



TETRA TECH

Remedial Investigation Report

**Sites 063 and 065
Jersey City, New Jersey**

**PPG Industries, Inc.
Pittsburgh, PA**

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ACRONYMS

Baldwin Oil	Baldwin Oil & Commodities, Inc.
bgs	below ground surface
CCPW	Chromate chemical production waste
COPEC	Contaminants of Potential Environmental Concern
COPR	Chromite ore processing residue
CrSCC	Chromium Soil Cleanup Criteria
EE	Ecological Evaluation
ESC	Ecological Screening Criteria
ESNR	Environmentally Sensitive Natural Resources
GWQS	Ground Water Quality Standard
HDPE	High Density Polyethylene
IDW	Investigation derived waste
IGW SSL	Impact to Groundwater Soil Screening Level
mg/kg	milligram per kilogram
mL/min	milliliters per minute
MS/MSD	Matrix spike and matrix-spike duplicate
NJDEP	New Jersey Department of Environmental Protection
NRDC SRS	Non Residential Direct Contact Soil Remediation Standard
PPG Industries, Inc.	PPG
RDC SRS	Residential Direct Contact Soil Remediation Standard
RI	Remedial Investigation
SPLP	Synthetic Precipitation Leaching Procedure
Tetra Tech	Tetra Tech Inc.
ug/L	Microgram per Liter
USEPA	United States Environmental Protection Agency

EXECUTIVE SUMMARY

On behalf of PPG Industries, Inc. (PPG), Tetra Tech has prepared this Remedial Investigation (RI) Report summarizing field activities conducted at Sites 063, Baldwin Oil, and 065, Burma Road, in Hudson County, Jersey City, New Jersey. The RI was conducted to determine the nature and extent of the chromate chemical production waste (CCPW), also referred to as chromite ore processing residue (COPR), contamination.

Investigations conducted at the Sites are subject to the 1990 Administrative Consent Order between PPG and the New Jersey Department of Environmental Protection (NJDEP). In 2009, PPG, NJDEP and the City of Jersey City entered into a Judicial Consent Order with the purpose of remediating the sources and soil contamination at the impacted sites (AECOM, 2011)..

Sites 063 and 065 were investigated due to the presence of CCPW, which contains chromium, hexavalent chromium, and other metals, on the property in prior years. Interim remedial actions were conducted in 1999 to minimize exposure to CCPW. The investigations conducted for this RI report consisted of sampling soil (at different depths), water (surface and groundwater), and sediment. The soil, groundwater, surface water, and sediment samples were analyzed for CCPW metals (chromium, hexavalent chromium, antimony, nickel, vanadium, and thallium).

Initial investigation field activities were conducted during July, August, and September 2011. The soil, sediment, surface water, and groundwater samples for the initial investigation were analyzed using United States Environmental Protection Agency (USEPA) Method SW-846 6010C (USEPA, 2007b), based on the Remedial Investigation Work Plan (RIWP) (AECOM, 2011). The results (both detections and non-detections) were compared to the NJDEP Residential Direct Contact Soil Remediation Standards (RDC SRS), Non-Residential Direct Contact Soil Remediation Standards (NRDC SRS), and default Impact to Groundwater Soil Screening Levels (IGW SSL) for CCPW metals, and the NJDEP Chromium Soil Cleanup Criteria (CrSCC). Exceedances of these soil remediation standards/screening levels/CrSCC are shown on separate tables and figures. The NJDEP CrSCC for both trivalent and hexavalent chromium are shown on the RDC SRS tables and figures.

During the initial RI in 2011, 52 soil borings were installed at Sites 063 and 065 and 276 soil samples were collected from these borings. Of the 276 soil samples, 52 were surface soil and 224 were subsurface soil samples. Chromium, hexavalent chromium, antimony, nickel, vanadium, and thallium were present in the samples. The samples obtained during the initial investigation that contained chromium did not exceed the NJDEP CrSCC for trivalent chromium (120,000 milligrams per kilogram (mg/kg)). Hexavalent chromium was detected in 92 soil samples, 10 of which had concentrations that exceeded the NJDEP CrSCC (20 mg/kg). The boring locations where hexavalent chromium exceeded the NJDEP CrSCC are mostly clustered in a small area in the center of Site 063 near the southern end.

Antimony was detected in 48 soil samples; one sample contained a concentration that exceeded the RDC SRS (31 mg/kg) and 8 contained concentrations that exceeded the IGW SSL (6 mg/kg). Additionally, seven samples had non-detect values of antimony that exceeded the IGW SSL (6 mg/kg) and one sample had a non-detect value that exceeded the RDC SRS (31 mg/kg). Nickel was detected in the samples collected, five of which had concentrations that exceeded the IGW SSL (31 mg/kg). Vanadium was detected in the samples collected, 44 of which contained concentrations that exceeded the RDC SRS (78 mg/kg). Thallium was

detected in one sample at a concentration below the minimum soil remediation standard/screening level (3 mg/kg); however, there were seven samples with non-detect values for thallium that exceeded the RDC SRS (5 mg/kg) and the IGW SSL (3 mg/kg).

During the initial RI in 2011, seven groundwater monitoring wells were installed at Sites 063 and 065 and one groundwater sample was collected from each well and analyzed for CCPW metals. Three monitoring wells were resampled for hexavalent chromium because the holding time was exceeded. The highest concentrations of chromium, hexavalent chromium, antimony, nickel, and vanadium were detected in 063_MW01. Samples from three wells contained chromium concentrations that exceeded the NJDEP Groundwater Quality Standard (GWQS) (70 micrograms per liter (ug/L)). One sample had an antimony concentration that exceeded the NJDEP GWQS (6 ug/L). Samples from two wells contained nickel concentrations that exceeded the GWQS (100 ug/L). Samples from three wells had vanadium concentrations that exceeded the NJDEP GWQS (60 ug/L). Thallium was not detected in the groundwater samples obtained; however, the method detection limit for these groundwater samples exceeded the GWQS using USEPA Method SW-846 6010C (USEPA, 2007b) for the analysis.

During the initial RI in 2011, two surface water samples were collected from a catch basin and a storm sewer located on Sites 063 and 065. Surface water sample results were compared to the NJDEP Ecological Screening Criteria (ESC) for freshwater. Both surface water samples contained chromium and vanadium concentrations that exceeded the NJDEP ESC. Hexavalent chromium, antimony, and nickel were detected at concentrations below the NJDEP ESC. Thallium was not detected in either surface water sample; however, the method detection limit exceeded the NJDEP ESC for thallium in both surface water samples. The sanitary sewer/storm sewer is a combined system that discharges to a local sanitary treatment facility so any water that is transported within the pipe or along the pipe discharges to the local treatment facility. Water lines and gas lines along Burma Road do not have discharge points to surface water.

During the initial RI, two sediment samples were collected from a catch basin and a storm sewer located on Sites 063 and 065. Concentrations of metals in sediment were compared to NJDEP ESC for sediment in freshwater. Chromium and nickel concentrations in both sediment samples exceeded the NJDEP ESC. Hexavalent chromium and vanadium were detected but there are no NJDEP ESCs for either chemical in sediment. Antimony and thallium were not detected in either sediment sample.

The initial investigation did not fully delineate the extent of contamination in soil and groundwater; therefore, a delineation investigation was conducted in December 2012 and January 2013 according to the Technical Memorandum sent to NJDEP on July 16, 2012 with minor revisions, conference calls and discussions with NJDEP. Ten new soil borings were drilled for soil samples and Synthetic Precipitation Leaching Procedure (SPLP) samples were collected from four soil borings and used to calculate site-specific IGW SSLs for antimony and nickel. Three new groundwater wells were installed and the ten groundwater wells were sampled during the delineation investigation (one sample per well). The delineation investigation analyzed the soil and groundwater samples using USEPA Method SW-846 6020A (USEPA, 2007a), which has a lower quantitation level for the metals than USEPA Method SW-846 6010C (USEPA, 2007b). The method detection limit for the metals was less than the minimum soil remediation standard/screening level of CCPW metals for both soil and groundwater samples. This eliminated the reporting of non-detections that were greater than the minimum soil remediation standard/screening level of CCPW metals for soil and groundwater samples.

During the delineation investigation, 52 soil samples were collected; ten of which were surface soil samples and 42 of which were subsurface soil samples. Chromium, hexavalent chromium, antimony, nickel, vanadium, and thallium were present in the samples obtained. The samples collected during the delineation investigation that contained chromium did not exceed the NJDEP CrSCC for trivalent chromium (120,000 mg/kg). Hexavalent chromium was detected in 16 soil samples, two of which contained concentrations of hexavalent chromium that exceeded the NJDEP CrSCC (20 mg/kg). Antimony was detected in 14 soil samples; the concentration of antimony did not exceed the minimum soil remediation standard/screening level (6 mg/kg). Nickel was detected in the samples collected, nine of which contained nickel concentrations that exceeded the default IGW SSL (6 mg/kg). Vanadium was detected in the samples collected, two of which contained concentrations that exceeded the RDC SRS (78 mg/kg). Thallium was detected in nine soil samples at concentrations below the minimum soil remediation standard/screening level (3 mg/kg).

Groundwater samples were collected from the three new monitoring wells and the seven existing monitoring wells (one sample per well). The location of the samples with the highest chromium and antimony concentrations is 063_MW11. The location of the samples with the highest hexavalent chromium, nickel, and vanadium concentrations is 063_MW01. Chromium concentrations detected in five monitoring wells exceeded the GWQS (70 ug/L). Antimony concentrations detected in two monitoring wells exceeded the NJDEP GWQS (6 ug/L). Nickel concentrations in three wells exceeded the GWQS (100 ug/L). Vanadium concentrations in four wells exceeded the NJDEP GWQS (60 ug/L). Thallium was not detected in groundwater samples collected during the delineation investigation. Non-detected concentrations of antimony and thallium were less than the GWQS.

Using data collected during the historical investigations, initial RI, and delineation RI, the extent of contamination in soil at Sites 063 and 065 was fully delineated. While contamination is spread throughout Sites 063 and 065, it is confined within the limits of Sites 063 and 065, bordered by Burma Road to the east, Morris Pesin Drive to the south, and the New Jersey Turnpike Property to the west and north. Excavation and proper disposal of approximately 10,970 cubic yards of impacted soil is recommended to remove soil contamination.

Using data collected during the initial and delineation RIs, the extent of groundwater contamination has been delineated vertically; however, the horizontal extent of groundwater contamination has not been fully delineated. Based on the two groundwater gauging events, groundwater does not appear to be infiltrating and following the preferential pathways of underground utilities. Groundwater was measured at 3.41 feet below ground surface (bgs) to 3.70 feet bgs in 063_MW01 to 5.80 feet bgs in 063_MW08 and the depth of the storm water/sewer in that area is between 2 and 3 feet bgs. Groundwater depth may vary seasonally.

Groundwater contamination is present in shallow groundwater only, as evidenced by the low concentrations of metals in groundwater sample results from the deep well (063_MW08). The horizontal extent of groundwater contamination downgradient of 063_MW10 and 063_MW11 and upgradient of 063_MW06 and 063_MW07 has not been fully delineated. As per N.J.A.C. 7:26E-4.3(a)7 and N.J.A.C. 7:26E-4.9(a)7 a Groundwater Classification Exception Area/Well Restriction Area (CEA/WRA) should be prepared following the requirements detailed in N.J.A.C 7:26C-73.

Chromium, hexavalent chromium, antimony, nickel, and vanadium were identified as contaminants of potential environmental concern (COPECs) because the detectable concentrations in surface soil exceeded their respective NJDEP ESCs. However, no environmentally sensitive natural resources (ESNRs) have been identified at or near Sites 063 and 065. Therefore, a completed exposure pathway between the COPECs in surface soil and the ESNRs does not exist. For that reason, an ecological risk assessment in accordance with New Jersey Administrative Code 7:26E-4.7 does not need to be conducted. Also, it is not likely that aquatic organisms would be impacted by metals in groundwater if it discharges to surface water.

1.0 INTRODUCTION

1.1 Purpose of Report

On behalf of PPG Industries, Inc. (PPG), Tetra Tech has prepared this Remedial Investigation (RI) Report summarizing field activities conducted at Sites 063, Baldwin Oil, and 065, Burma Road, in Hudson County, Jersey City, New Jersey. Site 063 is located at 1 Burma Road (Block 2154.4, Lot 4 according to the most recent Hudson County Map or Block 1497, Lot 4), Jersey City, Hudson County, New Jersey (see Figure 1). The Site Remediation Program Identification Number for Site 063 is G000008791. Site 065 is a narrow strip of land on the west side of Burma Road, between Burma Road and Site 063. Site 065 has no Block or Lot numbers assigned. The Site Remediation Program Identification Number for Site 065 is G000008693. The RI was conducted to determine the nature and extent of chromate chemical production waste (CCPW), also referred to as chromite ore processing residue (COPR) contamination. The initial RI was conducted in accordance with the scope of work outlined in AECOM's March 2011 Remedial Investigation Work Plan for Non-Residential Chromate Production Waste Sites – Sites 063 and 065 and the delineation RI was conducted in accordance with a Technical Memorandum submitted to the New Jersey Department of Environmental Protection (NJDEP) on July 16, 2012.

Investigations conducted at the Site are subject to the 1990 Administrative Consent Order between PPG and the New Jersey Department of Environmental Protection (NJDEP). In 2009, PPG, NJDEP and the City of Jersey City entered into a Judicial Consent Order with the purpose of remediating the sources and soil of contamination at the impacted sites (AECOM, 2011).

Sites 063 and 065 (referred to as the Site) were investigated due to the presence of CCPW that contained chromium, hexavalent chromium, and other metals on the property in prior years. Interim remedial actions were conducted in 1999 to minimize exposure to CCPW. The initial RI, conducted in June through August 2011, consisted of sampling soil (at different depths), water (surface and groundwater), and sediment. The initial RI did not fully delineate the nature and extent of contaminated soil and groundwater. Therefore, a sampling plan to collect additional data to facilitate delineation was designed and approved in July 2012. This delineation RI was conducted in December 2012 through February 2013 and consisted of sampling soil and groundwater.

The RI report provides the following:

- Characterization of potential CCPW-contaminated soil, surface water, sediment, and groundwater at the Site;
- Horizontal and vertical extent of CCPW-contaminated media at the Site;
- Assessment of the surface and subsurface site characteristics, including groundwater depth and flow direction;
- Presentation of data needed to develop a remedial action work plan to mitigate the effects of CCPW and CCPW-contamination on human health and the environment.

1.2 Historical information

Baldwin Oil & Commodities, Inc., (Baldwin Oil), leased the warehouse at Site 063 from Burma Realty from June 1961 until August 1978. In August 1978, Tyrube Associates, Inc., purchased

the property, and Baldwin Oil continued to operate on the property until the 1980's. Baldwin Oil packaged solvent products with packaging volumes ranging from pints to gallons to drums (AECOM, 2011).

On July 19, 1990, PPG agreed to an Administrative Consent Order issued by the NJDEP, stating they would perform interim remedial measures on certain sites, including Baldwin Oil, with the purpose of preventing possible exposure to CCPW and CCPW-impacted material (AECOM, 2011).

Sites 063 and 065 were listed as potential sites of chromium contamination. The data collected at the time were limited. In December 1987, NJDEP collected a scraped surface sample from the loading dock on the west side of Site 063 exceeding 3,000 parts per million (ppm) of total chromium. The exact location of this sample is unknown. In February 1988, NJDEP collected another sample from Site 065 where the total chromium concentration was 910 milligrams per kilogram (mg/kg) (AECOM, 2011).

In 1990, an inspection conducted by PPG and NJDEP occurred at Sites 063 and 065 during which they observed evidence of CCPW at the loading dock on the west side of the Site 063 warehouse, as well as on the exterior of the warehouse (southern and eastern walls). During this inspection, a four inch wide crack was observed in the interior of the warehouse but was not identified on any maps. Additionally, strong solvent odors and spills were observed beneath tanks placed on the over-ground storage tank area which was installed in 1959.

Due to the warehouse's structural instability, PPG and NJDEP agreed to demolish it, conduct interim remedial measures, and perform a RI. Warehouse demolition occurred in late 1998, and slab removal occurred in early 1999. The interim remedial measures included the removal of the warehouse's concrete slab, loading dock floor slab, and underlying fill materials (including most of the CCPW fill), above-ground storage tank demolition, installation of a high density polyethylene (HDPE) liner, and backfill and grading of the Site (AECOM, 2011). Soil sampling was performed in 1998 to obtain information for the removal of the warehouse's concrete slab and loading dock floor slab below the warehouse. After demolition of the warehouse occurred, additional sampling was conducted at the beginning of 1999 (AECOM, 2011).

CCPW was visually identified in the borings through the warehouse foundation but not in the borings surrounding the warehouse's concrete slab and loading dock floor slab. CCPW was observed as nodules in samples of soft reddish-brown silt or clay immediately below the concrete floor to a depth of 7.5 feet below ground surface (bgs). The criterion for hexavalent chromium at Sites 063 and 065 was set at 100 mg/kg. The majority of the soil borings through the warehouse's concrete slab foundation had a concentration of hexavalent chromium exceeding 100 mg/kg. Material exceeding the 100 mg/kg criterion ranged in depth from just below the concrete floor to 10 feet bgs. From this investigation, it was concluded that the highest concentrations of hexavalent chromium were located in the middle section of the warehouse foundation, towards the northern side of the warehouse (AECOM, 2011).

The interim remedial measures implemented for Sites 063 and 065 include warehouse demolition, removal of the warehouse's concrete slab, loading dock floor slab, and underlying fill materials, above-ground storage tank demolition, installation of fencing, installation of the HDPE liner, and paving areas with surface impacts. These measures were undertaken by PPG to reduce potential exposure to soil contaminated with CCPW and were not designed to completely remove chromium contaminations. Appendix A contains historical figures and a

table that shows data from the interim remedial measure, including location and depth of the post-excitation samples collected. The figure and table in Appendix A summarize the sample results for the soil remaining in place following the excavation interim remedial measure. More information regarding interim measures can be found in the document provided by IT Corporation (AECOM, 2011).

The southern part of the site is being used as a parking lot (approximately 1/4th of the site) and the remaining part of the site is a fenced, vacant lot.

1.2.1 Site 063 – Baldwin Oil

Site 063 is bordered by Site 065 and Burma Road to the east, Morris Pesin Drive to the south, and property owned by the New Jersey Turnpike Authority to the west (see Figures 1 and 2). Site 063 is approximately 2.11 acres (AECOM, 2011). Site 063 originally contained a warehouse (approximately 210 feet long by 120 feet wide) that was demolished as part of the interim remedial actions completed in 1998 and 1999. The warehouse was constructed on a floor slab approximately four feet above grade and included a loading dock along the north and west sides. Northeast of the warehouse were nine aboveground storage tanks previously used for the storage of various oil products and organic solvents (AECOM, 2011). Appendix A contains historical figures that show data from the previous investigations, including location and depth of the samples collected, and the interim remedial measures completed to date.

1.2.2 Site 065 – Burma Road

Site 065 is a strip of land approximately eight feet wide and 300 feet long (see Figures 1 and 2). Site 065 is located on the shoulder of Burma Road, between the road and Site 063. Site 065 was included with Site 063 due to its location and proximity to Site 063 (AECOM, 2011). Appendix A contains historical figures that show data from the previous investigations, including location and depth of the samples collected, and the interim remedial measures completed to date.

1.3 Report Organization

This report is organized as follows:

- Section 1 provides a brief introduction and history of the site.
- Section 2 describes the field activities that were conducted.
- Section 3 describes the environmental settings of Sites 063 and 065.
- Section 4 summarizes the results from the RI.
- Section 5 contains information regarding the receptor evaluation and the baseline ecological evaluation.
- Section 6 provides an overall summary and conclusions for the site.

2.0 INVESTIGATION SUMMARY

2.1 Modifications to the Work Plan

Several minor modifications were made during the initial and delineation RIs at Sites 063 and 065:

- Disposable, dedicated plastic trowels and paper bowls were used for soil sampling and homogenization. This eliminated the need to decontaminate stainless steel trowels and bowls, and eliminated the associated volume of decontamination water.
- Bentonite chips were used to fill the relatively small diameter Geoprobe holes instead of grout.
- Five-foot long Geoprobe cores and sleeves were used instead of 4-foot long cores and sleeves.
- Soft-dig techniques (vacuum boring) were utilized to a depth of 5 feet for borings completed outside of the area covered by the HDPE liner. Initially, a combination of vacuum boring and hand-augering was used to protect utilities. However, hand-augering to obtain samples at depth proved to be difficult within the fill material, which contained abundant gravel. In addition, there was concern that vacuuming could remove potentially contaminated zones within the soil without their presence being noted. An alternative approach that was used involved vacuuming to a depth of 5 feet without collecting samples, and then using direct-push as close as possible to this cleared hole.
- Boring 063_E008, which was located on a steep incline, was not installed. The boring location could not be moved farther west due to the presence of a salt dome on the neighboring property, and would be too proximal to boring 063_D008 if moved to the bottom of the incline.
- Monitoring wells 063_MW09 and 063_MW12 and the associated borings were not installed due to access issues with the New Jersey Turnpike Authority.
- Monitoring well 063_MW11 was moved approximately 12 feet to the west into Site 065 in order to prevent road closures during well sampling.
- Several sampling locations were moved (less than 10 feet) relative to their original map locations due to the presence of underground utilities, surficial obstructions, and general accessibility. Figures provided in this report reflect the final sample locations.
- For the initial RI field work, samples were analyzed using United States Environmental Protection Agency (USEPA) Method SW-846 6010C (USEPA, 2007b), based on the Remedial Investigation Work (RIWP) (AECOM, 2011). However, because USEPA Method SW-846 6010C (USEPA, 2007b) created several instances where the method detection limit was greater than the minimum soil remediation standard/screening level, samples collected during the delineation RI were analyzed using USEPA Method SW-846 6020A (USEPA, 2007a), which provides lower method detection limits.

2.2 Soil Investigation

2.2.1 Soil Boring Investigation

The objective of the soil sampling program was horizontal and vertical delineation of CCPW and CCPW-impacted materials at the Site. A copy of the Health and Safety Plan for this investigation can be found in Appendix B. A 60-foot by 60-foot grid was applied to the Site to facilitate the location of soil borings. During the initial RI, 11 soil borings were drilled at Site 065 and 41 soil borings were drilled at Site 063 between July 11 and August 1, 2011, as shown on Figure 2. Boring logs for the initial RI are presented in Appendix C-1, and geological cross sections (including the presence of CCPW) are shown in Figures 3 and 4. Sample nomenclature for the soil samples consists of the NJDEP site number (063 or 065) and the grid location (number/letter combination) from which the sample was collected as described in the NJDEP-approved Remedial Investigation Work Plan (AECOM, 2011). Table 1 summarizes pertinent data for the soil borings.

On March 2, 2012 NJDEP requested an additional investigation to complete the delineation at the Site after reviewing the draft RI report. A Technical Memorandum was submitted to NJDEP on July 16, 2012 with minor revisions, conference calls and discussions with NJDEP for further soil delineation that was conducted in December 2012 and January 2013. Ten borings were drilled and Synthetic Precipitation Leaching Procedure (SPLP) samples were collected from four additional locations, 063_B005, 063_C005, 063_C010, and 063_C011. Table 1 summarizes pertinent data for the soil borings, and their location is shown on Figure 2. Boring logs completed for the delineation RI are presented in Appendix C-2.

2.2.2 Surface and Subsurface Soil Sampling

Soil samples were collected using a track-mounted Geoprobe rig operated by New Jersey licensed drillers employed with Environmental Probing, Inc. (EPI) of Cream Ridge, New Jersey except for samples 065_A008_0.0 and 065_B015_0.0, which were collected using a disposable, dedicated plastic trowel, and 065_B015_4.0, which was collected using a decontaminated hand-auger. Geoprobe soil cores were collected by hydraulically advancing a 5-foot long, 2-inch diameter sampling tube with dedicated 1½-inch acetate liners to the designated sample depth in the subsurface. In borings located within the coverage of the HDPE liner, a 2 foot x 2 foot excavation was dug through the backfill covering the liner, and the liner was removed with a decontaminated knife.

The majority of the soil borings were advanced to a depth of 20 feet to facilitate soil sample collection (see description below), except for four borings (063_D004, 063_C011, 063_B007, and 063_B014), which were proposed to be advanced to a depth of 50 feet for the purposes of deep geological exploration. Refusal was encountered for these four borings at a depth ranging from 28 to 42 feet. Because of the shallow refusal (28 feet) at boring 063_B007, an additional deep boring was advanced at 063_B005, where refusal was encountered at 37 feet.

Each soil core collected in the acetate liner was opened and field screened with a Photoionization Detector (PID). The soil cores were logged according to the Burmeister Soil Classification System and Unified Soil Classification System, and soil color was classified using Munsell Color Charts to provide consistent descriptions. Additional observations (eg: staining, sheens, mottlings, CCPW material) and recovery percentages were noted. Soil boring logs are included in Appendix C.

In accordance with the NJDEP-approved Remedial Investigation Work Plan (AECOM, 2011), analytical samples were selected from each boring based upon the following sample rationale:

- One surficial soil sample from 0 to 0.5 feet bgs (or from the first 6-inch soil/fill interval beneath pavement or beneath the interim remedial measures bedding material underlying the HDPE liner);
- One sample from each 4-foot interval unless CCPW is visually identified;
- Where CCPW material is visually identified:
 - One sample directly above visible CCPW material unless the surficial sample contains CCPW;
 - One sample directly below the bottom of visible CCPW;
- One sample directly above the first native soil;
- One sample approximately 4 feet below the fill/native soil interface; and
- One sample approximately 8 feet below the fill/native soil interface (4 feet below the previous sample interval).

Table 1 provides a sample summary including details regarding sample collection depths.

Soil samples were collected within 6-inch discrete intervals for laboratory analysis. Soil samples were placed in laboratory-provided glassware. After the designation of a sample identification number, soil samples were sealed, labeled, packed on ice, documented following proper chain of custody procedures and delivered by courier to Test America in Edison, New Jersey, a NJDEP-certified laboratory for analysis. Soil samples were analyzed for hexavalent chromium, total chromium, antimony, nickel, thallium, and vanadium, ORP (Eh), and pH. See Table 2 for a list of the analytical methods used.

After the termination of each soil boring, the boreholes were back-filled with bentonite chips, and the soil cuttings were disposed of in 55-gallon drums for waste disposal characterization. In borings located within the coverage of the HDPE liner, the liner was repaired at each location by welding matching HDPE liner in place and the trench above the liner was backfilled with gravel.

2.2.3 Sediment and Surface Water Sampling

During the initial RI, two sediment and two surface water samples were collected from a catch basin and a storm sewer located on Sites 063 and 065 (see Figure 2). No sediment or surface water samples were collected during the delineation RI. The sediment samples were grab samples from the storm sewer (065_A010SS_SED) along Burma Road and from the catch basin (063_E005CB_SED) along the western property line. The surface water samples were samples from the storm sewer (065_A010SS_SW) and from the catch basin (063_E005CB_SW) where the sediment samples were collected.

Sediment samples were collected from the catch basin and storm sewer using a disposable, dedicated plastic trowel, which was lowered to the desired depth by attaching to a decontaminated 4 inch Geoprobe rod provided by the drillers. Once the desired volume was collected, the sample was homogenized in a paper bowl. Surface water samples were collected

from the catch basin and storm sewer by lowering a dedicated laboratory-provided plastic bottle attached to bailer twine to the desired depth. Each sample was placed in laboratory-provided glassware. After the designation of a sample identification number, sediment and surface water samples were sealed, labeled, packed on ice, documented following proper chain of custody procedures, and delivered by courier to Test America for analysis. Samples were analyzed for hexavalent chromium, total chromium, antimony, nickel, thallium, vanadium, ORP (Eh), and pH. See Table 2 for a list of the analytical methods used.

2.3 Groundwater Investigation

2.3.1 Monitoring Well Installation

Seven monitoring wells were installed in the surficial aquifer during the initial RI in July 2011: 063_MW01, 063_MW02, 063_MW03, 063_MW04, 063_MW05, 063_MW06, and 063_MW07. Three monitoring wells (063_MW08, 063_MW10, and 063_MW11) were installed in December 2012 and January 2013 at the Site during the delineation RI. Monitoring wells 063_MW-10 and 063_MW-11 were installed to delineate the lateral extent of impacts, while monitoring well 063_MW-8 was installed for vertical delineation at the Site. Monitoring wells coincided with soil boring locations where soil samples were also collected, except for 063_MW11, which was moved (with NJDEP approval) approximately 12 feet to the west to prevent road closures during well sampling. Wells were installed using the hollow stem auger (HSA) method with a track-mounted Geoprobe rig operated by New Jersey-licensed drillers employed with EPI.

Groundwater field sheets, notes, and NJDEP Monitoring Well Certification Forms Part A & B for the monitoring wells can be found in Appendix D. A copy of the Health and Safety Plan can be found in Appendix B. The locations of the monitoring wells are shown on Figure 2, and pertinent well information is included in Table 3.

In accordance with the NJDEP-approved Remedial Investigation Work Plan (AECOM, 2011), the majority of the wells were drilled to a depth ranging from 7 feet to 10 feet below grade with 5 feet of screen to facilitate the placement of the top of the well screen directly at the water table within the surficial aquifer, but above the underlying confining meadow mat layer based on visual observations from soil sampling. Well 063_MW08 was drilled to a depth of 20 feet below grade with 5 feet of screen to delineate the extent of vertical impact within groundwater at the Site. The wells were constructed of 2-inch inside diameter schedule 40, flush-threaded, NSF-approved PVC well screen and casing riser pipe. The screen slot size was 0.010 inches (10 slot), and the screen length was 5 feet for the wells.

A filter pack of clean silica sand was installed flush with the bottom of the well to at least one foot above the top of the well screen. A minimum 1-foot seal of bentonite was placed on top of the sand pack. The annular space above the bentonite was then backfilled with a cement/bentonite grout mixture from the top of the primary seal to within 1 to 2 feet of ground surface to allow for the placement of either a flush-mount or stick-up protective casing.

The monitoring wells were completed with either flush-mount or stick-up protective steel covers. A 2-foot by 2-foot wide by 6-inch thick concrete pad was placed flush with the ground surface. For wells installed within the HDPE liner, cement-bentonite grout was used to seal the opening in the liner against the well stick-up cover. The 2-foot by 2-foot wide by 1-foot trench was then filled with Portland cement to create the concrete pad. Monitoring well construction details are summarized in Table 3.

2.3.2 Monitoring Well Development

Following installation, each monitoring well was developed to remove drill cuttings or formation fines from the well screen. The monitoring wells were developed by air lifting, then by surging and pumping if not fully developed after using air lifting. Measurements of pH, temperature, turbidity, and specific conductance were collected until these parameters stabilized or, at the discretion of the site geologist, the purged water was visibly clear of sediment. Water quality measurements and volume of water removed from each well were recorded on well development forms for the investigation and are included in Appendix D. Monitoring wells 063_MW02, 063_MW04, 063_MW06, and 063_MW07 were difficult to develop. During well development for 063_MW08, five well volumes were removed, with approximately 4 feet of draw down. Five well volumes were purged from 063_MW10 with minimal drawdown. Three well volumes were purged from 063_MW11. Well 063_MW11 was purged dry and had a slow recharge rate.

2.3.3 Water Level Measurements

Prior to groundwater sampling for the initial RI in September 2011, synoptic groundwater level measurements were collected from monitoring wells at Site 063 to provide data for calculating groundwater elevations. During the initial RI, depth to groundwater in the wells was measured on September 16, 2011. During the delineation RI, depth to groundwater in the existing and newly installed monitoring wells was measured on February 6 through February 8, 2013. The measurements were taken from the top of inner casing at the referenced measuring point. Water level measurements were noted with the time and recorded to the nearest 0.01 foot using an electronic water level meter. Depth to water measurements recorded for both initial RI and delineation RI wells and the resulting groundwater elevations are summarized in Table 3. A groundwater contour map can be found in Figure 5 and 5A; the contour reporting forms can be found in Appendix D.

2.3.4 Groundwater Sampling

Initial RI monitoring wells were sampled on August 4, 2011 and on September 16, 2011. On August 4, 2011, monitoring wells 063_MW01, 063_MW03 and 063_MW05 were sampled because the other four initial RI wells were not yet developed. At the request of PPG, Tetra Tech sampled 063_MW01, 063_MW03 and 063_MW05 to accommodate the due-diligence requirements of Spectra, an oil and gas company, who was planning to install a natural gas transmission line across the western boundary of Site 063. The remaining initial RI wells were sampled on September 16, 2011. Samples were analyzed for hexavalent chromium, total chromium, antimony, nickel, thallium, vanadium, ORP (Eh), and pH. Monitoring wells 063_MW01, 063_MW03, and 063_MW05 were resampled for hexavalent chromium on September 16, 2011 because the samples collected on August 4, 2011 did not meet the holding time for this parameter. See Table 2 for a list of the analytical methods used. Monitoring well locations are shown on Figure 2. Groundwater sampling field record sheets are provided in Appendix D.

As part of the delineation RI, initial RI monitoring wells, as well as delineation RI wells, were sampled on February 6 through February 8, 2013. Samples were analyzed for hexavalent chromium, total chromium, antimony, nickel, thallium, vanadium, ORP (Eh), and pH.

Groundwater sampling was conducted using low-flow purging and sampling procedures consistent with the NJDEP Field Sampling Procedures Manual dated August 2005. Groundwater sampling procedures are described below.

The wells were sampled using two-inch diameter QED submersible bladder pumps. Polyethylene tubing and bladders were utilized given that Teflon tubing and bladders are only required for sampling volatile organic compounds, consistent with the NJDEP Field Sampling Procedures Manual dated August 2005. A new polyethylene bladder was dedicated to each well. A properly decontaminated pump was lowered to the middle of the well screen interval of each well. A new piece of disposable, 1/4-inch diameter, polyethylene tubing was used at each well. The pumping rate was measured with a graduated beaker and a stop-watch, and the flow rate was adjusted to remain between 100 and 500 milliliters per minute (mL/min). Purging continued until field parameters had stabilized, consistent with procedures outlined in the August 2005 NJDEP Field Sampling Procedures Manual. During sampling, the flow rate was maintained between 100 and 500 mL/min pursuant to the NJDEP guidance document and parameters were maintained according to the NJDEP Field Sampling Procedures Manual. Copies of the complete field parameter records are provided in Appendix D.

2.4 Surveying

The initial and delineation RI soil borings and monitoring wells were surveyed for horizontal and vertical control by DPK Consulting LLC of Middlesex, New Jersey. At each monitoring well location, the vertical elevation of the ground surface and the top of casing were surveyed. Vertical elevations are based on the North American Vertical Datum 1988. Horizontal locations of each sample location are based on the New Jersey State Plane Coordinate System (North American Datum 1983).

2.5 Investigation Derived Waste (IDW) Disposal

During the RIs, both solid and liquid IDW was generated, including soil cuttings, well development and purge water, decontamination water, disposable personal protective equipment, Geoprobe soil sample acetate liners, and disposable sampling utensils, tubing, and bladders. Solid and liquid IDW was placed in U.S. Department of Transportation-approved 55-gallon drums. Drums were left at a designated secure location on site until the contents were sampled and analyzed. Once laboratory results were available, the drums were sent to off-site disposal facilities by a licensed contractor. The results of the laboratory analyses and the hazardous waste manifest for the IDW are provided in Appendix E. AECOM handled the waste disposal during the initial RI and WTS managed the waste disposal during the delineation RI.

2.6 Analytical Methods, QA/QA, Data Validation, and Sample Handling

2.6.1 Analytical Methods

Soil, sediment, groundwater, and surface water samples were analyzed by Test America Laboratories of Edison, NJ (NJDEP Certification # 12028). Analytical methods are summarized in Table 2.

2.6.2 Equipment Decontamination

To reduce the possibility of cross-contamination, equipment that may have come in contact with soil or groundwater was properly decontaminated utilizing the following procedure from the Field Sampling Plan/Quality Assurance Project Plan (AECOM, 2010): 1) utensils and downhole

equipment (e.g., Geoprobe sampling tubes, Geoprobe rods, and sampling pumps) were wiped clean and were scrubbed with Liquinox soap plus a tap water wash to remove visible contamination; 2) these items were next rinsed with tap water to remove any remaining debris; 3) the equipment was again rinsed with deionized water. Disposable items (e.g., acetate soil sample core liners) were utilized to reduce the potential spread of contamination on site.

During the initial RI, 19 field blanks were collected. Of those 19, three field blanks had positive results. Two field blanks (FB071511 and FB072011) were associated with soil samples and one field blank (FB080411) was associated with water samples. Positive results for these three samples were noted for hexavalent chromium; however, the concentrations of hexavalent chromium detected in these blanks were less than the reporting limit; thus, the result is considered estimated. Since these positive results are estimated and the other results were non-detect, it is a reasonable determination that no residual amounts of the metals analyzed were introduced to the samples through the sampling equipment.

2.6.3 Quality Assurance/Quality Control

Quality assurance and quality control (QA/QC) samples collected and submitted for laboratory analysis during this investigation include field blanks, field duplicates, and matrix spike/matrix spike duplicate (MS/MSD) samples.

Aqueous field blanks were created by passing analyte-free water through the sampling equipment (disposed soil sampling equipment or polyethylene bladder/tubing) and collecting it in laboratory-provided glassware. Analysis of the field blank for the compounds of concern was intended to demonstrate that no residual amounts of these compounds were introduced into the samples by the sampling equipment. One aqueous field blank was collected and analyzed for the parameters sampled each day.

Field duplicate samples were collected at a ratio of five percent (i.e., one field duplicate per 20 samples matrix). Field duplicate soil samples were extracted from the same location and soil type as the respective soil sample. Aqueous field duplicate samples were collected simultaneously with the sample duplicated.

MS/MSD samples were collected at a ratio of five per cent (i.e., one MS/MSD per 20 samples matrix). MS/MSD samples provide information about the effect of the sample matrix on the preparation and measurement methodology. MS/MSD samples were extracted from the same location and soil type as the respective soil sample. Aqueous MS/MSD samples were collected simultaneously with the sample.

2.6.4 Data Validation

Validation is a comparison of data quality indicators against prescribed acceptance criteria to assess analytical method performance and whether analytical laboratory data were of an acceptable technical quality for use in decision making. The laboratory data were validated and the results can be found in Appendix F. The data were reviewed with reference to the NJDEP document titled "Quality Assurance Data Validation of Analytical Deliverables for Inorganics (based on USEPA SW-846 methods SOP5.A.16)" (NJDEP, 2002), Standard Operating Procedure for Analytical Data Validation of Hexavalent Chromium, SOP 5.A.16, Rev 1, October 2001 (NJDEP, 2001), and "Field Sampling Plan/Quality Assurance Project Plan" prepared by AECOM and dated June 2010. The following minor non-compliances were noted during validation: calibration non-compliances, MS/MSD recovery non-compliances, laboratory

spike/laboratory spike duplicate recovery non-compliances, lab duplicate imprecision, field duplicate impression, holding time exceedance, post-digestion spike recovery non-compliance, uncertainty near the detection limit and percent solid recoveries less than 30%. Estimated qualifications applied during validation were minor and did not affect data usability.

In accordance with the NJDEP-approved Remedial Investigation Work Plan (AECOM, 2011), USEPA Method SW-846 6010C (USEPA, 2007b) was used for analysis of metals. Initially, the laboratory (Test America) reported the results to the Reporting Limit which led to a number of instances where a non-detect result exceeded the minimum remediation standard/screening level for CCPW metals. To eliminate the majority of instances where detection levels were greater than the minimum remediation standard/screening level for CCPW metals, results were reported to the Method Detection Limit rather than the Reporting Limit. Even with the change from the Reporting Limit to the Method Detection Limit, non-detected results for antimony and thallium exceeded applicable remediation standards/screening level for several samples from the initial RI using USEPA Method SW-846 6010C (USEPA, 2007b). The delineation RI used USEPA Method SW-846 6020A (USEPA 2007a), which has a lower quantitation level for the metals analyzed, and the non-detected results for antimony and thallium did not exceed the applicable remediation standards/screening level.

Over 75 soil samples were reanalyzed for hexavalent chromium because the analytical quality control criteria failed. Low percent recoveries in MS/MSDs resulted in samples being reanalyzed as per SW846 Method 7196A (USEPA, 1992) requirements. Results of the data validation for the 75 samples that were reanalyzed can be found in Appendix F.

2.6.5 Sample Handling

The samples were picked up from field personnel by a laboratory-employed courier for delivery to the laboratory within the prescribed holding time. Samples were packed in coolers with ice to prevent breakage and to keep them cool. A chain-of-custody form accompanied the samples from the time of collection until the laboratory received them, and was signed by parties relinquishing and receiving the samples. Copies of the chain-of-custody sheets are provided with the laboratory reports and are included with the data validation in Appendix F.

3.0 ENVIRONMENTAL SETTING

3.1 Climate

The climate and meteorology of the Jersey City Area have been summarized based on climatological data reported for the nearest National Oceanic and Atmospheric Administration (NOAA) office, located in Newark, New Jersey.

In general, New Jersey has a continental climate with prevailing northwest winds during the winter months and southwest winds during the summer months. Based on data from the Newark, New Jersey, Airport, temperature falls of 5 to 15 degrees, depending on the season, are not uncommon when the wind changes from southwesterly to southeasterly. Periods of very hot weather, lasting as long as a week, are associated with a west-southwest airflow which has a long trajectory over land. Extremes of cold are related to rapidly moving outbreaks of cold air traveling southeastward from the Hudson Bay region. Temperatures of zero or below occur in one winter out of four, but are much more common several miles to the west of the NOAA station (NOAA, 2011).

A considerable amount of precipitation is realized from the Northeasters of the Atlantic coast. These storms, more typical of the fall and winter, generally last for a period of two days and commonly produces between one and two inches of precipitation. Storms producing four inches or more of snow occur between two to five times each winter. Snowstorms producing eight inches or more have occurred in about one-half the winters.

Average daily temperatures at Jersey City range from 32.8°F in January to 75.8°F in July, with a minimum temperature of -12°F, and a maximum temperature of 106°F. The mean annual temperature is approximately 54°F.

Mean annual rainfall at Jersey City is 43.96 inches. The lowest average monthly rainfall (2.86 inches) occurs in November and the highest average monthly rainfall (4.15 inches) occurs in July. Approximately half of the annual precipitation falls during the warm season (April through September). Annual snowfall totals about 25 inches in central New Jersey and 34.1 inches in Newark. Prevailing wind direction and mean annual wind speed at the Newark NOAA station are southwest and 10.2 mph, respectively (NOAA, 2011).

3.2 Topography

The topography at Sites 063 and 065 is generally flat, gradually sloping towards the east, which is most likely due to industrial development at the site. Ground surface elevations range from approximately 16 feet above mean sea level (msl) on the southwest side of the site to approximately 6 feet above msl on the northeast side of the site (AECOM, 2011).

3.3 Geology

3.3.1 Regional Geology

Sites 063 and 065 lie within the glaciated section of the Piedmont Physiographic Province of the Appalachian Highlands, along the eastern edge of the Newark Basin; the area is underlain by formations of Recent and Pleistocene sediments. The Triassic age bedrock throughout the region is composed of non-marine sedimentary rocks, consisting mainly of sandstone, mudstone, and conglomerate. The Triassic Newark Supergroup consists of non-marine

sedimentary rocks with diabase intrusives. It is common for the Triassic Newark Supergroup to exhibit a slight dip to the northwest with local warping and occasional faulting. The formations generally strike northeast to southwest and dip between 10 to 20 degrees northwest. The Newark Supergroup can be divided into three formations based on lithology: 1) the Stockton Formation, 2) the Lockatong Formation, and 3) the Passaic Formation (AECOM, 2011).

The Stockton Formation beneath Sites 063 and 065 has a gray to reddish-brown sandstone, combined with conglomerate, siltstone, and shale. The siltstone may be gray, green, or purple and fossiliferous. The Stockton Formation is about 850 feet thick beneath Sites 063 and 065. The Lockatong Formation, located west of the Site, consists of fossil-rich thinly laminated to thickly bedded gray to black siltstone and shale. A diabase sill of Lower Jurassic Age intrudes the Lockatong Formation west of the Site within Jersey City. The Passaic Formation is located west of the Site, and it is the thickest formation (about 10,000 feet). The Passaic consists of reddish-brown mudstones, shale, siltstone, and sandstone with interbedded conglomeritic sandstones along the basin margins (AECOM, 2011).

3.4 Hydrology and Hydrogeology

Upper New York Bay is the body of water that is closest (approximately 600 feet away) to Sites 063 and 065.

3.4.1 Regional Hydrogeology

Groundwater in the region occurs in three overburden water-bearing zones and within bedrock fractures. The water-bearing zones include an unconfined water-bearing zone within the fill material, an unconfined to semi-confined zone within the alluvial sediments beneath the fill, and an unconfined to semi-confined zone within the glacial silt, sand and gravel overlaying the bedrock (AECOM, 2011).

The shallow water-bearing zone can range from moderate to high hydraulic conductivity, depending on the fill materials. Hydraulic conductivity within the Stockton Formation is non-existent (AECOM, 2011).

The water-bearing zones underneath the fill are characterized with low to moderate conductivity due to the silt and clay content. Groundwater flow in this water-bearing zone is influenced by infiltration and the characteristics of the fill material. Groundwater in the fill material is typically encountered within 5 to 10 feet bgs. Groundwater flow in the intermediate and deep water-bearing zones is expected to be towards Upper New York Bay. Groundwater beneath Sites 063 and 065 is not considered to be potable; thus, public water supply is not drawn from this formation in the Jersey City area. No potable water supply is present near Sites 063 and 065. A pre-1990 report indicated that one industrial groundwater well was located in the vicinity of the Site. However, an updated well search was conducted and no wells were found within a half mile radius of the Site. Updated well search materials are presented in Appendix G.

3.4.2 Study Area Specific Hydrogeology

Monitoring wells have been placed at the Site to assess the CCPW impacts to groundwater. Based on the groundwater gauging data collected from the September 16, 2011 and February 6 through February 8, 2013 sampling events, site specific water level measurements indicate groundwater flows east towards Upper New York Bay.

4.0 NATURE AND EXTENT OF CONTAMINATION

This section presents a discussion of the nature and extent of contamination of CCPW metals (chromium, hexavalent chromium, nickel, antimony, vanadium, and thallium) in soil, sediment, surface water, and groundwater at Sites 063 and 065 for both the initial and delineation RIs. The following sections contain the discussion and results for the contamination in each of the media.

The RIs were conducted in accordance with the NJDEP-approved Remedial Investigation Work Plan (AECOM, 2011) using USEPA Method SW-846 6010C (USEPA, 2007b) for analysis of metals. Initially, the laboratory (TestAmerica) reported the results to the Reporting Limit which led to a number of instances where non-detectable concentrations exceeded the minimum remediation standard/screening level for CCPW metals. In July 2012, after discussions with Shaw, NJDEP, and the laboratory, it was determined that results should be reported to the Method Detection Limit rather than the Reporting Limit. This change eliminated the majority of instances where detection level concentrations were greater than the minimum remediation standard/screening level for CCPW metals. The delineation sampling conducted in December 2012 and January 2013 utilized USEPA Method SW-846 6020A (USEPA, 2007a), which has a lower quantitation level for the metals analyzed and discussed in the subsequent sections. There were no instances where delineation sampling results had detection level concentrations that exceeded the minimum remediation standard/screening level for CCPW metals.

Concentrations of metals in soil and groundwater were compared to the minimum remediation standards/screening level/NJDEP Chromium Soil Cleanup Criteria (CrSCC) identified in the NJDEP-approved Remedial Investigation Work Plan (AECOM, 2011). Concentrations of metals in sediment and surface water were compared to NJDEP Ecological Screening Criteria (ESC) concentrations based on comments received from the NJDEP on March 2, 2012. Table 4 shows the remediation standards/screening level/NJDEP CrSCC by media for each of the metals evaluated in this report. In addition to comparing the soil sample results to the minimum soil remediation standard/screening level/NJDEP CrSCC, they were compared to the NJDEP Residential Direct Contact Soil Remediation Standards (RDC SRS), the NJDEP Non-Residential Direct Contact Soil Remediation Standards (NRDC SRS), the NJDEP Default Impact to Groundwater Soil Screening Levels (IGW SSL), and the NJDEP CrSCC separately. Note that comparison of the NJDEP CrSCC for chromium and hexavalent chromium to the laboratory data is included with the RDC SRS comparisons. Exceedances of these soil remediation standards/screening levels/CrSCC are shown on separate tables and figures. The NJDEP CrSCC for both trivalent and hexavalent chromium are shown on the RDC SRS tables and figures.

Based on the June 4, 2012, NJDEP comments, SPLP samples were collected during the delineation investigation from four locations to calculate site-specific IGW SSLs for antimony and nickel. Site-specific IGW values were calculated for antimony and nickel using the NJDEP guidance document (NJDEP, 2008). In accordance with the NJDEP guidance document, default IGW SSL values were chosen as screening level because they were greater than the calculated site-specific IGW values. The results of the site-specific IGW calculations are included in Appendix H.

4.1 Initial RI Soil Results

A total of 276 soil samples were collected from 52 borings between July 11 and August 1, 2011 at different soil depths. From these samples, 52 were surface samples (first soil sample in each boring, 0 to 0.5 feet) and 224 samples were obtained at multiple depths in the subsurface (samples after the first sample in a boring, regardless of depth). Figure 2 shows the locations where the 52 soil borings were drilled to obtain these samples. Figure 6 shows the location of the soil borings and the analytical results for the samples from the borings. The borings that had a sample that exceeded the minimum soil remediation standard/screening level for at least one metal are identified in red, and the borings for which no samples exceeded the minimum soil remediation standard/screening level for the metals analyzed are in blue. Figure 6 also shows the soil borings where COPR is present in a sample in green and those where COPR is absent from the samples in white.

Figures 7A and 7B summarize the sample locations and depths where metals exceeded the NJDEP RDC SRS/NJDEP CrSCC and default IGW SSL, respectively. There were no exceedances of NJDEP NRDC SRS. Table 5 contains a summary of the soil analytical results (Appendix I contains the complete data resulting from soil analysis). Tables 5A, 5B, and 5C compare the soil analytical results to the NJDEP RDC SRS/NJDEP CrSCC, NRDC SRS, and default IGW SSL, respectively. Information regarding frequency of detection, minimum and maximum detections, location of the maximum detection, and applicable statistics (average and standard deviation) can be found on Tables 6 (surface and subsurface soil results), Table 7 (surface soil results) and Table 8 (subsurface soil results).

4.1.1 Chromium

Chromium was detected in each of the surface and subsurface soil samples collected. For surface soil, the 52 samples collected had detectable chromium concentrations. The concentration of chromium in the surface samples did not exceed the NJDEP CrSCC of 120,000 mg/kg. The location of the surface sample with the highest concentration of chromium (14,200 mg/kg) is 063_C006, collected at a depth of 1 foot bgs (first sample beneath the bedding material underlying the HDPE liner).

The 224 subsurface samples contained chromium but the concentration did not exceed the NJDEP CrSCC. The location of the subsurface sample with the highest concentration of chromium (32,900 mg/kg) is 063_C005, collected at a depth of 2.5 feet bgs. In addition, there were no samples for which the method detection limit exceeded the NJDEP CrSCC.

4.1.2 Hexavalent Chromium

For the surface samples, there were 40 samples had detectable hexavalent chromium concentrations, of which one sample had a hexavalent chromium concentration that exceeded the NJDEP CrSCC of 20 mg/kg. The location of the surface sample with the highest concentration of hexavalent chromium (estimated at 33.3 mg/kg) is 063_B006, collected at a depth of 1.0 foot bgs. There were 52 subsurface samples that contained detectable hexavalent chromium concentrations. Of these samples, nine samples contained hexavalent chromium concentrations that exceeded the NJDEP CrSCC of 20 mg/kg. The location of the subsurface sample with the highest concentration of hexavalent chromium (9,470 mg/kg) is 063_C005, collected at a depth of 2.5 feet bgs. In addition, there were no samples for which the method detection limit exceeded the NJDEP CrSCC.

The boring locations where hexavalent chromium exceeded the NJDEP CrSCC are limited to specific area (mostly clustered in a small area in the center of Site 063 near the southern end (borings 063_C004a, 063_C005, 063_C006, 063_C007 and 063_B006). There is another soil boring where hexavalent chrome exceeded the criteria, 063_B013 (northern end of the site). It is possible to say that high concentrations of hexavalent chrome are clustered and limited to a small area of the site.

4.1.3 Antimony

Fifteen surface samples exhibited detectable concentrations of antimony, of which three samples contained concentrations of antimony that exceeded the minimum soil remediation standard/screening level (6 mg/kg). The location of the surface soil sample with the highest concentration is 063_B005, collected at a depth of 1.3 feet bgs (first sample beneath the bedding material underlying the HDPE liner), with an estimated concentration of 38.2 mg/kg. There were 33 subsurface samples that detected antimony; from these samples, 5 samples had concentrations above the minimum soil remediation standard/screening level (6 mg/kg). The location of the subsurface sample with the highest concentration of antimony (estimated at 13 mg/kg) is 063_B011 collected at a depth of 0.5 feet bgs. Additionally, four surface and three subsurface soil samples had non-detect values that exceeded the IGW SSL (6 mg/kg) and one subsurface soil sample had a non-detect value that exceeded the RDC SRS (31 mg/kg). Sample dilution resulted in elevation of method detection limits. Samples were diluted due to interference from other analytes. Six out of these seven non-detect samples that exceed the IGW SSL have a non-detect value between 1.5-2 times greater than the IGW SSL. One result (32.8 UJ mg/kg) was approximately five times greater than the IGW SSL. Because only eight out of the 276 samples analyzed contained detectable antimony concentrations that exceeded standards/screening level, antimony is not considered a contaminant of concern and the non-detect values that exceed the soil remediation standard/screening level are not expected to impact the results of the RI. The locations of those samples are 063_C005, 063_C006, 063_C010, 065_A006, 065_A007, and 065_A013.

The higher antimony concentrations can be found mainly on the edge of Site 063 that borders Site 065. There is no evidence that high concentrations of antimony are clustered.

4.1.4 Nickel

Nickel was detected in each surface and subsurface sample collected. For the surface samples, the 52 samples collected had detectable nickel concentrations, of which 31 had nickel concentrations that exceeded the minimum soil remediation standard/screening level (31 mg/kg). The location of the surface sample with the highest concentration of nickel (333 mg/kg) is 063_B013, collected at a depth of 0 feet bgs. There were 224 subsurface samples that detected nickel; from these samples, 23 samples had concentrations above the screening level (31 mg/kg). The location of the subsurface sample with the highest concentration of nickel (661 mg/kg) is 063_C005, collected at a depth of 2.5 feet bgs. In addition, there were no samples for which the method detection limit exceeded any standards/screening criteria.

The boring locations for which nickel exceeded the minimum soil remediation standard/screening level are spread out through Sites 063 and 065. There is no apparent clustering of nickel exceedances.

4.1.5 Vanadium

Vanadium was detected in each surface and subsurface sample collected. For the surface samples, 52 samples had vanadium present. Twenty surface samples contained concentrations of vanadium that exceeded the minimum soil remediation standard/screening level of 78 mg/kg. The location of the surface sample with the highest concentration of vanadium (497 mg/kg) is 063_C011, collected at a depth of 0.4 feet bgs (first sample beneath cobble/gravel ground cover). There were 224 subsurface samples that detected vanadium. Of these samples, 24 had concentrations above the minimum soil remediation standard/screening level (78 mg/kg). The location of the subsurface sample with the highest concentration of vanadium (718 mg/kg) is 063_C005, collected at a depth of 2.0 feet bgs. In addition, there were no samples for which the method detection limit exceeded any standards/screening level. The exceedances of vanadium are spread out across Sites 063 and 065. There is no apparent clustering of vanadium exceedances.

4.1.6 Thallium

There was no thallium detected in the surface samples obtained from Site 063/065. One subsurface sample detected thallium; however, it was not above the minimum soil remediation standard/screening level (3 mg/kg). The location of the subsurface sample with the highest concentration of thallium (estimated at 1 mg/kg) is 063_D006, collected at a depth of 1.5 feet bgs.

Additionally, two surface and five subsurface soil samples had non-detect values that exceeded the IGW SSL (3 mg/kg) and the RDC SRS (5 mg/kg). Sample dilution resulted in elevation of method detection limits. Samples were diluted due to interference from other analytes. Four of these non-detects are approximately two times greater than the IGW SSL, while the other three non-detects are between two and six times greater than the IGW SSL. Because there were no samples for which a detected concentration of thallium exceeded the soil remediation standards/screening level, thallium is not considered a chemical of concern and the non-detect values that exceed the IGW SSL are not expected to impact the results of the RI. The locations of those samples are 063_B005, 063_C005, 063_C006, 063_C007, 063_D005, and 065_A006. For more information regarding which samples were subject to dilution, see Appendix F.

4.1.7 Comparison to Residential Direct Contact Soil Remediation Standards

This site has been designated as a Non-Residential CCPW Site, but results were compared to RDC SRS for comparative purposes. Comparison of soil concentrations to the RDC SRS/NJDEP CrSCC can be found on Tables 5A, 7, and 8 and Figure 7A. Concentrations of chromium in surface and subsurface soil did not exceed the NJDEP CrSCC (120,000 mg/kg). Ten samples contained hexavalent chromium concentrations that exceeded the NJDEP CrSCC (20 mg/kg). One surface soil sample (063_B005) contained an antimony concentration (38.2 mg/kg) that exceeded the RDC SRS (31 mg/kg) at a depth of 1.3 feet bgs (first sample beneath the bedding material underlying the HDPE liner). Antimony did not exceed the RDC SRS in subsurface soil; however, one subsurface sample had a non-detect value that exceeded the RDC SRS. Concentrations of nickel detected in surface and subsurface soil did not exceed the RDC SRS (1600 mg/kg). Forty four samples contained vanadium concentrations that exceeded the RDC SRS (78 mg/kg). Thallium was not detected in any surface samples and was detected in one subsurface sample but two surface samples and five subsurface samples had non-detect values that exceeded the RDC SRS (5 mg/kg). There were no occurrences of the method

detection limit exceeding the RDC SRS for chromium, nickel, hexavalent chromium, or vanadium.

4.1.8 Comparison to Non-Residential Direct Contact Soil Remediation Standards

Since this site has been identified as a Non-Residential CCPW Site, results were compared to the NJDEP NRDC SRS. The comparison of the soil results to the NRDC SRS can be found in Tables 5B, 7, and 8. There were no exceedances of the NRDC SRS in surface or subsurface soil for antimony, nickel, thallium, or vanadium. In addition, there were no occurrences of the method detection limit exceeding the NRDC SRS for the metals analyzed.

4.1.9 Comparison to Impact to Groundwater Soil Screening Levels

Comparison of soil concentrations to IGW SSLs can be found on Table 5C, 7, and 8. Site-specific IGW SSLs were calculated for antimony and nickel using the method described by NJDEP (NJDEP, 2008). Because the calculated site-specific values were less than the default IGW SSLs the default values were used, as specified in the NJDEP guidance document (NJDEP, 2008). Three surface and five subsurface samples contained antimony concentrations that exceeded the default IGW SSL (6 mg/kg). Thirty one surface and 23 subsurface soil samples contained nickel concentrations that exceeded the default IGW SSL (31 mg/kg). Three surface and four subsurface samples contained non-detect values of antimony that exceeded the default IGW SSL. There were no occurrences of the method detection limit exceeding the default IGW SSL for nickel. There is no IGW SSL criterion for vanadium. Thallium was not detected in any surface samples and was detected in one subsurface sample but two surface samples and five subsurface samples had non-detect values that exceeded the default IGW SSL (3 mg/kg).

4.1.10 CCPW in Soil

CCPW was observed in 23 soil borings (see Appendix C). Figures 3 and 4 contain cross sections that show the depths where CCPW was observed (in green) during the initial RI. Figures 6, 7A, and 7B show the borings and depths where CCPW was found.

4.2 Initial RI Groundwater Results

Seven groundwater samples were collected from seven wells (one sample per well) during the initial RI and analyzed for antimony, chromium, hexavalent chromium, nickel, thallium, and vanadium. Three monitoring wells were resampled for hexavalent chromium because the holding time was exceeded for samples collected on August 4, 2011. Figure 2 shows the locations of the seven monitoring wells. Figure 8 has the groundwater results from these samples. Groundwater results were compared to NJDEP Groundwater Quality Standards (GWQS) (see Table 4). Figure 9 shows the locations and results of the samples that exceeded the GWQS. Analytical results from the groundwater analysis can be found on Table 9, and the frequency of detection, minimum and maximum detection, location of maximum, and applicable statistics (average and standard deviation) can be found on Table 10. Appendix J contains groundwater analytical data. During the site investigation, a water line, 29x45-inch embedded cylinder pipe sanitary sewer/storm sewer, and 12-inch steel iron pipe gas line were identified along Burma Road as part of the underground utility survey (Appendix K). Based on the two groundwater gauging events, groundwater does not appear to be infiltrating and following the preferential pathways of underground utilities. Groundwater was measured at 3.41 feet bgs to 3.70 feet bgs in 063_MW01 to 5.80 feet bgs in 063_MW08 and the depth of the storm water/sewer in that area is between 2 and 3 feet bgs. Groundwater depth may vary seasonally.

4.2.1 Chromium

Chromium was detected in six of the seven wells sampled (063_MW01, 063_MW02, 063_MW03, 063_MW05, 063_MW06, and 063_MW07). Samples from three wells (063_MW01, 063_MW06, and 063_MW07) contained concentrations that exceeded the NJDEP GWQS (70 micrograms per liter (ug/L)). The location of the sample with the highest chromium concentration (5,160 ug/L) is 063_MW01. There were no samples for which the method detection limit exceeded the GWQS. Figure 10 shows an isoconcentration map with the chromium results.

4.2.2 Hexavalent Chromium

Hexavalent chromium was detected in three of the seven wells sampled (063_MW01, 063_MW03, and 063_MW06). The location of the sample with the highest hexavalent chromium concentration (21.8 ug/L) is 063_MW01. There is no NJDEP GWQS for hexavalent chromium. As discussed in Section 2.3.4, samples from three wells, including 063_MW01, exceeded the holding time for hexavalent chromium and were re-sampled. Based on the results of the re-analysis, the results for the samples that exceeded holding time are valid and usable results. The concern with exceeding holding time for hexavalent chromium is that hexavalent chromium will break down into other types of chromium; however, the initial sample results are approximately the same as the re-analysis results for the three wells, so it appears that exceeding the holding time did not affect the results. Detections in both the initial samples and the re-analyzed samples will be used.

4.2.3 Antimony

Three of the seven wells sampled had detectable antimony concentrations (063_MW01, 063_MW04, and 063_MW05). One sample had a concentration higher than the NJDEP GWQS (6 ug/L). The location of the sample with the highest antimony concentration (estimated at 16.8 ug/L) is 063_MW01. There were no samples for which the method detection limit exceeded the GWQS. Figure 11 shows an isoconcentration map with the antimony results.

4.2.4 Nickel

Nickel was detected in six of the seven wells sampled (063_MW01, 063_MW03, 063_MW04, 063_MW05, 063_MW06, and 063_MW07). Samples from two wells (063_MW01 and 063_MW06) contained nickel concentrations that exceeded the GWQS (100 ug/L). The location of the sample with the highest nickel concentration (318 ug/L) was 063_MW01. There were no samples for which the method detection limit exceeded the GWQS. Figure 12 shows an isoconcentration map with the nickel results.

4.2.5 Vanadium

Four of the seven wells sampled had detectable vanadium concentrations (063_MW01, 063_MW02, 063_MW06, and 063_MW07). Samples from three wells (063_MW01, 063_MW06, and 063_MW07) had concentrations that exceeded the NJDEP GWQS (60 ug/L). The location of the sample with the highest vanadium concentration (1,870 ug/L) was 063_MW01. There were no samples for which the method detection limit exceeded the GWQS. Figure 13 shows an isoconcentration map with the vanadium results.

4.2.6 Thallium

Thallium was not detected in any of the seven wells sampled at Sites 063 and 065. However, the method detection limit for these groundwater samples exceeded the GWQS using USEPA Method SW-846 6010C (USEPA, 2007b) for the analysis.

4.3 Surface Water Results

Two surface water samples were collected from a catch basin and a storm sewer located on Sites 063 and 065. The location where these two samples were collected can be found in Figure 2. The sanitary sewer/storm sewer is a combined system that discharges to a local sanitary treatment facility so water that is transported within the pipe or along the pipe discharges to the local treatment facility. Water lines and gas lines do not have discharge points to surface water. Table 11 contains the analytical results for each sample (Appendix L contains the complete data set of surface water results). Concentrations of metals in surface water were compared to NJDEP ESC for freshwater. Table 4 contains the NJDEP ESC used to compare the concentrations of metals found in surface water (NJDEP, 2009).

Both surface water samples contained chromium concentrations that exceeded the ESC (42 ug/L). Hexavalent chromium was detected in one of the surface water samples at a concentration below the ESC (10 ug/L). Antimony was detected in one of the two surface water samples at a concentration below the ESC (80 ug/L). Nickel was detected in both surface water samples at concentrations below the ESC (52 ug/L). Vanadium was detected in both surface water samples at concentrations that exceeded the ESC (12 ug/L). Thallium was not detected in either surface water sample; however, the method detection limit exceeded the NJDEP ESC for thallium in both surface water samples.

4.4 Sediment Results

Two sediment samples were obtained from a catch basin and a storm sewer located on Sites 063 and 065; one sample from each location 063_E005CB and 065_A010_SS. The location for these samples can be found on Figure 2. Table 12 contains the analytical results for each sample (Appendix M contains the complete data set of sediment sample results). Concentrations of metals in sediment were compared to NJDEP ESC for sediment in freshwater and are found in Table 4 (NJDEP, 2009).

Concentrations of chromium and nickel found in both sediment samples exceeded the ESC (26 ug/L and 16 ug/L, respectively). Hexavalent chromium was detected in one sediment sample, but there is no ESC for hexavalent chromium in sediment. Antimony and thallium were not detected in either sediment sample. Vanadium was detected in both sediment samples but there is no ESC for vanadium in sediment.

4.5 Delineation Investigation Results

According to the Technical Memorandum sent to NJDEP on July 16, 2012 with minor revisions, conference calls and discussions with NJDEP, further soil delineation was conducted in December 2012 and January 2013. Ten borings were drilled and four SPLP samples were collected from soil borings 063_B005, 063_C005, 063_C010, and 063_C011. Table 1 summarizes pertinent data for the soil borings, and their location is shown on Figure 2. Boring logs completed for the delineation investigation are presented in Appendix C-2. Three new groundwater wells were installed (063_MW08, 063_MW10, and 063_MW11) in December 2012 and January 2013 at Sites 063 and 065 during the delineation RI. The seven initial investigation and three delineation investigation groundwater wells were sampled between February 6 through 8, 2013, during the delineation investigation (one sample per well). Locations of the groundwater monitoring wells are presented on Figure 2.

The delineation investigation utilized USEPA Method SW-846 6020A (USEPA, 2007a), which has a lower quantitation level for the metals analyzed. The method detection limit for the metals was less than the minimum soil remediation standard/screening level and the GWQS for CCPW metals. This eliminated the reporting of non-detections that were greater than the minimum soil remediation standard/screening level and GWQS for CCPW metals in both soil and groundwater samples.

Metal concentrations in soil and groundwater were compared to minimum soil remediation standards/screening levels/NJDEP CrSCC and GWQS identified in the NJDEP-approved Remedial Investigation Work Plan (AECOM, 2011). Table 4 shows the minimum soil remediation standard/screening level/NJDEP CrSCC and GWQS for each of the metals evaluated in this report for both soil and groundwater. The soil sample results obtained during the delineation investigation were also compared to the NJDEP RDC SRS, NRDC SRS, IGW SSL, and NJDEP CrSCC separately. Note that comparison of the NJDEP CrSCC for chromium and hexavalent chromium to the laboratory data is included with the RDC SRS comparisons. Exceedances of these soil remediation standards/screening levels/CrSCC are shown on separate tables and figures. The NJDEP CrSCC for both trivalent and hexavalent chromium are shown on the RDC SRS tables and figures.

Based on comments provided to PPG by NJDEP on June 4, 2012, site-specific IGW SSLs for antimony and nickel were calculated using the NJDEP guidance document (NJDEP, 2008). In accordance with the NJDEP guidance document, default IGW SSL values were chosen as screening level because they were greater than the calculated site-specific IGW values. The results of the site-specific IGW calculations are included in Appendix H.

4.6 Delineation Investigation Soil Results

Fifty two soil samples were collected in December 2012 at different soil depths, ten of which were surface samples (0 to 0.5 feet or first 0.5 feet soil/fill interval beneath pavement) and 42 of which were subsurface samples (multiple depths). Figure 2 shows the location where the soil borings were drilled to obtain these samples. Figure 14 displays the location of the soil borings and the analytical results for the samples obtained from the borings. The borings that had a sample that exceeded the minimum soil remediation standard/screening level/NJDEP CrSCC for at least one metal are identified in red, and the borings for which no samples exceeded the minimum soil remediation standard/screening level for the metals analyzed are in blue. Figure 14 also shows the soil borings where COPR is present in a sample in green and those where COPR is absent from the samples in white.

Figures 7A and 7B summarize the sample locations and depths where metals exceeded the NJDEP RDC SRS/NJDEP CrSCC and default IGW SSL, respectively. There were no exceedances of NJDEP NRDC SRS.

Table 13 contains a summary of the soil analytical results from the delineation investigation (Appendix I contains the complete data resulting from soil analysis). Tables 13A, 13B, and 13C compare the delineation RI soil analytical results to the NJDEP RDC SRS/NJDEP CrSCC, NRDC SRS, and default IGW SSL, respectively. Note that comparison of the NJDEP CrSCC for chromium and hexavalent chromium to the laboratory data is included with the RDC SRS comparisons. Information regarding frequency of detection, minimum and maximum detections, location of maximum detection, and applicable statistics (average and standard deviation) can

be found in Table 14 (surface and subsurface soil results), Table 15 (surface soil results) and Table 16 (subsurface soil results).

4.6.1 Chromium

Chromium was detected in each of the surface and subsurface samples collected. The chromium concentration in the surface and subsurface soil samples did not exceed the NJDEP CrSCC (120,000 mg/kg). The location of the surface sample with the highest chromium concentration (3,400 mg/kg) is at 063_C013 at a depth of 0.0 feet bgs. The location of the subsurface sample with the highest chromium concentration (3,320 mg/kg) is at 063_Z009 at a depth of 5 feet bgs.

4.6.2 Hexavalent Chromium

Hexavalent chromium was detected in five of the ten surface soil samples and in 11 of the 42 subsurface samples collected. The concentration of hexavalent chromium in the surface soil samples did not exceed the NJDEP CrSCC (20 mg/kg). Two subsurface samples contained hexavalent chromium concentration that exceeded the NJDEP CrSCC (20 mg/kg). The location of the surface soil sample with the highest hexavalent chromium concentration (13.2 mg/kg) is 063_B006A at a depth of 0.5 feet bgs (first sample beneath the bedding material underlying the HDPE liner). The location of the subsurface soil sample with the highest hexavalent chromium concentration (44.8 mg/kg) is 063_B006A at a depth of 1 foot bgs.

4.6.3 Antimony

Antimony was detected in five surface and nine subsurface samples collected. The concentration of antimony in the surface or subsurface soil samples did not exceed the minimum soil remediation standards/screening level (6 mg/kg). The location of the surface soil sample with the highest antimony concentration (3.3 mg/kg) is located at 063_F010 at a depth of 0.0 feet bgs. The location of the subsurface soil sample with the highest antimony concentration (estimated at 2 mg/kg) is at 063_Z013 at a depth of 10 feet bgs.

4.6.4 Nickel

Nickel was detected in each of the surface and subsurface soil samples collected. Five surface samples and four subsurface samples contained nickel concentrations that exceeded the minimum soil remediation standard/screening level (31 mg/kg). The location of the surface sample with the highest nickel concentration (321 mg/kg) is 063_C013 at a depth of 0 feet bgs. The location of the subsurface sample with the highest nickel concentration (175 mg/kg) is 063_C014 at a depth of 0.5 feet bgs.

4.6.5 Vanadium

Vanadium was detected in each of the surface and subsurface soil samples collected. One surface and one subsurface soil sample contained vanadium concentrations that exceeded the minimum soil remediation standard/screening level (78 mg/kg). The location of the surface soil sample with the highest vanadium concentration (313 mg/kg) is 063_C013 at a depth of 0 feet bgs. The location of the subsurface soil sample with the highest vanadium concentration (220 mg/kg) is 063_C014 at a depth of 0.5 feet bgs.

4.6.6 Thallium

Thallium was detected in three surface soil samples and six subsurface soil samples collected. The concentration of thallium in the surface or subsurface soil samples did not exceed the minimum soil remediation standard/screening level (3 mg/kg). The location of the surface soil

sample with the highest thallium concentration (0.46 mg/kg) is 063_Z009 at a depth of 0.5 feet bgs. The location of the subsurface soil sample with the highest thallium concentration (0.32 mg/kg) is 063_B006A at a depth of 1 foot bgs.

4.6.7 Comparison to Residential Direct Contact Soil Remediation Standards

This site has been designated as a Non-Residential CCPW Site, but results were compared to RDC SRS/NJDEP CrSCC for comparative purposes. Comparison of soil concentrations to the RDC SRS/NJDEP CrSCC can be found in Tables 13A, 14, 15, and 16 and Figure 7A. Chromium concentrations detected in surface and subsurface soil did not exceed the NJDEP CrSCC of 120,000 mg/kg. Two subsurface samples contained hexavalent chromium concentrations that exceeded the NJDEP CrSCC of 20 mg/kg. Antimony concentrations detected in surface and subsurface soil did not exceed the RDC SRS (31 mg/kg). Nickel concentrations detected in surface and subsurface soil did not exceed the RDC SRS (1600 mg/kg). One surface and one subsurface soil sample contained vanadium concentrations that exceeded the RDC SRS (78 mg/kg). Thallium concentrations detected in surface and subsurface soil did not exceed the RDC SRS (5 mg/kg).

4.6.8 Comparison to Non-Residential Direct Contact Soil Remediation Standards

Since this site has been identified as a Non-Residential CCPW Site, results were compared to the NJDEP NRDC SRS. Comparison of the soil results to the NRDC SRS can be found in Tables 13B, 14, 15, and 16. There were no exceedances of the NRDC SRS in surface or subsurface soil for antimony, nickel, thallium, or vanadium.

4.6.9 Comparison to Impact to Groundwater Soil Screening Levels

Comparison of soil concentrations to IGW SSLs can be found in Tables 13C, 14, 15, and 16. Site-specific IGW SSLs were calculated for antimony and nickel using the method described in the NJDEP guidance document (NJDEP, 2008). In accordance with the NJDEP guidance document, default IGW SSL values were chosen as the screening levels because they were greater than the calculated site-specific IGW values. Antimony and thallium concentrations detected in surface and subsurface soil did not exceed the IGW SSLs (6 mg/kg and 3 mg/kg, respectively). Five surface and four subsurface samples contained nickel concentrations that exceeded the default IGW SSL (6 mg/kg). There is no IGW SSL criterion for vanadium. Table 13C presents the comparison of soil sample concentrations to the IGW SSLs. Tables 15 and 16 present the frequency of detection for surface and subsurface soils, respectively.

4.6.10 CCPW in Soil

CCPW was observed in three soil borings drilled during the delineation investigation (063_B006A, 063_C013, and 063_C014; see Appendix C). Figures 3 and 4 contain cross sections that show the depths where CCPW was observed (in green) during the initial RI. Figures 6, 7A, and 7B show the borings and depths where CCPW was found.

4.7 Delineation Investigation Groundwater Results

Ten groundwater wells were sampled during the delineation investigation (one sample per well). Seven groundwater samples were collected from the seven existing monitoring wells (063_MW01 through 063_MW07). Three new monitoring wells were installed and sampled during the delineation investigation at Site 063: 063_MW08, 063_MW10, and 063_MW11. Locations of the groundwater monitoring wells are presented on Figure 2. Figure 8 has the groundwater results from these samples. Groundwater results were compared to NJDEP GWQS (Table 4). Figure 9 shows the locations and results of the samples that exceeded the

GWQS. Analytical results from the groundwater analysis can be found in Table 17, and the frequency of detection, minimum and maximum detection, location of maximum, and applicable statistics (average and standard deviation) can be found in Table 18. Appendix J contains groundwater analytical data. Groundwater samples obtained during the delineation investigation were analyzed using U.S. EPA Method SW-846 6020A (USEPA, 2007a). Non-detected concentrations for the metal analyzed did not exceed the GWQS.

During the site investigation, a water line, 29x45-inch embedded cylinder pipe sanitary sewer/storm sewer, and 12-inch steel iron pipe gas line were identified along Burma Road as part of the underground utility survey (Appendix K). Based on the two groundwater gauging events, groundwater does not appear to be infiltrating and following the preferential pathways of underground utilities. Groundwater was measured at 3.41 feet bgs to 3.70 feet bgs in 063_MW01 to 5.80 feet bgs in 063_MW08 and the depth of the storm water/sewer in that area is between 2 and 3 feet bgs. Groundwater depth may vary seasonally. The water line and gas line do not have direct discharge to surface water. The combined sanitary/storm sewer discharges to the local waste water treatment facility.

4.7.1 Chromium

Chromium was detected in eight of the ten groundwater samples collected (063_MW01, 063_MW02, 063_MW03, 063_MW06, 063_MW07, 063_MW08, 063_MW10, and 063_MW11). Samples from five wells (063_MW01, 063_MW06, 063_MW07, 063_MW10, and 063_MW11) contained chromium concentrations that exceeded the NJDEP GWQS (70 ug/L). The location of the sample with the highest chromium concentration (51,400 ug/L) is 063_MW11. Figure 15 shows an isoconcentration map with the chromium results.

4.7.2 Hexavalent Chromium

Hexavalent chromium was detected in seven of the ten wells sampled (063_MW01, 063_MW02, 063_MW03, 063_MW05, 063_MW06, 063_MW07, and 063_MW08). The location of the sample with the highest hexavalent chromium concentration (270 ug/L) is 063_MW01. There is no NJDEP GWQS for hexavalent chromium. Figure 16 shows the isoconcentration map with the hexavalent chromium results.

4.7.3 Antimony

Antimony was detected in five of the ten groundwater samples collected (063_MW01, 063_MW04, 063_MW06, 063_MW10, and 063_MW11). Samples from two wells (063_MW01 and 063_MW11) contained antimony concentrations that exceeded the NJDEP GWQS (6 ug/L). The location of the sample with the highest antimony concentration (283 ug/L) is 063_MW11. Figure 17 shows an isoconcentration map with the antimony results.

4.7.4 Nickel

Nickel was detected in seven of the ten wells sampled (063_MW01, 063_MW04, 063_MW06, 063_MW07, 063_MW08, 063_MW10, and 063_MW11). Samples from three wells contained nickel concentrations that exceeded the GWQS of 100 ug/L (063_MW01, 063_MW06, and 063_MW11). The location of the sample with the highest nickel concentration (272 ug/L) was 063_MW01. Figure 18 shows the isoconcentration map with the nickel results.

4.7.6 Vanadium

Eight of the ten wells sampled had detectable vanadium concentrations (063_MW01, 063_MW02, 063_MW03, 063_MW04, 063_MW06, 063_MW07, 063_MW10, and 063_MW11).

Samples from four wells had vanadium concentrations that exceeded the NJDEP GWQS of 60 ug/L (063_MW01, 063_MW06, 063_MW10, and 063_MW11). The location of the sample with the highest vanadium concentration (1,620 ug/L) was 063_MW01. Figure 19 shows the isoconcentration map with the vanadium results.

4.7.5 Thallium

Thallium was not detected in the ten wells sampled during the delineation investigation. The non-detected concentrations of thallium were below the GWQS of 2 ug/L.

4.8 Soil Conclusions

The results of the historical investigation, initial RI, and delineation RI were used to determine the extent of soil contamination (area and volume) at Sites 063 and 065. Based on the initial investigation, additional soil samples were collected during the delineation RI to define the extent of contamination in the northwestern edge, the entire eastern border (along Burma Road), a small portion of the southwestern edge, and the area around boring 063_B006.

While contamination is spread throughout Sites 063 and 065, the contamination is confined to the limits of Sites 063 and 065. Delineation RI soil borings (063_Z005, 063_Z009, 063_Z011 and 063_Z013) along Burma Road confirmed that contamination extends to the site boundary along Burma Road. Soil borings along the southwest portion of Sites 063 and 065 (063_E003, 063_D003, 063_D002, and 063_Z002) do not have metal concentrations above the RDC SRS or CrSCC and CCPW was not observed; therefore, the extent of contamination to the southwest is contained within the site boundary. On the west side of the site (along the fence line), soil borings are free of metal contamination; however, two of those borings (063_D10 and 063_E05) had CCPW. The northern boundary of the site is at the structural fill for the New Jersey Turnpike off ramp interchange.

Together, the historical investigations and initial and delineation RIs defined the extent of horizontal and vertical contamination in the soil at Sites 063 and 065. Figure 20 presents a visual interpretation of where contamination is present at depth (color red) based on RDC SRS/NJDEP CrSCC exceedances, and where CCPW was observed (green color), mainly in the first few feet bgs, during the field investigations. Figure 20 identifies the area where remediation is needed within Sites 063 and 065. Based on the present data a proposed excavation of this area up to 4 feet deep yields an excavation volume of approximately 10,970 cubic yards of impacted soil. The contamination limits were identified based on exceedances and presence of CCPW in the soil.

4.9 Groundwater Conclusions

The results of the initial RI and delineation RI were used to determine the horizontal and vertical extent of groundwater contamination. Based on initial RI groundwater results from well 063_MW01, which contained high concentrations of chromium, antimony, nickel, and vanadium, three monitoring wells were installed during the delineation RI (063_MW08, 063_MW10, and 063_MW11) to delineate the extent of contamination downgradient from 063_MW01. Well 063_MW08 was installed to delineate the vertical extent of groundwater contamination and 063_MW10 and 063_MW11 were installed to delineate the horizontal extent of groundwater contamination.

The highest concentrations of chromium and antimony were found in samples from monitoring well 063_MW11. The highest concentrations of hexavalent chromium, nickel, and vanadium were found in samples from monitoring well 063_MW01. Chromium concentrations that exceeded the NJDEP GWQS were found in five wells. Hexavalent chromium was not detected or detected at very low levels in the wells sampled during the initial RI; however, the hexavalent chromium concentration in 063_MW01 was approximately 12 times greater in the delineation RI than in the initial RI. Also, hexavalent chromium concentrations in 063_MW03, 063_MW05, 063_MW06, and 063_MW07 were slightly higher in the delineation RI samples. Sites 063 and 065 were completely inundated during Hurricane Sandy in October 2012, between when the initial RI and delineation RI groundwater samples were collected. This flooding may have affected the hexavalent chromium concentrations in the delineation investigation samples. Antimony concentrations that exceeded the GWQS were found in two wells. Nickel concentrations that exceeded the GWQS were found in three wells. Vanadium concentrations that exceeded the GWQS were found in five wells. Thallium was not detected in groundwater samples from Sites 063 and 065.

Based on the results of the initial and delineation RIs, the extent of groundwater contamination has been delineated vertically; however, the horizontal extent of groundwater contamination has not been fully delineated. Groundwater contamination is present in shallow groundwater only, as evidenced by the groundwater sample results from the deep well (063_MW08). The horizontal extent of groundwater contamination downgradient of 063_MW10 and 063_MW11 and upgradient of 063_MW06 and 063_MW07 has not been fully delineated. Based on the two groundwater gauging events, groundwater does not appear to be infiltrating and following the preferential pathways of underground utilities. Groundwater was measured at 3.41 feet bgs to 3.70 feet bgs in 063_MW01 to 5.80 feet bgs in 063_MW08 and the depth of the storm water/sewer in that area is between 2 and 3 feet bgs. Groundwater depth may vary seasonally.

5.0 RECEPTOR EVALUATION AND BASELINE ECOLOGICAL EVALUATION

This receptor evaluation and baseline ecological evaluation (EE) was performed in accordance with the requirements of New Jersey Administrative Code 7:26E in addition to the NJDEP Ecological Evaluation Technical Guidance (for the EE) to assess actual or potential adverse ecological effects on wildlife and plants resulting from site-related contamination at Hudson County Chromium Sites 063 and 065 (the Site) in Jersey City, Hudson County, New Jersey (Figure 1). The receptor evaluations for Sites 063 and 065 are presented in Appendices H-2 and H-3, respectively, and are discussed further in Section 5.2.

In accordance with New Jersey Administrative Code 7:26E, the EE documents the following actions:

1. Evaluates the data identified or collected in the site investigation to identify the site-specific contaminants that are of ecological concern.
2. Identifies environmentally sensitive natural resources (ESNRs) within the site boundaries and on properties immediately adjacent to the Site.
3. Identifies potential contaminant migration pathways to the ESNRs identified or observations of potential impact to the identified ESNRs that might be attributed to site contamination. Such observations shall include, but not be limited to: stressed or dead vegetation; discolored soil; sediment or water; absence of biota in a specified area of the system as compared to other similar areas of the same system; or presence of a seep or discharge; and
4. Draws conclusions regarding the need to conduct further investigations.

5.1 Site Background, Setting, and Facility History

A more detailed site background is presented in the main portion of the RI report, so only a brief discussion is presented here. Site 063 is located at 1 Burma Road in Jersey City, New Jersey (Figure 2). Site 063 is approximately 2.11 acres of vacant land with no buildings. Site 065 is comprised of the narrow (less than 8 feet wide) strip of land on the west side of Burma Road, between Burma Road and Site 063. It also has no buildings or structures on it. The topography at Sites 063 and 065 is generally flat, gradually sloping towards the east, which is most likely due to the industrial development at the Site (AECOM, 2011). A description of the location of the site and its history is provided in Section 1. The areas surrounding Sites 063 and 065 are primarily used for industrial purposes. Figure 4 in Appendix G-1 provides land use within 1,000 feet of the Site. Future use for the area is expected to be a parking lot with the possibility of mixed commercial, industrial, and residential (AECOM, 2011).

5.2 Receptor Evaluation

A receptor evaluation was performed for Sites 063 and 065. The report from this evaluation can be found in Appendix G-2 and G-3 respectively. In summary, no ESNRs have been identified at or near the Site.

As discussed earlier in this document, a water line, sanitary sewer/storm sewer, and gas line were identified along Burma Road. Based on the two groundwater gauging events, groundwater does not appear to be infiltrating and following the preferential pathways of

underground utilities. Even if the underground utilities were acting as preferential pathways, they would not likely result in a significant exposure to aquatic organisms for the following reasons. Because the sanitary sewer/storm sewer is a combined system that discharges to a local sanitary treatment facility, any water that is transported within the pipe or along the pipe will not discharge to surface water. For this reason, although some site-related contaminants were found in the surface water and sediment samples that were collected from the catch basin and storm sewer, the water and sediment from these areas would not discharge to a surface water body. Also, water lines and gas lines that may run near the property do not have any discharge points to surface water.

5.3 Environmentally Sensitive Natural Resources

ESNRs include, but may not be limited to, areas defined within New Jersey Administrative Code 7:1E-1.8(a), groundwater, and areas and/or resources that are protected or managed pursuant to the Pinelands Protection Act, New Jersey Statutes Annotated 13:18A-1 et seq. and the Pinelands Comprehensive Management Plan, New Jersey Statutes Annotated 7:50. Some of these areas include water bodies such as rivers, streams, creeks, ponds, lakes and reservoirs, wetlands and wetland transition areas, and habitat for Federal and State endangered or threatened plant and animal species.

The ecological habitat at the Site is very poor and the habitat immediately surrounding the Site is generally poor as well. Although there are some small vegetated areas along the perimeter, approximately half of the Site is covered with a liner, which is topped with gravel. The area surrounding the Site is a mixture of roads, industrial complexes, and landscaped lawns. Therefore, the area would provide very limited habitat for ecological receptors.

No surface water bodies are immediately adjacent to the Site, and as discussed above and below it is not likely that aquatic organisms would be impacted by metals in groundwater, so no surface water impacts are expected. The nearest surface water body to the Site is the Upper New York Bay, which is approximately 600 feet east-southeast of the Site. Figure 6 in Appendix G-1 shows surface water bodies within ½-mile of the Site. The drainage structure on the western side of the Site is below ground and was installed to prevent surface run-off from entering the Site (AECOM, 2011). On the eastern side of the Site, the Fabriform drainage structure was constructed to close a drainage ditch. This structure is tied into the storm sewer to the north (see Figure 2). Other surface water bodies within a ½-mile radius of the Site include manmade drainage ditches, manmade ponds, and drainage features created as part of the Liberty National Golf Course. Some groundwater impacts were observed through the groundwater sampling in the shallow water-bearing zone (see Section 5.4 below).

No wetlands were identified on the Site. Wetland maps from the New Jersey Geographic Information System show the closest wetlands were constructed as part of the Liberty National Golf Course and are located west of the Site (see Figure 7 in Appendix G-1).

A formal search for rare, threatened, and endangered species was not conducted because, given the industrial nature of the Site and surrounding area and the site activities that have occurred to date, it is highly unlikely that protected species are present at the Site. Also, no sensitive areas were found at or adjacent to the Site on the NJDEP i-Map NJDEP web site (http://njgin.state.nj.us/dep/DEP_iMapNJDEP/viewer.htm) or the NJDEP GeoWeb (<http://www.state.nj.us/dep/gis/geoweb/launch.htm>) (NJDEP, 2011c; NJDEP, 2011d).

5.4 Contaminants of Potential Ecological Concern

Pursuant to New Jersey Administrative Code 7:26E-3.11, the investigator must identify the presence of Contaminants of Potential Environmental Concern (COPECs). Although no ESNRs have been identified at or near the Site, COPECs at the Site (surface soil and groundwater) were identified for completeness of the document. The surface soil COPECs were identified by comparing the chemical concentrations in the surface soil samples to values in the most recent version of the NJDEP Ecological Screening Criteria Table (see Tables 3, 19, and 20) (NJDEP, 2011e). Table 19 presents the data from the initial investigation, while Table 20 presents the data from the delineation investigation. Based on this comparison, antimony, chromium, hexavalent chromium, nickel, and vanadium were detected at concentrations that exceeded their respective screening criteria and are identified as COPECs. However, because the habitat at the site is very poor, it is not likely that significant populations of ecological receptors would be present.

The groundwater COPECs were identified by comparing the chemical concentrations in the groundwater samples to values in the most recent version of the NJDEP Ecological Screening Criteria Table (see Tables 21 and 22) (NJDEP, 2011e). This comparison was conducted separately for the initial investigation and the delineation investigation groundwater results. The average metal concentrations in the groundwater samples were compared to the surface water aquatic screening criteria because the groundwater would be discharging as an average concentration as it flows across the site. The saline chronic water quality screening levels were preferentially selected over the freshwater values because the water in the Upper New York Bay, where groundwater from the site could potentially discharge, is saline. However, freshwater values were used if saline values were not available.

Therefore, the average groundwater concentrations in Tables 21 and 22 were first compared directly to the surface water criteria, and were then compared to the surface water criteria multiplied by factors of 10, 25, and 50 (for dilution factors of 10x, 25x, and 50x, respectively). Based on the initial investigation data, the average chromium, nickel, and vanadium concentrations exceeded the screening criteria without a dilution factor. Chromium and vanadium slightly exceeded the screening levels with a dilution factor of 10, while vanadium slightly exceeded the screening level with a dilution factor of 25. None of the chemicals exceeded the screening levels with a dilution factor of 50. Based on the delineation investigation data, the average chromium, nickel, and vanadium concentrations exceeded the screening criteria without a dilution factor. Chromium and vanadium exceeded the screening levels with dilution factors of 10 and 25, while vanadium slightly exceeded the screening level with a dilution factor of 25. Chromium also exceeded the screening level with a dilution factor of 50 by a factor of about 2. Although the closest point from the Site to the Bay is almost 1000 feet to the south, groundwater flows to the east where the Bay is over a half-mile away. Therefore, by the time groundwater discharges to the Bay, the chemical concentrations would be substantially reduced. Also, because of the large volume of water in the Bay, the groundwater would be mixed rapidly with the surface water so exceedances of aquatic criteria would be unlikely. Therefore, it is not likely that aquatic organisms would be impacted by metals in groundwater if it discharges to surface water.

5.5 Conclusions

Several metals, including antimony, chromium, hexavalent chromium, nickel, and vanadium, were identified as COPECs because they were detected at concentrations in surface soil that

exceeded their respective NJ Ecological Screening Criteria. However, no ESNRs have been identified at or near the Site. Therefore, there is not a complete exposure pathway between the COPECs in surface soil and the ESNRs. For that reason, an ecological risk assessment in accordance with New Jersey Administrative Code 7:26E-4.7 does not need to be conducted. Also, it is not likely that aquatic organisms would be impacted by metals in groundwater if it discharges to surface water.

6.0 CONCLUSIONS AND RECOMMENDATIONS

6.1 CONCLUSIONS

Sites 063 and 065 were investigated due to contamination from CCPW. Remedial actions were conducted previously in 1998 and 1999 to minimize exposure to CCPW. Contaminated soil remained on site at Sites 063 and 065 following the remedial actions since they were not designed to completely remove chromium contaminations. Post-excavation sample results were collected after the remedial actions were implemented. The initial RI consisted of sampling soil, groundwater, surface water, and sediment to determine the extent of contamination remaining at Sites 063 and 065. The initial RI field work occurred from July to September 2011. Samples were analyzed using USEPA Method SW-846 6010C (USEPA, 2007b). The results of the initial investigation are as follows:

Soil

- 276 soil samples were obtained; 52 were surface soil samples and 224 were subsurface soil samples.
- Chromium was detected in the surface and subsurface samples collected during the initial investigation. The highest concentration of chromium found was (estimated at 32,900 mg/kg) at location 063_C005, collected at a depth of 2.5 feet bgs. The lowest concentration of chromium found was 3.6 mg/kg. The concentration of chromium in the soil samples did not exceed the NJDEP CrSCC (120,000 mg/kg).
- Hexavalent chromium was detected in 92 soil samples. Ten samples contained concentrations of hexavalent chromium that exceeded the NJDEP CrSCC (20 mg/kg). These ten samples were localized (center of site near southern end and northern end of site). The highest concentration of hexavalent chromium (estimated at 9,470 mg/kg) was in the sample at 063_C005, collected at a depth of 2.5 feet bgs.
- Antimony was detected in 48 soil samples and the highest estimated concentration (38.2 mg/kg) was detected in sample 063_B005 at a depth of 1.3 feet bgs. Fourteen soil samples contained antimony concentrations that exceeded the minimum soil remediation standard/screening level. Seven samples had non-detect values that exceeded the minimum soil remediation standard/screening level due to the use of USEPA Method SW-846 6010C (USEPA, 2007b) in the initial RI. There is no evidence that high concentrations of antimony are clustered.
- Nickel and vanadium were found in soil samples throughout Sites 063 and 065. Soil samples that contained nickel and vanadium concentrations that exceeded the minimum soil remediation standards/screening levels were widespread throughout Sites 063 and 065 (54 and 44 exceedances for nickel and vanadium, respectively). The highest concentration of nickel (estimated at 661 mg/kg) was in the sample at 063_C005, collected at a depth of 2.5 feet bgs. The highest concentration of vanadium (718 mg/kg) was in the sample at 063_C005, collected at a depth of 2.0 feet bgs.
- Thallium was detected in one subsurface soil sample and its concentration was below the minimum soil remediation standard/screening level; however, seven soil samples had non-detect values that exceeded the minimum soil remediation standard/screening level due to the use of USEPA Method SW-846 6010C (USEPA, 2007b) in the initial RI.

- The non-detect values of antimony and thallium that exceeded the minimum soil remediation standard/screening level are not expected to impact the results of the initial RI. Only eight out of the 276 samples analyzed contained detectable antimony concentrations that exceeded soil remediation standards/screening levels, so antimony is not considered a contaminant of concern. Similarly, there were no samples for which a detected concentration of thallium exceeded the soil remediation standards/screening levels; thus, thallium is not considered a chemical of concern.
- CCPW was observed in 23 soil borings during the initial RI.

Groundwater

- Seven groundwater samples were obtained from the seven monitoring wells at Sites 063 and 065. Three monitoring wells were resampled for hexavalent chromium because the original samples exceeded the holding time requirements. Because the initial sample results are approximately the same as the re-analysis results for these three wells, it appears that exceeding the holding time did not affect the results. Detections in both the initial samples and the re-analyzed samples were used.
- The sample where the highest concentration of antimony, chromium, nickel, vanadium, and hexavalent chromium were detected is 063_MW01.
- Six groundwater samples detected chromium. Three of the samples had concentrations of chromium that exceeded the screening criteria. The highest concentration of chromium was 5160 ug/L was found in the sample from 063_MW01.
- Three samples contained hexavalent chromium. The highest concentration found was 21.8J ug/L found in the first sample collected from 063_MW01. This sample exceeded the holding time and the re-analyzed sample collected from 063_MW01 was non-detect for hexavalent chromium; however, results from samples that exceeded the holding time for hexavalent chromium are considered valid and usable results. A hexavalent chromium criterion is not required for this remedial action in accordance with NJDEP's February 8, 2007 Chromium Cleanup Policy.
- Antimony was detected in three samples. The sample collected from 063_MW01 had an estimated concentration (16.8 ug/L) that exceeded the GWQS.
- Six groundwater samples detected nickel. Two samples contained nickel concentrations that exceeded the GWQS. The highest nickel concentration (318 ug/L) was found in the sample from 063_MW01.
- Four groundwater samples contained vanadium and three of those samples had vanadium concentrations that exceeded the GWQS. The highest vanadium concentration (1870 ug/L) was found in the sample from 063_MW01.
- Thallium was not detected in the seven wells sampled. However, the method detection limit for these seven groundwater samples exceeded the GWQS using USEPA Method SW-846 6010C (USEPA, 2007b) for the analysis.
- The highest concentrations of the metals were detected in monitoring well 063_MW01.

Sediment and Surface Water

- Two sediment samples were obtained from a catch basin and a storm sewer located on Sites 063 and 065. Chromium and nickel concentrations in both sediment samples exceeded the NJDEP ESC. Hexavalent chromium and vanadium were detected but there are no NJDEP ESC for either chemical in sediment. Antimony and thallium were not detected in either sediment sample.
- Two surface water samples were obtained from a catch basin and a storm sewer located on Sites 063 and 065. Both surface water samples contained chromium and vanadium concentrations that exceeded the NJDEP ESC. Hexavalent chromium, antimony, and nickel were detected at concentrations below the NJDEP ESC. Thallium was not detected in either surface water sample; however, the method detection limit exceeded the NJDEP ESC for thallium in both surface water samples. The sanitary sewer/storm sewer is a combined system that discharges to a local sanitary treatment facility so any water that is transported within the pipe or along the pipe discharges to the local treatment facility. Water lines and gas lines do not have discharge points to surface water.

The initial RI did not fully delineate the nature and extent of contaminated soil and groundwater. Therefore, a sampling plan to collect additional data to facilitate delineation was designed and approved in July 2012. This delineation RI was conducted in December 2012 through February 2013 and consisted of sampling soil and groundwater. The delineation sampling conducted in December 2012 and January 2013 utilized USEPA Method SW-846 6020A (USEPA, 2007a), which has a lower quantitation level for the metals analyzed. There were no instances where delineation sample results had detection level concentrations that exceeded the minimum soil remediation standard/screening level and GWQS. The results of the delineation investigation are as follows:

Soil

- 52 soil samples were obtained during the delineation RI; 10 were surface soil samples and 42 were subsurface soil samples.
- Chromium was detected in the surface and subsurface samples collected during the delineation RI. The concentration of chromium in the surface and subsurface soil samples did not exceed the NJDEP CrSCC (120,000 mg/kg). The highest estimated chromium concentration (3,400 mg/kg) was in the sample from 063_C013, collected at a depth of 0.0 feet bgs.
- Hexavalent chromium was detected in 16 soil samples, two of which contained hexavalent chromium concentrations that exceeded the NJDEP CrSCC (20 mg/kg). The highest hexavalent chromium concentration (44.8 mg/kg) was in the sample at 063_B006A, collected at a depth of 1 foot bgs.
- Antimony was detected in 14 soil samples, the concentration of antimony in these soil samples did not exceed the minimum soil remediation standard/screening level. The highest antimony concentration (3.3 mg/kg) was in the sample at 063_F010, collected at a depth of 0.0 feet bgs.

- Nickel and vanadium were found in soil samples throughout Sites 063 and 065. Nine soil samples contained nickel concentrations that exceeded the minimum soil remediation standard/screening level and two soil samples contained vanadium concentrations that exceeded the minimum soil remediation standard/screening level. The highest concentrations of nickel and vanadium (estimated at 321 mg/kg and 313 mg/kg, respectively) were in the sample at 063_C013, collected at a depth of 0 feet bgs.
- Thallium was detected in nine soil samples; the concentration of thallium in these soil did not exceed the minimum soil remediation standard/screening level.
- CCPW was observed in three soil borings collected during the delineation investigation.
- Use of USEPA Method SW-846 6020A (USEPA 2007a) instead of SW-846 6010C (USEPA, 2007b) eliminated the reporting of non-detections that were greater than the minimum soil remediation standards/screening levels.

Groundwater

- Ten groundwater wells were sampled during the delineation investigation (one sample per well); the seven wells installed during the initial RI and three new wells installed during the delineation RI.
- The deep well installed during the delineation RI (063_MW08) shows that deep groundwater is not contaminated.
- During the site investigation, a water line, gas line, and combined sanitary/storm sewer were identified along Burma Road. Based on the two groundwater gauging events, groundwater does not appear to be infiltrating and following the preferential pathways of underground utilities. The water line and gas line do not have direct discharge to surface water. The combined sanitary/storm sewer discharges to the local waste water treatment facility.
- The highest concentrations of chromium and antimony were found in samples from monitoring well 063_MW11. The highest concentrations of hexavalent chromium, nickel, and vanadium were found in samples from monitoring well 063_MW01. Thallium was not detected in the groundwater samples.
- Eight groundwater samples contained detectable chromium concentrations, five of which contained chromium concentrations that exceeded the NJDEP GWQS. The highest chromium concentration (51,400 ug/L) was found in the sample from 063_MW11.
- Seven groundwater samples contained detectable hexavalent chromium concentrations. The highest hexavalent chromium concentration (270 ug/L) was found in the sample from 063_MW01. A hexavalent chromium criterion is not required for this remedial action in accordance with NJDEP's February 8, 2007 Chromium Cleanup Policy.
- Five groundwater samples contained detectable antimony concentrations, two of which contained antimony concentrations that exceeded the NJDEP GWQS. The highest antimony concentration (283 ug/L) was found in the sample from 063_MW11.

- Seven groundwater samples contained detectable nickel concentrations, three of which contained nickel concentrations that exceeded the GWQS. The highest nickel concentration (272 ug/L) was found in the sample from 063_MW01.
- Eight groundwater samples contained detectable vanadium concentrations, four of which contained vanadium concentrations that exceeded the NJDEP GWQS. The highest vanadium concentration (1,620 ug/L) was found in the sample from 063_MW01.
- Thallium was not detected in the ten wells sampled at Sites 063 and 065.
- Hexavalent chromium was not detected or detected at very low levels in the wells sampled during the initial RI. The hexavalent chromium concentration in 063_MW01 was approximately 12 times greater in the delineation RI than in the initial RI. Also, hexavalent chromium concentrations in 063_MW03, 063_MW05, 063_MW06, and 063_MW07 were slightly higher in the delineation RI samples. Sites 063 and 065 were completely inundated during Hurricane Sandy in October 2012, between when the initial RI and delineation RI groundwater samples were collected. This flooding may have contributed to the elevated hexavalent chromium concentrations in well 063_MW01, 063_MW03, 063_MW05, 063_MW06, and 063_MW07 between the initial and delineation RI samples.
- Chromium concentrations that exceeded the GWQS were found in wells 063_MW01, 063_MW06, 063_MW07, 063_MW10, and 063_MW11. Antimony concentrations that exceeded the GWQS were found in wells 063_MW01 and 063_MW11. Nickel concentrations that exceeded the GWQS were found in wells 063_MW01, 063_MW06, and 063_MW11. Vanadium concentrations that exceeded the GWQS were found in wells 063_MW01, 063_MW06, 063_MW07, 063_MW10, and 063_MW11.
- Use of USEPA Method SW-846 6020A (USEPA 2007a) instead of SW-846 6010C (USEPA, 2007b) eliminated the reporting of non-detections that were greater than the GWQS.

Using data collected during the historical investigations, initial RI, and delineation RI, the extent of contamination in soil at Sites 063 and 065 was fully delineated. While contamination is spread throughout Sites 063 and 065, it is confined within the limits of Sites 063 and 065. Delineation RI soil borings along Burma Road confirmed that the extent of the contamination extends to the boundary along Burma Road. Contamination was not observed in soil borings along the southwest edge of Sites 063 and 065. On the west side of the site (along the fence line), soil borings are free of metal contamination; however, two borings contained CCPW. The northern boundary of the contamination is the structural fill for the New Jersey Turnpike off ramp interchange. Together, the historical investigations and initial and delineation RIs defined the extent of horizontal and vertical contamination in the soil. Figure 20 identifies the proposed soil excavation area (up to 4 feet deep).

Using data collected during the initial and delineation RIs, the extent of groundwater contamination has been delineated vertically; however, the horizontal extent of groundwater contamination has not been fully delineated. Groundwater contamination is present in shallow groundwater, as evidenced by the low concentrations of metals in groundwater sample results from the deep well (063_MW08). The highest concentrations of chromium and antimony were found in samples from monitoring well 063_MW11. The highest concentrations of hexavalent chromium, nickel, and vanadium were found in samples from monitoring well 063_MW01. The

horizontal extent of groundwater contamination downgradient of 063_MW10 and 063_MW11 and upgradient of 063_MW06 and 063_MW07 has not been fully delineated. Based on the two groundwater gauging events, groundwater does not appear to be infiltrating and following the preferential pathways of underground utilities.

Several metals were identified as COPECs because the detectable concentrations in surface soil exceeded their respective screening criteria. However, no ESNRs have been identified at or near Sites 063 and 065. Therefore, a completed exposure pathway between the COPECs in surface soil and the ESNRs does not exist. For that reason, an ecological risk assessment in accordance with New Jersey Administrative Code 7:26E-4.7 does not need to be conducted. Also, it is not likely that aquatic organisms would be impacted by metals in groundwater if it discharges to surface water.

6.2 RECOMMENDATIONS

Figure 20 presents a visual interpretation of where contamination is present at any given depth (color red) based on RDC SRS exceedances, and where CCPW was observed (color green), mainly in the first few feet bgs, during the field investigation. Pre-excavation or pre-design sampling of the remedial limits to the north/northwest of boring 063_E005, to the north/northwest of borings 063_B013 and 063_C014 and to the east of boring 063_B003 will be conducted as part of the Remedial Action Work Plan. Soil samples with exceedances of the impact to groundwater standard are collocated with the residential direct contact exceedances and the Remedial Action Work Plan will incorporate these exceedances into the remedial design of the soil remedy. Excavation of this area up to 4 feet deep yields an excavation volume of approximately 10,970 cubic yards of impacted soil.

Based on the groundwater results, a Groundwater Classification Exception Area/Well Restriction Area (N.J.A.C. 7:26E-4.3(a)7 and N.J.A.C. 7:26E-4.9(a)7) for the shallow groundwater should be prepared following the requirements details in N.J.A.C 7:26C-73. An additional groundwater investigation will be completed to determine if the shallow groundwater has been impacted following the implementation of the soil remedy. This groundwater investigation will also be conducted to determine the horizontal delineation of shallow groundwater contamination downgradient of 063_MW11 and upgradient of wells 063_MW06 and 063_MW07. In addition, the groundwater investigation will include the determination of locations and invert depths of the utilities in the vicinity of the impacted groundwater in order to determine if there is the potential for contaminant migration along utility bedding and/or infiltration into utilities.

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APPENDIX C-2 DELINEATION INVESTIGATION