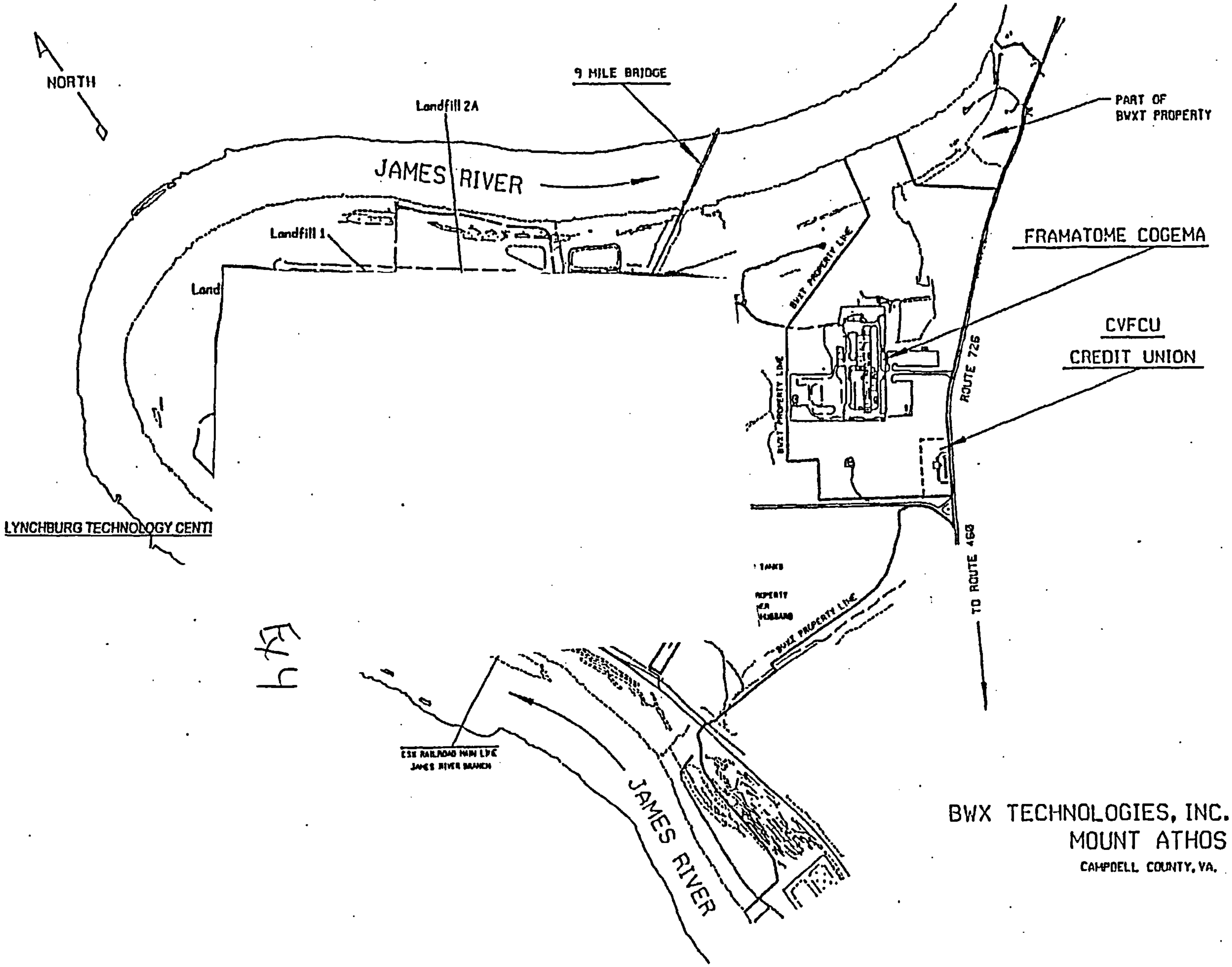
NRC 2000A *Industrial Waste Landfills Final Status Survey Report (FSSR) (TAC NO. L31259)*, May, 2000, Letter 00-043 to BWXT

NRC 2000B *Industrial Waste Landfills Final Status Survey Report (FSSR) (TAC NO. L31388)*, November, 2000, Letter 00-108 to BWXT

NRC 2001A *BWXT Amendment NO. 66 (TAC NO. L31446) Submittal Dated December 14, 2000, Postponment of Landfill No. 1 Decommissioning,* February, 2001, Letter 01-021 to BWXT.

NRC 2001B *BWXT Amendment NO. 71 (TAC NO. L31447) Submittal Dated December 22, 2000, Final Status Survey Report (FSSR) for the Industrial Waste Landfills 2A and 2B*, May, 2001, Letter 01-048 to BWXT.

Appendix A, Figures



Date: 07/21/97

Figure 1, NPD Site Map and Locations of Industrial Waste Landfills

Figure 2, Landfill 1 Trenches