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2001 Environmental Monitoring Report

**Bettis Atomic Power Laboratory
West Mifflin, Pennsylvania 15122-0079**

**Prepared for the
U.S. Department of Energy
By Bechtel Bettis, Inc.
Under Contract No. DE-AC11-98PN38206**

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**2001 ENVIRONMENTAL
MONITORING REPORT**

for the

**BETTIS ATOMIC POWER LABORATORY
PITTSBURGH SITE**

**PREPARED FOR THE U.S. DEPARTMENT OF ENERGY BY
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WEST MIFFLIN, PENNSYLVANIA 15122-0079**

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LIST OF ACRONYMS

CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CMS	Corrective Measures Study
DCE	1,2-Dichloroethylene
DL	Duquesne Light
DLC	Decision Level Concentration
DOE	U.S. Department of Energy
EPA	U.S. Environmental Protection Agency
HEPA	High Efficiency Particulate Air
NPDES	National Pollutant Discharge Elimination System
NRC	Nuclear Regulatory Commission
PADEP	Pennsylvania Department of Environmental Protection
PA/SI	Preliminary Assessment and Site Inspection
PAH	Polynuclear Aromatic Hydrocarbon
PCB	Polychlorinated Biphenyls
PCE	Tetrachloroethylene (Perchloroethylene)
RCRA	Resource Conservation and Recovery Act
RFI	RCRA Facility Investigation
SIS	Springwater Intercept System
TCE	Trichloroethylene
TLD	Thermoluminescent Dosimeters
VOC	Volatile Organic Compound
VNGI	Valley National Gases, Inc.

OTHER COMMON ABBREVIATIONS

μCi	microcurie = 1×10^{-6} curie
μCi/ml	microcuries per milliliter
	micrograms per liter
mg/l	milligrams per liter
mrem	millirem
ml	milliliter
mg/kg	milligrams per kilogram
pCi	picocurie = 1×10^{-12} curie
pCi/g	picocuries per gram
pCi/l	picocuries per liter

ABSTRACT

The 2001 results for the Bettis-Pittsburgh radiological and nonradiological environmental monitoring programs are presented. The results demonstrate that the existing procedures ensured that releases to the environment during 2001 were in accordance with applicable Federal, State, County, and local regulations. Evaluation of the environmental data indicates that current operations at the Site continue to have no adverse effect on human health and the quality of the environment.

A conservative assessment of radiation exposure to the general public as a result of Site operations demonstrates that the dose received by any member of the public was well below the most restrictive dose limits established by the Environmental Protection Agency, the Nuclear Regulatory Commission, and the U.S. Department of Energy.

A risk assessment of potentially exposed populations to chemical residues in the environment at the Site demonstrates that any potential risk posed by these residues is much less than the risks encountered in normal everyday life.

EXECUTIVE SUMMARY

The results of the 2001 radiological and nonradiological environmental monitoring programs for the Bettis Atomic Power Laboratory-Pittsburgh Site are summarized below. Tables 1 and 2 summarize the major elements of the environmental monitoring programs.

Liquid Effluents (Other than to Sanitary Sewer)

Approximately 48,400,000 gallons of noncontact cooling water, process waste water, and storm runoff were released to the environment via the Bull Run (Outfall 001) and Northeast Area (Outfall 002) Monitoring Stations. Radioactivity attributed to current Site operations was not detected in any of the samples of these releases. Radioactivity concentrations were either below decision level concentrations (DLCs) or were typical of background levels in city water and precipitation with the exception of a single detection of low level radioactivity in Outfall 001 attributable to residual historic radioactivity in or around the storm drain line. If one were to exclusively drink the water containing the Bettis radioactivity from Outfall 001, the amount ingested would be less than the amount of natural radioactivity found in one banana. The Decision Level Concentration (DLC) is the minimum value of the measured analyte concentration that provides a degree of confidence that a positive amount of analyte is present in the material analyzed. Monitoring data for chemical constituents in liquid effluents demonstrated that these effluents did not have any significant impact on the quality of the receiving water. These results demonstrated compliance with the U. S. Department of Energy (DOE) standards and the Site's National Pollutant Discharge Elimination System (NPDES) Permit.

Storm water runoff via Storm Water Outfalls 003, 004, 005 and 006 and treated ground water via Outfall 007 was released to the environment. These discharges were made in accordance with the Site's NPDES Permit.

Sanitary Sewer Discharges

Sanitary sewage was discharged to a Publicly Owned Treatment Works. Wastes discharged to the sanitary system were in compliance with applicable regulations.

Radioactivity attributable to Site operations was not detected in any of the samples of processed ground water which was discharged to the sanitary sewer system.

Ground Water

Analyses of the ground water samples from five water-bearing zones beneath the Site show only low levels of strontium-90 similar to that found from worldwide testing of nuclear weapons. These levels of strontium-90 are consistent with background radioactivity found in virtually all drinking water.

The results of the majority of the ground water analyses for a variety of chemicals were less than minimum detection levels. Some analyses indicated the presence of volatile organic compounds (VOCs), primarily tetrachloroethylene (PCE), which are associated with past degreasing operations at Bettis and possibly by prior tenants when the Site was an airfield. The presence of these chemicals is not due to current Site operations.

TABLE 1

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM ⁽¹⁾		
MEDIA MONITORED	ANALYSIS FREQUENCY	ROUTINE ANALYSES
LIQUID EFFLUENTS <ul style="list-style-type: none"> • Bull Run Monitoring Station • Northeast Area Monitoring Station • Sanitary Sewer (SAN2) 	Weekly	Gross Alpha, Gross Beta
	Quarterly	Strontium-90, Gamma
	Semiannually	Gross Alpha, Gross Beta
LIQUID INFLUENTS <ul style="list-style-type: none"> • City Water • Precipitation 	Weekly	Gross Alpha, Gross Beta
	Quarterly	Strontium-90, Gamma
GROUND WATER <ul style="list-style-type: none"> • Wells • Inactive Waste Site Seepage 	Annually	Gross Alpha, Gross Beta, Strontium-90, Gamma, Uranium-233/234, Uranium-235, Uranium-238
SURFACE WATER <ul style="list-style-type: none"> • Bull Run Stream (BR5) 		
STREAM SEDIMENT AND VEGETATION <ul style="list-style-type: none"> • Bull Run Stream • Northeast Area Stream • Thompson Run Stream • Streets Run Stream (Control) 	Semiannually (Sediment)	Gross Alpha, Gross Beta, Gamma
	Annually (Sediment)	Strontium-90 (Bull Run and Streets Run Streams only)
	Annually (Vegetation)	Strontium-90, Gamma
SEDIMENT <ul style="list-style-type: none"> • Bull Run Monitoring Station • Northeast Area Monitoring Station • Storm Drain Components 	Annually	Gross Alpha, Gross Beta, Gamma
SOIL <ul style="list-style-type: none"> • Duquesne Light/Valley National Gases Inc. 	Every Two Years (2002) ⁽²⁾	Gross Alpha, Gross Beta, Strontium-90, Gamma, Uranium-233/234, Uranium-235, Uranium-238
RADIATION <ul style="list-style-type: none"> • Site Perimeter 	Continuously	Gamma Radiation
<ul style="list-style-type: none"> • Bull Run Stream 	Every Fifth Year (2006) ⁽²⁾	
<ul style="list-style-type: none"> • Duquesne Light/Valley National Gases Inc. 	Every Two Years (2002) ⁽²⁾	
AIRBORNE EFFLUENT <ul style="list-style-type: none"> • Particulate Activity 	Weekly	Gross Alpha, Gross Beta
	Quarterly	Gross Alpha, Gross Beta, Strontium-90, Gamma
<ul style="list-style-type: none"> • Radon 	Annually	Radon-220, Radon-222
AIRBORNE (Ambient Background) <ul style="list-style-type: none"> • Large, PA • West Mifflin, PA 	Weekly	Gross Alpha, Gross Beta

NOTES: (1) The monitoring methods used in this program are "grab and composite" sampling. The particulate activity in the airborne effluent is monitored on a continual basis.

(2) Indicates year when sampling/monitoring is next due to occur.

TABLE 2

NONRADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM ⁽¹⁾		
MEDIA MONITORED	ANALYSIS FREQUENCY	ROUTINE ANALYSES
LIQUID EFFLUENTS <ul style="list-style-type: none"> Bull Run Monitoring Station Northeast Area Monitoring Station 	Semimonthly	Dissolved oxygen, fecal coliforms, oil and grease, pH, suspended solids, temperature.
	Semiannually	Alkalinity, aluminum, ammonia, chloride, hardness, iron (dissolved), iron (total), osmotic pressure, total dissolved solids.
	Annually	Antimony, arsenic, base neutral/acids, beryllium, cadmium, chromium (hexavalent), chromium (total), copper, cyanide (free), lead, mercury, nickel, pesticides, polychlorinated biphenyls, selenium, silver, thallium, volatile organic compounds, zinc.
<ul style="list-style-type: none"> Bull Run Outfall (001) Storm Water Outfall 003 Storm Water Outfall 004 Storm Water Outfall 005 Storm Water Outfall 006 	Quarterly	Fecal coliforms, aluminum (Outfalls 004 and 005 only)
<ul style="list-style-type: none"> SIS Outfall 007 	Semimonthly	Iron (dissolved), pH, suspended solids, tetrachloroethylene, trichloroethylene, 1,2-dichloroethylene
<ul style="list-style-type: none"> Sanitary Sewer (SAN-10) 	Semiannually	Biochemical oxygen demand, chloride, dissolved oxygen, hardness, oil and grease, pH, temperature.
	Annually	Mercury, silver.
LIQUID INFLUENTS <ul style="list-style-type: none"> City Water 	Semimonthly	Dissolved oxygen, fecal coliforms, oil and grease, pH, suspended solids, temperature.
	Semiannually	Alkalinity, aluminum, ammonia, chloride, color, fluoride, hardness, iron (dissolved), iron (total), manganese, nitrate and nitrite, osmotic pressure, phenols, sulfate, methylene blue active substance, total dissolved solids, threshold odor, turbidity.
	Annually	Antimony, arsenic, polynuclear aromatic hydrocarbons, beryllium, cadmium, chromium (hexavalent), chromium (total), copper, cyanide (free), lead, mercury, nickel, pesticides, polychlorinated biphenyls, selenium, silver, thallium, volatile organic compounds, zinc.
GROUND WATER <ul style="list-style-type: none"> Wells Inactive Waste Site Seepage 	Annually	Volatile organic compounds Polychlorinated biphenyls and polynuclear aromatic hydrocarbons (Inactive Waste Site Seepage Only)
	Every Three Years (2004) ⁽²⁾	Antimony, arsenic, barium, beryllium, cadmium, chromium, copper, iron, lead, manganese, mercury, nickel, selenium, silver, sodium, thallium, zinc, chloride, fluoride, nitrate, sulfate, sulfide, cyanide, polynuclear aromatic hydrocarbons, phenol, and suspended solids (Wells only)
SEDIMENT <ul style="list-style-type: none"> Bull Run Monitoring Station Northeast Area Monitoring Station Storm Drain Components 	Annually	Polychlorinated biphenyls, volatile organic compounds, total mercury.
<ul style="list-style-type: none"> Bull Run Stream (BR1, BR5) 	Annually	Volatile organic compounds
SOIL <ul style="list-style-type: none"> Duquesne Light/Valley National Gases, Inc. 	Annually	Polychlorinated biphenyls, volatile organic compounds, polynuclear aromatic hydrocarbons.
SURFACE Water <ul style="list-style-type: none"> Bull Run Stream (BR1, BR5). 	Annually	Volatile organic compounds.

NOTES: (1) The monitoring method used in this program is "grab" sampling except for suspended solids sampling at the Bull Run and Northeast Area Monitoring Stations. These samples were collected as composite samples over a 24-hour period.
 (2) Indicates year when sampling/monitoring is next due to occur.

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Some of the water that seeps out of the hillside on the Duquesne Light (DL) and Valley National Gases Inc. (VNGI) properties below the Inactive Waste Site (IWS) contains low levels of Bettis radioactivity, primarily strontium-90 and uranium. The concentrations of these materials are consistent with previous levels and are well below the concentrations for unrestricted areas by the U.S. Nuclear Regulatory Commission (Reference 4). This intermittent seepage is not used for any purpose and is not a source of drinking water.

Analyses of some of the seepage below the IWS for VOCs showed the presence of low levels of PCE, trichloroethylene (TCE), and dichloroethylene (DCE). The concentrations of these materials are consistent with concentrations previously observed and reported.

Sediment, Soil, and Vegetation

Analyses for radioactivity in the Site's effluent streambeds demonstrated that there were no measurable changes in the low levels of radioactivity, from historical operations, in the streambeds during 2001.

Analyses of vegetation collected in and along the Site's effluent streams did not detect any radioactivity in excess of natural background levels.

Analyses for a variety of chemicals in the soil in the main drainage area that is downslope of the IWS typically showed the presence of low levels of Program residues, primarily PCE and polychlorinated biphenyls (PCBs). The levels of these materials were consistent with previous levels and indicate that there has not been any build-up in this area in the last several years.

Soil sampling for radioactivity in the main drainage area that is downslope of the IWS was not required to be conducted in CY 2001. Two additional soil samples were collected on VNGI property and analyzed for radioactivity as part of another program. The radioactivity in these samples was consistent with natural background levels.

Analyses for a variety of chemicals in the storm drain sediment showed the presence of low levels of PCE, PCBs, and mercury in some samples. The concentrations were consistent with previous results. Analyses for VOCs in the Bull Run stream sediment show the presence of low levels of PCE. The maximum PCE concentration measured was approximately 0.38 milligrams per kilogram, which is slightly higher than previous results, but is not indicative of any buildup or release because the average concentration was consistent with previous results.

Analyses for radioactivity in storm drain sediment showed levels consistent with background.

Radiation

Radiation surveys of the Site perimeter demonstrated that radiation levels were typical of background for Western Pennsylvania. Perimeter thermoluminescent dosimetry data also confirmed that Site operations did not cause any measurable change in the natural radiation levels surrounding the Site.

In CY 2001, a radiation survey was performed of the on-site portion of the Bull Run Stream. The results of this survey are consistent with results of previous surveys in this area.

Airborne Effluents

Radioactivity in Site airborne effluents was controlled using high efficiency particulate filters and wet scrubbing systems to maintain particulate radioactivity releases to as-low-as-reasonably-achievable. The amount of long-lived (>1 day half-life) particulate radioactivity released in airborne effluents was approximately 0.00000069 Curie in 2001. Comparison of the Site's airborne effluents with background air samples showed that the Site's airborne particulate effluent was up to ten times lower than natural background airborne particulate radioactivity.

Nonradiological constituents in Site emissions for Site fuel combustion and heating units were estimated utilizing U.S. Environmental Protection Agency (EPA) emission factors and were well below applicable EPA and Allegheny County standards. Operation of the Site's fuel combustion and heating equipment was conducted in accordance with applicable regulations and permits.

Risk Assessment

A risk assessment was approved by the EPA in 1994 as part of the Site's Resource Conservation and Recovery Act (RCRA) Facility Investigation. The assessment determined the "reasonable maximum exposure" of on-site and off-site populations to chemical residues in the environment at the Site.

The assessment concluded that chemical residues in the environment at the Site did not pose significant health risks to potentially exposed populations using "reasonable maximum exposure" assumptions. The only study area where the carcinogenic risk estimate exceeded the EPA screening criterion of 1×10^{-6} (one chance in a million) is a small area of soil on a remote portion of DL and VNGI properties, with a maximum carcinogenic risk of about 2×10^{-5} . However, an individual must be exposed (skin contact, ingestion, and inhalation) for 250 days/year for 25 years to achieve this risk. This risk is highly conservative because the contaminated portions of DL and VNGI properties are in infrequently accessed or undeveloped locations. In reality, the risk of personnel exposure to the chemical residues is far less than 1×10^{-6} .

The 2001 monitoring results support the conclusions of the 1994 risk assessment.

Dose-to-Man

Radiation exposure to the general public from Site airborne releases was too low to measure and could only be estimated using conservative, EPA authorized calculational models. The resultant evaluation of all exposure pathways conservatively estimated a maximum annual hypothetical dose range of 0.14 to 2.4 millirem to an individual off-site. Realistically, the actual maximum annual dose would approach 0.14 millirem. However, using the larger value of 2.4 millirem, the dose is only 2.4% of the numerical limit established for members of the general public by the Nuclear Regulatory Commission and the DOE for DOE facilities such as Bettis-Pittsburgh. The annual dose to the population from Site operations within a 50-mile radius of the Site was conservatively estimated to be about 1.24 man-rem which is negligible when compared to the approximately 900,000 man-rem received by this population from natural background radiation.

Chemical and Hazardous Waste

A waste minimization program is in place to minimize the generation of chemical and hazardous wastes. These wastes were handled, controlled, and stored by trained personnel in accordance with applicable State regulations and permits. In addition, these wastes were not disposed of on the Site. Approximately 28,680 pounds of hazardous wastes were generated and packaged for off-site disposal by waste vendors. These vendors operate under Federal and State permits. Approximately 29,720

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gallons of processed ground water and water from sampling, containing traces (less than one ounce total) of a few volatile organic compounds, were discharged to the sanitary sewer system in accordance with Federal, State, and local regulations.

In 2001, Bettis was a contributing member to an Oak Ridge team that received a White House Closing the Circle Award in the Recycling Category for Oak Ridge's Electronic Recycle Program. Bettis, along with other facilities, participated in an Oak Ridge program that accepted computer equipment for recycling. The Oak Ridge National Recycling Center refurbishes electronics for resale or recycling. Bettis has made three shipments during the time period of November 2000 through June 2001, with a total acquisition value of greater than two million dollars.

Radioactive Waste

The generation of low-level radioactive waste continues to be minimized by limiting the materials that could become contaminated and by implementing various waste volume reduction techniques. Radioactive waste generated on-site is shipped off-site for disposal. A total of 204 cubic meters of the low-level radioactive waste generated on-site during 2001 were packaged in various type containers, which comply with U. S. Department of Transportation specifications, and shipped to a DOE-owned disposal facility. When necessary, small amounts of radioactive liquids were solidified prior to shipment off-site for disposal. Two-hundred-six cubic meters of radioactive surface contaminated scrap metals were shipped to a commercial radioactive material processing facility for radioactive metal recycling.

Off-site shipments of radioactive waste and radioactive scrap metal were controlled by written procedures to ensure compliance with State and Federal regulations and the disposal and recycling sites' criteria.

Mixed Waste

Mixed waste is waste that is both RCRA hazardous and radioactive. In 1995, the DOE voluntarily agreed to apply PADEP requirements to the hazardous constituents of mixed waste. In addition, the U.S. DOE Pittsburgh Naval Reactors Office (PNR) and the EPA signed a Consent Agreement/Consent Order (CACO) for the storage and treatment of mixed wastes that are generated at the Site. Pennsylvania received mixed waste regulatory authority from the EPA in November 2000. In September 2001, the PADEP issued a revised hazardous waste storage permit that incorporated relevant requirements of the Federal Facility Compliance Act. The CACO was terminated on January 15, 2002. A Site Treatment Plan for all of the Site's mixed wastes continues to be implemented in accordance with the Permit. Mixed wastes are not disposed of on-site. A mixed waste management program is in place to minimize generation of these wastes. In 2001, there was one shipment of 0.63 cubic meters of inorganic sludge/particulate to ATG, Inc. for stabilization.

Environmental Assessments

In 1988, a *Preliminary Assessment and Site Inspection (PA/SI) Report* was completed for the Site to meet the requirements of Section 120 of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). During 1989, EPA completed their review of the Site's PA/SI and concluded that no further action under CERCLA was required for the Site.

In 1990, PNR and EPA Region III signed a Consent Order to conduct a RCRA Facility Investigation (RFI) and Corrective Measures Study (CMS). The purpose of the RFI was to characterize the chemical residues in the environment at the Site and the purpose of the CMS was to determine site-specific remedial alternatives. The investigation of ground water, surface water, soil, sediment, and

air specified in the RFI work plans was completed in 1993. The Final RFI Report was approved by the EPA in August of 1994. The RFI report stated that some of the ground water under the Site and some soil areas contain low levels of chemical residues. The most prevalent residue is PCE which is the same solvent used to dry-clean clothing. The report included an assessment of risk to on-site and off-site populations from exposure to the chemical residues. This risk assessment concluded that there are no areas on-site or off-site which present a risk to human health that exceeds the EPA's acceptable risk criteria.

The Final CMS Report was submitted to the EPA in November 1994 and approved by the EPA in March 1995. This report recommended actions to ensure the risks to human health will remain low and to further reduce the chemical residues in the environment.

The EPA issued its preliminary recommendations for corrective measures in September 1995 and requested public comment on the recommendations. The EPA responded to public comments, issued its final recommendations for corrective measures, and terminated the Consent Order in 1997. Bettis proactively implemented or completed most of the final recommended corrective measures prior to signing a Corrective Measures Implementation Order (CMIO) which was effective on April 16, 2001. The CMIO covers completion of three remaining actions including soil vapor extraction of a small landfill, performance of a ground water study below the IWS, and continuation of routine environmental monitoring. These programs are underway.

Compliance Summary

During 2001, Site operations remained in compliance with existing permits and applicable regulations governing use, emission, transportation, and disposal of solid, liquid, and gaseous materials and wastes with one exception. Bettis-Pittsburgh inadvertently disposed of a very small amount of hazardous waste to a residual waste landfill. The item was a 30-gram oxygen sensor from an electronic metering system. The sensor was smaller than but similar in hazard to a flashlight battery. Bettis-Pittsburgh self reported this event to the PADEP, which subsequently issued an inspection report noting the event to document the finding. There was no impact on human health or the environment from the inadvertent disposal.

Conclusion

Operations at the Bettis Atomic Power Laboratory-Pittsburgh Site during 2001 did not result in any significant release of radioactivity or hazardous materials to the environment. Operations also did not have any adverse effect on human health or the quality of the environment at the Site or in the surrounding communities.

INTRODUCTION

The first nonagrarian use of the Bettis-Pittsburgh Laboratory Site was that of an airfield which operated on the Site from approximately 1926 until 1948. This private airfield served mainly small, privately-owned planes. The general pattern of buildings and roadways currently existing on-site are based on the original airfield design.

The Bettis Laboratory was organized in 1948 through the joint efforts of Westinghouse Electric Corporation, the Navy, and the Atomic Energy Commission. Westinghouse acquired title to the Bettis airfield property (~146 acres) and associated buildings in May of 1949. Additional properties were purchased in 1952. In 1957, the approximately 202 acres were deeded to the Federal Government. In February 1999, Bechtel Bettis, Inc. assumed operations of the facility for the U. S. Department of Energy (DOE) under the jurisdiction of the Pittsburgh Naval Reactors Office (PNR). All grounds, buildings, and equipment on the Site are the property of the Federal Government.

The primary mission of the Bettis Laboratory has always been directed toward the design, development, testing, and operational follow of nuclear reactor propulsion plants for naval surface and submarine vessels. Specifically, the Laboratory exists to support this nation's capability to deploy and maintain a modern nuclear Navy. In addition to the primary objective of continuing work in the development of the nuclear Navy, the Laboratory has also played a role in the development of the first U.S. full-scale nuclear power plant for civilian use, the Shippingport Atomic Power Plant.

This document summarizes the 2001 results of the radiological and nonradiological environmental monitoring programs at the Site. This report also discusses the Site programs for handling and off-site disposal of radioactive waste, chemical and hazardous waste, and mixed waste. The report is prepared in conformance with DOE guidelines.

SITE BACKGROUND AND ENVIRONMENTAL SETTING

The Site is situated on a 202-acre tract of land in the Borough of West Mifflin, and is located approximately eight miles southeast of the downtown section of Pittsburgh, Pennsylvania. Figure 1 shows the location of the Site with respect to the surrounding communities, and Figure 2 shows the land uses immediately adjacent to the Site. Figure 3 shows an aerial view of the developed portion of the Site. A heavily wooded area borders the Site on the east. Most of this property is owned by the Borough of West Mifflin and a portion of this property has been developed into the West Mifflin Community Park. A fence has been erected to prevent inadvertent access to the Site property from the park area. An industrial district is located along the northern boundary of the Site. Commercial and residential developments border the Site on the south and west. The land use of the region surrounding the Site is largely industrial and residential. The total population within a 50-mile radius of the Site is approximately 3,000,000.

Physiography

Physiography refers to the natural physical landforms of an area. The Site is located within Allegheny County, Pennsylvania, which is situated within the Allegheny Plateau physiographic province of North America. Stream erosion of a formerly raised plateau produced the present rugged land surface. The geologic formations are generally flat-lying, or gently folded and inclined. Stream frequency and the percentage of the land found in slopes decrease with distance from the major drainageways, such as the Monongahela River.

Topography

The Site is located approximately 6000 feet northwest of the Monongahela River. The maximum elevation at the Site is approximately 1200 feet above sea level. The minimum elevation, approximately 975 feet above mean sea level, occurs on the northern site boundary. The normal pool elevation of the Monongahela River near the Site is approximately 720 feet above sea level. Thus, the developed portions of the Site are approximately 480 feet above the surface of the Monongahela River.

Surface drainage at the Site is primarily toward the east, discharging into the Bull Run Stream and its tributaries. The principal sources of water in the Bull Run Stream originating from the Site include *once-through, noncontact cooling water, storm water runoff, and process water*. The Bull Run Stream flows about 1.4 miles before joining the Thompson Run Stream which empties, about 2.6 miles downstream, into the Monongahela River in the City of Duquesne. A narrow, mostly sloped area that includes a small developed portion of the Site drains northwest toward the Thompson Run Stream. The Monongahela River is used as a raw water source for public water supply serving the Site and some surrounding communities.

Because of the location and elevation of the Site, flooding from local streams or rivers is not possible. Some minor bank overflowing of the Bull Run Stream may occur downstream from the Site during heavy rainfall.

Several springs are present on the Site property. The largest of these, Buono Spring, RQ-20 Spring, and Northeast Spring, are on the eastern, nondeveloped portion of the Site. These are permanent springs with varying, but very low flows that are reflective of the seasons and precipitation events. In 1997, the Springwater Intercept System was constructed to collect these springs and other seeps. The water is treated by air stripping to remove volatile organic compounds (VOCs) and the water is discharged to the Bull Run Stream basin via NPDES Outfall 007.

FIGURE 3 AERIAL VIEW OF THE DEVELOPED PORTION OF THE BETTIS LABORATORY

Soils

The soils at the Site are residual in origin or are the result of filling operations. The residual soils were formed by weathering of the underlying Monongahela Group bedrock. The soils on-site are classified as the Culleoka and Urban Land-Guernsey soils. The Culleoka soils are characterized as moderately deep, well-drained soils formed from shale and fine-grained sandstone bedrock. They generally occur on upland slopes, have moderate permeability, and normally a water table below four feet throughout the year. The surface soil can be described as dark brown, granular silt loam, while the subsoil is yellowish-brown, blocky silt loam to channery clay loam. The substrata consists of yellowish-brown, massive, very channery clay loam.

The Urban Land-Guernsey soils are described as variable, consisting of disturbed land resulting from cut and fill operations and subsequent coverage with urban works. These soils occur in a complex pattern with Culleoka soils which are described above. The Guernsey soils are characterized as deep, well-drained soils with a low permeability and a winter water table within one or two feet of the surface. This soil type is formed from interbedded clay shale, shale, and limestone bedrock.

None of the Site land is utilized for agrarian purposes.

Regional Stratigraphy

The geologic formations that underlie the portion of Allegheny County in which the Site is located are part of the Pennsylvanian System. The Monongahela, Conemaugh, and Allegheny Groups, all part of the Pennsylvanian System, underlie the Site. The Monongahela Group, the uppermost group, includes beds of limestone, variable shales, discontinuous layers of sandstone and coal beds. The base of the Pittsburgh Coal marks the base of the Monongahela Group. Table 3 presents a generalized description of the rock strata beneath the Site.

Some of the important beds in the Monongahela Group are the Uniontown Limestone, Benwood Limestone, Sewickley Sandstone, Fishpot Limestone, Pittsburgh Sandstone, and the Redstone and Pittsburgh Coals. Core borings taken on-site confirm that the bedrock consists of layers of limestone, shale, and sandstone.

Extensive mining of the Pittsburgh Coal seam has occurred to the west and south as well as under the Site. The Pittsburgh Coal seam lies about 200-250 feet below the developed portion of the Site. Most of the Pittsburgh Coal that can be mined has been removed. There are no current coal mining activities in this area.

Structural Geology

The bedrock under the Site declines to the southeast a few feet per mile. The Pittsburgh Coal seam under the Site dips 1% to the southeast.

Hydrogeology

The Site is underlain by the geologic units of the Pennsylvanian Monongahela Group. The Monongahela Group is not an important local aquifer. Well yields from the Monongahela Group range from less than one to 30 gallons per minute. Pump tests performed at the Site in the Sewickley

TABLE 3

GENERALIZED SECTION OF ROCK STRATA BENEATH THE BETTIS LABORATORY				
System	Group	Formation	Strata	Remarks
P E N N S Y L V A N I A N	Monongahela	Pittsburgh	Cyclic sequences of shale, limestone, claystone, and coal. Pittsburgh Coal seam is bottom stratum.	Extends from at or near surface down to Pittsburgh Coal. Mined out about 200-250 feet below Bettis.
	Conemaugh	Casselman	Cyclic sequences of sandstone, shale, silty claystone ("red beds"), and thin limestone and coal.	Coal deposits of this group not normally mined. Formation is about 250-300 feet thick; base is near normal level of Monongahela River.
		Glenshaw	Cyclic sequences of sandstone, shale, red beds, and thin limestone and coal; fossiliferous limestone.	Formation is 300 to 380 feet thick.
	Allegheny	Freeport	Upper Freeport Coal seam is top stratum.	Major coal bed, 600 to 630 feet below level of Pittsburgh Coal.
Pennsylvanian System Rocks extend down to about sea level.				

Sandstone Water-Bearing Zone, which is one of the main water-bearing zones in the Monongahela Group at the Site, could not sustain flow rates of one to three gallons per minute.

The topographic features of the area, such as high hills cut by major stream valleys, greatly affect the direction and depth of water tables. There may be subregional ground water regimes where the discharge of the ground water is to local streams. In cases where the stream channels lie below the water table, some aquifers may discharge on valley slopes.

Based on data obtained through rock coring, monitoring well drilling, geophysical logging, and ground water elevation monitoring, the ground water under the Site is present in five different water-bearing zones. The water-bearing areas are referred to as water-bearing zones rather than aquifers because the amounts of water present in these zones are not sufficient to meet the definition of an aquifer as defined by the American Geological Institute. The water-bearing zones in descending order are: Perched, Benwood Limestone, Sewickley Sandstone, Pittsburgh Sandstone, and Pittsburgh Coal.

The Pittsburgh Coal Water-Bearing Zone represents the basal ground water flow at the Site. These water-bearing zones are described in detail in Reference (1).

There are no springs or wells on-site or in the local, hydraulically downgradient area which are known to be used for drinking water, industrial, or irrigation purposes.

Meteorology

The Site has a humid, continental type of climate modified only slightly by the Atlantic Seaboard and the Great Lakes. Data accumulated by the Site meteorological monitoring system during 2001 indicated that prevailing winds for the Site occurred about 31% of the time from the south-southeast and about 25% of the time from the west-northwest. Wind speeds of greater than five miles per hour (mph) occurred about 71% of the time and less than five mph about 29% of the time. The average monthly temperatures during the year ranged from 29 to 73°F. The annual precipitation amounted to approximately 23 inches of water.

ENVIRONMENTAL MONITORING PROGRAMS

The major elements of the Site's radiological and nonradiological environmental monitoring programs are summarized in Tables 1 and 2. The various programs and the monitoring results are discussed in this section.

A. LIQUID EFFLUENTS

The purpose of the liquid effluent monitoring programs is to determine the effectiveness of control methods and to measure constituent concentrations in effluents for comparison with applicable standards and natural background levels. In addition to monitoring liquid effluents from the Site, samples of precipitation and influent city water are monitored and used for background comparisons.

Sources

The principal sources of liquid effluents to the storm drain system included noncontact cooling water, storm water runoff, and process waste water. Total effluent flow through the outfalls at the Bull Run Monitoring Station and the Northeast Monitoring Station is measured in accordance with the National Pollutant Discharge Elimination System (NPDES) permit. In 2001, the total was 48,400,000 gallons for both outfalls. Approximately 82% of this volume was released at the Bull Run Monitoring Station. This comprises most of the flow in the Bull Run Stream. Storm water runoff via Storm Water Outfalls 003, 004, 005 and 006 and treated ground water via Outfall 007 was also released to the environment in accordance with the Site's NPDES Permit. Figure 4 shows the locations of these outfalls.

Water used for sanitary and cleaning purposes was discharged via the sanitary sewer system to the West Mifflin Borough, Thompson Run Sewage Treatment Plant, which discharges treated effluent to the Thompson Run Stream. In addition, approximately 29,720 gallons of processed ground water and water generated from sampling efforts were discharged to the Thompson Run Sewage Treatment Plant. This water contained traces of volatile organic compounds (VOCs), primarily tetrachloroethylene (PCE), which were within allowable release limits to the treatment plant. The Borough of West Mifflin, the U. S. Environmental Protection Agency (EPA), and the Pennsylvania Department of Environmental Protection (PADEP) were previously notified of the discharges as required by applicable regulations.

Liquid Monitoring

The samples and analyses specified below constitute the minimum samples and analyses conducted at the Site during 2001.

Radiological: Water samples of storm drain liquid effluents were collected continuously at the Bull Run and Northeast Area Monitoring Stations shown on Figure 4. Weekly, the composite samples were picked up and analyzed for gross alpha and gross beta radioactivity. Quarterly, composites of the weekly samples were analyzed for strontium-90 and gamma-emitters. Influent city water and precipitation samples were analyzed similarly to the liquid effluent samples. Annually, a water sample is collected from the Bull Run Stream at the Site boundary (BR5, Figure 4) and analyzed for gross alpha, gross beta, radiostrontium, gamma emitters and isotopic uranium. Samples of processed ground water were analyzed for gross alpha and gross beta radioactivity prior to release of the processed water to the sanitary sewer to ensure that the processed water did not contain any detectable radioactivity. The decision level concentrations (DLCs) were below the levels allowed by the EPA for drinking water in 40 CFR 141 (Reference 6).

Samples of sanitary effluent were collected weekly at the outfall of the main site area, location SAN-2 shown on Figure 4. These samples were analyzed for gross alpha and gross beta radioactivity.

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Quarterly, a composite of the weekly samples from SAN-2 was analyzed for strontium-90 and gamma emitters. Semiannually, samples of sanitary effluent were collected at location SAN-10 which includes sanitary effluent for the entire Site as shown on Figure 4. These samples were analyzed for gross alpha and gross beta radioactivity.

Nonradiological: Semimonthly, samples of storm drain effluents discharged through the Bull Run and Northeast Area Monitoring Stations were collected and analyzed, in accordance with the NPDES permit, for oil and grease, pH, suspended solids, and temperature and in addition, dissolved oxygen and fecal coliforms. Semiannually, samples were collected and analyzed for alkalinity, aluminum, ammonia, chloride, hardness, iron (dissolved), iron (total), osmotic pressure, and total dissolved solids. Annually, samples were collected and analyzed for antimony, arsenic, base neutral/acids, beryllium, cadmium, chromium (hexavalent), chromium (total), copper, cyanide (free), lead, mercury, nickel, pesticides, PCBs, selenium, silver, thallium, VOCs, and zinc.

Semimonthly, samples of effluent from the Springwater Intercept System (SIS) were collected at Outfall 007 and analyzed for iron (dissolved), pH, suspended solids, PCE, TCE, and DCE. These analyses are required by the Site's NPDES permit.

Samples of the influent municipal water supply, which comprised a significant portion of the Site's liquid effluents, were collected at the same frequencies and analyzed for the same parameters described above for the Bull Run and Northeast Area effluents.

Quarterly samples of storm water runoff were collected at the Bull Run Outfall (001) and Storm Water Outfalls 003, 004, 005, and 006 and analyzed for fecal coliforms. Samples of storm water runoff from Storm Water Outfalls 004 and 005 were also analyzed for aluminum. These analyses are required by the Site's NPDES Permit.

Semiannually, samples of sanitary effluent were collected at location SAN-10 which includes sanitary effluent for the entire Site. These samples were analyzed for biochemical oxygen demand, chloride, dissolved oxygen, hardness, oil and grease, pH, and temperature. Annually, samples of sanitary effluent were collected and analyzed for mercury and silver.

Samples of Bull Run Stream were collected from two locations, BR1 and BR5 shown on Figure 4, and analyzed for VOCs.

Liquid Analyses

Radiological: Liquid samples (liquid effluent, city water, precipitation, sanitary effluent, ground water, etc.) were prepared for gross alpha and beta analysis by evaporation of approximately 200 ml of liquid. The alpha and beta radioactivity of the samples were measured using a low background proportional counter. Typical DLCs for alpha and beta radioactivity for 200 ml samples were 2.0×10^{-9} μ /ml and 3.0×10^{-9} μ /ml, respectively.

Gamma spectrometry was also performed quarterly on composites of weekly samples to identify gamma-emitting radionuclides using a Germanium-Lithium or a Germanium detector and a multichannel analyzer. A typical DLC for cesium-137 and cobalt-60 in a 1000 ml sample of these composites was 5.0×10^{-9} μ Ci/ml.

Strontium-90 analyses were performed on selected composites of weekly samples using a standard strontium radiochemical procedure. A typical DLC achieved for strontium-90 was 5.0×10^{-10} μ Ci/ml for a 1000 ml sample.

Nonradiological: Analyses of influent, effluent, and surface water samples were performed using test methods described in References (2), (3), or other EPA-approved methods.

Liquid Monitoring Results and Conclusions

Radiological: The results of the weekly analyses for alpha radioactivity in the Site's storm drain effluents showed that the levels were very near or below the DLC and were typical of the background alpha radioactivity levels measured in the city water influent and precipitation. None of 52 alpha radioactivity measurements of the effluents exceeded the limit of Reference (4) for alpha radioactivity, based on thorium-232, in water in uncontrolled areas.

The results of the weekly analyses for beta radioactivity in the Site's storm drain effluents showed that the average beta radioactivity levels were consistent with the levels measured in the city water influent and precipitation. Three samples from the Bull Run outfall were further characterized during 2001 as required by the monitoring program since the gross beta radioactivity was slightly above 1×10^{-8} $\mu\text{Ci/ml}$. One sample revealed the presence of cobalt-60 (17.2 pCi/l) and cesium-137 (17.2 pCi/l). The levels of cobalt and cesium detected in the effluent are approximately factors of 200 and 60 respectively less than the 10 CFR 20 effluent concentration limits in water. The most likely potential source of the detectable radioactivity was historic, low-level radioactivity in or around the storm drain line. The other two samples were taken during the winter and the radioactivity was consistent with the natural activity in winter de-icing materials. However, none of the 52 beta radioactivity measurements of the effluents exceeded the limit of Reference (4) for beta radioactivity, based on strontium-90, in water in uncontrolled areas.

Table 4 presents the quarterly composite sample results for the Site's storm drain effluents at the Bull Run and Northeast Area Monitoring Stations and for precipitation and city water samples. The quarterly composite radioactivity results for the potential contaminants-of-concern for the Site's effluents, city water, and precipitation were all less than the DLCs.

There was one occasion during 2001 when the gross radioactivity analyses results of the sanitary effluent exceeded local investigation levels. On this occasion, the gross beta activity was 1.4×10^{-7} $\mu\text{Ci/ml}$ and an investigation revealed that the elevated activity was due to the presence of thallium-201. Thallium-201 is a medical isotope and is not associated with Bettis operations.

The alpha and beta radioactivity levels in processed ground water released to the sanitary sewer were less than the DLC of 3.0×10^{-9} $\mu\text{Ci/ml}$. This level is below the level allowed by the EPA in drinking water and is typical of natural background levels.

The alpha, beta, and strontium-90 radioactivity levels in the sample of Bull Run Stream at location BR5 (Figure 4) were at or below DLCs. The natural uranium concentrations were: uranium-234, 0.48×10^{-9} $\mu\text{Ci/ml}$; uranium-235, 0.094×10^{-9} $\mu\text{Ci/ml}$; and uranium-238, 0.55×10^{-9} $\mu\text{Ci/ml}$. These uranium concentrations are consistent with natural background concentrations for uranium in surface water.

Based on the above, the control methods at the Site were effective in ensuring that the water discharged from the Site was of sufficiently high quality to preclude an adverse impact on the environment or downstream water quality. Site-generated radioactivity was not released to the Site's effluent streams or sanitary sewers.

TABLE 4

LIQUID INFLUENT AND EFFLUENT RADIOACTIVITY RESULTS ⁽¹⁾ Units 10^{-9} $\mu\text{Ci/ml}$					
Sample Location	Activity Analysis	First Quarter	Second Quarter	Third Quarter	Fourth Quarter
Bull Run Monitoring Station Effluent	Strontium-90	<0.49	<0.6	<0.48	<0.31
Northeast Area Monitoring Station Effluent		<0.48	<0.34	<0.48	<0.40
Precipitation		<0.43	<0.37	<0.46	<0.34
City Water		<0.37	<0.26	<0.44	<0.31
Bull Run Monitoring Station Effluent	Cesium-137	<6.5	<6.0	<4.6	<6.0
Northeast Area Monitoring Station Effluent		<7.1	<6.2	<4.3	<5.6
Precipitation		<6.6	<6.2	<4.5	<5.8
City Water		<5.5	<5.8	<4.8	<7.2
Bull Run Monitoring Station Effluent	Cobalt-60	<5.9	<5.8	<4.4	<5.3
Northeast Area Monitoring Station Effluent		<5.4	<5.9	<3.9	<5.2
Precipitation		<5.9	<5.5	<3.9	<5.7
City Water		<5.5	<5.1	<4.0	<6.7

NOTE: (1) < signifies the data were below the DLC. The DLC varies slightly due to the sample size, the chemical recovery yield, count time, and the presence of dissolved materials.

Nonradiological: A summary of sample analysis results for influent city water and effluent water from the Site are presented in Tables 5, 6, and 7. Since a major portion of the Site's process wastewater effluent is noncontact cooling water, the quality of the effluent is significantly influenced by the quality of the influent city water. Therefore, the influent city water was sampled for the same parameters as the effluent. Table 5 provides the analysis results for the parameters that are required to be sampled by the Site's NPDES Permit. Table 5 also identifies the discharge limits for these parameters as established in the NPDES Permit. Tables 6 and 7 provide the analysis results for various parameters that provide an overall indication of general water quality. Tables 6 and 7 also list the guidelines for general water quality that have been derived from guidelines provided by the PADEP in Reference (5). These guidelines are not effluent limits, but can be compared against the analysis results to provide an indication of the quality of the effluent from the Site.

The results in Table 5 show that the samples collected in accordance with the Site's NPDES Permit were within the established discharge limits. The sample results for the storm water outfalls in Table 5 indicate the presence of fecal coliform bacteria. An investigation of the possible sources of the fecal coliforms indicated that the on-site sanitary sewer lines are not the cause for the presence of the fecal coliforms and the source of the fecal coliform bacteria is likely from animals that inhabit the area. Sampling has indicated that the levels of fecal coliforms in Outfall 001 are influenced by off-site storm water containing fecal coliforms. A review of EPA documents which discuss storm water quality indicated that the levels of fecal coliforms detected in the storm water outfalls are consistent with those found in typical urban storm water runoff.

In addition, the general water quality results in Tables 6 and 7 show that all of the non-regulated parameter analysis results were within the water quality guidelines.

VOC samples were collected from the Bull Run Stream at locations BR1 and BR5 (Figure 4). Results for VOCs of concern were consistent with previous results. The maximum VOC detected was PCE at 0.009 mg/l.

Based on the above, the control methods at the Site were effective in ensuring that the water discharged from the Site was of sufficiently high quality to preclude any adverse impact on the environment or downstream water quality.

TABLE 5

SUMMARY OF NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NPDES) PERMIT SAMPLE ANALYSIS RESULTS ⁽¹⁾									
Parameter	Units	Limit	Outfall 001 Range	Outfall 002 Range	Outfall 003 Range	Outfall 004 Range	Outfall 005 Range	Outfall 006 Range	Outfall 007 Range
Aluminum	mg/l					1.21 – 3.83	0.82 – 2.26		
Dissolved Iron	mg/l	7.0							<0.01 - 0.07
Fecal Coliforms ⁽²⁾	colonies / 100 ml		<100 – 220000		<100 – 30000	<100 – 6000	<100 – 10050	<100 – >200000	
Oil and Grease	mg/l	15 Avg 30 Max	<1.0 – 2.0	<1.0 – 2.0					
pH	units	6.0 – 9.0	7.6 – 8.3	7.6 – 8.5					7.8 – 8.5
Suspended Solids ⁽³⁾	mg/l	25 Avg 50 Max	<1.0 – 6.0	<1.0 – 4.0					<1.0 – 1.0
Temperature	F	110	48 – 77	37 – 77					
Tetrachloro-ethylene	mg/l	0.0022 Avg 0.0055 Max							<0.001
Trichloro-ethylene	mg/l	0.005 Avg 0.0125 Max							<0.001
1,2-Dichloro-ethylene	mg/l	0.005 Avg 0.0125 Max							<0.001

NOTES:

- (1) The parameters listed are required to be sampled in accordance with the NPDES Permit for the Site. Fecal coliform storm water runoff samples are required to be collected quarterly from Outfalls 001, 003, 004, 005, and 006. Aluminum storm water runoff samples are required to be collected quarterly from Outfalls 004 and 005. Oil and grease, pH, suspended solids, and temperature samples are required to be collected semimonthly from Outfalls 001 and 002. Dissolved iron, pH, suspended solids, tetrachloroethylene, trichloroethylene, and 1,2-dichloroethylene are required to be collected semimonthly from Outfall 007.
- (2) The fecal coliform levels shown above are generally typical of urban runoff as reported in the Handbook for Urban Runoff Prevention and Control Planning (EPA/625/R-93/004 dated September, 1993). The EPA notes that the primary source of bacteria in urban runoff is from animal wastes which is consistent with the source of fecal coliforms detected in the Bettis storm water runoff.
- (3) For Outfall 007, the concentration limits for suspended solids = 30 mg/l average and 75 mg/l maximum.

TABLE 6

**SUMMARY OF SEMIMONTHLY AND SEMIANNUAL
INFLUENT AND EFFLUENT WATER QUALITY RESULTS**

Parameter	Units	Guideline ⁽¹⁾	Influent City Water Range	Outfall 001 Range	Outfall 002 Range	Sanitary Effluent Range
Alkalinity	mg/l as CaCO ₃	>20	24.2 – 39.2	30.5 – 51.1	41.0 – 47.4	
Aluminum	mg/l		<0.10	<0.10	<0.10	
Ammonia	mg/l	1.87	0.09 – 0.47	0.07 – 0.20	<0.02 – 0.32	
Biochemical Oxygen Demand	mg/l	250				111 – 115
Chloride	mg/l		23.5 – 39.9	38.2 – 52.0	41.9 – 44.9	53.0 – 62.1
Fecal Coliform	colonies/100 ml	200 ⁽³⁾	<10 – <11	12 – 63 ⁽²⁾	10 – 39	
Fecal Coliform	colonies/100 ml	2000 ⁽⁴⁾	<10	16 – 166 ⁽²⁾	<10 – 28	
Hardness	mg/l		95.0 – 152	107 – 192	111 – 154	113 – 160
Iron, Dissolved	mg/l		<0.01 – 0.02	0.01 – 0.02	0.03	
Iron, Total	mg/l	1.5	0.05	0.09 – 0.51	0.20 – 0.25	
Oil and Grease	mg/l	100	<1.0 – 2.0			16 – 24
Osmotic Pressure	Mosm/Kg	50	23 – 27	26 – 30	25 – 29	
Oxygen, Dissolved	mg/l	>4.0	4.2 – 10.0	5.0 – 10.0	4.6 – 10.0	2.0 – 6.6
pH	units	5.0 – 11.0	7.2 – 7.7			8.4
Solids, Dissolved	mg/l		184 – 314	224 – 390	244 – 319	
Temperature	F	150	36 – 81			73 – 77

NOTES:

- (1) Guidelines for general water quality parameters are based on the guidelines for warm water fishes as identified by the PADEP in Pennsylvania Code, Title 25, Chapter 93, Water Quality Standards. The guidelines noted are for Outfalls 001 and 002 and do not apply to sanitary effluent. Applicable sanitary effluent guidelines are based on West Mifflin Borough Ordinance 905.
- (2) These fecal coliform results do not include the results provided in Table 5 which are collected as part of the storm water sampling program. The results shown are from samples that were collected mainly during periods of little or no precipitation.
- (3) The guideline is the geometric mean of five consecutive samples collected on different days for the period May 1 to September 30. The analysis results are the minimum and maximum geometric means of five consecutive samples collected on different days during this period.
- (4) The guideline is the geometric mean of five consecutive samples collected on different days for the period October 1 to April 30. The analysis results are the minimum and maximum geometric means of five consecutive samples collected on different days during this period.

TABLE 7

ANNUAL INFLUENT AND EFFLUENT WATER QUALITY RESULTS						
Parameter	Units	Guideline ⁽¹⁾	Influent City Water	Outfall 001	Outfall 002	Sanitary Effluent
Antimony	mg/l	1.100	<0.10	<0.10	<0.10	
Arsenic	mg/l	0.340	<0.005	<0.005	<0.005	
Base Neutrals/Acids	mg/l	--- (2)	--- (2)	--- (2)	--- (2)	
Beryllium	mg/l		<0.001	<0.001	<0.001	
Cadmium	mg/l	0.018	<0.005	<0.005	<0.005	
Chromium, Hexavalent	mg/l	0.016	<0.01	<0.01	<0.01	
Chromium, Total	mg/l		<0.01	<0.01	<0.01	
Copper	mg/l	0.044	<0.01	0.04	<0.01	
Cyanide, Free	mg/l	0.022	<0.001	0.002	<0.001	
Lead	mg/l	0.382	0.001	0.011	0.001	
Mercury	mg/l	0.002	<0.0002	<0.0002	<0.0002	<0.0002
Nickel	mg/l	1.31	<0.01	<0.01	<0.01	
Pesticides	mg/l	--- (2)	--- (2)	--- (2)	--- (2)	
Polychlorinated Biphenyls	mg/l		<0.001	<0.001	<0.001	
Selenium	mg/l		<0.010	<0.020	<0.020	
Silver	mg/l	0.033	<0.0005	<0.0005	<0.0005	<0.0005
Thallium	mg/l	0.065	<0.040	<0.040	<0.080	
Volatile Organic Compounds	mg/l	--- (2)	--- (2)	--- (2)	--- (2)	
Bromodichloromethane		--- (4)	0.022	0.002 J ⁽³⁾	<0.005	
Chloroform		1.900	0.053	0.002 J ⁽³⁾	<0.005	
Dibromochloromethane		--- (4)	0.007	<0.005	<0.005	
Zinc	mg/l	0.335	0.13	0.30	0.07	

NOTES:

- (1) The guideline is the maximum concentration guideline based on the fish and aquatic life criteria provided by the Pennsylvania Department of Environmental Protection in Pennsylvania Code, Title 25, Chapter 16, Water Quality Toxics Management Strategy. The guidelines noted are for Outfalls 001 and 002 and do not apply to sanitary effluent. A hardness value of 336 mg/l was used to calculate several guidelines.
- (2) A complete listing of the compounds analyzed along with the associated guidelines are identified in Appendix A, Table 1, Chapter 16, Water Quality Toxics Management Strategy. Analysis results for each compound analyzed were less than the minimum detection level for the parameter unless otherwise specified.
- (3) "J" data qualifier indicates that analyte is present, but reported value may not be accurate or precise.
- (4) No specific guideline available.

B. GROUND WATER

The purpose of the ground water monitoring programs is to determine the impact of operations on the ground water. The nonradiological monitoring program is also performed to monitor for the migration of chemical residues in ground water.

Sources

The primary source of radioactivity and chemical constituents in the Site's ground water is from operations conducted in the 1950's and 1960's. During that time, small amounts of radioactivity were released from a few isolated locations on-site as a result of minor breaches in containers and underground pipes containing radioactive materials. Since that time, vigorous efforts to prevent recurrence of these problems have been successful, and much of the soil containing residual radioactivity has been removed. However, there remain some areas of soil within the Site confines that contain small amounts of radioactivity from past Site operations. Monitoring is conducted to detect any influence of this activity on water quality.

The chemical constituents originated from infrequent spills or the past practice of on-site disposal of small amounts of spent solvents, typically degreasing agents such as PCE from Site operations. It is also possible that solvent disposal by prior tenants when the Site was an airfield may have contributed to the ground water contamination. Since the early 1970s, these materials have been disposed of off-site.

Ground Water Monitoring

The samples and analyses specified below constitute the minimum samples and analyses conducted at the Site during 2001. The well locations and on-site springs are shown on Figure 5. The wells monitor five water-bearing zones under the Site down to and including the Pittsburgh Coal Water-Bearing Zone. These water-bearing zones, which are illustrated and discussed in detail in the Final RFI Report, Reference (1), are listed below in order of increasing depth: Perched, Benwood Limestone, Sewickley Sandstone, Pittsburgh Sandstone, and Pittsburgh Coal. The on-site springs and seeps are surface discharge points for water predominantly from the Benwood or Sewickley Water-Bearing Zones.

Radiological: Ground water samples, from on-site and off-site springs, select wells and a discharge point for the abandoned Pittsburgh Coal Mine under the site, were collected at least annually and analyzed typically for gross alpha, gross beta, strontium-90, gamma-emitters, and uranium isotopes.

Seepage samples were collected from the Inactive Waste Site (IWS) and areas below it as shown in Figure 6 and analyzed for gross alpha, gross beta, strontium-90, gamma-emitters, and uranium isotopes.

Nonradiological: Ground water samples were collected from select wells and a discharge point for the abandoned Pittsburgh Coal Mine under the Site at least annually and analyzed for volatile organic compounds. In addition, three wells from each water-bearing zone are sampled every third year for additional inorganic and organic analyses to provide additional water quality data.

Seepage samples were collected from the IWS and areas below it and analyzed for VOCs, PCBs, and polynuclear aromatic hydrocarbons (PAHs).

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WATER-BEARING ZONE

- ▲ PERCHED
- BENWOOD LIMESTONE
- ▣ SEWICKLEY SANDSTONE
- PITTSBURGH SANDSTONE
- PITTSBURGH COAL

FIGURE 5 LOCATIONS OF WELLS AND SPRINGS

Ground Water Analyses

Radiological: Ground water analysis methods are discussed under Liquid Analyses in Section A.

Nonradiological: Analyses of ground water samples were performed using test methods described in Reference (3).

Ground Water Monitoring Results and Conclusions

Radiological: Tables 8A – 8F present the radioactivity data for the ground water monitored in 2001

The radioactivity data for the Perched Water-Bearing Zone are consistent with natural background levels of radioactivity in ground water in this area. Strontium-90 was not detected in Wells 87, 88 or 89 in 2001. Wells 87, 88 and 89 were installed at the recommendation of the Pennsylvania Department of Environmental Protection (PADEP) to monitor for migration of residual radioactivity from under the Materials Evaluation Laboratory. Historically, nine of the eleven wells monitoring the Perched Water-Bearing Zone have been sampled on at least one occasion for radioactivity. The remaining two wells have not contained sufficient water for sampling. The 2001 data do not show any increases in the ground water radioactivity levels. Overall, Bettis operations have not affected the natural radioactivity in the Perched Water-Bearing Zone.

The radioactivity data for the Benwood Water-Bearing Zone wells that were sampled in 2001 are consistent with typical natural background levels with the exception of the unenriched uranium results which were slightly higher than typical background levels for the Bull Run Spring. Uranium has been handled at Bettis in both an unenriched form (that is, with the same uranium isotopic ratio as naturally occurring uranium) and in an enriched form (that is, with a higher uranium-235 isotopic ratio than naturally occurring uranium). Since the detected uranium is unenriched and the results are at the upper end of the range of natural background levels, the uranium is likely to be from uranium naturally present in the soil. This ground water is not a source of drinking water. Nonetheless, the uranium results for the Bull Run Spring are far below the concentration in Reference (6) for uranium in drinking water. Historically, 41 of 43 wells in the Benwood Zone have been sampled on at least one occasion for radioactivity and the results reported. The remaining two wells have not contained sufficient water for sampling. A review of the results from samples taken during previous years has shown that only Wells 17 and 18, located on the IWS, have been measurably affected by Bettis operations. Strontium-90 has been detected in Well 17 above background levels but well below the concentration in Reference (4) for strontium-90 in water in unrestricted areas. Detectable levels of unenriched uranium in Wells 17 and 18, while above background concentrations, are well below the concentration in Reference (4) for uranium in water in unrestricted areas. The presence and levels of these radionuclides are consistent with the low levels of residual radioactivity in soil in the IWS from past operations.

The radioactivity data for the Sewickley Sandstone Water-Bearing Zone wells that were sampled in 2001 are consistent with natural background levels except for the uranium results from Well 36 which were at the upper end of the range of natural background levels but are consistent with historical samples from this well. Historically, all 13 wells in the Sewickley Zone have been sampled on at least one occasion and the results reported. A review of the results from samples taken during previous years has shown that Wells 36, 78 and 21D have contained unenriched uranium at levels at the upper end of the range of natural background levels. Since these wells are remote from areas likely affected by Bettis operations, the uranium is unenriched, and the uranium concentrations are near typical background levels, the detected uranium is considered to be from uranium naturally present in the soil. Bettis operations have not had a significant effect on the natural radioactivity in the Sewickley Sandstone Water-Bearing Zone.

TABLE 8A

GROUND WATER RADIOACTIVITY RESULTS Perched Water Bearing Zone Units: 10^{-9} $\mu\text{Ci/ml}$				
Analysis Parameter	Sample Locations ⁽¹⁾			
	W56	W87	W88	W89
Gross Alpha	<15	<6.9	<5.7	<10
Gross Beta	<7.6	4.8 ± 4.7	6.3 ± 4.5	<3.9
Strontium-90	<0.45	<0.2	<0.2	<0.11
Cesium-137	<5.9	<5.7	<5.5	<5.6
Cobalt-60	<5.1	<4.8	<5.2	<5.2
Uranium-233/234 ⁽²⁾	0.22 ± 0.21	0.45 ± 0.25	1.1 ± 0.49	0.77 ± 0.44
Uranium-235	<0.19	<0.12	<0.11	<0.19
Uranium-238	<0.14	0.46 ± 0.25	0.55 ± 0.34	0.31 ± 0.26

NOTE: All notes for Table 8 can be found after Table 8F.

TABLE 8B

GROUND WATER RADIOACTIVITY RESULTS Benwood Limestone Water Bearing Zone Units: 10^{-9} $\mu\text{Ci/ml}$				
Analysis Parameter	Sample Locations ⁽¹⁾			
	W26	W35	W53	W57
Gross Alpha	<7.0	<5.6	<14	<30
Gross Beta	<3.7	<3.4	<7.5	<7.9
Strontium-90	<0.34	<0.30	<0.56	<0.51
Cesium-137	<6.6	<5.9	<6.7	<6.8
Cobalt-60	<5.7	<4.9	<5.7	<5.5
Uranium-233/234 ⁽²⁾	1.7 ± 0.56	<0.15	0.33 ± 0.25	0.46 ± 0.30
Uranium-235	<0.19	<0.14	<0.11	<0.19
Uranium-238	1.6 ± 0.55	<0.11	0.23 ± 0.21	0.23 ± 0.21

NOTE: All notes for Table 8 can be found after Table 8F.

TABLE 8B (Continued)

GROUND WATER RADIOACTIVITY RESULTS Benwood Limestone Water Bearing Zone Units: 10^{-9} $\mu\text{Ci/ml}$			
Analysis Parameter	Sample Locations ⁽¹⁾		
	W68	W80	W100
Gross Alpha	<6.3	<6.7	<9.5
Gross Beta	<5.9	<6.0	<3.9
Strontium-90	<0.33	<0.52	<0.14
Cesium-137	<8.3	<6.2	<5.4
Cobalt-60	<7.7	<5.3	<5.4
Uranium-233/234 ⁽²⁾	0.50 ± 0.32	0.62 ± 0.33	<0.068
Uranium-235	<0.19	<0.15	<0.084
Uranium-238	0.23 ± 0.21	0.43 ± 0.28	<0.13

NOTE: All notes for Table 8 can be found after Table 8F.

TABLE 8B (Continued)

GROUND WATER RADIOACTIVITY RESULTS Benwood Limestone Water Bearing Zone Units: 10^{-9} $\mu\text{Ci/ml}$					
Analysis Parameter	Sample Locations ⁽¹⁾				
	Bull Run Spring	Buono Spring ⁽³⁾	RQ-20 Spring ⁽³⁾	CY Spring	SIS (Outfall 7)
Gross Alpha	<10	<6.7	<5.4	8.9 ± 7.1	<5.6
Gross Beta	<3.9	<3.6	<3.4	<3.2	<3.4
Strontium-90	0.14 ± 0.12	<0.14	<0.34	<0.19	<0.26
Cesium-137	<5.5	<6.5	<6.1	<6.9	<5.6
Cobalt-60	<5.0	<5.0	<5.5	<5.2	<4.8
Uranium-233/234 ⁽²⁾	2.2 ± 0.68	0.66 ± 0.30	0.32 ± 0.17	0.63 ± 0.35	1.1 ± 0.38
Uranium-235	0.24 ± 0.22	<0.15	<0.1	<0.21	<0.09
Uranium-238	1.7 ± 0.58	0.17 ± 0.14	0.18 ± 0.12	<0.17	0.60 ± 0.26

NOTE: All notes for Table 8 can be found after Table 8F.

TABLE 8C

GROUND WATER RADIOACTIVITY RESULTS Sewickley Sandstone Water Bearing Zone Units: 10^{-9} $\mu\text{Ci/ml}$					
Analysis Parameter	Sample Locations ⁽¹⁾				
	W36	W51	W97	W98	Northeast Spring ⁽³⁾
Gross Alpha	<4.2	<6.8	<3.1	<4.5	<6.1
Gross Beta	<3.1	<3.6	<2.9	<3.2	6.3 ± 4.6
Strontium-90	<0.24	<0.47	<0.17	<0.15	<0.21
Cesium-137	<6.9	<5.1	<5.7	<5.7	<6.4
Cobalt-60	<4.9	<5.4	<4.5	<5.3	<5.6
Uranium-233/234 ⁽²⁾	1.7 ± 0.45	0.96 ± 0.46	0.19 ± 0.14	<0.16	0.61 ± 0.33
Uranium-235	<0.071	<0.18	<0.099	<0.14	<0.15
Uranium-238	0.74 ± 0.26	0.43 ± 0.30	<0.13	<0.11	0.42 ± 0.27

NOTE: All notes for Table 8 can be found after Table 8F.

TABLE 8D

GROUND WATER RADIOACTIVITY RESULTS Pittsburgh Sandstone Water Bearing Zone Units: 10^{-9} $\mu\text{Ci/ml}$					
Analysis Parameter	Sample Locations ⁽¹⁾				
	W46	W60	W61	W75	W96
Gross Alpha	<4.1	<6.6	<6.7	<6.0	<4.3
Gross Beta	<3.1	<6.0	<6.0	<5.8	<3.1
Strontium-90	<0.34	<0.49	<0.51	<0.35	<0.18
Cesium-137	<5.1	<6.2	<5.8	<6.5	<5.6
Cobalt-60	<5.1	<5.9	<4.9	<5.5	<5.2
Uranium-233/234 ⁽²⁾	0.40 ± 0.27	0.59 ± 0.30	0.32 ± 0.25	0.25 ± 0.15	<0.2
Uranium-235	<0.18	<0.14	<0.19	<0.083	<0.19
Uranium-238	<0.13	<0.1	<0.14	0.18 ± 0.14	<0.14

NOTE: All notes for Table 8 can be found after Table 8F.

TABLE 8E

GROUND WATER RADIOACTIVITY RESULTS Pittsburgh Coal Water Bearing Zone Units: 10^{-9} μ Ci/ml			
Analysis Parameter	Sample Locations ⁽¹⁾		
	W44	W44A	W45
Gross Alpha	12 ± 8.3	<5.4	<3.2
Gross Beta	7.2 ± 4.4	6.1 ± 4.4	5.3 ± 3.9
Strontium-90	0.61 ± 0.34	1.1 ± 0.47	<0.39
Cesium-137	<5.5	<6.6	<6.7
Cobalt-60	<5.4	<5.5	<6.0
Uranium-233/234 ⁽²⁾	<0.19	<0.11	<0.18
Uranium-235	<0.18	<0.15	<0.19
Uranium-238	<0.14	<0.15	<0.14

NOTE: All notes for Table 8 can be found after Table 8F.

TABLE 8E (Continued)

GROUND WATER RADIOACTIVITY RESULTS Pittsburgh Coal Water Bearing Zone Units: 10^{-9} μ Ci/ml						
Analysis Parameter	Sample Locations ⁽¹⁾					
	W48	W52	W63	W95	DM176	BKG ⁽⁴⁾ (Gasowski Farm Well)
Gross Alpha	<3.0	<6.2	<6.9	<4.7	<5.2	<5.0
Gross Beta	<2.9	5.9 ± 4.6	<6.0	<3.2	4.7 ± 4.2	13 ± 4.7
Strontium-90	<0.26	<0.41	<0.32	<0.19	<0.11	<0.51
Cesium-137	<6.8	<6.9	<6.6	<5.7	<5.5	<6.3
Cobalt-60	<5.9	<5.3	<5.7	<5.0	<4.6	<4.8
Uranium-233/234 ⁽²⁾	0.32 ± 0.26	0.28 ± 0.22	0.26 ± 0.18	0.37 ± 0.26	<0.14	0.27 ± 0.23
Uranium-235	<0.2	<0.13	<0.12	<0.19	<0.18	<0.2
Uranium-238	<0.2	<0.1	<0.13	0.37 ± 0.26	<0.19	0.26 ± 0.21

NOTE: All notes for Table 8 can be found after Table 8F.

TABLE 8F

GROUND WATER RADIOACTIVITY RESULTS INACTIVE WASTE SITE, DUQUESNE LIGHT and VALLEY NATIONAL GASES INC.⁽⁵⁾ Hillside Seepage Runoff Units: 10⁻⁹ µCi/ml							
SAMPLE ⁽¹⁾ LOCATION	Analyses						
	Gross Alpha	Gross Beta	Strontium 90	Cesium 137	Uranium 234 ⁽²⁾	Uranium 235	Uranium 238
Inactive Waste Site							
IW-01	32 ± 8.8	12 ± 3.4	0.42 ± 0.34	< 4.7	30 ± 5.6	1.8 ± 0.79	26 ± 4.9
IW-02	230 ± 21	62 ± 5.5	2.4 ± 0.39	< 6.6	140 ± 24	6.5 ± 1.9	140 ± 24
Wet-Weather Drainage Ditch							
DL-01	13 ± 5.9	15 ± 3.4	3.2 ± 0.48	< 6.6	6.0 ± 1.7	< 0.29	4.7 ± 1.5
DL-02	17 ± 6.8	11 ± 3.3	1.7 ± 0.45	< 5.5	6.5 ± 2.0	0.63 ± 0.61	5.9 ± 1.8
VNGI-01	5.5 ± 4.6	6.6 ± 3.0	2.0 ± 0.66	< 7.0	6.0 ± 1.3	0.23 ± 0.21	6.1 ± 1.4
	7.7 ± 4.9	6.9 ± 3.0	1.6 ± 0.49	< 6.5	6.1 ± 1.3	0.32 ± 0.23	5.4 ± 1.2
Wet-Weather Drainage Ditch Runoff Area							
VNGI-02	5.0 ± 4.0	7.4 ± 2.9	1.2 ± 0.44	< 5.4	4.2 ± 1.0	0.28 ± 0.23	3.9 ± 0.98
VNGI-03	< 2.3	2.9 ± 2.6	0.32 ± 0.24	< 6.8	2.8 ± 0.63	0.14 ± 0.12	2.3 ± 0.55

NOTES:

- (1) W48=Monitoring Well No.48; SIS = Springwater Intercept System; IW = Inactive Waste Site; DL = Duquesne Light; VNGI = Valley National Gases Inc.; P11 = Location of Piezometer 11; DM176 = Sample of Pittsburgh Coal Mine water discharge into the Dravosburg storm sewer system.
- (2) The analytical method cannot distinguish between U-233 and U-234. The results are attributed to U-234 based on the source of the radioactivity.
- (3) These springs are included in the SIS. Samples were collected at access points in the drainage system.
- (4) BKG = background. The water from this well is from the zone below the Pittsburgh Coal Water Bearing Zone but is considered to be representative of background water quality.
- (5) Refer to Figure 6 for these sample locations. Multiple sample results are from duplicate samples.

The radioactivity data for the Pittsburgh Sandstone Water-Bearing Zone wells that were sampled in 2001 are consistent with natural background levels. Historically, nine of 12 wells in the Pittsburgh Sandstone Zone have been sampled on at least one occasion and the results reported. The remaining three wells have not contained sufficient water for sampling. A previous sample taken from Well 58 in 1994 contained unenriched uranium above normal background. Well 58 is remote from areas likely affected by Bettis operations and the uranium in this well was considered to be from natural sources. Nevertheless, the levels of natural uranium are well below the EPA drinking water limits of Reference (6) for this activity in water in unrestricted areas. Bettis operations have not affected the natural radioactivity in the Pittsburgh Sandstone Water-Bearing Zone.

The radioactivity data for the Pittsburgh Coal Water-Bearing Zone wells that were sampled in 2001 are consistent with background levels from atmospheric nuclear weapons testing with the possible exception of Wells 44 and 44A that are located within a few feet of each other. The results from Wells 44 and 44A indicate the presence of low levels of strontium-90 at levels similar to those detected in Well 44A in 1999 and in Wells 44 and 44A in 1998. Well 44A is set in a remaining coal pillar while Well 44 is set in a mined-out void. The highest detected concentration was one-eighth the Reference (6) drinking water limit that is the most restrictive strontium-90 limit in water. Low levels of strontium-90 is present in the soil in the Inactive Waste Site from past Bettis operations and higher than background levels of strontium-90 have been detected in surface drainage from the Inactive Waste Site as discussed in past reports. It is not clear what part of the source of strontium-90 detected in Wells 44 and 44A could be from past atmospheric nuclear weapons testing or from past Bettis operations. Samples will continue to be taken from this zone to monitor for the presence of strontium-90. Historically, seven of the eight wells in this zone have been sampled on at least one occasion. The remaining well has not contained sufficient water for sampling. Overall, Bettis operations have not had a significant effect on the background radioactivity in the Pittsburgh Coal Water-Bearing Zone.

Historically, some of the water in the abandoned Pittsburgh Coal Mine under the Site has discharged into the Borough of Dravosburg combined sanitary/storm sewer system. During 1998, the combined storm sewer system was modified so the discharge from the abandoned mine no longer enters the sanitary sewer system. Samples of this discharge were analyzed for radioactivity, and the results are in Table 8E as sample point DM176. The results are consistent with natural background levels of radioactivity and demonstrate that Site operations have not affected the natural radioactivity in this water.

The IWS water samples (Table 8F, IW-01 and IW-02) were collected from the discharges of a french drain shown in Figure 6. This water picks up low levels of radioactivity as it passes through the IWS. The discharges from the drain are absorbed back into the ground within several feet of the discharge points and do not flow offsite over the surface. The radioactivity data show the presence of strontium-90 at 2.4×10^{-9} $\mu\text{Ci/ml}$ and uranium. The maximum levels of uranium were uranium-234, 1.4×10^{-7} $\mu\text{Ci/ml}$; uranium-235, 6.5×10^{-9} $\mu\text{Ci/ml}$; and uranium-238, 1.4×10^{-7} $\mu\text{Ci/ml}$.

Some of the water that migrates through the IWS also emerges occasionally in and adjacent to a wet-weather drainage ditch on DL and VNGI properties and may flow as shown in Figure 6 if there is sufficient seepage. Most often, the water that emerges from the ditch is absorbed back into the ground before it reaches the locations of Wells 44 and 44A (Figure 6). The radioactivity data in Table 8F show the presence of strontium-90 and uranium as noted in the liquid discharges from the french drain up gradient on the IWS. The maximum strontium-90 concentration was 3.2×10^{-9} $\mu\text{Ci/ml}$. The maximum uranium concentrations were uranium-234, 6.5×10^{-9} $\mu\text{Ci/ml}$; uranium-235, 0.63×10^{-9} $\mu\text{Ci/ml}$ and uranium-238, 6.1×10^{-9} $\mu\text{Ci/ml}$.

The concentrations of radionuclides in the seepage below the IWS are well below their Reference (4) concentrations for unrestricted areas. Based on the concentrations of the radionuclides and the fact that the ditch water is not consumed by humans, the presence of these low levels of radioactivity in the runoff does not pose a threat to humans.

In summary, the radiological operations at the Laboratory did not impact the ground water in 2001. Some of the seepage samples collected below the IWS contain low levels of radioactivity attributed to historical operations. The radioactivity data for the french drain discharges on the IWS and in the seepage on DL and VNGI properties are consistent with previous data and do not indicate any increase in the radioactivity levels. These levels are all well below the limits of Reference (4). Overall, site operations have not significantly affected the natural radioactivity in the water-bearing zones under the Site.

Nonradiological: The results of the analyses of ground water for the chemical constituents of concern are presented in Tables 9A through 9F. The results are summarized below.

Previous environmental monitoring results have shown that the contaminants-of-concern in Site ground water are VOCs, primarily PCE and its degradation products, TCE and DCE. Ground water samples analyzed during the RCRA Facility Investigation showed the following average total VOC level in the water-bearing zones: Perched, 0.1 mg/l; Benwood Limestone, 1.3 mg/l; Sewickley Sandstone, 5.9 mg/l; and Pittsburgh Sandstone, 0.065 mg/l. VOCs associated with Site operations have not been detected above the analytical laboratory's minimum detection levels in the Pittsburgh Coal Water-Bearing Zone. The 2001 ground water monitoring results for VOCs are consistent with previous results.

Samples of seepage collected from the IWS and from the main wet-weather ditch (Figure 6) on DL and VNGI properties contained PCE, TCE and DCE. The maximum levels of these compounds were 0.180, 0.054 and 0.110 mg/l respectively. These data are consistent with previous data and do not indicate any changes in the levels. PCBs and PAHs were not detected in samples of this seepage, which is consistent with previous data.

Some of the water in the abandoned Pittsburgh Coal Mine under the Site discharges into the Borough of Dravosburg storm drain system. A sample (DM176) of this discharge was analyzed for volatile organic compounds. None of the VOCs associated with Site operations were detected in this discharge. This result is consistent with previous sample results.

The total metals, general chemistry, and polynuclear aromatic hydrocarbon results are consistent with previous results. These analyses are performed every three years on three wells in each water-bearing zone to confirm that the observations and conclusions presented in the RFI have not changed. In general, the metals and general chemistry analyses revealed concentrations similar to background levels in western Pennsylvania. No polynuclear aromatic hydrocarbons, other than those associated with plastic sample collection, handling, and analytical equipment were detected in the ground water samples.

The 2001 ground water monitoring results are consistent with previous results and do not show any changes in the migration pattern of chemical residues in the ground water.

TABLE 9A

GROUND WATER NONRADIOLOGICAL RESULTS Perched Water-Bearing Zone			
PARAMETER	W56 ⁽¹⁾	W87	W89
VOCs ⁽²⁾ (mg/l)			
Tetrachloroethylene	<0.005	<0.005	0.112
Trichloroethylene	<0.005	<0.005	0.015
1,2-Dichloroethylene	0.005 J	<0.005	0.004 J
Total Metals ⁽⁴⁾ (mg/l)			
Arsenic	0.004	<0.005	<0.005
Barium	0.41	0.11	0.079
Cadmium	<0.005	0.002 B	0.004 B
Chromium	<0.005 L	<0.005 L	<0.005 L
Iron	10.6	0.009 B	0.02 B
Lead	<0.001 L	<0.005 L	<0.005 L
Manganese	25.0	0.004 B	0.005 B
Mercury	<0.0002	<0.00009 B	<0.0002
Selenium	<0.005 L	<0.005 L	0.002 L
Silver	<0.01	<0.01	<0.01
General Chemistry ⁽⁵⁾			
Chloride (mg/l)	1680	451	896
pH (pH units)	6.76	7.03	6.71
Specific Conductance (umhos/cm)	5640	1124	3030
Sulfate (mg/l)	151	69	216

Notes: All notes for Table 9 can be found after Table 9F.

TABLE 9B

GROUND WATER NONRADIOLOGICAL RESULTS Benwood Water-Bearing Zone									
PARAMETER	W26 ⁽¹⁾	W35	W53	W57	W68	W80	W92	W93	W100
VOCs ⁽²⁾ (mg/l)									
Tetrachloroethylene	2.22	<0.005	<0.005	<0.005	0.004 J ⁽³⁾	<0.005	<0.005	0.168	<0.005
Trichloroethylene	0.312	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.050	<0.005
1,2-Dichloroethylene	0.213	<0.005	0.006	<0.005	<0.005	<0.005	<0.005	0.030	<0.005
Total Metals (mg/l) ⁽⁴⁾									
Arsenic		<0.005				<0.005			<0.005
Barium		0.058				0.077			0.057
Cadmium		<0.005				0.002 B			<0.005
Chromium		<0.005 L				<0.005 L			<0.005 L
Iron		1.39				0.13			7.60
Lead		0.003 J				<0.001 L			<0.001 L
Manganese		0.82				0.05			0.68
Mercury		<0.0002				<0.0002			<0.0002
Selenium		<0.005 L				<0.005 L			<0.005 L
Silver		<0.007 B				0.01 B			0.008 B
General Chemistry ⁽⁵⁾									
Chloride (mg/l)		326				169			1290
pH (pH units)	6.68	6.96	7.24	6.91	7.25	6.52	7.5	6.95	6.58
Spec. Cond. (umhos/cm)	1427	1056	3640	1252	1255	1030	694	1032	3220
Sulfate (mg/l)		90				270			156

Notes: All notes for Table 9 can be found after Table 9F.

TABLE 9C

GROUND WATER NONRADIOLOGICAL RESULTS Sewickley Sandstone Water-Bearing Zone					
PARAMETER	W36 ⁽¹⁾	W51	W65	W97	W98
VOCs ⁽²⁾ (mg/l)					
Tetrachloroethylene	<0.005	0.614	20.2	<0.005	<0.005
Trichloroethylene	0.003 J ⁽³⁾	0.114	2.02	<0.005	<0.005
1,2-Dichloroethylene	<0.005	0.078	1.18	<0.005	<0.005
Total Metals (mg/l) ⁽⁴⁾					
Arsenic	<0.005		<0.005	<0.005	
Barium	0.074		0.052	<0.10	
Cadmium	0.005 B		<0.005	<0.005	
Chromium	<0.005 L		<0.005 L	<0.005 L	
Iron	0.02 B		0.04 B	0.04 B	
Lead	<0.005 L		<0.001 L	0.001 B	
Manganese	0.12		1.06	0.02 B	
Mercury	<0.0002		<0.0002	<0.0002	
Selenium	<0.005 L		<0.005 L	<0.005 L	
Silver	<0.01		0.02 B	<0.01	
General Chemistry ⁽⁵⁾					
Chloride (mg/l)	191		215	50.6	
pH (pH units)	6.56	6.69	7.2	6.3	7.2
Specific Conductance (umhos/cm)	1262	1252	2370	374	730
Sulfate (mg/l)	191		494	80	

Notes: All notes for Table 9 can be found after Table 9F.

TABLE 9D

GROUND WATER NONRADIOLOGICAL RESULTS Pittsburgh Sandstone Water-Bearing Zone					
PARAMETER	W46 ⁽¹⁾	W60	W61	W75	W96
VOCs ⁽²⁾ (mg/l)					
Tetrachloroethylene	<0.005	0.020	<0.005	<0.005	<0.005
Trichloroethylene	<0.005	0.002 J	<0.005	<0.005	<0.005
1,2-Dichloroethylene	<0.005	<0.005	<0.005	<0.005	<0.005
Total Metals (mg/l) ⁽⁴⁾					
Arsenic		<0.005		<0.005	<0.005
Barium		0.064		0.06	0.066
Cadmium		<0.005		<0.005	<0.005
Chromium		<0.005 L		<0.005 L	<0.005 L
Iron		0.04 B		0.03 B	0.86
Lead		<0.001 L		<0.001 L	<0.001 L
Manganese		0.01 B		0.61	0.28
Mercury		0.00009 B		<0.0002	<0.0002
Selenium		<0.005 L		<0.005 L	<0.005 L
Silver		0.01 B		<0.01	0.008 B
General Chemistry ⁽⁵⁾					
Chloride (mg/l)		292		194	199
pH (pH units)	7.32	7.05	7.28	7.05	7.26
Specific Conductance (umhos/cm)	475	1114	1544	960	927
Sulfate (mg/l)		117		105	161

Notes: All notes for Table 9 can be found after Table 9F.

TABLE 9E

GROUND WATER NONRADIOLOGICAL RESULTS Pittsburgh Coal Water-Bearing Zone							
PARAMETER	W44 ⁽¹⁾	W44A	W45	W48	W63	W95	DM176 ⁽⁶⁾
VOCs ⁽²⁾ (mg/l)							
Tetrachloroethylene	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Trichloroethylene	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
1,2-Dichloroethylene	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Total Metals (mg/l) ⁽⁴⁾							
Arsenic			<0.005		<0.005	<0.005	
Barium			0.034		0.009	0.016	
Cadmium			<0.005		0.002 B	<0.005	
Chromium			<0.005 L ⁽³⁾		<0.005 L	<0.005 L	
Iron			0.05 B		1.54	9.23	
Lead			0.00092 B		<0.001 L	<0.001 L	
Manganese			0.03 B		0.27	0.42	
Mercury			<0.0002		<0.0002	<0.0002	
Selenium			<0.005 L		<0.005L	<0.005 L	
Silver			0.01 B		0.01 B	<0.01	
General Chemistry ⁽⁵⁾							
Chloride (mg/l)			26.4		177	196	
pH (pH units)	6.41	6.22	6.7	6.18	5.07	4.32	5.6
Specific Conductance (umhos/cm)	1053	1186	553	908	1493	927	1335
Sulfate (mg/l)			123		535	476	

Notes: All notes for Table 9 can be found after Table 9F.

TABLE 9F

GROUND WATER NONRADIOLOGICAL RESULTS INACTIVE WASTE SITE, DUQUESNE LIGHT and VALLEY NATIONAL GASES INC Ground Water Seepage Runoff ^(3,7,8,10) Units: mg/l							
SAMPLE LOCATION	VOCs			PCBs		PAHs	
	PCE	TCE	DCE	1248	1260	B(a)P	B(a)A
Inactive Waste Site							
IW-01	0.007	0.006	<0.005	<0.0016	<0.0016	<0.015	<0.015
IW-02	0.054	0.054	0.110				
Wet-Weather Drainage Ditch							
DL-01	<0.005	<0.005	<0.005	<0.0015	<0.0015	<0.010	<0.010
DL-02	0.180	0.020	0.016	<0.001	<0.001	<0.011	<0.011
VNGI-01 ⁽⁹⁾	0.130	0.015	0.011	<0.001	<0.001	<0.010	<0.010
	0.130	0.015	0.011	<0.001	<0.001	<0.010	<0.010
Wet-Weather Drainage Ditch Runoff Area							
VNGI-02	0.017	<0.005	<0.005	<0.001	<0.001	<0.010	<0.010
VNGI-03	0.002 J	<0.005	<0.005	<0.001	<0.001	0.010 R,i	<0.010

Notes:

- (1) W86 = Well 86
- (2) Samples were analyzed for approximately 39 volatile organic compounds. Only the results for the potential contaminants of concern are reported. Results for the other volatile organic compounds were typically less than the minimum detection level that was generally 0.005 mg/l. The reported results represent the maximum results where more than one sample was analyzed from a sample location.
- (3) Data qualifiers: J = compound detected, reported value estimated due to uncertainty near the minimum quantitation level; B = qualitatively suspect result, analyte detected in laboratory blanks at similar concentration (not considered a positive result); L = analyte not detected, quantitation limit is estimated; R,i = compound not detected, reported value is rejected due to poor recovery of the associated internal standard.
- (4) In addition to the metals reported, analyses were also performed for antimony, beryllium, copper, nickel, sodium, thallium, and zinc. For the most part, results for these other metals are typically less than the minimum detection level. The levels of sodium reflect the chloride levels in the water.
- (5) In addition to the General Chemistry parameters reported, analyses were also performed for fluoride, nitrate, sulfide, cyanide, phenol and polynuclear aromatic hydrocarbons. The results for these parameters are consistent with previous results.
- (6) Sample of Pittsburgh Coal Mine water discharge into the Dravosburg storm drain system.
- (7) Refer to Figure 6 for sample locations.
- (8) Samples were analyzed for over 40 VOCs, seven PCB isomers, and 17 PAH compounds. Results are presented only for the potential contaminants-of-concern.
- (9) Multiple results are from duplicate samples.
- (10) PCE = Tetrachloroethylene; TCE = Trichloroethylene; DCE = 1,2-Dichloroethylene; B(a)P = Benzo(a)Pyrene; B(a)A = Benzo(a)Anthracene

C. AIRBORNE EFFLUENTS

The purpose of the airborne effluent monitoring program is to determine the effectiveness of control methods, to measure concentrations in effluents for comparison with applicable standards and natural background levels, and to assess the effect of any inadvertent releases to the environment.

Sources

Sources of radioactive airborne materials included operations associated with examining nuclear fuel and reactor materials. Areas of the Site wherein unencapsulated radioactive materials were handled were equipped with wet scrubbers or filtered exhaust systems. The high efficiency particulate air (HEPA) filters were preceded as necessary by prefilters to remove dust and large particulates. HEPA filters were tested upon installation and at least annually thereafter to assure that high removal efficiencies (99.95%) are maintained.

Sources of airborne effluents not related to radiological operations were heating systems, such as gas and oil fueled boilers and space heaters, testing of diesel generating units, and small-scale operations involving chemicals. Fuel burning and combustion equipment were operated in compliance with the Site's existing individual boiler permits and the Air Operating Permit application which was submitted to the Allegheny County Health Department (ACHD) in November 1995. The Site permit, which will replace the individual unit air operating permits, is anticipated to be issued in the near future. Air exhausted from the Site's fume hoods was treated, where appropriate, by filtration or wet scrubbers to minimize the release of materials.

Airborne Monitoring

The samples and analyses specified below constitute the minimum samples and analyses conducted at the Site during 2001.

Radiological: Radioactive airborne effluents from the Site were continuously monitored using fixed-filter air stations operated at a constant, metered sample flow rate. Particulate radioactivity in the effluents was collected on 0.8 micron millipore filters. Select exhausts were specifically monitored for plutonium-238, europium-152, uranium-233, cesium-137, and strontium-90 as required by 40 CFR 61 Subpart H. Filters were collected and analyzed at least weekly for gross alpha and gross beta radioactivity with the exception of the filter from the L-Building facility which was collected and analyzed quarterly. Quarterly, the particulate filters from each exhaust were composited and analyzed for gross alpha, gross beta, strontium-90, and gamma-emitters. In addition, sampling for the short half-life (55 seconds) radon-220 from former thorium handling areas was performed annually using a charcoal filter cold-trap method. The Site's radiological exhaust monitoring systems were in compliance with the U. S. Environmental Protection Agency (EPA) requirements in Reference (7).

Background airborne particulate radioactivity was monitored continuously using fixed-filter air samplers positioned off-site at locations (Large, PA and West Mifflin, PA) which are approximately 5 miles and 1.5 miles, respectively, from the Site. These air filters were collected and analyzed weekly for gross alpha and gross beta radioactivity.

Nonradiological: There were no major chemical operations at the Site during 2001 which might generate significant quantities of airborne chemical pollutants. Estimates of particulate and gaseous emissions were used to ensure that applicable standards were met. Monitoring of nonradiological emissions was not required or necessary.

Airborne Analyses

Radiological: Particulate filter samples were analyzed for gross alpha and gross beta radioactivity at approximately 48 hours after collection to permit the decay of the naturally occurring, short-lived radon-thoron daughter products accumulated on the filters. The alpha and beta radioactivities were measured using a lead-shielded, gas-flow proportional counter. Quarterly, the sample filters were composited and analyzed for gross alpha and beta radioactivity as well as gamma-emitters. Typical decision level concentrations (DLCs) for gross alpha and beta radioactivity were 2.0×10^{-16} $\mu\text{Ci/ml}$ and 4.0×10^{-16} $\mu\text{Ci/ml}$, respectively.

Gamma analyses were conducted using a high resolution Germanium-Lithium or Germanium detector and a multichannel analyzer. A typical DLC for cesium-137 was 8.0×10^{-16} $\mu\text{Ci/ml}$. Uranium and plutonium analyses of selected composites were performed using alpha spectrometry. Typical detection levels for uranium-233 and plutonium-238 were 1.0×10^{-16} $\mu\text{Ci/ml}$ and 2.0×10^{-16} $\mu\text{Ci/ml}$, respectively. In addition, strontium-90 analyses were performed on selected quarterly filter composites from potential source areas. A typical DLC for strontium-90 was 8.0×10^{-16} $\mu\text{Ci/ml}$.

The charcoal filters used for measuring radon-220 releases were analyzed using the high resolution Germanium-Lithium or Germanium detector. The radon-220 concentrations were determined from the characteristic photo-peak of lead-212 which is the principal gamma-emitting product of radon-220 decay.

Nonradiological: Discharges of nonradioactive airborne pollutants were not significant enough to require airborne monitoring. Estimates of emissions were performed, as necessary, to ensure that applicable standards were met.

Airborne Monitoring Results and Conclusions

Radiological: The results of the monitoring of particulate and gaseous radioactivity effluents from the Site during 2001 are summarized in Table 10. Specific results from the airborne monitoring program are discussed below. Although comparisons of the Site's particulate airborne radioactivity results were made to background particulate radioactivity levels measured at off-site locations, no background corrections were made to the Site's release results.

The average concentration of airborne particulate gross alpha radioactivity released during 2001 was less than 3.35×10^{-16} $\mu\text{Ci/ml}$ and the average concentration of airborne particulate gross beta radioactivity was less than 1.32×10^{-15} $\mu\text{Ci/ml}$. In comparison, the average background gross alpha and gross beta airborne particulate radioactivity measured at the off-site locations were 3.6×10^{-15} $\mu\text{Ci/ml}$ and 4.5×10^{-14} $\mu\text{Ci/ml}$, respectively. Thus, on average, the gross alpha airborne radioactivity concentration in air emitted from the Site was about one-tenth the background airborne radioactivity levels. The gross beta airborne particulate radioactivity concentration in air emitted from the Site was one-thirtieth the background airborne radioactivity levels. Thus, the Site's filtration systems on the radiological exhausts are removing naturally occurring radioactivity from the air.

There were no detectable releases of cesium-137, uranium-233, plutonium-238 and europium-152 during 2001. The concentrations of these radionuclides listed in Table 10 are based on the DLC of the analyses.

TABLE 10

AIRBORNE EFFLUENT RADIOACTIVITY RESULTS ⁽¹⁾		
Activity	Average Concentration At Release Point ⁽²⁾ ($\mu\text{Ci/ml}$)	Limit At Site Boundary ⁽³⁾ ($\mu\text{Ci/ml}$)
Effluent Gross Alpha	$\leq 3.35\text{E-}16$	$6.0\text{E-}15^{(4)}$
Background Gross Alpha	$\leq 3.60\text{E-}15$	
Effluent Gross Beta	$\leq 1.32\text{E-}15$	$3.0\text{E-}11^{(5)}$
Background Gross Beta	$\leq 4.50\text{E-}14$	
Plutonium-238	$< 3.95\text{E-}17$	$2.0\text{E-}14$
Europium-152	$< 3.60\text{E-}15$	$3.0\text{E-}11$
Uranium-233	$< 6.54\text{E-}17$	$5.0\text{E-}14$
Cesium-137	$< 5.74\text{E-}16$	$2.0\text{E-}10$

- NOTES:**
- (1) For radioactivity with half-lives greater than one day.
 - (2) < signifies the data are below the DLC.
 - (3) Nuclear Regulatory Commission limits as prescribed in Title 10, Code of Federal Regulations, Part 20 for air in uncontrolled regions.
 - (4) Based on thorium-232.
 - (5) Based on strontium-90.

Based on the results of radon-220 effluent measurements and pathway evaluations, the average concentration of radon-220 at the location of the nearest off-site receptors was estimated to be approximately $2.3 \times 10^{-12} \mu\text{Ci/ml}$. This level is below the Federal limit of $3.0 \times 10^{-11} \mu\text{Ci/ml}$ for radon-220 in the air of uncontrolled areas. The releases of the very short-lived (55 seconds) radon-220 gaseous radioactivity from the Site resulted in no adverse effect on the surrounding environment and did not result in radiation exposures above the EPA and U. S. Department of Energy (DOE) radiation dose standards.

The total airborne radioactivity released from the Site with radionuclide decay half-lives greater than one day was less than 0.00000069 (6.9×10^{-7}) Curie.

The results of the Site's airborne radiological effluent monitoring program demonstrate the effectiveness of control methods. The results also show that the amount of airborne radioactivity released was too small to result in any measurable change in the background radioactivity levels in the environment. The concentrations of radioactivity released from the Site during 2001 were below the applicable limits for radioactivity in ambient air. Furthermore, the estimated radiation dose to any member of the public from the airborne radioactivity released was too low to measure and was significantly below the radiation protection standard established by the EPA in Reference (7).

Nonradiological: The results of evaluations and calculations for the Site's sources of airborne chemical pollutants are summarized below.

Heating System Exhaust

The boilers and space heating systems at the Site were fueled with natural gas and Number 2 distillate fuel oil. The heating systems were operated in accordance with the ACHD, Article XXI, Air Pollution Control regulations. Conservative estimates of the pollutant releases utilizing EPA emission

factors were made. These calculations showed that the airborne emissions from the Site's heating systems are well below the applicable local limits identified in Reference (8).

Diesel Generator Testing

The diesel generators tested at the Site were fueled with low sulfur Number 2 distillate fuel oil. The testing was conducted in accordance with the ACHD, Article XXI, Air Pollution Control regulations. Conservative estimates of the pollutant releases utilizing EPA emission factors were made. These calculations showed that the airborne emissions from the diesel generator testing was well below the applicable local limits identified in Reference (8).

Exhausts from Site Fume Hoods

Chemical vapors discharged by the Site's fume hoods were similar to those from other research labs engaged in analytical chemistry and development efforts. On the basis of the small scale of the operations, the types of material handled, and the treatment provided, it was concluded that the Site fume hood exhausts did not have any adverse effect on the environment.

Asbestos Removal Work

Asbestos removal work was conducted in compliance with the Federal, State and local requirements to limit the potential discharge of asbestos fibers to the environment. During 2001, the ACHD conducted 14 clearance inspections of asbestos abatement projects and passed all areas for release of the work area to the public.

D. SEDIMENT, SOIL, AND VEGETATION

The purpose of the sediment and soil monitoring programs is to monitor for the migration of existing radioactive and chemical residues. The purpose of the stream vegetation radiological monitoring program is to monitor for the uptake of radioactivity into stream vegetation.

Sources

The source of the radioactive and chemical residues in portions of the storm drain system and the Bull Run Stream basin is from operations conducted in the 1950's and 1960's. A significant amount of contaminated soil along Bull Run was removed many years ago and disposed of off-site at an U. S. Department of Energy (DOE) burial ground.

The source of soil contamination on portions of Duquesne Light (DL) and Valley National Gases Inc. (VNGI) properties immediately downgrade of the Bettis Inactive Waste Site (IWS) is from residual chemical and radioactive contaminants in the IWS.

Sediment, Soil, and Vegetation Monitoring

Radiological: Routine sediment samples were collected semiannually from the streambeds of the Site's effluent streams and from an off-site control stream, as shown in Figure 7. Seven sediment samples were collected along the length of the Bull Run and Thompson Run Streams. One sample each was collected from the Northeast Area Stream, and the Streets Run Stream. The sediment sample from the Streets Run Stream is a background sample since there are no known nuclear or radiological facilities in operation which could release radioactive effluents to this stream.

Sediment samples were also collected from the catch basins at the Bull Run and Northeast Area Monitoring Stations and from storm drain components upstream of both these stations; these sample locations are shown in Figure 7. Sediment samples were analyzed for gross alpha and gross beta radioactivity and gamma-emitters. Samples from one location were also analyzed for strontium-90.

Routine soil samples were not required to be collected for radioactivity analyses from within and below the drainage ditch on DL and VNGI properties during CY2001. Two additional soil samples were collected from VNGI property as part of a program reported in the CY2000 Environmental Monitoring Report. These samples were analyzed for gross alpha and gross beta radioactivity and gamma emitters.

Vegetation samples were collected from select locations in and along the Site's effluent streams. The vegetation samples were analyzed for strontium-90 activity and gamma-emitters.

Nonradiological: Sediment samples were collected from the catch basins at the Bull Run and Northeast Area Monitoring Stations and from select storm drain components, as shown in Figure 7. The sediment samples were analyzed for PCBs, VOCs, and mercury.

Sediment samples were collected annually from two locations (BR1 and BR5) in the Bull Run Stream, as shown in Figure 4. These samples were analyzed for VOCs.

Soil samples were collected from within and below the drainage ditch on DL and VNGI properties, as shown in Figure 8. These samples were analyzed for PCBs, PAHs, and VOCs.

LEGEND:
● SOIL SAMPLE LOCATION

FIGURE 8: SOIL SAMPLE LOCATIONS ON VALLEY NATIONAL GASES INC. AND DUQUESNE LIGHT PROPERTIES

Sediment, Soil, and Vegetation Analyses

Radiological: The sediment samples were oven-dried, milled, homogenized, and screened to remove large stones and extraneous materials. The vegetation samples were air dried, chipped, and blended. Aliquots of the homogenized sediment samples were uniformly distributed on a planchet and the alpha and beta radioactivities were measured by counting the dried samples using a lead shielded, gas-flow proportional counter. Gamma analyses were performed on the sediment and vegetation by counting the dried samples with a gamma spectrometry system. Typical decision level concentrations (DLCs) for the gamma analyses were 0.1 pCi/g for sediment and 0.03 pCi/g for vegetation samples.

Strontium-90 analyses of the samples were performed utilizing a standard strontium radiochemical procedure. The strontium was chemically separated and the sample was counted for beta radioactivity using the low background proportional counter described above. Typical DLCs for strontium-90 ranged from 0.1 - 0.3 pCi/g.

Nonradiological: Analysis of sediments and soils were performed using test methods described in Reference (3).

Sediment, Soil, and Vegetation Monitoring Results and Conclusions

Radiological: The results of the radioactivity analyses of sediments and vegetation are summarized in Tables 11 and 12.

The alpha and beta radioactivity levels in the Bull Run Stream, Thompson Run Stream and the Northeast Area Stream sediment samples were consistent with the alpha and beta radioactivity levels in the background (Streets Run) stream sediment.

Low levels of cesium-137 radioactivity, up to a maximum concentration of 2.1 pCi/g, were detected in the sediment samples from the Bull Run and Thompson Run Streams. This radioactivity is from effluent releases which occurred more than 35 years ago. The radioactivity levels for cobalt-60 and strontium-90 in the sediment from the Bull Run, Thompson Run and the Northeast Area Streams were below DLCs and were consistent with background radioactivity levels.

Radioactivity levels in vegetation collected in the Site's effluent streams and Thompson Run Stream were consistent with background radioactivity levels in vegetation.

In summary, the data did not indicate any uptake of residual radioactivity in stream vegetation or any significant changes in the residual radioactivity levels in stream sediments.

The results of the sediment samples taken from the storm drain system are summarized in Table 11 and show the presence of background levels of cesium-137 and uranium as cited in Reference (10). The cesium-137 results ranged up to 0.26 pCi/g, which are consistent with levels of cesium-137 found throughout the environment due to fallout from past atmospheric nuclear weapons testing. The uranium results are consistent with naturally occurring background levels of uranium in this area.

The results of the soil samples collected on VNGI property are provided in Table 13. The radioactivity levels in these samples are consistent with background levels of radioactivity.

TABLE 11

STORM DRAIN AND STREAM SEDIMENT RADIOACTIVITY RESULTS^(1,2)

Units: pCi/g

Sample Location	Analyses						
	Gross Alpha	Gross Beta	Strontium-90	Cesium-137	Cobalt-60	Uranium-235	Uranium-238
Stream Sediment							
Bull Run/ Thompson Run Streams	<2.9 to 12 ± 5.1	18 ± 3.5 to 38 ± 4.0	<0.19 to <0.36	0.19 ± 0.04 to 2.1 ± 0.042	<0.02 to <0.052		
Northeast Area Stream	7.2 ± 4.6 to 10 ± 5.1	28 ± 3.7 to 28 ± 3.8	<0.36	<0.024 to 0.071 ± 0.026	<0.027 to <0.035		
Background (Streets Run Stream)	5.1 ± 4.3 to 7.4 ± 4.5	18 ± 3.3 to 22 ± 3.3	<0.25	<0.024 to <0.026	<0.023 to <0.026		
Storm Drain⁽³⁾							
Bull Run Monitoring Station	9.0 ± 4.8 9.1 ± 5.0 8.5 ± 4.9	10 ± 2.9 18 ± 3.6 18 ± 3.4	<0.43	0.084 ± 0.036 0.081 ± 0.027 0.059 ± 0.037	<0.016 <0.022 <0.016		
Northeast Area Monitoring Station	6.0 ± 4.5	17 ± 3.5	<0.4	0.055 ± 0.041	<0.033		
YD 65B	5.6 ± 4.4 6.3 ± 4.1 < 2.6	9.7 ± 3.1 13 ± 2.5 17 ± 2.8	<0.33 <0.36 <0.34	0.068 ± 0.065 0.17 ± 0.056 0.088 ± 0.035	<0.033 <0.033 <0.027	< 0.18 < 0.21 < 0.15	< 0.55 1.4 ± 0.74 < 0.43
MH 60	< 3.1 < 3.1 < 3.0 7.6 ± 5.0 5.5 ± 4.6	20 ± 4.1 13 ± 3.7 16 ± 3.8 18 ± 4.0 15 ± 3.7		0.11 ± 0.035 0.041 ± 0.027 0.18 ± 0.034 0.054 ± 0.047 0.26 ± 0.048	<0.017 <0.017 <0.014 <0.02 <0.021	< 0.086 < 0.11 < 0.076 < 0.13 0.12 ± 0.055	< 0.50 < 0.34 < 0.23 < 1.1 < 1.3
MH 70	< 2.9 8.0 ± 4.7 5.4 ± 4.3 7.0 ± 4.6 < 3.0	13 ± 3.3 12 ± 3.0 15 ± 3.2 16 ± 3.3 15 ± 3.7		< 0.03 < 0.03 < 0.047 < 0.027 0.066 ± 0.035	<0.03 <0.029 <0.03 <0.026 <0.032	< 0.18 < 0.17 < 0.17 < 0.15 < 0.18	< 0.62 2.7 ± 0.8 1.1 ± 0.73 1.0 ± 0.73 1.7 ± 0.69

NOTES:

- (1) < signifies the data are below the DLC.
 (2) The shaded area indicates that the measurement was not required.
 (3) Multiple results are from replicate samples.

TABLE 12

STREAM VEGETATION RADIOACTIVITY RESULTS⁽¹⁾

Units: pCi/g

Sample Location	Analyses		
	Strontium-90	Cobalt-60	Cesium-137
Bull Run/Thompson Run	<0.069 to <0.11	<0.02 to <0.075	<0.014 to <0.064
Northeast Area	<0.036	<0.036	<0.029
Background	<0.067	<0.033	<0.027

NOTE:

- (1) < signifies the data are below the DLC

Nonradiological: The results of the nonradiological soil and sediment samples collected and analyzed in 2001 are provided below.

Table 14 provides the results for the primary chemicals of concern for the soil samples collected on DL and VNGI properties immediately below the IWS. The sample locations are shown in Figure 8.

The results of soil samples collected from the top few inches of the ground surface within and below the wet-weather drainage ditch on DL and VNGI properties, show the same chemical residues as reported in the Resource Conservation and Recovery Act (RCRA) Facility Investigation, Reference (1). The VOC detected in the highest concentration was PCE at 1.750 mg/kg and this result is consistent with previous results. Several PAHs were detected in the soil samples. The PAH compound of primary interest, benzo(a) pyrene, was detected at 2.33 mg/kg. The concentration of this and other PAH compounds are consistent with previous results reported in Reference (1) and with anthropogenic background (i.e. man-made background) PAH concentrations in the vicinity of the Site. PCB results were consistent with previous results. The maximum concentration detected was 2.4 mg/kg of Aroclor-1260.

In summary, the 2001 nonradiological soil results do not show any noteworthy changes in the low levels of chemical residues or their locations in the soil below the IWS.

The results of sediment sampling for chemical residues in the site's storm drain system, in the Bull Run and Northeast Area Monitoring Stations, and in the Bull Run Stream are shown in Table 15. The sample locations are shown in Figure 7. The results show the presence of low levels of PCBs, VOCs, and mercury in some of the samples of storm drain sediment. The PCB results in the storm drain sediment ranged to 16.3 mg/kg. PCE, the primary VOC of concern, was detected only in the Bull Run Monitoring Station sediment at a maximum concentration of 0.008 mg/kg. Mercury was detected in the storm drain system at a maximum concentration of 0.072 mg/kg. These results are consistent with previous data.

Low levels of PCE were measured in samples from the Bull Run Stream. The maximum PCE concentration was 0.38 mg/kg. However, this result is slightly higher than the previous maximum concentration, but is not indicative of any buildup or release. The PCE concentration in a duplicate sample was 0.028 mg/kg which is consistent with previous data.

TABLE 13

DUQUESNE LIGHT and VALLEY NATIONAL GASES, INC. SOIL SAMPLES RADIOLOGICAL RESULTS							
Units: pCi/g							
SAMPLE LOCATION ⁽¹⁾	Analyses						
	Gross Alpha	Gross Beta	Strontium 90	Cesium 137	Uranium 234	Uranium 235	Uranium 238
VNG-14A	9.1 ± 4.9	19 ± 3.4		0.21 ± 0.056		< 0.13	< 0.90
VNG-16A	12 ± 5.3	34 ± 4.2		1.3 ± 0.099		< 0.083	< 1.0

NOTES:

- (1) Refer to Figure 8 for these sample locations.

TABLE 14

DUQUESNE LIGHT and VALLEY NATIONAL GASES INC. SOIL SAMPLES NONRADIOLOGICAL RESULTS ⁽¹⁾							
Units: mg/kg							
SAMPLE LOCATION	VOCs ⁽²⁾			PCBs ⁽²⁾		PAHs ⁽²⁾	
	PCE	TCE	DCE	1248	1260	B(a)P	B(a)A
DL-01	0.537	0.039	<0.007	<0.073	0.893	0.839	1.010
VNGI-01	1.750 L,s	<0.400 UL,s	<0.400 UL,s	<0.081	0.382	0.519 J	0.657
VNGI-02 ⁽³⁾	0.246	0.017	<0.006	<0.637	2.400	2.080	2.470
	0.200	0.015	<0.006	<0.618	1.730	2.330	2.410
VNGI-03	<0.005	<0.005	<0.005	<0.052	0.332	0.136 J	0.129 J
VNGI-04	<0.006	<0.006	<0.006	<0.054	0.388 J,u	0.461	0.403

NOTES:

- (1) Refer to Figure 8 for these sample locations
- (2) Samples were analyzed for up to 40 VOCs, seven different PCB isomers, and 17 PAHs. Results are presented only for the primary contaminants-of-concern.
PCE = Tetrachloroethylene; TCE = Trichloroethylene; DCE = 1,2-Dichloroethylene;
B(a)P = Benzo (a) Pyrene; B(a)A = Benzo (a) Anthracene.
- (3) Duplicate samples.
- (4) Qualifier Definitions:
L,s = Compound detected. Result may be biased low due to surrogate recovery below the lower control level.
UL,s = Compound not detected. Quantitation limit may be biased low due to surrogate recovery below the lower control level.
J = Compound detected. Reported value may not be accurate or precise due to uncertainty near the detection limit.
J,u = Compound detected. Reported value may not be accurate or precise due to percent differences between columns greater than 25%.

TABLE 15

STORM DRAIN AND STREAM SEDIMENT NONRADIOLOGICAL RESULTS ^(1,2,3)						
Units: mg/kg						
SAMPLE LOCATION	VOCs			PCBs		Hg
	PCE	TCE	DCE	1254	1260	
STORM DRAIN						
Bull Run Monitoring Station	0.004 J,r,l,f 0.008 J,f 0.008 J,f	< 0.006 < 0.006 < 0.006	< 0.006 < 0.006 < 0.006	0.294 J,f 0.135 J,cc,f 2.54 J,f	< 0.063 < 0.063 < 0.121	0.037 B,z 0.055 B,z 0.067
Northeast Area Monitoring Station	< 0.0049 < 0.005 < 0.0054	< 0.0049 < 0.005 < 0.0054	< 0.0049 < 0.005 < 0.0054	< 0.063 < 0.061 < 0.059	< 0.056 J,r,l 0.085 0.065	0.015 B,z 0.016 B,z 0.025 B,z
Manhole 60	< 0.005 UJ,l < 0.005 UJ,l < 0.005 UJ,l	0.004 J,r,l,i,s 0.002 J,r,l,i,s 0.004 J,r,l,i,s	< 0.005 UJ,l < 0.005 UJ,l < 0.005 UJ,l	0.173 J,cc 0.163 J,cc 0.177 J,cc	< 0.063 < 0.059 < 0.06	0.072 L,m 0.048 L,m 0.06 L,m
Manhole 70	< 0.006 UJ,l < 0.005 UJ,l < 0.005 UJ,l	< 0.006 UJ,l < 0.005 UJ,l < 0.005 UJ,l	< 0.006 UJ,l < 0.005 UJ,l < 0.005 UJ,l	0.039 J,r,l,cc 0.028 J,r,l,cc 0.058 J,cc	< 0.07 < 0.056 < 0.057	0.017 B,z 0.017 B,z 0.021 B,z
Yard Drain 65B	< 0.008 < 0.006 < 0.006	< 0.008 < 0.006 < 0.006	< 0.008 < 0.006 < 0.006	< 1 < 0.25 < 0.5	16.3 1.75 J,cc 4.76	0.019 B,z 0.012 B,z 0.011 B,z
BULL RUN STREAM						
BR1	0.38 J,oc,f,i,s 0.028 J,f	0.0066 R,sw < 0.0045	0.0066 R,sw <0.0045			
BR5	0.016	<0.0049	<0.0049			

NOTES:

- Samples were analyzed for over 40 VOCs and seven different PCB isomers. Results are presented only for the potential contaminants-of-concern.
PCE = Tetrachloroethylene; TCE = Trichloroethylene; DCE = 1,2-Dichloroethylene; and Hg = Mercury.
- Multiple results are from replicate samples.
- Data Qualifiers
J,r,l = Compound detected. Reported value is estimated because the value is less than the minimum quantitation level.
J,f = Compound detected. Reported value is estimated due to field replicate imprecision.
J,cc = Compound detected. Reported value estimated due to percent difference between columns exceeding 25%.
B,z = Compound present. Reported concentration may be biased high due to detection of mercury in the method blank.
UJ,l = Compound not detected. Quantitation level estimated due to samples not preserved within the acceptable period.
J,i,s = Compound detected. Reported value estimated due to high surrogate recovery and to the samples not being preserved within the acceptable period.
L,m = Compound present. Reported concentration may be biased low due to low recovery in matrix spike and matrix spike duplicate analyses.
J,oc = Compound detected. Reported result estimated because the detected concentration exceeded the instrument calibration range.
J,i = Compound detected. Reported value is estimated due to non-compliant internal standard.
J,s = Compound detected. Reported value is estimated due to low surrogate recovery.
R,sw = Compound not detected. Results may not be reliable due to surrogate spike failure and/or retention time outside of the proper band.

E. RADIATION MONITORING

The purpose of the environmental radiation monitoring program is to measure the ambient radiation levels around the Site to confirm that site operations have not altered the natural radiation background levels.

Radiation Sources

The sources of radiation at the Site include small specimens of irradiated and unirradiated fuel materials which were handled, processed, and stored at the Site. There are no nuclear reactors at the Site.

Radiation Monitoring

Environmental radiation levels were monitored in the vicinity of the Site with a network of lithium fluoride thermoluminescent dosimeters (TLDs). The approximate locations of the Site TLD monitors are shown on Figure 9. Control TLD monitors were posted at locations remote from the Site to measure the natural background radiation levels typical for western Pennsylvania. The control TLDs were located in nearby communities (Pleasant Hills, Reserve Township, Greensburg, Mt. Pleasant, Elizabeth, and Port Vue, PA). All TLD monitors were posted for quarterly exposure periods.

In addition to the TLD network, which was the primary monitoring method, a radiation survey was conducted around the site perimeter.

In 2000, the biennial radiation survey was performed in the wet weather drainage ditch on Duquesne Light (DL) and Valley National Gases Incorporated (VNGI) properties.

Radiation Analyses

The environmental TLDs were calibrated to a cesium-137 standard source. The TLD radiation exposures were measured quarterly utilizing an automated TLD readout system which was calibrated prior to the processing of the TLDs. TLD results were corrected to assure that the environmental TLDs reflected only the exposure received during the time they were posted in the environment.

The perimeter radiation survey and the wet-weather drainage ditch survey were conducted using a low-level radiation survey meter (PRM-7) at approximately three feet above the ground. This meter was calibrated with cesium-137 within six months prior to use and source checked for proper operation immediately prior to use.

Radiation Monitoring Results and Conclusions

The TLD results in Table 16 summarize the radiation levels measured during each quarter. The annual-average radiation exposure for the on-site TLDs was 78 mrem. The annual average radiation exposure at the off-site locations was 64 mrem. The quarterly perimeter and offsite results are analyzed to identify any statistically significant difference. Since the results had a high degree of overlap (offsite results ranged from 7 to 22 mrem/quarter and perimeter results ranged from 12 to 28 mrem/quarter), the quarterly analysis demonstrated that the exposure received by an individual located at the site perimeter was not different from that received from background radiation in the surrounding area.

TABLE 16

THERMOLUMINESCENT DOSIMETER (TLD) ENVIRONMENTAL RADIATION RESULTS						
Quarterly Exposure Period	ON-SITE RADIATION RESULTS			OFF-SITE BACKGROUND RESULTS		
	Number of Meas.	Range (mrem)	Average (mrem)	Number Of Meas.	Range (mrem)	Average (mrem)
First	21	12 - 23	17.6	6	7 - 20	13.7
Second	21	13 - 24	18.9	6	12 - 20	15.5
Third	21	16 - 27	21.9	6	14 - 22	19.0
Fourth	21	13 - 28	19.3	6	12 - 20	15.7

The radiation dose rates measured during the perimeter radiation survey averaged approximately 0.010 mrem/hr which, integrated over the TLD exposure period in 2001, predicted an annual exposure of 87 mrem.

The 2001 radiation monitoring results were consistent with the range of natural radiation levels of 82 to 104 mrem/year observed in an U.S. Public Health Service survey of the northwest and southwest areas of Pennsylvania, Reference (9).

Also, the radiation monitoring results were consistent with the range of natural radiation levels of 79 to 105 mrem/year determined by an aerial radiation survey, Reference (10), that encompassed a 100-square-mile area around the Site. Therefore, it was concluded that the radiation exposure to the general public at the site perimeter was not above the exposure received from natural background radiation. The data show that site operations did not cause any measurable change in the natural radiation environment surrounding the Site.

In CY 2001, a radiation survey was performed of the on-site portion of the Bull Run Stream. This survey is conducted at 5-year intervals and was last performed in the summer of 1996. The results of this survey are consistent with the results of the previous surveys in this area.

CONTROL OF CHEMICAL AND HAZARDOUS WASTES

Origin

Operations at the Site resulted in the generation of various types of chemical and hazardous wastes. These wastes included acid solutions, polychlorinated biphenyls, photographic solutions, oil solutions containing metals and organic solvents, batteries, and organic solvent contaminated solids.

Control Program

Hazardous wastes were managed in accordance with environmental regulations of the Commonwealth of Pennsylvania. Nonhazardous chemical wastes were managed in accordance with the Site's National Pollutant Discharge Elimination System Permit or other applicable Federal and State, or local regulations. The control programs minimized the quantity of waste generated, assured safe handling and storage of the wastes on-site, and provided for proper disposal of the wastes.

Specific training was provided to personnel who handled hazardous wastes to assure that they were knowledgeable of safe handling techniques and emergency response procedures. Chemical wastes were accumulated in designated staging and storage areas where they were segregated and packaged for shipment. Storage and accumulation areas were inspected periodically to verify that hazardous wastes were properly stored and controlled in accordance with approved procedures. Waste was stored only as necessary to accumulate sufficient volume for economical shipment to a waste disposal vendor.

Bettis-Pittsburgh self-reported to the Pennsylvania Department of Environmental Protection (PADEP) that the Laboratory had inadvertently disposed of a very small amount of hazardous waste to a residual waste landfill. The item was a 30-gram oxygen sensor from an electronic metering system. The PADEP issued an inspection report noting the event to document the finding. There was no impact on human health or the environment from the inadvertent disposal.

Disposal

No chemical or hazardous wastes were disposed on the Site with the exception of one 30-gram oxygen sensor from an electronic metering system. The sensor was smaller than, but similar in hazard to a flashlight battery. Bettis-Pittsburgh self-reported this event to PADEP, which subsequently issued an inspection report noting the event to document the finding. There was no impact on human health or the environment from the inadvertent disposal. Approximately 28,680 pounds of hazardous waste were shipped off-site to permitted facilities for final disposition. Written documentation was received from these facilities verifying that the waste was received and handled in accordance with requirements. The Site chose vendors with treatment and disposal methods that would reduce long-term concerns and threats to the environment.

CONTROL OF RADIOACTIVE WASTES

Origin

Operations at the Site resulted in the generation of various types of low-level radioactive wastes. These wastes included liquids, filters, metal scrap, rags, resin, paper, soil, plastic, and decontamination debris.

Control Program

All radioactive wastes were managed in accordance with the U. S. Department of Energy Naval Nuclear Propulsion Program radiological control requirements.

The volume of waste containing radioactivity was minimized through the use of detailed work procedures and worker training to limit the amount of material that contacted radioactivity during work on radioactive systems and components; waste compaction was also used.

Detailed procedures were used during generation, handling, packaging, and transportation of radioactive waste material. Radioactive wastes shipped off-site were packaged in accordance with applicable DOE disposal site criteria and the U. S. Department of Transportation regulations in Reference (11). In addition, all radioactive liquid wastes were solidified prior to shipment. Internal reviews were made prior to each shipment to ensure that the radioactive material was properly identified, surveyed, and packaged in accordance with Federal and disposal site requirements.

Disposal/Treatment/Recycling

Radioactive waste was shipped off-site for disposal. During 2001, approximately 204 cubic meters of radioactive waste, which contained a total of 0.634 Curies of radioactivity, were shipped from the Bettis Site. As a waste minimization technique, 206 cubic meters of radioactive surface contaminated scrap metals were shipped off-site to a commercial radioactive material processing facility for radioactive metal recycling for reuse within the DOE Program.

CONTROL OF MIXED WASTES

Origin

A mixed waste is a waste that is both Resource Conservation and Recovery Act (RCRA) hazardous and radioactive. Operations at the Site resulted in the generation of a very small quantity of mixed wastes. These wastes included acidic solutions, oils, soil, and debris.

Control Program

Since mixed wastes are RCRA hazardous and radioactive, the controls for hazardous wastes are applied to the hazardous constituents and the controls for radioactive wastes are applied to the radioactive constituents.

In 1995, the Department of Energy Naval Nuclear Propulsion Program (NNPP) agreed to apply Pennsylvania hazardous waste requirements to the hazardous constituents in mixed waste prior to Pennsylvania being authorized by the Environmental Protection Agency (EPA) to regulate mixed waste. In November 2000, the Pennsylvania Department of Environmental Protection (PADEP) was authorized by the EPA to regulate mixed waste. In addition, Pittsburgh Naval Reactors Office and the EPA signed a Consent Agreement and Consent Order in 1995 for the management and treatment of mixed waste. In September 2001, the PADEP issued a revised hazardous waste storage permit that incorporated relevant requirements of the Federal Facility Compliance Act. The CACO was terminated on January 15, 2002. The radioactive constituents of mixed waste were managed in accordance with the NNPP radiological control requirements.

Mixed wastes were managed on-site in accordance with the Bettis Mixed Waste Management Plan, which was concurred with by the PADEP. The amount of mixed waste generated was minimized through the use of detailed work procedures and worker training. Mixed wastes were accumulated in designated storage areas where they were packaged for storage for eventual off-site treatment in accordance with the EPA-approved Site Treatment Plan.

In June 2001, the EPA and PADEP visited Bettis to review the remediation program. In addition, they conducted an inspection of the mixed waste management facility at Bettis. No deficiencies were noted.

Disposal

Mixed wastes were not disposed on-site. In 2001, 0.63 cubic meters of Inorganic Sludge/Particulate were shipped to ATG, Inc for treatment. There were no other off-site shipments of mixed waste in 2001.

ENVIRONMENTAL MONITORING QUALITY ASSURANCE

General Quality Assurance Controls

All environmental monitoring was conducted by trained and qualified personnel. Samples were collected in strict accordance with written procedures, and sample containers were specifically selected and cleaned for each type of sample in accordance with Federal guidelines. Samples were preserved upon collection, where necessary, and handled using a chain-of-custody procedure to preserve the integrity of the samples from the point of collection through analysis. Analyses were performed in accordance with approved procedures that met Federal guidelines and requirements.

Radiological Quality Assurance Controls

Analyses for radioactivity were performed by Bettis. The internal quality control followed the guidelines and practices recommended by the Nuclear Regulatory Commission in Reference (12) and the U. S. Environmental Protection Agency (EPA) in Reference (13). Bettis participated in an interlaboratory quality assurance crosscheck program sponsored by the U. S. Department of Energy (DOE) - Environmental Measurements Laboratory (EML). This agency transmitted samples of water, air filters, vegetation, and soil to Bettis for radiological analyses. The purpose of this program was to evaluate the precision and accuracy of the Site's radioanalytical techniques and results. In December 2001, an equipment malfunction in the radiochemistry laboratory resulted in "Not Acceptable" results for both the DOE soil and vegetation samples. The samples were re-analyzed using equipment confirmed as operating within instrument specifications and the results were within the DOE EML acceptable ranges indicating satisfactory Laboratory performance. Appendix A summarizes the results from the crosscheck program. In addition, environmental monitoring data analyzed prior to the recognition of the equipment malfunction was reevaluated and corrections to the data results were made as necessary. The corrected data was used for this report. This reevaluation of the data indicated no significant impact on the environmental monitoring program. Actions are being taken to prevent a reoccurrence of these types of problems.

Nonradiological Quality Assurance Controls

Nonradiological analyses were normally performed by off-site laboratories under contract to Bettis. These laboratories followed quality control guidelines recommended by the EPA in References (2) and (3) as appropriate. Quality control samples such as reagent blanks, trip blanks, duplicates, replicates, and/or reference standards were used to monitor sampling and analytical laboratory performance, and measure accuracy and precision. In addition, an audit of an off-site laboratory was conducted by Bettis Analytical Chemistry and Environmental Engineering personnel to ensure the laboratory practices were adequate and in accordance with approved procedures.

Selected data packages from these off-site laboratories were reviewed by chemists in the Bettis Analytical Chemistry group using guidelines established by EPA Region III or by an independent subcontracted data validator. These reviews included a check of calculations, standards, graphs, and laboratory quality control sample results (blanks, spikes, reference standards). Concerns noted in the reviews were resolved with the laboratories before final acceptance of the data. In some cases (i.e., Tables 9A through 9F, 14 and 15), the validity of the data was qualified. Overall, the analytical laboratories demonstrated satisfactory performance.

ASSESSMENT OF RISK FROM CHEMICAL RESIDUES

A risk assessment was prepared as part of the Site's Resource Conservation and Recovery Act (RCRA) Facility Investigation. This assessment was prepared using the Superfund related methodology outlined in Reference (14). The detailed assessment, presented in Reference (1), is summarized below.

The objective of the assessment was to determine the reasonable maximum exposure of on-site and off-site populations to environmental contamination at the Site. The media containing chemical residues are soil, ground water, surface water (springs and streams), and sediment. Residues whose concentrations exceeded the U. S. Environmental Protection Agency (EPA) Region III's risk-based screening levels were selected as potential contaminants-of-concern. The residues evaluated were largely volatile organic compounds, polychlorinated biphenyls, and polynuclear aromatic hydrocarbons.

Risks were evaluated for realistic industrial land-use scenarios, now and in the future. EPA exposure parameters were used for off-site commercial/industrial workers at Duquesne Light (DL) and Valley National Gases Incorporated (VNGI). Site-specific exposure parameters were used for pathways where standard EPA values were not available or were not appropriate. All exposure pathways judged to be complete now and in the future were quantified. Ground water exposure was not quantified because Bettis-Pittsburgh and off-site populations receive municipal water and this is unlikely to change in the foreseeable future.

The risk assessment quantified carcinogenic risk and noncarcinogenic hazard for four potentially exposed populations:

- On-site construction workers exposed to chemical residues in soil;
- Off-site commercial/industrial workers exposed to chemical residues in soil;
- Trespassing children exposed to chemical residues in water and sediment in springs and streams; and
- Off-site children exposed to chemical residues in water in a spring and sediment in a stream.

Based on EPA criteria, the calculated carcinogenic risk and noncarcinogenic hazard values were compared with the values of 0.000001 (1×10^{-6}) and 1.0 , respectively, which represent acceptable risk levels.

For on-site construction workers engaged in excavation activities, carcinogenic risks were quantified for all on-site locations where potential contaminants-of-concern were present. The noncarcinogenic hazard could be calculated only for two sites and the values were several orders of magnitude below the comparison criterion of 1.0 . The estimated carcinogenic risks did not exceed the comparison criterion of 1×10^{-6} at any location, with the highest being 5.4×10^{-7} for soil in the Inactive Waste Site (IWS) (Figure 8).

For off-site workers on DL and VNGI properties below the IWS, the estimated carcinogenic risk from exposure to polychlorinated biphenyls and polynuclear aromatic hydrocarbon compounds in surface soil in the main drainage ditch below the IWS (Figure 8) is about 2×10^{-5} . This risk estimate is highly

conservative due to the assumptions used in calculating intake (i.e., exposure for 250 days/year for 25 years) and because the chemical residues in this area are remote from DL and VNGI work areas. Actual carcinogenic risk would be much lower. Exposure to surface water and sediment in the on-site and off-site streams and springs was quantified for children, the only group that might have more than occasional contact with these media. The highest estimated risk was 1.0×10^{-7} for exposure to Thompson Run Stream sediment, which is below the comparison criterion of 1×10^{-6} . Noncarcinogenic hazards were several orders of magnitude below the comparison criterion of 1.0.

In summary, chemical residues in the environment at the Site do not pose significant health risks to potentially exposed populations using reasonable maximum exposure assumptions. The only study area with a carcinogenic risk estimate exceeding the comparison criterion is the drainage ditch area on DL and VNGI properties, with a maximum carcinogenic risk of about 2×10^{-5} . However, exposure (skin contact, ingestion, and inhalation) for 250 days/year for 25 years is required to achieve this risk. This risk is highly conservative because the contaminated area is in infrequently accessed or undeveloped locations. In reality, the risk to VNGI or DL workers is far less than 1×10^{-6} . Noncarcinogenic risks were all significantly less than the comparison criterion of 1.0.

The 2001 results of analyses for chemical residues in the environment support the conclusions of the risk assessment.

CORRECTIVE MEASURES IMPLEMENTATION

After approving the *Final Resource Conservation and Recovery Act (RCRA) Facility Investigation Report*, Reference (1), the U. S. Environmental Protection Agency (EPA) approved the *Final Corrective Measures Study Report*, Reference (15). The purpose of the study was to evaluate and recommend, where needed, corrective measures that would protect human health and the environment. The need for corrective measures was judged primarily from the carcinogenic risks and noncarcinogenic hazards potentially posed by the chemical contaminants-of-concern at the Site. The most prevalent residue is tetrachloroethylene, a common degreasing chemical that is the same solvent used to dry-clean clothing. The risk assessment, discussed in the previous section, demonstrated that the chemical residues in the environment at the Site do not realistically present a significant carcinogenic risk or noncarcinogenic hazard to human health. Therefore, extensive corrective measures are not necessary to protect human health now or in the foreseeable future.

The *Final Corrective Measures Study Report* proposed corrective measures to ensure that risks to human health remain low and to further reduce the chemical residues in the environment. In 1997, the EPA issued its final recommendations for corrective measures. Bettis has proactively implemented and completed the majority of the recommended corrective measures to the EPA's satisfaction. Under a Consent Order and Agreement with the Commonwealth of Pennsylvania, Bettis operates a Springwater Intercept System to collect and treat ground water that discharges to a local stream. Other activities included removal of contaminated sediment and/or liquid from portions of the Site's storm water drain system and from underground coke gas lines (remaining from historical non-Bettis usage), removal of a localized area of contaminated soil, and removal of a breached section of an abandoned coke gas line. Institutional controls are in place to ensure personnel safety and health for activities that could involve contact with environmental media containing chemical residues. Monitoring programs for ground water, surface water and sediment, storm drains, and the coke gas lines are also in place to ensure the conclusions of the *RCRA Facility Investigation Report* remain valid.

In 2000, efforts were initiated with the EPA to implement a Corrective Measures Implementation Order (CMIO). The CMIO became effective on April 16, 2001. The CMIO provides a standard EPA protocol for implementation of the remaining tasks: soil vapor extraction of the Bettis landfill, and a pre-design ground water study on the northern hillside of the Laboratory. These tasks will take several years to complete. The CMIO also requires continuing routine environmental monitoring.

Soil vapor extraction is an in-situ process that physically removes volatile contaminants from soils by inducing airflow through the soil. The air is then passed through activated carbon filter units to capture the volatile contaminants prior to discharge to the atmosphere. The purpose of the vapor extraction corrective measure is to reduce a potential source of ground water contamination. During 2001, a project management plan was submitted and approved by the EPA.

The purpose of the ground water study on the northern hillside is to determine the sources and qualities of ground water that occasionally are released to the surface as seepage. The ground water study, which has been approved by the EPA, will be used to determine if a subsurface drainage system is a necessary or appropriate remedy for this area. During 2001, data collection from the installed monitoring system was initiated.

ASSESSMENT OF RADIATION DOSE-TO-MAN

Effluent monitoring results at the Site during 2001 demonstrated that radioactivity releases were below applicable Federal radioactivity limits. Radiation exposure to the general public from airborne releases was too low to measure and could only be determined with calculational models using the airborne effluent radioactivity data. Airborne effluent radioactivity data which were below the decision level concentrations (DLCs) were assumed to be at the DLC. Therefore, a conservative assessment of the radiation dose-to-man was performed by analyzing the exposure pathways whereby radioactivity might be transmitted from the Site to the general public. The following potential exposure pathways were considered in this assessment. The first two pathways contribute more than 99% of the dose-to-man.

- Direct radiation from residual radioactivity in the Bull Run Stream basin;
- Inhalation of airborne radioactivity;
- Exposure to ground deposits from airborne radioactivity;
- Immersion in the atmosphere containing the released airborne radioactivity;
- Ingestion of food contaminated by deposition of airborne radioactivity;
- Ingestion of radioactivity in the drinking water supply; and
- Direct radiation from Site operations.

Radioactivity attributed to Bettis operations was not released to the Site's streams in 2001. Therefore, exposure to radioactivity in water was not a potential exposure pathway. Specific radionuclide composition of the airborne releases was factored into the assessment. The dose for each exposure pathway was explicitly calculated for each radionuclide and applicable daughters. The air pathway calculations used wind direction data and meteorological parameters that were measured by the Site's meteorological monitoring system in 2001. The Site's meteorological monitoring system measures wind speed, gusts, wind direction, temperature, relative humidity, and inches of rain. The measurements are integrated over 15-minute intervals. The system is part of the Atmospheric Release Advisory Capability service developed by Lawrence Livermore National Laboratory to model the atmospheric release of radioactive materials. The population distribution in the vicinity of the Site was based on 1990 census data. The atmospheric dispersion of the Site's radioactive airborne releases and resulting dose were calculated using an U. S. Environmental Protection Agency (EPA)-approved computer program described in Reference (16). The radiation dose assessment attributed to Site operations during 2001 is presented in Table 17. Radiation doses were calculated for the whole body and most limiting organ of individuals at locations of maximum exposure to the nearest offsite receptor and for the total population within 50 miles of the Site.

TABLE 17

RADIATION DOSE-TO-MAN FROM SITE OPERATIONS		
Maximum Estimated Radiation Exposure to the Nearest Off-Site Receptor		
Exposure Pathways	Estimated Dose Equivalent ⁽¹⁾	
	Effective Whole Body Dose (mrem)	Maximum Dose to Limiting Organ (mrem)
<ul style="list-style-type: none"> • Liquid Pathways • Airborne Pathways <ul style="list-style-type: none"> • Particulate Radioactivity Release⁽³⁾ • Gaseous Radioactivity Release⁽⁴⁾ • EPA Limit • Direct Exposure Pathways <ul style="list-style-type: none"> • Direct Radiation from Bettis Operations • Exposure to Residual Radioactivity in the Bull Run Basin 	None ⁽²⁾ 0.0001 0.14 10 None 0 – 2.3	None ⁽²⁾ 0.00223 (Bone) 1.03 (Bone) None 0 – 2.3 (Whole Body)
Maximum Whole Body Dose to Individual	0.14 - 2.4	
• DOE Limit	100	
50-Mile Population Radiation Exposure		
Exposure Pathways	Estimated Population Dose Equivalent ⁽¹⁾	
	Effective Whole Body Dose (man-rem)	Maximum Dose to Limiting Organ (man-rem)
<ul style="list-style-type: none"> • Liquid Pathways • Airborne Pathways • Direct Exposure Pathways 	None ⁽²⁾ 1.23 0 – 0.01	None ⁽²⁾ 9.01 (Bone) 0 – 0.01 (Whole Body)
Maximum Whole Body Population Dose	1.24	

NOTES: (1) The dose estimated for the airborne pathways is the committed "50-year" effective dose equivalent. This means that an individual would receive the indicated dose over a 50-year period following inhalation of

The results in Table 17 show that the maximum whole body radiation exposure which any member of the public could hypothetically receive due to past and present operations ranged from 0.14 to 2.4 mrem. Nearly all of this very low potential dose would be from gaseous radioactivity and from exposure to the Bull Run soil and sediments that contain residual radioactivity from operations over 35 years ago. Based on a conservative estimate that an individual would spend as much as one hour per day, every day of the year, walking along the Bull Run stream bank in the areas with radiation levels above background, the annual hypothetical dose received would be approximately 2.3 mrem. This is less than the amount of additional radiation exposure an individual would receive from a cross-country

airplane flight, Reference (17). The maximum potential radiation dose is well below the most restrictive dose limits of the Nuclear Regulatory Commission (NRC) and the U. S. Department of Energy (DOE). The maximum potential dose is less than 1% of the approximately 300 mrem dose a person receives each year from naturally occurring radiation in the environment, Reference (18). The dose resulting from the low levels of radioactivity in the Site's airborne effluents is significantly less than the limits of the EPA in Reference (7).

In conclusion, the maximum radiation exposure to any member of the public as a result of operations at the Bettis Site during 2001 was substantially below the radiation exposure limits established by the DOE, the NRC, and the EPA. Moreover, the accumulated radiation exposure received during 2001 by the total population of approximately 3,000,000 within 50 miles of the Site was conservatively estimated to be approximately 1.24 man-rem, which is negligible compared to the approximately 900,000 man-rem dose received from natural background radiation. Therefore, the radioactivity released from the Site, as a result of past and present operations, has not resulted in any significant radiation exposure to the general public.

ENVIRONMENTAL PERMITS

The Site has obtained or applied for the environmental permits required by applicable regulations. Table 18 provides a listing of the environmental permits for the Bettis-Pittsburgh Site in 2001.

TABLE 18

ENVIRONMENTAL PERMITS				
Operation Permitted	Unit Permitted	Permit Number	Permitting Agency	Renewal Date
Air Emissions	Bettis-Pittsburgh Site	Operating Permit Application 95-0067	Allegheny County Health Department	(Note 1)
	Bettis-Pittsburgh Site	Open Burning Permit #F99-15	Allegheny County Health Department	December 31, 2001 (Note 2)
	Bettis-Pittsburgh Site Asbestos Abatement Operation & Maintenance Plan	PAA-010001	Allegheny County Health Department	December 31, 2001 (Note 3)
	Asbestos Abatement, Various Areas	PAA 99-0728, PAA 00-0319, 0331, 0332, 0710, PAA 01-0186, 0606	Allegheny County Health Department	(Note 4)
Water Discharges	Bull Run Monitoring Station, Northeast Area Monitoring Station, Stormwater Outfalls	National Pollutant Discharge Elimination System Permit PA0000914	Pennsylvania Department of Environmental Protection	August 16, 2001 (Note 5)
	Springwater Intercept System	National Pollutant Discharge Elimination System Permit Amendment PA0000914-A2	Pennsylvania Department of Environmental Protection	August 16, 2001 (Note 5)
Hazardous and Mixed Waste Storage	Chemical/Hazardous Waste Storage Building Mixed Waste Storage Facility	Hazardous Waste Storage Permit PA0890090004	Pennsylvania Department of Environmental Protection	February 23, 2005 (Note 6)

NOTES:

- (1) A Site "Air Operating Permit" application was submitted to the Allegheny County Health Department in November 1995. The renewal date will be five years after the issuance date. Until the requested Operating Permit has been approved by the County, the requirements of both the existing permits for the individual boilers and the requirements contained in the application for the new operating permit will be followed.
- (2) Permit was issued for two years.
- (3) Permit is renewed annually.
- (4) Permits are required for asbestos abatement work. The individual work effort involves the removal or encapsulation of greater than 260 linear feet or 160 square feet of asbestos containing material. Permits are obtained on an as needed basis. Seven permits listed were active in 2001. Three of the seven active asbestos abatement permits were obtained in 2001. No work was performed for Permit Number PAA 99-0728 in 2001. This permit was not closed out until 2001.
- (5) A NPDES permit renewal application was submitted to the Pennsylvania Department of Environmental Protection on February 15, 2001. A draft NPDES Permit was received from the PADEP on November 27, 2001.
- (6) The Pennsylvania Department of Environmental Protection issued a revised permit for operating the Mixed Waste Storage Facility on September 4, 2001 to incorporate Site Treatment Plan requirements.

As noted in previous sections, the inspections conducted by outside regulatory agencies found the Site to be in compliance with the requirements of the environmental permits discussed in Table 18.

REFERENCES

- (1) *Final RCRA Facility Investigation Report for the Bettis Laboratory, West Mifflin, Pennsylvania.* June 1994.
- (2) U.S. Environmental Protection Agency. "Guidelines Establishing Test Procedures for the Analysis of Pollutants." *Code of Federal Regulations*. Title 40, Part 136.
- (3) U.S. Environmental Protection Agency. *Test Methods for Evaluating Solid Waste Physical/Chemical Methods*. SW-846.
- (4) Nuclear Regulatory Commission. "Standards for Protection Against Radiation." *Code of Federal Regulations*. Title 10, Part 20.
- (5) Commonwealth of Pennsylvania. "Chapter 93, Water Quality Standards." "Chapter 16, Water Quality Toxics Management Strategy." *Pennsylvania Code*. Title 25, Environmental Protection.
- (6) U.S. Environmental Protection Agency. "National Primary Drinking Water Regulations". *Code of Federal Regulations*. Title 40, Part 141.
- (7) U.S. Environmental Protection Agency. "National Emission Standards for Hazardous Air Pollutants; Subpart H - National Emission Standard for Radionuclide Emissions from Department of Energy Facilities." *Code of Federal Regulations*. Title 40, Part 61.
- (8) *Allegheny County Health Department Rules and Regulations, Article XXI, Air Pollution Control.*
- (9) "Summary of Natural Environmental Gamma Radiation Using a Calibrated Portable Scintillation Counter." *Radiological Health Data and Reports*. Volume 9, Number 11, pp. 620-695. November 1968.
- (10) "An Aerial Radiological Survey of West Mifflin, Pennsylvania, and Surrounding Areas." *EG&G/EM Survey Report*. DOE/NR-8319. March 1984.
- (11) U.S. Department of Transportation. "Hazardous Material Regulations." *Code of Federal Regulations*. Title 49, Parts 171-178.
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APPENDIX A

USDOE/EML RADIOANALYTICAL QUALITY ASSURANCE RESULTS					
Date	Media	Parameter	Known Value ⁽¹⁾	Reported Value ⁽¹⁾⁽²⁾	Evaluation ⁽³⁾
Jun01	Water	Cobalt-60	2654.35	3021.95	Acceptable with Warning
		Cesium-137	1973.19	2339.99	Acceptable with Warning
Jun01	Soil	Cesium-137	47032.2	46680.81	Acceptable
Jun01	Vegetation	Cesium-137	22759.26	22383.54	Acceptable
		Cobalt-60	821.71	858.47	Acceptable
Jun01	Air Filter	Manganese-54	176.24	180.21	Acceptable
		Cobalt-60	525.46	491.14	Acceptable
		Cesium-137	236.78	236.46	Acceptable
Dec01	Water	Cobalt-60	5649.27	5497.9	Acceptable
		Cesium-137	1219.94	1330.15	Acceptable
Dec01	Soil	Cesium-137	16551.28	11839.14	Not Acceptable ⁽⁴⁾
Dec01	Vegetation	Cobalt-60	954.16	664.67	Not Acceptable ⁽⁴⁾
		Cesium-137	27840.9	20007.61	Not Acceptable ⁽⁴⁾
Dec01	Air Filter	Manganese-54	2193.48	1919.4	Acceptable with Warning ⁽⁴⁾
		Cobalt-60	473.03	386.26	Acceptable with Warning ⁽⁴⁾
		Cesium-137	462.21	405.99	Acceptable with Warning ⁽⁴⁾

- NOTES:**
- (1) Units are pCi/liter for water samples, pCi/kg for soil and vegetation samples, and pCi/filter for air filter samples.
 - (2) The reported value is the result of a single determination.
 - (3) Acceptable performance indicates that the measurement fell between the 15th and 85th percentile. The acceptable with warning designation indicates that the measurement fell between the 5th and 15th percentiles or the 85th and 95th percentiles. The not acceptable designation is established at less than the 5th percentile and greater than the 95th percentile.
 - (4) These evaluations were associated with an equipment malfunction. The DOE samples in question were re-analyzed using equipment confirmed as operating within instrument specifications and the results were within the DOE EML acceptable ranges indicating satisfactory performance for the Laboratory. In addition, environmental monitoring data analyzed prior to the recognition of the equipment malfunction was reevaluated and corrections to the data results were made as necessary. This reevaluation of the data indicated no significant impact on the environmental monitoring program. Actions are being taken to prevent a reoccurrence of these types of problems.