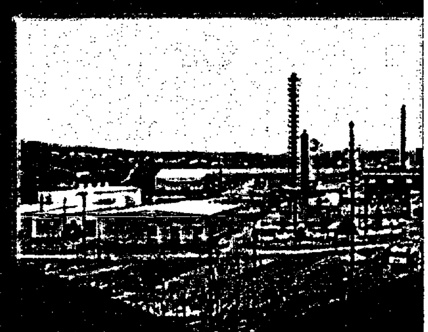
Molycorp

Supplemental Site Characterization Report for the Washington, Pennsylvania Site



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4812001

MALCOLM PIRNIE

Molycorp, Inc.
Washington, Pennsylvania Site

Supplemental Site Characterization Report

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Executive Summary

This supplemental site characterization report documents characterization activities conducted at the Molycorp, Inc. (Molycorp) Washington, Pennsylvania site between September 2003 and February 2004. These activities were carried out in accordance with the Supplemental Site Characterization Plan for the Washington, Pennsylvania Site (Malcolm Pirnie, September 2003). Both the U.S. Nuclear Regulatory Commission (NRC) and the Pennsylvania Department of Environmental Protection (PADEP) were provided with draft copies of the characterization plan for review and comment prior to its finalization in September 2003.

The supplemental characterization effort was comprehensive in nature addressing both radiological and non-radiological concerns that may exist separately or together in various parts of the site and in various media (surface water, groundwater, and soils). Moreover, this program was designed to supplement a substantial body of existing information developed during several previous investigations.

This report provides background information on the site, describes the facility setting, highlights previous investigations, details activities carried out in this investigation, describes the physical properties and characteristics of native and artificial materials encountered in the investigation, presents results of radiological and non-radiological measurements, and presents results of a preliminary ecological characterization.

The purpose of the supplemental characterization was to collect additional data necessary to develop a technically sound site closure plan that addresses both radiological and non-radiological issues. Implementation of the closure plan is intended to result in unrestricted release (radiological issues) of the property, termination of the site's NRC Source Materials License, and closure of non-radiological issues such that the site may be used in the future for purposes consistent with current zoning and physical constraints.

Site Description

Molycorp's Washington Facility is located in Canton Township, Washington County, Pennsylvania, approximately 35 miles southwest of Pittsburgh, Pennsylvania. The site consists of approximately 73 acres ranging from woodlands to industrial areas. Molycorp actively utilized approximately 20 acres for manufacturing operations.

To better understand this complex site and to facilitate characterization and ultimately remediation activities, the site has been divided into ten main areas of interest:

Area 1	Process Plant Area (Subdivided in 1A and 1B)
Area 2	North Slag Area
Area 3	South Slag Area
Area 4	Tylerdale Connecting Railroad
Area 5	MGP Tar Pond Area (Subdivided into 5A-5E)
Area 6	Streams
Area 7	Hill Area (Subdivided into 7A and 7B)
Area 8	Cox Plus
Area 9	Green Street
Area 10	Offsite Areas

Site Characterization Activities

Malcolm Pirnie mobilized to the site on September 15, 2003 to initiate supplemental characterization activities at the site. Various site characterization activities continued through early February 2004.

A 100% coverage walkover survey for detection of gross gamma radiation was performed in areas that were used by Molycorp for manufacturing operations and other selected areas of the site. More than 108,000 gamma measurements were collected.

Malcolm Pirnie geoscientists supervised installation of seven test pits and 235 soil borings, 22 of which were completed as groundwater monitoring wells. Soil samples were collected and the lithology described for the soil borings which were completed utilizing split spoon sampling techniques. More than 1,600 2-foot core segments from soil borings were scanned for radioactivity with a 2-inch-by-2-inch NaI scintillation detector. Additionally, all soil samples were scanned for organic vapors with a photoionization detector (PID). Selected soil samples were analyzed for chemical and radiological constituents. In addition, 16 sediment and surface water sampling locations were established in Chartiers Creek and Sugar Run. Subsequent to completion of all soil boring and monitoring well installation activities, groundwater samples were collected from newly installed and existing wells (a total of 51 wells) and analyzed for chemical and radiological constituents.

Physical Properties

The overburden layer consists of naturally developed brown to black silty and clayey soils with organic matter in areas of the site not developed or disturbed by past industrial activities. Typically, the soils ranged in thickness from several inches to several feet.

For areas of the site disturbed by industrial activities, this soil layer may be absent or much thinner than in other areas of the site. These areas of the site typically possess an overburden layer containing a variety of fill materials intermixed with slag, red-dog, refractory brick, sulfur, and various forms of glass. Especially in Areas 1 and 2, debris from recent demolition of buildings that previously occupied the site commonly is found intermixed within the overburden layer. The fill material primarily consists of very dense to loose black to reddish-brown moist sands, silts, and clays in varying amounts.

Only limited direct evidence of contamination (i.e., free product or organic odors) was observed in any of the overburden soil samples. The only place that contamination was observed consistently was in areas in which MGP tar has migrated to ground surface or begun to discharge/seep out of the banks of Chartiers Creek. Typical thickness of the fill material ranged from 2 to 12 feet bgs with only a minor amount of fill material being located beneath the water table.

Located directly beneath the overburden is a layer consisting of a mixture of sands, silts, clays, and some gravels. This layer appears to have been deposited by running water most likely by Chartiers Creek. Typically this layer consists of a downward coarsening in the alluvium, with the majority of the clay and silt deposits being located closer to the overburden layer, while the sands and gravels were primarily located on top of the bedrock layer. The overburden water table is located in the unconsolidated alluvium layers with groundwater being encountered between 3 and 18 feet bgs. The unconsolidated alluvium layer ranges in thickness from several feet to approximately 20 feet.

Bedrock primarily consists of very dense, highly plastic and fissile weathered gray shale. The depth to bedrock varies over the site, depending on the proximity to Chartiers Creek and the local topography; however, depth to bedrock ranges from 4.3 to 25.7 feet bgs. Typically, the upper foot or so of bedrock was highly weathered and in some instances appeared to be a very tight gray clay. Underlying the shale is a laminated fine-grained sandstone layer, which is underlain by a thin coal seam, and alternating layers of gray limestone, mudstone, and shale.

Groundwater in the overburden wells was observed to occur at an elevation ranging from 1038 to 1012 feet AMSL on December 3, 2003, immediately prior to beginning groundwater sampling activities. Groundwater in the Bedrock Wells BR-1 through BR-8 was observed to range from 1038 to 1011 feet AMSL. In both cases the horizontal groundwater flow direction primarily is toward Chartiers Creek with an approximate hydraulic gradient of 0.022 to 0.048 in the overburden wells. There appears to be an upward vertical gradient in the bedrock monitoring wells located adjacent to Chartiers Creek, indicating that Chartiers Creek acts as a hydrological divide of the overburden and uppermost bedrock aquifers. As a result, groundwater in the vicinity of the site will discharge to Chartiers Creek.

Single well hydraulic conductivity test data collected from rising and falling head slug tests conducted in all of the monitoring wells (except TB-01) provide a range of aquifer hydraulic conductivity values to represent site-specific conditions. Values for overburden hydraulic conductivity ranged from 1.28×10^{-7} centimeters per second (cm/sec) to 3.87×10^{-5} cm/sec while bedrock hydraulic conductivity ranged from 1.59×10^{-6} cm/sec to 1.12×10^{-5} cm/sec. Median and geometric mean values for the overburden wells were calculated as 3.79×10^{-6} cm/sec and 8.10×10^{-6} cm/sec, respectively.

Soil – Radiological Findings

Natural background for U-238, Ra-226 and Th-232 was determined to be 1.59 pCi/g U-238, 1.65 pCi/g Ra-226, and 1.50 pCi/g Th-232. In addition, this investigation established that uranium chain constituents are present in significant quantities in some areas of the site. These uranium chain components are distributed in a non-uniform fashion—sometimes commingled with thorium and sometimes not. The investigation established that Th-232 and Th-228 are in secular equilibrium, and that U-238, U-234, and Th-230 also are in secular equilibrium. Disequilibria between U-238 and Ra-226 was identified.

Results of the gamma walkover survey indicate that most of Area 1A is unaffected. Area 1B exhibits some "clean" regions but exhibits more widespread elevated surface readings with hot spot regions coinciding with former building footprints. Area 2 is similar to Area 1B with higher surface readings in building footprints and in the western portion of the site. Slightly elevated surface readings are evident throughout Area 3 with hot spot regions along Chartiers Creek. Elevated surface readings also are evident in the western section of Area 10A which abuts the northeastern portion of Area 3. Surface readings along the access road east of Area 3 that leads to the tunnel under I-70 were less than or equal to background. Slightly elevated surface readings recorded south of Area 3 are for the most part below levels of significance, with a small number of interspersed hot spots. Similarly, the area north of the confluence of Sugar Run and Chartiers Creek exhibited a few elevated spots. A walkover of the slag portion of the South Tar Pond access road showed surface levels to be less than or equal to background. The glass/refractory brick area along the hillside in Area 4 also exhibited slightly elevated surface readings. Walkover survey measurements in the portion of Area 8 that formerly served as the site of a house trailer also were slightly elevated but are below levels of significance

All of the net core scan data for portions of the site east of Chartiers Creek were kriged for each 2-foot depth interval to obtain a qualitative profile of radiological contamination with depth. Concentration data for Th-232, U-238 and Ra-226 were superimposed over the core scanning krig information for each depth interval where data exist. Generally, the core scan data are good indicators of the location and magnitude of the radiological constituents in the subsurface but cannot be used alone to distinguish among the various radioisotopes.

Two hundred and four soil samples were analyzed by high-resolution gamma spectroscopy to quantify Th-232/228, U-238/234, and Ra-226. In addition, a subset of 24 soil samples also was analyzed for isotopic thorium and isotopic uranium by alpha spectroscopy.

Uranium was identified to be the primary radiological constituent in Area 1 while thorium predominates in Areas 2, 3 and 10A, although the two components are intermingled at a number of locations. Ra-226 always coexists with U-238 although not in equilibrium. These observations with respect to locations are consistent with what is known of the operational history of the facility: uranium, probably associated with ferrotungsten production, is the primary contaminant in the older region of the plant and thorium, associated with ferrocolumbium production in the 1960s, predominates in Areas 2 and 3. The majority of Area 1A is unaffected by radiological contamination.

Soil – Non-Radiological Findings

Significant findings related to soil samples subjected to non-radiological analyses included:

- No VOCs were detected above residential Statewide Health Standards (SHS).
- Some PAHs were detected above residential SHS in areas of visible tar impact – primarily in Area 5.
- No PCBs were detected.
- Arsenic, boron, iron and lead were detected sporadically at concentrations greater than residential SHS across the site including background locations.
- TCLP analyses for metals demonstrated that the soil samples tested were not hazardous.

- SPLP analyses for metals indicated that only boron and vanadium exceeded primary Statewide Health Standards in some leachate samples. Molybdenum was elevated in some of the leachate samples.

Field evidence regarding tar impacts may be summarized as follows:

- In Area 5A, the South Tar Pond, there was field evidence of impacts to greater than 10 feet.

- In Area 5B, the area North of the South Tar Pond, there was field evidence of impacts to the west of the South Tar Pond and to the northeast of the South Tar Pond. The field evidence suggested no impacts in the vast majority of this area.

- In Area 5C, the Area East of the North Tar Pond, there was field evidence of impacts to depth all along I-70

- In Area 5D, the North Tar Pond Area, there was field evidence of impacts at a few locations to a depth of about 10 feet.

- In Area 5E, the Area west of Chartiers Creek (also the eastern part of Area 4), the field evidence indicates impacts near Chartiers Creek and Sugar Run.

- In Area 7B, impacts near Chartiers Creek were observed.

Groundwater – Radiological Findings

U-238/234, Ra-226, or Ra-228 are present in negligible quantities, well below drinking water MCLs. The conclusion is that U-238/234, Ra-226, and Ra-228 are not present in site groundwater at significant concentrations.

Groundwater – Non-Radiological Findings

Several VOCs were detected in the groundwater samples collected across the site, with several of the compounds being detected at estimated concentrations below their respective laboratory reporting limits. The only exceedances of residential use aquifer SHS were for chloromethane in MW-47 and vinyl chloride in MW-7, both in Area 1B. No VOCs were detected above their laboratory detection limits in any of the bedrock wells that have been installed at the site.

Several SVOCs and PAHs were detected in the groundwater samples at estimated concentrations both above and below their respective laboratory reporting limits. Pentachlorophenol in MW-47 was the only exceedance of residential used aquifer SHS. The majority of the detected and identified compounds were present only in a few wells scattered across the site. In fact all of the PAHs detected in the samples collected from Areas 5B and 5D were detected only in Monitoring Wells MW-55 and MW-51, respectively. Therefore, it would appear for the most part that the occurrence of SVOCs and PAHs in groundwater is localized and not widespread. Furthermore, only one SVOC compound (dimethylphthalate) was detected slightly above its detection limit in groundwater samples (BR-4) collected from the bedrock aquifer. No SHS exists for dimethylphthalate, but this detection is not considered to be significant. None of the PAHs exceed residential SHS.

No PCB compounds were detected above laboratory reporting limits in any of the groundwater samples.

Both boron and thallium concentrations in excess of residential used aquifer SHS were widespread across the site both in overburden and bedrock wells. Lead concentrations in excess of SHS were widespread in Area 2 and a high concentration of vanadium was detected in MW-1 in this area.

Elevated molybdenum and tungsten levels were observed in groundwater samples from Areas 1A, 1B, 2, 3, 5B, and 5D. Slightly elevated levels were observed in Areas 8 and 10A. Generally, in the production areas, molybdenum levels increased from east to west with the highest concentration of 190 milligrams per liter (mg/L) being observed in Area 2. The highest tungsten concentration measured was 4.9 mg/L in Area 1B. SHS do not exist for either molybdenum or tungsten.

Results for Cr+6 analyses performed on samples collected from Areas 2, 3, and 5B indicate that when this compound was detected in groundwater samples, it was at low concentrations.

Groundwater samples collected from Monitoring Wells BR-1, MW-2, MW-4, MW-6, MW-18, and MW-24 were analyzed for perchorlate to determine if past site activities had resulted in the introduction of perchlorate into the groundwater system. Perchlorate was detected in Monitoring Wells MW-2, MW-18, and MW-24 at concentrations of 0.209, 976, and 34.7 parts per billion, respectively. MW-18 is located just west of the former site (Building 26) of a solvent extracting process which used perchlorate and of a waste acid tank where it was stored. Based on the results it appears that perchlorate concentrations in groundwater decrease away from this area.

Elevated pH was observed at various locations across the site in both overburden and bedrock wells. No pattern was apparent in the spatial distribution of elevated pH.

Sediment

Concentrations of U-238/234, Th-232/228 and Ra-226 in sediments in Chartiers Creek were near background levels. For VOCs, SVOCs and metals, concentration measured in upstream background samples exceeded concentrations measured in sediments collected within the site.

Surface Water

Only background levels were measured in surface water samples analyzed for gross alpha and gross beta.

Water samples were analyzed for VOCs, SVOCs , and Act 2 Metals plus Mo and W. Only the VOC chloromethane was detected in two of the surface water samples at a concentration that was slightly above the laboratory reporting limit. No other organic compounds or SVOCs were detected in any of the surface water samples. None of the reported detections are deemed to be significant. Iron and manganese levels were somewhat elevated in both streams but no other metals/inorganics were observed at unusual levels.

Preliminary Ecological Characterization

A preliminary ecological characterization was conducted. Activities included: identifying species or habitats of concern, conducting a site visit, describing the environmental setting, and completing a benthic macroinvertebrate survey of Chartiers Creek and Sugar Run. The areas of potential ecological concern identified during the site visit include tar impacted surface soils and sediments, the South Tar Pond, the impacted soil in the foundation area, and the presence of a slight sheen to the standing water in Area 7A. There were no visual signs of diseased or distressed vegetation identified during the site visit. No federal or state-listed endangered or threatened species or other species of concern or habitats of concern were identified on or in the vicinity of the site. No exceptional value wetlands were identified on or in the vicinity of the site.

The benthic macroinvertebrate survey findings indicate that the benthic assemblages are in fair condition. Although differences in the benthic metrics were observed between the Chartiers Creek reference station and potentially impacted downstream stations (with the exception of SS-2), the differences are minimal. The benthic macroinvertebrate community metrics for Station SS-2 suggest some level of impairment when compared to the metrics of the other Chartiers Creek stations.

Introduction

SECTION 1

This supplemental site characterization report documents characterization activities conducted at the Molycorp, Inc. (Molycorp) Washington, Pennsylvania site between September 2003 and February 2004. These activities were carried out in accordance with the Supplemental Site Characterization Plan for the Washington, Pennsylvania Site (Malcolm Pirnie, September 2003). Both the U.S. Nuclear Regulatory Commission (NRC) and the Pennsylvania Department of Environmental Protection (DEP) were provided with draft copies of the characterization plan for review and comment prior to its finalization in September 2003.

The supplemental characterization effort was comprehensive in nature addressing both radiological and non-radiological concerns that may exist separately or together in various parts of the site and in various media (surface water, groundwater, soils). Moreover, the program was designed to supplement a substantial body of existing information developed in several previous investigations.

The field and analytical program consisted of the following:

- Field Activities
  - 213 soil borings were completed
  - 22 new monitoring wells were installed
  - 7 test pits were dug
  - 16 stream sampling locations were established
  - 51 monitoring wells were sampled
- Radiological Soil Analysis
  - 1637 samples were scanned
  - 200 soil samples were analyzed by gamma spectroscopy

25 soil samples were analyzed by alpha spectroscopy for isotopic Th and U
8 sediment samples were analyzed by gamma spectroscopy

- Radiological Water Analysis
  - 51 groundwater samples were analyzed for gross alpha/gross beta
  - 16 surface water samples were analyzed for gross alpha/gross beta
  - 13 groundwater samples were analyzed for isotopic U, Ra^{226} and Ra^{228}
- Chemical Soil Analysis
  - 209 soil samples were analyzed for Act 2 Metals plus Mo and W
  - 115 soil samples were analyzed for Total Cyanide
  - 115 soil samples were analyzed for Weak Acid Dissociable Cyanide
  - 100 soil samples were analyzed for BTEX
  - 99 soil samples were analyzed for PAH
  - 79 soil samples were analyzed for VOCs
  - 45 soil samples were analyzed for SVOCs
  - 37 soil samples were analyzed for Phenolics
  - 35 soil samples were analyzed for TOC
  - 16 sediment samples were analyzed for VOCs
  - 16 sediment samples were analyzed for SVOCs
  - 16 sediment samples were analyzed for Act 2 Metals plus Mo and W
  - 16 soil samples were analyzed for PCBs
  - 10 soil samples were analyzed for Le and Ce
  - 8 sediment samples were analyzed for PCBs
  - 7 sediment samples were analyzed for TOC
  - 5 soil samples were analyzed for Cr^{+6}, Ti, and Mg
  - 22 TCLP metals analyses were performed on soil samples
  - 22 SPLP metals analysis were performed on soil samples
- Chemical Water Analysis
  - 39 groundwater samples were analyzed for VOCs, SVOCs, and Act 2 metals plus Mo and W
  - 12 groundwater samples were analyzed for BTEX, PAH, Act 2 Metals plus Mo and W, Phenolics, and Weak Acid Dissociable Cyanide
  - 8 groundwater samples were analyzed for PCBs
  - 8 groundwater samples were analyzed for Cr^{+6}, Ti, and Mg
  - 6 groundwater samples were analyzed for Perchlorate
  - 17 groundwater samples and 1 seep sample were analyzed for major cations and anions
  - 16 surface water samples were analyzed for VOCs, SVOCs, and Act 2 metals plus Mo and W

- Ecological Characterization
  - Species/habitants of concern identified
  - Enironmental setting described
  - Benthic/macroinvertebrate survey completed at 6 locations in Chartiers Creek and Sugar Run

Subsequent sections of this report provide background information on the site, describe the facility setting, highlight previous investigations, detail activities carried out in this investigation, describe the physical properties and characteristics of native and artificial materials encountered in the investigation, present results of radiological and non-radiological measurements and present results of a preliminary ecological characterization.

1.1 Purpose and Objectives

The purpose of the supplemental site characterization at the Molycorp Washington facility was to collect additional data necessary to develop a technically sound site closure plan that addresses both radiological and non-radiological issues. Implementation of the closure plan is intended to result in unrestricted release (radiological issues) of the property, termination of the site's NRC Source Materials License, and closure of non-radiological issues such that the site may be used in the future for purposes consistent with current zoning and physical constraints.

The supplemental site characterization was designed to collect data relative to attainment of the following objectives:

- For Combined Radiological/Non-radiological Issues:
  - Determine the nature and geographic location, concentration, and volume of contaminant residues in soil.
  - Determine the vertical and horizontal extent of impacts to groundwater, if any.

- Determine if offsite contamination resulting from Molycorp operations exists adjacent to site property lines.

- For Radiological Specific Issues:

  - Develop volume estimates based on unrestricted release concentration criteria for remediation of radiological material.

  - Better define the concentration, volume, and distribution of thorium and other radionuclides which may be present at the site, including buried uranium containing slag.

  - Determine if thorium series and uranium series are separate or co-mingled and determine relative mix of uranium and thorium.

  - Establish equilibrium status of uranium 238 (U-238) and thorium 232 (Th-232) and their daughter products.

  - Determine the extent of radiological contamination and if it exists below the water table.

- For Non-radiological Specific Issues:

  - Define lateral and vertical extent of soil impacted with manufactured gas plant (MGP) tar, including area and thickness, in order to evaluate remedial alternatives, including excavation and offsite disposal.

  - Define lateral and vertical extent of soil and groundwater impacted by other non-radiological constituents of concern.

  - Evaluate suitability of leaving non-radiologically contaminated, fill material on site.

- General:
  - Document surface and subsurface characteristics of the site including: geology, surface and groundwater hydrology, and surficial materials and features.
  - Perform ecological assessment of the site consistent with the requirements of Act 2.

1.2 Site Background

1.2.1 Site Location and Description

Molycorp's Washington Facility is located in Canton Township, Washington County, Pennsylvania, approximately 35 miles southwest of Pittsburgh, Pennsylvania, as shown on Figure 1, Site Location Map. The site consists of approximately 73 acres ranging from woodlands to industrial areas. Molycorp actively utilized approximately 20 acres for manufacturing operations. The main processing areas were bounded to the north by a fence line with Findlay Refractories Company and to the south by Caldwell Avenue. Employee vehicle parking, equipment and miscellaneous storage were located south of Caldwell Avenue. The eastern boundary is the former CSX and Baltimore and Ohio (B&O) railway line adjacent to Green Street. Chartiers Creek serves as the western boundary of the former manufacturing areas. Interstate 70 (I-70) runs along the southeastern area of the site. Former Building 39 was located south of Caldwell Avenue.

As subsequently discussed, the Molycorp site has been divided into ten study areas for purposes of design and conduct of the supplemental site investigation. Figure 2, Site Plan, depicts the ten areas together with certain site features of interest. Figure 3 provides an aerial photograph of the site taken in 2003, after completion of building demolition. Much of the site is relatively flat and located within the floodplain of the northward-flowing Chartiers Creek. This lowland area is where most of the previous site investigations and remedial activities have occurred.

The southwestern section of the site consists of a steep hillside with elevations ranging from 1020 feet mean sea level (MSL) up to 1125 feet MSL.

Wetlands are found in small areas in both the lowland and hillside areas of the site, with the largest wetland comprising 1.3 acres.

1.2.2 Site History

The main plant area was purchased by The Railway Spring and Manufacturing Company in 1902. This parcel was owned by the Railway Spring and Manufacturing Company (later known as the Railway Spring Company or the Car Springs Company) until it was sold to the Electric Reduction Company in 1916. The Molybdenum Corporation of America (in 1974 the name was changed to Molycorp, Incorporated) was formed from the Electric Reduction Company in 1920. Manufacturing operations by the Electric Reduction Company (and successors) originally were conducted in buildings constructed prior to the 1916 purchase of the site. The original building configuration is depicted in Figure 4. These buildings survived until the late 1970's.

Over time, the plant expanded westward as low lying areas were filled with byproduct slags and new buildings were constructed. Construction activities to support facility upgrading were performed over the years as needed. A total of 42 buildings were constructed on the facility property, however, not all of the buildings were present at the same time as obsolete buildings were replaced by newer buildings. Profiles of the buildings including date of construction and major activities carried out are provided in Appendix A. The final plant configuration area circa 1995 is shown in Figure 4. All of the main plant site buildings were demolished in 2002 with only the guard house and truck scales remaining in place.

Additional properties were acquired by Molycorp from time to time throughout the lifetime of the operating facility in anticipation of future expansion. Two notable acquisitions of property south of Caldwell Avenue took place in 1976: the Morris Farm property (Area 7B in Figure 2) and a parcel (Area 5 and 7A, Figure 2) which originally was owned by Hazel-Atlas Glass Company, who operated an MGP nearby. A byproduct of this gasification process was tar. As discussed subsequently, this MGP (Pennsylvania

Atlas Chemical Company) is thought to have been the source of tar present in a building foundation which exists in the southwestern corner of Area 7A and/or in tar ponds in Area 5.

To better understand this complex site and to facilitate characterization and ultimately remediation activities, the site has been divided into ten main areas of interest:

Area 1	Process Plant Area (Subdivided into 1A and 1B)
Area 2	North Slag Area
Area 3	South Slag Area
Area 4	Tylerdale Connecting Railroad
Area 5	MGP Tar Pond Area (Subdivided into 5A-5E)
Area 6	Streams
Area 7	Hill Area (Subdivided into 7A and 7B)
Area 8	Cox Plus
Area 9	Green Street
Area 10	Offsite Areas

1.2.2.1 Manufacturing Operations (Areas 1, 2 and 3)

Table 1 lists significant events in the history of Molycorp operations at the site. Molycorp manufactured several product types at the site over its operating history, including:

- Molybdenum trioxide powder
- Ferromolybdenum metal
- Ferrotungsten metal
- Ferrocolumbium metal

- Calcium boride
- Other rare earth and transition elements

The majority of the products generated consisted of molybdenum trioxide powder, ferromolybdenum metal, and ferrotungsten metal, with smaller quantities of the remaining products. Primary processes that were used to manufacture these products included roasters for converting molybdenum disulfide concentrates to molybdenum trioxide powder and ferroalloy furnaces to produce ferromolybdenum, ferrotungsten and ferrocolumbium. Supplemental processes were used to enhance product recovery and/or to control offgases/reduce waste. Eight former Resource Conservation and Recovery Act (RCRA) impoundments along the west side of the property were utilized for these supplemental processes.

Ferrotungsten was produced at the site from the 1920's into the 1970's. During this time several mines provided concentrates as feed material. Although the exact quantities in the various feed concentrates are unknown, it is expected that some slags resulting from this process contained uranium.

In 1963, the Molybdenum Corporation of America obtained a Source Materials License (License SMB-744) from the Atomic Energy Commission (AEC) (later NRC) because of the processing of concentrates that contained 0.05 percent (or higher) of uranium and/or thorium. Between 1964 and 1970, Molycorp produced ferrocolumbium alloy from concentrate produced from ore mined in Araxa, Brazil. Slag from the production of the ferrocolumbium alloy was in the form of refractory glass/ceramic slag containing thorium.

Waste slags from the ferroalloy operations were utilized on site to fill in low-lying areas and as a subbase in some building construction. Although the largest quantity of fill consisted of non-radioactive ferromolybdenum slags, thoriated slags associated with ferrocolumbium production and ferrotungsten slags possibly containing uranium also were deposited on the property.

Area 1 For purposes of designing and executing the Supplemental Characterization, Area 1 was subdivided into an eastern portion (1A) and a western portion (1B)

> ***Area 1A Description*** The original manufacturing buildings were located in the eastern area and remained intact until approximately 1979 at which time, they were demolished and new structures were constructed atop the same locations. These original buildings predate Molycorp (and predecessors) and existed throughout the time period when radioactive slags were produced at the facility. Little or no radioactive fill was placed in this area of the process plant.
>
> ***Area 1B Description*** Historical information does not support the absence of contamination in the western section of Area 1 (1B). Previous investigations detected radiological contamination in this section of the process plant.

Area 2 This area, west of the original process plant area (Area 1), was a lowland containing ponds of various configurations throughout much of the operating history of the facility. Over the years, this area was filled with various slag byproducts of the manufacturing operations. As the plant expanded westward, buildings were erected above the fill in this area. Eight surface impoundments were constructed along the western boundary near Chartiers Creek in 1968. These impoundments were closed in 1995 and backfilled with clean soils.

Given the historical development of this portion of the plant, radiological contamination would be expected throughout the area. This has been confirmed by previous radiological surveys including the extensive characterization study carried out in 1994.

Area 3 This area south of Caldwell Avenue was the site of a former pile containing thoriated slag. The pile was located in the western part of the area adjacent of Chartiers Creek. To the east of the former pile location, is the site of a former pond that received ball milled slag in the form of a slurry. Farther east, in the central portion of the site is the former location of Building 39 that was utilized to store spare parts.

1.2.2.2 Tylerdale Connecting Railroad (Area 4)

Area 4 is a former railroad right-of-way that separates Area 5 to the south, Area 3 to the north, and bisects Area 7 with Area 7B to the north, and Area 7A to the south. In the past, a Tylerdale rail line was located in Area 4. The rail line and associated structures have been removed and the area now is vegetated.

1.2.2.3 MGP Tar Areas (Areas 5 & 7A)

An historical review was undertaken in this investigation to develop information on the MGP tar present on the site. Table 2 summarizes information regarding the history of activities related to Area 5 (MGP Tar Ponds) and Area 7A (Foundation) up until the time the property was purchased by Molycorp, around 1976.

Also summarized in Table 2 is the history of the Pennsylvania Atlas Chemical Company which was apparently an MGP built by Hazel-Atlas to supply gas for its glass making operations. The Pennsylvania Atlas Chemical Company was located east of Area 5 on the eastern side of I-70. A gas holder associated with the Pennsylvania Atlas Chemical Company appears to have been located east of Area 5 and north of Chartiers Creek where I-70 is currently located.

After Molycorp purchased Areas 5 and 7A, these areas were subjected to investigation and remediation. The remedial activities in Area 5 are discussed in Section 1.2.6.2. When Molycorp purchased Area 7A, there was an uncovered, concrete foundation approximately 100-feet by 150-feet in area. The foundation walls were partially underground and partially aboveground. The bottom of the foundation contained a layer of tar reported to be less than a foot thick. In the 1980s, the walls of the foundation were pushed in and the foundation was filled with soil. Subsequent to this action, the soil settled and tar oozed upward in the void spaces in the soil so that the soil in the foundation now contains tar.

The historical review leaves several issues unresolved and it appears that further historical research will not resolve these issues. First, the building and operations associated with the Foundation are not known with any certainty. Second, the purpose of the tar ponds is not known, although they may have served as settling basins for tar-water mixtures from the offsite Pennsylvania Atlas Chemical Company, a MGP in the Foundation area or both. The tar-water mixture would have been sent to the ponds where the tar would settle to the bottom, since it is denser than water. Third, when the gasholder under I-70 was constructed and whether or not it had a below ground foundation is not known with any certainty, although the recollections of a Pennsylvania Department of Transportation (Penn DOT) employee suggest that it had a below ground foundation.

Area 5 (MGP Tar Ponds) Most of Area 5 lies in the floodplain of Chartiers Creek. For the purpose of developing the supplemental characterization for Area 5, this area was subdivided into five smaller sub-areas (Figure 2):

Area 5A (South Tar Pond)

Area 5B (North of the South Tar Pond) – the area to the north of the South Tar Pond extending to Chartiers Creek and Sugar Run

Area 5C (Eastern North Tar Pond) – the portion of the North Tar Pond to the east of the service road, between the service road and I-70

Area 5D (Western North Tar Pond) – the portion of the North Tar Pond to the west of the service road

Area 5E (Across the Creeks) – the property across Chartiers Creek and Sugar Run from the Tar Pond area

Area 7A (Foundation) Area 7A is the southern portion of the hill area which contains an old foundation. The area currently is not used, is surrounded by forest, and probably would revert to forest except that vegetation in the area periodically is cut. There is very limited access to this area. Residential areas exist to the south, but this area is separated from these residences by B&O railroad tracks.

1.2.2.4 Streams (Area 6)

There are two surface water bodies which traverse the site: Sugar Run and Chartiers Creek. Chartiers Creek enters the site (bisecting Area 5) from the southeast and crosses the property to run along the western boundaries of Areas 3 and 2. Average streamflow as Chartiers Creek enters the site is approximately 8,000 gallons per minute. The Creek continues to the northeast and ultimately discharges into the Ohio River. Tar seeps have been observed at several locations along the banks of Chartiers Creek in Area 5 and tar has been observed along the base of the creek channel at several locations in Areas 5 and 7B.

Sugar Run enters the site from the west and discharges into Chartiers Creek in Area 5. Average streamflow as Sugar Run enters the site is 1,200 gallons per minute. Sugar Run is believed to be unaffected by site-related industrial activities. No tar seeps have been observed along Sugar Run.

1.2.2.5 Hill Area (Area 7B)

Area 7B is the portion of Area 7 (Figure 2) that is north of Area 4. Area 7B formerly was an active farm (Morris Farm) that was acquired by Molycorp close in time to the acquisition in 1976 of the southern part of Area 7. There is no record of non-agricultural activity occurring on Area 7B. However, it appears that debris, apparently residential, has been placed in a portion of this area. Area 7B is open land including forested and grassy areas.

1.2.2.6 Cox Plus (Area 8)

The Cox Plus area, located in the northwest corner of the site, is bounded on the east by Chartiers Creek, on the south by Caldwell Avenue and on the west by a residential neighborhood on Point View drive. Area 8 is open land (primarily forested with some grassy areas) except for a paved road (Weirich Avenue), which runs north to south and bisects Area 8. Area 8 slopes upward to the west at a 15 percent grade. A power line right-of-way and several unpaved footpaths cross Area 8. There are no structures located in Area 8 . A trailer home with a septic tank formerly was located in Area 8. Except for Weirich Avenue, Area 8 currently is unused and there are no reports of previous industrial activity or waste disposal in Area 8.

1.2.2.7 Green Street (Area 9)

The Green Street area is located east of Area 1. Historical evidence, including photographs and aerial photographs, indicates that Area 9 was a residential area continuously since at least the early 1900's. There is no historical evidence that Area 9 was used as a process area or disposal area. Currently, the area consists of vacant land housing two office trailers one of which currently serves as the Molycorp site office.

1.2.2.8 Offsite Areas (Area 10)

Offsite areas of potential concern included in this investigation were:

- Vicinity of the abutment of the small bridge over Chartiers Creek near the southwest corner of Area 2;
- Caldwell Avenue between Areas 1 and 2, and Area 3; and
- The area located adjacent to the northeast corner of Area 3 where a temporary rail line was located in the 1979-1981 time period to allow receipt of raw materials during demolition and reconstruction activities in the main plant area.

1.2.3 Land Use

Land use for the site was approximately 30% heavy industrial (i.e., the portion of the site that is north of Caldwell Avenue and east of Chartiers Creek) and 70% open land including forested and grassy areas. The site is bounded by transportation, heavy industrial and residential areas to the east, heavy industrial areas to the north, residential areas to the west and transportation and residential areas to the south. According to the current zoning map (Canton Township Zoning Map, 11/08/2000), zoning designations for the site include medium density residential for the approximately 65% of the site that is located west of Chartiers Creek and mixed use (including light industrial, heavy industrial, highway commercial and medium density residential) for the approximately 35% of the site that is located east of Chartiers Creek. Adjacent property owners can be classified into three major categories based on the current use of the land – residential, industrial, and public. The residential properties lie west of Weirich Avenue. Industrial properties are predominantly located to the north of the site and consist of the former Findlay Refractories Company and Allegheny Ludlum Corporation. Railroad lines are located south of the site. Land under public ownership includes the Canton Township Voluntary Fire Company property, the right-of-way for I-70 and other public streets.

1.2.4 Previous Investigations

From 1980 to the present, numerous investigations have been conducted at the site. As a result, a substantial body of characterization data exists on the environmental condition of the site. Table 3 lists the previous site investigations that were considered in preparing and executing the supplemental characterization plan. In the course of preparing this plan, data from past investigations were assembled in a georeferenced, relational database containing more than 15,000 datapoints.

1.2.5 Regulatory Highlights (Source Materials)

In 1963, the Molybdenum Corporation of America obtained a Source Materials License (License SMB-744) from the AEC (later NRC) because of the processing of ores that contained 0.05 percent (or higher) of uranium and/or thorium. Between 1964 and 1970, Molycorp produced ferrocolumbium alloy from concentrates derived from ore mined in Araxa, Brazil that was delivered to the Washington Facility. Slag from the production of the ferrocoloumbium alloy was in the form of a refractory glass/ceramic containing thorium.

In 1966, Molycorp initiated discussions with the Pennsylvania Department of Health and AEC in pursuit of an on-site burial permit. A formal application was submitted in 1967. About this time period, Applied Health Physics, Inc. conducted a series of leaching studies on the ferrocolumbium slags. These studies indicated that the radioactive materials were fixed and would not leach into the groundwater in excess of prescribed limits. No action was taken by the state or the AEC on the request for an on-site burial permit (Foster Wheeler, 1995a).

In June of 1971, an AEC compliance inspection revealed that thorium-bearing slags had been buried on-site. It was speculated that the burial occurred during a large scale clean-out of settling basins and regrading of the plant site by a private contractor who was unaware of restrictions on landfilling ferrocolumbium slags. Subsequently, AEC issued a Notice of Violation (NOV) and requested Molycorp to excavate these materials and dispose of them in accordance with AEC regulations.

In 1972, Molycorp excavated soil containing relatively high concentrations of thorium-bearing slag, and shipped approximately 14 truckloads of this soil/slag material to a disposal facility in New York State. However, that facility later refused to accept any additional material because it was, in the facility manager's words, "of insignificant contamination, and too large a volume" to bury at a site with limited disposal space. As a consequence, in 1973 the remaining thoriated slag material that was to be shipped offsite was instead consolidated into a single storage pile south of Caldwell Avenue and covered with a foot-thick layer of clean fill and vegetation.

An NRC contractor, Oak Ridge Associated Universities (ORAU), conducted a radiological survey of the site in 1985, which identified elevated levels of thorium in the dikes which separated RCRA the surface impoundments, and indicated the potential of subsurface thoriated slags in the western portion of the site. Subsequently, the Washington Facility was listed in NRC's 1990 Site Decommissioning Management Plan (SDMP) list.

Molycorp renewed its NRC license for the Washington County facility in 1992. Because the facility had appeared on the 1990 SDMP list, this license renewal included an amendment incorporating a schedule for characterizing and decommissioning the site. Since that time, a number of decommissioning reports and plans have been submitted to the NRC including:

- Plan for Site Characterization Plan in Support of Decommissioning of the Molycorp, Inc., Washington, PA Facility (RSA, Inc. and Vail Engineering, Inc., 1993)
- Site Characterization Report for License Termination of the Washington, PA Facility (Foster Wheeler Environmental Corporation, 1995)
- Decommissioning Plan for the Washington, PA Facility (Foster Wheeler Environmental Corporation, 1995)

- Washington Facility Environmental Report (ICF Kaiser, Inc., 1997)

- Washington, PA Facility Decommissioning Plan, Part 1 Revision (Radiological Services, Inc., 1999)

- Washington, PA Facility Decommissioning Plan, Part 2 Revision (Radiological Services, Inc., 2000)

- Supplemental Site Characterization Plan for the Washington, Pennsylvania Site (Malcolm Pirnie, 2003)

The 1993 Site Characterization Plan explained how Molycorp would test and analyze the property to determine the presence and location of the thorium-bearing slag. As called for in the Site Characterization Plan, Molycorp drilled over 400 core borings and generated more than 12,000 soil measurements. Furthermore, Molycorp installed 19 groundwater wells, and took 64 groundwater samples. Through this process, Molycorp created a three-dimensional picture of areas with elevated thorium levels. The findings of that study were reported in the 1995 Site Characterization Report.

Based on the findings of the Site Characterization Report, Molycorp prepared an initial Decommissioning Plan that was submitted to the NRC in late 1995. This plan proposed removing any material that had a level of thorium above 30 pCi/g. The plan did not address contamination below structures.

In 1996, Molycorp excavated approximately 4,000 cubic yards of material that was located along and beyond its northern property boundary. This thorium-bearing slag and soil was stored in covered roll-off containers on Molycorp's property. In 2000, the thoriated slag in the roll-off containers as well as the slag pile south of Caldwell Avenue was transported offsite and disposed at the Envirocare facility in Utah.

In 1999, the NRC advised Molycorp of the results of its review of the 1995-decommissioning plan. As a result of the NRC's review, in June of 1999, Molycorp submitted to the NRC the Part I Revision to the Decommissioning Plan, which changed the remediation goal from 30 pCi/g to 10 pCi/g. The plan also described how Molycorp would excavate the thorium-bearing slag in various areas of the property.

In July of 2000, Molycorp submitted the Part 2 Revision to the Decommissioning Plan that addressed a proposal to construct an onsite disposal cell for material that exceeded SDMP Action Criteria (10 pCi/g). The Decommissioning Plan Part 2 Revision was never approved. Molycorp has since abandoned its plans to construct the onsite cell and now intends to close the site in a manner that results in unrestricted release with respect to radiological issues.

NRC has issued a series of amendments to Molycorp's Materials License (No. SMB-1393). The most recent amendment is No. 6, which was issued on May 1, 2002. The amendment specifies conditions that must be met as part of decommissioning the site.

In September 2003, Molycorp submitted a Supplemental Site Characterization Plan to NRC and PADEP. This plan addressed both radiological and non-radiological issues and served to guide the efforts described in this report.

1.2.6 Remedial Actions

Six principal remedial actions have occurred at the site including:

- Excavation of Buried Thorium-bearing Slag
- MGP Tar Ponds Remediation
- Impoundments Closure
- Northern Property Boundary Remediation
- Slag Pile Removal
- Building Demolition

Each of these remedial actions is described in the following subsections.

1.2.6.1 Excavation of Buried Thorium-bearing Slag

In 1971, an AEC compliance inspection identified that thorium-bearing slags had been buried on-site. The AEC issued a Notice of Violation (NOV) and requested Molycorp to take remedial action including excavation and disposal of the buried slags. In 1972, Molycorp authorized Applied Health Physics to excavate, sample, concentrate as much as possible and ship these materials to the Nuclear Fuel Services disposal facility in West Valley, New York. Disposal was terminated when disposal site officials determined that the slag was of insufficient contamination to bury and wasted valuable disposal space. The solution implemented in 1973 was to consolidate the remaining slag on-site into a pile located south of Caldwell Avenue and east of Chartiers Creek, as depicted in Figure 2.

1.2.6.2 MGP Tar Ponds Remediation

In 1980, Molycorp engaged SRW to investigate the tar pond areas south of Caldwell Avenue. Molycorp had purchased the property in 1976 in anticipation of future expansion. Based on results of the investigation, SRW concluded that tar probably extends under the I-70 embankment, and is mixed with fill under the embankment. Tar was determined to be approximately 1.5 to 2 feet thick in the north and south pond areas. Tar also was observed in and along Chartiers Creek. Soil materials beneath the tar were of low permeability indicating a low rate of fluid movement into lower layers.

SRW prepared a tar pond closure plan in January 1984. The closure plan recommended excavation of tar from the north tar pond area and placement of the material behind a compacted bermed area at the south pond. The south tar pond area would be covered with a geotextile fabric and compacted soil cap, and revegetated. Supporting work would include construction of access roads, stream crossings, culverts, arch bridges, and diversion ditches.

Prior to undertaking the proposed action, SRW prepared a letter to the Pennsylvania Department of Environmental Resources (DER) dated October 8, 1985 to address surface tar cleanup, tar seeping along the I-70 embankment, and surface water and groundwater monitoring requirements during the upcoming tar closure project. The letter indicated that a soil cover would be placed and surface water and groundwater monitoring would be performed. The groundwater monitoring requirement subsequently was discontinued by DER.

Tar from the northern pond area ultimately was removed and placed in the south tar pond area in the mid-1980s. Information regarding the details of the completed effort are unavailable.

1.2.6.3 Impoundment Closure

Historically, wash water and slag from ore processing activities were allowed to flow into surface depressions/ponds located on the western portion of the facility during the first half of the 20th century. These depressions/ponds were upgraded to 8 holding ponds in the late 1960's. Each holding pond area was reported to be 80 feet long and 30 feet wide. A clay dike was constructed along the western edge of the holding ponds in 1969 to restrict any possible flow of leachate into Chartiers Creek. The holding ponds were lined with a clay and PVC liner. Originally the holding ponds were used for recovery of molybdenum disulfide solids from the wet scrubber system on the roasters. Beginning in 1976, baghouse/scrubbers were used to capture the molybdenum disulfide. The holding ponds were retained for spill control and for containing acid plant flushing solutions.

After enactment of RCRA in 1980, Molycorp submitted a Part A permit to obtain interim status to use the holding ponds as surface impoundments. Molycorp later submitted a Part B permit application. PADER denied use of the impoundments as a RCRA unit because a double liner/leachate system was not in place, the impoundment bottoms were too close to the water table, and the impoundments were within the 100-year floodplain of Chartiers Creek.

The impoundments continued to be used for spill control/acid plant flushing solutions which were not classified as a hazardous material. The United States Environmental Protection Agency (USEPA) subsequently terminated interim status for all unpermitted surface impoundments in 1989, and no hazardous material could be placed in these units after that time.

The eight surface impoundments were closed in June 1995. The remedial action included removal of all impoundment materials with the exception of the clay liner.

1.2.6.4 Northern Property Boundary Remediation

A remedial action was performed in 1996 along the northern boundary of the facility and adjacent property (Findlay Refractories property). Results of that effort were reported in a radiological status report submitted by Foster Wheeler Environmental Corporation (Foster Wheeler) in December 1996. The work included excavation and removal of materials containing thorium, radium, and uranium isotopes. Excavated materials consisting of slag and refractory materials were scanned with a sodium iodide (NaI) scintillation counter and segregated into appropriate piles. Contaminated material above the threshold criteria was transferred to rolloff containers, and samples of the containers were collected for on-site gamma spectroscopy. In 2000, the contaminated material was transported offsite and disposed at the Envirocare facility in Utah.

A final status survey was conducted by Foster Wheeler to demonstrate that the radiological conditions on and in the immediate proximity of the Findlay Refractories/Molycorp property line satisfy the release criteria and that the area is considered acceptable for unrestricted use.

1.2.6.5 Slag Pile Removal

In 2000 and 2001, the contaminated slag pile located south of Caldwell Avenue and east of Chartiers Creek, was removed. Approximately 10,000 cubic yards of material were shipped offsite for disposal at the Envirocare facility in Utah.

1.2.6.6 Building Demolition

In 2002, Molycorp contracted MACTEC, Inc. to decommission the 21 buildings that remained on the site. The project included demolition and disposal of all aboveground structures and buildings. Except for the guardhouse and scales, all existing structures (buildings, tanks, dryers, baghouses, utilities) were removed from the site by the end of 2002. Building foundations were removed except for Building 2 and 2W. Wastes created by the demolition activities were identified, segregated, and shipped to appropriate waste disposal facilities.

Final status surveys of the building materials were conducted in accordance with the requirements listed in NUREG/CR 5849, “Manual for Conducting Radiological Surveys in Support of License Termination”, RSI’s “Decommissioning Plan for the Washington, PA Facility, Part 1 Revision”, Molycorp’s “U.S. Nuclear Regulatory Commission Material License, Amendment No. 5, SMB-1393”, and MACTEC’s “Survey Plan for Determining the Final Status of Buildings at the Molycorp Site”.

Summary of Existing Site Information

SECTION 2

2.1 Summary of Previous Investigations

Numerous investigations have been conducted at the site to address various environmental issues. For the most part, these investigations have been concerned with identifying areas that have been impacted by radiological materials; however, some non-radiological investigations have been completed as well. Surface and subsurface soil samples have been collected as part of radiation surveys; groundwater monitoring wells have been installed to monitor groundwater quality in the area of the processing plant; soil and groundwater samples have been collected as part of the site characterization and decommissioning process; and samples of overburden fill material have been analyzed to determine chemical composition. More limited investigations have been conducted to address the MGP tar present in Areas 5 and 7A. Previous investigations carried out for the various areas of the site are discussed below and are summarized in Table 3.

2.1.1 Areas 1, 2, and 3 - Process Plant, North Slag, and South Slag Areas

Area 1, the Process Plant, is the partially paved portion of the site that formerly contained the roasters, acid plant, and other buildings that housed various processes that were carried out on site. This area contains the original location of site operations. Area 2, the North Slag Area, also was a processing area where pyrochlore concentrates were processed. Slag fill, some of it radioactive, was placed in this area prior to construction of the buildings. Area 3, the South Slag Area, is an area where slag generated by the manufacturing process was deposited or buried. This area of the site was largely undeveloped during the entire life of the manufacturing process but did contain a building that was utilized for parts storage. Additionally, the western portion of this area is where the thoriated slag pile existed as well as a pond which contained ball milled slag.

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Oak Ridge Associated Universities (ORAU) performed a radiological survey of the facility in 1985. The western third of the manufacturing area, as well as the area south of Caldwell Avenue, were the focus of this investigation. Work performed included surface radiation scans, direct radiation measurements, and radionuclide sampling of surface soils at numerous locations utilizing a grid to identify sampling location. Surface water and sediment samples from Chartiers Creek, sediment samples from two storm drains, and groundwater samples from Monitoring Wells M1 through M4 also were collected. Results of this investigation indicated that there was widespread surface thorium contamination. Subsurface contamination also was suspected but was not verified.

Radiation Surveillance Associates, Inc. (RSA) was retained by Molycorp in 1990 to perform a radiation survey on the western third of the facility, specifically focusing on the vertical profiling of thorium levels in the vicinity of the eight RCRA holding ponds/impoundments. The survey included approximately 400 measurements of the gamma radiation field at one meter above the ground surface. Additionally, 32 soil borings were completed and downhole gamma logging measurements were collected every six inches from ground surface to the bottom of the boring at bedrock. Radiation measurements also were taken in the 4 existing monitoring wells. In general, subsurface thorium concentrations were found to be above the surface soil concentrations in most samples, and there was a considerable lateral variation in radiation levels. Radiation levels usually decreased to background levels by a depth of nine feet.

In 1991 Remcor performed a facility wide groundwater investigation. This investigation included installation of 17 monitoring wells (identified as M5 through M18 with two well clusters at M-9, M-15, and M-18) across Areas 1 and 2, installation of 2 staff gages, collection of 6 soil samples for geotechnical analyses, and collection of 30 soil samples for thorium analysis. Two rounds of groundwater samples were collected from the 17 newly installed monitoring wells and 4 existing wells as a part of this investigation. Groundwater samples were analyzed for general water quality parameters including pH, acidity, specific conductance, total dissolved solids (TDS), total suspended solids (TSS), total organic carbon (TOC), total organic halogens (TOX), phenol, sulfate, nitrogen, chloride, carbonate, bicarbonate, metals, and molybdenum. Results of the analysis indicated that pH in the center of the facility was elevated, sulfate was elevated in the majority of the wells, and molybdenum concentrations downgradient of the holding ponds and Building 26 and in the vicinity of the M-15 monitoring well cluster were elevated. Several other metals also were detected in the groundwater samples at elevated concentrations. The soil samples analyzed for thorium isotopes ranged in concentration as follows: 1.0-9.46 pCi/g Th-232, 1.14-3.9 pCi/g Th-228 and 1.27 – 9.3 pCi/g Th-230.

In response to an October 29, 1992 NRC comment letter, which questioned the procedure for converting the downhole measurements to subsurface soil concentrations, RSA prepared a second report in 1992. The second report contained justification regarding the approaches used in RSA's 1990 investigation and specific response to the NRC comments. Also included in the 1992 report was laboratory radiological analysis for soil samples that were reported but not provided in the 1990 RSA report.

A site characterization plan to support decommissioning of the facility was prepared in August 1993. The plan defined affected areas from a radiological perspective associated with thorium-based contamination. The defined affected areas included the western third of the facility property, the area south of Caldwell Avenue, and the ground surface of buildings 29 and 34 and areas beneath Buildings 33, 35, 36, 38, 39, and 42.

Foster Wheeler and RSA performed site characterization field activities during the spring, summer, and fall of 1994 in accordance with the site characterization plan and associated NRC comments. This site characterization focused on radiological investigations related to thorium-based materials, with limited sampling for non-radiological parameters to be used as indicator parameters. The field investigation included the completion of over 400 soil borings (SB1 through SB410 and offsite borings) throughout Areas 1, 2, and 3; installation of an additional 14 monitoring wells (MW19 through MW29, UG2, UG3, and UG4) and 2 pumping wells (PW1 and PW2); and the performance of a radiological survey. In addition, soil, surface water, sediment, storm sewer, and groundwater samples were collected and analyzed. A pumping test also was performed to support groundwater-modeling activities for the facility.

The radiological survey consisted of downhole gamma logging by lowering a sodium iodide detector into each of the soil borings and collecting a count measurement at 6-inch intervals. A second technique, gamma spectroscopy of soil samples was employed to create a "quality assurance" database. The second technique involved the analysis, at 6-inch intervals, by an on-site gamma spectrometer for reportedly 20% of the split spoon samples collected during the site characterization.

Two rounds of groundwater samples from all available monitoring wells on the facility property and surface water in Chartiers Creek were collected and analyzed for metals, molybdenum, chloride, phenols, sulfate, TDS, TOC, TOX, and radionuclides. Sediment samples were collected from seven locations in Chartiers Creek and analyzed for thorium. Storm sewer samples also were collected from seven locations and were analyzed for metals, molybdenum, chloride, phenols, sulfate, TDS, and pH.

Radiological survey results indicated shallow soil contamination in the northeast quadrant of the property, in the north central portion of the property, near the impoundments, and in the southern parcel across Caldwell Avenue. The majority of the thorium contamination was found at shallow depths (typically less than 5 feet and mostly less than 10 feet beneath the ground surface).

The subsurface investigation conducted as part of the site characterization produced a database of 12,499 measurements of surficial and subsurface thorium concentrations. Based on results of the downhole gamma and gamma spectroscopy measurements, three conclusions were formulated concerning thorium contamination in the former manufacturing area at the subject site: 1) the thoriated material is distributed randomly, 2) the major portion of the thoriated material is close to the surface in irregularly shaped bands, and 3) no migration has taken place vertically or horizontally.

Groundwater sample results indicated that molybdenum concentrations generally increased from east to west across the plant area to greater than 285 milligrams per liter (mg/l) in monitoring well M5. Molybdenum groundwater sample results also were elevated in upgradient monitoring well UG2 which was installed along a rail spur in the vicinity of former Building 2/2W. Elevated molybdenum concentrations (98 and 126 mg/l) were identified in Bedrock Well BR1 during the two rounds of groundwater sampling. Selenium concentrations were highest in monitoring well M15S at a level of 0.204 mg/l during the first round of groundwater sampling.

Thorium was detected at low concentrations in wells located in the northern portion of the facility including monitoring wells M6, M12, M14, M15S, M18S, and M25. The highest detected concentration of Th-230 was 3 pCi/l. Uranium and radium isotopes were detected in the 1 to 2 pCi/l range. Based on these concentrations, Foster Wheeler concluded that groundwater is not a significant pathway for radionuclide transport.

Surface water sample results indicated no significant impacts from site activities. None of the samples had concentrations of thorium or uranium above laboratory reporting limits. Only radium was detected at concentrations ranging from 5 to 6 pCi/l in the surface water samples collected from Chartiers Creek. Further, Foster Wheeler concluded that no significant thorium impact was evident in the sediment samples collected from Chartiers Creek. Storm sewer sample results indicated the presence of molybdenum at concentrations that increased downstream within each storm sewer line.

In response to a request from NRC, RSI performed an evaluation of the degree of equilibrium of uranium and thorium at the facility. The evaluation that was performed was summarized in a report prepared in March 2001. The evaluation included the collection and analysis for uranium and thorium series radionuclides of five composite samples in January 2000 from archived split spoon samples from the 1994 site characterization conducted by Foster Wheeler. The report concluded that uranium/thorium ratios in the soils are variable, the principal thorium and uranium series members are in equilibrium, and Ra-226 is not in equilibrium.

In 2001, MFG Inc. conducted an investigation to characterize the northwest area (Area 2) of the facility and the area south of Caldwell Avenue (Area 3) to determine appropriate means of managing the overburden materials that exist above the radiologically contaminated slag. The investigation included installation of 20 soil borings utilizing split spoon sampling techniques. Each sample was scanned for the presence of radioactivity and the presence of volatile organic compounds (VOCs). Selected soil samples were collected and analyzed for metals which have established Pennsylvania Act 2 standards, plus molybdenum. Five of the samples were analyzed for VOCs and semi-volatile organic compounds (SVOCs). All of the samples submitted to the laboratory also were analyzed for radiological parameters. After receipt of the metals analyses results, the five samples that yielded the highest concentrations of the eight RCRA metals also were subjected to the toxicity characteristic leaching procedure (TCLP) and/or synthetic precipitation leachate procedure (SPLP) (6 total) analyses.

Arsenic and vanadium exceeded the surface soil non-residential statewide health standards (SHS) at some locations in the MFG investigation, with arsenic the predominant exceedence (SBs 8, 9, 11, 16, and 20). There were no exceedences of the SHS for subsurface soils. Arsenic, boron, lead, and selenium exceeded the soil to groundwater SHS in samples collected from SBs 1, 6, 8, 9, 11, 15, and/or 18. The majority of the exceedences were for boron. VOCs and SVOCs were detected (borings SB 2, 6, 9, 11, and 18); however, none of the results exceeded the Act 2 SHS and the majority of detections were SVOCs. The TCLP results were below the regulatory limit for a characteristic hazardous waste. SPLP results exceeded the Act 2 medium-specific concentrations (MSCs) for non-residential used aquifers for boron, selenium, vanadium, arsenic, and lead for samples collected from borings SB 1, 2, 8, 11, 15, and 16. The MFG report concluded that the materials overlying the radiological contaminated slag could be returned to the site if properly addressed, provided that exposure pathways are eliminated by appropriate capping, and that appropriate evaluations are performed in accordance with Act 2.

During March 2002, Harding ESE collected groundwater samples from monitoring wells M2, M4, M8, M10, M13, M18, M20, MW24, MW25, MW26, MW27, MW28, MW29, MW31, UG4, BR1, and BR2 for isotopic analyses of radium, thorium, and uranium. Additionally, surface water and sediment samples were collected from Chartiers Creek and analyzed for the same parameters as the groundwater samples. None of the radioisotopes were identified in any of the water samples at a concentration greater than 2.5 pCi/l, with the majority of the results being identified at concentrations below 1 pCi/l. None of the sediment radioisotopes were reported in excess of 1.6 pCi/g. Groundwater samples collected from Monitoring Wells BR1 and M4 also were analyzed for dissolved molybdenum and cobalt. Cobalt was not detected in either of the groundwater samples above the laboratory reporting limit while molybdenum was detected at concentrations of 63.7 (BR1) and 16.2 mg/l (M4).

2.1.2 Area 4 – Tylerdale Connecting Railroad

This portion of the site was never used in the manufacturing process or as a disposal area. However, some low level radioactive material in the form of colored glass and/or refractory brick used or produced by the Hazel-Atlas Glass Company has been found on the southern slope of the railroad right of way. Two monitoring wells were installed in this portion of the site by ICF Kaiser International, Inc. (ICF Kaiser) as a part of their 1996 evaluation of potential impacts (both radiological and non-radiological) relating to various alternatives for decommissioning the facility. No soil or groundwater samples were collected during the 1996 investigation.

2.1.3 Areas 5 and 7A – Manufactured Gas Plant Tar Areas

Areas 5 and 7A consist of the areas of the site that have been historically referred to as the "North Coal Tar Pond Area", "South Coal Tar Pond Area", and the portion of Area 7 that is south of Area 4. These areas have been impacted by tar that most probably was produced as a by-product by one or more manufactured gas plants previously located on or near the site.

A limited number of investigations have been completed on MGP tar impacted areas. The first investigation occurred when Molycorp retained SRW in 1980 to study the Tar Ponds in Area 5. SRW installed eight soil borings, 4 in the North Tar Pond area (3 in the portion of the tar pond west of the service road and one in the portion of the tar pond between the service road and I-70) and 4 in the South Tar Pond area. SRW also visually delineated the extent of tar impacts in the North Tar Pond, the South Tar Pond and Chartiers Creek

Following the remediation that occurred in the tar pond area during 1995 (i.e., excavation and disposal of tar from the north tar pond into the south tar pond), SRW attempted to install three groundwater monitoring wells adjacent to the south tar pond. However, only one of the test borings was completed as a monitoring well because the other two borings contained evidence of tar and tar impacts. The completed monitoring well (GW-3) was never sampled.

To further remediate tar impacts in Areas 5 and 7A, Molycorp contracted ICF Kaiser in 1997 to develop a design for increasing the height of the dike surrounding the South Tar Pond. As part of this work, ICF Kaiser installed seven soil borings and completed four test pits. Two of the borings and one test pit were placed along the surface of the dike. In the two borings outside the dike, evidence of tar impacts were noted from 1.5 to at a minimum of 4 feet below ground surface. On the other hand, tar was observed in soil samples beneath the diked area to depths of 15 feet at some locations.

Civil and Environmental Consultants, Inc. (CEC) were retained in 2000 to locate historical oil and natural gas wells in Areas 5 and 7A. As part of this investigation three test pits were dug in the area around the South Tar Pond. Additionally, CEC completed four test pits to the east of the foundation located in Area 7A. All of the test pits were completed to a depth of approximately two feet and no tar impacts were identified in any of the test pits.

2.1.4 Area 6 – Streams

Surface water and sediment samples have been collected from Chartiers Creek in the past during investigations to address concerns related to the manufacturing areas (Areas 1, 2, and 3) and MGP Tar Pond Area (Area 5) areas. These sampling events have been discussed previously in this chapter.

2.1.5 Area 7B

This portion of Area 7 consists of the land north of Area 4, the Tylerdale Connecting Railroad. This area consists of three distinct parcels. The eastern parcel is flat land between Chartiers Creek and property owned by the Canton Township Voluntary Fire Company. This parcel has an access road to Area 5 and Area 7A. The central parcel is a thin strip located between property owned by the Canton Township Voluntary Fire Company and Sugar Run. The western parcel consists of land behind residences along Caldwell Avenue extending south to Sugar Run and then across Sugar Run to Area 4. This parcel is generally flat, encompassing the floodplain of Sugar Run. Prior to Molycorp purchasing the land in 1976, it was a farm. No manufacturing or processing activities have ever occurred here. As a result, no previous investigations have been conducted in this portion of the site.

2.1.6 Area 8 - Cox Plus

The Cox Plus area is located to the west and on the other side of Chartiers Creek from the former manufacturing area. This portion of the site was never used in the manufacturing process or as a disposal area. The only known use was as the location of a house trailer. No previous investigations have been conducted in this area.

2.1.7 Area 9 - Green Street

The Green Street area consists of parcels of land located to the east of the former manufacturing area. Historical information indicates that residential homes have been situated on these parcels of land since before the Electrical Reduction Company purchased the Washington facility from the Railway Spring Company in 1916. As a result, there is no reason to believe that fill or other materials associated with the site ever were placed on these parcels of land. No previous investigations have been completed in this area.

2.1.8 Area 10 - Offsite Areas

The offsite parcel of land located to the east of Area 3, Caldwell Avenue between the process area and Area 3, and the portion of Caldwell Avenue that includes the abutments for the small bridge over Chartiers Creek have been designated as the offsite areas. Soil borings were installed in the vicinity of the parcel east of Area 3 during the 1994 Foster Wheeler site characterization. Thorium concentrations above 10 pCi/g were measured by the downhole gamma logging technique in several of the soil borings completed in this vicinity.

2.2 Geology and Hydrogeology

The site is located in Canton Township, Washington County, Pennsylvania. The Washington County area is situated in the Pittsburgh Low Plateau Section of the Appalachian Plateaus Physiographic Province. This section of Pennsylvania typically consists of flat lying to gently folded sedimentary units that have been regionally elevated and dissected by dendritic stream erosion. The Molycorp site itself is located primarily on fill material that was placed over top of Chartiers Creek alluvium which in turn overlies claystone and other sedimentary rocks of Pennsylvanian and Permian ages. Subsequent discussion of the geology and hydrogeology of the Molycorp Washington site is based on interpretation of several site investigations completed by various entities since 1991. These investigations include:

- Interim Report - Groundwater Assessment and Recovery System Design by Remcor, Inc., 12/23/1991

- Site Characterization Report for License Termination of the Washington, PA Facility by Foster Wheeler Environmental Corporation, January 1995

- Washington Facility Environmental Report by ICF Kaiser, April 1997

- Overburden Slag Investigation Report by MFG, Inc. February 2002

- Supplemental Characterization monitoring Plan for Groundwater, Surface Water, and Sediment by MFG, Inc., March 2002

Local geologic and hydrogeologic conditions of the site are more pertinent to site characterization than those of the region. Therefore, the following discussion provides only a brief summary of regional geologic conditions to provide a general perspective. A more detailed discussion of site conditions is provided in Chapter 4 of this report.

2.2.1 Regional Geology and Hydrogeology

2.2.1.1 Site Location and Description

Bedrock structures in this portion of Washington County have been influenced by the Washington anticline; the axial trace of this north plunging structure is located approximately ½ mile to the northwest of the Molycorp site. Further, the axial trace of the south plunging Finney Syncline, which is located approximately 1 mile to the southeast of the subject site, also has influenced the bedrock geology. As a result, the bedrock beneath the site is gently folded with a general trend of north 23-30 degrees east, resulting in a gentle dip to the northwest, towards the Finney Syncline. No major faults have been mapped in the area surrounding the site (ICF Kaiser, 1997).

Bedrock formations in Washington County consist of cyclical sequences of relatively flat lying sandstone, shale, limestone, claystone, and conglomerate which were deposited during the Pennsylvanian and Permian ages. These units contain rich coal seams and numerous gas and oil deposits. Recent alluvium, in and adjacent to streambeds, consists of unconsolidated clays, silts, sands, gravels, and cobbles.

Bedrock immediately beneath the site consists of the Permian age Washington Formation and the underlying Pennsylvanian-Permian age Waynesburg Formation of the Dunkard Group. The Washington Formation, which ranges in thickness from approximately 160 to 234 feet, consists of alternating beds of shale and sandstone with several coal beds and thin-bedded, discontinuous limestone members. Most of the sandstones that comprise this formation are light gray, medium-grained, and cross-bedded while the limestone units generally are gray and finely crystalline. The limestone units may also be argillaceous with interbedded gray shale.

The Pennsylvanian-Permian age Waynesburg Formation, ranging in thickness from approximately 100 to 245 feet, stratigraphically underlies the Washington Formation and is comprised of cyclical sequences of sandstone, shale, limestone, and siltstone with some claystone and coal. Although the Waynesburg Formation is lithologically similar to the rest of the Dunkard Group, it tends to be somewhat sandier, has few, if any, redbeds, and its coal beds are thicker and more persistent. The limestone typically is gray, argillaceous, and interbedded with claystone, while the sandstone units generally are light gray, very fine to medium grained, and crossbedded. The shale unit typically is gray and locally calcareous.

2.2.1.2 Regional Hydrogeology

Groundwater in Washington County occurs both in artesian and water table aquifers, with well yields ranging from less than one to over 350 gallons per minute (gpm).

Where present, alluvium deposits are made up of weathered rock material that has been transported and deposited by the flowing stream water. These deposits are composed of poorly to well sorted clay particles to boulder size rocks that are well rounded by the action of the flowing water. Well yields in the alluvial deposits depend primarily on the permeability and thickness of the saturated deposits. Few wells are known to be completed in the local alluvial deposits; however, two known wells reportedly produce 200 and 350 gpm and are 28 and 63 feet deep, respectively. A search of the Pennsylvania Groundwater Information System water well database did not reveal any potable water wells that communicate with the allovial deposits in the general vicinity of the site. (Newport, 1973)

Directly under the alluvial deposits at the site is the Washington Formation which typically is a poor water producing unit since soft shale units having particularly low well yields comprise the majority of this formation. As a result of the cyclic nature of bedding in the bedrock units, perched lenses of water above the water table may be present. Regional well yields for this formation range from less than one to 70 gpm, with a median well yield of 2 gpm.

The Waynesburg Formation underlies the Washington Formation and like the Washington Formation, also is generally a poor water producing unit. The few fractures that are present and their small size within the formation is a limiting factor on well yields. The mean reported yield for wells completed in the Waynesburg Formation regionally is 10 gpm.

2.2.2 Site Geology

Site geologic and hydrogeologic conditions as presented here are based on reported data from several site investigations, which in total included drilling and monitoring over 400 soil borings; monitoring well installation, sampling, and hydraulic testing; and groundwater mapping and modeling. Discussion of site geology is divided into two sections: the lowland section which contains Chartiers Creek and the main production areas of the site, and the upland section which consists of the hill area on the southern edge of the subject site. The lowland geology description is based largely on soil borings completed during the Site Characterization Study performed by Foster Wheeler in 1994, while the upland description is based on the 1996 investigation conducted by ICF Kaiser.

2.2.2.1 Topography

The site consists of approximately 73 acres of contiguous land owned by Molycorp, Inc. located in Canton Township, Washington County, Pennsylvania. Most of the site area is relatively flat and located east of and within the floodplain of the northward-flowing Chartiers Creek. It is on these lowlands where most of the former industrial facilities were located and where most of the contamination has been found and investigated.

The southwestern portion of the site contains a steep hillside bounded to the north by Sugar Creek, to the east by Sugar and Chartiers Creek, to the south by an active railroad line and to the west by undeveloped land. Elevations increase in this portion of the site from approximately 1020 feet MSL along Sugar Creek in the north up to 1125 feet MSL at the top of a steep hill to the south.

2.2.2.2 Lowland Section

The geology of the lowland section of the site has been well characterized by more than 400 soil borings drilled to depths ranging from 4.3 to 36 feet below ground surface (ft bgs). The lowland area lies on the alluvial floodplain of Chartiers Creek and is known to contain both natural and anthropogenic materials (fill) with a maximum total thickness of 22 feet. Portions of the lowland area are covered with asphalt and/or concrete from the former manufacturing facilities. The composition, thickness, and extent of each of the units previously identified are summarized below.

Fill Material – The uppermost lowland area unit at the site is fill material composed of a mixture of slag and spent refractory bricks, with mixed natural sand, gravel, silt, and clay. Some of the fill material contains radiological contaminants which have been vitrified to a glass-like form. The fill has been found at all boring locations throughout the manufacturing areas of the site and its thickness ranges from 2 to 12 feet, with an average thickness of 7 feet.

Clay Unit - Beneath the fill is a clay-rich alluvium unit that is poorly sorted with silt, sand, and gravel. The thickness of this unit ranges from 0 to 16 feet and may serve as an aquitard, slowing downward migration of groundwater throughout much of the site. However, the clay unit does have variable concentrations of silt, sand, and gravel and was found not to be continuous beneath the entire lowland portion of the site.

Sand and Gravel Unit – Beneath the clayey alluvium lies a more course-grained alluvium referred to as the sand and gravel unit. This layer is described as containing the same natural constituents as the clayey alluvium but with greater percentages of sand and gravel and less clay and silt than that of the overlying clay unit.

Bedrock – Bedrock encountered in the lowland section of the site has been identified as claystone of the Pennsylvanian-Permian age Waynesburg Formation. Claystone composition and texture is similar to that of shale but lacks the fine lamination or fissility typical of shale. The bedrock surface was encountered in most of the soil borings completed in this area of the site. As a result, the depth to bedrock (ranging from 15 to 22 ft bgs) is well documented; however, the composition and degree of fracturing of the bedrock is not well known since only two monitoring wells were completed into the bedrock in the lowland section of the site. Boring logs for Monitoring Well BR-1 describe the bedrock sequence as claystone from 17 to 18.5 ft bgs, interbedded shale and sandstone from 18.5 to 24 ft bgs, coal from 24 to 26 ft bgs, and sandstone and shale to the bottom of the boring at 35 ft bgs. The rock quality designation of the cores retrieved from Monitoring Well BR-1 was 13, indicating a high percentage of fractures within the local bedrock.

2.2.2.3 Upland Section

Only limited investigation has been completed in the upland section of the site, with the investigation concentrating on the hill area located to the southwest of the former manufacturing area. This investigation, described in ICF Kaiser's April 1997 report entitled Washington Facility Environmental Report, consisted of installation of five monitoring wells and mapping of rock outcrops. Only a limited amount of alluvial deposits, maximum thickness of 14 feet, were identified above bedrock in this portion of the subject site.

Based on boring logs contained in the ICF Kaiser report, it appears that the near surface stratigraphic sequence in the upland section consists of slightly to highly weathered iron-stained mudstones and carbonaceous shale. The carbonaceous shale coal that was identified between a depth of 16.2 to 24.3 ft bgs in test boring TB-01 may be the Washington Coal. The strata beneath this coal layer consists primarily of cross-bedded, laminated fine to medium grained sandstone which in turn is underlain by the Little Washington Coal. Beneath the Little Washington Coal is a sequence dominated by unweathered to slightly weathered shale and shaely limestone containing the occasional sandstone lens. Beneath this sequence is the Waynesburg "A" Coal and a sequence consisting of hard, gray, unfractured limestone and shale.

2.2.3 Site Hydrogeology

Discussion of the hydrogeology at the site has been divided into two sections consistent with the previous geological discussion. The lowland section is the area of the site adjacent to Chartiers Creek and contains the main production areas of the former plant site, while the upland section consists of the southwest hill on the southern edge of the site. As with the geological description, the lowland hydrogeology description is based largely on results and interpretations reported in the 1995 Foster Wheeler Site Characterization Study. Information regarding the upland hydrogeology is based on results and interpretations contained in the 1997 ICF Kaiser Environmental Report.

2.2.3.1 Lowland Hydrogeology

The unsaturated zone has been determined generally to be less than four feet thick in the lowland section of the site and primarily consists of fill material. However, in some portions of the lowland area, the water table does fall below the base of the fill material and the upper portion of the underlying clayey alluvium is unsaturated. As previously mentioned, the clayey alluvium layer generally may serve as a confining layer; but there are numerous places where there is an interconnection between the water table and the deeper sand and gravel layer.

Potentiometric maps that have been prepared indicate that the horizontal hydraulic gradient is towards Chartiers Creek, with an average gradient of 0.03 feet per foot (ft/ft). Because of the presence of the clay alluvium layer separating the fill material and the sand and gravel unit, a three-foot difference has been noted in nested monitoring wells that monitor each zone. Using the average thickness of the clay alluvial layer, 10 feet, the vertical downward hydraulic gradient has been calculated to be approximately 0.3 ft/ft.

Hydraulic testing, in the form of two constant-rate pumping tests and seventeen slug tests were performed to ascertain additional information regarding the hydraulic characteristics in the lowland area of the site. Pumping test results indicate that the transmissivities of the fill material range from 118 square feet per day (ft^2/day) to 196 ft^2/day with a storage coefficient ranging from 0.062 to 0.064. Based on this information and the measured saturated thickness of the fill material (5 to 10 feet), a hydraulic conductivity ranging from approximately 13 to 27 feet per day (ft/day) was calculated.

2.2.3.2 Upland Hydrogeology

All of the monitoring wells that were installed in this portion of the site were completed in bedrock. No perched water zones were observed in the limited thickness of alluvium that was encountered during drilling. Packard tests, segregating only a portion of the monitoring well to conduct a hydraulic test, were performed on the various bedrock units encountered in the monitoring wells. Based on the results of these packard tests, it was determined that the hydraulic conductivity in the upland bedrock units ranges from impermeable (<3.5 x 10^{-8} ft/day) for units that were either not fractured or only showed minor evidence of fracturing to 3.7 ft/day for fractured horizons.

Supplemental Investigation Activities

SECTION 3

Malcolm Pirnie mobilized to the site on September 15, 2003 to initiate supplemental characterization activities at the site. Various site characterization activities continued through mid-January, 2004.

A 100% coverage walkover survey for detection of gross gamma radiation was performed in Areas 1, 2 and 3; for a 10-meter buffer zone on the outside of the site fence; along the access road east of Area 3; and along the slag portion of the access road to the South Tar Pond. In addition, gamma walkover survey measurements were made in slag disposal areas south of Area 3 and west of Area 5 across Chartiers Creek; at selected other locations in Area 5; along the hillside in Area 4; in Area 10A east of Area 3; and in Area 8. More than 108,000 gamma measurements were made.

Malcolm Pirnie supervised installation of seven test pits and 235 soil borings, 22 of which were completed as groundwater monitoring wells. Soil samples were collected and the lithology described for 233 of the soil borings which were completed utilizing split spoon sampling techniques. Two of the soil borings had to be completed utilizing a hand auger because they were inaccessible to the drill rigs utilized during the investigation. A backhoe was used to complete the test pits to an average depth of eight feet below ground surface (bgs). In addition, 16 sediment and surface water sampling locations were established in Chartiers Creek and Sugar Run. Subsequent to completion of all soil boring and monitoring well installation activities, groundwater samples were collected from newly installed and existing wells and analyzed for chemical and radiological constituents. Figure 5, Sampling Locations, shows the locations of all borings, monitoring wells, test pits, and soil and sediment sampling points included in this investigation.

One sampling location MPSB-126, located in Area 8, is not shown on Figure 5 because of its remote location. Boring MPSB 124 was not completed because of proximity to a waterline. MPSB-181 was planned for the center of the South Tar Pond but was not completed because the location could not be safely accessed. All boring and well locations were surveyed using state plane (State Plane 1983, PA South) coordinates.

The following sections provide a detailed description of the investigations completed by Malcolm Pirnie.

3.1. Walkover Gamma Survey

Near surface gamma radiation levels were measured using a 2 x 2 inch NaI detector linked to a Trimble ProXRS Global Positioning System (GPS). Radiation detection measurements were collected continuously and data recorded approximately every 4 to 5 seconds. The Trimble Pro XRS was integrated with a Ludlum 2221 ratemeter with a 44-10 detector.

Prior to initiating the gamma survey, an on-site benchmark was located and the GPS instrument was calibrated to this local site control point. A GPS accuracy check was performed at this on-site monument at the start and end of each day. This positional information collected at the monument benchmark was used to make error corrections while post-processing the GPS data.

To perform the survey, the GPS rover and data collector were connected to the detector/ratemeter to log gamma readings. The data collector was set up to log the following for each data point:

- Gamma reading
- Date and time of reading
- Real-time differentially corrected GPS coordinates

- Surface description

- Instrument identification number

Gamma data were logged at a frequency of one reading every two seconds. The travel rate was at approximately 0.5 meters per second. Each reading was recorded automatically.

At the end of each day, data were downloaded to the GPS software on a laptop computer and overlaid with the site base map to assess coverage. This practice ensured that all areas were covered and that anomalies were adequately defined. After the survey was complete, data were exported to the project data management system.

3.2. Soil Sampling Activities

Soil sampling was conducted to gain an understanding of the lateral and vertical extent of contamination at the site and to provide specific quantitative analysis of the nature of contamination. Malcolm Pirnie utilized the services of Terra Testing, Inc. (Terra Testing) of Washington, PA to conduct both split spoon sampling and test pit installation. Prior to mobilizing to the site, all local utilities were identified through the Pennsylvania One-Call system.

Split Spoon and Hand Auger Sampling

A total of 235 soil borings were advanced through unconsolidated material using either split spoon sampling techniques in conjunction with hollow-stem auger (HAS) drilling techniques or hand augering techniques. Terra Testing provided a Central Mine Equipment (CME) Model 85 truck mounted drill rig, a CME Model 45C-300 rubber track-mounted drill rig, and a CME Model 850 rubber wide track-mounted drill rig to complete the split spoon sampling activities at the site. Split spoon sampling consists of advancing a sample barrel measuring 2-inches in diameter by 24-inches in length into the subsurface to extract a core sample from the soil. After collecting the 2-foot sample, the drill rig augered to the top of the next sampling interval and then the sample barrel was advanced to extract another 24-inch core. This procedure was repeated continuously from either ground surface or one-foot below ground surface to the target depth. For purposes of this investigation, the target depth for each boring corresponded to the top of the first bedrock unit. Split spoon sampling barrels were thoroughly decontaminated between each sample interval using a solution of Alconox and water. Additionally, the augers were decontaminated using a high-pressure steam washer prior to being used on a different boring location.

Because of their location, two soil borings (MPSB-196 and MPSB-197) had to be completed with a hand auger. Both of these soil borings were installed to delineate the extent of tar impacts to the west of Chartiers Creek.

Soil samples were collected from all of the soil borings which ranged in total depth from 3.0 to 25.7 feet bgs. If auger or split spoon refusal was encountered at an unexpectedly shallow depth, the boring was abandoned and a new boring was offset and advanced a few feet away. Each discrete 2-foot soil sample that was collected was scanned in the field for the presence of organic odors utilizing a RAE Systems MiniRAE 200 photoionization detector (PID) (Appendix B, Field Screening Data). Subsequent to scanning the soil samples for organic vapors, the grain size, color, appearance, odors, and relative moisture content of each soil sample were described and then the soil samples were placed in individual zipper locking storage bags. Subsequently, all of the soil cores collected from an area suspected of being impacted by radiological contamination were scanned using a 2-inch by 2-inch NaI scintillation detector, Ludlum Model 44-10, linked to a Ludlum Model 2221 scaler to develop a gamma radiation profile of each boring. Results of the radiological scanning also are presented in Appendix B. Copies of the boring logs generated from data gathered during soil boring activities are contained in Appendix C, Boring Logs. Residual soils generated from soil boring activities were placed in a poly-lined roll off box.

Results of the field screens for gamma radiation and organic vapor content allowed for qualitative determination of areas of potential contamination within each sample interval. These observations were utilized to guide selection of soil boring locations to be sampled for analysis, as well as which sample interval. Soil samples selected for radiological analysis were submitted to Paragon Analytics, Inc. (Paragon) of Fort Collins, Colorado while the soil samples selected for chemical (i.e., organic and inorganic) analysis were submitted to Pace Analytical Services, Inc. (Pace) of Export, Pennsylvania. Specific sample locations, intervals, and analytical program are detailed in Appendix D, Analytical Program Summary, Tables D-1, D-2 and D-3 for all of the soil samples. All samples were transported to the respective laboratories following all appropriate chain of custody protocols.

Surface Sediment Sampling

Surficial sediment samples were collected from sixteen locations along Chartiers Creek and Sugar Run. The sediment sampling locations were selected based on conditions observed during a walkover along Chartiers Creek and Sugar Run and were located as close as possible to historical sampling locations. To obtain data on sediment conditions that have not been impacted by site activities, three upstream background-sampling locations were selected along Chartiers Creek. Each sample was collected, using a dedicated disposable hand trowel, at the sediment and surface water interface and under similar flow conditions. Once collected, each sample was stored in an ice-filled cooler, if appropriate, and transported to Pace and/or Paragon under standard chain of custody protocols.

Test Pit Sampling

Seven test pits were completed in the area of the Old Foundation (Area 7A) to investigate the lateral and vertical extent of tar impacts to this portion of the site. Six of the test pits were located outside of the former foundation area while the seventh test pit was located within the foundation. Each test pit located outside of the former foundation was completed to a depth of eight feet with a backhoe. Because of the presence of concrete walls and pillars, the test pit dug within the foundation was only completed to an approximate depth of 5 feet bgs. As each bucket of soil was removed from the test pit, it was examined to determine if any tar impacts could be observed. Material excavated from the test pits was scanned for radiological contamination periodically with a 2-inch by 2-inch NaI detector during the excavation process. Following the completion of perimeter test pits, soil samples were collected from the surface (0-2 feet bgs) and the bottom of the test pit (8 feet bgs). Each collected soil sample was placed in laboratory provided bottleware and stored in an ice-filled cooler until they were delivered to Pace under standard chain of custody protocol.

Monitoring Well Installation

Following the completion of soil sampling activities at soil borings MW-41 through MW-55 and BR-3 through BR-8, 2-inch inside diameter (ID) Schedule 40 polyvinyl chloride (PVC) monitoring wells were installed. The locations of the monitoring wells were selected based on site topography, historical analytical data, to identify potential off-site sources of contamination, and to determine the lateral and vertical extent of contamination. In part, Monitoring Wells BR-3, MW-41 and MW-42 were located to assist in efforts to identify the source of high pH water impacting Outfall 002.

Each monitoring well was constructed using 2-inch ID Schedule 40 PVC flush joint, threaded couple-screen and riser pipe. Screened sections consisting of 10 feet (except BR-4 which consisted of 20 feet) of factory slotted 0.010-inch PVC were attached to an appropriate length of riser pipe and lowered to the bottom of the boring through the 4 ¼-inch ID hollow stem auger (HAS). An attempt was made to ensure that the screened section of each monitoring well overlapped the water table to enable any non-aqueous phase liquids floating on the water to enter the monitoring well. A coarse-grained silica sand filter pack was gradually installed between the inner wall of the augers and the well screen as the augers were being slowly removed from the boring. This process continued until the sand pack extended approximately 1 ½ to 2-feet above the top of the screened section of PVC. Bentonite pellets were placed directly on top of the sand pack to an approximate thickness of 2 feet and were hydrated to seal off any potential surface water infiltration. The remainder of the annular space was filled with a bentonite-cement slurry. After capping the PVC riser with an expandable locking cap, a steel protective casing was installed within the bentonite-cement slurry and secured in place by a concrete pad. Copies of boring logs generated from data gathered during well installation activities are contained in Appendix C, Section C-2.

Following installation of the new groundwater monitoring wells, all of the monitoring wells onsite, with the exception of monitoring wells MW-1 through MW-4 (which routinely were sampled for other purposes and did not require development), were developed using either dedicated, disposable polyethylene bailers and nylon rope or a Tempest III submersible pump that was decontaminated between use at each monitoring well. Prior to well development, well volumes for each monitoring well were calculated to assist in the determination of how much groundwater needed to be removed during well development. Groundwater quality indicator parameters (i.e., pH, specific conductance, temperature, dissolved oxygen (DO), oxidation-reduction potential (ORP), and turbidity) were monitored at regular intervals to ensure the wells had been sufficiently developed. Once the indicator parameters stabilized to within 10 percent of the previous three readings, well development was terminated.

3.3. Groundwater Sampling and Analysis

All of the on-site monitoring wells, both existing and newly installed, were included in the sampling/analysis program. Some of the existing wells were renamed to provide a consistent nomenclature for this effort. Cross references to old and new designations are provided in Table 4.

Prior to initiating groundwater-sampling activities, the depth to water was measured at each monitoring well using an electric water level meter calibrated to within 0.02-foot. Groundwater elevation data are presented in Appendix E, Groundwater Elevation Measurement, and a potentiometric map based on groundwater measurements collected on December 03, 2003 is given in Figure 6. Once all groundwater level data were recorded, Malcolm Pirnie personnel purged and sampled each of the new and existing monitoring wells utilizing low stress (low flow) purging and sampling procedures. The purpose of low stress purging and sampling is to collect groundwater samples that are representative of groundwater conditions in the sampled aquifer. This sampling technique has three primary benefits: 1) it minimizes disturbance of any sediments which may have accumulated on the bottom of the well; 2) it minimizes aeration of the groundwater during sample collection thus minimizing the potential for VOC loss; and 3) it significantly reduces the volume of groundwater purged from a monitoring well. With the exception of Monitoring Well TB-01-1, all monitoring wells were purged and sampled utilizing a Geopump or Solinst peristaltic pump with dedicated tubing. A YSI flow thru cell and a Lamotte turbidity meter were used to monitor groundwater field parameters (i.e., pH, specific conductivity, temperature, DO, ORP, and turbidity). Because of its depth, Monitoring Well TB-01-1 was sampled with a decontaminated Tempest III submersible pump along with the flow thru cell and turbidity meter.

Each monitoring well was purged at a rate ranging from 250 to 500 milliliters per minute. Purging continued until the field parameters stabilized for three consecutive readings in accordance with the guidelines specified in the USEPA *Ground Water Sampling Procedure Low Stress (Low Flow) Purging and Sampling* document. Subsequent to purging each monitoring well, groundwater samples were collected and placed into laboratory provided bottleware containing the appropriate preservative, if any, for the required analysis. Each sample was stored in an ice-packed cooler, if appropriate, prior to transfer to Pace or Paragon following appropriate chain of custody protocols. A summary of the analytical program for groundwater samples is provided in Appendix D, Tables D4 – D6.

3.4. In-Situ Aquifer Characterization Testing

Subsequent to completion of groundwater sampling activities, single-well aquifer characterization tests (i.e., slug tests) were performed on all of the site monitoring wells with the exception of the TB-01 well series. Rising and falling head slug tests were performed on the monitoring wells to determine hydraulic conductivity values for the water bearing horizons at various locations across the site. A pressure transducer/data logger was installed in each monitoring well for use during the slug test as a means to accurately collect instantaneous changes in water levels. A decontaminated PVC slug, constructed of a 4-foot length of 1-inch ID schedule 40 PVC riser piper, with end caps secured by stainless steel screws and filled with an inert silica sand, was lowered into the water column at the same time that the data logger program was started. The data logger recorded changes in water level as it equilibrated back to static conditions (falling head test). Once the water level reached static or near static conditions, the data logger program file was saved and a second data collection program was initiated in conjunction with the rapid removal of the slug. The subsequent rise in water level back to static conditions over time (rising head test) was recorded and utilized to calculate the in-place hydraulic conditions of the water-bearing zone. Since the uppermost water-bearing zone is an unconfined aquifer, the rising head tests were necessary to obtain a true representation of the saturated aquifer conditions.

The data gathered during the slug tests were used in concert with data published in the 1995 Foster Wheeler Site Characterization Report to provide hydraulic conductivity information on the tested aquifers. Further, horizontal gradients were calculated utilizing water level elevations measured at all site wells prior to groundwater sampling activities.

3. 5. Surface Water Sampling and Analysis

Sixteen surface water samples were collected, 12 from Chartiers Creek, including 3 background sampling locations and 4 from Sugar Run. Each sampling location is depicted on Figure 5. To ensure that representative samples were collected, each sampling location was selected along a straight reach of the creek having a fairly regular cross-section. To promote thorough mixing of streamflow components, care was taken to ensure that the sampling locations were downstream of riffles. Additionally, samples were collected upgradient from the point of entry in an attempt to minimize the collection of disturbed sediments.

Surface water samples were collected by submerging a closed unpreserved sample bottle, with the mouth of the bottle pointing downstream, and then slowly removing the lid. The bottle was allowed to fill completely prior to replacing the lid under water. For those bottles that contained preservative, water was slowly transferred from a filled unpreserved bottle, ensuring that no headspace was present in any of the bottles for VOC analysis. Each surface water sample was stored in an ice-packed (if required) cooler prior to transfer to Pace or Paragon following appropriate chain of custody protocols.

3.6 Preliminary Ecological Characterization

As part of this site characterization investigation, a preliminary ecological characterization was completed. Activities in this process included: identifying species or habitats of concern, conducting a site visit, describing the environmental setting, and completing a benthic macroinvertebrate survey of Chartiers Creek and Sugar Run to determine the presence of possible ecological receptors at the site. The following agencies and sources of information were consulted: (1) the Pennsylvania Natural Diversity Index (PNDI) search to identify known records of species and habitats of special concern on and near the site; (2) the U.S. Fish and Wildlife Service (USFWS), the Pennsylvania Fish and Boat Commission (PAFBC), and the Pennsylvania Game Commission (PAGC) to identify known occurrences of species and habitats of concern in the site vicinity; (3) a list of species of special concern for Washington County obtained from Pennsylvania Department of Conservation and Natural Resources (PADCNR), and (4) the state-wide list of species of concern included in the Technical Guidance Manual for Act 2 (PADEP 2002). The PNDI, PAFBC, PAGC, and USFWS database searches did not identify any state listed or federally listed rare, candidate, endangered or threatened species in the project area.

A site walkover survey was conducted by the project biologist to characterize the environmental setting. A wetland delineation was not performed as part of this site characterization. However, general observations of potential wetland habitat were noted. Wetlands designated on the National Wetlands Inventory Map together with the 100-years flood plain are shown on Figure 7.

A benthic macroinvertebrate community survey also was performed. Four sampling stations were selected in Chartiers Creek and two in Sugar Run. The Chartiers Creek stations included one upstream or reference station and three downstream stations located within Molycorp's property boundary. The Sugar Run stations consisted of one reference station and a second downstream station located within Molycorp's property boundary. *In situ* measurements of temperature, conductivity, pH, turbidity, and dissolved oxygen were made for each sampling station in conjunction with the benthic macroinvertebrate sampling. All measurements were made using a Horiba Water Quality Checker Model U-10. The physical habitat descriptors/features observed and recorded during the field assessment included:

(1) visual appearance of water and sediment quality

(2) water depths at each station

(3) stream channel width

(4) estimated stream velocity

(5) substrate composition

(6) degree of canopy cover over the sample area

(7) description of vegetation

Benthic macroinvertebrate samples were collected, identified and analyzed according to methods prescribed in the U.S. Environmental Protection Agency's Rapid Bioassessment Protocols for Use in Streams and Rivers (USEPA 1999), Biological Technical Guidance for Streams and Small Rivers (USEPA 1996), and Macroinvertebrate Field and Laboratory Methods for Evaluating the Biological Integrity of Surface Waters (USEPA 1990a).

A standard kick net (13 inches wide x 20 inches deep) with nylon net (600 x 600 ˙m mesh size) was used to collect the qualitative benthic macroinvertebrate samples. Four kick samples were collected from each sample station. Prior to sampling each station for benthic macroinvertebrates, the stream was inspected to identify the best available instream habitat. Care was taken not to disturb sample areas while inspecting these streams.

For each qualitative sample collected, four kick net samples were randomly collected within a riffle habitat. The kick net was placed into the stream with the flat part of the net resting on the bottom and perpendicular to the stream flow. Samples were collected by disturbing (i.e. kicking) a one-square meter area of stream bottom directly in front of the net, such that the current carried organisms into the net. Coarse substrate, including boulder, cobble, and gravel, was disturbed by kicking in front of the net to dislodge any clinging organisms. The substrate was thoroughly disturbed to a depth of four inches, if possible, to dislodge any bottom-dwelling organisms.

The proportion of boulder, cobble, gravel, sand, and silt substrate, as well as percent Coarse Particulate Organic Matter (CPOM; i.e., leaves) present at each kick net sample location was estimated and recorded.

Immediately after collecting a kick net sample, the net was carefully inverted and the contents emptied into a Number 30 sieve. The net was examined for clinging organisms, which were washed into the sieve. Materials retained on the sieve were washed into a 500-mL wide-mouth sample collection bottle and preserved with 95% ethanol. The station number, stream name, station location and date were marked on each collection bottle.

Physical Properties

SECTION 4

This chapter addresses the physical properties of the soils and groundwater encountered during the Supplemental Site Characterization. Section 4.1 presents a discussion of the physical properties of the soils, while Section 4.2 provides a description of groundwater properties at the site.

4.1. Soil Properties

Three sampling techniques (split-spoon, hand auger, and test pits) were utilized to collect representative soil samples for chemical and radiological evaluation, as well as to determine the physical properties of the unconsolidated material and bedrock at the site. The vast majority of the samples were collected utilizing split spoon sampling techniques; however, two of the sampling locations were evaluated using hand auguring techniques because a drill rig could not gain access to that portion of the site. Both of these sampling locations were intended primarily to delineate contamination associated with tar seeps located along the western bank of Charteries Creek in Area 7B. Additionally, test pits were completed in Area 7A to delineate the extent of tar in the area of the former foundation. All of the test pits located outside of the former foundation were completed to a depth of eight feet bgs, with descriptions of the soil encountered being recorded. The test pit that was completed within the former foundation could only be completed to a depth of 5 feet bgs because of concrete walls and pillars.

Malcolm Pirnie geoscientists observed all of the soil sampling activities and recorded their observations in bound field notebooks. Observations recorded included a detailed description of the color, grain size, degree of sorting, mineral composition, roundness/angularity, degree of moisture, and evidence of contamination. Three soil layers were encountered during the investigation: overburden, unconsolidated alluvium, and bedrock. A description of each layer is provided below. Figure 8 shows the locations of transects across the site associated with the cross-sections of the soils and bedrock encountered during this investigation which are provided on Figures 9 through 11.

During their 1994 Site Characterization, Foster Wheeler described three primary lithological groupings above the bedrock. The identified lithologies consisted of a layer of fill material with an average thickness of 7 feet and a clayey layer that was not continuous across the site and, where continuous, appeared to act as a confining layer. A layer consisting of gravel, silt, clay, sand, and weathered bedrock was located between the clayey layer and bedrock. Since the Foster Wheeler investigation centered only on Areas 1, 2, and 3, only unconsolidated materials that had been repeatedly disturbed by the industrial activities in these areas were encountered. As such, naturally deposited soils were seldomly encountered, if ever, during their investigation. However, despite the fact that Malcolm Pirnie has investigated a much larger area, the soils described during the Foster Wheeler investigation are generally similar to the soils encountered during this supplemental site characterization. One major difference between the soil identified in Malcolm Pirnie and Foster Wheeler site characterizations is the clay layer identified by Foster Wheeler. Foster Wheeler personnel identified a clay layer, which they considered to act as a confining layer between the fill material and the sand and gravel unit located directly above bedrock. During the recent site characterization work, Malcolm Pirnie geoscientists considered the clayey silt and silty clay intervals located directly beneath the fill material to be part of a gradational sequence ending in a sandy gravel lithology directly above bedrock. Further, based on the grain size and the physical properties observed in the field, it did not appear that the fine grained sequence directly beneath the fill material would act as a confining layer and therefore should not be considered separately from the rest of the alluvial sequence.

4.1.1. Overburden Layer

The overburden layer consists of naturally developed brown to black silty and clayey soils with organic matter in areas of the site not developed or disturbed by past industrial activities. Typically the soils ranged in thickness from several inches to several feet.

For areas of the site disturbed by industrial activities (i.e., Areas 1, 2, and to a lesser extent Area 3), this soil layer may be absent or much thinner than in other areas of the site. These areas of the site typically possess an overburden layer containing a variety of fill materials intermixed with slag, red-dog, refractory brick, sulfur, and various forms of glass. Especially in Areas 1 and 2, debris from the recent demolition of the buildings that previously occupied the site commonly is found intermixed within the overburden layer. The fill material primarily consists of very dense to loose black to reddish-brown moist sands, silts, and clays in varying amounts.

Only limited direct evidence of contamination (i.e., free product or organic odors) was observed in any of the overburden soil samples; however, several did exhibit elevated PID readings. The only place that contamination was observed consistently was in parts of Areas 5 and 7A where MGP tar has migrated to ground surface or begun to discharge/seep out of the banks of Chartiers Creek. Typical thickness of the fill material ranged from 2 to 12 feet bgs with only a minor amount of fill material, if any, being located beneath the water table. A topographic map showing ground surface elevation contours is given on Figure 12.

Soil samples were collected from the overburden layer and analyzed for chemical parameters, radiological parameters, or both. The exact analytical program run for the samples was determined by the sample location and by observations made during sample collection. Field screening and core scanning also were utilized to identify which soil sampling intervals within the overburden layer to submit for laboratory analysis.

4.1.2. Unconsolidated Alluvium

Located directly beneath the overburden is a layer consisting of a mixture of sands, silts, clays, and some gravels. This layer appears to have been deposited by running water, most likely by Chartiers Creek in the past. Typically this layer consists of a downward coarsening in the alluvium, with the majority of the clay and silt deposits being locating closer to the overburden layer, while the sands and gravels were primarily located on top of the bedrock layer. The overburden water table is located in the unconsolidated alluvium layers with groundwater being encountered between 3 and 18 feet bgs. As such, the moisture content in this layer increases with depth. The unconsolidated alluvium layer ranges in thickness from several feet to approximately 20 feet.

As with the overburden layer, selected soil samples were submitted for chemical and/or radiological analysis. Sample selection again was based on field screening measurements, core scanning and observations made during sample collection. However, unlike the overburden layer, evidence of contamination in the form of free product, petroleum hydrocarbon sheens, and elevated PID measurements were observed in the unconsolidated alluvium layer in some areas of the site. In particular, elevated PID measurements were recorded in Area 1A at Soil Boring MPSB-15A, while free product, a strong petroleum odor, or a petroleum sheen were observed in samples collected from Area 3 in Soil Borings MPSB-99, MPSB-100, MPSB-101, and MPSB-104.

For soil borings completed in areas of the site that were being investigated relative to MGP tar concerns, tar or evidence of tar commonly was identified. Some borings, such as Soil Borings MPSB-148, MPSB-149, and MPSB-149A, contained several feet of tar or tar intermixed with unconsolidated alluvium. Other borings contained a blackish-gray soft clayey material that possessed a strong tar and/or petroleum odor.

Figure 13 illustrates the areas of the site in which the unconsolidated alluvium contained direct evidence of contamination. As can be seen in this figure, contamination primarily was observed in the soil borings that were completed in Areas 5 and 7 which correspond to MGP tar that has been observed at the site.

4.1.3. Bedrock Layer

Bedrock primarily consists of very dense, highly plastic and fissile weathered gray shale. The depth to bedrock varies over the site, depending on the proximity to Chartiers Creek and the local topography; however, depth to bedrock ranges from 4.33 to 25.66 feet bgs. Figure 14 displays the top of bedrock for the site as interpreted from split spoon refusal during this investigation. Bedrock type also is identified in this figure. Typically, the upper foot or so of bedrock was highly weathered and in some instances appeared to be a very tight gray clay. Underlying the shale is a laminated fine-grained sandstone layer, which is underlain by a thin coal seam, and alternating layers of gray limestone, siltstone, and shale.

4.1.4. Groundwater Properties

Groundwater in the overburden wells was observed to occur at an elevation ranging from 1038.03 to 1012.16 feet AMSL on December 3, 2003, immediately prior to beginning groundwater sampling activities (Figure 6). Groundwater in the Bedrock Wells BR-1 through BR-8 was observed to range from 1037.81 to 1010.77 feet AMSL. In both cases the horizontal groundwater flow direction primarily is toward Chartiers Creek with an approximate hydraulic gradient ranging from 0.022 to 0.048 in the overburden wells. In addition, based on the groundwater elevation data, it appears that there is an upward vertical gradient in the bedrock monitoring wells located adjacent to Chartiers Creek, indicating that Chartiers Creek acts as a hydrological divide of the overburden and uppermost bedrock aquifers. As a result, groundwater in the vicinity of the site will discharge to Chartiers Creek.

Single well hydraulic conductivity test data collected from rising and falling head tests conducted in all of the monitoring wells (except TB-01) provides a range of aquifer hydraulic conductivity values to represent site-specific conditions. Data for each test was inputted into a Microsoft Excel spreadsheet and hydraulic conductivity values were calculated using the Bouwer-Rice method. The only factor which could potentially interfere with the Bouwer-Rice method relates to the fact that the exact thickness of the bedrock aquifer is unknown. The approximation of bedrock aquifer thickness introduces some error to the calculated hydraulic conductivity values. To gain a representative hydraulic conductivity for both the overburden and bedrock aquifers, the Bouwer-Rice results were statistically analyzed to provide a minimum, maximum, median, and geometric mean. The statistical results are provided in Table 5, while Appendix F contains all of the calculations for the determination of hydraulic conductivity using the Bouwer-Rice method.

Values for overburden hydraulic conductivity ranged from 1.28×10^{-7} centimeters per second (cm/sec) to 3.87×10^{-5} cm/sec while bedrock hydraulic conductivity ranged from

1.59 x 10^{-6} cm/sec and 1.12 x 10^{-5} cm/sec. Median and geometric mean values for the overburden wells were calculated as 3.79 x 10^{-6} cm/sec and 8.10 x 10^{-6} cm/sec, respectively. These values differ from the typical range (10^{-5} to 10^{-3}cm/sec) encountered in this type of alluvium (Fetter, 2001). Furthermore, these values also are slightly lower than the values reported in the 1994 Foster Wheeler Site Characterization Report. Foster Wheeler conducted 20 slug tests and calculated hydraulic conductivities that ranged from 1.25 feet per day (feet/day) (4.41 x 10^{-5} cm/sec) to 0.57 feet/day (2.01 x 10^{-5} cm/sec). One reason for the difference between the calculated hydraulic conductivities is that Malcolm Pirnie tested a larger number of wells, some of which were completed in areas which did not contain any fill material. Another cause for the difference in the calculated hydraulic conductivity values is that all of the new monitoring wells installed as part of this supplemental site characterization are fully penetrating wells. In other words, all of the wells monitor the full thickness of the overburden aquifer, while some of the monitoring wells that Foster Wheeler tested only partially penetrated the aquifer.

Supplemental Characterization Results

SECTION 5

This chapter presents results of field investigation activities conducted by Malcolm Pirnie at the Molycorp Washington Facility. Section 5.1 provides a discussion of the radiological investigations carried out in various areas of the site. Characterization results for soils in each of the individual areas of the site are presented in Section 5.2, while groundwater conditions are described in Section 5.3. Results of the sediment and surface water sampling are detailed in Section 5.4, soil leaching studies are presented in Section 5.5 and an ecological characterization of Chartiers Creek and Sugar Run is discussed in Section 5.6.

5.1 Radiological Investigations

Radiological concerns, primarily thorium, have been the main focus of previous investigations. The present investigation was designed to improve the quantitative understanding of concentrations and distribution of radionuclides and chemical contaminants. This subsection addresses radiological aspects that encompass multiple areas of the site.

Natural background in site soils for U-238, Ra-226 and Th-232 was determined from analysis of thirteen subsurface samples by high-resolution gamma spectrometry. Soil samples were obtained from a background location in Area 9 (sample was obtained from excavation for a sewer line for the Malcolm Pirnie field office trailer and was used as a phantom core in establishing daily background for all core scanning activities—BKG-9), and from twelve other subsurface locations as listed in Table 6. Results of analyses for each sample location at the depth interval indicated are given in Table 6. Natural background for site soils was determined to be 1.59 pCi/g U-238, 1.65 pCi/g Ra-226, and 1.50 pCi/g Th-232.

High-resolution gamma spectroscopy was the primary analytical technique utilized to quantify U-238/234, Th-232/228 and Ra-226. As a quality control check, results of isotopic alpha spectroscopy for Th-232 and U-238 for 23 soil samples were compared with corresponding gamma spectroscopy determinations as shown on Figures 15 and 16. Agreement between the two techniques was evaluated using a t-Test for two paired samples. The results of the t-Test indicated that the means of the gamma spectroscopy based distributions were not statistically different from the means of the alpha spectroscopy based distributions at the 95% confidence level.

Although thorium was known to be distributed in a heterogeneous fashion throughout Areas 1, 2 and 3, little information existed on the magnitude and distribution of uranium chain components. As discussed in subsequent sections of this report, this investigation has established that uranium chain constituents are present in significant quantities in some areas of the site. These uranium chain components are distributed in a non-uniform fashion—sometimes commingled with thorium and sometimes not.

One of the issues investigated in the supplemental characterization related to the secular equilibrium status of uranium chain and thorium chain components. This issue was addressed by performing isotopic uranium and isotopic thorium analyses on 23 soil samples collected from various depth intervals at locations in Areas 1, 2, and 3. Results of these analyses are presented in Appendix G Soil Radiological Data, Table G-1, and on Figures 17 and 18. These results clearly show that Th-232 and Th-228 are in secular equilibrium, and that U-238, U-234, and Th-230 are in secular equilibrium.

The relationship between U-238 and Ra-226 was investigated by comparing concentrations of the two isotopes as determined by high-resolution gamma spectroscopy in more than 200 soil samples obtained from various locations and depths across the site. All soil samples were sealed in airtight containers with a 21-day ingrowth period before counting. Results show disequilibria between U-238 and Ra-226 as illustrated on Figure 19.

5.1.1 Walkover Gamma Survey

A 100% gamma walkover survey using a 2-inch by 2-inch sodium iodide detector was performed in Areas 1, 2 & 3 and for a 10 meter perimeter along the fence line outside of these areas, terrain permitting. During the course of the investigation, the complete coverage survey was extended to investigate a non-radioactive slag disposal area south of Area 3 and another non-radioactive slag disposal site in Area 5 E. Survey measurements also were made in portions of the glass/refractory brick bank site in Area 4 that could be accessed by the surveyor and along the slag portions of the access road to the South Tar Pond. In addition, Area 10A, the access road to the tunnel under I-70 and randomly selected locations in Area 5 were surveyed. A walkover survey also was performed in the vicinity of the former house trailer in Area 8. More than 108,000 data points were collected in the walkover survey.

Background was determined from measurements primarily collected at one location to be 2,740 counts per minute (cpm). However, background for naturally occurring nuclides may vary greatly across an industrial site such as the Molycorp Washington facility. The Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM) points out that variations in background of a factor of 5 or greater can occur in the space of a few hectares. Results reported as net values include a "gray region" greater than 0 and less than approximately 5,000 net cpm where the reported activity may be due in whole or in part to variations in background count rate.

The minimum detectable concentration (MDC) was calculated for the detector system used (calibrated to Cs-137) and the primary radionuclides of concern using the methodology detailed in NUREG-1575, MARSSIM. The results for increasing background count rates are presented in Table 7. The detector can easily detect the radionuclides of concern at background rates measured.

In order to evaluate the level above the background value of 2,740 cpm that indicates an activity concentration of concern, the net cpm values were converted to pCi/g for Ra-226, Th-232 and natural uranium. Results are presented in Table 8. The natural uranium results can be disregarded since they are calculated based only on U-238, U-235 and U-

234 and not the contributions of the remaining members of the uranium decay chain (including Ra-226). The MDC and activity concentrations calculated for Ra-226 will be limiting for the uranium contamination on site.

Table 8 reveals that at a level of between 2,500 and 5,000 net cpm, activity concentrations of Th-232 and Ra-226 exceed 5 pCi/g. This conservatively assumes that the true background count rate is 2,740 cpm. Considering that variations of background by a factor of 5 times are not unusual, a level of 5,000 net cpm is in the middle of the gray region between background variability and significant contamination above background. A more reasonable assessment of significant activity concentration would assume a background rate approaching 5,000 cpm (less than 2 times the conservative estimate of 2,740) as a starting point and push the level of significant activity concentration of 5 pCi/g to approximately the level represented by 7,500 net cpm in the survey maps.

Results of the gamma walkover survey are presented on Figures 20, 21, and 22 for various areas across the site. Net cpm readings have been kriged to provide a continuous representation of surface radiation levels. Colors and shading have been utilized to portray the intensity of the detected radiation. A black x on the figure denotes a point where a gamma reading was less than or equal to background (2,740 cpm).

As can be seen from Figure 20, large portions of Area 1A exhibit surface radiation levels less than or equal to the conservative background estimate. Most of the remainder of Area 1A is characterized by slightly elevated cpm readings with several "hot spots" interspersed. As discussed above, net readings below 5,000 cpm are considered insignificant and not indicative of contaminated areas. Hot spots (>5,000 cpm) observed in Area 1A are not indicative of subsurface contamination and probably represent surface contamination stemming from building demolition activities conducted in 2002. Generally, the walkover survey results substantiate historical information that most of Area 1A, since it predated Molycorp's presence and remained relatively intact throughout Molycorp's operations, is unaffected.

Area 1B exhibits some "clean" regions but exhibits more widespread elevated surface readings with hot spot regions coinciding with former building footprints. Area 2 is similar to Area 1B with higher surface readings in building footprints and in fill areas in the western portion of the site.

Slightly elevated surface readings are evident throughout Area 3 with hot spot regions in the western portion of the area along Chartiers Creek, in the vicinity of the former slag pile, and in the central-eastern and northeast portions of this area. Elevated surface readings also are evident in the western section of Area 10A which abuts the northeastern portion of Area 3. This was the site of a temporary railroad spur that was used to offload raw materials into Area 3 during reconstruction activities in the main plant in the 1979-1981 time period.

Surface readings along the access road east of Area 3 that leads to the tunnel under I-70 were less than or equal to background.

Slightly elevated surface readings recorded in the slag disposal area south of Area 3 and in the area of the former North Tar Pond are for the most part below levels of significance, with a small number of interspersed hot spots. Similarly, Area 5E north of the confluence of Sugar Run and Chartiers Creek exhibited slightly elevated surface readings with a few interspersed hot spots. Glass and refractory brick were observed in this area in the vicinity of the Tylerdale Connecting Railroad right-of-way.

A walkover of the slag portion of the South Tar Pond access road which passes through Area 5E and bisects Area 5B showed surface levels to be less than or equal to background.

The glass/refractory brick area along the hillside in Area 4 also exhibited slightly elevated surface readings.

Walkover survey measurements in the portion of Area 8 that formerly served as the site of a house trailer also were slightly elevated but are below levels of significance. These readings may have been associated with what appeared to be imported aggregate.

5.1.2 Core Scanning

More than 1,675 2-foot core segments from borings in Areas 1, 2, 3, 5, 8, 9, 10A, 10B, Caldwell Avenue, and the tunnel access road were scanned for radioactivity with a Ludlum Model 44-10 2-inch-by-2-inch NaI scintillation detector coupled to a Ludlum Model 2221 scaler. At each location, each split spoon segment from the surface to the bottom of the boring was scanned.

Background was determined each day by performing five consecutive one-minute fixed counts on a phantom core segment of background soil obtained from Area 9 (BKG-9). Core segments then were counted using the same geometry as the phantom soil sample and background was subtracted to obtain a net reading in counts per minute.

Core scanning data for each boring location then were reviewed to select a segment or segments to submit to the laboratory for radiological analysis.

All of the net core scan data for portions of the site east of Chartiers Creek were kriged for each 2-foot depth interval to obtain a qualitative profile of radiological contamination with depth as shown in Figures 23-32. All of the boring locations used in the kriging are shown on the figures. It should be noted that the background correction of the core scanning data probably underestimated overall site background since it was based on a soil sample from a single location. Background soil samples obtained from other locations (see Table 6) exhibited net core scan counts that ranged from 0-659 cpm and averaged 190 cpm higher than the BKG-9 core scan. Therefore, the 0-500 cpm range plotted in Figures 23-32 is most likely in the background range.

5.1.3 Core Sample Radiological Analyses

Two hundred and four core segments were analyzed by high-resolution gamma spectroscopy to quantify Th-232/228, U-238/234, and Ra-226. In addition, a subset of 24 core segments also was analyzed for isotopic thorium and isotopic uranium by alpha spectroscopy. Analytical determinations were made for borings in Areas 1, 2, 3, 8, 9, 10A, 10B, Caldwell Avenue and the access road to the tunnel.

Concentration data for Th-232, U-238 and Ra-226 have been superimposed over the core scanning krig information for each depth interval where data exist. Th-232 data are shown on Figures 33-40, U-238 data on Figures 41-48, and Ra-226 data on Figures 49-56. Generally, the core scan data are good indicators of the location and magnitude of the radiological constituents in the subsurface but cannot be used alone to distinguish among the various radioisotopes.

To gain additional insight into the distribution of radionuclear species, the analysis depicted on Figure 57 was performed. This figure depicts locations where either Th-232 or U-238 predominate (one is present at greater than twice the concentration of the other and both are not less than 1 pCi/g above background). This presentation is informative in that it indicates that U is the primary radiological constituent in Area 1 while Th predominates in Areas 2, 3 and 10A, although the two components are intermingled at a number of locations. Ra-226 always coexists with U-238 although not in equilibrium. These observations are consistent with what is known of the operational history of the facility: uranium, probably associated with ferrotungsten production, is the primary contaminant in the older region of the plant and thorium, associated with ferrocolumbium production in the 1960s, predominates in Areas 2 and 3.

5.2 Soil/Slag Investigations

Soil samples were collected for chemical and radiological analysis based on their spatial location at the site and observations made during sample collection. Samples were collected primarily using split spoon sampling techniques. Hand auguring was used in two instances. In the case of the seven test pits, samples were obtained from soil piles excavated by a backhoe. Each sample was collected and preserved in accordance with the specific analytical method to be utilized to characterize the sample. Specific procedures followed during sample collection are discussed in Section 3.1 of this report. It is noted that the chemical laboratory consistently reported acetone detections in soil samples. Laboratory contamination is the suspected cause of these detections.

5.2.1 Area 1A

Area 1 was divided into an eastern portion (Area 1A) and western portion (Area 1B) because of different historical activities. The original manufacturing buildings were located in the eastern area and remained intact until approximately 1979 at which time, they were demolished and new structures were constructed atop the same locations. These original buildings predate Molycorp (and predecessors) and existed throughout the time period when radioactive slags were produced at the facility. It is believed that little or no radioactive fill was placed in this area of the process plant. Therefore, it is unlikely that extensive subsurface radioactive contamination exists in this portion of the plant. However, to confirm this hypothesis and to determine if industrial activities resulted in chemical contamination of Area 1A, 20 soil borings and 4 monitoring wells were completed in this portion of the site.

Continuous 2-foot sample intervals were collected from all of the soil borings and monitoring wells and each soil interval was scanned in the field for organic vapors and for gamma radiation. Screening results were utilized to identify which soil samples should be submitted for chemical and/or radiological laboratory analysis.

5.2.1.1 Radiological Findings

As discussed previously and as illustrated on Figure 20, the gamma walkover survey revealed this eastern plant area to be free of surface contamination with the exception of a few locations primarily in the northwestern portion of the area.

Core scan data as well as laboratory analytical information illustrated on Figures 23-56 demonstrate that the Area 1A subsurface is largely unaffected by radiological contamination except for one sub area in the west central portion where significant uranium contamination extends from about 2 to 10-feet bgs. The core scan data indicate slightly elevated readings (500-1,000 cpm) in the 0-2 ft. interval in the northern section of Area 1A due primarily to scans of borings MPSB-14, 16, 19 and MW-45. Analyses of samples from this interval in MPSB-16 show levels of Th-232, U-234 and Ra-226 near background. MPSB-14 and MPSB-19 were not analyzed in the 0-2 ft. interval but MPSB–19 exhibited near background levels of Th-232, U-238, and Ra-226 at a deeper interval with a higher net core scan reading. MBSP-14, analyzed at depth, appears to be influenced by the uranium anomaly in the west central portion of this area. MW-45 in the 1-3 foot interval exhibited slightly elevated U-238 and Ra-226 levels. These findings, except for the uranium anomaly, are consistent with historical information on this region of the plant.

5.2.1.2 Non-Radiological Findings

Soil samples submitted for chemical analysis from this portion of the site were analyzed for Volatile Organic Compounds (VOCs) utilizing USEPA Method 8260B, Semi-Volatile Organic Compounds (SVOCs) by USEPA Method 8270C, PCBs by USEPA Method 8082, Act 2 Metals plus molybdenum (Mo) and tungsten (W) by USEPA Method 6010B and 7471 (mercury only), and lanthanum (La) and cerium (Ce) by USEPA Method 6020. Not all of the submitted soil samples were analyzed for all of these parameters as shown in Table D-2. Analytical results for the soil samples collected from the soil borings and monitoring wells are contained in Appendix H, Tables H-1 and H-2.

No VOCs were detected in soil samples collected from Area 1A above residential Statewide Health Standards (SHS). Only acetone was identified in all of the soil samples analyzed for VOCs. Based on the low concentrations reported and the fact that acetone is a common laboratory contaminant, its identification is not believed to be an indicator of subsurface conditions in Area 1A. Several other VOCs (benzene, 2-butanone, carbon disulfide, ethylbenzene, toluene, 1,1,2-trichloroethane, m&p-xylene, and o-xylene) were detected either at estimated concentrations below or slightly above their respective laboratory detection limits. Given the very low levels and sporadic detections, is difficult to draw conclusions regarding these observations. However, it is interesting to note that benzene, ethylbenzene, toluene, and xylenes were identified in soil samples collected from monitoring wells MW-43 (26-27 feet bgs) and MW-44 (17-17.1 feet bgs). Monitoring Well MW-43 is located near the eastern property boundary of Area 1A and thus would be hydraulically upgradient of areas that would have been impacted by past manufacturing activities at the site. Furthermore, as with Monitoring Well MW-44, this sample was collected from the bottom of the boring. If the compounds identified in these two borings had been a result of past site activity one would expect to see the compounds present in the other samples submitted from these sampling locations.

A number of SVOCs were detected above laboratory reporting limits in one or more of the soil samples submitted for analysis. In addition, bis(2-ethylhexyl)phthalate, carbazole, and dibenz(a,h)anthracene were identified at estimated concentrations below their respective laboratory limits in some of the analyzed soil samples. However, none of these compounds were detected at concentrations which exceeded residential SHS as shown in Appendix H, Tables H-1 and H-2.

PCB analysis was performed on samples collected from five of the sampling locations located in Area 1A. No PCBs were detected above laboratory detection limits in any of the samples collected from this portion of the site.

Analyses for Act 2 metals plus Mo and W were performed on the majority of the samples submitted to the laboratory. All of the metals were detected above laboratory reporting limits in at least one of the submitted samples. The detection of the metals is expected since metals also were detected in samples collected from three background off-site locations (MPSB-126, MW-49 and MW-41). Only the metals arsenic, iron, manganese, selenium, and thallium were observed to sporadically exceed residential SHS as shown in Appendix H. No pattern could be detected in the occurrence of the above listed SHS exceedences and may in part be the result of natural background conditions.

In addition to the standard Act 2 metals analysis, Malcolm Pirnie analyzed three soil samples for La and Ce because these metals were utilized on site at one time. Both metals were detected slightly above their laboratory reporting limits.

5.2.2 Area 1B

Historical information and previous site characterization work does not support the absence of contamination in the western portion of Area 1. To investigate the vertical and lateral extent of both radiological and chemical contamination in this area of the site, a systematic pattern of borings was completed. A total of 26 soil borings and 2 monitoring wells were completed in this area, with special attention being given to the former building footprints since no previous investigations had collected samples from those areas. The same field screening procedures that were utilized to identify samples for chemical and radiological analysis as in Area 1A were utilized in Area 1B. Samples from all boring locations were submitted for radiological analyses while samples from 12 sampling locations were submitted for various chemical analyses.

5.2.2.1 Radiological Findings

Results of the gamma walkover survey illustrated on Figure 20 show some areas to be free of surface contamination but large portions of Area 1B exhibit readings in the 5,000 cpm range or higher with hot spots associated with former building areas.

Core scan data (Figures 23-32) indicate that radiological contamination may extend from the surface down to a depth of 10 feet in some places. The highest levels of subsurface radiological contamination exist in the southern portion of the area in the footprint of a former building (Building 1).

Analytical data from core samples show that U-238/234 is more predominant in this area than Th-232/228 although the two coexist in significant quantities, primarily in the vicinity of former Building 1 (Figure 57). Radiological contamination in the Building 1 vicinity is relatively shallow and disappears below four feet, while to the north of this area elevated levels are encountered at the two foot interval and extend to a depth below eight feet.

5.2.2.2 Non Radiological Findings

Soil samples submitted for chemical analysis from this portion of the site were analyzed for the same parameters using the same methods as described for Area 1A with the addition of hexavalent chromium (Cr^{+6}), titanium (Ti), and magnesium (Mg) analyzed by USEP Methods 6010B and 7196. These latter analyses were requested by PADEP. Not all of the submitted soil samples were analyzed for all of these parameters as shown in

Table D-2. Analytical results for the soil samples collected from the soil borings and monitoring wells completed in area 1B are contained in Appendix H, Tables H-3 and H-4.

Acetone was the only organic compound that was identified in all of the samples submitted for VOC analysis. As previously discussed for Area 1A, the acetone detections reported are believed to not be significant. Several other VOCs were identified either at estimated concentrations below their respective laboratory reporting limits or slightly above the reporting limits. All of the identified VOCs are well below residential SHS.

Several SVOCs were identified at estimated concentrations below their laboratory reporting limits but greater than the method detection limits. These compounds included: benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, dibenz(a,h)anthracene, and indeno(1,2,3-cd)pyrene. All detectionss were below residential SHS. In addition to the VOC and SVOC analyses, four samples were analyzed for PCBs. None of the samples contained a detectable concentration of PCBs.

Act 2 metals plus Mo and W analyses were completed on the majority of soil samples that were submitted to the laboratory. As in Area 1A, some sporadic exceedances of SHS were observed at locations in Area 1B as shown in Tables H-3 and H-4.

At the request of PADEP, additional metal constituents (Cr^{+6}, Ti, and Mg) were analyzed to address possible NPDES permit concerns associated with future remedial activities. These analyses were performed at one location in Area 1B with the results shown in Table 9. La and Ce were added to the analytical program by Molycorp because they had been used on the site at one time. Only Cr^{+6} has a published SHS and the detected concentration of 1.9 mg/kg is well below this standard.

5.2.3 Area 2

This area, west of the original process plant area (Area 1), was a lowland containing ponds of various configurations throughout much of the operating history of the facility. Over the years, this area was filled with various slag byproducts of the manufacturing operations. As the plant expanded westward, buildings were erected on top of the fill in this area. Eight surface impoundments were constructed along the western boundary near Chartiers Creek in 1968. These impoundments were closed in 1995 and backfilled with clean soils.

Based on the overall history of this portion of the site and results of previous investigations, Malcolm Pirnie installed 42 soil borings and one monitoring well to assess the condition of the subsurface and to delineate contamination that may be present. Screening techniques, consisting of scanning the split spoon samples with a PID and NaI detector, were employed to guide selection of samples for chemical and radiological analysis.

5.2.3.1 Radiological Findings

Results of the gamma walkover survey, Figure 20, show areas of surface contamination in the eastern portion of this area in and around the footprints of former buildings. To the west of these areas, are some relatively clean surfaces (<5,000 cpm) interspersed with some hot spots. The westernmost portion of this area exhibits moderate contamination with some hot spots particularly in the southwestern corner.

Core scanning results show significant pockets of contamination in several regions of the site, some of which are first encountered near the surface, some in the 2-4 feet interval and some extend as deep as 14 feet. Thorium is the predominant contaminant in this region of the plant as illustrated on Figure 57. However, uranium/radium in significant quantities are commingled with thorium in some horizons. All three constituents were measured in the 12-14 feet interval at several locations in this area. Significant contamination is absent below 14 feet.

5.2.3.2 Non-Radiological Findings

Samples from seventeen of the 43 boring locations in Area 2 were submitted for chemical analysis. Analytical protocols for these soil samples are as described for Area 1A. Not all of the submitted soil samples were analyzed for all of these parameters as indicated by

Table D-2. Analytical results for the soil samples collected from the soil borings and monitoring wells are contained in Appendix Tables H-5 and H-6.

No VOC detections above Pennsylvania residential SHS were observed. With the exception of MPSB-41 (7-9'), acetone either was detected above its laboratory reporting limit or identified at an estimated concentration below the laboratory reporting limit in all of the samples submitted for VOC analysis. As discussed for Areas 1A and 1B these acetone detections are not considered to be significant. Several other VOCs (including benzene, 2-butanone, carbon disulfide, ethylbenzene, toluene, and xylenes) were detected/identified at various sampling locations and depths. Not all of these compounds were detected above their respective laboratory reporting limits. SVOCs were only detected above their respective laboratory reporting limits in samples collected from Soil Borings MPSB-41 (7-9'), MPSB-61 (6-8'), MPSB-63 (6-8'), and MPSB-76 (8-10'). In addition, several other SVOCs were identified below their respective laboratory reporting limits. No residential SHS were exceeded for any of the detected/identified SVOCs collected from Area 2.

Five samples were submitted for PCB analysis. None of the sampling locations contained a detectable concentration of PCBs.

Metals analysis on the submitted soil samples indicates that all of the analyzed constituents were detected above laboratory reporting limits in at least one of the sampling locations. Residential SHS were exceeded for a number of inorganic constituents as shown in Appendix H, Table H-5. Results of supplemental analyses for Cr^{+6}, Ti, Mg, La, and Ce are presented in Table 9. Cr^{+6} was not detected above the laboratory detection limit.

5.2.4 Area 3

Area 3 is located to the south of Caldwell Avenue. This area was the site of a former pile containing thoriated slag. The pile was located in the western part of the area adjacent to Chartiers Creek. To the east of the former pile location, is the site of a former pond that received ball milled slag in the form of a slurry. Farther east, in the central portion of the site is the location of former Building 39 that was utilized to store spare parts. A now abandoned gas well also was located in this part of the site. In order to investigate potential sources of contamination, 29 soil borings and 2 monitoring wells were completed in Area 3. Soil samples collected from these 31 sampling locations were screened in the field to determine which specific sample locations and depth intervals should be submitted for laboratory analysis.

5.2.4.1 Radiological Findings

As shown on Figure 20, the gamma walkover survey revealed hot spot surface readings in the western region of this area along the fence line above Chartiers Creek and in the east-central portion of the area. Much of the central region exhibited borderline detections in the <5,000 net cpm range.

Core scan data indicate pockets of contamination throughout the northern and central portions of this area. Thorium contamination predominates in Area 3 but uranium and radium are interspersed at some locations. Radiological contamination is dispersed in irregular patterns both laterally and vertically. Impacts extend to 14 feet in some spots but are absent in the 14-16 feet interval.

5.2.4.2 Non-Radiological Findings

Soil samples from 15 of the 31 sampling locations were submitted for chemical analyses of VOCs, SVOCs, and Act 2 Metals plus Mo and W. Not all of the submitted soil samples were analyzed for all of these parameters as indicated by Appendix D, Table D-2. Analytical results for the soil samples collected from the soil borings and monitoring wells are contained in Appendix H, Tables H-7 and H-8.

No VOC detections above residential SHS were observed. Acetone was the only VOC that was detected either above or below its respective laboratory reporting limit. As discussed for other areas of the site, these detections are not believed to be significant. Several other VOCs, most notably benzene, ethylbenzene, toluene, m&p-xylene, and o-xylene, were detected in several of the samples. In particular these compounds were detected in the samples collected from Soil Borings MPSB-101 (10-12 ft bgs), MPSB-106 (12-14 and 20-22 ft bgs), MPSB-108 (18-20 ft bgs), and MPSB-122 (6-8 ft bgs). These locations correspond to areas in which potential hydrocarbon contamination, in the form of an oily sheen on the samples and strong petroleum odors was noted during sample collection. Additionally, these locations are located in the vicinity of the former natural gas well. Several SVOCs were detected slightly above their respective laboratory reporting limits or were identified at an estimated concentration below the laboratory reporting limit. All of the detected/identified compounds were detected at concentrations well below residential SHS. Act 2 metals plus Mo and W analysis were completed on the majority of soil samples that were submitted to the laboratory. Several of the inorganic constituents (arsenic, boron, iron, and lead) exceeded residential SHS at sporadic locations as highlighted in Table H-7.

5.2.5 Area 4

Area 4 consists of the former Tylerdale Connecting Railroad right-of-way. The tracks previously used in the area have been removed and natural vegetation has begun to reclaim the land. Refractory brick and glass produced by the Hazel-Atlas Glass Manufacturing (Hazel-Atlas) Plant has been identified along the slopes of the right-of-way. A previous survey performed in this area indicated that some of the refractory glass and brick contained gamma emitters. It is believed that the glass was colored with a yellowish/greenish uranium-containing ore, resulting in the glass being slightly radioactive. The debris pile is believed to be naturally occurring radioactive material (NORM).

Malcolm Pirnie included this area in the gamma walkover survey. Because of the terrain, it was impossible to achieve 100% coverage of the area. However, the path the surveyor walked is evident from inspection of Figure 21. Surface readings ranged from less than background to less than 5,000 cpm, generally below levels of concern.

To investigate the subsurface environment from a chemical aspect, one soil boring was completed to refusal with soil samples being collected continuously from the ground surface to the bottom of the boring.

Two soil samples, MPSB-189 (2-4') and MPSB-189 (12-14'), were submitted to the laboratory for chemical analysis of VOCs, SVOCs, PCBS, and Act 2 Metals plus Mo and W. These sample intervals were selected for analysis based on field screening and their respective location within the boring.

Several VOCs were detected in the samples analyzed, with the majority of the detections being in the 12-14 feet bgs sample. Once again, acetone was identified in both of the samples from this location. All of the VOC detections are well below SHS for residential areas.

Some SVOCs were detected in both of the soil samples that were submitted for laboratory analysis with the majority of the detections being either slightly above or below the laboratory reporting limits. No exceedances of residential SHS were observed.

PCB analyses were performed on both of the samples. No PCBs were detected above laboratory reporting limits.

Act 2 metals plus Mo and W analyses were completed on both soil samples, with only arsenic exceeding its residential SHS as noted Table H-9.

5.2.6 Field Interpretation of Soil Samples from Areas 5 and 7

Soil samples collected from all soil borings from Areas 5 and 7 were characterized in the field based on whether or not there was evidence of impacts based on sight or smell, particularly the presence of tar. The observations, plotted for the intervals 0-2 feet, 2-10 feet and greater than 10 feet on Figures 58, 59 and 60, were used to guide placement of borings as the field investigation proceeded and to select soil samples to be submitted for chemical analysis.

As indicated on Figures 58, 59 and 60, the areas where field evidence was most significant are as follows:

- In Area 5A, the South Tar Pond, there was field evidence of impacts to greater than 10 feet.

- In Area 5B, the area North of the South Tar Pond, there was field evidence of impacts to the west of the South Tar Pond and to the northeast of the South Tar Pond. The field evidence indicated no impacts in the vast majority of this area.

- In Area 5C, the Area East of the North Tar Pond, there was field evidence of impacts to depth all along I-70

- In Area 5D, the North Tar Pond Area, there was field evidence of impacts at a few locations to a depth of about 10 feet.

- In Area 5E, the Area west of Chartiers Creek (also the eastern part of Area 4), the field evidence indicates that tar is migrating and discharging into Chartiers Creek and potentially Sugar Run.

- In Area 7B, the field evidence indicates tar was present both at the surface and at depth near Chartiers Creek.

5.2.7 Area 5A

This area of the site consists of the South Tar Pond and the earthen berm that was constructed to contain the tar. Four borings were advanced within the tar pond and two in the berm to investigate the thickness of the MGP tar and how the presence of the tar may have impacted the subsurface environment. Continuous split spoon samples were collected from ground surface to the bottom of the boring.

Generally, the tar pond was characterized by pockets of tar on the surface of a clay layer approximately 2 to 3 feet thick. A layer of tar 4 to 6 feet thick was encountered underneath the clay layer. The tar layer was underlain by a variable thickness layer of soil saturated with tar then a layer of tar impacted soil and finally, unimpacted soil.

Two samples from each sampling location were submitted for chemical analysis. Samples for laboratory analysis were selected by observing the soil samples from each boring and choosing the interval that displayed the most visibly impacted saturated soil and the interval that was approximately six inches below the last visible evidence of tar impacts. Additionally, a composite sample of unsaturated soil was collected to aid in evaluating remedial alternatives for the tar pond.

The berm borings were completed to verify that slag had not been utilized in the construction of the berm. No slag was encountered in berm borings. However, while installing Soil Boring MPSB-188, a strong odor not consistent with other tar area borings was observed in the boring along with a sheen on the inside of the split spoons.

Soil samples collected from the tar pond were analyzed for BTEX compounds by USEPA Method 8260B, PAH compounds by USEPA Method 8270C, Acid Extractable Phenolics by USEPA Method 8270, Total Cyanide by USEPA Method 9012, Weak Acid Dissociable Cyanide by USEPA Method 4500-1, TOC by USEPA Method 9060M, and Act 2 Metals plus Mo and W by USEPA Method 6010B and 7471 (mercury only). The samples from Soil Boring MPSB-188 were analyzed for VOCs by USEPA Method 8260B, SVOCs by USEPA Method 8270C, Total Cyanide by USEPA Method 9012, Weak Acid Dissociable Cyanide by USEPA Method 4500-1, and Act 2 Metals plus Mo and W by USEPA Method 6010B and 7471 (mercury only).

At least one of the BTEX compounds was detected in all of the sampling locations in the tar pond. Only the sample collected from Soil Boring MPSB-177 (10-12 ft bgs) contained less than two of the compounds above laboratory reporting limits. However, it should be noted that because of sample dilution, reporting limits for these samples were elevated and detections may be masked. Of the VOCs, only acetone, benzene, and carbon disulfide were detected in the samples collected from the berm of the tar pond. None of these detections exceed residential SHS.

Nearly all of the PAH compounds were detected in all of the samples. Furthermore, those constituents that were not detected may be present but because of sample dilution and the consequential increase in laboratory reporting limits, those constituents may be masked.

SVOCs were detected only in the sample collected from the 8 - 10 feet bgs sampling interval for the soil boring that was completed on the northern berm of the tar pond. Since there was no visual evidence of tar in the soil boring or along the slope of the berm, the presence of these compounds may represent migration of tar constituents into the surrounding berm.

Act 2 metals plus Mo and W analyses were completed on all of the soil samples that were submitted for analysis. Only arsenic in the samples collected from soil borings MPSB-177, MPSB-178, MPSB-179 and MPSB-188 and the tar composite and boron in soil boring MPSB-178 exceeded the residential SHS as shown in Table H-10.

5.2.8 Area 5B

This portion of the site is located to the north of the South Tar Pond extending to Sugar Run and Chartiers Creek. Evidence of tar has been observed only in the area immediately outside the South Tar pond, particularly to the west of the tar pond. To develop a better understanding of conditions in this area, 23 soil borings and 5 monitoring wells were completed in Area 5B. The majority of these soil borings were installed to delineate the vertical and lateral extent of tar contamination as illustrated on Figure 61. Soil samples collected from 12 of these sampling locations were submitted for analytical determinations.

The lateral extent of tar contamination initially was determined in the field based on observations of the collected soil samples (see Section 5.2.6). Tar and/or a tar odor were observed in Soil Borings MPSB-172 and MPSB-173 and Monitoring Wells BR-7 and MW-55. These soil borings were completed to the west of the South Tar Pond. At one point in time the South Tar Pond extended into this portion of Area 5B; however, during the North Tar Pond remediation, surficial tar contamination was removed from this portion of the old South Tar Pond and placed within the constructed bermed area. No tar impacts were observed in any of the other soil borings and monitoring wells, though high PID readings and a strong organic odor were observed in Soil Boring MPSB-166. These readings and odors were very similar to those observed in Soil Boring MPSB-188, which is located in the berm of the South Tar Pond and directly topographically and hydraulically upgradient from MPSB-166.

To confirm that the lateral extent of contamination had been delineated, six additional soil borings (MPSB-190 through MPSB-195) were completed to refusal and soil samples were collected from the ground surface, the water table or highest PID reading, and the bottom of the boring. Analytical results indicate that tar impacts are restricted to the area to the west of the South Tar Pond. Additionally, the area between MPSB-188 and MPSB-166 shows signs of contamination; however, based on the odor and PID readings relative to all of the other tar contaminated PID readings, the nature of the contamination may differ from other tar impacts. Soil samples collected from Area 5B were analyzed for BTEX compounds, PAH compounds, Acid Extractable Phenolics, Total Cyanide, Weak Acid Dissociable Cyanide, TOC, and Act 2 Metals plus Mo and W. Based on close proximity to Soil Boring MPSB-188 and the presence of strong organic vapor odors noted during boring, samples collected from MPSB-166 and MPSB-195 were analyzed for VOCs and SVOCs rather than BTEX and PAH compounds. Appendix Table D-3 presents a matrix of the soil samples collected from Area 5B and analyses performed on each specific sample. Analytical results for the collected soil samples are presented in Appendix Tables H-11 and H-12.

Several volatile compounds were detected in samples collected from this part of the site. Acetone, benzene, 2-butanone, carbon disulfide, chloroform, ethylbenzene, toluene, and m&p-xylene were identified. However, none of these compounds were present in concentrations which exceeded Statewide Health Standards for residential areas. In fact the majority of the compounds were identified below their respective laboratory reporting limits. Many PAH/SVOCs, were detected in the samples that were collected for analysis from this part of the site. However, only benzo(a)pyrene in these surface soil samples exceeded residential SHS. The detected compounds are those that are commonly associated MGP tar, so that their presence is not unexpected given the close proximity to the South Tar Pond. The highest concentrations of PAHs generally were found in surface soil samples (0-2 feet). Of the metals/inorganic constituents only arsenic, boron, and iron were found sporadically to be present in excess of residential SHS.

5.2.9 Area 5C

Area 5C is located to the east of the service road and to the west of I-70. Evidence of tar impacts had been observed both in the unsaturated and saturated zones by SRW. During a preliminary site walkover, Malcolm Pirnie personnel noted the presence of tar discharging from a low point in this area. To characterize the nature and extent of MGP tar impacts in this area, one soil boring (MPSB-148) was advanced to refusal within a portion of Area 5C in which tar impacts previously were noted. Following completion of this soil boring, additional soil borings (MPSB-149, MPSB-149A, and MPSB-149B) were installed to the north of the first boring until no visible evidence of tar impacts were observed (MPSB-149B).

Soil samples collected from Soil Boring MPSB-148 were analyzed for BTEX compounds, PAH compounds, Acid Extractable Phenolics, Total Cyanide, Weak Acid Dissociable Cyanide, TOC, and Act 2 Metals plus Mo and W. No samples from the MPSB-149 soil borings were analyzed since the purpose of these borings was to delineate the lateral extent of tar contamination.

BTEX and PAH compounds characteristic of MGP tar were detected in all three soil samples that were collected from Soil Boring MPSB-148. Detection of these compounds was expected since this area was known to be impacted by tar and evidence of tar was observed in several of the soil samples collected during installation of this boring. The only metals exceedance of residential SHS was arsenic in the surface soil samples.

Results of analyses performed on samples from boring MPSB-148 are given in Appendix Table H-13.

5.2.10 Area 5D

This sub-area of Area 5, located to the west of the service road and east of Chartiers Creek encompasses the former North Tar Pond, which was remediated in 1985. However, several tar seeps continue to exist in this area of the site, as well as along the bank of Chartiers Creek. A portion of this area was used for non-radioactive slag disposal in the late 1970s.

A gamma walkover survey was performed in this area as illustrated in Figure 21. Most of the area surveyed exhibits surface readings well below levels of significance. A few areas with readings in excess of 5,000 cpm are interspersed.

Core scanning with a 2-inch by 2-inch NaI detector was performed on all borings completed in this area. No evidence of elevated subsurface activity was evident.

Twenty soil borings and three monitoring wells were completed in this area to investigate the lateral and vertical extent of tar-impacted soils. Eight of the soil borings were shallow (depth of two feet) because their purpose was to assess if upwelling of tar had occurred thereby impacting the fill material that was placed in this area following the 1985 remediation. Samples were submitted for laboratory analysis from 16 of the soil sampling locations. Soil samples collected from Area 5D were analyzed for BTEX compounds, PAH compounds, Acid Extractable Phenolics, Total Cyanide, Weak Acid Dissociable Cyanide, TOC, and Act 2 Metals plus Mo and W. Table D-3 presents a matrix of the soil samples collected from Area 5D and the associated analyses. Analytical results for the collected soil samples are provided in Appendix Tables H-14 and H-15.

All of the BTEX compounds were identified in at least some of the soil samples submitted for analysis, even the shallow samples (i.e., 0-2 feet bgs) that were collected in areas that previously had been remediated. None of the identified concentrations exceeded residential SHS. Additionally, numerous PAH compounds were detected above their laboratory reporting limits in the samples collected from Area 5D. As with the BTEX compounds, the PAH compounds primarily were detected in the surficial samples. In general, the samples with the highest PAH concentrations occur in the top 2-4 feet in this area.

Act 2 metals plus Mo and W analysis were completed on the majority of soil samples submitted to the laboratory. Sporadic detections of arsenic, boron, and selenium in excess of their respective residential SHS were reported in soil samples collected from Area 5D.

5.2.11 Area 5E

Area 5E is located between Chartiers Creek and Sugar Run with a northern boundary corresponding to the southern boundary of Area 7B. For the purpose of this discussion, the eastern portion of Area 4, the former Tylerdale Railroad right-of-way, is included in this evaluation. There was no historical evidence of tar impacts in this portion of the site. A portion of the area was utilized for non-radioactive slag disposal in the early 1980s.

An extensive gamma walkover survey was performed in this area as illustrated on Figure 21. Surface readings generally were at or below background. Pockets of less than 5,000 cpm readings interspersed with some small areas of elevated surface activity also were observed in this region. The elevated readings may be associated with refractory brick and glass which was observed in Area 5E.

Core scanning was performed on borings completed in this area. No evidence of elevated subsurface activity was detected.

In order to investigate the possibility of tar impacts in Area 5E, four soil borings were completed to refusal. Soil samples were continuously collected from these four soil sampling locations and field screened for evidence of tar impacts. Based on results of the field screening and observations of tar seeps in the vicinity of Soil Boring MPSB-151, samples from three of the soil sampling locations were submitted for laboratory analysis. Soil samples were analyzed for BTEX compounds, PAH compounds, Acid Extractable Phenolics , Total Cyanide, Weak Acid Dissociable Cyanide, TOC, and Act 2 Metals plus Mo and W.

Total xylenes in MPSB-151was the only BTEX detection in any of the soil samples from Area 5E and this detection was at a concentration well below residential SHS.

Several PAH compounds were detected above laboratory reporting limits in this area of the site. However, only one soil sample (MPSB-153 6-8 feet bgs) evidenced high concentrations of PAH compounds. A hydrocarbon sheen and a strong hydrocarbon odor were observed at this interval during sampling. None of the PAHs exceeded residential SHS in any of the samples collected from this area.

Arsenic and iron sporadically exceeded residential SHS in soil samples collected from this area.

Analytical results for soils samples from this area are provided in Appendix H, Table H-16.

5.2.12 Area 7A

Area 7A is located on the southern portion of the Hill Area, to the southwest of the former main processing areas (Areas 1 and 2). This area contains a plateau on which a former building foundation exists. The foundation is filled with tar believed to have originated from a MGP located on or near the plateau. To the west of the old foundation is a low-lying wetland.

To investigate the lateral and vertical extent of tar impacts in this area, five soil borings and seven test pits were completed. All but one of the test pits were completed in areas that were believed to be located outside of the foundation walls while the soil borings were completed within the low-lying wetland area. One of the test pits was completed within the foundation. Samples from this location were not analyzed.

Soil samples were collected from the ground surface and bottom of the soil borings and test pits to examine the impact of the tar. Soil samples were analyzed for BTEX compounds, PAH compounds, Acid Extractable Phenolics, Total Cyanide, Weak Acid Dissociable Cyanide, TOC, and Act 2 Metals plus Mo and W.

BTEX and PAH compounds were detected in the soil boring samples collected from the low-lying portion of Area 7A. Typically the BTEX compounds were detected at the highest concentrations at the ground surface; however, none of the detected concentrations exceeded residential SHS. The highest PAH concentrations were measured in the samples collected from the bottom of the borings. None of the PAHs detected in samples from soil borings exceeded SHS.

BTEX and PAH compounds also were detected in the soil samples collected from the six test pits that were completed in the vicinity of the former foundation. With the exception of the ground surface sample collected from Test Pit TP-5, all of the concentrations of the contaminants were relatively low. However, the PAH concentrations from TP-5 were considerably higher than all of the other PAH concentrations in the other test pit samples. This is the only sample where PAHs exceeded SHS. None of the BTEX concentrations exceeded SHS.

Arsenic and iron were detected above residential SHS in some of the soil samples. Analytical results for soil boring and test pit samples are presented in Appendix Table H-17.

5.2.13 Area 7B

Area 7B is the portion of the site which is located to the north of Areas 4 and 5E and extends to the Molycorp property boundary. This part of the site formerly was an active farm, and as such there was no historical evidence of industrial activity taking place in Area 7B. However, during the initial stream walk of Chartiers Creek, tar was observed along the western bank of Chartiers Creek (eastern boundary of Area 7B). To investigate the origin of this tar, two soil borings were completed in Area 7B. Both soil borings were completed using a hand auger because the area was inaccessible by any of the drill rigs that were used during the site characterization. Each soil boring was completed to refusal and soil samples were collected and logged continuously from the ground surface to the bottom of each boring.

Soil samples were selected for laboratory analysis based on visual observations during sampling and based on vertical location (i.e., at ground surface and the bottom of the boring). Three samples from each boring were submitted for analysis of VOCs, SVOCs, Total Cyanide, Weak Acid Dissociable Cyanide, and Act 2 Metals plus Mo and W. Soil boring MPSB-196 was installed adjacent to an area in which tar appeared to be seeping into Chartiers Creek, while Soil Boring MPSB-197 was installed in an area that was expected to be free to tar impacts. Several VOCs (acetone, benzene, 2-butanione, carbon disulfide, ethylbenzene, methylene chloride, styrene, toluene, m&p-xylene, and o-xylene) were detected in the samples collected from MPSB-196, while only acetone, 2-butanone, and carbon disulfide were detected in the sample collected from MPSB-197. Of the detected VOCs, only benzene was detected above residential SHS for the sample collected from MPSB-196 (29 – 36 inches bgs). In addition, several SVOCs typically associated with MGP tar also were detected in soil samples collected from both sampling locations. It should be noted that the concentrations of SVOCs were much higher in the samples collected from MPSB-196 than those collected in MPSB-197. Based on these results tar has been identified seeping into Chartiers Creek from Area 7B and the northern extent of the contamination has been identified.

Act 2 metals plus Mo and W analysis were completed on all of soil samples that were submitted to the laboratory. With the exception of cadmium and thallium, all of the constituents that comprise the Act 2 metals list were detected above the respective laboratory-reporting limit in at least one of the submitted soil samples, with only arsenic and iron exceeding residential SHS.

5.2.14 Area 8

Area 8, located in the northwest section of the site, is bounded to the east by Chartiers Creek, to the south by Caldwell Avenue, and to the west by residential homes. This section of the site is open land (primarily forested with some grassy areas) except for Weirich Avenue which runs north to south and bisects the area. The only structure that is known to have occupied Area 8 was a trailer home with a septic system.

A walkover survey conducted in the vicinity of the former trailer site revealed surface readings which ranged from background to 5,000 cpm as shown on Figure 22. Slightly elevated readings are believed to be associated with aggregate that appears to have been placed as a driveway.

To investigate the subsurface in this area, a soil boring (MPSB-126) was advanced to refusal and continuous soil samples were collected. Additionally, in an attempt to assess if Chartiers Creek acts as a hydrologic barrier and to assess the conditions of bedrock to the west of Chartiers Creek, a bedrock monitoring well (BR-4) was installed in the vicinity of Monitoring Well UG-3.

Core scans performed on all sample intervals from MPSB-126 and BR-4 indicated no significant elevated levels of radioactivity in the subsurface. Analytical data indicated levels of Th and U in subsurface soils from these locations to be at background levels.

Soil samples collected from MPSB-126 and BR-4 also were submitted for analysis of VOCs, SVOCs, and Act 2 Metals plus Mo and W.

With the exception of acetone, no VOCs or SVOCs were detected in any of the soil samples collected from Soil Boring MPSB-126. Acetone was identified in all three of the soil samples collected from this location; however, not at levels of significance.

Soil samples collected from Monitoring Well BR-4 were reported to contain several VOCs, including acetone. All of the VOCs that were detected are well below residential SHS. As with Soil Boring MPSB-126, no SVOCs were detected above laboratory reporting limits for the soil samples collected from Monitoring Well BR-4.

Only arsenic was detected at a concentration in excess of residential SHS in the sample collected from BR-4 (10 – 11 feet bgs). Since this area is hydrologically upgradient from the site and there is no evidence of industrial activities having taken place in Area 8, the detection could represent background conditions.

5.2.15 Area 9

This part of the site is located to the east of Area 1 and Green Street and consists of open land (primary grassy areas and scrub/shrub with a few trees) and two office trailers. All historical evidence indicates that Area 9 has been a residential area since at least the early

1900's. The two office trailers that are currently in this area are connected to water, sewer, and electric utilities.

Two monitoring wells, MW-41 and BR-3 (one overburden and one bedrock), were installed in Area 9 to gather background data and to investigate conditions which might relate to a high pH spring that has been reported in Area 1. Soil samples were collected continuously from ground surface until split spoon and auger refusal. At this point the overburden well was completed while the bedrock well was drilled to its target depth utilizing air rotary drilling techniques. Cuttings produced during installation of the bedrock well were observed and logged.

Core scanning was performed on samples from both MW-41 and BR-3 and samples from both wells were analyzed by high-resolution gamma spectroscopy. Levels of Th-232/228, U-238 and Ra-226 were at background.

Soil samples collected from Monitoring Well MW-41 (overburden well) were field screened and the interval containing the highest organic vapor concentration, the soil and water table interface, and the bottom of the boring were submitted to the laboratory for analysis of VOCs, SVOCs, and Act 2 Metals plus Mo and W. Not all of the submitted soil samples were analyzed for all of these parameters as indicated by Table D-2. Analytical results for the soil samples collected from the soil borings and monitoring wells are contained in Table H-21.

With the exception of the identification of acetone, benzene, and 2-butanone at concentrations below the laboratory reporting limit, no VOCs were detected in the soil samples collected from Monitoring Well MW-41. As with all of the other identifications of acetone, it is believed that the acetone identified in these samples is not representative of subsurface conditions. The concentrations of benzene and 2-butanone that were reported, 3.6 and 1.7 micrograms per kilogram, respectively, are well below residential SHS. No SVOCs were detected in the sample collected from Monitoring Well MW-41. Arsenic was detected in excess of residential SHS.

5.2.16 Area 10A

Area 10A is located to the east of Area 3 and to the west of the B&O Railroad. No available records indicate that slag or process material was produced or stored in this area; however, during the 1994 Foster Wheeler site characterization, thorium was reported to be present in the vicinity of the Area 3 fence at concentrations in excess of 10 pCi/g. Consequently, a gamma walkover was performed, and five soil borings and one monitoring well were installed in Area 10A to further investigate its radiological status. All borings were completed to split spoon and auger refusal. Each of the collected soil samples was scanned with a NaI detector and PID to determine which samples should be submitted for laboratory analysis. Subsequently, the walkover survey was extended to include the area east of the access road and the entire length of the access road. In addition, three borings were completed in the access road.

5.2.16.1 Radiological Findings

Results of the walkover survey are presented in Figure 20. Surface radiation levels were high immediately adjacent to the northeastern portion of Area 3 and dropped to background levels immediately to the east. The access road itself and the area east of the access road were at or below background surface readings.

Three borings east of the Area 3 boundary evidenced significant contamination both in core scans and laboratory data. Thorium was determined to predominate but radium and uranium also were present. This contamination was contained in the 0-4 feet layer and disappeared completely below 4 feet. The two borings and monitoring well MW-49 located farther to the east were completely free of radiological contamination. Borings completed in the access road also were free of radiological contamination.

5.2.16.2 Non-Radiological Findings

Only soil samples collected from Monitoring Well MW-49 were submitted for chemical analysis for VOCs, SVOCs and Act 2 Metals plus Mo and W. Not all of the submitted soil samples were analyzed for all of these parameters as indicated by Table D-2.

Analytical results for the soil samples collected from the soil borings and monitoring wells are contained in Table H-22.

Several VOCs (acetone, 2-butanone, carbon disulfide, and m&p-xylene) were identified in the soil samples collected from Monitoring Well MW-49. Only acetone was identified above its laboratory-reporting limit in one of the submitted samples, while all of the other compounds were identified at estimated concentrations below their respective laboratory limits. All of the compounds were identified well below residential SHS. No SVOCs were detected in the sample submitted for analysis. With the exception of thallium, all of the metals analyzed for were identified in the sample collected from Monitoring Well MW-49. However, since no slag was observed in the soil samples collected from this location, the detected concentrations likely represent background conditions of this area.

5.2.17 Area 10B

This sub-area of the site consists of the area around the abutments to the small bridge on Caldwell Avenue and Caldwell Avenue between the bridge and Green Street. Soil borings were advanced in this area because of concerns that slag or processed material could have been used either as a base material for the roads or as fill material around the bridge. Seven soil borings were completed in this area and scanned in the field for gamma emitters using a NaI detector and organic vapors using a PID. Since no organic vapors were detected above background (established as 5.0 parts per million for this investigation) no samples were submitted for chemical analysis. However, at least one sample from each boring was submitted for radiological analysis. No slag was observed in any of the bridge abutment or roadway borings. Core scanning did not indicate elevated levels of radioactivity and radiological analysis of core segments showed the absence of contamination.

5.3 Groundwater Investigations

To investigate the condition of groundwater, samples were collected from all of the existing and newly installed monitoring wells. Prior to initiating groundwater sampling activities, all monitoring wells, with the exception of Monitoring Wells MW-1 through

MW-4, were developed. Monitoring Wells MW-1 through MW-4 did not need to be developed since they are part of a quarterly groundwater sampling program at the site. Each monitoring well was developed either with a disposable polyethylene hand bailer or a Tempest III pump, which was decontaminated after each use. Field parameters (i.e., ORP, pH, specific conductance, temperature, and turbidity) were monitored during well development and utilized to determine when each well had been sufficiently developed. Monitoring well development data is contained in Appendix I.

Following monitoring well development, a synoptic round of groundwater elevation measurements was made. Each monitoring well then was purged and sampled utilizing USEPA low stress (low flow) purging and sampling techniques. A peristaltic pump was used for purging and sampling activities to ensure that a flow rate between 250 to 500 milliliters per minute could be maintained. All groundwater was pumped through an YSI Model 556 flow thru cell so that field parameters (i.e., DO, ORP, pH, specific conductance, and temperature) could be measured. Additionally, turbidity measurements were collected to aid in determining when each monitoring well had been sufficiently purged and groundwater sampling could commence.

Groundwater samples for chemical and radiological analysis were collected immediately following stabilization of the field parameters as detailed in USEPA low flow sampling guidance. Radiological and metals samples were field filtered.

Groundwater samples collected from all of the monitoring wells were submitted for gross alpha and gross beta analysis. Based on the results of the gross alpha analysis fourteen of the groundwater samples were reanalyzed for isotopic uranium, Ra-226 and Ra-228. Thorium was not included in the isotopic reanalysis since it is highly insoluble and is unlikely to appear in groundwater.

Depending on the location of the monitoring well, groundwater samples submitted for chemical analysis were analyzed for one of two sets of parameters. Groundwater samples from non-MGP tar impacted areas were analyzed for VOCs, by USEPA Method 8260B, SVOCS by USEPA Method 8270C, and Act 2 Metals plus Mo and W by USEPA Methods 6010B and 7471 (mercury). Selected groundwater samples also were analyzed for PCBs by USEPA Method 8082, perchlorate by USEPA Method 8321, and Cr^{+6}, Mg, and Ti by USEPA Methods 7196 and 6010. Groundwater samples collected from wells that were installed to monitor for MGP tar impacts were analyzed for BTEX by USEPA Method 8021, PAH compounds by USEPA Method 8310, Act 2 Metals plus Mo and W by USEPA Methods 6010B and 7471 (mercury), Phenolics by USEPA Method 8270, and Weak Acid Dissociable Cyanide by Method ASTM 4500-1. In addition, samples from two monitoring wells (MW-52 and MW-54) were analyzed for Cr^{+6}, Mg, and Ti by USEPA Methods 7196 and 6010.

Data obtained during groundwater sampling activities in December, 2003 revealed wide variations in groundwater pH across the site as illustrated on Figure 62. In addition, the presence of a seep in the southeastern corner of Area 1A has been noted earlier in this report. At the time the seep was uncovered in the late 1970's, it was found to be alkaline in the range of pH 10. This seep continues to be collected in a french drain system and continues to be alkaline. In order to further investigate the complex site groundwater pH conditions, during February, 2004, samples were collected from 17 monitoring wells and the seep and were analyzed for major anions and cations. The wells included in this effort and the analyses performed are given in Tables 10A and 10B.

5.3.1 Radiological Findings

Results of the gross alpha and gross beta analyses for all of the groundwater samples together with the isotopic uranium and radium results for the 14 reanalyzed samples are given in Table 11. A comparison of gross alpha/beta results with isotopic determinations is presented on Figure 63.

Gross alpha concentrations ranged from 3 to 24 pCi/L and gross beta from 1 to 31 pCi/L in groundwater samples. The gross alpha concentrations could not be attributed to U-238/234, Ra-226, or Ra-228 singly or in combination as can be seen from Figure 61. All of these isotopes are present in negligible quantities, well below drinking water Maximum Contaminant Levels (MCLs).

Because the originally reported alpha activities could not be accounted for from the isotopic analyses, a follow up was performed to investigate these discrepancies. Five planchetts from the original alpha/beta prep were recounted to confirm activities. All five planchettes showed greatly lower alpha activity than the originally reported alpha values ranging from 8 to 24 pCi/L. Gross beta activities in the recount compared favorably with the original determination. These results indicate that the nuclides accounting for the original alpha activity had decayed in the intervening six weeks. This would point to the shorter lived daughter nuclides of the thorium and uranium decay chains.

The conclusion is that U-238/234, Ra-226, and Ra-228 are not present in site groundwater at significant concentrations.

5.3.2 Non-Radiological Findings

Groundwater analytical results are presented in Appendix J, with the analytical results for each area/sub-area presented on a separate table. Several VOCs were detected in the groundwater samples collected across the site, with several of the compounds being detected at estimated concentrations below their respective laboratory reporting limits. In particular, only benzene, chloroform, chloromethane, ethylbenzene, methyl chloride, vinyl chloride, m&p-xylene, and o-xylene were detected above their respective laboratory reporting limits in at least one of the submitted groundwater samples. All of the above listed compounds were detected at concentrations slightly above their respective detection limits and no spatial pattern to their occurrence or concentration could be ascertained. Furthermore, no VOCs were detected above their laboratory detection limits in any of the bedrock wells that have been installed at the site. The only exceedances of residential used aquifer SHS were for chloromethane in MW-47 and vinyl chloride in MW-7, both in Area 1B.

Several SVOCs and PAHs were detected in the groundwater samples at estimated concentrations both above and below their respective laboratory reporting limits. Pentachlorophenol in MW-47 was the only exceedance of residential used aquifer SHS.

The majority of the detected and identified compounds were present only in a few wells scattered across the site. In fact all of the PAHs detected in the samples collected from Areas 5B and 5D were detected only in Monitoring Wells MW-55 and MW-51, respectively. Therefore, it would appear for the most part that the occurrence of SVOCs and PAHs in groundwater is localized and not widespread. Furthermore, only one SVOC compound (dimethylphthalate) was detected slightly above its detection limit in groundwater samples (BR-4) collected from the bedrock aquifer. No SHS exists for dimethylphthalate, but this detection is not considered to be significant. None of the PAHs exceed residential SHS.

A total of eight groundwater samples collected from Areas 1A, 1B, 2, and 4 were submitted for PCB analysis. No PCB compounds were detected above laboratory reporting limits in any of the groundwater samples.

Both boron and thallium concentrations in excess of residential used aquifer SHS were widespread across the site both in overburden and bedrock wells. Lead concentrations in excess of SHS were widespread in Area 2 and a high concentration of vanadium was detected in MW-1 in this area. Iron and manganese levels above secondary standards also were found to be widespread across the site except for bedrock wells in Areas 4, 5B, 7A, 7B, and 8.

High molybdenum and tungsten levels were observed in groundwater samples from Areas 1A, 1B, 2, 3, 5B, and 5D. Slightly elevated levels were observed in Areas 8 and 10A. Generally, in the production areas, molybdenum levels increased from east to west with the highest concentration of 190 mg/L being observed in Area 2. The highest tungsten concentration measured was 4.9 mg/L in Area 1B.

Results for the additional Cr^{+6} analyses performed on samples collected from Areas 2, 3, and 5B indicate that this compound is present in groundwater at low concentrations. Analytical results for these groundwater samples are contained in Tables J-3, J-4 and J-6, respectively.

Groundwater samples collected from Monitoring Wells BR-1, MW-2, MW-4, MW-6, MW-18, and MW-24 were analyzed for perchorlate to determine if past site activities had resulted in the introduction of perchlorate into the groundwater system. Perchlorate was detected in Monitoring Wells MW-2, MW-18, and MW-24 at concentrations of 0.209, 976, and 34.7 parts per billion, respectively. That well MW-18 had the highest perchlorate concentration is not surprising. This well is located just west (downgradient) of both Building 26 which housed the Molycorp solvent extraction (SX) process and the SX waste acid storage tanks. The SX process involved extraction of rhenium from an ammonical solution. The loaded solvent was stripped of rhenium using perchloric acid. Waste sulfuric and perchloric acids from this process were stored in fiberglass tanks without secondary containment from the mid 1960's to the mid 1980's. Perchlorate concentrations in groundwater decrease away from this area.

Analytical results for the February sampling event (Appendix K) were utilized to compare the geochemical signatures of the sampled groundwater monitoring wells and the seep. The sampled locations were broken up into three groupings: 1) bedrock monitoring wells; 2) neutral pH monitoring wells; and 3) alkaline pH monitoring locations. To better assess the similarities or differences between the sampling locations groups, Piper Plots, Pie Diagrams, Stiff Diagrams and Radial Diagrams (Figures K-1 – K-10) were generated based on the analytical results.

Upon review of the analytical data and the qualitative descriptions contained in Figures K-1 – K-10, several trends were observed. First, all of the bedrock monitoring wells, with the exception of Monitoring Well BR-3, exhibit a similar geochemical signature with the predominate ionic species consisting of sodium, chloride, and bicarbonate and to a lesser extent carbonate. Bedrock Monitoring Well BR-3 has a geochemical signature consistent with the neutral pH alluvial monitoring locations, possibly as a result of communication between BR-3 and the alluvial aquifer. The neutral pH monitoring locations predominantly consist of the ionic species of sodium, calcium, and magnesium and the anionic species chloride, bicarbonate, and sulfate.

One noticeable difference between the neutral an alkaline pH monitoring locations is the absence of bicarbonate in the alkaline samples which is consistent with the conversion of bicarbonate into carbonate at the elevated pH concentrations observed in these wells. Another difference between the neutral and alkaline groundwater samples is the near absence of magnesium in alkaline groundwater samples and the relative dominance of calcium as the primary cationic species. Predominant cationic species of the seep are calcium and sodium, with a small contribution of magnesium. Predominant anionic species of the seep are chloride and sulfate, with a small contribution of carbonate. Consistent with having an alkaline pH, no bicarbonate was present in the seep sample.

Based on the cation distribution as viewed on the Piper plot (Figure K-1) the seep groundwater sample is chemically similar to several neutral pH shallow groundwater samples (calcium is dominant, but not as dominant as in the alkaline groundwater samples). The anion distribution of seep groundwater is similar to the alkaline groundwater samples by virtue of the absence of bicarbonate; but has a much higher percentage of chloride, which is a characteristic of the nearest shallow monitoring wells (MW-19, MW-41 and MW-42). Overall, the geochemical characteristics of the seep are most similar to neutral pH groundwater at monitoring well MW-42, and alkaline pH groundwater at monitoring wells MW-1 and MW-47.

5.4 Sediment and Surface Water

On September 17, 2003, a walkover of Chartiers Creek and Sugar Run was conducted. The purpose of the walkover was to observe conditions on the bank of the streams and the stream bottoms. Information gathered from this stream walk subsequently was used to identify locations for surface water, sediment and macro-invertebrate samples. Observations were made at the locations indicated on Figure 64. The observations are summarized in Table 12.

Based on results of the stream walk, sediment and surface water samples were collected from sixteen locations within Chartiers Creek and Sugar Run to investigate potential impacts on these water bodies. Twelve sampling locations were established along Chartiers Creek, including three off-site background sampling locations, while Sugar Run had four sampling locations. One of the Sugar Run sampling stations was added to monitor the location of a metal pipe emerging from the bank of Sugar Run which was discovered during the earlier stream walk. Care was taken to ensure that the sampling locations selected for this investigation were in close proximity to previous sediment and surface water sampling locations.

The analytical program for the sediment and surface water samples varied depending on the location of the sample and what type of contaminant to be investigated (i.e., radiological or tar). Tables D-1 and D-4 describe the analytical program for the different sediment and surface water sampling locations, respectively.

Sediment samples for radiological analyses (U, Th, Ra) were collected from seven on site and one off-site sampling locations. Sixteen surface water samples were analyzed for gross alpha and gross beta.

Various chemical parameters were analyzed to characterize the stream and sediments. Approximate surficial flow conditions and general field parameters (DO, ORP, pH, specific conductance, and temperature) were recorded prior to collection of the surface water samples. Analytical results for the sediment and surface water samples are provided in Tables L-1 through L-7.

5.4.1 Surface Sediment Samples

Concentrations of U-238/234, Th-232/228 and Ra-226 in sediments in Chartiers Creek were near background levels as shown in Table 13.

Several VOCs (acetone, benzene, 2-butanone, carbon disulfide, cis-1,2-dichloroethene, and toluene) were detected above their respective laboratory limits in the samples collected from Chartiers Creek. Acetone, 2-butanone, and carbon disulfide were the only VOCs detected above their laboratory reporting limits in the sediment samples collected along Sugar Run. In addition, several other VOCs were identified at estimated concentrations below their laboratory detection limits in samples from both creeks. With the exception of acetone, none of the VOCs detected were observed in all of the sampling locations. The detection of acetone is believed to be questionable. None of the reported VOCs were detected in a consistent pattern that would indicate that VOC contaminants are discharging from the site to sediments within Chartiers Creek and Sugar Run. In fact, most of the VOCs were detected only in the background samples and for those that were detected at other sampling locations the concentration was lower than at the background sampling locations.

Numerous SVOCs were detected in the sediment samples collected from the creeks, primarily in Chartiers Creek. The compounds detected are typical of MGP tar. The majority of the detected SVOCs were found in the upstream background samples, which also exhibit the highest concentrations. SVOC concentrations in the sediment samples appear to decrease at downstream locations in Chartiers Creek as the stream traverses the site.

Concentrations of arsenic in Chartiers Creek and Sugar Run sediments exceed SHS at numerous locations.

5.4.2 Surface Water Samples

Surface water samples from sixteen locations in Chartiers Creek were analyzed for gross alpha and gross beta. Only background levels were measured as shown in Table 14.

Water samples from all 16 locations were analyzed for VOCs, SVOCs , and Act 2 Metals plus Mo and W.

Only the VOC chloromethane was detected in two of the surface water samples (SW-4 and SW-5) at a concentration that was slightly above the laboratory reporting limit. Additionally, acetone and chloromethane (SW-2 only) were identified at concentrations below their laboratory reporting limits. No other organic compounds or SVOCs were detected or identified in any of the surface water samples. None of the reported detections are deemed to be significant. Iron and manganese levels were somewhat elevated in both streams but no other metals/inorganics were observed at unusual levels.

5.5 Soil Leaching Studies

Toxicity Characteristic Leaching Procedure (TCLP) and Synthetic Precipitation Leaching Procedure (SPLP) analyses for metals were performed on a total of 22 soil samples taken from 12 borings located in Areas 1, 2 and 3 to determine if the slag located in these areas was hazardous by characteristic or had the potential to release metals as groundwater percolates through the fill material.

Where possible, a soil sample from each location was collected in the fill material and the alluvial material to determine if any of the metals were leaching from either material, and if the fill material was being leached, to determine if the leached metals were being deposited in the alluvial material. However, two of the samples [MPSB – 15A (4-6 feet bgs) and MPSB-49 (12-14 bgs)] had insufficient sample volume remaining to enable TCLP and SPLP analyses following the analyses of all the primary parameters (i.e., VOCs, SVOCs, Act 2 Metals plus Mo and W).

TCLP analytical results were compared to RCRA regulatory levels while SPLP results were compared to Pennsylvania Act 2 Statewide Health Standards (SHS). Tables 15 TCLP Analysis and Table 16, SPLP Analysis contain the analytical results together with the regulatory limits for all of the metals analyzed.

Review of the TCLP data shows that only arsenic, barium, cadium, and selenium were detected above their respective laboratory reporting limits. All of these detections were at concentrations that are slightly above the laboratory reporting limit and well below RCRA regulatory levels. Based on the TCLP results, the soils analyzed are not hazardous.

SPLP results indicate that aluminum, boron, iron, manganese, molybdenum, tungsten, and vanadium were regularly detected above their respective laboratory reporting limits. Furthermore, some of the detected concentrations of aluminum, boron, iron, manganese, and vanadium exceeded SHS for residential used aquifers. (SHS for aluminum, iron, and manganese are secondary standards having no human health significance.) Most of the SHS exceedances for boron and vanadium occurred in samples collected from Areas 1B and 2, with only one exceedance occurring in Area 3 and none in Area 1A.

5.6 Preliminary Ecological Characterization

An ecological assessment of the site and in particular Chartiers Creek and Sugar Run was performed. As part of the ecological assessment, macroinvertabrate samples were collected to determine if past site activities had resulted in any damage to the surface water ecosystem.

As part of this site characterization, a preliminary ecological characterization has been completed. Initial activities in this characterization included: identifying species or habitats of concern, conducting a site visit, describing the environmental setting, and completing a benthic macroinvertebrate survey of Chartiers Creek and Sugar Run (Appendix M). The areas of potential ecological concern identified during the site visit include tar impacted surface soils and sediments, the South Tar Pond, the impacted soil in the foundation area, and the presence of a slight sheen to the standing water in Area 7A. There were no visual signs of diseased or distressed vegetation identified during the site visit. No federal or state-listed endangered or threatened species or other species of concern or habitats of concern were identified on or in the vicinity of the site. No exceptional value wetlands were identified on or in the vicinity of the site.

The principal output from the benthic macroinvertebrate survey are metrics that provide semi-quantitative characterization of the density and diversity of the benthic macroinvetebrate population. In general, the overall metrics for both Chartiers Creek and Sugar Run suggest that the benthic assemblages are in fair condition. Although differences in the benthic metrics were observed between the Chartiers Creek reference station and potentially impacted downstream stations (with the exception of SS-2), the differences are minimal. It should be recognized that the differences observed in the benthic community metrics between the Chartiers Creek and Sugar Run upstream and downstream sampling stations may be attributable to differences in physical habitat. The benthic macroinvertebrate community metrics for Station SS-2 suggest some level of impairment when compared to the metrics of the other Chartiers Creek stations.

Table 1

Significant Events in the History of Manufacturing at the Washington Site

Date	Event
1902	Main Plant Area purchased by the Railway Spring and Manufacturing Company.
1916	Electric Reduction Company purchased the site.
1920	Molybdenum Corporation of America formed from the Electric Reduction Company (in 1974 the name was changed to Molycorp, Incorporated).
1963	NRC license obtained to produce ferrocolumbium
1968	Eight surface impoundments installed
1969	Ferrocolumbium slag used as fill over large areas of the site
1970	NPDES permit obtained
1971	NRC requests site cleanup
1976	Areas 5 and 7A purchased – MGP tar present
1976	Area 7B Morris Farm purchased
1976 – 1981	Slag Fill in Morris Farms part of Area 5
1978	Ferrocolumbium slag cleanup completed
1980	Building demolition and reconstruction completed
1980	RCRA Part A permit application filed
1981 - 1986	Slag Fill in Area 5E
1982	Sulfuric acid plant online
1985	Tar pond remediation conducted; RCRA Part B permit denied
1991	Facility placed on stand-by; limited production thereafter
1992	NRC requests decommissioning
1994	Site characterization conducted
1995	Surface impoundments Phase I closure completed
2001	Slag pile excavated and shipped offsite for disposal
2002	Building demolition completed

Table 2

Historical Information Concerning the MGP Tar present at the Washington Site

Date	Event
1887 - 1902	A search of Brown's directory indicates that a small coal gas operation was present in Washington from 1887 to 1902. Reportedly it was abandoned in 1903 due to competition from natural gas. The 1896 Sanborn map shows an MGP on the north side of East Maiden between Lincoln and East Avenue. It was called the Washington Gas Company and is present on the 1900 Sanborn map, but not the 1904 Sanborn map. This MGP is thousands of feet east of Areas 5 and 7.
1900 - 1950	An internal Molycorp document entitled "Project History" indicates that a coal gasification plant was operated in the vicinity of the Foundation from around 1900 through possibly 1950. Tar from this facility "flowed downhill from the plant through wooden trenches and pipes to one of three unlined tar ponds."
1902	The Hazel-Atlas Glass Company built Hazel No. 2, a glass-making operation, to the west of Griffith Avenue, north of the Baltimore and Ohio Railroad around 1902. The Hazel No. 2 facility is not on the 1896 or 1900 Sanborn maps, but appears on the 1904 Sanborn map. The facility apparently replaces the American Tin Plate Company, originally the Washington Steel and Tin Plate Works, which appears on the 1896 and 1900 Sanborn maps.
1914 – 1925	Between 1914 and 1925, the Pennsylvania Atlas Chemical Company was built. The 1925 Sanborn map shows the facility to the west of the Hazel No. 2 facility, east of Chartiers Creek and north of the Baltimore and Ohio Railroad. A 100 ft. diameter iron gas holder with a 200,000 cu. ft. capacity is shown to the northwest of the facility. This facility is listed as producing gas and its by-products.
1915	Meeting minutes from the Hazel-Atlas board indicate that building an MGP to supply gas to Hazel No. 2 was discussed on November 27, 1915. The minutes of June 27, 1916 indicate the board approved a contract with Smith Gas Engineering Company of Lexington, Ohio to design and build a "gas producer plant to supply clean gas to Hazel No. 2 Factory." The minutes of February 13, 1917 indicate that gas production had started at Hazel No. 2.
1916	Minutes from the Hazel-Atlas board dated June 27, 1916 discuss the cost of retaining walls and moving railroad spurs when constructing the gasification operation. There is a massive retaining wall just to the east of the two existing tanks on the former Hazel No. 2 property and there were railroad spurs on the property where the Hazel No. 2 facility was located. There is no apparent retaining wall in the Foundation area and no evidence from aerial photos that a railroad spur ran to the Foundation. Thus, the initial gasification operations appear to have been located in the same general area as the Pennsylvania Atlas

Table 2

Historical Information Concerning the MGP Tar present at the Washington Site

	Chemical Company.
1922	Meeting minutes from the Hazel-Atlas board indicate that contracts had been prepared with Combustion Utilities Corporation by July 29, 1922 to build the Pennsylvania Atlas Chemical Company gas producer plant. Problems with the plant are noted in meeting minutes from January 28, 1926, but Combustion Utilities Corporation apparently continued to run the plant until at least 1931. The facility is not shown on the 1947 Sanborn map. Two tanks, labeled oil tanks, are on the property, but they are not in the same locations as tanks shown on the 1925 Sanborn map. These two tanks appear to still exist on this property.
1950	On July 8, 2003, discussions were held with Gerry Johnson an individual who worked at the Hazel-Atlas Hazel No. 2 facility for a number of years starting around 1950. Gerry Johnson indicated that nothing was operating in the Foundation area at this time, but that there was a tank and three other structures around the Foundation. Gerry Johnson believed that these structures were eventually stripped by vandals.
1954	The 1954 USGS map shows three ponds to the west of Hazel No. 2, one to the south of Chartiers Creek, one immediately north of Chartiers Creek and a small pond north of this pond. The foundation does not appear on this map. The Tylerdale Connecting Railroad, which runs east to west between Caldwell Avenue and the Baltimore and Ohio Railroad, appears to end at a "mine dump" at Lincoln Hill about 6,000 ft. southwest of the foundation. This was reportedly an operating coal mine around 1900. Interstate 70 is not on this map.
1969	The 1969 USGS map shows Interstate 70, the southern pond and the foundation. It shows the service road from Caldwell Avenue that runs south through the former pond area north of Chartiers Creek, then east through a tunnel under I-70 to the area where the Pennsylvania Atlas Chemical Company formerly was located. It also shows two tanks on this property that apparently are the two tanks currently on this property.
1955 – 1960 (?)	Drawings for Interstate 70 from Penn DOT show a rectangular symbol labeled "Coal Tar" under the footprint for Interstate 70, to the north of the tunnel associated with the service road that runs under the interstate. This rectangle is in the general vicinity of where the iron gas holder is located on the 1925 Sanborn map. The drawings also indicate that one "Pond with Tar Base" is located immediately west of Interstate 70 in the general area of the North Tar Pond and a second "Pond with Tar Base" is located west of Interstate 70 in the

Table 2

Historical Information Concerning the MGP Tar present at the Washington Site

	general area of the South Tar Pond.
1980	Vijay Wagh, formerly an assistant plant manager for Molycorp at the Washington, PA facility, talked to a former Hazel-Atlas Hazel No. 2 employee around 1980. This individual indicated that the Foundation was once a glass-making plant and that in order to provide gas for this plant, coal was "cooked in a vat" to generate gas. Periodically, the vat would be tapped and tar would be allowed to flow by gravity down the hill to the pond area. This individual indicated that the gas-making operation began around 1900 and lasted 12 to 13 years.
1983	An internal Molycorp memorandum from George Dawes to Lars Hansen dated October 17, 1983 summarizes a meeting between Molycorp personnel and Penn DOT personnel. At this meeting, M. Jones of Penn DOT indicated that when Interstate 70 was constructed in the late 1950s, a 16-18 foot deep pit of tar was encountered within the footprint of the road. Penn DOT filled the pit with rocks to provide the stability needed for constructing the road. This action caused the tar to overflow into a pond near the pit that Penn DOT claims already contained tar. This pit may have been a below ground foundation for the iron gas holder and the pond presumably was the North Tar Pond.

Table 3

Previous Site Investigations Summary

Report Title	Summary of Activities
SRW, March 3, 1980; Sampling and Study of Subsurface Conditions Tar Pond Area Washington, Pennsylvania (SRW, 1980)	• Drilled 8 test borings in the tar pond area • Installed 6 well points • Performed geotechnical analyses on 20 soil samples • Collected 6 surface water and 6 groundwater samples for water quality
SRW, February 2, 1982; Groundwater Monitoring Plan Holding Pond Area, February 2, 1982 (SRW, 1982)	• Proposed plan for installation of 4 monitoring wells (M1-M4)
SRW, January 4, 1984; Tar Pond Closure Plan Molycorp, Incorporated, Washington, Pennsylvania (SRW, 1984)	• Prepared an engineered closure plan for the tar areas for submittal to the PADEP • Site reconnaissance and supporting activities • Excavated 4 test pits in potential borrow areas
SRW, October 8, 1985; Proposed Construction and Monitoring Activities, Molycorp Tar Pond Closure (SRW 1985)	• Addressed additional surface tar cleanup and placement in the south pond • Address tar seepage along I-70 embankment • Identified surface water and groundwater monitoring requirements
Radiological Site Assessment Program; Manpower Education, Research and Training Division; Oak Ridge Associated Universities; Radiological Survey of Molybdenum Corporation of America, Washington, Pennsylvania, Preliminary Report, June 1985 (ORAU, 1985)	• Investigated western third of facility and area south of Caldwell Avenue • Performed radiological surface scans, direct measurements, and radionuclide concentrations in numerous soil samples, surface water and sediment (1 upstream and downstream, 2 storm sewer outfalls), 4 groundwater (MI-M4), and associated buildings
RSA, December 27, 1990; A Subsurface Survey for Thorium Content at the Molycorp Plant site in Washington, Pennsylvania (RSA, 1990)	• Radiological study of western portion of facility focusing on vertical profiling of 8 impoundment areas • Performed 400 surface measurements • Drilled 32 soil borings and performed subsurface measurements at 6 inch depths in all and 5 existing wells (M1-M5) • Collected soil samples for lab radiological analyses to support calibration
Remcor, December 23, 1991; DRAFT Interim Report Ground Water Assessment and Recovery System Design (Remcor, 1991)	• 17 monitoring wells (M5-M18; 2 well clusters at M-9, M-15 and M-18) • 6 soil samples for geotechnical analysis • 30 soil samples for thorium analysis • 2 rounds of groundwater samples in 17 new and existing wells for metals and geochemistry analysis
Molycorp, August 31, 1992, Revised September 30, 1994; Plan for Closure of Eight Surface Impoundments at Molycorp's Washington, Pennsylvania Facility (RSA, Vail, Molycorp, 1994)	• Planning document for removing 8 impoundments and their contents • Average yearly groundwater sample results from M1-M4 indicated contamination • Chartiers Creek surface water sample results from 1991 indicated downstream molybdenum contamination • Selenium in impoundments samples close to RCRA hazardous waste

Table 3

Previous Site Investigations Summary

Report Title	Summary of Activities
RSA and Vail Engineering, August 5, 1993; Molycorp Plan for Site Characterization in Support of Decommissioning of the Molycorp Inc. Washington, Pennsylvania Facility, Volume 1: Report Text and Appendix a-j, Volume 2: Appendix k (RSA, Vail, 1993)	• Detailed plan for upcoming site characterization to support NRC decommissioning / delicensing • Focused on thorium based contamination from ore processing and associated slag
Foster Wheeler Environmental Corporation, January 1995; Site Characterization Report for License Termination of the Washington, Pennsylvania Facility, Volume 1: Section 1-6, Volume 2: Appendicies a-o less g,n; Volume 3: g.m. (Foster Wheeler, 1995a)	• Reported site characterization activities performed in 1994 • Site characterization included, drilling 418 borings, installation of 17 wells, radiological survey, soil, groundwater, storm sewer, surface water and sediment sampling. Pumping test performed to support modeling
Foster Wheeler Environmental Corporation, June 1995; Workplan for The Closure of Eight Surface Impoundments (Foster Wheeler, 1995b)	• Defined procedures for the removal of 8 impoundments
Foster Wheeler Environmental Corporation, October 1995, Final Closure Report for Eight Surface Impoundments at the Washington, PA Facility (Foster Wheeler, 1995, revised May 1996)	• TCLP metals analyses of clay liner and impoundment berm material
Foster Wheeler Environmental Corporation, July 1995; Decommissioning Plan for the Washington, Pennsylvania Facility (Foster Wheeler, 1995c)	• Decommission plan as required by NRC • Plan included removal of all soil / slag above 30pC/g • Onsite disposal cell would be located in coal tar foundation area, coal tar to be relocated to south coal tar area
Foster Wheeler Environmental Corporation, December 1996; Final Radiological Status Report for the Removal Action Conducted Along the Northern Boundary of the Molycorp, Incorporated Property, Washington, Pennsylvania (Foster Wheeler, 1996c)	• Removal action performed in northern border of property and adjacent property to support sewer line construction • Contaminated slag in excess of 5pCi/g removed and placed in 184 rolloffs with NaI screening and gamma spectroscopy analyses
ICF Kaiser, April 1997; Washington Facility Environmental Report, Volume 1: Text, Volume 2: Appendices (ICF Kaiser, 1997)	• Environmental report required by NRC to comply with desire to dispose of material from both Washington and York facilities at the Washington facility • Included overview and evaluation of 3 on-site alternatives, off-site disposal and no action
Dade Moeller & Associates and Edward A. Emmett, 1997; Review of Decommissioning Plan for the Molycorp Washington Pennsylvania Site and Discussion of Associated Health Impacts on the Community and Evaluation of Potential Health Risks of Human Exposure to Radiation From Thorium Bearing Slag Associated with the Molycorp, Washington, Pennsylvania Site (Moeller and Emmett, 1997)	• Decommission plan review and evaluation of thorium health effects

Table 3

Previous Site Investigations Summary

Report Title	Summary of Activities
Radiological Services, Inc., June 30, 1999; Washington, Pennsylvania Facility Decommissioning Plan, Part 1 Revision (RSI,1999)	• Decommissioning plan for removal of material in excess of 10pCi/g
Splitstone and Associates, March 2000, Geostatistical Analysis and Estimation of Contaminated Soil Volume at the Molycorp Washington, Pennsylvania Site (Splitstone and Associates, 2000)	• Geostatistical analysis report to determine soil volumes for thorium concentration ranges using probability kriging
Hutchinson Group, April 2000, Geophysical Investigation of the Molycorp Facility, Washington, PA	• Geophysical investigation of Areas 5, 7 and part of 8 to identify locations of possible former oil and gas wells
CEC, May 2000, Findings of Search for Historic Oil/Gas Wells, Molycorp Facility, Washington, Pennsylvania	• Test pits were excavated in locations identified as anomalies in the April 2000 geophysical report by the Hutchinson Group.
Radiological Services, Inc., March 2001; Assessment of Uranium Content and Radioactive Decay Series Equilibrium in Soil at the Molycorp Washington, Pennsylvania Facility (RSI, 2001)	• Evaluated degree of equilibrium of thorium and uranium • 5 samples collected from 3 to 6 borings for thorium / uranium series radionuclides
MFG, February 2002; Overburden Slag Investigation Report, Molycorp, Incorporated, Washington, Pennsylvania Plant (MFG, 2002)	• Characterization of overburden material to determine if it can be used as fill • 20 borings were drilled with metals radiological, VOC, SVOC, TCLP, and SPLP analyses • Exceedences SHS noted in metals analyses • No VOC/SVOC exceedences • SPLP results exceeded SHS • TCLP results indicated non hazardous
MFG, March 2002, Supplemental Characterization Monitoring Plan for Groundwater, Surface Water and Sediment, Molycorp, Inc. Washington, Pennsylvania	• Monitoring plan to satisfy Condition 15A of Amendment No. 5 of Materials License SMB-1393
Harding ESE, May 2002, Report to Summarize Sampling Activities, Washington, Pennsylvania Site	• Samples from 17 existing wells, 4 sediment samples and 4 surface water samples were collected from Chartiers Creel and analyzed for isotopes of uranium, thorium and radium
Tetra Tech NUS, Inc., August 2002, Peer Review and Data Gap Analysis of Facility Characterization Data at Molycorp's Washington, Pensylvania Facility (TT-NUS, 2002)	• Summarizes and evaluates past investigations and remedial actions at the site • Identifies data gaps and recommends additional investigation to address data gaps
MACTEC, Inc., July 2002, Final Status Survey Report for all buildings at the Molycorp Site, Washington, PA	• Final status surveys of the building materials were conducted for 21 buildings that were demolished in 2002

Table 4
Existing Monitoring Well Designations

Previous Monitoring Well Identification	Current Monitoring Well Identification
M1	MW-1
M2	MW-2
M3	MW-3
M4	MW-4
M5	MW-5
M6	MW-6
M7	MW-7
M9	MW-9
M10	MW-10
M16	MW-16
M18	MW-18
M19	MW-19
M21	MW-21
M24	MW-24
M25	MW-25
M26	MW-26
M27	MW-27
M28	MW-28
M29	MW-29
M40	MW-40

Table 5
Slug Test Statistical Results

Well Identification	Test Type	Bedrock Monitoring Wells Calculation (Bouwer-Rice 1976)		Overburden Monitoring Wells Calculation (Bouwer-Rice 1976)	
		Hydraulic Conductivity (ft/day)	Hydraulic Conductivity (cm/sec)	Hydraulic Conductivity (ft/day)(1)	Hydraulic Conductivity (cm/sec)(2)
BR-1	Rising Head	0.03	1.12E-05		
BR-2	Rising Head	0.01	4.30E-06		
BR-3	Rising Head	0.03	9.17E-06		
BR-4	Rising Head	0.00	1.59E-06		
BR-5	Rising Head	0.01	2.35E-06		
BR-6	Rising Head	0.03	1.08E-05		
BR-7	Rising Head	0.01	3.72E-06		
BR-8	Rising Head	0.01	3.20E-06		
GW-3	Rising Head			0.02	8.44E-06
MW-1	Rising Head			0.00	1.97E-07
MW-2	Rising Head			0.02	8.40E-06
MW-3	Rising Head			0.00	1.28E-07
MW-4	Rising Head			0.02	7.84E-06
MW-6	Rising Head			0.01	2.52E-06
MW-7	Rising Head			0.00	3.07E-07
MW-9	Rising Head			0.00	1.51E-06
MW-10	Rising Head			0.01	4.49E-06
MW-16	Rising Head			0.05	1.88E-05
MW-18	Rising Head			0.01	2.44E-06
MW-19	Rising Head			0.03	1.03E-05
MW-21	Rising Head			0.01	3.94E-06
MW-24	Rising Head			0.01	2.54E-06
MW-25	Rising Head			0.01	3.42E-06
MW-26	Rising Head			0.01	3.62E-06
MW-27	Rising Head			0.04	1.53E-05
MW-28	Rising Head			0.02	5.42E-06
MW-29	Rising Head			0.01	1.92E-06
MW-40	Rising Head			0.01	3.73E-06
MW-41	Rising Head			0.01	1.84E-06
MW-42	Rising Head			0.03	1.09E-05
MW-43	Rising Head			0.01	2.32E-06
MW-44	Rising Head			0.03	1.02E-05
MW-45	Rising Head			0.02	7.45E-06
MW-46	Rising Head			0.03	1.04E-05
MW-47	Rising Head			0.01	4.08E-06
MW-48	Rising Head			0.01	3.68E-06
MW-49	Rising Head			0.11	3.87E-05

Table 5
Slug Test Statistical Results

Well Identification	Test Type	Bedrock Monitoring Wells Calculation (Bouwer-Rice 1976)		Overburden Monitoring Wells Calculation (Bouwer-Rice 1976)	
		Hydraulic Conductivity (ft/day)	Hydraulic Conductivity (cm/sec)	Hydraulic Conductivity (ft/day)[1]	Hydraulic Conductivity (cm/sec)[2]
MW-50	Rising Head			0.01	3.78E-06
MW-51	Rising Head			0.01	3.39E-06
MW-52	Rising Head			0.01	2.99E-06
MW-53	Rising Head			0.01	2.50E-06
MW-54	Rising Head			0.03	9.13E-06
MW-55	Rising Head			0.01	3.79E-06
TB-02	Rising Head	0.01	2.90E-06		
TB-03	Rising Head	0.01	2.67E-06		
TB-04	Rising Head	0.02	5.62E-06		
TB-05	Rising Head	0.01	4.23E-06		
UG-3	Rising Head			0.02	5.94E-06
UG-4	Rising Head			0.02	5.43E-06
Minimum		0.00	1.59E-06	0.00	1.28E-07
Maximum		0.03	1.12E-05	0.11	3.87E-05
Median		0.01	3.98E-06	0.01	3.79E-06
Geometric Mean		1.22E-02	4.29E-06	2.30E-02	8.10E-06

Footnotes:
1) ft/day - feet per day
2) cm/sec - centimeters per second

Table 6
Soil Background Determination

Sample Identification	Net Core Scan (CPM)	Ra-226 (pCi/g)	U-238 (pCi/g)	Th-232 (pCi/g)
BKG-9	0	1.77	1.17	1.48
BR-3 (10-12')	126	1.84	1.44	1.6
BR-4 (2-4')	0	1.86	1.71	1.41
MPSB-05 (8-10')	122	1.58	1.00	1.94
MPSB-125 (8-10')	101	1.65	1.46	1.38
MPSB-126 (2-4')	153	1.30	0.97	1.73
MPSB-201A (15-17')	229	1.37	0.90	1.15
MPSB-202 (11-13')	242	1.99	3.00	1.48
MPSB-205 (7-9')	245	1.51	1.51	1.36
MW-41 (10-12')	659	1.75	2.72	1.26
MW-41 (19-21')	351	1.60	2.08	1.93
MW-42 (5-7')	167.5	1.73	1.39	1.09
MW-49 (4-6')	78	1.54	1.35	1.75
Average	**190**	**1.65**	**1.59**	**1.50**
Min	**0**	**1.30**	**0.90**	**1.09**
Max	**659**	**1.99**	**3.00**	**1.94**
Standard Deviation	**172**	**0.20**	**0.65**	**0.27**

BKG-9: Background for Area 9
pCi/g: picocuries per gram
CPM: Counts Per Minute

Table 7
MP Molycorp Washington Site Gamma Walkover MDC

Gamma Scan with a 2"x2" NaI detector for:	B (cpm)	i (sec)	p	ε_i (cpm /μR/h)	d'	s_i (counts)	MDCR (ncpm)	$MDCR_s$ (ncpm)	Scan MDC (μR/h)	CF (pCi/g / μR/h)	Scan MDC (pCi/g)
Cs-137[1]	2740	1	0.5	971	1.380	9	560	791	0.81	3.81	3.1
Th-232[a, 2]	2740	1	0.5	895	1.380	9	560	791	0.88	0.99	0.9
Ra-226[a, 3]	2740	1	0.5	820	1.380	9	560	791	0.97	1.41	1.4
U-natural[b, 4]	2740	1	0.5	3657	1.380	9	560	791	0.22	211	46
Th-232[a, 2]	3240	1	0.5	895	1.380	10	608	860	0.96	0.99	1.0
Ra-226[a, 3]	3240	1	0.5	820	1.380	10	608	860	1.05	1.41	1.5
U-natural[b, 4]	3240	1	0.5	3657	1.380	10	608	860	0.24	211	50
Th-232[a, 2]	3740	1	0.5	895	1.380	11	654	924	1.03	0.99	1.0
Ra-226[a, 3]	3740	1	0.5	820	1.380	11	654	924	1.13	1.41	1.6
U-natural[b, 4]	3740	1	0.5	3657	1.380	11	654	924	0.25	211	53
Th-232[a, 2]	5240	1	0.5	895	1.380	13	774	1094	1.22	0.99	1.2
Ra-226[a, 3]	5240	1	0.5	820	1.380	13	774	1094	1.33	1.41	1.9
U-natural[b, 4]	5240	1	0.5	3657	1.380	13	774	1094	0.30	211	63
Th-232[a, 2]	7740	1	0.5	895	1.380	16	940	1330	1.49	0.99	1.5
Ra-226[a, 3]	7740	1	0.5	820	1.380	16	940	1330	1.62	1.41	2.3
U-natural[b, 4]	7740	1	0.5	3657	1.380	16	940	1330	0.36	211	77

Notes:

B = background count rate (cpm)
cpm = counts per minute
i = scan time interval
p = surveyor effeciency (ranges from 0.5 to 0.75)
ε_i = instrument efficiency (from Table 6.4 of NUREG-1507)
d' = value selected from Table 6.1 of NUREG-1507
s_i = minimal number of net source counts
MDCR = minimum detectable count rate

$MDCR_s$ = surveyor MDCR
MDC = minimum detectable concentration
CF = conversion factor (Microshield/NUREG-1507)
ncpm = net counts per minute
pCi/g = pico curies per gram
μR/h = micr Roentgen per hour
[a]In Equilibrium with progeny
[b]Sum of U-234, 235 and 238

[1]The detector was calibrated to Cs-137 and the reported efficiency was 971 cpm/μR/hr.
[2]The detector efficiency adjusted for the difference in Cs-137 and Th-232 sensitivity (830/900) x 971cpm/μR/hr.
[3]The detector efficiency adjusted for the difference in Cs-137 and Ra-226 sensitivity (760/900) x 971cpm/μR/hr.
[4]The detector efficiency adjusted for the difference in Cs-137 and uranium sensitivity (3990/900) x 971cpm/μR/hr.

Table 8
Gamma Walkover Activity Concentration Estimate

Gamma Scan with a 2"x2" NaI detector for:	Net Rate (cpm)	ε_i (cpm /μR/h)	CF (pCi/g / μR/h)	Activity Concentration (pCi/g)
Cs-137[1]	500	971	3.81	1.96
Th-232[a, 2]	500	895	0.99	0.55
Ra-226[a, 3]	500	820	1.41	0.86
U-natural[b, 4]	500	3657	211	29
Th-232[a, 2]	750	895	0.99	0.83
Ra-226[a, 3]	750	820	1.41	1.29
U-natural[b, 4]	750	3657	211	43
Th-232[a, 2]	1000	895	0.99	1.11
Ra-226[a, 3]	1000	820	1.41	1.72
U-natural[b, 4]	1000	3657	211	58
Th-232[a, 2]	2500	895	0.99	2.76
Ra-226[a, 3]	2500	820	1.41	4.30
U-natural[b, 4]	2500	3657	211	144
Th-232[a, 2]	5000	895	0.99	5.53
Ra-226[a, 3]	5000	820	1.41	8.60
U-natural[b, 4]	5000	3657	211	288

Notes:
ε_i = radionuclide specific instrument efficiency calculated by multipling the Cs-137 reported calibration efficiency of 971 by the ratio of the standard radionuclide efficiencies taken from Table 6.4 of NUREG-1507.
[a]In Equilibrium with progeny
[b]Sum of U-234, 235 and 238
[1]The detector was calibrated to Cs-137 and the reported efficiency was 971 cpm/μR/hr.
[2]The detector efficiency adjusted for the difference in Cs-137 and Th-232 sensitivity (830/900) x 971cpm/mR/hr.
[3]The detector efficiency adjusted for the difference in Cs-137 and Ra-226 sensitivity (760/900) x 971cpm/mR/hr.
[4]The detector efficiency adjusted for the difference in Cs-137 and uranium sensitivity (3990/900) x 971cpm/mR/hr.

Table 9
Additional Metal Parameters

Constituent	MSC[1] Residential 0-15 Feet	MSC[2] Soil-to-Groundwater Residential Used Aquifers 100 X GW MSC	Generic Value		Area 1A				Area 1B	Area 2								Area 5D	
				Sample Identification	MPSB-16	MPSB-17	MPSB-18	MPSB-19	MPSB-94	MPSB-41	MPSB-43	MPSB-53	MPSB-59	MPSB-62A	MPSB-77	MPSB-82	MW-48	MPSB-146	MW-52
				Sample Depth (ft bgs)[3]	13-15	7-9	8-10	6-8	4-6	9-11	4-4.6	5-7	6-8	4-6	12-14	8-10	11-13	8-10	4-6
				Sample Date	9/29/2003	9/29/2003	9/29/2003	9/29/2003	10/16/2003	10/3/2003	10/2/2003	10/3/2003	10/6/2003	10/7/2003	10/10/2003	10/10/2003	10/8/2003	10/28/2003	10/28/2003
				Units															
Cerium	--[4]	--	--	mg/kg[5]	56.8	35.6	40	13.9	NS	30.1	85.1	48.8	189	91.2	24.7	NS	NS	NS	NS
Lanthanum	--	--	--	mg/kg	25.5	17.1	10.9	9.29	NS	14.3	39.8	28.6	107	78.9	106	NS	NS	NS	NS
Chromium^{+6}	94	10	190	mg/kg	NS	NS	NS	NS	1.9	NS	NS	NS	NS	NS	NS	<0.7	<0.62	<0.66	<0.66
Magnesium	--	--	--	mg/kg	NS	NS	NS	NS	10,000	NS	NS	NS	NS	NS	NS	87	410	1,600	2,700
Titanium	--	--	--	mg/kg	NS	NS	NS	NS	1,100	NS	NS	NS	NS	NS	NS	1,800	130	78	82

Footnotes:
(1) MSC - Medium Specific Concentrations (MSCs) for Organic and Inorganic Regulated Substances in Soil, Appendix A, Tables 3 and 4 - Direct Contact Numeric Values , 25 PA Code Chapter 250.
(2) MSC - Medium Specific Concentrations (MSCs) for Organic and Inorganic Regulated Substances in Soil, Appendix A, Tables 3 and 4 - Soil to Groundwater Numeric Values, 25 PA Code Chapter 250.
(3) ft bgs - feet below ground surface
(4) -- Medium specific concentration not yet established by Pennsylvania Department of Environmental Protection.
(5) mg/kg - milligrams per kilogram

Table 10A
Monitoring Locations Included in Water Chemistry Study

Sampling Location	Reason for Sampling	November 2003 pH
Seep	High pH	--
BR-7	Nested Wells	8.7
MW-55		10.1
BR-8	Nested Wells	9.1
MW-54		6.96
BR-3	Nested Wells – upgradient of seep	6.6
MW-41		6.8
MW-42	Vicinity of Seep – upgradient	6.9
MW-18	High pH	10.0
MW-24	High pH	9.8
MW-27	High pH	10.2
MW-47	Elevated pH	8.8
MW-48	High pH	10.4
MW-1	High pH	10.8
MW-6	Downgradient of high pH well	6.8
MW-19	Vicinity of Seep	6.6
BR-2	pH similar to BR-7; West of Chartiers Creek	8.7
BR-4	Bedrock Well West of Chartiers Creek	8.3

Note: reported pH concentrations are the last readings collected during monitoring well development with the exception of MW-1 which is the pH reading during sample collection.

Table 10B
Parameters Analyzed in Water Chemistry Study

ANIONS	CATIONS	OTHER
CO_3	Ca	Alkalinity
HCO_3	Mn	pH
Cl	Fe	Specific Conductivity
SO_4	NH_3	Dissolved Oxygen
NO_3	Na	Temperature
NO_2	K	
F	Al	
PO_4	Mg	
	Mo	
	Cu	
	Zn	
	Si	

Table 11
Groundwater Radiological Results

Sample Identification	Gross Alpha (pCi/L)[1]	Gross Beta (pCi/L)	Ra-226 (pCi/L)	Ra-228 (pCi/L)	U-234 (pCi/L)	U-235 (pCi/L)	U-238 (pCi/L)
BR-1	20.8	15.9	0	0.95	0.038	0.033	0
BR-2	3	3.1	NA[2]	NA	NA	NA	NA
BR-3	5.6	1.8	NA	NA	NA	NA	NA
BR-4	7.2	1.2	0.02	0.79	1.19	0.035	0.67
BR-5	4.1	2.8	NA	NA	NA	NA	NA
BR-6	4.5	2.5	NA	NA	NA	NA	NA
BR-7	3	1.2	NA	NA	NA	NA	NA
BR-8	3	2.7	NA	NA	NA	NA	NA
GW-3	3	2.8	NA	NA	NA	NA	NA
MW-1	10.6	30.0	0.41	0	0.015	0	0.042
MW-2	5	5.0	NA	NA	NA	NA	NA
MW-3	5.8	7.9	0.12	0.01	2.52	0.096	1.99
MW-4	3	4.2	NA	NA	NA	NA	NA
MW-5	24.3	31.0	0.23	0.82	0.29	0.009	0.008
MW-6	6.3	4.0	0	1.06	0.35	0.023	0.31
MW-7	11.2	2.5	0.39	0.1	4.08	0.19	2.92
MW-9	10.5	1.6	0	0.23	0.86	0.032	0.68
MW-16	11.2	7.0	0.04	0.32	0.112	0.017	0.128
MW-18	7.3	19.3	0.11	0.47	0.2	0.059	0.28
MW-19	3	1.2	NA	NA	NA	NA	NA
MW-21	15.9	6.0	0.04	1.04	0.049	0	0.042
MW-24	3.5	8.1	NA	NA	NA	NA	NA
MW-25	3	2.9	NA	NA	NA	NA	NA
MW-26	3	6.1	NA	NA	NA	NA	NA
MW-27	3	7.3	NA	NA	NA	NA	NA
MW-28	3.4	4.3	NA	NA	NA	NA	NA
MW-29	3	1.2	NA	NA	NA	NA	NA
MW-40	4.6	2.1	NA	NA	NA	NA	NA
MW-41	8.2	1.2	0.21	0.3	0.053	0.016	0.045
MW-42	5.5	4.1	NA	NA	NA	NA	NA
MW-43	3	1.2	NA	NA	NA	NA	NA
MW-44	4.2	1.3	NA	NA	NA	NA	NA
MW-45	5.4	2.3	NA	NA	NA	NA	NA
MW-46	6.1	9.1	0.13	0.4	0.66	0.075	0.46
MW-47	6.5	22.0	0	0.12	0.069	0	0
MW-48	4.7	8.4	NA	NA	NA	NA	NA
MW-49	3.4	1.7	NA	NA	NA	NA	NA
MW-50	3	3.8	NA	NA	NA	NA	NA
MW-51	3	11.3	NA	NA	NA	NA	NA
MW-52	3	3.0	NA	NA	NA	NA	NA
MW-53	3	1.2	NA	NA	NA	NA	NA
MW-54	3.9	2.49	NA	NA	NA	NA	NA
MW-55	3	4.0	NA	NA	NA	NA	NA
TB-01-1	3	1.7	NA	NA	NA	NA	NA
TB-02	3	1.2	NA	NA	NA	NA	NA
TB-03	3	1.2	NA	NA	NA	NA	NA
TB-04	3	1.9	NA	NA	NA	NA	NA
TB-05	3	1.2	NA	NA	NA	NA	NA
UG-3	3	1.94	NA	NA	NA	NA	NA
UG-4	3.4	2.0	NA	NA	NA	NA	NA

Footnotes:
(1) pCi/L - picocurries per liter
(2) NA - Not Analyzed

Table 12 Observations Made During Stream Walk

Location	Observations
Chartiers Creek	
SS-01	stream bed is rocky, possible tar nodule
Outfall for Findlay Refractory and street (east side of Chartiers Creek)	sheen, white color to water, odor to water , believed to be NPDES discharge
SS-02	stream bed is silty soil with pebbles, possible tar nodule
Outfall-032 (west side of Chartiers Creek)	approximately 6 in diameter pipe which may discharge runoff from Caldwell Avenue, stream bottom is silty soil with little rocks
Molycorp NPDES Outfall at Bridge	stream bottom is rocky upstream and then soft and silty downstream
Outfall S-04	pipe about 3 feet in diameter, stream bottom sediment is fine, no indication of tar impacts
S-035	relatively shallow location for about 20 feet, tar nodules present
S-036	relatively shllow location, tar appears to be seeping out along western side or there is a tar depositional area all along this stream bank
S-037	point where old railroad bridge crossed creek, old piers present, brick and rubble all along bank, tar on east bank, tar apparently on much of stream bottom, sheens on water apparently seeping into stream, slag on bank
S-038	an approximately 2 foot diameter discharge pipe on eastern side, tar seep on east bank, no evidence of tar on west bank, small tar deposit on west bank about 10 feet further downstream
S-05	relatively shallow location, S-38 to S-05 is relatively deep, fine sediment at S-05, there is evidence of tar along east bank and possibly on bottom of stream
Confluence of Sugar Run	tar on western and eastern bank
Chartiers Creek upstream of confluence with Sugar Run	tar seeps all along eastern bank
S-039A	relatively shallow water at this location, tar on western bank, eastern bank highly eroded
S-042	concrete dam, tar seeps upstream along eastern bank, no evidence of seeps along west bank, about 30 feet upstream from dam is pipe, about 20 feet upstream from pipe the tar seeps appear to stop, may be covered by roots
S-06	upstream area, no apparent tar seeps
S-043	water shallow, high flow, rocks, tar seep along east bank
S-07	at I-70 on Molycorp side, rocky bottom mostly
S-08	upstream of Molycorp site on eastern side of I-70,seeps along Hazel Atlas side of creek with sheen, possible tar odor in sediment, lots of bricks in stream
Sugar Run	
S-09	Sugar Run upstream of confluence with Chartiers Creek, no evidence of tar on either bank, rocks on bed, much smaller than Chartiers Creek,
Upstream of tunnel under access road	stream bed in finer material, no evidence of tar or tar seeps
S-10	upstream in Sugar Run where railroad crosses, no evidence of tar or tar seeps
S-11	no evidence of tar in stream, refractory brick present in stream bottom
S-12	no evidence of refractory brick for a while, hydrocarbon odor, pipe (3-4")

Table 12 Observations Made During Stream Walk

Location	Observations
Chartiers Creek	
SS-01	stream bed is rocky, possible tar nodule
Outfall for Findlay Refractory and street (east side of Chartiers Creek)	sheen, white color to water, odor to water , believed to be NPDES discharge
SS-02	stream bed is silty soil with pebbles, possible tar nodule
Outfall-032 (west side of Chartiers Creek)	approximately 6 in diameter pipe which may discharge runoff from Caldwell Avenue, stream bottom is silty soil with little rocks
Molycorp NPDES Outfall at Bridge	stream bottom is rocky upstream and then soft and silty downstream
Outfall S-04	pipe about 3 feet in diameter, stream bottom sediment is fine, no indication of tar impacts
S-035	relatively shallow location for about 20 feet, tar nodules present
S-036	relatively shllow location, tar appears to be seeping out along western side or there is a tar depositional area all along this stream bank
S-037	point where old railroad bridge crossed creek, old piers present, brick and rubble all along bank, tar on east bank, tar apparently on much of stream bottom, sheens on water apparently seeping into stream, slag on bank
S-038	an approximately 2 foot diameter discharge pipe on eastern side, tar seep on east bank, no evidence of tar on west bank, small tar deposit on west bank about 10 feet further downstream
S-05	relatively shallow location, S-38 to S-05 is relatively deep, fine sediment at S-05, there is evidence of tar along east bank and possibly on bottom of stream
Confluence of Sugar Run	tar on western and eastern bank
Chartiers Creek upstream of confluence with Sugar Run	tar seeps all along eastern bank
S-039A	relatively shallow water at this location, tar on western bank, eastern bank highly eroded
S-042	concrete dam, tar seeps upstream along eastern bank, no evidence of seeps along west bank, about 30 feet upstream from dam is pipe, about 20 feet upstream from pipe the tar seeps appear to stop, may be covered by roots
S-06	upstream area, no apparent tar seeps
S-043	water shallow, high flow, rocks, tar seep along east bank
S-07	at I-70 on Molycorp side, rocky bottom mostly
S-08	upstream of Molycorp site on eastern side of I-70,seeps along Hazel Atlas side of creek with sheen, possible tar odor in sediment, lots of bricks in stream
Sugar Run	
S-09	Sugar Run upstream of confluence with Chartiers Creek, no evidence of tar on either bank, rocks on bed, much smaller than Chartiers Creek,
Upstream of tunnel under access road	stream bed in finer material, no evidence of tar or tar seeps
S-10	upstream in Sugar Run where railroad crosses, no evidence of tar or tar seeps
S-11	no evidence of tar in stream, refractory brick present in stream bottom
S-12	no evidence of refractory brick for a while, hydrocarbon odor, pipe (3-4")

Table 13
Surface Sediment Radiological Results

Sample Identification	Ra-226 (pCi/g)[1]	U-234/238 (pCi/g)	Th-232 (pCi/g)
SS-1	1.68 ± 0.23	2.49 ± 0.84	1.96 ± 0.32
SS-2	1.32 ± 0.18	1.57 ± 0.94	1.13 ± 0.19
SS-3	1.50 ± 0.21	1.95 ± 0.88	1.46 ± 0.25
SS-4	1.42 ± 0.22	1.59 ± 0.87	1.20 ± 0.28
SS-5	1.45 ± 0.19	2.9 ± 1.1	1.12 ± 0.19
SS-6	1.42 ± 0.22	2.06 ± 0.81	1.12 ± 0.24
SS-7	1.64 ± 0.23	2.10 ± 0.97	1.37 ± 0.25
SS-10	1.62 ± 0.23	2.3 ± 1.0	1.31 ± 0.25

Footnote:
(1) pCi/g - picocurries per gram
Not corrected for background

Table 14
Surface Water Radiological Results

Sample Identification	Gross Alpha (pCi/L)[1]	Gross Beta (pCi/L)
SW-1	0.48	1.4
SW-2	0	1.3
SW-3	0	0.8
SW-4	0.4	1.1
SW-5	0	1.5
SW-6	0.37	2.7
SW-7	0.79	3
SW-8	0.19	1.6
SW-9	0	2.7
SW-10	0.81	2.2
SW-11	0.95	1.6
SW-12	0.8	1.5
SW-13	0.67	3.3
SW-14	2.2	4.1
SW-15	0.75	2.4
SW-16	0.68	1.6

Footnote:
(1) pCi/L - picocurries per liter
Not corrected for background

Table 15
TCLP Analysis

Constituent	TCLP Regulatory Levels[1]	Sample Identification	MPSB-15A	MPSB-19	MPSB-19	MPSB-25	MPSB-25	MPSB-28	MPSB-28	MPSB-37	MPSB-37	MPSB-43	MPSB-43	MPSB-49	MPSB-77	MPSB-77
		Sample Depth	14-16	6-8	12-14	15-17	19-21	10-12	12-14	2-2.6	4-4.3	4-4.6	12-14	4-6	12-14	16-18
		Sample Date	9/29/2003	9/29/2003	9/29/2003	9/30/2003	9/30/2003	10/1/2003	10/1/2003	10/1/2003	10/1/2003	10/2/2003	10/2/2003	10/13/2003	10/10/2003	10/10/2003
TCLP[2]		**Units**														
Arsenic	5.0	mg/L[3]	<0.050	<0.050	<0.050	<0.050	<0.050	0.057	<0.050	<0.050	<0.050	0.05	<0.050	<0.050	<0.050	<0.050
Barium	100.0	mg/L	<1.0	<1.0	<1.0	<1.0	<1.0	1.1	<1.0	1.3	1.6	1.2	<1.0	<1.0	<1.0	<1.0
Cadmium	0.5	mg/L	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Chromium	5.0	mg/L	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Lead	5.0	mg/L	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Mercury	0.2	mg/L	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Selenium	1.0	mg/L	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0.10	<0.10	<0.10	<0.10	0.11	<0.10	<0.10
Silver	5.0	mg/L	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050

Footnotes:
(1) Regulatory levels obtained from US Enivronmental Protection Agency Website.
(2) TCLP Compounds were analyzed by US Environmental Protection Agency Method SW 846 6010B and 7471.
(3) mg/L - milligrams/liters
105 = Reported concentration exceeds TCLP regulatory level.

Table 15
TCLP Analysis

Constituent	TCLP Regulatory Levels(1)	Sample Identification / Sample Depth / Sample Date	MPSB-91 4-6 10/14/2003	MPSB-91 6-8 10/14/2003	MPSB-96 5-7 10/13/2003	MPSB-96 9-11 10/13/2003	MPSB-113 2-4 10/21/2003	MPSB-113 4-6 10/21/2003	MPSB-123 6-8 10/21/2003	MPSB-123 10-12 10/21/2003
TCLP(2)		Units								
Arsenic	5.0	mg/L(3)	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Barium	100.0	mg/L	1.2	1.2	1.1	<1.0	<1.0	1.6	1.2	1.3
Cadmium	0.5	mg/L	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0.17	<0.050
Chromium	5.0	mg/L	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Lead	5.0	mg/L	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Mercury	0.2	mg/L	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Selenium	1.0	mg/L	0.17	0.11	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Silver	5.0	mg/L	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050

Footnotes:
(1) Regulatory levels obtained from US Enivronmental Protection Agency Website.
(2) TCLP Compounds were analyzed by US Environmental Protection Agency Method SW 846 6010B and 7471.
(3) mg/L - milligrams/liters
105 = Reported concentration exceeds TCLP regulatory level.

Table 16
SPLP Analysis

Constituent	MSC[1] Residential Used Aquifers	MSC Residential Non-Use Aquifers	Sample Identification	MPSB-15A	MPSB-19	MPSB-19	MPSB-25	MPSB-25	MPSB-28	MPSB-28	MPSB-37	MPSB-37	MPSB-43	MPSB-43	MPSB-49	MPSB-77
			Sample Depth	14-16	6-8	12-14	15-17	19-21	10-12	12-14	2-2.6	4-4.3	4-4.6	12-14	4-6	12-14
			Sample Date	9/29/2003	9/29/2003	9/29/2003	9/30/2003	9/30/2003	10/1/2003	10/1/2003	10/1/2003	10/1/2003	10/2/2003	10/2/2003	10/13/2003	10/10/2003
SPLP[2]			Units													
Aluminum	200[3]	200[3]	µg/L[4]	**36,000**	**7,900**	**18,000**	**4,200**	**8,300**	**2,300**	**7,500**	**510**	**560**	60	**7,100**	**890**	**20,000**
Antimony	6	6,000	µg/L	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50
Arsenic	50	50,000	µg/L	<50	<50	<50	<50	<50	130	<50	<50	<50	<50	<50	<50	<50
Barium	2,000	2,000,000	µg/L	<1,000	<1,000	<1,000	<1,000	<1,000	<1,000	<1,000	<1,000	<1,000	<1,000	<1,000	<1,000	<1,000
Beryllium	4	4,000	µg/L	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Boron	600	600,000	µg/L	300	140	250	200	<100	**4,600**	**1,100**	**660**	300	**1,000**	**610**	**1,400**	390
Cadmium	5	5,000	µg/L	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50
Chromium	100	100,000	µg/L	50	<50	<50	<50	<50	<50	<50	69	<50	<50	<50	<50	<50
Cobalt	2,000	2,000,000	µg/L	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50
Copper	730	730,000	µg/L	73	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50
Iron	300[3]	300[3]	µg/L	**29,000**	**3,600**	**14,000**	**3,000**	**6,900**	**2,400**	**5,600**	<1,000	<1,000	<1,000	**7,400**	<1,000	**39,000**
Lead	5	5,000	µg/L	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50
Manganese	50[3]	50[3]	µg/L	**1,300**	<100	<100	<100	<100	<100	<100	<100	<100	<100	**110**	<100	**540**
Mercury	2	2,000	µg/L	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Molybdenum	--[5]	--	µg/L	1,200	550	280	380	<100	14,000	500	1,200	2,100	5,000	5,100	6,600	380
Nickel	100	100,000	µg/L	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100
Selenium	50	50,000	µg/L	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	310	<100	<100
Silver	100	100,000	µg/L	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50
Thallium	2	2,000	µg/L	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100
Tin	22,000	22,000,000	µg/L	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100
Tungsten	--	--	µg/L	440	130	<50	<50	<50	2,600	71	8,500	3,600	510	660	140	<50
Vanadium	260	260,000	µg/L	65	<50	<50	<50	<50	**2,200**	<50	<50	98	87	**440**	<50	<50
Zinc	2,000	2,000,000	µg/L	67	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	83

Footnotes:
(1) MSC - Medium Specific Concentrations (MSCs) for Organic and Inorganic Regulated Substances in Groundwater, Appendix A, Tables 1 and 2, 25 PA Code Chapter 250.
(2) SPLP Compounds were analyzed by US Environmental Protection Agency Method SW 846 6010B and 7471.
(3) Secondary Maximum Contaminant Level
(4) µg/L - micrograms/liters
(4) Identified concentration is an estimated value below the laboratory reporting limit but above the method detection limit.
(5) -- Medium Specific Concentration not yet established by Pennsylvania Department of Environmental Protection.

610 = Reported concentration exceeds MSC for Residential Use Aquifer.

610 = Reported concentration exceeds MSC for Residential Non-Use Aquifer.

610 = Reported concentration exceeds MSC for Residential Used and Non-Use Aquifer.

Table 16
SPLP Analysis

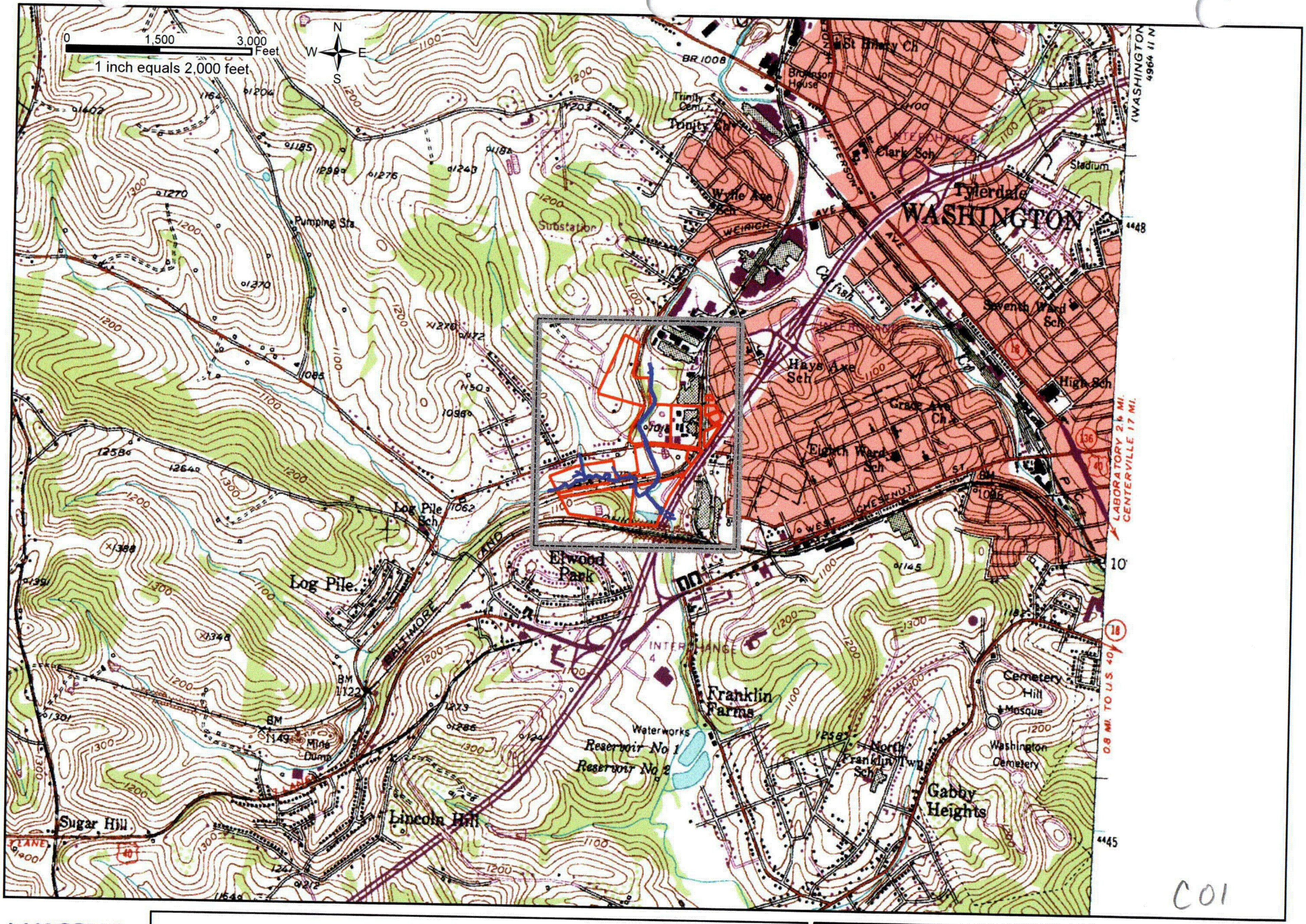
Constituent	MSC(1) Residential Used Aquifers	MSC Residential Non-Use Aquifers	Sample Identification / Sample Depth / Sample Date	MPSB-77 16-18 10/10/2003	MPSB-91 4-6 10/14/2003	MPSB-91 6-8 10/14/2003	MPSB-96 5-7 10/13/2003	MPSB-96 9-11 10/13/2003	MPSB-113 2-4 10/21/2003	MPSB-113 4-6 10/21/2003	MPSB-123 6-8 10/21/2003	MPSB-123 10-12 10/21/2003
SPLP(2)			Units									
Aluminum	200(3)	200(3)	µg/L(4)	**8,400**	**1,400**	130	**2,000**	**3,500**	**980**	**1,100**	<50	**17,000**
Antimony	6	6,000	µg/L	<50	<50	<50	<50	<50	<50	<50	<50	<50
Arsenic	50	50,000	µg/L	<50	<50	<50	<50	<50	<50	<50	<50	<50
Barium	2,000	2,000,000	µg/L	<1,000	<1,000	<1,000	<1,000	<1,000	<1,000	<1,000	<1,000	<1,000
Beryllium	4	4,000	µg/L	<10	<10	<10	<10	<10	<10	<10	<10	<10
Boron	600	600,000	µg/L	340	**710**	**910**	220	<100	110	110	**960**	**930**
Cadmium	5	5,000	µg/L	<50	<50	<50	<50	<50	<50	<50	<50	<50
Chromium	100	100,000	µg/L	<50	<50	<50	<50	<50	<50	<50	<50	<50
Cobalt	2,000	2,000,000	µg/L	<50	<50	<50	<50	<50	<50	<50	<50	<50
Copper	730	730,000	µg/L	<50	<50	<50	<50	<50	<50	<50	<50	<50
Iron	300(3)	300(3)	µg/L	**13,000**	<1,000	<1,000	**1,100**	**2,100**	<1,000	<1,000	<1,000	**17,000**
Lead	5	5,000	µg/L	<50	<50	<50	<50	<50	<50	<50	<50	<50
Manganese	50(3)	50(3)	µg/L	**190**	<100	<100	<100	<100	<100	<100	**100**	**110**
Mercury	2	2,000	µg/L	<10	<10	<10	<10	<10	<10	<10	<10	<10
Molybdenum	--(5)	--	µg/L	3,500	4,100	4,500	620	<100	<100	2,700	34,000	16,000
Nickel	100	100,000	µg/L	<100	<100	<100	<100	<100	<100	<100	<100	<100
Selenium	50	50,000	µg/L	<100	<100	<100	<100	<100	<100	<100	<100	<100
Silver	100	100,000	µg/L	<50	<50	<50	<50	<50	<50	<50	<50	<50
Thallium	2	2,000	µg/L	<100	<100	<100	<100	<100	<100	<100	<100	<100
Tin	22,000	22,000,000	µg/L	<100	<100	<100	<100	<100	<100	<100	<100	<100
Tungsten	--	--	µg/L	<50	710	3,100	<50	<50	<50	<50	150	180
Vanadium	260	260,000	µg/L	<50	<50	64	<50	<50	<50	<50	<50	<50
Zinc	2,000	2,000,000	µg/L	<50	<50	<50	<50	<50	<50	<50	<50	51

Footnotes:
(1) MSC - Medium Specific Concentrations (MSCs) for Organic and Inorganic Regulated Substances in Groundwater, Appendix A, Tables 1 and 2, 25 PA Code Chapter 250.
(2) SPLP Compounds were analyzed by US Environmental Protection Agenc
(3) Secondary Maximum Contaminant Level
(4) µg/L - micrograms/liters
(4) Identified concentration is an estimated value below the laboratory report
(5) -- Medium Specific Concentration not yet established by Pennsylvania De

610 = Reported concentration exceeds MSC for Residential Use Aquifer.

610 = Reported concentration exceeds MSC for Residential Non-Use Aquifer.

610 = Reported concentration exceeds MSC for Residential Used and Non-Use Aquifer.



C01

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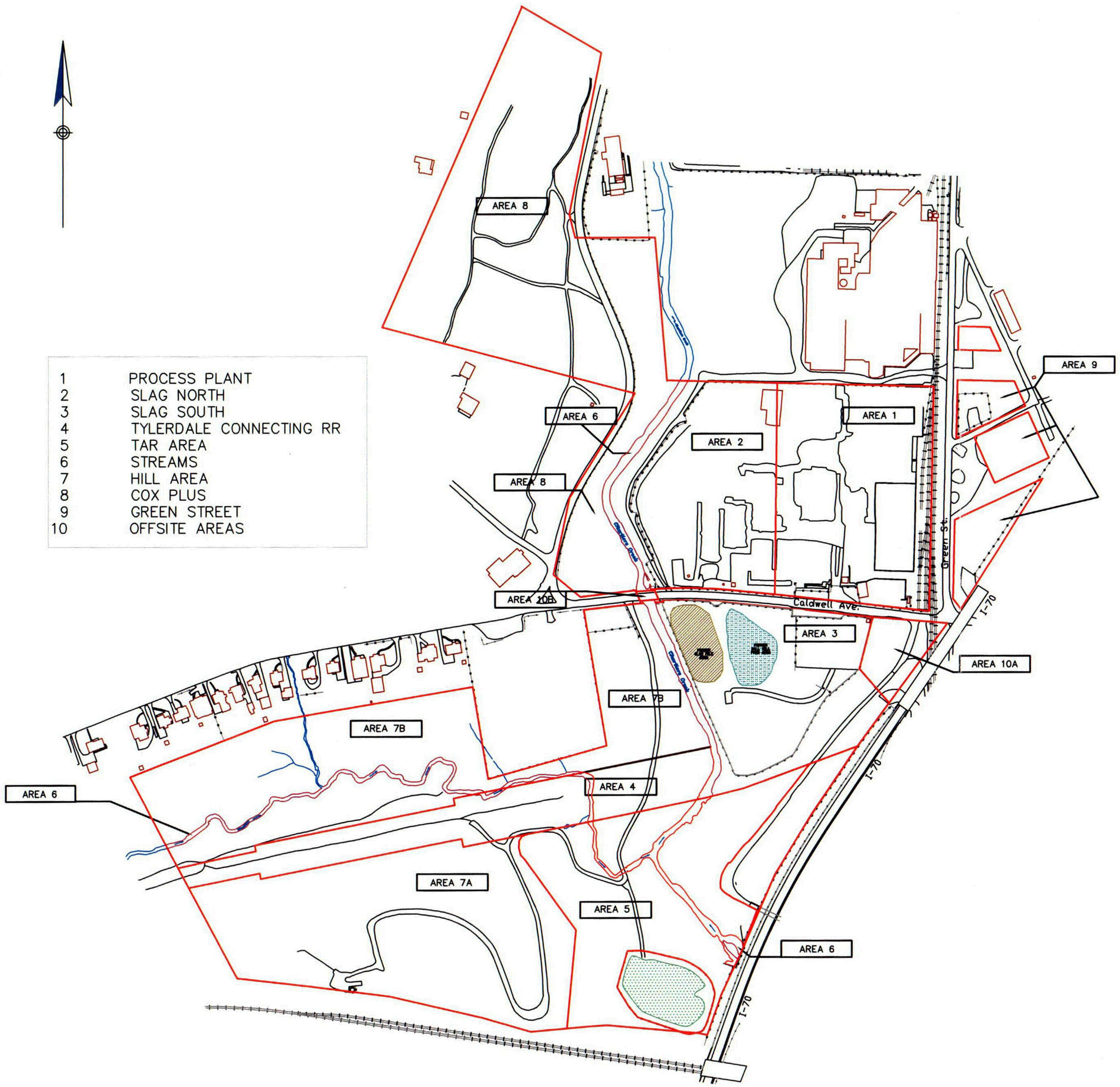
Supplemental Site Characterization Report
for the Washington Pennsylvania Site

April 2004

Figure 1
Site Location Map
(Washington West, PA Quad - Revised 1969)



Area 1 - Sub-Areas

Area 5 - Sub-Areas

C02

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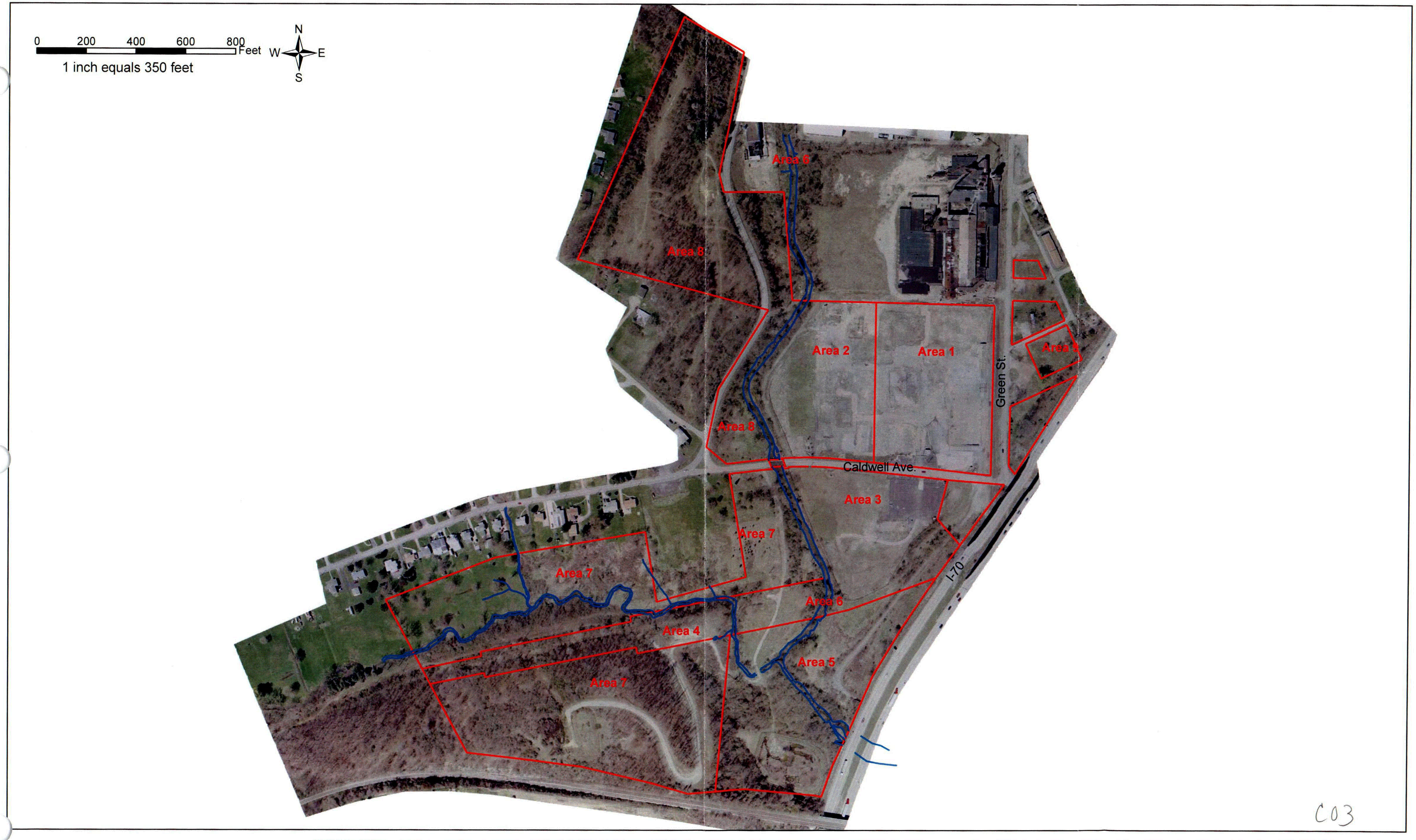
April 2004

Figure 2
Area Designations



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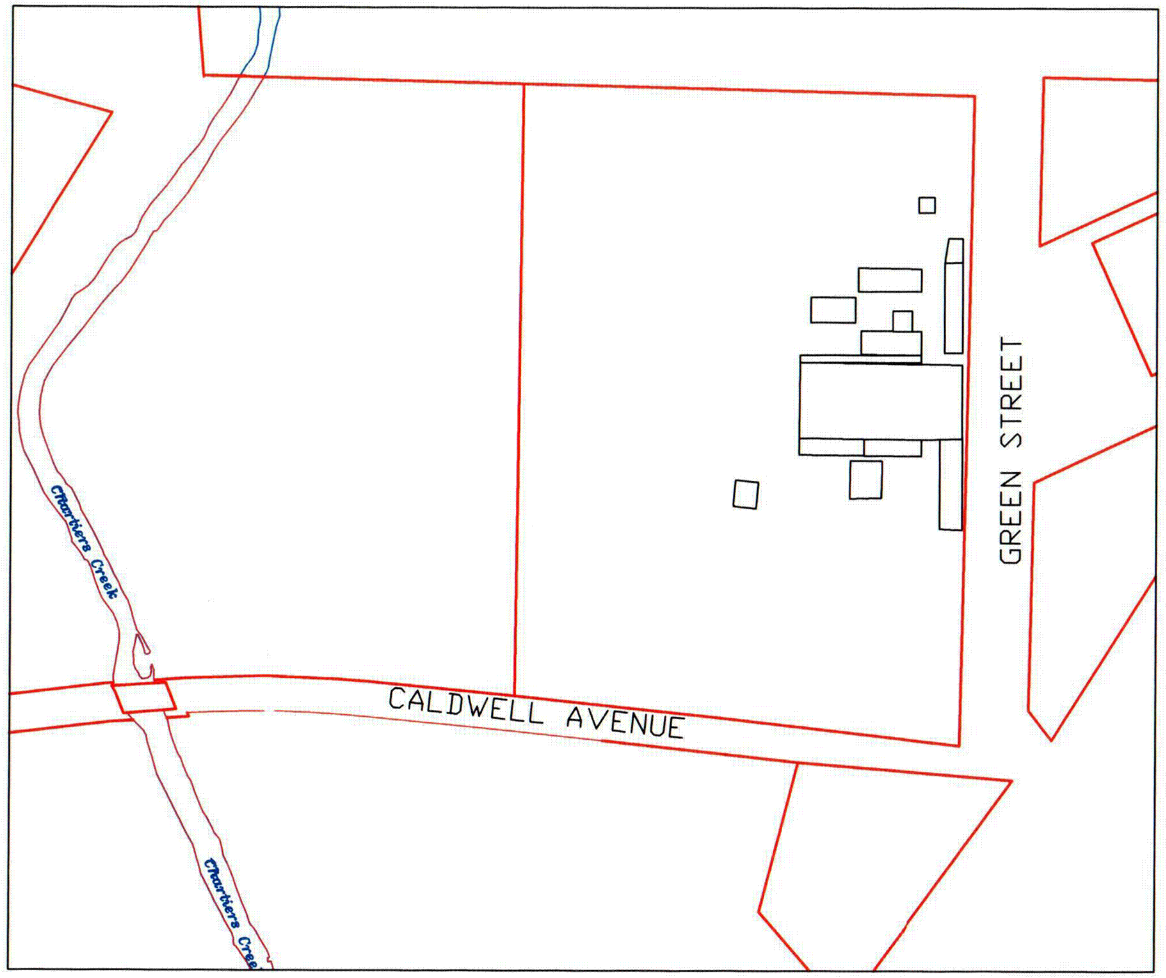
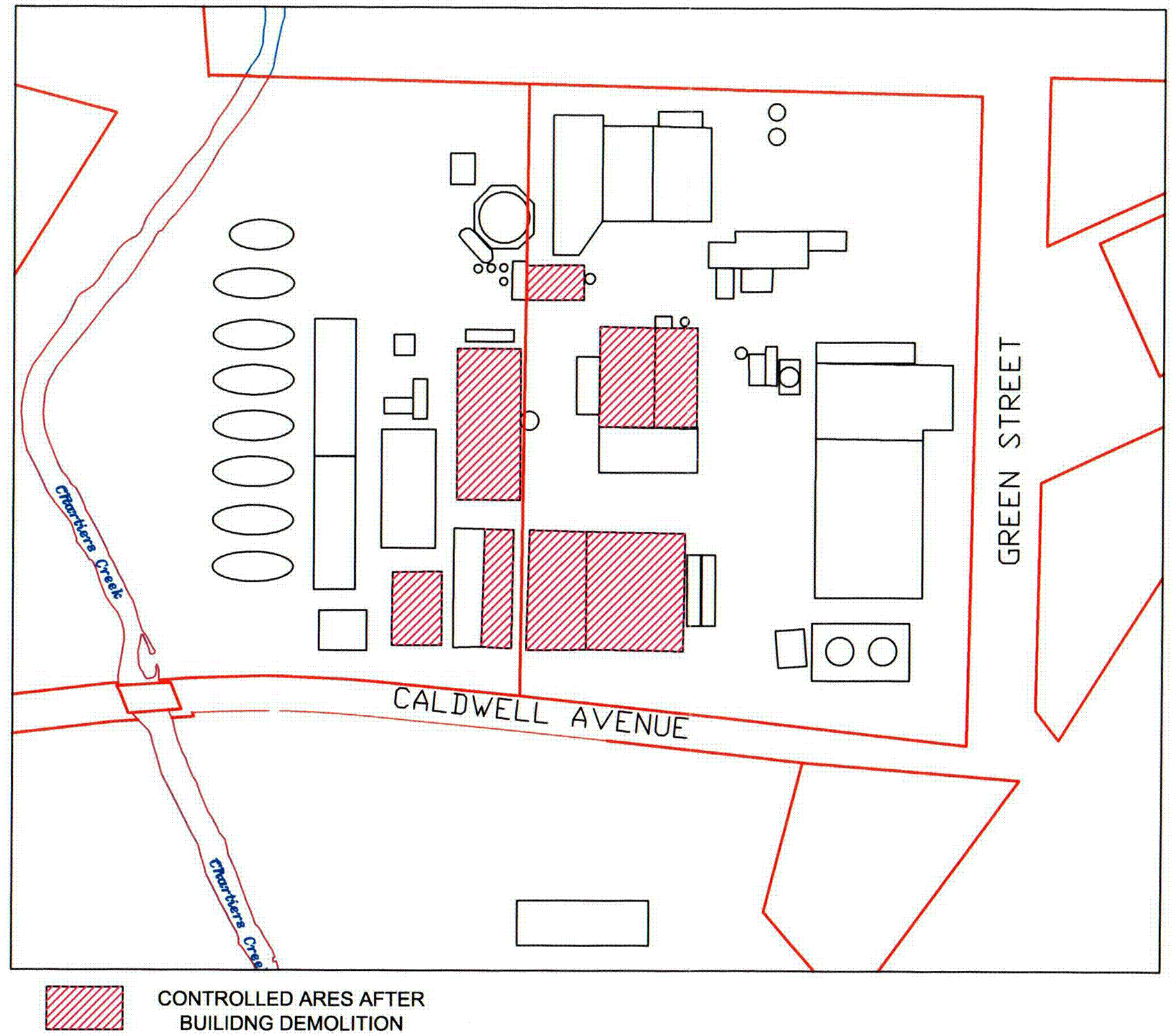
April 2004

Figure 3
Aerial Photograph
(April 2003)



ORIGINAL BUILDING CONFIGURATION AT PURCHASE (1916)



FINAL BUILDING CONFIGURATION PRIOR TO DEMOLITION

C04

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Figure 4
Building Configurations

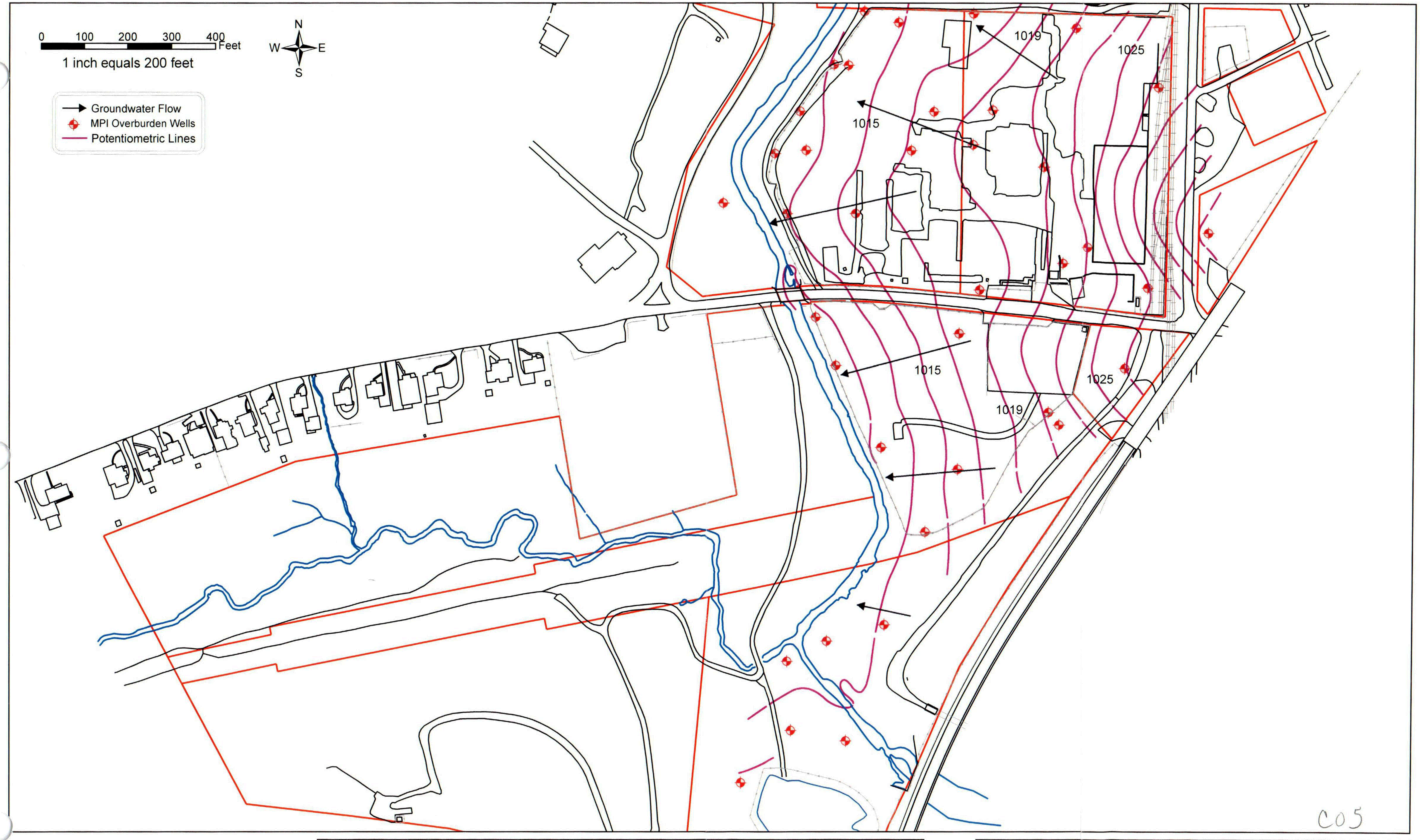
THIS PAGE IS AN OVERSIZED DRAWING OR FIGURE,

THAT CAN BE VIEWED AT THE RECORD TITLED:

FIGURE 5
"Sample Locations"

WITHIN THIS PACKAGE..

D-01



C05

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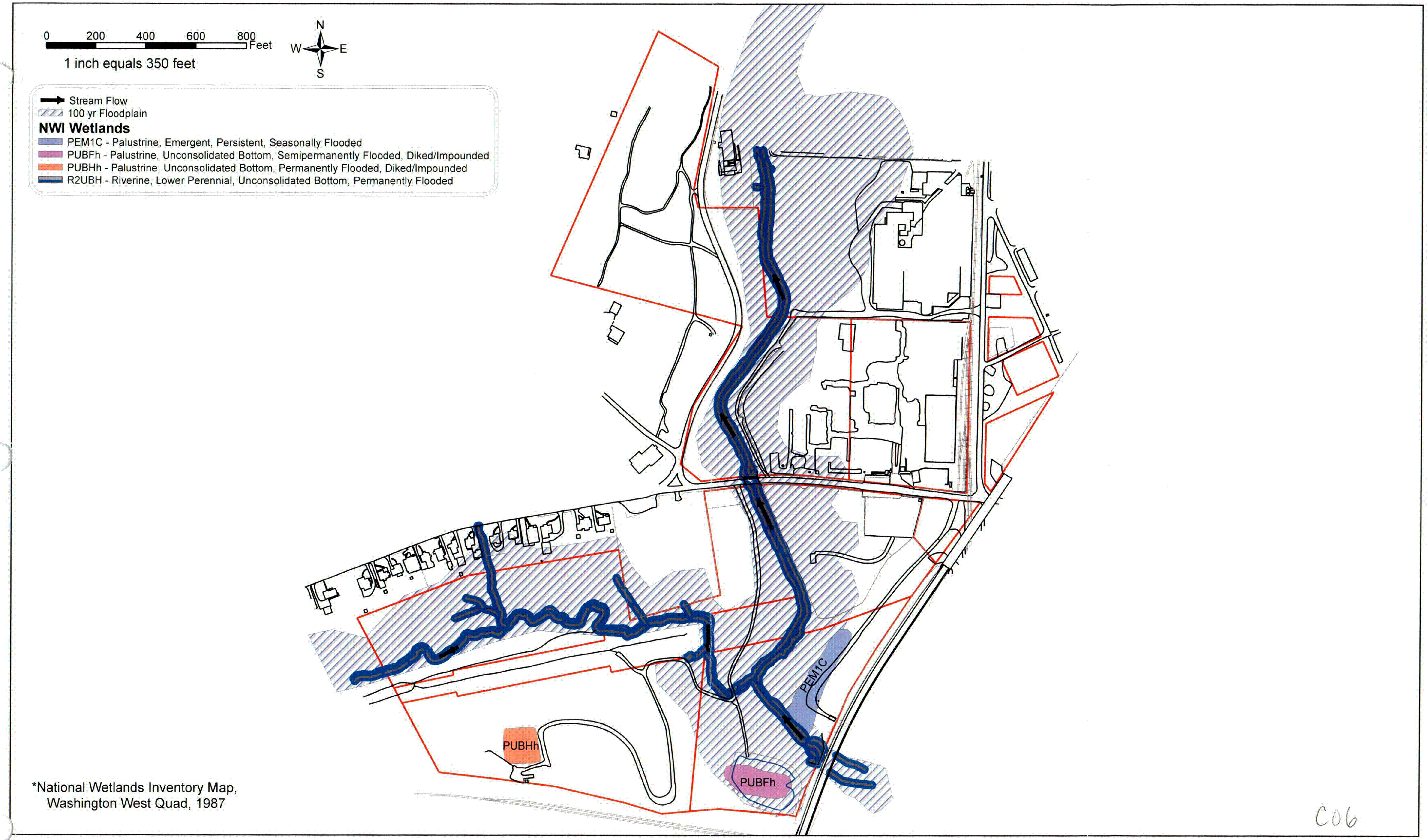
Figure 6
Site Potentiometric Map
Overburden Wells, December 2003



MALCOLM PIRNIE

Supplemental Site Characterization Report
for the Washington Pennsylvania Site

April 2004

Figure 7
Wetlands and Floodplain Map

THIS PAGE IS AN OVERSIZED DRAWING OR FIGURE,

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FIGURE 9
Sheet 1
"CROSS SECTION A-A"

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D-02

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FIGURE 10
SHEET 2
"CROSS SECTION B-B"
AND C-C' "

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D-03

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FIGURE 11
SHEET 3
"CROSS SECTION D-D'"

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D-04