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Remedial Action Report – Soil Area of Concern (AOC 1) Final

Hudson County Chromate Site 156
Metropolis Towers
270-280 Luis Munoz Marin Boulevard
Jersey City, New Jersey
NJDEP Program Interest Number: G000008770
Case Tracking Number: 104063

Document No. 156-001

Contents

List of Tables

List of Figures

List of Photographs

List of Appendices

List of Acronyms

%D	percent difference
%R	percent recovery
ACO	Administrative Consent Order
AMP	Air Monitoring Plan
AMS	air monitoring station
AMT	Air Monitoring Technician
AOC	Area of Concern
amsl	above mean sea level
ARS	Alternative Remediation Standard
BEMQA	Bureau of Environmental Measurements and Quality Assurance
bgs	below ground surface
CCPW	Chromate Chemical Production Waste
CID	Case Inventory Document
CEC	Civil & Environmental Consultants, Inc.
COPR	Chromite Ore Processing Residue
Cr	total chromium
Cr^{+3}	trivalent chromium
Cr^{+6}	hexavalent chromium
CrSCC	Chromium Soil Cleanup Criteria
CY	cubic yards
DIGWSSL	Default Impact to Groundwater Soil Screening Level
DGA	dense-graded aggregate
EDR	Event Documentation Reports
EDV	Environmental Validation, Inc.
Eh	redox potential
ENTACT	ENTACT, LLC
EQA	Environmental Quality Associates, Inc.
FSPM	Field Sampling Procedures Manual
FSP-QAPP	Field Sampling Plan – Quality Assurance Project Plan
ft	feet
ft bgs	feet below ground surface
GGM	Green-gray mud
GWQS	Groundwater Quality Standard
HCC	Hudson County Chromate
HCV	Hampton Clarke-Veritech, Inc.
HEP	Hudson-Essex-Passaic
HUD	Housing and Urban Development
ICP	Inductively Coupled Plasma
ID	identifier
IGWSRS	site-specific impact to groundwater soil remediation standards
IGW	impact to groundwater
IRM	Interim Remedial Measure
JCO	Judicial Consent Order
JCMUA	Jersey City Municipal Utilities Authority
LCS	laboratory control sample

LF	linear feet
LSRP	Licensed Site Remediation Professional
mg/kg	milligrams per kilogram
MRCE	Mueser Rutledge Consulting Engineers
MS	matrix spike
MSD	matrix spike duplicate
N/A	not available
NAVD 88	North American Vertical Datum of 1988
Ni	nickel
NJ	New Jersey
N.J.A.C.	New Jersey Administrative Code
NJDEP	New Jersey Department of Environmental Protection
NJDEPE	New Jersey Department of Environmental Protection and Energy
NJDCA	New Jersey Department of Community Affairs
NJDOT	New Jersey Department of Transportation
No.	number
NRDCSRS	Non-Residential Direct Contact Soil Remediation Standard
PATH	Port Authority Trans Hudson
PAM	portable air monitoring
PCBs	polychlorinated biphenyls
PM_{10}	particulate matter 10 microns or less in diameter
PSEG	Public Service Electric and Gas Company
PVSC	Passaic Valley Sewerage Commission
Q	qualifier
QA	quality assurance
QAPP	Quality Assurance Project Plan
QC	quality control
RA	Remedial Action
RAR	Remedial Action Report
RAWP	Remedial Action Work Plan
RDCSRS	Residential Direct Contact Soil Remediation Standard
RI	Remedial Investigation
RIR	Remedial Investigation Report
RIWP	Remedial Investigation Work Plan
RPD	relative percent difference
SA	Site Administrator
Sb	antimony
SCC	Soil Cleanup Criteria
SDG	Sample Delivery Group
SF	square feet
SOP	Standard Operating Procedures
SRP	Site Remediation Program
SRP-PI	Site Remediation Program – Program Interest
SRS	Soil Remediation Standards
SPLP	Synthetic Precipitation Leaching Procedure
SRRA	Site Remediation Reform Act
TAL	target analyte list
TCL	target compound list
TEE	terminal excavation elevation
Tl	thallium

TPI	TPI Environmental, Inc.
TPH	Total petroleum hydrocarbons
TRSR	Technical Requirements for Site Remediation
TWA	Treatment Works Approval
µg/L	micrograms per liter
UHOT	unregulated heating oil tank
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
UST	underground storage tank
V	vanadium
WCD	WCD Group

List of Definitions

The following definitions apply solely to this document.

CCPW	Chromate Chemical Production Waste, a by-product generated from the production of sodium bichromate, including Chromite Ore Processing Residue (COPR), Green-Gray Mud, and fill mixed with COPR or Green-Gray Mud.
Chromium	An element found in nature that is commonly used in manufacturing activities. Chromium may be present in soil or water as trivalent chromium (Cr^{+3}) and hexavalent chromium (Cr^{+6}). Cr^{+3} is an essential nutrient at trace concentrations. Cr^{+6} can be present in many forms, some of which are carcinogenic at high concentrations. Total chromium (Cr), as measured in soil or groundwater, is the sum of Cr^{+3} and Cr^{+6}.
COPR	Chromite Ore Processing Residue is a specific type of CCPW generally characterized as a reddish brown, coarse to fine gravel with varying amounts of sand and silt particles. The gravel portion of the matrix is typically defined as nodules from the chromium manufacturing process that range in size from 3/4- to 1/8-inch in diameter. However, nodules have been infrequently detected at diameters of over an inch. Different sized nodules may be found cemented together to form larger clusters. The matrix of these clusters may consist of cement-like silt. These nodules can be easily disintegrated with a hammer. Occasionally, when detected in the saturated zone, COPR nodules may appear as a fine-grained material that has been weathered. The permeability of this material is variable. The inner matrix of COPR nodules typically contains higher concentrations of Cr^{+6} than the surface of the nodules but lower concentrations than Green-Gray Mud (GGM). The typical approximate range of Cr^{+6} concentrations in COPR is between 300 and 5,000 milligrams per kilogram (mg/kg).
GGM	Green-Gray Mud is generally a lime green dense silt, with minor amounts of fine sand and clay. When found in the saturated zone, the grain size of this material may have been affected further due to weathering processes. This can give the material a wet, clayey silt or silty clay appearance with little or no physical or structural integrity. This material has a low permeability. The pH of this material is generally 11 to 12 units. The typical approximate range of Cr^{+6} concentrations in Green-Gray Mud is greater than 5,000 mg/kg.
Groundwater	The supply of fresh water found beneath the Earth's surface, which can be extracted by wells or through natural springs.
IRM	Interim Remedial Measure. Remedial action taken at a contaminated site to reduce the potential for human health or environmental exposure to contaminants at a site before a remedial investigation is complete.
Meadow Mat	A naturally occurring organic estuarine deposit located at approximately 13 to 20 feet below the ground surface, pre-excavation.

List of Definitions (Continued)

RAR	Remedial Action Report. A report documenting how a responsible party remediated a contaminated site or area of concern.
Remediation	Actions to reduce, isolate, or remove contamination with the goal of protecting human health and the environment.
RIR	Remedial Investigation Report. A report documenting the findings and recommendations from a remedial investigation of a contaminated site or area of concern.
Site Administrator (SA)	Under the terms of an agreement among PPG, the New Jersey Department of Environmental Protection and the City of Jersey, this court-appointed individual is responsible for: • Developing a master schedule; • Resolving issues that might arise; • Obtaining technical expertise required for the review of PPG's submittals; and • Maintaining regular communications with community representatives.
Soil	All solid earthen material (other than CCPW). Exceptions to this definition are specifically noted in the text.
SRS	New Jersey Soil Remediation Standards (SRS), (N.J.A.C. 7:26D et seq.).

1.0 Introduction

This Remedial Action Report (RAR) was prepared by AECOM on behalf of PPG to provide the results of soil remediation activities specifically related to the Soil Area of Concern (AOC) 1 and demonstrate environmental compliance for the Soil AOC 1 at Hudson County Chromate (HCC) Site 156, Metropolis Towers (the Site), located at 270-280 Luis Munoz Marin Boulevard, Jersey City, Hudson County, New Jersey (**Figure 1**). The Remedial Action (RA) activities for AOC 1 were implemented from March 2013 through May 2014 and from September 2017 through November 2017, pursuant to the *Remedial Action Work Plan* (RAWP) (CEC, November 2012), conditionally approved on January 22, 2013. The RAWP is included in **Appendix A**. The New Jersey Department of Environmental Protection (NJDEP) approval letter is included in **Appendix B**.

The Site is bounded to the north by Christopher Columbus Drive; to the south by Montgomery Street; to the east by Warren Street; and to the west by Luis Munoz Marin Boulevard. The Site occupies tax parcels Block 13101 Lots 1 and 2. The New Jersey Department of Environmental Protection (NJDEP) Site Remediation Program, Program Interest (SRP-PI) Number for Site 156 is G000008770.

In 1990, PPG and the NJDEP entered into an Administrative Consent Order (ACO) to investigate and remediate locations where Chromate Chemical Production Waste (CCPW) or CCPW-impacted materials related to former PPG operations may be present. On June 26, 2009, NJDEP, PPG, and the City of Jersey City entered into a Judicial Consent Order (JCO) (Superior Court of New Jersey Law Division – Hudson County, 2009) with the purpose of remediating the soils and sources of contamination at these HCC Sites as expeditiously as possible. The goal of the JCO is to complete the investigation and remediation of the PPG Sites in accordance with a judicially enforceable master schedule. Priority for the remedial activities was given to residential locations where CCPW and CCPW-related contamination was present. The provisions of the original ACO remain in effect with the JCO taking precedence where conflicts exist between the two documents.

1.1 Remedial Action Objective

For AOC 1, the objective of the Site 156 Soil RA was to remediate, via excavation and off-site disposal, all visible CCPW and soil impacted with hexavalent chromium (Cr^{+6}) contamination where it exceeds the NJDEP Chromium Soil Cleanup Criteria (CrSCC) of 20 milligrams per kilogram (mg/kg), including any co-located concentrations of CCPW-related metals (antimony [Sb], chromium [Cr], nickel [Ni], thallium [Tl], and/or vanadium [V]) where they exceed NJDEP Residential Direct Contact Soil Remediation Standards (RDCSRS). Note that as presented in **Section 1.3**, an Alternative Remediation Standard (ARS) for V of 370 mg/kg has previously been approved by NJDEP for use at this Site. The soil data were also compared to the Default Impact to Groundwater Soil Screening Levels (DIGWSSL) and site-specific Impact to Groundwater Soil Remediation Standards (IGWSRS) for Ni.

This RAR addresses remediation of only Cr^{+6} and CCPW-related constituents. PPG is not legally responsible for the remediation of other chemicals exceeding NJDEP Soil Remediation Standards (SRS) or Ground Water Quality Standards (GWQS) that may be present at the Site. The Site 156 property owners were notified when impacts other than Cr^{+6} and CCPW-related constituents were encountered during site activities at the property.

1.2 Remedial Action Requirements

This RAR was prepared in accordance with the following requirements and guidance:

- *Remedial Action Work Plan (RAWP) – Metropolis Towers – Site 156 (Formerly Gregory Park Apartments) 270-280 Luis Munoz Marin Boulevard Soil, Jersey City, New Jersey (NJ)* (Civil and Environmental Consultants, Inc. (CEC), November 16, 2012), as conditionally approved by NJDEP on January 22, 2013 (CEC, 2012);
- New Jersey Administrative Code Chapter 26C, *Administrative Requirements for the Remediation of Contaminated Sites*, N.J.A.C. 7:26C, last amended on May 4, 2015 (NJDEP, 2009);
- NJDEP *Technical Requirements for Site Remediation* (TRSR), N.J.A.C. 7:26E- 5.7 (May 7, 2012) (NJDEP, 2012a);
- NJDEP *Remediation Standards*, N.J.A.C. 7:26D (May 7, 2012, updated September 2017) (NJDEP, 2012b);
- NJDEP *Chromium Soil Cleanup Criteria*, September 2008, revised April 2010 (NJDEP, 2008).
- NJDEP Commissioner Jackson's February 8, 2007 *Memorandum Regarding Chromium Moratorium* (NJDEP, 2007).
- NJDEP *Ground Water Quality Standards*, N.J.A.C. 7:9C (last amended on July 22, 2010, readopted March 4, 2014, updated January 2018) (NJDEP, 2010);
- NJDEP *Well Construction and Maintenance; Sealing of Abandoned Wells*, N.J.A.C. 7:9D (January 31, 2014, updated January 2018) (NJDEP, 2014a);
- Appendix G of the July 19, 1990 NJDEP *Administrative Consent Order (ACO)* (NJDEP, 1990);
- June 26, 2009 *Partial Consent Judgment (JCO) Concerning the PPG Sites* (Superior Court of New Jersey Law Division – Hudson County, 2009);
- NJDEP *Site Remediation Program Alternative and Clean Fill Guidance for Site Remediation Program (SRP) Sites* (December 29, 2011) (NJDEP, 2011a);
- NJDEP *Development of Site-Specific Impact to Ground Water Soil Remediation Standards using the Synthetic Precipitation Leaching Procedure* (November 2013) (NJDEP, 2013a);
- NJDEP *Site Remediation Program Technical Guidance for Investigation of Soil, Remedial Investigation of Soil, and Remedial Action Verification Sampling for Soil* (August 1, 2012, last updated March 2015) (NJDEP, 2012c);
- NJDEP *Field Sampling Procedures Manual* (August 2005, last updated April 11, 2011) (NJDEP, 2005);
- NJDEP *Guidance Document – Development of Impact to Ground Water Soil Remediation Standards Using the Soil-Water Partition Equation*, Version 2.0 -November 2013 (NJDEP, 2013b);
- NJDEP *Technical Guidance for the Attainment of Remediation Standards and Site Specific Criteria*, Version 1.0, September 24, 2012 (NJDEP, 2012d);
- *Field Sampling Plan – Quality Assurance Project Plan* (FSP-QAPP) (AECOM, 2010);
- *Program Health and Safety Plan, Rev. 1, PPG Industries, Inc., Hudson County Chromium Sites, Jersey City, New Jersey*. February 2014, (AECOM, 2014a);

- *Development of a Site-Specific Impact to Ground Water (IGW) Standard for Total Nickel in Layout Area 1* (CEC, 2013a); and
- D*evelopment of a Site-Specific Impact to Ground Water (IGW) Standard for Total Nickel in Layout Area 2 and Layout Area 3* (CEC, 2013b).

1.3 Remediation Standards

For this RA, pre- and post-excavation soil analytical results were compared to NJDEP SRS, pursuant to N.J.A.C. 7:26D. However, NJDEP did not develop specific SRSs for Cr, trivalent chromium (Cr^{+3}) or Cr^{+6} at the time N.J.A.C. 7:26D was promulgated. Therefore, Cr^{+6} concentrations are compared to the NJDEP CrSCC of 20 mg/kg for soil remediation compliance during this RA. There is currently no NJDEP SRS and no NJDEP Soil Cleanup Criteria (SCC) for total Cr. Therefore, total Cr results are compared to the interim NJDEP Residential SCC for Cr^{+3} of 120,000 mg/kg. There is no non-residential SCC for Cr^{+3}.

The SRS for CCPW-related metals for the Site are based on current NJDEP RDCSRS, with the exception of V, which has a NJDEP-approved ARS. In a letter dated December 12, 2011 (NJDEP, 2011b), NJDEP accepted the use of a 370 mg/kg ARS for V (**Appendix B**). IGWSRS for Ni were developed for each remedial area (CEC, 2013a and CEC, 2013b). The elevation of the groundwater was estimated as the 50^{th} percentile of water gauging readings from 2016 and 2017 sampling events (using wells from the shallow aquifer and excluding the well in the basement of Building No. 2 which exhibited unusual readings compared to the remainder of the wells). The estimated groundwater elevation is 0.91 feet in the North American Vertical Datum 1988 (ft NAVD 88).

The concentrations of other metals found in association with CCPW are compared to the most stringent SRS, or site-specific value, as indicated below:

Table 1 Soil Remediation Standards for CCPW Metals

Contaminant	RDCSRS (mg/kg)	NRDCSRS (mg/kg)	DIGWSSL (mg/kg)	Site-Specific IGWSRS
Antimony (Sb)	31	450	6	NA
Nickel (Ni)	1,600	23,000	48	Layout Area 1: 411 Layout Area 2: 322 Layout Area 3: 565
Thallium (Tl)	NA	NA	3	NA
Vanadium (V)	370*	1,100	NA	NA

Notes:
CCPW – Chromate Chemical Production Waste
RDCSRS – Residential Direct Contact Soil Remediation Standard
NRDCSRS – Non-Residential Direct Contact Soil Remediation Standard
DIGWSSL – Default Impact to Ground Water Soil Screening Levels
IGWSRS – Impact to Ground Water Soil Remediation Standards
NA – Standard Not Available
*Site-specific Alternative Remediation Standard (ARS)

1.4 Site Remediation Program Documentation

The required NJDEP SRP/Site Remediation Reform Act (SRRA) forms are provided with this submission in **Appendix C**, including the Cover/Certification Form, Case Inventory Document (CID), an updated Receptor Evaluation Form, Alternative or New Remediation Standard and/or Screening Level Application Form for the V RDCSRS and Ni IGWSRS. The NJDEP RAR form is only available online and cannot be prepared for this submittal because it is under NJDEP direct oversight.

NJDEP correspondence for the Site is provided in **Appendix B**. Previous Site reports are provided in **Appendix A**. Remedial work plans are provided in **Appendix D**.

2.0 Background Information

This section provides a review of Site background information including a description of the physical setting, geology, hydrogeology, the receptor evaluation update, an overview of the Site AOCs, and a description of previous soil removals.

2.1 General Site History

Site 156 encompasses the Metropolis Towers property (also referred to as Gregory Park Apartments), which occupies approximately 8.6 acres (see **Figure 1**). The property consists of two 20-story, multi-unit residential buildings (Buildings 1 and 2). Most of the area surrounding the buildings is paved and is used as parking for property residents. A small percentage of the property consists of green space. The buildings were constructed between 1961 and 1967 with aid from Federal grants issued by the United States (U.S.) Department of Housing and Urban Development (HUD). The buildings are constructed of reinforced concrete and are supported by driven piles.

Historically, a two-story building known as the Central Building was located between Buildings 1 and 2. An in-ground swimming pool was located on the second floor of the Central Building. The building was demolished in 2006, but pilings and grade beams from the building were still present at the Site prior to excavation.

A review of historical Sanborn maps indicates that between the late 1800's and 1950, Site 156 was occupied by several industries including National Iron Works, a filling station, a painting contractor, a chemical warehouse, auto truck parking, a motor freight station, a machine shop, and a furniture manufacturer. Aerial photographs from 1951 depict various commercial, light industrial, and row-style housing buildings at Site 156.

In 1990, the NJDEP notified PPG that Mr. Claude Perretti issued a statement noting that approximately 9,000 cubic yards of CCPW was used as backfill at the Site in 1961. The exact location of where the material was placed was not known. Several soil removal activities have taken place at the Site since 1961. In 1976 or 1977, a total of 5,200 to 6,800 cubic yards of soil was excavated from the north and south parking lots of Building 1. There is no indication that this excavation was conducted for remedial purposes. An unknown volume of soil was excavated from the northeast corner of Building 1 in response to a leak from an above ground heating oil tank in 1986-1987 and again in 1987 as part of the Port Authority Trans Hudson (PATH) ventilation duct remodeling (CEC, 2012).

2.2 Surrounding Land Use

The surrounding land use is a mix of residential and commercial properties. Located west of the apartment complex and across Luis Munoz Marin Boulevard is the City Hall of Jersey City. Nearby are several office towers, as well as several public schools and churches. The PATH Grove Street Station is located across Christopher Columbus Drive (formerly Railroad Avenue) and a PATH subway tunnel runs beneath Christopher Columbus Drive along the northern edge of the Site. A ventilator shaft for the PATH tunnel lies adjacent to the Site at the corner of Christopher Columbus Drive and Warren Street.

2.3 Local and Regional Geology

2.3.1 Topography

The project area has little topographic relief, with ground surface elevations generally ranging from approximately 4 to 8 feet (ft) above mean sea level (amsl) using the North American Vertical Datum of 1988 (NAVD 88). Storm water runoff is channeled into the municipal storm sewer system. **Figure 1** shows the regional topography near the Site on a United States Geological Survey (USGS) Topographic Map.

2.3.2 Regional Geology

The Site lies within physiographic province of the Piedmont Plain, which is characterized by low ridges trending in the northeasterly direction. The area is underlain by formations of Recent, Pleistocene and Triassic ages. The bedrock at the Site belongs to the Newark Basin, which is the most northerly of the three basins known as the Newark Supergroup. The Newark Supergroup is comprised of rock from the Upper Triassic and Jurassic ages and lie along an arcuate belt stretching from southern New York to central Virginia.

The Newark Supergroup is divided into three formations on the basis of lithology: (1) the lower unit - the Stockton Formation, (2) the middle unit – the Lockatong Formation, and (3) the upper unit - the Passaic Formation. Site 156 is underlain primary by the Stockton Formation; however, a gradational contact and/or interfingering with the Lockatong Formation may exist at the Site. The Stockton Formation consists of gray to reddish brown sandstone, interbedded with conglomerate, siltstone and shale. The siltstone may be gray, green or purple and fossiliferrous. This formation may be found at depths greater than 40 ft and has a thickness of approximately 850 ft beneath the Site. The Stockton dips gently to the west. The Lockatong Formation is a fossil-rich gray to black siltstone and shale, which is thinly laminated to thick bedded. West of the Site, within Jersey City, a diabase sill of Lower Jurassic Age intrudes the Lockatong Formation.

The sediments overlying the Newark Supergroup in this area are usually Pleistocene glacial drift deposits. The Pleistocene glacial drift deposits exist as stratified and unstratified sediments ranging from silty clay to sands and gravels. In the eastern part of Newark, a buried valley has been identified with depth to bedrock ranging from 125 to 300 ft. The axis of this valley runs roughly southwest-northeast, suggesting that the valley passes north of Jersey City, but portions could exist in western Jersey City. Preglacial Lakes Hackensack and Hudson, which existed to the north of the Site, may have contributed outwash deposits to this area as drainage of these lakes occurred. The terminal moraine stretches to south of Jersey City, across Perth Amboy, New Jersey; Staten Island, New York; and western Long Island.

Recent alluvial deposits consist of unconsolidated mud and silt, with peat and other organic material, and occasional sand and gravel lenses. Streams have deposited alluvial sediments either directly on the Stockton Formation or on top of the Pleistocene age glacial sediments. These deposits have resulted in the creation of the meadowlands tidal marshes. A peat layer called meadow mat is frequently associated with the tidal marsh deposits of silty clay. These marsh areas have been dewatered and backfilled in many areas of Jersey City resulting in a surface layer of fill material overlying the meadow mat unit (first natural deposit).

2.3.3 Project Area Geology

The Project Area is located on fill material that was placed on top of the salt marsh and estuarine native soils for the expansion of Jersey City. A thick sequence of unconsolidated natural material underlies the fill. The major geologic units at the Site from top to bottom include:

- A non-native fill layer (the shallow zone);

- Native soils consisting of sand, silty sand, and clays generally separated from the fill by organic sediments or meadow mat (the intermediate zone);
- Till directly above the bedrock consist of glacial drift deposits that exist as stratified and unstratified sediments ranging from silty clay to sands and gravels; and,
- Bedrock of the Stockton Formations and possibly Lockatong Formation.

2.3.4 Project Area Overburden

Shallow soils (consisting of fill material) in the vicinity of the Site generally extend from the ground surface to between 11 and 18 ft below ground surface (bgs). At Site 156, the deepest soil borings, which were previously installed at the site for investigation purposes, have extended to 80.3 ft bgs. Bedrock beneath the Site has been encountered between 47 and 55.5 ft bgs, with one notable exception where bedrock was encountered at 37.5 ft bgs in a historic boring, LB-23, located near the boundary of the property along Columbus Drive (Langan, 2004). Meadow mat was encountered during pre-design investigations between 11.8 and 15.3 ft bgs.

2.4 Local and Regional Hydrogeology

Regionally, groundwater occurs in four hydrostratigraphic zones:

- The shallow fill zone (shallow water-bearing unit);
- The intermediate sand and silty sand zone (intermediate water-bearing zone);
- The deep sand, till, and gravel lenses (deep water bearing zone); and
- Bedrock of the Stockton and Lockatong Formations.

2.4.1 Regional Groundwater in Fill Deposits

Groundwater in the fill is typically encountered between 5 to 10 ft bgs. In general, shallow groundwater flow patterns represent a subdued version of land surface topography. Variations from this can be attributed to factors such as heterogeneities in the fill, subsurface structures, and spatially variable recharge due to the presence of impervious surfaces.

2.4.2 Regional Groundwater in Native Unconsolidated Deposits

While there are some more permeable zones of sand and gravel in the intermediate zone, the aquifer below the meadow mat can be characterized as low to moderately permeable because of the high silt content. Observations of clay also support the presence of a lower permeability below the meadow mat.

Groundwater flow in the deep zone glacial deposits and alluvium is controlled by primary permeability or flow through the interconnected pore spaces in the soil matrix. Groundwater moves most readily through the glacial deposits. Conceptually, in this stratum, groundwater flows horizontally but is influenced strongly by local recharge and discharge zones (i.e., drainage divides and surface water bodies, respectively).

2.4.3 Regional Groundwater in Stockton and Lockatong Formations (Bedrock)

Regionally, the unconsolidated native deposits and bedrock are considered part of an aquifer system serving most of the industrialized sections of northern New Jersey. Hydrogeologic properties of the Stockton and Lockatong Formations are not well-documented, but are expected to be similar to the Passaic Formation. Hydraulic conductivity within the rock matrix is virtually nonexistent. Hydraulic conductivity is due to the presence of secondary features such as fractures and joints. The thickness of water-bearing zones is limited to fractures or fracture sets ranging from a few inches up to several feet thick. Groundwater occurrence and flow is controlled by major bedding plane partings and/or intensely fractured seams. Near-vertical fractures are also present but are considered minor flow paths. Groundwater flow within the bedrock is generally anisotropic, with preferential flow to the northeast or southwest along the strike of the beds. Well yields range from several gallons to several hundred gallons per minute, with yields generally decreasing with depth. Groundwater within the bedrock occurs under both unconfined and confined conditions.

2.4.4 Project Area Hydrogeology

The shallow water-bearing zone includes groundwater present in fill material, from the water table to the top of the meadow mat (typically between 11.8 and 19.5 ft bgs). Data from these wells indicate that the water table at the Site is between approximately 3.5 and 7 ft bgs across the Site. Historically, groundwater flow at the Site has been observed to be to the southwest with additional flow to the north and west. During the 2017 monitoring events, groundwater flow was observed to be to the southwest on the southwestern portion of the site; however, a groundwater elevation high was present in the center of the Site, resulting in northwesterly and northeasterly groundwater flow components on the northwestern and northeastern portions of the Site, respectively. Groundwater flow at the Site may be influenced by dewatering or other activities offsite. The estimated groundwater elevation at the Site is 0.91 ft NAVD 88. The evaluation to determine the Site groundwater elevation is provided in the memorandum entitled *PPG Site 156 (Metro Towers) Supplemental Remedial Investigation 2017 Groundwater Sampling Results*, dated February 2018 (AECOM, 2018b) (**Appendix E**). Water gauging results from 2016 and 2017 sampling events were used in the calculation.

2.5 Surface Water and Wetlands

2.5.1 Wetlands

There are no wetlands on or adjacent to Site 156.

2.5.2 Surface Water

There are no surface water bodies on or adjacent to Site 156. Major water bodies in the vicinity of the Site include the Hudson River, located approximately 2,000 ft to the east and the Morris Canal Basin of the Upper New York Bay located approximately 2,000 ft to the south. There are no open water bodies on the Site. Most of Site 156 is improved with impervious pavement. Therefore, surface drainage at the Site is directed into the city's combined sewer overflow system. During precipitation periods, some runoff water may seep into the ground via infiltration through the limited vegetated areas and through cracks in the pavement.

2.6 Receptor Evaluation Update

The purpose of a receptor evaluation is to document the existence of human or ecological receptors, and the actions taken to protect those receptors, at contaminated sites. Pursuant to N.J.A.C. 7:25E-1.12, receptor evaluations must include general Site information, an evaluation of surrounding land use, a description of contamination, a discussion of groundwater use in the area, an evaluation of vapor intrusion potential and an ecological evaluation.

PPG submitted an Initial Receptor Evaluation Form for Site 156 in August 2011. An updated Receptor Evaluation Form was included in the January 2016 Remedial Investigation Report/Remedial Action Work

Plan Building No. 2 – Boiler Room Subslab Soil and Interior Concrete Surfaces (AOC 3) Revision 2. An updated Receptor Evaluation Form is provided with this RAR (**Appendix C**).

2.6.1 Land Use

The updated receptor evaluation identifies the current land uses at the Site and at properties within 200 feet of the property boundary. Within 200 feet of the property, residences are located on-site and off-site and one child care center is located off-site. Current Site uses are residential and commercial. Future development plans for the Site include construction of a Whole Foods store and other residential and commercial structures, but no specific plans have been provided to PPG. Contaminated soil was not accessible to the general public because of the presence of asphalt, concrete, and building cover. Soil and concrete impacts in the Building No. 2 basement were remediated by interim remedial measures and by implementation of a remedial action in the fall of 2017. Implementation of the RA for the Building No. 2 basement is documented in a separate RAR.

2.6.2 Groundwater

Total chromium (Cr) has been detected in groundwater at concentrations exceeding the GWQS of 70 micrograms per liter (µg/L) at one well in 2016. The soil remediation for AOC 1 that was conducted in September 2017 removed soil in the area surrounding the impacted well. Well abandonment, installation of a new shallow well and an intermediate well, and groundwater sampling was conducted in the fall of 2017. Documentation of the recent groundwater sampling is provided in **Appendix E**.

A 1 mile radius well search was conducted on June 10, 2018. A permit for one public non-community well was identified in the well search. The location is shown in Attachment B-1 of **Appendix C**. The public non-community well is located approximately 1,300 feet north of the Site. The current status of the public non-community well is not known. One industrial well was identified within one half mile of the Site. The well is located approximately 1,100 feet southeast of the Site. Both wells are expected to be bedrock wells based on their 200-foot depth. The City of Jersey City is serviced by public water supply.

2.6.3 Vapor Intrusion

There are no Vapor Intrusion Ground Water Screening Levels for Cr^{+6} and the CCPW metals that would trigger a vapor intrusion evaluation. A receptor evaluation for vapor intrusion is not required for Cr^{+6} and CCPW metals.

2.6.4 Ecological

As part of the receptor evaluation, an ecological receptor evaluation for Site 156 was conducted in accordance with the NJDEP requirements in N.J.A.C. 7:26E-1.16 for areas contaminated with, or by, CCPW. The evaluation was qualitative in nature and was used to determine whether further ecological investigation is required based on the co-occurrence of the following conditions:

- Contaminants of ecological concern exist on-Site;
- An environmentally sensitive area exists on or immediately adjacent to the Site; and,
- Potential contaminant migration pathways to an environmentally sensitive area exist, or an impact to an environmentally sensitive area is indicated based on visual observation.
- Contaminants of ecological concern associated with chromate waste at Site 156 can include Cr^{+6}, other metals, and elevated pH. Environmentally sensitive areas do not exist on or immediately adjacent to this Site, except for groundwater. Contaminant migration pathways to an

environmentally sensitive area do not exist based on visual observations of the Site, except for migration of CCPW contaminants to groundwater. As documented in this RAR, Cr^{+6} and CCPW metals contamination has been remediated in soil and groundwater. Because all three conditions have not been met, no further ecological investigations are needed for Site 156.

2.7 Previous Soil Removals Unrelated to Chromium Remediation

As documented in the *Remedial Investigation Report Group 1 – Site 156 Gregory Park Apartments Site* (ICF Kaiser, 1993), a former excavating company employee reported to NJDEP that in 1976 or 1977, approximately 350-400 loads of material, each approximately 15-17 cubic yards (CY), were removed from the north and south parking lots. It is not known why this material was removed, and there is no indication that this was a remedial action undertaken to remove Chromite Ore Processing Residue (COPR) from the site. The employee recalled each excavation was 200 feet by 75 to 100 feet wide and five to seven feet deep.

Several other soil removals, unrelated to the COPR fill, took place at the Site. In the 1986-1987 timeframe, an above ground heating oil tank located at the northeast corner of Gregory Park I leaked resulting in product flowing to the streets and the removal of an unknown volume of surface soils. Also, the 1987 remodeling of the Port Authority Trans Hudson (PATH) ventilation duct involved the removal of an unknown volume of soil.

3.0 Areas of Concern

Historical investigations conducted at the Site identified two AOCs: AOC 1 for CCPW impacts to soils; and AOC 2 for CCPW impacts to groundwater. A third AOC was identified in 2012 when chromium blooms were found in the Building No. 2 Boiler Room following Hurricane Sandy – this is AOC 3 for concrete and soil Cr^{+6} contamination that was identified within or beneath the footprint of the Building No. 2 Boiler Room. The attached CID (**Appendix C**) provides a description of each AOC and a summary of the associated contaminants identified in each, and indicates the current regulatory status. **Figure 2** provides the location of AOC 1, AOC 2, and AOC 3. Soil AOC 1 consists of eight remedial areas: A, B, C North, C South, D, E, F, and F1, which were grouped into four areas for remediation: Layout Area 1, 2 and 3; and a fourth Supplemental Layout Area 3 that partially overlapped Layout Area 3. (**Figure 2**).

Based on the findings from previous RI activities, soil remedial areas within AOC 1 were identified to include the following:

- The Site-wide presence of historic fill material including brick, glass, concrete, wood, etc., at depths ranging from the ground surface to between 6.5 and 19 ft bgs;
- The presence of Cr^{+6} at concentrations exceeding the CrSCC;
- The presence of visible CCPW;
- The presence of CCPW-related metals at concentrations exceeding the RDCSRS and ARS; and
- The presence of CCPW-related metals at concentrations exceeding the DIGWSSL and IGWSRS.

Pursuant to the approved RAWP (CEC, 2012), the proposed overall approach to RA of AOC 1 at Site 156 was to excavate soils impacted with Cr^{+6} at concentrations exceeding the CrSCC of 20 mg/kg and to excavate areas where visible CCPW was identified. Soils that may be impacted with other CCPW-related metals at concentrations exceeding their respective RDCSRS and/or DIGWSSL/IGWSRS would also be excavated, but only to the extent that they are co-located with Cr^{+6} exceedances in soil samples or visible CCPW. More information on the AOC 1 remedial investigations and RAs is presented in the remainder of this RAR.

4.0 Remedial Investigation Summary

This section provides a summary of the findings and recommendations from the Remedial Investigation Reports (RIRs), RAWP, and supplemental RIR memorandum. This summary does not address AOC 2 and AOC 3. The following reports were prepared for AOC 1 with initial environmental activities starting in 1990:

- *Remedial Investigation Report Group 1 – Site 156 Gregory Park Apartments Site* (ICF Kaiser, 1993);
- *Remedial Investigation Report Group 1 – Site 156 Gregory Park Apartments Site* (IT Corporation, 2001);
- *Remedial Action Work Plan, Metropolis Towers Site, 270-280 Luis Munoz Marin Blvd., Jersey City, New Jersey* (Langan Engineering and Environmental Services, Inc. [Langan], 2005);
- *Remedial Action Work Plan, Metropolis Towers Site – Site 156 (Formerly Gregory Park Apartments) 270-280 Luis Munoz Marin Boulevard, Jersey City, New Jersey* (Civil & Environmental Consultants, Inc. [CEC], 2006);
- *Remedial Action Work Plan Addendum, Metropolis Towers Site – Site 156 (Formerly Gregory Park Apartments) 270-280 Luis Munoz Marin Boulevard, Jersey City, New Jersey* (CEC, 2010);
- *Remedial Action Work Plan, Metropolis Towers Site – Site 156 (Formerly Gregory Park Apartments) 270-280 Luis Munoz Marin Boulevard, Jersey City, New Jersey* (CEC, 2012);
- *Development of a Site-Specific Impact to Ground Water (IGW) Standard for Total Nickel in Layout Area 1* (CEC, 2013a);
- *Development of a Site-Specific Impact to Ground Water (IGW) Standard for Total Nickel in Layout Area 2 and Layout Area 3* (CEC, 2013b);
- *Layout Areas 2 & 3 Remediation, Metropolis Towers – Site 156, Draft Issued for Construction* (AECOM, 2013); and
- *Draft Remedial Action Report – Soil, Chromate Chemical Production Waste Site 156* (AECOM, 2014b).

Following completion of the remedial action and a draft remedial action report (AECOM, 2014b), residual contamination in soil was identified through a detailed review of the remedial investigation (RI) data and the data collected during the soil remedial action. The RI work plans (RIWP) and documentation of findings are provided in the following reports and memoranda:

- *Remedial Action Report Tables and Figures*, Prepared for PPG by AECOM, dated January 16, 2015 (AECOM, 2015a);
- *PPG Site 156 (Metro Towers), Scope of Work to Address Additional Hexavalent Chromium Exceedances and Complete Delineation for Antimony in Soil*, Prepared for PPG by AECOM, dated August 19, 2015 (AECOM, 2015b);
- *PPG Site 156 (Metro Towers) Scope of Work and Technical Rationale for Supplemental Remedial Investigation – Soil and Groundwater Sampling*, Prepared for PPG by AECOM, dated November 16, 2015 (AECOM, 2015c);
- *PPG Site 156 (Metro Towers) Revised Scope of Work and Technical Rationale for Supplemental Remedial Investigation - Soil and Groundwater Sampling*, Prepared for PPG by AECOM, dated February 26, 2016 (AECOM, 2016a);

- *PPG Site 156 (Metro Towers) Proposed Activities to Address Exceedances from the Supplemental Remedial Investigation – Work Plan Addendum for Soil Sampling*, Prepared for PPG by AECOM, dated June 30, 2016 (AECOM, 2016b);
- *PPG Site 156 (Metro Towers) Supplemental Remedial Investigation Results, Survey Controls Review and Additional Remedial Investigation Activities Work Plan*, Prepared for PPG by AECOM, dated September 23, 2016 (AECOM, 2016c);
- *PPG Site 156 (Metro Towers) Supplemental Remedial Investigation Results, Survey Controls Review and Additional Remedial Investigation Activities Work Plan*, Prepared for PPG by AECOM, dated February 20, 2017 (AECOM, 2017a), and
- *PPG Site 156 (Metro Towers) Supplemental Remedial Investigation Results, Survey Controls Review and Additional Remedial Investigation Activities Work Plan*, Prepared for PPG by AECOM, dated March 29, 2017 (AECOM, 2017b).

A brief summary of each report and memorandum is provided below. The documents are provided in **Appendix A**.

In addition to the remedial investigations documented in the reports and memoranda listed above, additional soil samples were collected in 2017. Soil sampling was conducted in April 2017 to provide pre-design sample data for the remedial action completed in September and October 2017. The memorandum for soil is provided in **Appendix E** to document the 2017 remedial investigations (*PPG Site 156 (Metro Towers) Supplemental Remedial Investigation Results*, dated February 2018 (AECOM, 2018a). A summary of the 2017 soil sampling event is also provided below. Sample and test pit locations are shown on **Figure 3**.

4.1 Remedial Investigation Report Group 1 – Site 156 Gregory Park Apartments Site (ICF Kaiser, 1993)

The primary objective of the 1993 RI was to delineate the vertical and horizontal extent of chromium in soils related to COPR at Site 156. The 1993 RI was conducted by ICF Kaiser on behalf of PPG. The field investigation involved the collection of soil samples from 68 test borings and from five borings that were advanced for the installation of the monitoring wells. Fourteen soil samples were fractionated by grain size to determine the concentration of both Cr and Cr^{+6} within each fraction of the samples.

Cr and Cr^{+6} concentrations in soils were delineated in locations where Cr was estimated to exceed 500 mg/kg and Cr^{+6} was estimated to exceed 10 mg/kg. Soils with chromium exceedances were generally found to lie at depths of between approximately 2 to 12 feet below the floor level of the Central Building. The chromium (Cr^{+6}) delineation zones were found to be entirely within the western side of the city block, and the majority of chromium contaminated soil was found to be located under the Central Building. It appeared that COPR was used to fill a depression and ponded area formerly located near the Central Building entrance. Because COPR was not found in borings beneath the north end of Building I, COPR was most likely only used as fill adjacent to the building. Based on the historical site plans, the chromium delineation zones corresponded to areas where fill was known to have been placed; however, not all of the historical fill areas contained chromium exceedances.

4.2 Remedial Investigation Report Group 1 – Site 156 Gregory Park Apartments Site (IT Corporation, 2001)

The primary objective of this RI was to delineate the vertical and horizontal extent of chromium in soils related to COPR at Site 156. The 2001 RI was prepared by IT Corporation on behalf of PPG. This RI report ultimately incorporated all of the soil data presented in the 1993 RI. The 2001 RI supersedes the ICF Kaiser 1993 RI report.

The investigation of local ground settlement and foundation damage revealed no relationship between the damage and the presence of COPR. The damage was found to be attributable to differential settlement resulting from the consolidation of loose, random fill materials.

4.3 Remedial Action Work Plan, Metropolis Towers Site, 270-280 Luis Munoz Marin Blvd., Jersey City, New Jersey (Langan, 2005)

In 2005, Langan prepared this RAWP on behalf of Metrovest, the Site owner at the time. This RAWP addressed remediation of COPR and chromium-impacted soil at Site 156 only. Langan incorporated the environmental data collected during PPG's investigations which had been presented in the 1993 RI Report for Site 156 prepared by ICF Kaiser Engineers (**Section 4.1**).

On behalf of Metrovest, Langan collected supplemental environmental data between August 2001 and July 2002 which involved the completion of 29 soil borings at the Site. The borings were completed to obtain geotechnical engineering data for the proposed building foundations as well as supplemental environmental data to further delineate chromium impacts. The boring locations were selected based on a review of previously existing PPG data and the proposed site redevelopment plans.

Approximately 65 soil samples were collected from the Langan borings which were analyzed for Cr and Cr^{+6}. The samples were collected at depths ranging from approximately 1.5 ft to 26.5 ft bgs. Langan also collected and analyzed 22 soil samples for volatile organics, semi-volatile organics, polychlorinated biphenyls (PCBs), metals, and/or total petroleum hydrocarbons (TPH) at depths ranging from 1.5 feet to 11.5 feet below grade. The soil samples analyzed for chromium parameters contained Cr at concentrations ranging from 9.1 mg/kg to 10,500 mg/kg, with no sample concentrations exceeding the NJDEP Soil Cleanup Criterion for Cr of 120,000 mg/kg. Cr^{+6} concentrations ranged from 0.3 U to 1,930 mg/kg, with seven samples exceeding the NJDEP's CrSCC of 20 mg/kg. Based on the results of the 22 non-chromium soil samples collected, elevated levels of semi-volatile organics, lead, mercury, and TPH were found within fill material in several areas of the site. The contaminants appeared to be representative of historic fill. The Langan sample results for the chromium and non-chromium sample results generally agreed with sample data previously reported by PPG.

4.4 Remedial Action Work Plan, Metropolis Towers Site – Site 156 (Formerly Gregory Park Apartments) 270-280 Luis Munoz Marin Boulevard, Jersey City, New Jersey (CEC, 2006)

The 2006 RAWP was prepared by CEC on behalf of PPG to address remediation of COPR and chromium-impacted soil at Site 156. The RAWP incorporated data previously collected by PPG and Metrovest (**Sections 4.1, 4.2** and **4.3**). As an initial RAWP activity, PPG performed an additional investigation to supplement the previous PPG and Metrovest Investigations, to further define the extent of contamination, and to provide information for defining the remedial action. The objectives of the 2006 RAWP Investigation were: to obtain specific data requested by NJDEP (in August 15, 2001 comments on 2001 RI Report) regarding soil delineation; to obtain samples of concrete and soil for pre-remedial waste analysis to define appropriate material classification for disposal or reuse; and to obtain pre-excavation samples to replace post-excavation sampling in excavation areas located below the water table.

Interior borings within the central building and the corridor between Buildings I and II were installed at 26 locations to obtain concrete samples and samples of soil immediately beneath the concrete slab. Concrete cores, collected at six locations, either showed, or were assumed to show, coloration associated with COPR contact, chromium impregnation, or included visible COPR material. At four locations, the soil samples contained Cr^{+6} concentrations greater than the CrSCC (20 mg/kg).

More than 47 pre-excavation borings were installed in remedial areas A, B, C, D, and F with the objective of achieving post-excavation sampling requirements (one post-excavation soil sample per 900 square feet of excavation bottom and one sidewall soil sample per 30 linear feet of excavation sidewall) in soil/fill materials located below the water table. Sampling objectives were achieved in remedial areas A, B, and D. Sampling objectives were achieved in Area C, with the exception of the east and west ends of the corridor and the eastern central building wall. Sampling objectives were achieved in Area F with the exception of the eastern edge of the perimeter, where the geoprobe sampling probe could not penetrate to the required depths. PPG planned to complete this sampling following demolition of the building prior to initiating remedial action in that area.

A pre-demolition visual survey was conducted to identify the presence of chromium contamination in concrete block located above the foundation slab in the Central Building area and the walkway area located between Buildings I and II. Visually affected masonry was sampled on the interior or exterior surfaces (two samples per location) and analyzed for Cr and Cr^{+6}. The masonry wall sample results indicated Cr^{+6} concentrations of less than the CrSCC (20 mg/kg). Samples were obtained from three test pits for use in developing the site-specific impact to groundwater and allergic contact dermatitis standards. None of the materials sampled contained Cr^{+6} in the concentration range required for performance of the evaluations; the concentrations were less than the required range.

4.5 Remedial Action Work Plan Addendum, Metropolis Towers Site – Site 156 (Formerly Gregory Park Apartments) 270-280 Luis Munoz Marin Boulevard, Jersey City, New Jersey (CEC, 2010)

This RAWP Addendum was prepared by CEC and presented the results of investigations performed by PPG after the submission of the RAWP to NJDEP in July of 2006. This addendum also incorporates additional information, analyses, and evaluations.

Following demolition of the Central Building connecting the two residential towers, PPG performed a series of supplemental soil investigations. These investigations focused on completing the delineation of Cr^{+6} and CCPW metals in specific areas to reduce the need for post-excavation sampling following excavation. The investigations also addressed verbal comments received from NJDEP during a presentation of the 2006 RAWP to NJDEP following submittal of the document. The supplemental soil investigations were conducted as part of this addendum within Remedial Area C (central area) and in Layout Area 1 (**Figure 2**).

The central area investigations included the advancement of six Geoprobe borings. The objective of the investigations was to extend the sampled depths in borings and select post-excavation borings within the Central Building foundation slab limits to define the depth at which material concentrations for Cr^{+6} and CCPW metals are less than regulatory limits, and to define the horizontal and vertical limits along the eastern boundary of Area C-North where material concentrations are less than Cr^{+6} and CCPW metals regulatory limits.

The Layout Area 1 supplemental investigation was conducted to supplement delineation of the lateral and vertical extent of material containing Cr^{+6} and CCPW metals at concentrations greater than regulatory limits near specific locations identified during the previous sampling. The Layout Area 1 investigation included drilling additional soil borings, collecting soil samples, and performing analysis of the collected soil samples, as generally requested by the NJDEP in verbal comments regarding soil delineation. Between August 2006 and February 2007, 35 soil borings were installed and soil samples were collected from these borings. Based on visual observations during the installation of borings within Layout Area 1 Area E (**Figure 2**), the subsurface contained fill, rubble, and other materials from previously demolished structures adjacent to an abandoned roadway. The top of this layer was typically encountered from 3 to 6 ft bgs.

4.6 Remedial Action Work Plan, Metropolis Towers Site – Site 156 (Formerly Gregory Park Apartments) 270-280 Luis Munoz Marin Boulevard, Jersey City, New Jersey (CEC, 2012)

The 2012 RAWP was prepared by CEC on behalf of PPG to address remediation of COPR and chromium-impacted soil at Site 156. The RAWP detailed the proposed remedial action at Site 156 and included excavation of soils impacted with Cr^{+6} concentrations greater than the CrSCC of 20 mg/kg and soils where visible CCPW was identified. Soils that may be impacted with other CCPW metals at concentrations greater than their respective RDCSRS and/or DIGWSSL would also be excavated, but only to the extent that they are co-located with Cr^{+6} exceedances in soil samples or visible CCPW.

The 2012 RAWP was based on the environmental sampling results summarized in **Section 4.1** through **Section 4.5** of this RAR. In addition, the 2012 RAWP incorporated the results of sampling that was conducted in 2011 and 2012 to replace the Cr^{+6} results from earlier supplemental sampling investigations that had been rejected during data validation. It also supplemented the sidewall and pit bottom pre-excavation sampling to meet NJDEP requirements for confirmation samples, and provided for the collection of existing concrete samples for analysis of PAH and PCBs to aid in evaluation of concrete recycling and the collection of a set of synoptic water level measurements from on-site wells.

Sampling and analysis was performed by AECOM in the following areas (**Figure 2**): Area E (also including Area B); Area C-North; Area C-South; Area F (also including Area D), and Area C concrete. Within Area E, 16 direct-push borings were advanced and sampled, and one additional boring was also advanced and sampled within adjacent Area B. Thirty-two direct-push borings were advanced and sampled within Area C-North; 27 direct-push boring locations were advanced and sampled within Area C-South; six direct-push boring locations were advanced and sampled within Area F; and two additional borings were completed and sampled within adjacent Area D. In Area C-North, 12 concrete cores were collected. In Area C-South, five cores were collected.

4.7 Development of a Site-Specific Impact to Ground Water (IGW) Standard for Total Nickel in Layout Area 1 (CEC, 2013a)

CEC prepared this report to document the development of a site-specific IGWSRS for Ni within the remedial area designated as Layout Area 1 at Site 156. Soil samples obtained from the unsaturated zone were analyzed for Ni in the soil and in leachate using the Synthetic Precipitation Leaching Procedure (SPLP). The site-specific IGWSRS for Ni within Layout Area 1 was calculated to be 411 mg/kg.

4.8 Development of a Site-Specific Impact to Ground Water (IGW) Standard for Total Nickel in Layout Area 2 and Layout Area 3 (CEC, 2013b)

CEC prepared this report to document the development of site-specific IGWSRS for Ni and Sb within the remedial areas designated as Layout Area 2 and Layout Area 3, and for total antimony (Sb) within Layout Area 2 at Site 156. Soil samples were obtained from the unsaturated zone and were analyzed for Ni and Sb in the soil and in leachate using the SPLP. The site-specific IGWSRS for Ni within Layout Area 2 was calculated to be 322 mg/kg and within Layout Area 3, 565 mg/kg. A site-specific IGWSRS for Sb could not be calculated because the total Sb concentrations in the soils sampled and analyzed were less than the DIGWSSL for Sb of 6 mg/kg.

4.9 Layout Areas 2 & 3 Remediation Bid Package September 2013 (AECOM, 2013)

AECOM prepared Layout Area 2 and 3 drawings and specifications for bid based on the 2012 RAWP.

4.10 Draft Remedial Action Report October 2014 (AECOM, 2014b)

AECOM prepared a draft RAR for soil remediation at Layout Areas 1, 2 and 3. NJDEP/Weston provided comments on the tables and figures.

4.11 Remedial Action Report Tables and Figures January 2015 (AECOM, 2015a)

AECOM prepared a revised version of the RAR tables and figures in response to NJDEP/Weston comments on the October 2014 RAR (AECOM, 2014b).

4.12 Remedial Investigation April through July 2016

Following the completion of the soil remedial action in 2013 and 2014, AECOM prepared a draft remedial action report (AECOM, 2014b). A September 2015 review of the RAR conducted by NJDEP/Weston and AECOM identified potential soil remedial action areas that were either not captured in the RAWP and/or were outside of the final soil RA excavation limits. There were also some areas identified where additional delineation or confirmation sampling for CCPW-related metals was needed. On behalf of PPG, AECOM prepared a revised memorandum entitled, *PPG Site 156 (Metro Towers) Revised Scope of Work and Technical Rationale for Supplemental Remedial Investigation - Soil and Groundwater Sampling* dated February 26, 2016 (AECOM, 2016a), which incorporated NJDEP comments and provided a revised Scope of Work for supplemental RI activities.

Additional supplemental RI soil sampling was proposed to meet the following objectives: to investigate Cr^{+6} sample locations where the remaining soils exceed the CrSCC of 20 mg/kg; to obtain confirmation samples for Cr^{+6} within 1 foot of terminal excavation elevations (TEEs); to complete horizontal and vertical delineation of Cr^{+6} and CCPW metals contamination; and to meet NJDEP sample frequency requirements in accordance with NJDEP's *Technical Guidance for Site Investigation of Soil, Remedial Investigation of Soil, and Remedial Action Verification Sampling for Soil* (NJDEP, 2012c).

The Supplemental RI soil sampling was conducted in April 2016 and consisted of advancing soil borings with a direct push drill rig to collect excavation limit confirmation samples; advancing borings with a hollow stem auger drill rig to remediate locations with elevated Cr^{+6} concentrations; and collecting confirmation samples from a shallow excavation area and test pit.

A hollow stem auger rig was utilized to overdrill and remediate Cr^{+6} at two boring locations (CS LB3 and CS PS3-1) and collect soil samples from a third location. Direct push drilling was conducted to collect soil samples from eight borings. The shallow excavation at borings LA1-1 and PPG1-T02, and the test pit at PPG1-M05 were excavated and confirmation soil samples were collected. The excavations were backfilled with dense-graded aggregate (DGA). Asphalt was placed over the test pit location. Topsoil (7 inches) was placed over the fill at the shallow excavation and then seeded.

The soil sampling results were documented in the memorandum entitled, *PPG Site 156 (Metro Towers) Proposed Activities to Address Exceedances from the Supplemental Remedial Investigation – Work Plan Addendum for Soil Sampling*, dated September 23, 2016 (AECOM, 2016c). The Cr^{+6} concentrations were less than the 20 mg/kg CrSCC for the soil boring samples and confirmation samples except for three soil samples and a duplicate collected from the overdrilled borings (CS LB3 and CS PS3-1) with Cr^{+6} concentrations ranging from 47.1 J mg/kg to 106 J mg/kg, and one soil boring (CS L5) with a Cr^{+6} concentration of 26.8 J mg/kg. With the exception of three boring locations, the extent of Cr^{+6} and CCPW metals remaining in the Site soil has been delineated. Further investigation and remedial action was recommended for these three locations.

4.13 Remedial Investigation October 2016

In October 2016, a supplemental RI was conducted to remediate the Cr^{+6} exceedances at the three boring locations sampled in April 2016, to address the discrepancy in the depth of DGA compared to the post-excavation as-built survey for the 2013 to 2014 soil remedial action at two April 2016 sampling locations, and to collect a surface soil sample from previously placed clean fill at the April 2016 shallow excavation. The work plan for the October 2016 sampling event was presented in *PPG Site 156 (Metro Towers) Supplemental Remedial Investigation Results, Survey Controls Review and Additional Remedial Investigation Activities Work Plan*, dated September 23, 2016 (AECOM, 2016c). The results of the sampling event are presented in *PPG Site 156 (Metro Towers) Supplemental Remedial Investigation Results, Survey Controls Review and Additional Remedial Investigation Activities Work Plan*, dated March 29, 2017 (AECOM, 2017b).

A direct push rig with 3-inch macrocores was used to collect samples from borings CS I1-1, CS I2-1, CS L5-E, CS L5-N, CS L5-S, and CS L5-W (**Figure 3**). A hollow stem auger rig was utilized to overdrill and remediate Cr^{+6} at boring locations CS L5-E, CS L5-N, CS L5-S, and CS L5-W. Test pits were advanced at boring locations CS LB3 and CS PS3-1 (TP CS LB3 and TP CS PS3-1) and backfilled with DGA. A grab sample was collected from the shallow excavation top soil for analysis for target analyte list (TAL) and target compound list (TCL) parameters.

The confirmatory soil samples and post-excavation soil samples collected as part of the RI at Site 156 in October 2016 demonstrated that the analytical data for soils in the test pits located at CS LB3 and CS PS3-1 and two boring locations (CS L5-E and CS L5-W) adjacent to CS L5 have residual concentrations of Cr^{+6} that exceed the CrSCC for Cr^{+6}. Concentrations of CCPW metals in soil in these areas were less than the applicable standards for CCPW metals (see **Section 1.3** for the remediation standards). The test pit bottom samples exhibited concentrations that were less than the CrSCC for Cr^{+6} and applicable standards for CCPW metals (see **Section 1.3** for the remediation standards). Further investigation and remedial action was recommended for two test pits (TP CS LB3 and TP CS PS3-1) and two borings (CS L5-E and CS L5-W).

Clean fill (DGA) was placed in the excavations during the 2013 and 2014 soil remediation activities. The lower elevation of DGA was compared to the post-excavation as-built at the location of each boring. In some instances, the lower elevation of DGA based on the boring logs differed from that which was indicated on the post-excavation as-built at the location of the boring. For the samples collected to address the discrepancy in the depth of DGA compared to the post-excavation as-built drawing, the DGA elevations from the boring logs were consistent with the nearby spot elevations on the as-built drawing. The Cr^{+6} and CCPW metals concentrations are less than the applicable remedial standards (see **Section 1.3** for the remediation standards).

For the topsoil sample, the concentrations of TAL/TCL parameters were less than the respective RDCSRS except for benzo(a)pyrene. The concentrations of TAL/TCL parameters were less than the DIGWSSL except for chlordane (alpha and gamma), dieldrin, aluminum, and manganese. Based upon the limited number of contaminants, the low-level exceedances detected, and the fact that this topsoil was placed in an area where historic fill exists, no additional sampling was proposed.

4.14 Remedial Investigation Activities April 2017

Supplemental RI soil sampling activities at the Site were conducted in April 2017 to delineate Cr^{+6} contamination identified in samples collected in October 2016 from two test pits (TP CS LB3 and TP CS PS3-1) and two borings (CS L5-E and CS L5-W). A direct push rig was used to collect samples from 47 boring locations below clean fill DGA that was previously placed at the Site. The soil samples were analyzed for Cr^{+6}. The soil boring samples collected as part of the RI at Site 156 in April 2017 demonstrated that the analytical data for the soils at 27 boring locations had residual concentrations of Cr^{+6} that exceed the CrSCC for Cr^{+6}. Excavation of the contaminated soil was recommended to address these boring sample exceedances. The remedial action that was conducted to remove the residual soil contamination is documented in **Section 5** and **Section 6** of this RAR. The April 2017 sampling event is documented in the *PPG Site 156 (Metro Towers) Supplemental Remedial Investigation Results*, dated February 2018 (AECOM, 2018a) (**Appendix E**).

5.0 Remedial Action Description (AOC 1)

This report section provides a description of the remedial action implemented for AOC 1.

5.1 Remediation Description

Based on the results of Remedial Investigations at Site 156 (**Section 4**), and pursuant to the approved RAWP, the overall approach to Remedial Action was to excavate soils impacted with Cr^{+6} at concentrations greater than the CrSCC of 20 mg/kg, and to excavate the areas where visible CCPW was identified. Soils that were impacted with other CCPW metals at concentrations greater than their respective RDCSRS, DIGWSSL, or site-specific IGWSRS would also be excavated. Confirmation sampling results are discussed in **Section 6** and presented in **Table 2** to demonstrate the effectiveness of the remedy. The post-excavation as-built survey drawings are depicted on **Figures 4A, 4B, 5A, and 5B,** and provided in **Appendix G**. Details of the remediation are provided in the report sections that follow.

5.2 Contractors and Subcontractors

A number of contractors and subcontractors provided various services to PPG as part of the field remediation activities. The following companies provided services during the RA:

- Accutest Laboratories of Dayton, New Jersey (Accutest) (NJ Certification # 12129) provided laboratory services as a subcontractor to WCD Group of Pennington, New Jersey (WCD), for post-excavation analytical samples, and as a subcontractor to AECOM, during the Layout Areas 2 and 3, and Supplemental Layout Area 3 activities;
- AECOM was retained as the Engineer-in-Charge for Layout Area 2 including the electrical duct relocation activities in Layout Area 2, Layout Area 3, and the Supplemental Layout Area 3 excavation in 2017;
- Borbas Surveying and Mapping of Boonton, New Jersey (Borbas) provided surveying services for boring locations and for the electrical duct relocation;
- ChemTech of Mountainside, New Jersey (ChemTech) (NJ Certification # 20012) was a subcontractor of ENTACT and provided laboratory services for backfill analytical samples;
- Emilcott of Morristown, New Jersey provided air monitoring services at the Site during remedial activities;
- ENTACT, LLC of Latrobe, Pennsylvania (ENTACT), was the remediation contractor for Layout Areas 2 and 3. ENTACT was retained directly by PPG, and provided equipment and personnel needed to excavate and load impacted soil and materials at the Site;
- Hampton Clarke-Veritech of Fairfield, New Jersey (HCV) (NJ Certification #07071) was a subcontractor of WCD and provided laboratory services for post-excavation soil samples at Layout Area 1;
- J. Fletcher Creamer & Son, Inc. (Creamer) of Hackensack, New Jersey was the construction subcontractor during relocation of the electrical duct in Layout Area 2;

- Maser Consulting, P.A. of Red Bank, New Jersey (Maser) was a subcontractor to ENTACT, providing land surveying services during Layout Area 2 and Layout Area 3 remedial activities, and a subcontractor to AECOM, providing land surveying services during the Supplemental Layout Area 3 excavation in 2017;
- Mueser Rutledge Consulting Engineers (MRCE) of New York, New York provided vibration and settlement monitoring services and conducted a pre-condition survey of Buildings 1 and 2 at the Site prior to remedial activities;
- POSILLICO Environmental of Farmingdale, New York was retained directly by PPG and was the remediation contractor for Layout Area 1 at the Site, providing equipment and personnel needed to excavate and load impacted soil and materials;
- Securitas of Jersey City, New Jersey, provided round-the-clock-security at the Site;
- SGS of West Creek, NJ provided drilling services for installation of the well-point dewatering system;
- SOR Testing Laboratories, Inc. of Cedar Grove, New Jersey (SOR) was a subcontractor of ENTACT and provided laboratory services for backfill geotechnical samples;
- Test America Laboratories of Edison, New Jersey (Test America) (NJ Certification # 12028) provided laboratory services for the waste classification and pre-excavation analytical samples;
- TPI Environmental of Easton, Pennsylvania (TPI) provided geophysical and geoprobe services at the Site;
- WCD Group of Pennington, New Jersey (WCD) was the construction oversight contractor for Layout Areas1, 2 and 3. WCD was retained directly by PPG. Additionally, WCD coordinated the collection and surveying of the post-excavation analytical samples; and
- WTS, Inc. of Lewiston, New York (WTS) was PPG's waste logistics manager and coordinated the transport and disposal of the remediation wastes with appropriately permitted and licensed transport companies and disposal facilities.

5.3 Access, Control, and Security

The Site perimeter was secured throughout the period of RA activities through the use of existing fencing or temporary construction fencing. In addition to fencing, security personnel were present at the Site 24-hours a day to control access to the Site.

During excavation activities, active construction zones (exclusion, contaminant reduction, and support zones) were established by the remediation contractor. Only trained authorized personnel were allowed in the exclusion zone to minimize exposure and other health and safety hazards. Open excavations were temporarily secured with a tarp or sprayed with a water mist until further excavation activities were resumed.

5.4 Air Monitoring

Air Monitoring during RA activities was conducted in accordance with the Project Air Monitoring Plan (AMP), Metropolis Towers Site, Jersey City, New Jersey, as presented in the RAWP and amended. In summary, a combination of real-time monitoring and integrated sampling was performed during periods of active work at the fence line and the perimeter of the exclusion zone. Real-time particulate matter 10 microns or less in diameter (PM_{10}) monitoring was conducted at two portable air monitoring (PAM) stations along the Site fence line. Additionally, 8-hour integrated Cr^{+6} and PM_{10} samples were collected daily at the two PAM stations at the Site fence line. Periodic hand-held monitoring was performed at four to ten locations at the perimeter of the exclusion zone. The Site was monitored during excavation and other intrusive activities for visible dust by the Air Monitoring Technician (AMT). If visible dust was observed, the AMT coordinated with the contractor to take appropriate steps to control emissions.

During the Supplemental Layout Area 3 RA activities from September to October 2017, air monitoring was conducted in accordance with the Site-Specific AMP, Metropolis Towers Site, Jersey City, New Jersey, as presented in the RAWP and amended. In summary, a combination of real-time 15-minute average PM_{10} monitoring and 8-hour integrated Cr^{+6} and total particulate sampling was performed during periods of active work at all five air monitoring station (AMS) locations situated around the Site perimeter. Additionally, 24-hour and 72-hour integrated Cr^{+6} and total particulate sampling with lab analysis was also conducted at one AMS. No hand-held monitoring was performed during these supplemental RA activities. The Site was monitored during excavation and other intrusive activities for visible dust by the AMT. If visible dust was observed, the AMT coordinated with the contractor to take appropriate steps to control emissions.

Monthly Air Quality Reports and/or Monthly Summaries of air monitoring results (referred to as Event Documentation Reports [EDR]) were prepared by Emilcott and were made available to the public via upload to the Chromium Cleanup Partnership Website. Copies of these monthly submittals (March 2013 through May 2014 [excluding September 2013 when work was not conducted], September 2017, and October/November 2017) are provided in **Appendix H**.

5.5 Site 156 Remedial Action Overview/Field Activities – Layout Area 1

Mobilization and site preparation by Posillico and WCD in Layout Area 1 began in late 2012, and remediation of Layout Area 1 was initiated in early 2013.

Excavation within Area B of Layout Area 1 was conducted between March 18 and 22, 2013 and backfilling of the excavated area was completed on March 25, 2013. During excavation of this area, an electrical duct bank consisting of a concrete-encased utility conduit was encountered, and the concrete was observed to be impacted with green staining, which was confirmed to be chromium contamination. As a result, the duct bank was remediated and replaced between May and August 2013. Restoration of the duct bank area was completed on August 14, 2013.

Excavation of Area E within Layout Area 1 was initiated on March 20, 2013 and was completed on May 6, 2013. Backfilling was completed on May 15, 2013 and restoration was completed on July 31, 2013.

Areas where visual CCPW was observed were over-excavated and post-excavation samples were collected to confirm that the Cr^{+6} and CCPW impacts were removed.

5.6 Site 156 Remedial Action Overview/Field Activities – Layout Area 2

Mobilization and site preparation in Layout Area 2 began on February 7, 2014. Excavation was initiated on February 26, 2014 and continued through May 23, 2014. The area was dewatered using a sump pump system prior to the start of excavation (beginning on February 10, 2014) and continuing through the duration of excavation activities (until May 23, 2014).

During the excavation activities, Weston and AECOM observed visible CCPW material in Grids A(-1), B(-1), B0, C(-1), C0, D4, E3, F2, F9, G6, G9, and H1. Areas where visual CCPW was observed were over-excavated and post-excavation samples were collected to confirm that the Cr^{+6} and CCPW impacts were removed.

On April 2, 2014 a 1,000 gallon underground storage tank (UST) was encountered in the area north of Building 1 (pothole excavation). The UST contained approximately 400 gallons of water and approximately

10 gallons of petroleum-like product. Holes were present at the bottom of the tank, but the underlying and adjacent soil did not appear to be impacted. The contents of the UST were sampled and analyzed for Cr^{+6} and CCPW-related metals and a fingerprint analysis was conducted to determine the nature of the contents. The results of the fingerprint analysis indicated that the UST contained No. 2 diesel fuel oil. The property owner retained the services of a New Jersey Licensed Site Remediation Professional (LSRP) to oversee removal of the UST; the tank was removed from the excavation area on May 15, 2014 and was transported off-site for disposal on May 21, 2014. NJDEP Data Miner identifies an Activity Number of CSP160001 for an unregulated heating oil tank (UHOT) case, document title 14-05-15-0933-25 UHOT with a case status of NFA-A (unrestricted use) and case status date of March 28, 2016.

A vein of visual CCPW was observed along the retaining wall on the north edge of Building 1 in the pothole excavation on April 8, 2014 (Grid B-(-1)). Visual CCPW was excavated beneath the retaining wall and a post-excavation soil sample was collected (B(-1) Bottom) and analyzed for Cr^{+6} and CCPW-related metals. Analytical results indicated that the concentration of Cr^{+6} in residual soil in this area was less than the CrSCC. Additionally, CCPW impacts to concrete encasing the telecommunications line in the pothole excavation were also observed on April 8, 2014. Impacted concrete was sampled and analyzed for Cr^{+6} and CCPW-related metals for waste disposal purposes.

Relocation of the Public Service Electric and Gas Company (PSEG) utility duct in Layout Area 2 was initiated on January 14, 2014 by Creamer, under the supervision of AECOM personnel. The utility duct ran from Luis Munoz Marin Boulevard (Marin Boulevard) across the Site. The existing duct route was within the limits of excavation in Layout Area 2 and was relocated along the Christopher Columbus Drive right-of-way. Relocation of the utility duct was completed in March 2014.

Remedial activities in Layout Area 2, including site restoration, were completed on June 23, 2014.

5.7 Site 156 Remedial Action Overview/Field Activities – Layout Area 3

Mobilization and site preparation in Layout Area 3 began on September 20, 2013. Excavation was initiated on November 5, 2013 and continued to February 14, 2014. Remedial Area F1, shown on **Figure 2**, was completed as part of the Layout Area 3 excavation. The area was dewatered prior to the start of excavation. A well-point dewatering system was initially installed in Layout Area 3, but failed to properly dewater the excavation area due to soil conditions at the Site. The well-point system was subsequently replaced with a sump pump dewatering system.

During excavation, Weston and AECOM observed visible CCPW material in Grids I1, J1, J2, J3, J4, K0, K1, K2, K3, K4, L0, L4, M0, M6, M7, and M8. Areas where visual CCPW was observed were over-excavated and post-excavation samples were collected to confirm that the Cr^{+6} and CCPW impacts were removed. Where post-excavation samples exceeded the CrSCC, the area was over-excavated and additional post-excavation samples were collected to confirm that the Cr^{+6} and CCPW impacts were removed.

Remedial activities in Layout Area 3, including site restoration, were completed in May 2014.

5.8 Site 156 Remedial Action Overview/Field Activities – Supplemental Layout Area 3

Mobilization and site preparation for the remedial action excavation in Supplemental Layout Area 3 began on September 5, 2017. Excavation was initiated on September 11, 2017 and continued through October 13, 2017. Excavation-related activities (e.g., backfilling, compaction testing , dewatering, and waste disposal), continued until November 3, 2017. A sump pump dewatering system, consisting of two sumps in Layout Area 3, was installed on September 13, 2017 to remove groundwater from the excavation and to pump the water into onsite fractional tanks. Dewatering was initiated on September 12, 2017 and continued through

October 19, 2017. No additional water was pumped out after this date since the DGA backfill was placed above the water table. Up until November 3, 2017, groundwater that had been stored in the fractional tanks was transported to the permitted water treatment system at Garfield Avenue. The treatment system at Garfield Avenue pre-treats water to concentrations less than the Passaic Valley Sewerage Commission (PVSC) sewer use permit limits prior to discharge into the public sanitary system.

No visible CCPW material was observed by Weston or AECOM during excavation. AECOM and Weston field personnel inspected the excavated grids for potential chromium contamination, and no signs of contamination were found during the supplemental remedial action activities. Post-excavation sampling locations were determined as part of the design to satisfy the NJDEP requirement for one top, middle, and bottom sidewall sample per 30 linear feet of sidewall and one bottom sample per 900 square feet of excavation bottom. Additional samples were collected where soil was excavated beyond the designed excavation extents to demonstrate attainment of the 20 mg/kg CrSCC for Cr^{+6}.

Backfilling activities for the remedial action excavation in Supplemental Layout Area 3 were concluded on October 30, 2017. Remedial activities in Supplemental Layout Area 3 excavation, including paving and site restoration, were completed on November 3, 2017.

5.9 As-Built Drawings

As-built drawings are provided in **Appendix G** for the post-excavation surface at Layout Area 1 and a separate drawing for Layout Areas 2 and 3, and Supplemental Layout Area 3 is included. There are no permanent structures or engineering controls associated with the AOC 1 remedy.

5.10 Documentation of Waste Generated

A description of the various types and quantities of waste generated by the AOC 1 remedial action is provided in the subsections below. Copies of fully executed manifests and bills of lading documenting off-site transport of waste are provided in **Appendix I**.

Note that the disposal quantities (tons/pounds) that are presented on the physical manifest scans listed in **Appendix I** do not necessarily match the corresponding individual manifest totals for material transported to this disposal facility. Soil excavated from Site 156 was consolidated with waste material from PPG Site 114 in Jersey City before being loaded into rail cars. The manifest totals are for waste generated from Site 156 and Site 114. The waste material from Site 114 and Site 156 was shipped to the EQ Detroit facility located at 1923 Frederick Street, Detroit, MI. Therefore, when the material was off-loaded at the disposal facility the weight of each transport vehicle may have been different than what was listed initially (in Jersey City) on each manifest.

5.10.1 Non-Hazardous Asphalt

A total of 1,286.13 tons of non-hazardous waste asphalt were transported and disposed of at the Cumberland County Improvement Authority facility located at 169 Jesses Bridges Road, Deerfield Township, NJ between March 2013 and May 2014.

A total of 504.12 tons of non-hazardous waste asphalt were transported and disposed of at the Bayshore Recycling Corporation facility located at 75 Crows Mill Road, Keasbey, NJ between September 2017 and October 2017.

5.10.2 Non-Hazardous Debris

A total of 3.18 tons of non-hazardous waste debris were transported and disposed of at the Gloucester County Improvement Authority facility located at 503 Monroeville Road, Swedesboro, NJ in October 2017 as part of the Supplemental Layout Area 3 excavation.

5.10.3 Non-Hazardous Concrete

A total of 1,286.54 tons of non-hazardous waste concrete were transported and disposed of at the Cumberland County Improvement Authority facility located at 169 Jesses Bridges Road, Deerfield Township, NJ between March 2013 and May 2014.

5.10.4 Chromium-Contaminated Concrete and Debris

A total of 1,613.65 tons of hazardous waste concrete (chromium-contaminated concrete) and a total of 119.57 tons of hazardous waste debris (chromium-contaminated debris) were transported and disposed of at the EQ Industrial Services, Inc. facility located at the Michigan Disposal Waste Treatment Plant, 49350 N I-94 Service Drive, Belleville, Michigan between November 2013 and May 2014.

5.10.5 Concrete Contaminated with Asbestos

A total of 32.02 tons of concrete contaminated with asbestos were transported and disposed of at the Chemical Waste Management Emelle facility located at 36964 Alabama Highway 17 North, Emelle, Alabama on June 2014. Also, a total of 69.84 tons of concrete contaminated with asbestos material were transported and disposed of at the Wayne Disposal, Inc. facility located at 49350 North I-94 Service Drive, Belleville, MI on June 2014.

5.10.6 Non-Hazardous Soil

A total of 27,841.02 tons of non-hazardous soil material were transported and disposed of at the Cumberland County Improvement Authority facility located at 169 Jesses Bridges Road, Deerfield Township, NJ between March 2013 and October 2017.

5.10.7 Soil with Oil

A total of 80.06 tons of non-hazardous soil material contaminated with fuel oil from Layout Area 2 were transported and disposed of at the Wayne Disposal, Inc. facility located at 49350 North I-94 Service Drive, Belleville, MI between December 2013 and June 2014.

5.10.8 Hazardous Lead Soil

A total of 26.62 tons of hazardous lead soil material were transported and disposed of at the Clean Earth of New Jersey facility located at 105 Jacous Avenue, Kearny, NJ in September 2017 as part of the Supplemental Layout Area 3 excavation.

5.10.9 Chromite Ore Processing Residue (COPR)

A total of 32,062.71 tons of Low Chrome and Low COPR mixture hazardous waste were transported via rail cars to the EQ Industrial Services, Inc. facility located at the Michigan Disposal Waste Treatment Plant, 49350 N I-94 Service Drive, Belleville, MI between November 2013 and May 2014. Also, a total of 155.66 tons of Low COPR hazardous waste were transported via rail cars to the EQ Detroit facility located at 1923 Frederick Street, Detroit, MI between November and December 2013.

A total of 771.22 tons of Low COPR mixture hazardous waste were transported via over-the-road truck to Envirite of Pennsylvania, Inc., located at 730 Vogelsong Road in York, Pennsylvania. Also, a total of 146.11

tons of COPR hazardous waste was transported via rail cars to Stablex Canada, Inc. facility located at 760 Boulevard Industrial, Blainville, QC, Canada between August 2013 and May 2017.

5.10.10Groundwater

Throughout the course of the project, water was removed from various excavation areas as necessary in order to allow for the excavation and backfilling activities to proceed. Groundwater was pumped from the excavation using submersible pumps and stored within fractional tanks on site pending treatment. A well point system was originally installed in Layout Area 3 for the purpose of lowering the water table in the excavation area; however, the system was removed due to poor soil conditions and low flow. Recovered water was treated at an onsite treatment plant as needed to remove the Cr^{+6} and CCPW metals and discharged to the PVSC via Jersey City Municipal Utilities Authorities (JCMUA) conveyance piping under appropriate connection and discharge permits including permits and letters of authorization from PVSC and JCMUA, and a Treatment Works Approval (TWA) from NJDEP (**Appendix J**).

Between November 4, 2013 and May 30, 2014, a total of 1,849,600 gallons of impacted groundwater were recovered, treated, and discharged to support the remediation activities.

Groundwater was encountered while excavating test pits at Site 156 during October 2016. On October 24, 2016, 3,697 gallons of groundwater from two excavated test pits were removed via a vacuum truck and disposed of at Envirite of Pennsylvania, Inc. A few days later, on October 26, 2016, groundwater from one of the excavated test pits was pumped into 38 55-gallon drums, and was shipped on November 10, 2016 for disposal at Stablex Canada, Inc.

During the Supplemental Layout Area 3 excavation, groundwater was pumped from the excavation using submersible pumps and stored within fractional tanks. The groundwater was transported by truck to PPG's permitted Garfield Avenue treatment plant for pre-treatment and discharge. Bills of lading for the groundwater are provided in **Appendix I**. Approvals for the Garfield Avenue treatment plant are provided in **Appendix J**. Between September and October 2017, a total of 441,483 gallons of groundwater were pumped from the excavation and transported to the Garfield Avenue treatment plant.

5.11 Site Restoration Activities

As remedial action areas were excavated, and subsequent to the completion of post-excavation sampling and analysis, clean backfill, typically consisting of dense-graded aggregate was placed in the excavation and compacted. Utilities that were removed during excavation, including the storm drain and overhead electrical lines, were restored. The remedial area was paved with asphalt to restore the area to pre-remediation conditions.

5.12 Documentation of Fill

Documentation of the source, type, quantities, and location of each type of clean fill used as part of the remedial action at the site is provided below.

A total of 5,872.89 tons of clean DGA backfill was utilized during the Layout Area 1 excavation between March and April 2013. The source of the virgin rock material was from two projects: the East Side Access, New York, New York Project; and the 86th Street, New York, New York Project. This virgin rock material was then processed at the Liberty Stone & Aggregates Facility located at 50 Caven Point Avenue, Jersey City, NJ. Backfill material was transported directly to Site 156 for placement. No alternative fill was used for the Layout Area 1 excavation.

A total of 43,681.07 tons of clean backfill (Dust/Screenings, New Jersey Department of Transportation (NJDOT) DGA/Type 5A, Quarry Processed Aggregate) was utilized from a Weldon Material, Inc. (Weldon) quarry located in Watchung, NJ. A total of 11,554.1 tons of clean DGA material was utilized from TILCON New York, Inc. (TILCON) quarries located in Pompton Lakes, NJ and Mt. Hope, NJ. Backfill material was transported directly to Site 156 for placement. No alternative fill was used for the Layout Area 2 and Layout Area 3 excavations.

The clean backfill sampling requirements for the Layout Area 1, Layout Area 2, and Layout Area 3 excavations are addressed in the 2012 RAWP approved by the NJDEP. The requirements in the RAWP were to collect one sample for every 5,000 tons of clean virgin material imported onsite and to analyze the sample(s) for:

- TCL Volatile Organic Compounds (Method SW846 8260B/5035);
- Acid / Base Neutral Extractable Compounds (Method SW846 8270C/3550B);
- NJDEP Extractable Petroleum Hydrocarbons (Method SW846 3545);
- Herbicides (Method SW846 8151/3550B);
- Pesticides (Method SW846 8081A/3545);
- PCBs (Method SW846 8082/3545);
- TAL Metals (Method SW846 6010B, 6020, 6020B, 7471A);
- Cr^{+6} (Method SW846 3060A/7196A);
- Redox Potential (Eh);
- Percent Solids; and
- pH.

Clean fill documentation including certifications and analytical data from the Layout Area 1, Layout Area 2 and Layout Area 3 excavations are provided in **Appendix K**.

A total of 22.62 tons of quarry-processed aggregate material from a Stavola Construction Materials quarry located in Bound Brook, NJ was utilized to backfill a test pit dug in April 2016. Approximately one cubic yard of clean fill (topsoil, 7 inches) had been placed over the fill at the shallow excavation. The topsoil was placed 1-inch higher than grade, to allow for compaction over time, and was seeded. This top soil was obtained from Advanced Soil Technologies, Brick, NJ. For the topsoil that was placed, copies of fully executed bills of lading and analytical data demonstrating compliance with the definition of clean fill are provided in **Appendix K**. A total of 105.57 tons of clean DGA backfill from the Pompton Lakes TILCON quarry was utilized to backfill test pits dug in October 2016.

A total of 5,324.44 tons of clean DGA backfill was utilized during the Supplemental Layout Area 3 excavation in October 2017. The backfill was obtained from two sources: TILCON quarries located in Pompton Lakes, NJ and Mount Hope, NJ. Backfill material was transported directly to Site 156 for placement.

A copy of the licensed quarry/mine material certifications for DGA placed in the test pits excavated in 2016 and the 2017 Supplemental Layout Area 3 excavation are provided in **Appendix K**.

No alternative fill was used for the AOC 1 remediation.

5.13 Documentation of Permits

A description of the permits required and obtained to implement the AOC 1 remedial action is included below. To date, no NJDEP permits have been required to complete the remedy. Permits were obtained from the Hudson-Essex-Passaic (HEP) Soil Conservation District for soil erosion and sediment control. Documentation for the New Jersey Department of Community Affairs (NJDCA) and HEP permits is provided in **Appendix J**.

Additionally the following permits were obtained:

- JCMUA groundwater discharge permit;
- Passaic Valley sewerage commission permits;
- Housing, economic development and commerce construction permit;
- Fire Department permit; and
- NJDEP treatment works approval.

Completion of a remedial action permit application is not required for AOC 1 because no institutional controls or engineering controls are required.

6.0 Effectiveness of the Remedy (AOC 1)

This section presents documentation that the AOC 1 remedial action is effective in protecting the public health and safety and the environment by demonstrating compliance with the applicable remediation standards (**Section 1.3**) for Cr^{+6} and CCPW metals.

The RAWP specified a combination of pre-excavation and specific post-excavation samples for Layout Area 1, Layout Area 2, and Layout Area 3. The combination of pre-excavation and post-excavation sampling was designed to meet the frequency requirements for confirmation sampling - lateral sidewalls (one sample per 30 linear feet) and floor (one sample per 900 square feet (SF) of remedial area). Additionally, post-excavation samples were collected where visible CCPW was observed and subsequently, these areas were over-excavated to confirm that the remedial action objectives were met. Following implementation and review of the pre-excavation sample elevations, not all areas of the excavation had sufficient sample results to meet the sampling frequency. This was due in part to over-excavation which resulted in areas with no pre-excavation samples located within one foot of the surveyed excavation surface. Post-excavation soil samples were collected in April 2016 and October 2016 to fill in data gaps and remove residual contamination.

During the Supplemental Layout Area 3 remediation conducted from September to November 2017, post-excavation soil samples were collected at a frequency of one sample per 30 linear feet of sidewall (top, middle and bottom) and one sample per 900 square feet of remedial area.

A tabulation of the Cr^{+6} and CCPW metal sample results for soil remaining in place is provided in **Table 2**. Sample locations and analytical results compared to the applicable standards for soil remaining in place samples are presented in **Figure 4A** and **Figure 4B** for Cr^{+6} and **Figure 5A** and **Figure 5B** for CCPW metals. Laboratory data packages and data validation reports for in-place soil are provided in **Appendix L** and **Appendix M**, respectively. The electronic data deliverables (EDDs) are provided in **Appendix F**. Boring logs for soil collected during the remedial investigation are provided in **Appendix N**.

6.1 Confirmation Soil Sampling Results

Analytical soil sample results were compared to the applicable standards (**Section 1.3**): CrSCC, RDCSRS, NRDCSRS, DIGWSSL and IGWSRS. Post-excavation sample results and pre-excavation soil sample results located within one foot of the surveyed post-excavation surface were selected to demonstrate compliance. NJDEP’s minimum post-excavation sampling frequency requirements are one sample per 30 linear feet of sidewall and one sample per 900 SF of remedial area. The overall excavation bottom area square footage, excavation sidewall linear footage (perimeter), and minimum number of post-excavation compliance samples required pursuant to the current *Technical Guidance for Site Investigation of Soil, Remedial Investigation of Soil, and Remedial Action Verification Sampling for Soil* (NJDEP, 2012c), are listed by Layout Area in **Table 3** below:

Table 3 Area and Perimeter of Layout Areas

Layout Area	Area (SF)	Perimeter (LF)	No. Sidewall Samples @ 1/30 LF	No. Bottom Samples @ 1/900 SF
1	19,815	724	25	23
2	37,490	748	25	42
3	46190	996	34	52

Notes:
LF – linear feet
No. - number
SF – square feet

The number of compliance confirmation samples collected for each parameter in each layout area is listed in **Table 4** below. The number of confirmation samples satisfies the NJDEP requirements of at least one sample per 30 linear feet of sidewall and one sample per 900 SF of remedial area with the exception of antimony in sidewall samples collected in Layout Area 2. While there are two fewer antimony confirmation sidewall samples than the NJDEP requirement, in Layout Area 2 there are 49 more combined sidewall and pit bottom confirmation sample results for antimony than are required.

Table 4 Number of Confirmation Samples by Layout Area

Layout Area	No. Sidewall Samples @ 1/30 LF	No. Sidewall Results for Antimony	No. Sidewall Results for Cr^{+6}	No. Sidewall Results for Nickel	No. Sidewall Results for Thallium	No. Sidewall Results for Cr	No. Sidewall Results for Vanadium
1	25	32	35	32	32	33	32
2	25	23	25	25	25	26	25
3	34	40	104	41	41	41	41
Layout Area	**No. Bottom Samples @ 1/900 SF**	**No. Bottom Results for Antimony**	**No. Bottom Results for Cr^{+6}**	**No. Bottom Results for Nickel**	**No. Bottom Results for Thallium**	**No. Bottom Results for Cr**	**No. Bottom Results for Vanadium**
1	23	32	35	35	35	38	35
2	42	93	162	96	96	98	96
3	52	129	168	132	132	144	132

Notes:
Cr – total chromium
Cr^{+6} – hexavalent chromium
No. - number
SF – square foot

LF – linear foot

6.1.1 Compliance Attainment by Averaging for CCPW Exceedances

The Sb concentration exceeded the DIGWSSL for the following samples: LA1-1 (3.0-3.5); 156-PE-57N_C0-6; 156-PE-82_B12-18; 156-B73B_1.5-2.0X; 156-B76W_3-4b; 156-B76W_3-4bd; 156-B76W_4-5c and 156-B97_A2-3. Compliance with the DIGWSSL was attained through compliance averaging. A memorandum documenting the averaging is provided in **Appendix O**.

6.2 Resolution of Compliance Exceptions

There are two locations where soil remaining in place exceeds the 20 mg/kg CrSCC for Cr^{+6}. An explanation for these exceptions is provided below.

6.2.1 Discussion Regarding Samples B74 and PE-81

Soil sample results listed in **Table 5** exceed the NJDEP's CrSCC of 20 mg/kg Cr^{+6} and are located below the TEE, according to the final as-built survey prepared contours.

Table 5 Samples Remaining in Place with Cr^{+6} Concentrations Exceeding the 20 mg/kg CrSCC

Original Location ID	Grid ID	Layout Area	Sample Date	Cr^{+6} (mg/kg)	Q	TEE (ft NAVD 88)	Sample Elevation (ft NAVD 88)
B74	N/A	1	8/31/2006	27.25	U	N/A	-6.7 to -7.2
PE-81	J1	3	9/29/2011	20.5		5.5	5.2 to 4.7

Notes:

Cr^{+6} – hexavalent chromium

ft - feet

N/A – not available

NAVD 88 – North American Vertical Datum of 1988

Q – qualifier

ID - identifier

mg/kg – milligrams per kilogram

U - The analyte was not detected above the sample reporting limit shown.

TEE – terminal excavation elevation

The sample from boring B74 was a pre-excavation sample; the Cr^{+6} result was not detected at a concentration exceeding the detection limit (which was greater than the 20 mg/kg CrSCC). The sample was not addressed in subsequent pre-excavation sampling and its location was not excavated. Sample 156-B74G-13.5-14.0, which correlates to boring B74, was diluted by the laboratory. No reason for the dilution was provided in the laboratory data package, or the data validation report. The raw data appears to indicate that this sample had a color or some type of interference, because the background absorbance is quite high for this sample compared to others in this sample delivery group. The results for three samples collected at depth intervals above this sample were non-detect (8-8.5 ft bgs [2.46 U mg/kg], 10-10.5 ft bgs [2.29 U mg/kg], and 12-12.5 ft bgs [2.36 U mg/kg]) with reporting limits less than 20 mg/kg. The boring log depicts a profile of fill material overlying native soil with native soil observed at 9.6 ft bgs (**Appendix N**). Sample 156-B74G-13.5-14.0 was collected in peat (**Appendix N**). The Cr^{+6} concentration profile and the boring log documentation support the conclusion that the concentration in sample 156-B74G-13.5-14.0 is likely less than the 20 mg/kg CrSCC.

The ratio of Cr^{+6} to total Cr was examined for samples in boring B74. As listed in **Table 6**, one sample (156-B74G_13.5-14.0) has a ratio that exceeds 1 and for the other samples collected from this boring, the maximum ratio is 0.32. For sample 156-B74G_13.5-14.0, with a ratio of 1.25, the actual Cr^{+6} concentration in the sample is less than the detection limit of 27.25 mg/kg. Using the maximum ratio of 0.32 found in the other samples from boring B74 and the total Cr concentration of 21.8 mg/kg, the predicted Cr^{+6} concentration for sample 156-B74G_13.5-14.0 is 7.1 mg/kg. This estimate of the Cr+6 concentration in sample 156-B74G_13.5-14.0 supports the contention that the elevated detection limit is a result of the analytical method and not an exceedance of the CrSCC.

Since the estimated Cr^{+6} concentration is less than the NJDEP CrSCC of 20 mg/kg, no additional remediation is required for soils associated with boring B74.

Table 6 Boring B74 Cr^{+6} Sample Results

Sample ID	Sample Depth (ft bgs)	Cr^{+6} (mg/kg)	Total Cr (mg/kg)	Ratio of Cr^{+6} /Total Cr (mg/kg)
156-B74A_1.1-1.6	1.1-1.6	2.14 U	6.6	0.32
156-B74B_4-4.5	4-4.5	24.2	257	0.09
156-B74C_5-5.5	5-5.5	5.5	155	0.04
156-B74D_8-8.5	8-8.5	2.46 U	15.2	0.16
156-B74F_10-10.5	10-10.5	2.29 U	12.1	0.19
156-B74F_12-12.5	12-12.5	2.36 U	12.9	0.18
156-B74G_13.5-14.0	13.5-14	27.25 U	21.8	1.25

Notes:
bgs – below ground surface
Cr – total chromium
Cr^{+6} – hexavalent chromium
ft – feet
ID - identifier
mg/kg – milligrams per kilogram
U - The analyte was not detected above the sample reporting limit shown.

For boring PE-81, located adjacent to Building 1, the TEE is above the sample elevation with a concentration exceeding the CrSCC of 20 mg/kg for Cr^{+6}. **Table 7** depicts information for the sample collected from boring PE-81.

Table 7 Cr^{+6} Sample Result from Boring PE-81 Exceeding the CrSCC

Location ID	Grid ID	Layout Area	Sample Date	Cr^{+6} Result (mg/kg)	Q	TEE (ft NAVD 88)	Sample Elevation (ft NAVD 88)
PE-81	J1	3	9/29/2011	20.5		5.5	5.2 to 4.7

Notes:

Cr^{+6} – hexavalent chromium

CrSCC - Chromium Soil Cleanup Criteria

ft - feet

N/A – not available

NAVD 88 – North American Vertical Datum of 1988

Q – qualifier

ID - identifier

mg/kg – milligrams per kilogram

U - The analyte was not detected above the sample reporting limit shown.

TEE - terminal excavation elevation

The Layout Area 3 as-built survey does not appear to accurately depict the excavation along the building. The as-built contours are shallow compared to the elevations documented in daily summary reports. In the January 15, 2014 daily summary report included in the memorandum entitled *PPG Site 156 (Metro Towers) Scope of Work and Technical Rationale for Supplemental Remedial Investigation – Soil and Groundwater Sampling*, dated November 16, 2015 (AECOM, 2015c) (**Appendix A**), AECOM documented that ENTACT excavated in grid J1 (where PE-81 is located). CCPW was observed along the slope of the excavation in J1 adjacent to Building 1. J1 was excavated to a depth of approximately 8 ft bgs. The surface elevation at PE-81 is 8.2 ft NAVD 88. The excavation extended below the sample at PE-81 collected from 5.2 to 4.7 ft NAVD 88 to an elevation of 0.2 ft NAVD 88. The excavation in grid J1 adjacent to Building 1 is documented in photos from the February 11, 2014 daily summary report (AECOM, 2015c) and is shown in **Photo 1** and **Photo 2** below.

PHOTO 1 - Grid J1, CCPW Removed

PHOTO 2 - Grid J1, Under the Grade Beam

The February 11, 2014 daily summary report stated that no visible CCPW was observed under the building in Grid J1. For reference, the bottom of the building grade beam was surveyed at a location less than two feet from boring PE-81. The elevation of the bottom of the building grade beam at that location is 5.7 ft NAVD 88.

In addition, pre- and post-excavation compliance samples adjacent to this boring location, comprised of the nearby bottom samples I1-UB and PE-12, and sidewall sample J1-SW (as depicted on **Figure 4A),** demonstrate that concentrations of Cr^{+6} in the soil in the vicinity of boring PE-81 are less than the CrSCC for Cr^{+6} of 20 mg/kg.

6.2.2 Visible CCPW Along Building 1

The field notes prepared by AECOM during the remediation of Layout Areas 2 and 3 identified areas of visible CCPW along and under Building 1 that were later removed via excavation on February 11, 2014. The visible CCPW was excavated along and under Building 1.

The January 8, 2014 daily summary report prepared by AECOM stated that, "*Visual CCPW was detected along the slope in grid I1and H1 adjacent grid line. ENTACT is currently assessing on how and if this impacted material should be removed, due to structural stability issues along building two (sic).*"

The January 30, 2014 daily summary report prepared by AECOM stated that, "*The locations excavated today have been previously cleared for backfilling. While CCPW is visible, removing it could impact the structural integrity of Building 1.*"

In the February 12, 2014 daily summary reports, AECOM states that, "*ENTACT excavated the "wedge" of material which had been left in place along the east edge of Building 2 (sic). The excavation extended from K1 through the southmost 10 ft of I1. A slope of material with varying quantities of CCPW had been left in place during the initial excavation in this area. This slope has been completely removed, leaving no impacted material behind. The area has been excavated straight down along the grade beam. Materials were cleared off of the grade beam and pile caps.*" Regarding CCPW observed along the gridline of I1 and H1, this report states that "*No visible CCPW was observed under the building in grids I1 or H1. One small pocket of questionable material (~0.5' x ~0.3' x ~0.3') had been observed in H1 under the plumb of the grade beam. The pocket was strictly surficial, extending inward ~0.3ft. Upon inspection, the pocket fell away to reveal clean materials under the building. AECOM and Weston agree that no impacted materials remain in this area.*"

6.3 COPR in Borings without Remaining Samples

The boring logs were reviewed for the presence of COPR and green staining as part of developing the excavation limits. The following borings have COPR or green staining indicated on the logs and no sample results remaining (**Table 2**). **Table 8** below demonstrates that soil containing COPR or green staining were excavated.

Table 8 COPR in Borings without Remaining Samples

Location ID	Surface Elevation (ft NAVD88)	COPR Observation Depths (ft bgs)	Deepest COPR Observation Elevation (ft NAVD88)	TEE (ft NAVD88)
FC-10	9.04	8.0-9.5	-0.5	-5.4
FC-18	8.13	1.3-2.5 4.0-4.8	3.3	0.4
FC-19	8.71	0.0 - 1.4 4.0 - 4.5 4.5-4.6 8.0-8.4	0.31	-0.2
FC-2	9.15	4.5-4.6	4.6	-3.5
FC-21	8.86	4.8-4.9	4.0	-3.7
FC-24	9.12	0-1.0 4.0-4.9 9.4-10.1	-0.98	-4.4
FC-25	9.25	5.0-8.0 8.0-8.8 8.8-9.5	-0.25	-4.1
FC-3	9.30	4.0-4.8	4.5	-6.5

Location ID	Surface Elevation (ft NAVD88)	COPR Observation Depths (ft bgs)	Deepest COPR Observation Elevation (ft NAVD88)	TEE (ft NAVD88)
FC-4	9.26	5.1-5.2 8.0-8.7	0.56	-6.5
FC-5	9.04	0.2-0.3	8.7	-5.2
FC-6	8.80	4.7-4.8	4.0	-4.2
FC-8	8.95	1.0-2.9 4.6-4.8	4.2	-2.2
FE-1	6.57	1.5-2.8	3.8	0.4
FF-2	5.96	4.5 -4.6 7.0-7.1	-1.1	-7.0
I-1D	8.6	4.91-6.58	2.0	0.7
I-15D	9.2	7.01-10.31 10.31-10.35	-1.2	-6.9
I-17D	8.7	6.92-8.92	-0.2	-7.8
I-18D	8.8	7.3-10.3	-1.5	-5.1
I-2D	9.3	6.83-7.83	1.5	-2.5
I-22D	9.3	6.88-9.2	0.1	-5.1
I-23D	9.5	4.0–5.0	4.5	-4.4
I-24D	9.5	9.0-9.9	-0.4	-4.4
I-25	8.7	1.7-4	4.7	-3.2
I-27	9.2	6.98-9.38	-0.2	-6.3
I-8D	9.1	7.35-8.85	0.3	-3.7
I-9/I-9D	9.8	0.88-2, 6.76-8.4	1.4	-4.2

Notes:

bgs – below ground surface

COPR – chromite ore processing residue

ft - feet

NAVD 88 – North American Vertical Datum of 1988

TEE – terminal excavation elevation

6.4 Sampling Methodologies

During the remedial investigations, soil samples were collected from test pits and from macrocores or split spoon samplers during drilling activities. Samples were collected by field personnel using the methods described in NJDEP's Field Sampling Procedures Manual (FSPM) (NJDEP, 2005). Details of the sampling methods are provided in **Appendix A**.

During remediation of Layout Areas 1, 2 and 3, post-excavation sidewall and pit bottom samples were obtained as discrete 6-inch intervals. The sampling was conducted to fill in gaps where the pre-excavation sampling was insufficient to meet the required sampling frequencies and where the excavation expanded beyond the designed footprint.

During remediation of Supplemental Layout Area 3, RA soil sampling was conducted according to the NJDEP's *Technical Guidance for Site Investigation of Soil, Remedial Investigation of Soil, and Remedial Action Verification Sampling for Soil* (NJDEP, 2012c). Post-excavation sidewall samples were collected at a minimum frequency of one sample per 30 linear feet of sidewall and one sample per 900 square feet of pit bottom. Along the sidewall, samples were collected from the top, middle and bottom of the sidewall. The sidewall and pit bottom samples were obtained as discrete 6-inch intervals.

Quality control samples (field duplicates, field blanks, and matrix spike (MS)/MS duplicates [MSD]) were collected at the frequencies defined in the Field Sampling Plan – Quality Assurance Project Plan (FSP-QAPP) (AECOM, 2010) or NJDEP-approved work plans for samples collected by PPG's contractors.

6.5 Laboratory Analyses

During the remedial investigations, soil samples were analyzed for Cr^{+6} and CCPW metals at NJ certified laboratories using standard analytical methods. Details of the analytical methods are provided in **Appendix E** for the April 2017 soil sampling event and **Appendix A** for previous sampling events.

During the Layout Area 1, 2, 3 and Supplemental Layout Area 3 remediation, sample analyses were performed by a NJ-certified laboratory (Accutest) for the samples collected in 2013 as part of the Layout Area 1 excavation. Analyses were performed in accordance with NJDEP-approved analytical protocols and the revised program FSP-QAPP. Quality assurance analytical measures were implemented in accordance with the *Technical Requirements for Site Remediation* (N.J.A.C. 7:26E-2) (NJDEP, 2012a) and comply with the requirements for a NJDEP-certified laboratory. Quality assurance samples (field blanks and field duplicates) were collected in accordance with the NJDEP's FSPM.

6.6 Reliability of Data: Validation and Usability

The purpose of this section is to ensure that analytical data produced by the laboratory are presented in a clear and useable format. In addition, data quality and technical usability was evaluated prior to data use. The samples collected at the site were analyzed according to USEPA SW-846 analytical methodologies, in which data reduction and reporting schemes are well developed and clearly defined. The employment of this method ensures comparability with other similarly analyzed environmental samples. Reduction, validation, and reporting specifications for these analyses are detailed below. Validation Reports for the soil sample result data packages are included in **Appendix M**.

There are no data validation reports available for the 1993 and 2001 RIR. The data from the 1993 and 2001 RIR could not be reviewed by AECOM because the data packages could not be located. Data validation reports could not be located for several Sample Delivery Groups (SDGs) or the data validation reports did not address one or more metals. The subsections below discuss the data validation, provide a summary of the validation results for the 1993 and 2001 RIRs, and provide a review of the unvalidated laboratory data packages or specific metals data that were not included in the validation reports.

6.7 Data Validation Reports

Data, as presented in the analytical data packages included as **Appendix L**, was primarily reviewed and validated using the following combination of method-specific criteria with professional judgement, as appropriate:

- NJDEP *Standard Operating Procedure: Quality Assurance Data Validation of Analytical Deliverables Inorganics (Based on USEPA SW-846 Methods), SOP No. 5.A.16*;

- NJDEP Office of Data Quality SOP 5.A.10, Rev 3 (September 2009), *SOP for Analytical Data Validation of Hexavalent Chromium - for USEPA SW-846 Method 3060A, USEPA SW-846 Method 7196A;*
- United States Environmental Protection Agency (USEPA) *"National Functional Guidelines for Inorganic Data Review"*, OSWER Publication 9240.1-51, EPA540-R-10-011, January 2010;
- US EPA *"ICP-AES Data Validation, SOP No. HW-2a, Revision 15"* (USEPA, 2012);
- NJDEP *Standard Operating Procedure (SOP) for Analytical Data Validation of Hexavalent Chromium*;
- NJDEP, *Data of Known Quality Protocols Technical Guidance*, Version 1.0, April 2014;
- NJDEP, *Data Quality Assessment and Data Usability Evaluation Technical Guidance*, Version 1.0, April 2014;
- NJDEP, *Analytical Laboratory Data Generation, Assessment and Usability Technical Guidance*, Version 1.0, April 2014; and
- NJDEP, *Quality Assurance Project Plan Technical Guidance*, Version 1.0, April 2014.

The data validation reports are provided in **Appendix M**.

Data validation was performed on the 2006-2007 PPG Supplemental Remedial Investigation data by Environmental Validation, Inc. (EDV) of Pittsburgh, PA. EDV validated samples for CCPW metals and Cr^{+6}. Cr^{+6} samples were validated using NJDEP SOP 5.A.16 (May 2002).

Data validation was performed on the 2011 and 2012 PPG Supplemental Remedial Investigation data by Environmental Quality Associates, Inc. (EQA) of Middletown, NY.

Data validation was performed on the 2013 Layout Area 1 post-excavation soil samples by EQA of Middletown, NY. EQA validated samples for CCPW metals and Cr^{+6}. The Cr^{+6} and CCPW metal sample results for the samples collected as part of the Layout Area 1 excavation were reviewed in accordance with the FSP-QAPP and the following NJDEP validation Standard Operating Procedure (SOP): NJDEP Office of Data Quality SOP 5.A.10, Rev 3 (September 2009), SOP for Analytical Data Validation of Cr^{+6} – for United States Environmental Protection Agency (USEPA) SW-846 Method 3060A, USEPA SW-846 Method 7196A, and USEPA SW-846 Method 7199.

Data validation was performed on the 2013/2014 Layout Area 2 and Layout Area 3 post-excavation soil samples by AECOM. The Cr^{+6} and CCPW metal sample results for the samples collected as part of the Layout Area 2 and Layout Area 3 excavation were reviewed in accordance with the FSP-QAPP and the following NJDEP validation SOPs:

- NJDEP Office of Data Quality SOP 5.A.10, Rev 3 (September 2009), *SOP for Analytical Data Validation of Hexavalent Chromium - for USEPA SW-846 Method 3060A, USEPA SW-846 Method 7196A*; and
- NJDEP Office of Data Quality SOP 5.A.16, Rev 1 (May 2002), *Quality Assurance Data Validation of Analytical Deliverables for Inorganics* (based on USEPA SW-846 Methods).

The data validation for samples collected during the 2017 Supplemental Layout Area 3 excavation was conducted by AECOM. The Cr^{+6} and CCPW metal sample results for the samples collected as part of the Layout Area 3 excavation were reviewed in accordance with the FSP-QAPP and the following NJDEP validation Standard Operating Procedure (SOP): NJDEP Office of Data Quality SOP 5.A.10, Rev 3 (September 2009), *SOP for Analytical Data Validation of Cr^{+6} - for USEPA SW-846 Method 3060A, USEPA SW-846 Method 7196A, and USEPA SW-846 Method 7199*.

The analytical data have been found to be of adequate quality and of sufficient precision, accuracy, representativeness, comparability, completeness, and sensitivity for the intended purpose. Data associated with parameters that did not meet quality control (QC) specifications or compliance requirements, were qualified in accordance with US EPA Region II/NJDEP specifications/guidelines, as appropriate. No gross QC failures were noted and no data were rejected except as noted below. The investigator has confidence that the laboratory data are usable for their intended purpose as part of a remedial action to demonstrate compliance with applicable standards and criteria and close out AOC 1. As the data quality objectives have been met, this analytical data may be relied on with confidence and used to support defensible conclusions regarding the Site. Although some analytical data may have been qualified, the data generated during the course of the work detailed here were generally found to be usable, with the following cases of note:

SDG JB62120: Based on the initial and reanalysis MS soluble and insoluble recoveries, the Cr^{+6} result in soil sample F2-BOTTOM was rejected. However, based on the reducing potential of the sample matrix shown by the Eh/pH phase diagram and the additional ancillary parameters, there is evidence to suggest that the matrix for this sample was reducing and not capable of supporting Cr^{+6}. Therefore, even though the sample result was rejected based on MS percent recoveries (%Rs), the result may be usable for site decisions as an estimated value. The highest detected Cr^{+6} result between the initial analysis and reanalysis was reported for this sample.

SDG JB54612: The result for M7-SIDEWALL (JB54612-2) was rejected, but may be usable for project objectives. The Cr^{+6} result for M7-SIDEWALL were rejected based on soluble and insoluble MS recoveries less than 50% in the initial analyses and reanalyses; however, since the reducing potential of the MS sample matrix shown by the Eh/pH phase diagram and the additional ancillary parameters reflect a reducing environment not capable of supporting Cr^{+6}, the Cr^{+6} results are considered usable for decision making purposes.

6.7.1 Soil Samples 1993 and 2001 RIRs

The analytical data for soils samples that were collected during the 1993 and 2001 RIRs was validated in accordance with the following New Jersey Department of Environmental Protection and Energy (NJDEPE) Bureau of Environmental Measurements and Quality Assurance (BEMQA) Data Validation SOPs:

- NJDEPE Office of Data Quality SOP 5.A.02, *Quality Assurance Data Validation of Analytical Deliverables -TAL- Inorganics*, Revision 2, January 1992.
- NJDEPE Office of Data Quality SOP 5.A.10, *Standard Operating Procedure for Analytical Data Validation of Hexavalent Chromium*, Revision 0, June, 1991.

Each analytical result was evaluated against specific quality assurance criteria during the validation process and was given the appropriate data qualifiers, which appear in **Table 2**.

Data validation reports containing the detailed results of the data validation were submitted to the NJDEP for their review. Rejected and negated data are not used in this RAR. The J-qualified data are considered to have only minor quality assurance (QA) problems and are good quality data. As noted previously, the data validation reports for the RIRs for these timeframes could not be located for inclusion in this RAR.

6.7.2 Unvalidated Data Packages

The unvalidated data packages were reviewed by AECOM using method specifications, USEPA Region II SOPs, and NJDEP, *Data Quality Assessment and Data Usability Evaluation Technical Guidance*, Version 1.0, April 2014 (NJDEP, 2014b). A summary of nonconformance issues, listed by Sample Delivery Group, is included below. The analytical data have been found to be of adequate quality and of sufficient precision, accuracy, representativeness, comparability, completeness, and sensitivity for the intended purpose. The J and UJ-qualified data were considered to have only minor QC problems and are good quality data. Results that were shown to be unusable were rejected and removed from this report.

SDG B636: Tl results were accepted without qualification.

SDG B694: Tl results were accepted without qualification.

SDG B749: Tl results were accepted without qualification.

SDG B822: For Sb, the nonconformance summary noted that MS recoveries were outside of quality control limits due to matrix interference. The nonconformance summary noted that multiple soil spike recoveries/relative percent differences (RPDs) were outside of quality control limits due to sample heterogeneity and/or matrix effects. Laboratory control sample (LCS)/LCS duplicate recoveries/RPDs were within quality control limits. Nonconforming Sb, Cr and V MS recoveries were greater than 30%. No data were rejected.

SDG B883: Tl results were accepted without qualification.

SDG B902: Tl results were accepted without qualification.

SDG B935: Tl results were accepted without qualification.

SDG C009: Tl results were accepted without qualification.

SDG D363: For Sb, the nonconformance summary noted that MS recoveries were outside of quality control limits due to matrix interference. For Cr^{+6}, the nonconformance summary noted that the MS soluble/MS insoluble recoveries were outside of the quality control limits due to matrix interference. The post spike/LCS recoveries were within quality control limits. The Cr^{+6} was reanalyzed, the nonconformance summary noted that the MS soluble recovery was outside of the quality control limits due to matrix interference. The MS soluble/post spike/LCS recoveries were within quality control limits. For Cr^{+6}, the nonconformance summary noted that the sample duplicate RPD was high. The data were from 2007; the Cr^{+6} quality control data were not included in the data package. The nature of the matrix cannot be determined. All Cr^{+6} data is usable with qualification as estimates. Due to the MS for Sb being less than 30%, the non-detect Sb results within the batch were rejected because of severe matrix effects and these results were removed from the report. No other data required rejection.

SDG D418: Tl results were accepted without qualification.

SDG E97917: There was an elevated Tl detection limit due to the initial dilution required to minimize matrix interference. LCS/blank spike recoveries were within quality control limits. For Cr^{+6}, the MS recovery was less than the lower quality control limit due to matrix effects. The post-spike recovery was within the quality control limits. If the Cr^{+6} MS recovery is outside criteria (75-125%), the data may still be valid despite the exceedance. As per SW846 Method 3060A, other data (Eh, pH, sulfides) can be collected to aid in the evaluation of MS recoveries. The sample matrix may be reducing in nature. Since the Eh/pH data was not provided in the data package, the reducing nature of the matrix cannot be confirmed. The LCS/blank spike recoveries were within quality control limits. All Cr^{+6} data is usable with qualification as estimates. No data were rejected.

SDG E98449: There were elevated Tl and Sb detection limits due to the initial dilution required to minimize matrix interference. LCS/blank spike recoveries were within quality control limits. For Cr^{+6}, MS recoveries were less than the lower quality control limit due to matrix interference. The post-digestion spike recovery was just under the lower limit of 75%, at 72.2%. The spike recovery of the pH-adjusted sample was acceptable and there was good agreement between the sample result and the 1:5 dilution results. If the Cr^{+6}

MS recovery is outside criteria (75-125%), the data may still be valid despite the exceedance. As per SW846 Method 3060A, other data (Eh, pH, sulfides) can be collected to aid in the evaluation of MS recoveries. The sample matrix may be reducing in nature. Since the Eh/pH data was not provided in the data package, the reducing nature of the matrix cannot be confirmed. The LCS/blank spike recoveries were within quality control limits. All Cr^{+6} data is usable with qualification as estimates. No data were rejected.

SDG E99250: LCS/blank spike recoveries were within quality control limits. For Cr^{+6}, the samples within this SDG were digested and analyzed within the same batch with SDG E98449. Even though the Cr^{+6} sample results may be qualified based on MS percent recoveries, the results may be usable for site decisions as estimated values.

SDG E99662: For Sb, the MS/MSD recoveries were 48.8% and 0%. The RPD between the MS and MSD recoveries for Tl was greater than 20%. The non-detect Sb results must be rejected because of the 0% MS recovery. Tl was not detected in any of the associated samples and does not require qualification in response to the nonconforming RPD. For Cr^{+6}, the nonconformance summary noted that the MS recoveries were less than the lower quality control limit due to matrix interference. The post-digestion spike recovery was within the quality control limits. If the Cr^{+6} MS recovery is outside criteria (75-125%), the data may still be valid despite the exceedance. As per SW846 Method 3060A, other data (Eh, pH, sulfides) can be collected to aid in the evaluation of MS recoveries. The sample matrix may be reducing in nature. Since the Eh/pH data was not provided in the data package, the reducing nature of the matrix cannot be confirmed. The LCS/blank spike recoveries were within quality control limits. All Cr^{+6} data is usable with qualification as estimated values. No data were rejected.

SDG J24443: For Sb, the case narrative noted that the sample and sample duplicate MS recoveries were outside of quality control limits due to possible matrix interference and/or sample heterogeneity and/or matrix effects. For Sb, the case narrative noted that the RPDs for MSD were outside of quality control limits due to possible sample heterogeneity. For Cr and Ni the %Ds for Inductively Coupled Plasma (ICP) serial dilution were outside of quality control limits due to possible matrix interference. The MSs for Sb were greater than 30%. ICP serial dilution percent differences (%Ds) for Cr and Ni indicate the possibility of a physical/chemical matrix interference. LCS/blank spike recoveries were within quality control limits. No data were rejected.

SDG J24580: Tl results were accepted without qualification.

SDG J24695: For Sb, the case narrative noted that MS and MSD recoveries were outside of quality control limits due to matrix interference and/or sample heterogeneity. The MS recoveries for Sb were greater than 30LCS/blank spike recoveries were within quality control limits. No data were rejected. Sb and Tl results were accepted without qualification.

SDG J24856: Tl results were accepted without qualification.

SDG J24928: For Sb, the case narrative noted that MS and MSD recoveries were outside of quality control limits due to matrix interference and/or sample heterogeneity. The Sb MS recoveries were greater than 30%. No data were rejected. Sb and Tl results were accepted without qualification.

SDG J25005: Tl results were accepted without qualification.

SDG J25769: Tl results were accepted without qualification.

SDG J28010: Tl results were accepted without qualification.

SDG J28082: Tl results were accepted without qualification.

SDG J28234: Tl results were accepted without qualification.

SDG J28714: Tl results were accepted without qualification.

SDG J28850: For Sb, the case narrative noted that MS and MS duplicate recoveries were outside of quality control limits due to matrix interference and/or sample heterogeneity. Sb spike recovery was greater than 30%. LCS/blank spike recoveries were within quality control limits. No data were rejected. Sb and Tl results were accepted without qualification.

SDG N707: There were elevated Tl detection limits due to the initial dilution required to minimize matrix interference. LCS/blank spike recoveries were within quality control limits. The soluble Cr^{+6} MS recovery was less than the lower quality control limit because of possible matrix interference. The post-digestion spike recovery was within the acceptance limits. If the Cr^{+6} MS recovery is outside criteria (75-125%), the data may still be valid despite the exceedance. As per SW846 Method 3060A, other data (Eh, pH, sulfides) can be collected to aid in the evaluation of MS recoveries. The sample matrix may be reducing in nature. Since the Eh/pH data were not provided in the data package, the reducing nature of the matrix cannot be confirmed. LCS/blank spike recoveries were within quality control limits. All Cr^{+6} data are usable with qualification as estimates. No data were rejected.

SDG N5411: The ICP serial dilution %D for Cr was greater than 10%. For Cr^{+6}, the MS recovery was less than the lower quality control limit due to matrix interference. The post-digestion and pH adjusted spike recoveries were less than the lower acceptance limits but greater than 30% because of matrix interference. There was good agreement between the sample result and the 1:5 dilution results. If the Cr^{+6} MS recovery is outside criteria (75-125%), the data may still be valid despite the exceedance. As per SW846 Method 3060A, other data (Eh, pH, sulfides) can be collected to aid in the evaluation of MS recoveries. The sample matrix may be reducing in nature. Since the Eh/pH data were not provided in the data package, the reducing nature of the matrix cannot be confirmed. LCS/blank spike recoveries were within quality control limits. All Cr^{+6} data is usable with qualification as estimates. The ICP serial dilution %D for Cr indicates the possibility of a physical/chemical matrix interference. LCS/blank spike recoveries were within quality control limits. No data were rejected.

SDG N5495: For Cr^{+6}, the MS recovery was less than the lower quality control limit of 75%, but greater than 30% because of possible matrix interference. The post-digestion spike was less than the lower limit. The pH-adjusted spike recovery and the agreement between the sample result and the 1:5 dilution result was acceptable. If the Cr^{+6} MS recoveries were outside criteria (75-125%), the data may still be valid despite the exceedances. As per SW846 Method 3060A, other data (Eh, pH, sulfides) can be collected to aid in the evaluation of MS recoveries. The sample matrix may be reducing in nature. Since the Eh/pH data were not provided in the data package, the reducing nature of the matrix cannot be confirmed. LCS/blank spike recoveries were within quality control limits. All Cr^{+6} data is usable with qualification as estimates. No data were rejected.

SDG N11347: For Cr^{+6}, the RPD between the original and duplicate results was greater than the maximum limit due to sample heterogeneity. The associated sample LB-19 (4.5-5) was positive and was qualified as an estimate because of imprecision due to sample heterogeneity. LB-19 (4.5-5) was removed and is not included in **Table 2**. No other data required qualification. No data were rejected.

SDG N18689: For Cr^{+6}, the MS recovery was less than the lower quality control limit of 75%, but greater than 30% because of possible matrix interference. The post-digestion spike was within the quality control limits. If the Cr^{+6} MS recovery is outside criteria (75-125%), the data may still be valid despite the exceedance. As per SW846 Method 3060A, other data (Eh, pH, sulfides) can be collected to aid in the evaluation of MS recoveries. The sample matrix may be reducing in nature. Since the Eh/pH data were not provided in the data package, the reducing nature of the matrix cannot be confirmed. All Cr^{+6} data is usable with qualification as estimates. LCS/blank spike recoveries were within quality control limits. No data were rejected.

SDG N18926: For Cr^{+6}, the MS recovery was less than 30% because of possible matrix interference. The post-digestion spike was within the quality control limits. If the Cr^{+6} MS recovery is outside criteria (75-125%), the data may still be valid despite the exceedance. As per SW846 Method 3060A, other data (Eh, pH, sulfides) can be collected to aid in the evaluation of MS recoveries. The sample matrix may be reducing in nature. Since the Eh/pH data were not provided in the data package, the reducing nature of the matrix cannot be confirmed. LCS/blank spike recoveries were within quality control limits. LCS/blank spike recoveries were within quality control limits. All Cr^{+6} data are usable with qualification as estimates. No data were rejected.

SDG: R2630686: All results were accepted without qualification.

SDG R2631276: Tl results were accepted without qualification.

SDG R2631395: All results were accepted without qualification.

SDG R2631398: All results were accepted without qualification.

SDG W423: Tl results were accepted without qualification.

SDG W508: For V, the nonconformance summary noted that sample duplicate RPDs were outside of quality control limits due to sample heterogeneity. The nonconformance summary noted that MS recoveries were outside of quality control limits due to matrix interference. The V MSs were greater than 30%. All LCS/blank spike recoveries were within the quality control limits. No data were rejected. V and Tl results were accepted without qualification.

SDG W550: Tl results were accepted without qualification.

SDG W615: Tl results were accepted without qualification.

7.0 Remedial Action Costs

PPG's total remediation cost for implementation of the remedial action at Site 156 was estimated at approximately $23.4 million. This includes costs for: remedial investigation; excavation; air monitoring; backfilling and construction management; groundwater management and treatment; waste transportation and disposal; and overall project management and reporting.

8.0 Conclusions

In summary, this RAR documents that the AOC 1 soil RA is effective in protecting public health and safety and the environment. On the basis of terminal excavation elevations and pre-excavation and post-excavation soil sample analytical results, PPG has demonstrated compliance with the applicable remediation standards for the soils at Site 156. Therefore, PPG requests a *No Further Action* determination with regard to Site soils (AOC 1).

9.0 References

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