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Remedial Action Report
Al Smith Moving & Furniture Company, Inc. (AOC ASM-1) Soil
Final

NJDEP Program Interest Number: 775998

PPG Garfield Avenue Group
Hudson County Chromate Sites
Jersey City, New Jersey

Document No. ASM-004B

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List of Acronyms and Abbreviations

AAC	Acceptable Ambient Concentration
ACM	asbestos-containing material
ACO	Administrative Consent Order
AMP	Air Monitoring Plan
AOC	Area of Concern
ARS	Alternative Remediation Standard
ASM	Al Smith Moving & Furniture Company, Inc.
bgs	below ground surface
BOL	bill of lading
CCPW	Chromate Chemical Production Waste
CENJ	Clean Earth of North Jersey
CID	Case Inventory Document
CMAA	Construction Manager as Agent
COC	chain-of-custody
Cr^{+6}	hexavalent chromium
CrSCC	Chromium Soil Cleanup Criteria
DCP	Dust Control Plan
DGA	dense-graded aggregate
DIGWSSL	Default Impact to Groundwater Soil Screening Level
EDD	electronic data deliverable
El.	elevation
ENTACT	ENTACT Environmental Services of Latrobe, Pennsylvania
EQ	Environmental Quality Company
ERFS	Environmental Remediation and Financial Services, LLC
FSP-QAPP	Field Sampling Plan – Quality Assurance Project Plan
ft	foot or feet
GA Group	Garfield Avenue Group
GGM	green-gray mud
GPS	Global Positioning System
HASP	Health and Safety Plan
HCC	Hudson County Chromate
IGWSRS-GAG	Impact to Groundwater Soil Remediation Standard - Garfield Avenue Group
JCMUA	Jersey City Municipal Utilities Authority
JCO	Judicial Consent Order
LCS	laboratory control sample
LCSD	laboratory control sample duplicate
LSRP	Licensed Site Remediation Professional
mg/kg	milligrams per kilogram
MGP	manufactured gas plant
MS	matrix spike
MSD	matrix spike duplicate

NAVD88	North American Vertical Datum of 1988
NJ	New Jersey
N.J.A.C.	New Jersey Administrative Code
NJDEP	New Jersey Department of Environmental Protection
NJDOT	New Jersey Department of Transportation
NJEDA	New Jersey Economic Development Authority
NJGIN	New Jersey Geographic Information Network
OGS	open grade stone
OSHA	Occupational Safety and Health Administration or Act
PCBs	polychlorinated biphenyls
PDI	pre-design investigation
PI	Program Interest
PPE	personal protective equipment
PSEG	Public Service Electric and Gas Company
PVSC	Passaic Valley Sewerage Commission
QA	quality assurance
QC	quality control
RA	remedial action
RAR	Remedial Action Report
RAWP	Remedial Action Work Plan
RDCSRS	Residential Direct Contact Soil Remediation Standard
RE	receptor evaluation
RI	Remedial Investigation
RIR	Remedial Investigation Report
RIWP	Remedial Investigation Work Plan
RPD	relative percent difference
SESCP	Soil Erosion and Sediment Control Plan
SOP	standard operating procedure
SRP	Site Remediation Program
SRS	Soil Remediation Standard
SSRIR	Supplemental Soil Remedial Investigation Report
SVOC	semi-volatile organic compound
SW	Southwestern
TEE	Terminal Excavation Elevation
TEP	Technical Execution Plan
TOC	total organic carbon
TRSR	Technical Requirements for Site Remediation
TSDF	treatment, storage, and disposal facility
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
VOC	volatile organic compound
Weston	Weston Solutions, Inc.

Regulatory Cross Reference Table

Regulatory Cross Reference Table
Remedial Action Report
Al Smith Moving, Garfield Avenue Group
PPG, Jersey City, New Jersey

N.J.A.C. 7:26E (last amended August 6, 2018) and 7:26C (last amended August 6, 2018) regulations are the primary source of Remedial Action Report (RAR) requirements. This document is not to be used as a replacement for the Technical Regulations.

Regulation	Description	Document Location	
N.J.A.C. 7:26E-5.7	Remedial Action Report Requirements	Report	Location
5.7(a)	The person responsible for conducting the remediation shall implement the remedial action and submit to the Department a remedial action report, along with a form found on the Department's website at www.nj.gov/dep/srp/srra/forms, pursuant to (b) below, and according to the applicable regulatory timeframe in N.J.A.C. 7:26E-5.8.	Remedial Action Report Al Smith Moving & Furniture Company, Inc. (AOC ASM-1) Soil	throughout
5.7(b)	The person responsible for conducting the remediation shall present and discuss in the remedial action report all of the information identified or collected pursuant to N.J.A.C. 7:26E-5.1 through 5.6, along with all of the following:	Remedial Action Report Al Smith Moving & Furniture Company, Inc. (AOC ASM-1) Soil	throughout
5.7(b) 1	The general reporting requirements in N.J.A.C. 7:26E-1.6;	Remedial Action Report Al Smith Moving & Furniture Company, Inc. (AOC ASM-1) Soil	see below
1.6(a) 1	Submit all documents, forms, spreadsheets and worksheets required in this chapter;	Remedial Action Report Al Smith Moving & Furniture Company, Inc. (AOC ASM-1) Soil	The Cover/Certification Form is included with the Regulatory Forms. The paper Remedial Action Report form is no longer accepted and is intended for work conducted under the Licensed Site Remediation Professional Program. As this work is being conducted under direct oversight and not being submitted online, no Remedial Action Report form is included.
1.6(a) 2	Certify and have the licensed site remediation professional certify, pursuant to N.J.A.C. 7:26C-1.5, all forms and documents prepared to pursuant to this chapter;	Remedial Action Report Al Smith Moving & Furniture Company, Inc. (AOC ASM-1) Soil	The Cover/Certification Form is included with the Regulatory Forms. The work is being conducted under direct oversight so it does not require certification by a Licensed Site Remediation Professional.
1.6(a) 3	Submit a completed case inventory document (CID) worksheet available on the Department's website at www.nj.gov/dep/srp/srra/forms at the front of each remedial phase workplan and report required by this chapter, except for a preliminary assessment report where no areas of concern were identified;	Remedial Action Report Al Smith Moving & Furniture Company, Inc. (AOC ASM-1) Soil	Regulatory Forms
1.6(a) 4	Submit a quality assurance project plan (QAPP) prepared pursuant to N.J.A.C. 7:26E-2.2 with each remedial phase workplan and report required by this chapter, except for a preliminary assessment report and remedial action report;	Remedial Action Report Al Smith Moving & Furniture Company, Inc. (AOC ASM-1) Soil	Not Applicable for this Remedial Action Report
1.6(a) 5	Except where a final remediation document for unrestricted use is filed with the Department within one year after the earliest applicable trigger to remediate listed in N.J.A.C. 7:26C-2.2, submit all sampling data electronically in a summary table using the format outlined in the Site Remediation Program's "Electronic Data Interchange Manual," available at www.nj.gov/dep/srp/hazsite/docs/, in effect as of the date the document is submitted and include items described in subsections 1.6(a) 5.i-iii of Tech Reg.	Remedial Action Report Al Smith Moving & Furniture Company, Inc. (AOC ASM-1) Soil	Electronic data deliverable provided to NJDEP for data used to document compliance with remedial action goals; receipts of submittal included in Appendix E - Laboratory Analytical Reports.
1.6(a) 6	Submit a geographic information system (GIS) compatible site plan that includes the site boundaries and the location of all areas of concern as polygons.	Remedial Action Report Al Smith Moving & Furniture Company, Inc. (AOC ASM-1) Soil	Figure 1-2 - Site Plan for Al Smtih Moving
1.6(b) 1	The physical setting of the site that includes a general description of soils, geology, hydrology, hydrogeology, and topography of the site and surroundings;	Remedial Action Report Al Smith Moving & Furniture Company, Inc. (AOC ASM-1) Soil	Section 2.2 - Physical Setting of the Site

Regulatory Cross Reference Table
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Regulation	Description	Document Location	
N.J.A.C. 7:26E-5.7	Remedial Action Report Requirements	Report	Location
1.6(b) 2	A description of any significant events or seasonal variations that may have influenced sampling procedures or analytical results;	Remedial Action Report Al Smith Moving & Furniture Company, Inc. (AOC ASM-1) Soil	No significant events or seasonal variations influenced sampling procedures or analytical results. Soil sampling results are discussed in: Section 2.1 - Summary of Soil Remedial Investigation Findings Section 4.2.1 - Proposed Terminal Excavation Elevations and Pre-Design Investigation Section 5.3 - Post-Excavation Soil Sampling
1.6(b) 3	A description of the results and implications of field measurements or area-specific changes in sampling protocol due to field conditions;	Remedial Action Report Al Smith Moving & Furniture Company, Inc. (AOC ASM-1) Soil	Not Applicable for this Site
1.6(b) 4	A list of: i. All variances from the requirements of this chapter submitted pursuant to N.J.A.C. 7:26E-1.7; and ii. All rationales submitted for deviations from any technical guidance pursuant to N.J.A.C. 7:26C-1.2(a)3;	Remedial Action Report Al Smith Moving & Furniture Company, Inc. (AOC ASM-1) Soil	Not Applicable for this Site
1.6(b) 5	The applicable regulatory timeframe, including: i. Regulatory citation of the regulatory timeframe; and ii. Calendar date of the regulatory timeframe;	Remedial Action Report Al Smith Moving & Furniture Company, Inc. (AOC ASM-1) Soil	Master Schedule, referenced in Section 1.0
1.6(b) 6	A summary table(s), organized by area of concern, of all sampling results, including sample location, medium, sample depth, field and laboratory identification numbers, analytical results, and comparison to remediation standards, and the following: i. Identification of each contaminant concentration exceeding a remediation standard; ii. Identification of each sample with a method detection limit or a practical quantitation level that exceeds a remediation standard, along with an explanation in the table key; and iii. A report of all soils and solids sample results in milligrams per kilogram on a dry weight basis, aqueous sample results in micrograms per liter, and air results in micrograms per cubic meter;	Remedial Action Report Al Smith Moving & Furniture Company, Inc. (AOC ASM-1) Soil	Tables 5-1 through 5-3 - Analytical Results for In-Place Soil
1.6(b) 7	For soil borings, test pits and monitoring wells: i. Stratigraphic logs, which include soil/rock physical descriptions and field instrument readings detected during drilling for each soil boring, test pit and monitoring well; ii. State permit numbers and as-built specifications, if applicable; and iii. Monitoring well certification forms A (the well construction as built certification) and B (the well location certification) available on the Department's website at www.nj.gov/dep/srp/regs/guidance.htm;	Remedial Action Report Al Smith Moving & Furniture Company, Inc. (AOC ASM-1) Soil	i. Appendix G - Boring Logs ii and iii. Not Applicable
1.6(b) 8	Maps and figures, with map scale and orientation, including: i. Site location, land use, receptor evaluation, and area of concern maps; ii. Sample location map(s), that include the following: (1) Field identification numbers for all samples; (2) Sample locations, sample depths and contaminant concentrations plotted on the map; and (3) If data for more than 25 samples are presented for an area of concern, soil, ground water and sediment contaminant isopleth maps and cross section diagram(s), including the horizontal and vertical distribution of contaminants in each media, with sample point location numbers and contaminant concentrations; and iii. Ground water elevation contour maps showing the location of all monitoring wells, piezometers, or other ground water sampling points, for each set of static ground water level measurements for each aquifer;	Remedial Action Report Al Smith Moving & Furniture Company, Inc. (AOC ASM-1) Soil	i. Site Location - Figure 1-1 - USGS Site Location Map Areas of Concern - Figure 1-2 - Site Plan for Al Smith Moving Land Use – Regulatory Forms – Receptor Evaluation ii. Sample Location Maps: Figures 5-1 through 5-3 - Al Smith Moving Sample Maps iii. Groundwater maps - Not Applicable

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Regulation	Description	Document Location	
N.J.A.C. 7:26E-5.7	Remedial Action Report Requirements	Report	Location
1.6(b) 9	A discussion of the usability of laboratory analytical data;	Remedial Action Report Al Smith Moving & Furniture Company, Inc. (AOC ASM-1) Soil	Section 6.0 - Reliability of Data: Data Validation and Usability
1.6(b) 10	A description of the significance of information generated in the library search of tentatively identified compounds and unknown compounds.	Remedial Action Report Al Smith Moving & Furniture Company, Inc. (AOC ASM-1) Soil	Not Applicable for this Site
5.7(b) 2	A presentation and discussion of all of the information identified or collected, pursuant to N.J.A.C. 7:26E-1.10 through 1.16 and an updated receptor evaluation on a form found on the Department's website at www.nj.gov/dep/srp/srra/forms;	Remedial Action Report Al Smith Moving & Furniture Company, Inc. (AOC ASM-1) Soil	Regulatory Forms - Receptor Evaluation and Section 8.0 - Receptor Evaluation Update
5.7(b) 3	A summary of the findings and recommendations for each area of concern from the remedial investigation report prepared pursuant to N.J.A.C. 7:26E-4.9;	Remedial Action Report Al Smith Moving & Furniture Company, Inc. (AOC ASM-1) Soil	Section 2.3 - Recommended Remedial Action
5.7(b) 4	A description, by area of concern, of each remedial action implemented;	Remedial Action Report Al Smith Moving & Furniture Company, Inc. (AOC ASM-1) Soil	Section 5.0 - Description of Remedial Action
5.7(b) 5	A list, by remedial action, of the remediation standards that apply to each remedial action;	Remedial Action Report Al Smith Moving & Furniture Company, Inc. (AOC ASM-1) Soil	Section 3.0 - Identification of Applicable Remedial Standards/Criteria and Table 3-1 - Soil Remediation Standards/Criteria
5.7(b) 6	Documentation, by area of concern, that each remedial action is effective in protecting the public health and safety and the environment by: i. Providing an overview of the data to establish the remedial action is operating as designed; or ii. Demonstrating compliance with the applicable remediation standards;	Remedial Action Report Al Smith Moving & Furniture Company, Inc. (AOC ASM-1) Soil	Section 7.0 - Documentation of the Protectiveness of the Remedial Action
5.7(b) 7	A remedial action permit application prepared pursuant to N.J.A.C. 7:26C-7, if applicable;	Remedial Action Report Al Smith Moving & Furniture Company, Inc. (AOC ASM-1) Soil	Not Applicable for this Site
5.7(b) 8	"As-built" diagrams for any permanent structures associated with the remedial action including, without limitation, caps or other structures associated with the remedial action and engineering controls, if applicable;	Remedial Action Report Al Smith Moving & Furniture Company, Inc. (AOC ASM-1) Soil	Section 7.0 - Documentation of the Protectiveness of the Remedial Action Appendix K - As-Built Diagrams
5.7(b) 9	A detailed description of site restoration activities, if applicable;	Remedial Action Report Al Smith Moving & Furniture Company, Inc. (AOC ASM-1) Soil	Section 7.2 - Description of Restoration Activities
5.7(b) 10	The total remediation costs through the implementation of the remedial action;	Remedial Action Report Al Smith Moving & Furniture Company, Inc. (AOC ASM-1) Soil	Section 7.3 - Total Remedial Action Cost
5.7(b) 11	Documentation of all types and quantities of waste generated by the remedial action, including copies of fully executed manifests or bill(s) of lading documenting any off-site transport of waste;	Remedial Action Report Al Smith Moving & Furniture Company, Inc. (AOC ASM-1) Soil	Section 7.4 - Documentation of Waste Generation and Disposal Appendix H - Hazardous Waste Disposal Documentation Appendix I - Non-Hazardous Waste Disposal Documentation
5.7(b) 12	Documentation of the source, type, quantities, and location of each alternative fill and clean fill used as part of the remedial action at the site; and	Remedial Action Report Al Smith Moving & Furniture Company, Inc. (AOC ASM-1) Soil	Section 7.5 - Documentation of Source, Type, Quantities, and Location of Fill Appendix J - Clean Fill Documentation
5.7(b) 13	A description of each permit required and obtained to implement the remedial action.	Remedial Action Report Al Smith Moving & Furniture Company, Inc. (AOC ASM-1) Soil	Section 7.6 - Identification of Required Permits and Authorizations Appendix C - Permits and Approvals

Executive Summary

This Remedial Action Report (RAR) has been prepared by AECOM on behalf of PPG to document the remedial action (RA) for Chromate Chemical Production Waste (CCPW) and CCPW-impacted soils at the Al Smith Moving & Furniture Company, Inc. property (ASM) Area of Concern (AOC) ASM-1. ASM (the Site) is part of the Garfield Avenue Group (GA Group) Sites, which include Sites 114, 132, 133, 135, 137, 143, and 186, and adjacent roadways and properties (**Figure 1-1**). Site 114 is the former location of a chromite ore processing facility previously owned by PPG, and the former Halladay Street Gas Works manufactured gas plant (MGP) previously owned by Public Service Electric and Gas Company (PSEG). ASM is tracked under the New Jersey Department of Environmental Protection (NJDEP) Site Remediation Program (SRP) Program Interest (PI) number 775998.

ASM is located at 33 Pacific Avenue in Jersey City, New Jersey (NJ) (**Figure 1-2**). ASM is identified as Block 21509, Lot 3 in the Jersey City Parcel Data from New Jersey Geographic Information Network (NJGIN), last updated October 6, 2015 (available at: https://njgin.state.nj.us/OGIS_IW, last accessed in November 2018). ASM is bordered to the northwest by Site 133 East (Block 21509, Lot 1), to the northeast by Site 135 (Block 21509, Lot 2), to the southeast by Pacific Avenue, and to the southwest by Caven Point Avenue. The total area encompassed by ASM is approximately 0.5 acres.

This RAR addresses only the soil impacts for which PPG is responsible under the *Administrative Consent Order* (ACO) (NJDEP, 1990) and the *Partial Consent Judgment Concerning the PPG Sites* (Judicial Consent Order [JCO]) (Superior Court of New Jersey Law Division – Hudson County, 2009). PPG is responsible for CCPW and CCPW-related impacts. At ASM, these constituents include:

- CCPW and hexavalent chromium (Cr^{+6}); and
- CCPW metals (antimony, total chromium, nickel, thallium, and vanadium).

PPG is not responsible for other constituents exceeding the NJDEP Soil Remediation Standards (SRS) or Default Impact to Groundwater Soil Screening Levels (DIGWSSLs) that may be present at the Site. Remediation of non-CCPW-related constituents, including those associated with historic fill remaining at the Site, is the responsibility of the property owner under the Licensed Site Remediation Professional (LSRP) program.

The Case Inventory Document (CID) summarizes the presence of one soil AOC for the Site, AOC ASM-1. This RAR presents a summary of the implemented RA for AOC ASM-1 (CCPW-impacted soils in ASM). Groundwater impacted by CCPW and/or MGP material throughout the GA Group Sites is being tracked under the Site 114 PI number G000005480 and is not included on the CID for ASM; documentation of the RA for groundwater for the GA Group Sites will be provided in a separate document.

Based on the findings of the Remedial Investigation (RI), the recommended RA for soils at the Site included the excavation and removal of visible CCPW and soils with concentrations of Cr^{+6} greater than the Chromium Soil Cleanup Criteria (CrSCC).

The overall objectives for Cr^{+6} and CCPW-impacted soil, as stated in the Remedial Action Work Plan (RAWP) (see **Section 4.1** for the RAWP submittal history), were:

- Elimination of potential exposure to Cr^{+6} in CCPW and CCPW-impacted soil (Cr^{+6} at concentrations greater than 20 milligrams per kilogram [mg/kg]) due to direct contact or windborne dust;
- Removal of accessible impacted soil at depths less than 20 feet (ft) below ground surface (bgs) and above the meadow mat;
- Removal of CCPW and certain impacted soil to depths greater than 20 ft bgs but to a maximum of 35 ft bgs where: a) the meadow mat is not present, and b) removal is technically prudent and beneficial to the future groundwater remediation; and
- Establishment of site conditions suitable for future uses of the Site.

For the purposes of planning and implementing the RA, ASM was identified as part of GA Group Off-Site Properties (also known as Phase 5). Excavation within ASM was conducted concurrently with excavation in the adjacent portions of Site 133 East and Site 135. Remedial excavation at the Site began on August 16, 2017 and was completed on January 8, 2018. Backfilling was completed on January 26, 2018. Restoration activities were completed on February 15, 2018.

Confirmation sampling results presented on figures and tables in this report indicate remedial objectives for AOC ASM-1 have been achieved as follows:

- Excavation of soil containing Cr^{+6} met the requirements specified in the NJDEP Memorandum entitled *Chromium Moratorium*, February 8, 2007 (the Chromium Policy) (NJDEP, 2007) in accordance with the *Updated Method to Determine Compliance with the Department's Chromium Policy, Garfield Avenue – Sites 114, 132, 133, 135, 137, and 143, Jersey City, NJ* (Method to Determine Compliance) (NJDEP, 2013). (Note that Cr^{+6} at concentrations that do not meet the Chromium Policy in accordance with the Method to Determine Compliance remain in place beyond the eastern extent of AOC ASM-1 and will be addressed separately as part of Pacific Avenue.)
- Soil concentrations for CCPW metals are in compliance with the CrSCC or SRS.
- Soil concentrations for CCPW metals in the unsaturated zone are in compliance with the DIGWSSLs and/or the site-specific Impact to Groundwater Soil Remediation Standards for the GA Group (IGWSRS-GAGs).

The soil RA for ASM AOC ASM-1 is effective in protecting public health and safety and the environment, and no further soil remediation is warranted for this AOC. This RAR demonstrates compliance with the applicable remediation requirements for the soils on ASM AOC ASM-1 and no further action with regard to AOC ASM-1 soils is needed. PPG requests the closure of AOC ASM-1 by the NJDEP through the issuance of a Consent Judgment Compliance Letter.

1.0 Introduction

This Remedial Action Report (RAR) has been prepared by AECOM on behalf of PPG to document the remedial action (RA) for Chromate Chemical Production Waste (CCPW) and CCPW-impacted soils at the Al Smith Moving & Furniture Company, Inc. property (ASM) (Area of Concern [AOC] ASM-1). ASM (the Site) is one of the Garfield Avenue Group (GA Group) Sites, which include Sites 114, 132, 133, 135, 137, 143, and 186, and adjacent roadways and properties (**Figure 1-1**). Site 114 is the former location of a chromite ore processing facility previously owned by PPG, and the former Halladay Street Gas Works manufactured gas plant (MGP) previously owned by Public Service Electric and Gas Company (PSEG). ASM is tracked under the New Jersey Department of Environmental Protection (NJDEP) Site Remediation Program (SRP) Program Interest (PI) number 775998.

ASM is located at 33 Pacific Avenue in Jersey City, New Jersey (NJ) (**Figure 1-2**). ASM is identified as Block 21509, Lot 3 in the Jersey City Parcel Data from New Jersey Geographic Information Network (NJGIN), last updated October 6, 2015 (available at: https://njgin.state.nj.us/OGIS_IW, last accessed in November 2018). ASM is bordered to the northwest by Site 133 East (Block 21509, Lot 1), to the northeast by Site 135 (Block 21509, Lot 2), to the southeast by Pacific Avenue, and to the southwest by Caven Point Avenue. The total area encompassed by ASM is approximately 0.5 acres.

In 1990, PPG and the NJDEP entered into an *Administrative Consent Order* (ACO) (NJDEP, 1990) to investigate and remediate locations where 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 *Partial Consent Judgment Concerning the PPG Sites*, also referred to as the Judicial Consent Order (JCO) (Superior Court of New Jersey Law Division – Hudson County, 2009), with the purpose of remediating soils and sources of contamination at these Hudson County Chromate (HCC) sites. Priority for the remedial activities was given to residential locations where the CCPW and CCPW-impacted materials were present. The provisions of the original ACO remain in effect with the JCO taking precedence where there are conflicts between the two documents.

As part of the JCO, a judicially enforceable master schedule was created, establishing RA milestone dates for the NJ Chrome Remediation Sites, including ASM. Since its establishment in 2009, the master schedule has been revised several times. The most recent revision to the Master Schedule was finalized on January 24, 2019 (Riccio, 2019).

PPG and PSEG are jointly responsible for remediation of MGP parameters related to the former Halladay Street Gas Works MGP. PSEG, as the former Halladay Street Gas Works MGP operator, is the lead party for addressing these impacts.

ASM is currently vacant land owned by the New Jersey Economic Development Authority (NJEDA), care of Al Smith Moving & Furniture Company, Inc. Prior to remediation, the property was almost completely occupied by a commercial warehouse building operated by the Al Smith Moving & Furniture Company, Inc. The building was demolished as part of the RA at the Site in 2017.

The Case Inventory Document (CID) summarizes the presence of one AOC for soil, as presented on **Table 1-1**. As part of the Supplemental Soil Remedial Investigation Report (SSRIR) for the GA Group Sites, contaminated soils within ASM were considered a single AOC (Al Smith Moving – Soil)

(AECOM, 2018b). As part of this RAR, the soil AOC has been renamed AOC ASM-1. The survey limits of AOC ASM-1 are shown on **Figure 1-2**. This RAR presents a summary of the implemented RA for ASM soils (AOC ASM-1).

Documentation of the RA for additional AOCs will be provided in separate documents. Groundwater impacted by CCPW and/or MGP material throughout the GA Group Sites is being tracked under the PI number of G000005480 for Site 114 (the location of the former Chromate Chemical Production Facility and MGP). Remediation of non-CCPW-related constituents is the responsibility of the property owner under the Licensed Site Remediation Professional (LSRP) program. The CID included herein only reflects the remediated soil AOC that PPG is responsible for associated with the ACO/JCO.

This RAR was prepared in accordance with the requirements set forth in the *Technical Requirements for Site Remediation* (TRSR), New Jersey Administrative Code (N.J.A.C.), Title 7, Chapter 26E, Subchapter 5.5 (N.J.A.C. 7:26E-5.5) (NJDEP, 1993b), Appendix A of the 1990 ACO (NJDEP, 1990), and the June 26, 2009 JCO (Superior Court of New Jersey Law Division – Hudson County, 2009).

The remainder of this RAR is organized as follows:

- **Section 2** provides the summary of soil remedial investigation (RI) findings and recommendations;
- **Section 3** identifies the applicable remedial standards/criteria;
- **Section 4** presents the summary of pre-remedial action design activities;
- **Section 5** provides the description of the RA implemented;
- **Section 6** discusses the reliability of the data including data validation and usability;
- **Section 7** includes documentation of the protectiveness of the remedy;
- **Section 8** provides the updated receptor evaluation information;
- **Section 9** presents the conclusions and recommendations; and
- **Section 10** lists the references cited in the report.

Supporting information is presented in the appendices.

2.0 Summary of Soil Remedial Investigation Findings and Recommendations

2.1 Summary of Soil Remedial Investigation Findings

RI activities performed at the GA Group Sites were detailed in the following reports, including Remedial Investigation Work Plans (RIWPs) and Remedial Investigation Reports (RIRs), previously submitted to the NJDEP:

- April 2003 *Remedial Investigation Work Plan – Site 114* (ENSR, 2003).
- March 2006 *Remedial Investigation Report – Site 114* (Site 114 RIR) (ENSR, 2006a).
- March 2006 *Remedial Investigation Work Plan – Site 114 (Off Site)* (ENSR, 2006b).
- September 2006 *Remedial Investigation Work Plan – Sites 132, 133, 135, 137 and 143* (ENSR, 2006c).
- December 2007 *Remedial Investigation Report Former Halladay Street Gas Works, Jersey City, New Jersey* (Halladay Street Gas Works RIR) (CMX, 2007).
- July 2008 *Remedial Investigation Report Addendum, Supplemental Offsite Soil Sampling, Former Halladay Street Gas Works, Jersey City, New Jersey* (RIR Addendum) (CMX, 2008).
- December 2009 *Remedial Investigation Report – Non-Residential Chromate Chemical Production Waste Sites, Sites 114, 132, 133, 135, 137, and 143* (AECOM, 2009).
- March 2011 *Soil Remedial Investigation Work Plan – Sites 114, 132, 133, 135, 137, 143 and Site 186* (AECOM, 2011a).
- November 2011 *Draft Remedial Investigation Report – Soil Garfield Avenue Group Non-Residential CCPW Sites 114, 132, 133, 135, 137, 143 and 186* (AECOM, 2011b).
- February 2012 *Remedial Investigation Report – Soil Garfield Avenue Group Non-Residential CCPW Sites 114, 132, 133, 135, 137, 143 and 186* (2012 RIR) (AECOM, 2012a).
- May 2014 *Remedial Investigation Report Former Halladay Street Gas Works Jersey City, New Jersey* (AMEC, 2014).
- August 2018 *Supplemental Soil Remedial Investigation Report, Final Revision 1, PPG Garfield Avenue Group, Hudson County Chromium Sites, Jersey City, New Jersey* (August 2018 SSRIR) (AECOM, 2018b), as approved by NJDEP on October 22, 2018 (NJDEP, 2018a).

The 2012 RIR provides a detailed summary of the previous RI investigations throughout the GA Group Sites. No additional data specific to ASM was collected as part of the August 2018 SSRIR; however, Impact to Groundwater Soil Remediation Standards for the Garfield Avenue Group (IGWSRS-GAGs) for antimony and nickel, applicable to the GA Group Sites (including ASM), were developed and presented in the August 2018 SSRIR (AECOM, 2018b).

The 2012 RIR incorporated the results of RI work conducted by both PPG and PSEG through 2011. The RI work was designed to delineate the compounds on or potentially emanating from Site 114 related to former chromite ore processing operations and related to PPG's former ownership of Site

114. The compounds present on Site 114 included volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), polychlorinated biphenyls (PCBs), metals, and hexavalent chromium (Cr^{+6}), as well as CCPW.

The RI activities identified the presence of Cr^{+6} in soils at concentrations greater than the NJDEP Chromium Soil Cleanup Criterion (CrSCC) on adjacent property Site 133 East and in the northern portion of adjacent property Site 135. Samples collected on ASM did not demonstrate concentrations of Cr^{+6} greater than the CrSCC. One sample immediately to the east of ASM in Pacific Avenue did demonstrate a concentration of Cr^{+6} greater than the CrSCC.

Vanadium was encountered at a concentration greater than the NJDEP SRS at one location along the Site 133 East/ASM boundary as presented in the 2012 RIR. However, the vanadium concentration was less than the site-specific Alternative Remediation Standard (ARS) established for the GA Group as presented in the August 2018 SSRIR. In the 2012 RIR, antimony and nickel at concentrations in ASM soil samples exceeded the DIGWSSLs; however, the concentrations of antimony and nickel were less than the IGWSRS-GAGs developed and presented in the August 2018 SSRIR (AECOM, 2018b).

Since Cr^{+6} exceedances and visible CCPW were not found on ASM during the RI phase, ASM was not originally identified as part of the GA Group Sites to be investigated and remediated under the ACO and JCO. During pre-design investigation activities at neighboring Sites 133 East and 135, visible CCPW and Cr^{+6} at concentrations exceeding the CrSCC were encountered in grids adjacent to ASM. Because adjacent grids required remediation, pre-design investigation (PDI) sampling was conducted in ASM in 2016 as described in the documents listed in **Section 4.2.1.**

Because visible CCPW and Cr^{+6} were encountered during PDI and RA activities outside the original extent of contamination reported in the 2012 RIR, additional delineation was required and conducted to the south and east of ASM in Caven Point Avenue and Pacific Avenue. Based on the results from the delineation investigation, delineation of Cr^{+6} and antimony impacts are complete as documented in the *Caven Point Avenue and Pacific Avenue Delineation Data Package* (AECOM, 2018e), included in **Appendix A**.

The PSEG RI activities did not identify MGP-related impacts in soil at ASM. As documented in the memorandum entitled *Response to NJDEP/Weston's Comments on PPG's ACO/JCO Parameters List (Revision 0)* (AECOM, 2017i), no MGP-related constituents were identified in ASM.

2.2 Physical Setting of the Site

The GA Group Sites, including ASM, are located in an urban area in Jersey City, Hudson County, NJ between Garfield Avenue, Caven Point Avenue, Pacific Avenue, and the NJ Transit Light Rail. The GA Group Sites consist of former industrial and commercial properties and businesses. The GA Group Sites, including ASM, are located within the Canal Crossing Redevelopment Area, which encompasses 111 acres of planned redevelopment space in the southeastern section of Jersey City, NJ (City of Jersey City, 2009).

There is little topographic relief within and surrounding the GA Group Sites, where the topography ranges from elevation (El.) 9 feet (ft) to 16 ft relative to the North American Vertical Datum of 1988 (NAVD88). However, west of Garfield Avenue, the land surface slopes upward and reaches approximately El. 100 ft NAVD88 about one-half mile to the west. The topography east of the GA Group Sites is fairly flat, extending to the Hudson River and Upper New York Bay. Due to highly compacted surface soils and other impervious features, storm water runoff within the GA Group Sites is primarily channeled into the municipal storm sewer system (ENSR, 2006a).

The GA Group Sites are located in a section of Jersey City that experienced significant industrial development in the early 1900s. To create more available land, developers filled the surrounding marshlands and estuarine areas. Research indicates that the fill included construction spoils consisting of silts and sands, garbage from New York City, ship ballast, coal ash, and incinerator ash. It is unknown what specific fill material was used in which locations. The meadow mat associated with wetland areas was covered with fill materials and/or removed for building foundations or other improvement projects (ENSR, 2006a).

2.2.1 Topography

The United States Geological Survey (USGS) Jersey City, NJ topographic quadrangle map (**Figure 1-1**) presents the regional topography for the GA Group Sites and surrounding area. ASM has little topographic relief, with ground surface ranging from El. 11 to 12.5 ft NAVD88. However, just to the west of Garfield Avenue, the topography rises approximately 30 to 40 ft in elevation within several hundred yards of ASM, and to about El. 100 ft NAVD88 about a half-mile west of ASM. As of May 2018, the surface elevation of ASM following soil remediation and restoration ranges from El. 10 to 12 ft NAVD88.

2.2.2 Regional Geology

The regional geology includes unconsolidated sediments of Recent and Pleistocene age. According to the New Jersey Geologic Survey, these sediments include alluvial, estuarine, eolian (windblown), and glacial lacustrine deposits, as well as glacial till of late Wisconsin age. The Triassic age bedrock of the Newark Group (Lockatong and Stockton formations) throughout the region is comprised of non-marine sedimentary rocks, consisting mainly of sandstone, mudstone, and conglomerate. A diabase sill (i.e., the Palisades Sill) intruded into the Lockatong formation west of Garfield Avenue approximately 200 million years ago.

2.2.3 ASM Geology

ASM is located on miscellaneous fill material that was used to reclaim the salt marsh for the construction of this portion of Jersey City. Soil boring logs and the NJDEP Historic Fill Map for the Jersey City Quadrangle establish that the ASM property is located within an area of historic fill (AECOM, 2012a). The estuarine native soils beneath the fill material include an organic meadow mat layer and a thick sequence of unconsolidated natural material. The major geologic units in the area of ASM from top to bottom include:

- A non-native fill layer (the shallow zone);
- Native soils consisting of sand, silty sand, and clays (the intermediate zone) generally separated from the fill by organic sediments or meadow mat;
- Till directly above the bedrock underlying sand with occasional gravel lenses generally separated from the intermediate zone by a layer of lower hydraulic conductivity silts and clayey silts (the deep zone); and
- Bedrock of the Lockatong and Stockton Formations (bedrock zone).

The bedrock surface is relatively shallow west of Garfield Avenue, but fairly deep beneath Site 114. Bedrock was observed at depths less than 10 ft below ground surface (bgs) west of ASM along Garfield Avenue, at depths exceeding 100 ft bgs below the center of Site 114, and at an approximate depth of 80 ft bgs at Halladay Street to the west of ASM (AECOM, 2012a).

East of the GA Group Sites, the bedrock surface rises to a large bedrock plateau that extends to the shoreline of New York Bay. The bedrock slopes downward again east of Ellis Island (Stanford, 1995).

Estuarine organic-rich deposits (i.e., meadow mat) were identified at a number of boring locations. Observations have indicated that the meadow mat is not continuous. Depths of the meadow mat range from approximately 10 to 21 ft bgs (AECOM, 2012a). Shallow soils (predominantly fill) extend from the ground surface to the top of the meadow mat, where the meadow mat is present, or to a similar depth where meadow mat is not present.

Below the meadow mat, soils are unconsolidated and are characterized by fine to medium sand and silt with clay and some gravel, typical of the current understanding of the geologic depositional history of the area. The native, unconsolidated soils range in thickness from approximately 56 to 77 ft, based on borings that extended to bedrock.

Excavation of the CCPW-impacted historic fill at ASM took place between September 2017 and January 2018. A summary of the restoration activities, including backfilling, is provided in **Section 7.2** of this RAR.

2.2.4 Hydrogeology

This RAR only addresses the RA of soil at ASM AOC ASM-1. Groundwater impacted by CCPW and/or MGP material throughout the GA Group Sites is being tracked under the PI number G000005480 for Site 114 (the location of the former Chromate Chemical Production Facility and MGP). The status of the groundwater investigation throughout the GA Group is documented in the *Groundwater Remedial Investigation Report, Draft* submitted to the NJDEP on October 1, 2018 (AECOM, 2018d). A separate RAR will be prepared and submitted to document the groundwater RA at the GA Group Sites. This description of hydrogeology is provided herein solely to meet the regulatory requirements of N.J.A.C. 7:26E-5.7(b)1 as specified by N.J.A.C. 7:26E-1.6(b)1.

2.2.4.1 Regional Groundwater Flow

Groundwater occurs regionally in the following hydrogeologic zones: the fill; the meadow mat and the unconsolidated overburden soils; and the bedrock. A summary of the groundwater flow in these formations is included below:

- **Fill (Shallow Water-Bearing Zone):** Groundwater in the fill is typically encountered within 10 ft bgs. In general, shallow groundwater flow patterns represent a subdued version of the land surface topography. Variations from this can be attributed to heterogeneities in the fill. For instance, tightly compacted dredged sediments would be expected to restrict water flow much more than construction debris. Subsurface infrastructure (e.g., basements, drains, sheet pile, utility corridors, etc.) would also affect groundwater flow patterns. Groundwater elevations in the shallow fill can also be influenced by recharge events.
- **Overburden (Intermediate and Deep Water-Bearing Zones) and Meadow Mat:** Groundwater flow in the overburden is controlled by hydraulic conductivity or flow through the connected porous spaces in the soil matrix. Groundwater flows horizontally in these soils, but may be influenced by local recharge and discharge zones (i.e., surface water bodies and drainage divides). Meadow mat is a dense matrix of organic material and fine-grained soils; the hydraulic conductivity of the meadow mat is expected to be three or more orders-of-magnitude less than the underlying overburden.

- **Bedrock (Bedrock Water-Bearing Zone):** Well yields from bedrock have been reported to range from several gallons to several hundred gallons per minute, with yields generally decreasing with depth. Groundwater in the bedrock formations occurs under both unconfined and confined conditions, primarily within secondary porosity due to fractures and joints. The Palisades Sill is understood to be a no flow boundary and has low permeability. In general, groundwater flow in bedrock is a very small fraction of the total groundwater flux through the area.

2.2.4.2 GA Group Sites Groundwater Flow

Like the regional hydrogeology, groundwater at the GA Group Sites occurs in several hydrogeologic zones:

- The shallow fill zone (shallow water-bearing zone);
- The intermediate sand and silty sand zone including the meadow mat (intermediate water-bearing zone);
- The deep sand, gravel lenses, silts, clays, and glacial till (deep water-bearing zone); and
- Bedrock of the Stockton Formation and Lockatong Formation (bedrock water-bearing zone).

Shallow groundwater flow is complex and is affected by various on- and off-site activities and features, including excavations, placement of clean and/or amended fill, sheet pile, implementation of interim groundwater remedial measures, other subsurface infrastructure, and localized variability in recharge. The principal direction of groundwater flow in the intermediate and deep water bearing-zones is from northwest to southeast. This flow direction is consistent with the geologic setting where the GA Group area is recharged from groundwater coming off the topographic high to the west. Recharge to the intermediate water-bearing zone is also occurring due to downward gradients in the fill and upward gradients in the deep water-bearing zone.

During a May/June 2018 groundwater sampling round, groundwater elevations throughout the GA Group Sites in the shallow, intermediate, and deep overburden, and bedrock groundwater zones ranged from El. 3.25 to 12.78 ft NAVD88 (shallow), El. 6.16 to 9.67 ft NAVD88 (intermediate), El. 6.44 to 8.03 ft NAVD88 (deep), and El. 7.55 to 10.48 ft NAVD88 (bedrock).

The 50th percentile groundwater elevation for ASM was estimated to be El. 6.2 ft NAVD88 based on 13 monitoring wells located on or adjacent to ASM gauged between February 2007 and December 2016. The monitoring well locations and data are included in **Appendix B**.

2.3 Recommended Remedial Action

Based on the findings of the RI, the recommended RA for soils at ASM included the excavation and removal of visible CCPW and soils with concentrations of Cr^{+6} greater than the CrSCC. It was anticipated that the presence of CCPW metals (antimony, total chromium, nickel, thallium, and vanadium) at concentrations greater than the CrSCC, SRS, DIGWSSLs, or the site-specific IGWSRS-GAGs would be resolved as a result of the excavation being driven by the presence of Cr^{+6} and visible CCPW impacts.

3.0 Identification of Applicable Remedial Standards/Criteria

3.1 Regulatory Requirements, Guidance, and Alternative/Site-Specific Determinations

The RAs described in the Remedial Action Work Plan (RAWP) (see **Section 4.1** for the RAWP submittal history) were performed in accordance with the following regulatory requirements, NJDEP Guidance, and Site-specific determinations:

- N.J.A.C. 7:9D – *Well Construction and Maintenance; Sealing of Abandoned Wells*, last amended January 2, 2018 (NJDEP, 2001).
- N.J.A.C. 7:26C – *Administrative Requirements for the Remediation of Contaminated Sites*, last amended August 6, 2018 (NJDEP, 1993a).
- N.J.A.C. 7:26D – *Soil Remediation Standards*, last amended September 18, 2017 (NJDEP, 2008a).
- N.J.A.C. 7:26E – *Technical Requirements for Site Remediation*, last amended August 6, 2018 (NJDEP, 1993b).
- NJDEP *Field Sampling Procedures Manual*, dated August 2005, last updated April 2011 (NJDEP, 2005).
- NJDEP *Technical Guidance for the Attainment of Remediation Standards and Site-Specific Criteria*, dated September 2012 (NJDEP, 2012c).
- NJDEP Memorandum from Lisa P. Jackson to Irene Kropp, Subject: *Chromium Moratorium*, February 8, 2007 (the Chromium Policy) (NJDEP, 2007).
- NJDEP *Chromium Soil Cleanup Criteria*, September 2008, revised April 2010 (NJDEP, 2008b).
- NJDEP *Administrative Consent Order*, dated July 19, 1990 (NJDEP, 1990).
- *Partial Consent Judgment Concerning the PPG Sites* (JCO) between NJDEP, PPG, and the City of Jersey City, June 26, 2009 (Superior Court of New Jersey Law Division - Hudson County, 2009).
- Letter from Mr. Thomas Cozzi to W. Michael McCabe, Subject: *Updated Method to Determine Compliance with the Department's Chromium Policy*, Garfield Avenue – Sites 114, 132, 133, 135, 137, and 143, Jersey City, NJ. August 13, 2013 (Method to Determine Compliance) (NJDEP, 2013).
- NJDEP Memorandum from Diane Groth to David Doyle, Subject: *PPG Garfield Avenue Group Sites, Adjacent Streets and Nearby Properties, Jersey City, NJ: Alternative Remediation Standard for Vanadium,* December 28, 2016 (NJDEP, 2016).
- August 2018 *Supplemental Soil Remedial Investigation Report, Final Revision 1, PPG Garfield Avenue Group, Hudson County Chromium Sites, Jersey City, New Jersey* (August 2018 SSRIR) (AECOM, 2018b), which presented the IGWSRS-GAG for antimony and nickel. The August 2018 SSRIR was approved by NJDEP on October 22, 2018 (NJDEP, 2018a).

3.2 Soil Remediation Standards/Criteria

For soil at ASM, under the ACO and JCO, PPG is responsible for CCPW and CCPW-related impacts only; no MGP-related constituents were found to be emanating from Site 114 onto ASM. Under the ACO and JCO, PPG is not responsible for any other constituents at concentrations exceeding NJDEP SRS, CrSCC, DIGWSSL, or IGWSRS-GAG that may be present at ASM. Remediation of non-CCPW-related constituents, including those associated with historic fill remaining at the Site, is the responsibility of the property owner under the LSRP program. This RAR addresses only the soil impacts for which PPG is responsible under the ACO and JCO.

The NJDEP SRS and other criteria relevant to the remediation at ASM are presented in **Table 3-1**.

4.0 Summary of Pre-Remedial Action Design Activities

Based on the findings of the RI (as summarized in **Section 2.0**), the recommended RA for soil at the Site included the excavation and removal of visible CCPW and soils with concentrations of Cr^{+6} greater than the CrSCC.

For the purposes of planning and implementing the RA, ASM was primarily identified as part of GA Group Phase 5. Excavation in ASM was conducted concurrently with excavation on portions of Site 133 East and Site 135. Documentation of the RA for soil at Site 133 East and Site 135 is being provided in a separate document.

4.1 Summary of the Remedial Action Work Plan (Soil)

Following the preparation and submittal of the RIR (AECOM, 2012a), AECOM (on behalf of PPG) prepared a RAWP. A summary of the RAWP submittal/approval history is as follows:

- On April 17, 2012, PPG/AECOM issued the *Draft Remedial Action Work Plan (Soil), Rev. 2, Garfield Avenue Group – Sites 114, 132, 133, 135, 137 and 143, Jersey City, New Jersey* (2012 RAWP) (AECOM, 2012d).
- On May 11, 2012, NJDEP found the 2012 RAWP to be administratively complete and issued a Conditional Approval in a letter from Thomas J. Cozzi to M. Michael McCabe, Subject: *Remedial Action Work Plan (Soil), Rev. 2, Garfield Avenue Group – Sites 114, 132, 133, 135, 137 and 143, Jersey City, New Jersey* (NJDEP, 2012b).
- On December 5, 2014, PPG/AECOM issued the *Draft Remedial Action Work Plan (Soil) Rev. 3, Garfield Avenue Group – Sites 114, 132, 133, 135, 137 and 143, Jersey City, New Jersey* (Draft 2014 RAWP) (AECOM, 2014), documenting compliance with the conditions of NJDEP's Conditional Approval.
- On February 28, 2018, Weston Solutions, Inc. (Weston), on behalf of NJDEP, issued an email that requested minor editorial changes to the Draft 2014 RAWP (Weston, 2018a).
- On May 15, 2018, PPG/AECOM issued the *Final Remedial Action Work Plan (Soil) Rev. 3, Garfield Avenue Group Sites, Jersey City, New Jersey* (Final RAWP Rev. 3) (AECOM, 2018a).
- On July 12, 2018, Weston, on behalf of NJDEP, issued an email that requested one additional minor editorial change to the Final RAWP Rev. 3 (Weston, 2018b).
- On August 21, 2018, on behalf of the City of Jersey City, Environmental Remediation and Financial Services, LLC (ERFS) provided comments on the Final RAWP Rev. 3 (ERFS, 2018a), which was distributed by the Site Administrator by email on August 21, 2018.
- On September 27, 2018, PPG/AECOM issued the *Final Remedial Action Work Plan (Soil) Rev. 4, Garfield Avenue Group Sites, Jersey City, New Jersey* (Final RAWP Rev. 4) (AECOM, 2018c).
- On October 10, 2018, on behalf of the City of Jersey City, ERFS provided concurrence on the Final RAWP Rev. 4 (ERFS, 2018b).
- On November 9, 2018, NJDEP approved the Final RAWP Rev. 4 (NJDEP, 2018b).

The overall objectives for Cr^{+6} and CCPW-impacted soil, as stated in the RAWP were:

- Elimination of potential exposure to Cr^{+6} in CCPW and CCPW-impacted soil (Cr^{+6} at concentrations greater than 20 milligrams per kilogram [mg/kg]) due to direct contact or windborne dust;
- Removal of accessible impacted soil at depths less than 20 ft bgs and above the meadow mat;
- Removal of CCPW and certain impacted soil to depths greater than 20 ft bgs but to a maximum of 35 ft bgs where: a) the meadow mat is not present, and b) removal is technically prudent and beneficial to the future groundwater remediation; and
- Establishment of site conditions suitable for future uses of the Site.

The selected RA for Cr^{+6} and CCPW-impacted soil (AOC ASM-1) was excavation (in areas where the impacted soil was present and accessible) to depths no deeper than 35 ft bgs, and off-site disposal. Excavation and treatment of soil containing Cr^{+6} was to meet the Chromium Policy (NJDEP, 2007) by following the Method to Determine Compliance (NJDEP, 2013). Meadow mat, where present, was to be protected to the extent practical since it provides a natural barrier to chromium migration and can reduce Cr^{+6} to trivalent chromium.

Excavation areas were to be backfilled with soil suitable for residential, commercial, or other possible purposes. In areas where deemed necessary, a capillary break was to be installed between groundwater and the ground surface to eliminate the chance of chromate crystallization from impacted groundwater wicking to surface. As described in the *Capillary Break Design Final Report (Revision 2)* (AECOM, 2017k), it was determined that a capillary break was not required within ASM AOC ASM-1.

To improve the design of the RAWP, several pre-design activities were planned. These activities were to include actions such as soil borings, test pits, utility surveys, geotechnical assessments and sampling, and obtaining permits where required. The goals of these events were: to define the limits of excavation and the locations of underground utilities under adjacent road ways; to obtain geotechnical data for design of excavation support; and to determine the depth of excavation in specific grids.

Sampling in soil borings prior to excavation (i.e., pre-excavation sampling) would be used to define the proposed terminal excavation elevation (TEE) for specific grids, subject to review and concurrence by NJDEP. Technical Execution Plans (TEPs) were to be prepared and submitted to NJDEP to define the sample collection and excavation methods to be used.

The excavation was to be implemented on a 30-ft by 30-ft grid pattern. To determine compliance with the remediation objectives, post-excavation sampling of pit bottoms and sidewalls or sampling in soil borings prior to excavation (i.e., pre-excavation sampling) was to be conducted in excavation areas, with analysis for Cr^{+6}. At ASM, where the TEE in adjacent grids varied by more than two feet, sidewall samples were to be collected every 30 linear ft and at two-ft depth intervals. Where the TEEs in adjacent grids varied by less than two feet, sidewall sampling was not required.

The final phase of remedial activities to be conducted at ASM was to include site restoration activities before demobilization from the area.

4.2 Summary of the Technical Execution Plan and Related Activities

4.2.1 Proposed Terminal Excavation Elevations and Pre-Design Investigation

Proposed TEEs for the ASM excavation were provided in a series of memoranda from PPG/AECOM to NJDEP/Weston and responses to comments from PPG/AECOM. The memoranda typically included detailed information demonstrating how the final excavation depth in each grid would comply with the Cr^{+6} decision trees in the Method to Determine Compliance (NJDEP, 2013). The following is a listing of the deliverables and correspondence that detailed the proposed TEEs and PDI investigation activities in ASM:

- On January 31, 2017, PPG/AECOM submitted the technical memorandum entitled *Al Smith Moving Property - Proposed Terminal Excavation Elevations Submittal* (AECOM, 2017a). On February 1, 2017 and February 17, 2017, PPG/AECOM provided supplemental information supporting the submittal.

- On March 3, 2017, Weston, on behalf of NJDEP, provided comments on PPG/AECOM's January 31, 2017 memorandum (Weston, 2017a).

- On March 31, 2017, PPG/AECOM submitted the technical memorandum entitled *Al Smith Moving Property - Proposed Terminal Excavation Elevations Submittal (Revision 1)* (AECOM, 2017d).

- On April 20, 2017, Weston, on behalf of NJDEP, provided comments on PPG/AECOM's March 31, 2017 memorandum (Weston, 2017c).

- On May 3, 2017, PPG/AECOM provided an email documenting concurrence on NJDEP/Weston's April 20, 2017 comments (AECOM, 2017e). A revised TEE Submittal was not issued.

4.2.2 Technical Execution Plan

The TEP for ASM provided more detailed information on the planned RA including descriptions of the remediation activities and goals as well as depictions of the anticipated horizontal extent of excavation and the post-excavation sampling approach. The TEP submittal history for ASM is provided below.

4.2.2.1 Southwestern (SW) Area TEP

- On March 9, 2012, PPG/AECOM issued the *Technical Execution Plan, Southwestern Area Soil Excavation; PPG Site114 – Garfield Avenue, Jersey City, New Jersey* (SW Area TEP) (AECOM, 2012b) and the Response to Comments reference table.
- On March 27, 2012, the NJDEP conditionally approved the SW Area TEP (NJDEP, 2012a).
- On April 23, 2012, PPG/AECOM submitted the *Final Technical Execution Plan, Southwestern Area Soil Excavation, PPG Site 114 – Garfield Avenue, Jersey City, New Jersey* (AECOM, 2012e).

4.2.2.2 ASM TEP

- On March 2, 2017, PPG/AECOM issued the *Technical Execution Plan, Al Smith Moving Property - Soil Excavation, Jersey City, New Jersey* (ASM TEP), dated March 1, 2017 (AECOM, 2017c).

- On March 31, 2017, Weston, on behalf of NJDEP, provided comments on the ASM TEP (Weston, 2017b).
- On May 12, 2017, PPG/AECOM issued the *Technical Execution Plan (Revision 1), Al Smith Moving Property - Soil Excavation, Jersey City, New Jersey* (ASM TEP - Revision 1) (AECOM, 2017f).
- On May 25, 2017, Weston, on behalf of NJDEP, provided comments on the ASM TEP - Revision 1 (Weston, 2017d).
- On June 2, 2017, PPG/AECOM provided an email documenting concurrence with NJDEP/Weston's May 25, 2017 comments (AECOM, 2017g). A revised TEP was not issued.

5.0 Description of the Remedial Action

The RA at AOC ASM-1 (CCPW-impacted soil in ASM) included the excavation of CCPW and visible CCPW-impacted soil, off-site transport and disposal of affected soil, backfilling of the excavations, and restoration of the affected areas. It was anticipated that the presence of CCPW metals (antimony, total chromium, nickel, thallium, and vanadium) at concentrations greater than the CrSCC, SRS, DIGWSSLs, or IGWSRS-GAGs would be resolved as a result of the excavation being driven by the presence of Cr^{+6} and visible CCPW.

The RA was performed in accordance with the NJDEP-conditionally-approved RAWP (AECOM, 2012d) as described in **Section 4.1**, and TEPs and TEE submittals, as described in **Section 4.2**.

Preparatory activities for the remediation of the GA Group Sites, overall, began in 2010 with obtaining regulatory permits and/or approvals to facilitate implementation of RA. Mobilization and preparation for RA of the GA Group Sites began in June 2010.

AECOM served as the remediation engineer. Mueser Rutledge Consulting Engineers served as the geotechnical/structural engineer.

ENTACT Environmental Services of Latrobe, Pennsylvania (ENTACT) served as Construction Manager as Agent (CMAA) to manage and coordinate the work of multiple contractors hired by PPG to perform the required remedial construction and support work.

AECOM performed the air monitoring at the Site during demolition and excavation activities, in accordance with the December 2010 *Revision of the Air Monitoring Workplan for Ground Intrusive Activities at the Garfield Avenue Site in Jersey City, New Jersey* (AMP) and applicable AMP Amendments (28, 30, and 31) (AECOM, 2010b).

ENTACT performed the remedial construction activities at the Site. These services consisted of coordination and disconnection of utilities, excavation and backfilling, decontamination, demolition, dewatering, and Site restoration.

ENTACT coordinated transportation and disposal of the waste streams generated from the RA activities.

The following sections summarize the RA activities as implemented.

5.1 Pre-Construction Activities

The following activities were conducted prior to starting excavation of CCPW and CCPW-impacted soils:

- Obtaining access agreement from property owner.
- Approval of permit applications and plans submitted to the state and local agencies.
- Implementation of a Soil Erosion and Sediment Control Plan (SESCP).
- Implementation of the AMP.

- Development of a site-specific Health and Safety Plan (HASP).
- Site utility clearance activities.
- Abandonment of monitoring wells located within the extent of excavation.
- Mobilization of equipment and set up of temporary facilities.
- Establishment of work zones.
- Demolition of existing structures.

The necessary permits were obtained from and approved by the state, local, and county agencies prior to initiation of activities covered by the permits as detailed in **Section 7.6**. Necessary permits and approvals are documented in **Appendix C**.

Access agreements were obtained from Al Smith Moving & Furniture Company, Inc.

Pre-construction activities including mobilization and placement of jersey barriers and temporary fencing, implementation of the SESCP, establishment of work zones, and utility clearance were performed in April and May 2017. The erosion and sediment controls consisted primarily of the placement of hay bales to contain soil that was potentially displaced during remedial activities. Hay bales were placed in areas where contractors were actively working at the Site and were relocated throughout the remediation activities, as needed, in accordance with the SESCP. Hay bales were installed along the downgradient perimeter of the Site.

The AMP was developed to provide specific procedures for measuring, documenting, and responding to potential airborne impacts during remedial activities at the Site. The AMP was approved by NJDEP prior to the initiation of work.

A HASP was developed for the RA at the GA Group Sites (including ASM) in accordance with the Occupational Safety and Health Act (OSHA) 1910.120. The HASP documents policies and procedures to be followed to protect workers and the public from potential hazards posed at the GA Group Sites. The HASP includes training program protocols, a medical surveillance program, equipment maintenance programs, personal hygiene practices, a project air monitoring plan, a dust control plan, and other information.

In addition to contacting the New Jersey One-Call system, a utility survey was conducted prior to undertaking intrusive Site activities. A private utility locator, Enviroscan, Inc. of Lancaster, Pennsylvania, performed a geophysical survey to mark underground utilities (gas, sewer, water, phone, cable, electrical, etc.) that existed within the proposed excavation area. As part of pre-demolition of the building on ASM, building utilities were disconnected and capped at the street. Electric and natural gas utilities were disconnected by PSEG and sewer and potable water service was cut and capped under the supervision of the Jersey City Municipal Utilities Authority (JCMUA).

Monitoring wells 135-P3C-MW1 (permit number E201502322) and 135-MW1A (permit number 2600082193) were properly decommissioned by NJ-licensed well drillers in accordance with the NJDEP's *Well Construction and Maintenance; Sealing of Abandoned Wells* (N.J.A.C. 7:9D) (NJDEP, 2001). Well decommissioning documentation is included in **Appendix D**.

Equipment was delivered during the initial mobilization phase for RA activities at the GA Group Sites and on an as-needed basis as work progressed. Temporary facilities including field office trailers, sanitary facilities, and Conex/intermodal boxes for equipment storage were mobilized onto Site 114

and set up for use during RAs. As remediation progressed, some support trailers were relocated to Sites 132, 133 East, and 135 to improve logistics.

Work zones were established to exclude unauthorized personnel from entering the Site and to prevent contamination from being tracked off Site or into clean work zones. The following work zones were established:

- A Secure Zone was established to exclude unauthorized personnel from entering the Site. The Secure Zone consisted of a steel chain link fence and locking gates. Warning signs were placed on the fence to prevent unauthorized entry into work areas.
- A Support Zone was established to stage office trailers, sanitary facilities, and Conex/intermodal storage boxes, and provide for vehicle parking.
- An Exclusion Zone encompassed areas associated with impacted material and/or heavy equipment hazards. Temporary fencing was installed to isolate the exclusion zones and modified Level D personal protective equipment (PPE), including Tyvek, was required when working in the exclusion zone.
- A Contamination Reduction Zone and a truck decontamination pad were constructed for transition from the Exclusion Zone. The Contamination Reduction Zone prevented the track-out of sediment onto off-Site streets other paved areas, and onto sidewalks from vehicles and personnel exiting the Site.

The building on ASM, a one-story structure, was demolished in July and August 2017, and the building slab was left behind to be removed as part of the excavation activities. Prior to the demolition of the buildings, pre-demolition activities including utility cutoffs and asbestos abatement were required prior to issuance of a demolition permit. An abatement contractor was acquired to remove universal waste materials and asbestos-containing material (ACM). Following the asbestos abatement, a NJ-Certified industrial hygienist certified the post-abatement air quality. The contractor demolished the structure down to the concrete slabs, segregated waste streams, and disposed of the waste in accordance with local, state (including New Jersey Department of Transportation [NJDOT]), and federal regulations.

5.2 Excavation

In accordance with the ASM Soil Excavation TEP - Revision 1 (AECOM, 2017f), the soil at ASM was excavated in 30-foot-by-30-foot-grid cells. Specifically, ASM includes Grid Rows S through Y (extending from west to east) and Grid Columns 49A through 41A (extending from south to north).

Each grid was excavated to a target depth. Soil analytical results from the RI soil boring program and the PDI soil boring program were used to determine the planned depths of the excavation. See **Section 2.0** for further information regarding the RI and **Section 4.0** for further information regarding the PDI activities, planned TEEs, and TEPs.

Although CCPW had not been observed during RI or PDI activities, green gray mud (GGM) was sporadically encountered during the course of excavation. During excavation, test pits were advanced throughout the property in order to confirm the extent of the GGM. The excavation was then expanded to remove the observed GGM and extend to (or beyond) clean Cr^{+6} confirmation pit bottom and sidewall samples.

Excavation of ASM AOC ASM-1 began on August 16, 2017 and was completed on January 8, 2018. Excavation was conducted concurrently with the excavation of the southeastern portion of Site 133 East and the southern portion of Site 135.

Excavation was performed by ENTACT utilizing an excavator. As excavation of CCPW-impacted material within the excavation proceeded, an excavator with a hammer attachment was used to break up existing slabs, concrete, or other concrete obstacles, such as building foundations, within the limits of the excavation to allow access to underlying soils.

AECOM implemented dust control measures at ASM, in accordance with the March 2011 Revision of the Dust Control Plan (DCP) and applicable DCP Amendments, during excavation, stockpiling, transportation, backfilling, and associated activities during the RA. Results of the air monitoring and sampling during the ASM activities were documented as part of the activities associated with the larger scale GA Group Sites, available on the Chromium Cleanup Website (http://www.chromiumcleanup.com/, last accessed in November 2018) in the form of Monthly Reports and Event Documentation Reports. The concentrations and the short-duration metrics demonstrate that the dust control measures were effective at maintaining Cr^{+6} in dust at concentrations less than the Acceptable Ambient Concentration (AAC).

ENTACT verified vertical excavation extents using global positioning system (GPS) survey equipment to document that proposed excavation depths were achieved. Once the excavation limits were met to the targeted depths within each grid cell, a representative from Weston and/or an AECOM geologist inspected the completed excavation for visible CCPW. If visible CCPW was noted, excavation would continue in half-foot increments until inspection revealed that there was no CCPW present. Post-excavation samples were collected if required to document compliance in accordance with the Method to Determine Compliance (NJDEP, 2013). **Figures 5-1** through **5-3** depict the grid layout of ASM and the final as-built TEEs.

Excavated materials were live-loaded into lined dump trucks where possible. Soil stockpiles were not used during this excavation. Concrete was stockpiled to be sized prior to load out in accordance with the Soil and Stockpile Management Plan for the GA Group Sites included in the 2012 RAWP (AECOM, 2012d). The stockpile was located to the west of ASM on an un-remediated portion of Site 133 West and Site 137B. Since the stockpile location will undergo remedial excavation as part of a subsequent phase of work, post-removal soil samples were not collected from below the stockpile. During times when excavation was progressing, but trucks were not on site, day piles were created in areas that had not yet been remediated, adjacent to or within the excavation. The ground surface was pitched so that liquid that may have drained out of the soils returned into the excavation prior to its transport for off-site disposal (see **Section 7.4** on waste generation and disposal).

Surface water runoff, storm water, groundwater entering the excavation, and decontamination wastewater were transferred by pump to the GA Group Sites groundwater treatment plant located on Site 114.

5.3 Post-Excavation Soil Sampling

During the course of RA activities, post-excavation pit bottom samples were collected, if required, to document compliance with the Chromium Policy (NJDEP, 2007) in accordance with the Method to Determine Compliance (NJDEP, 2013). Where the TEE in adjacent grids varied by more than two feet, sidewall samples were collected every 30 linear ft and at two-ft depth intervals. Where the TEE in adjacent grids varied by less than two feet, sidewall sampling was not conducted. In some cases, the

excavation was designed so that PDI or historical boring locations served as sidewall samples. The Specific Notes on **Table 5-1** explain how the Chromium Policy was met in these specific instances.

In the event that the excavation was expanded to remove visible CCPW beyond the original proposed excavation extents, either post-excavation pit bottom and sidewall samples or samples from soil borings prior to excavation (i.e., pre-excavation sampling) were used as confirmation samples. In addition, the areas were visually inspected by the Site Administrator's independent technical consultant, Weston, and/or an AECOM geologist to confirm that the excavation bottom and sidewalls were free of visible CCPW.

The post-excavation/confirmation samples were analyzed for:

- Cr^{+6} using United States Environmental Protection Agency (USEPA) SW-846 Method 3060A digestion and USEPA SW-846 Method 7196A, as modified by NJDEP;
- pH using USEPA SW-846 Method 9045C, D;
- Redox Potential using method ASTM International Method D1498-76M; and
- Total chromium, antimony, nickel, thallium, and vanadium using USEPA SW-846 Method 6010C (in 10% of selected samples only, per the RAWP [see **Section 4.1** for the RAWP submittal history] and Field Change Notification SWTEP 1 discussed in **Section 5.4**).

Additional excavation (re-dig) was completed where post-excavation soil samples exceeded the CrSCC (see **Section 3.0**). Typically, in these circumstances, the full 30-ft by 30-ft grid was excavated to remove the CrSCC exceedance(s). In the event that a sidewall sample exceeded the CrSCC, the sidewall was further excavated to remove the CrSCC exceedance.

Figures 5-1 through **5-3** and **Tables 5-1** through **5-3** present data for locations within the ASM AOC ASM-1 boundary that have samples remaining in place. In addition, locations from outside the ASM boundary and/or removed samples may be shown to demonstrate compliance with the RA objectives. Note that in Grids X46A and Y44A, the Cr^{+6} concentrations for the eastern sidewall samples at locations ASM-X46A-SW-E2 (sample ASM-X46A-SW-E-8.2-8.7) and ASM-Y44A-SW-E2 (sample ASM-Y44A-SW-E-3.7-4.2) were greater than the CrSCC. These samples are remaining in place beyond the ASM property line and AOC ASM-1 boundary, and will be addressed separately as part of the Pacific Avenue/Caven Point Avenue property in accordance with the January 24, 2019 Master Schedule (Riccio, 2019). Laboratory analytical reports and data validation reports for the data presented in these tables are included in **Appendix E** and **Appendix F**, respectively. The laboratory electronic data deliverables (EDDs) passed submission and have been logged into the NJDEP database, as documented in **Appendix E**.

5.4 Field Change Notifications

Field changes made during implementation of the TEP were documented in Field Change Notification forms. Field Change Notifications relevant to the RA activities at ASM are listed in **Table 5-4**.

6.0 Reliability of Data: Data Validation and Usability

6.1 Data Validation

Data validation was performed by AECOM to evaluate whether the analytical data collected to demonstrate compliance with the RA objectives were scientifically defensible, properly documented, of known quality, and met RA objectives. Data validation included the review of analytical procedures, quality control (QC) results, calibration procedures, data reduction, and completeness of the laboratory data packages as specified in the soil RIWP (AECOM, 2011a) and Field Sampling Plan – Quality Assurance Project Plan (FSP-QAPP) (AECOM, 2010a). Deficiencies noted were communicated to the laboratory and resolutions were documented in the data validation reports. If appropriate, data were qualified for use as described later in this section.

The laboratory analytical data packages (**Appendix E**) were reviewed in accordance with the FSP-QAPP (AECOM, 2010a), the NJDEP validation Standard Operating Procedures (SOPs) for Cr^{+6} and inorganic data, and USEPA Region 2 metals validation guidelines. The following NJDEP validation guidelines served as the basis for the actions taken during validation:

- 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 USEPA SW-846 Method 7199* (NJDEP, 2009); 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)* (NJDEP, 2002).

Where USEPA Region 2 inorganic validation guidelines were also used in assessing metals, the most current guidance in effect at the time of validation was used; the specific revision used is listed in each data validation memorandum provided in **Appendix F**. The link to USEPA Region 2 validation guidance on the USEPA website is shown below:

- https://www.epa.gov/quality/region-2-quality-assurance-guidance-and-standard-operating-procedures (last accessed in November 2018).

The level of validation ranged from a comprehensive validation according to the NJDEP guidelines to a limited validation based on QC summary information or completeness reviews, depending on the analyte and matrix. The validation procedures for the Cr^{+6} data included full validation, which involved a comprehensive review of both summary forms and raw data, whereas the metals data received limited validation. Limited validation for metals data was based on information provided by the laboratory on its QC summary forms and did not include raw data review. At a minimum, limited validation included validation of the following data elements:

- Agreement of analyses conducted with chain-of-custody (COC) requests;
- Holding times and sample preservation;
- Method blanks/field equipment blanks/trip blanks;
- Surrogate spike recoveries;

- Laboratory Control Samples (LCS) or equivalent results;
- Matrix Spike (MS)/Matrix Spike Duplicate (MSD) results;
- Laboratory duplicate results;
- Field duplicate results; and
- Quantitation limits and sample results (limited to evaluating dilutions and re-analyses).

Full validation was conducted on the Cr^{+6} data. Full validation included each of the data elements listed for limited validation along with review of calibration data and raw data, and spot checks for verification of calculations.

Validation reports were prepared for each data package that was validated. The validation reports are provided in **Appendix F**. The reports summarize the samples reviewed, parameters reviewed, nonconformance with the established criteria, and validation actions (including application of data qualifiers) presented in accordance with the NJDEP "hit list" format. Validation data qualifiers were based on the USEPA Region 2 validation guidelines for organic data and the NJDEP validation SOPs for the Cr^{+6} and inorganic data. The following qualifiers are used in data validation:

J Indicates the result was an estimated value; the associated numerical value was an approximate concentration of the analyte in the sample. J+ or J- is used when the direction of bias can be determined.

U Indicates the analyte was not detected in the sample above the sample reporting limit.

UJ Indicates the analyte was not detected above the reporting limit and the reporting limit was approximate.

UB The analyte concentration is less than or equal to three (3) times the concentration in the associated method/preparation blank. The presence of the analyte in the sample is negated due to laboratory blank contamination.

JB The analyte concentration is greater than three (3) times, but less than or equal to ten (10) times the concentration in the associated method/preparation blank. The presence of that analyte in the sample is considered "real" but the concentration is quantitatively qualified due to method blank contamination.

R The sample result was rejected due to serious deficiencies; the presence or absence of the analyte could not be confirmed.

RA The sample result was rejected due to NJ-specific data validation QC requirements; however, the result is usable for project objectives. Refer to the Data Quality and Usability section of the data validation report for further information.

6.2 Data Usability Assessment

Soil samples collected to demonstrate compliance with the RA objectives were sent to Test America Laboratories (formerly Severn-Trent Laboratories) in Edison, NJ (NJ certification 12028) or SGS-Accutest Laboratories in Dayton, NJ (NJ Certification 12129). The analyses were performed in accordance with USEPA- and NJDEP-approved analytical protocols in place at the time the analyses were performed. Quality assurance analytical measures were implemented in accordance with the

NJDEP TRSR (N.J.A.C. 7:26E) (NJDEP, 1993b) and complied with the requirements for a NJDEP-certified laboratory specified in *Regulations Governing the Certification of Laboratories and Environmental Measurements* (NJDEP, 1981). Specific quality control issues identified during validation are documented in the individual data validation reports provided in **Appendix F**. Results of the data validation indicated that, in general, the analytical data were of adequate quality to meet the project objectives. However, there were some quality assurance (QA)/QC issues identified during data validation that resulted in rejection of data or qualification of data as estimated.

Data usability was evaluated using the data quality indicators of precision, accuracy, representativeness, comparability, completeness, and sensitivity. Data that were not rejected during validation are regarded as usable.

Certain Cr^{+6} results that were rejected due to failure of the matrix spikes to meet the NJDEP-specified control limits of 50-150% were qualified "RA" to indicate the result may have value for information purposes. This qualifier is typically used for Cr^{+6} where the spiked sample matrix appears to be reducing and would not be expected to support the presence of Cr^{+6}. The presence of other indicators of a reducing environment such as total organic carbon (TOC), sulfide, or ferrous iron is a factor in the decision to utilize the "RA" qualifier.

6.2.1 Precision

Precision is the measure of agreement among repeated measurements of the same property under identical or substantially similar conditions and includes both field and analytical components. The information used to evaluate precision included results for field duplicates, matrix duplicates, and laboratory duplicates. For the ASM RAR data set, relative percent difference (RPD) non-conformances were observed for field and laboratory duplicates associated with Cr^{+6} and CCPW metals.

Field precision was assessed through the collection and analysis of field duplicates and was expressed as the RPD of the sample and field duplicate pair results. Overall, 21% of the RAR data were qualified as estimated (J) on the basis of field duplicate precision; this includes 78 Cr^{+6} and 95 CCPW metals results.

Laboratory precision was assessed through the RPD results for MS/MSDs, LCS/laboratory control sample duplicate (LCSD) pairs, and duplicate sample analyses. MS/MSDs and duplicate sample analyses do not reflect laboratory precision as purely as LCS/LCSDs since sample homogeneity, which can be a significant issue for soil samples, can impact the precision of sample and matrix spike duplicates. However, no differentiation of the applied reason code is made between LCS/LCSDs and MS/MSDs or sample duplicates. Overall, 5.5% of the ASM RAR data (35 Cr^{+6} and ten CCPW metals results) were qualified as estimated (J) on the basis of laboratory precision.

6.2.2 Accuracy

Accuracy is the degree of agreement between an observed value and an accepted reference or true value. The results of LCS data, surrogate recoveries, method blanks, and MS/MSDs were used as the primary indicators of accuracy; information such as sample container type, preservation, and holding time was also considered as impacting to analytical accuracy. Some of this information was assessed by the laboratory at the time of receipt (container type and preservation); other parameters were evaluated during the validation process.

Qualification of data as estimated (J/UJ) for accuracy was related to issues such as laboratory blank contamination, LCS results, MS results, temperature exceedances, and percent solids. A summary of the validation findings are presented by QC parameter type below.

The presence of target analytes in laboratory blanks and blanks related to field activities (i.e., field and trip blanks) was cited as a reason for qualification of 25 results for Cr^{+6} (7.2% of reported Cr^{+6} values) in the RAR data set. For those blanks in which contaminants or negative drift were detected, action levels were established in accordance with the NJDEP or USEPA Region 2 validation guidance documents. Associated sample results were qualified accordingly.

LCS recovery criteria were not met for 10 results (2.1%) of the CCPW data reported in this data set. The LCS percent recovery for these compounds was less than the established criteria indicating a potential for a low bias in these results.

In the metals fraction, 96 results (20.6%) of the reported metals data were qualified as estimated on the basis of MS or MSD recoveries. Of the total metals results qualified for MS/MSD recoveries, the majority of the results (74) were antimony values; in addition, 14 chromium, four nickel, two thallium, and two vanadium values were qualified on the basis of matrix spike recoveries.

Approximately 74% (254 results) of the Cr^{+6} results were qualified based on the results of matrix spike recoveries. Of these, 170 results (67% of the qualified results) were qualified as estimated due to soluble or insoluble spike results outside the range of 75-125% but within the limits of 50-150%; 84 results (33% of the qualified results) were qualified as “RA” due to soluble and insoluble spike recoveries which were below 50% but the supporting data indicated the sample matrix was reducing and unlikely to support the presence of Cr^{+6}.

Data points impacted by MS and/or MSD recoveries but deemed usable were qualified as estimated (flagged as J or UJ); individual validation memoranda address the potential for high or low bias to sample results based on matrix interferences. Results qualified as RA may be useful for informational purposes but the user is cautioned that the associated spike recoveries do not meet the criteria of 50-150%.

Other QC issues related to sample preservation procedures or high moisture content resulted in selected data points being qualified as estimated (flagged as J or UJ). Cr^{+6} results for six samples were qualified as estimated due to a temperature outside of the acceptable range of 4 ± 2°C when the samples were received at the laboratory. Approximately 13.6% of the RAR data set was qualified on the basis of low percent solids.

6.2.3 Representativeness

The representativeness of any field program is a function of the planning and procedures used to collect the samples and the locations and density of samples collected. Sampling and preservation methods were based on established methods and SOPs outlined in the soil RIWP (AECOM, 2011a) and FSP-QAPP (AECOM, 2010a), which are known to minimize error associated with the disturbance of environmental samples from their natural setting.

Factors to be considered in evaluating representativeness are the use of standard analytical procedures, sample preservation, and the use of the appropriate sample container. The analytical methods, preservation procedures, and containers used in this program were as specified in the FSP-QAPP.

The moisture content of samples is also a factor in the representativeness of the data. In accordance with USEPA Region 2 validation guidance, samples containing more than 50% moisture were qualified as estimated. This requirement resulted in qualification of 64 CCPW metals results and 46 Cr^{+6} results as estimated.

6.2.4 Comparability

Comparability of the data in the RAR data set was maximized by using standard methods for sampling, analysis, and data validation.

6.2.5 Completeness

Completeness is the measure of the amount of valid data obtained from a measurement system; valid data are defined as those data judged to be usable (i.e., not rejected as a result of the validation process). For the RAR, 812 individual data points were generated. Eighty-four data points (10.3%) were qualified as "RA" to indicate that, although QC exceedances were identified, the results still had value for understanding conditions at the RA area.

Cr^{+6} results are qualified as "RA" when none of the associated matrix spike results fall within the recovery range of 50-150% but the associated analytical data indicate that the sample matrix is reducing and would not be expected to support the presence of Cr^{+6}; therefore, the analytical data reported with the "RA" qualifier can provide information about the site conditions. If "RA" values are included in the assessment of completeness, 100% of the RAR data are considered to be fully usable or usable as indicative of site conditions.

6.2.6 Sensitivity

Analytical dilutions can be necessary due to the sample matrix or elevated concentrations of target or non-target analytes. The detection limits reported by the laboratory were adjusted to reflect dilution factors. None of the data associated with the RAR required dilutions that resulted in reporting of non-detect values that exceeded the Residential Direct Contact Soil Remediation Standards (RDCSRS) or CrSCC.

6.2.7 Data Quality/Data Usability Conclusions

The findings of this Data Quality Assessment and Data Usability Evaluation indicate that the data used to demonstrate compliance with the RA objectives are sufficiently representative of actual conditions and may be used to support decisions with the exceptions identified below:

- Cr^{+6} results qualified "RA" due to matrix spike recoveries outside the range of 50-150% may provide useful information for site decisions based on the apparent reducing nature of the matrix but should be used with an understanding of the data limitations.

Data qualifiers and reason codes were applied by the data validator to identify data limitations found in the validation process. Specific details regarding analytes and samples can be found in the individual data validation reports in **Appendix F**.

7.0 Documentation of the Protectiveness of the Remedial Action

Soil analytical results from the RI and PDI soil boring programs were used to pre-determine the depths of the excavation. These sampling results, in combination with the post-excavation sampling results, were used to document the effectiveness and completeness of the soil remediation.

Once the excavation limits met the final as-built TEEs, the Site Administrator's independent technical consultant, Weston, and/or an AECOM geologist inspected the completed excavation to confirm the absence of visible CCPW.

As summarized in **Section 5.3**, the locations of samples used to demonstrate compliance with the remediation goals are depicted on **Figures 5-1** through **5-3**. **Tables 5-1** through **5-3** present the analytical results for samples used to demonstrate compliance with the remediation goals. Laboratory analytical reports and data validation reports for the data presented in these tables are included in **Appendices E** and **F**, respectively. As discussed in **Section 6**, the laboratory analytical data for the collected samples was found to be usable for the purposes of defining the extents of the remedial excavation. **Appendix G** presents the available boring logs from the locations of samples that were used to demonstrate compliance with the remediation goals.

Excavation in ASM was not designed to remove all soil from the unsaturated zone, as detailed in the TEPs and TEE submittals (see **Section 4.2**). Therefore, the elevations of samples remaining in place were compared to the groundwater elevation, above which is the unsaturated zone. The groundwater elevation was estimated as the 50th percentile groundwater elevation from 13 monitoring wells located on or adjacent to ASM gauged between February 2007 and December 2016. The monitoring well locations and data are included in **Appendix B**. The estimated groundwater elevation which defines the unsaturated zone for this Site is El. 6.2 ft NAVD88.

AOC ASM-1 has been remediated as follows:

- Excavation of soil containing Cr^{+6} met the requirements specified in the Chromium Policy (NJDEP, 2007) in accordance with the Method to Determine Compliance (NJDEP, 2013). (Note that Cr^{+6} at concentrations that do not meet the Chromium Policy in accordance with the Method to Determine Compliance remain in place beyond the eastern extent of AOC ASM-1 and will be addressed separately as part of Pacific Avenue.)
- Soil concentrations for CCPW metals are in compliance with the CrSCC or SRS.
- Soil concentrations for CCPW metals in the unsaturated zone are in compliance with the DIGWSSLs and the site-specific IGWSRS-GAGs.

Waste manifests for soil and other materials that were loaded for off-site disposal are presented in **Appendix H** and **Appendix I**.

Clean fill documentation is provided in **Appendix J**.

7.1 As-Built Diagrams

The following as-built diagrams are included in **Appendix K**:

- An as-built diagram depicting the final extents of the excavation for ASM, as well as Halladay Street South, Site 133 East, and Site 135; and
- An as-built diagram of the final Site grades following restoration for ASM, as well as Halladay Street South, Site 133 East, and Site 135.

7.2 Description of Site Restoration Activities

After completion of the excavation activities at each grid cell, the grid was backfilled with DGA. In the grids adjacent to ASM on Site 133 East and Site 135, the backfill was amended with FerroBlack®-H by ENTACT in accordance with the plans and specifications. The placement of FerroBlack®-H serves as a phase of groundwater remediation as documented in the *Progress Report for Groundwater Pilot Study and FerroBlack®-H Amended Backfill Permits-By-Rule - 2016 Fourth Quarter (October to December)* (AECOM, 2017b). FerroBlack®-H was not used on ASM. Backfilling of ASM was completed in stages, keeping pace with the excavation. For ASM, backfilling was completed on January 26, 2018. Restoration activities were completed on February 15, 2018.

Clean fill for site restoration consisted of ¾-inch stone and dense-graded aggregate (DGA) backfill material supplied by Tilcon. Information regarding the source and quality of the backfill material is provided in **Section 7.5** below. Based on the compaction goal of 90% standard proctor, specified in the ASM TEP, ENTACT satisfactorily completed compaction of the backfill placed within the limits of ASM. Final compaction results ranged from 95.6% to 99.9%, exceeding the 90% compaction goal.

ASM was backfilled and restored in accordance with the *Restoration Technical Execution Plan, Garfield Avenue Group (Revision 1)* (Restoration TEP), dated August 2017 (AECOM, 2017h) and the PPG/AECOM memorandum entitled *Response to NJDEP/Weston's 08/31/17 Comments and the City of Jersey City/ERFS's 09/12/17 Comments on the Restoration Technical Execution Plan, Garfield Avenue Group (Revision 1)*, dated October 16, 2017 (AECOM, 2017j).

7.3 Total Remedial Action Cost

PPG's total remediation cost for implementation of the RA at AOC ASM-1 was estimated at approximately $7 million. This includes costs for: RI, engineering, demolition, excavation and backfilling, air monitoring, construction management, groundwater management and treatment, waste transportation and disposal, and overall project management and reporting.

7.4 Documentation of Waste Generation and Disposal

The approximate in-place volume of soil excavated from ASM AOC ASM-1 and disposed of off site is estimated at 8,400 cubic yards (approximately 12,600 tons assuming a soil density of 1.5 tons per cubic yard), based on the limits of excavation.

Waste manifests and bills of lading (BOLs) for the time period during which ASM was excavated are included in **Appendix H** (Hazardous Waste Disposal Documentation) and **Appendix I** (Non-Hazardous Waste Disposal Documentation), respectively.

ASM AOC ASM-1A was excavated concurrently with portions of Site 133 East and Site 135. During this phase of work, waste manifests and BOLs were tracked by sets of one to four grids. Loads that were from grids or sets of grids located only on Site 133 East or Site 135 are only included in the Site 133 East and Site 135 RAR. Loads that were removed from grids or sets of grids that straddle the ASM and Site 133 East or Site 135 boundaries are included in both RARs; as such, the total weight of the excavated soil according to the waste manifests and BOLs (21,070 tons) exceeds the weight estimated from the limits of excavation from ASM AOC ASM-1.

Other materials generated as a result of the RA activities at ASM included contaminated concrete and debris, demolition debris, and groundwater treatment plant sludge.

The following facilities were used for the off-site disposal of waste materials generated during RA activities at ASM:

Hazardous Waste Materials

- Stablex Canada, Inc., Blainville, Québec, Canada;
- Environmental Quality Company (EQ) - Michigan Disposal Waste Treatment Plant, Belleville, Michigan;
- EQ Envirite of Pennsylvania, Inc., York, Pennsylvania; and/or
- Clean Earth of North Jersey (CENJ) treatment, storage, and disposal facility (TSDF), Kearny, NJ.

Non-Hazardous Solid Waste Materials

- Cumberland County Improvements Authority Landfill, Deerfield Township, NJ; and/or
- CENJ TSDF, Kearny, NJ.

Non-Hazardous Liquid Waste (Water)

- Groundwater was pre-treated through the on-site treatment plant and discharged to the public sewer system (conveyed via the JCMUA system) to the Passaic Valley Sewerage Commission (PVSC) Wastewater Treatment Plant, Newark, NJ for final treatment and discharge. Prior to November 7, 2017, the groundwater treatment plant was located on Site 114 and operated under the PVSC Sewer Use Permit #31630010 (included in **Appendix C**). After November 9, 2017, the on-site treatment plant was relocated to Site 137 under the PVSC Sewer Use Permit # 31630035 (**Appendix C**). Between November 8 and 10, 2017, some liquid waste was transported directly to PVSC for treatment and disposal because the on-site treatment system was not yet operating at full capacity following the relocation of the plant from Site 114 to Site 137. A total of 27 loads (containing approximately 6,000 to 7,000 gallons each) were transported to PVSC during this timeframe. The liquid waste BOLs for this time period are included in **Appendix I**.

Copies of fully executed manifests, BOLs, and certificates of disposal documenting the off-site transport of waste material are presented in the following appendices:

- **Appendix H** – Hazardous Waste Disposal Documentation. This appendix includes fully executed manifests and certificates of disposal (if provided) documenting the off-site transport of hazardous soil, sludge, concrete, and other debris, such as scrap metal.
- **Appendix I** – Non-Hazardous Waste Disposal Documentation. This appendix includes BOLs documenting the off-site transport of non-hazardous soil, concrete, demolition debris, and sludge and liquid waste. Demolition debris that was classified as general refuse was not tracked and is not included.

7.5 Documentation of Source, Type, Quantities, and Location of Fill

Licensed quarry material was utilized for backfill and restoration and consisted of ¾-inch open grade stone (OGS) and DGA supplied by Tilcon (from their licensed mine facilities at 625 Mt. Hope Road, Wharton, NJ and Broad Street, Pompton Lakes, NJ), a licensed quarry facility permitted to operate as a commercial quarry by NJDEP.

To meet the minimum requirements of the NJDEP TRSR (NJDEP, 1993b) at the time of the ASM activities, the sources of imported fill were certified by the supplier as clean from a virgin source, based on their knowledge of the place of origin and history. In accordance with Field Change Notification #16A dated July 24, 2015, each quarry, on an annual basis, was required to provide its License (Mining Certificate) and Annual Certification that the material was from a clean, virgin source with analytical results provided by the quarry/mine in accordance with NJDEP's *Fill Material Guidance for SRP Sites* (NJDEP, 2015).

The concentrations of the analytes in samples collected from the quarry material were less than the NJDEP RDCSRS and the quarry material did not pose a potential impact to groundwater (per NJDEP's *Fill Material Guidance for SRP* Sites [NJDEP, 2015]), indicating that the material was acceptable for on-site use.

In addition, AECOM implemented a stringent visual inspection process, by on-site AECOM personnel, to verify the quality of the backfill. Visual inspection criteria included the size of the individual stones, the presence of foreign debris, the ratio of fines in the material, and significant differences in color.

A list of the quarry material load reports is provided in **Appendix J-1** and the analytical reports, mine certificates, and annual certifications are provided in **Appendix J-2**.

7.6 Identification of Required Permits and Authorizations

The permits and approvals needed for the RA at ASM are listed below:

- SESCP approvals from Hudson-Essex-Passaic County Soil Conservation District.
- Notice of Non-Applicability, Discharge to Surface Water General Permit for Construction Activity - Stormwater (5G3) NJDEP, Division of Water Quality.
- Flood Hazard Area Individual Permit for GA Group and Flood Hazard Area Individual Permit Modification, NJDEP, Division of Land Use Regulation.
- Water Use Registration, NJDEP, Division of Water Supply.
- Permit-By-Rule Discharge Authorization for Site-wide FerroBlack®-H Backfill Amendment, NJDEP, Site Remediation Program.
- Community Right-to-Know Survey for 2017, NJDEP.
- PVSC Sewer Use Permit #31630010 (Site 114 groundwater treatment plant).
- PVSC Sewer Use Permit # 31630035 (Site 137 groundwater treatment plant).

The necessary permits were obtained from and approved by the state, local, and county agencies prior to initiation of the activities covered by the permits. Necessary permits and approvals are documented in **Appendix C**.

Local permits that are not included in **Appendix C** include: local road closure and street opening permits (which were renewed approximately every 6 months), and the demolition permit (Permit Number 2017-2358).

8.0 Receptor Evaluation Update

The purpose of a receptor evaluation (RE) 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, REs 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.

The *Receptor Evaluation Report, Rev. 3, Non-Residential Chromate Chemical Production Waste Sites 114, 132, 133, 135, 137, 143 and 186 Jersey City, New Jersey,* dated March 20, 2012, was submitted to the NJDEP on March 23, 2012 (AECOM, 2012c). The Final Garfield Avenue Group RE/Ground Water RE/Baseline Ecological Evaluation Reports were submitted to the NJDEP on July 22, 2013. The updated RE form and required attachments are provided with this RAR.

9.0 Conclusions and Recommendations

9.1 Soil

This RAR documents that the soil RA for AOC ASM-1 is effective in protecting public health and safety and the environment and remedial objectives have been achieved as follows:

- Excavation of soil containing Cr^{+6} met the requirements specified in the Chromium Policy (NJDEP, 2007) in accordance with the Method to Determine Compliance (NJDEP, 2013). (Note that Cr^{+6} at concentrations that do not meet the Chromium Policy in accordance with the Method to Determine Compliance remain in place beyond the eastern extent of AOC ASM-1 and will be addressed separately as part of Pacific Avenue.)
- Soil concentrations for CCPW metals are in compliance with the CrSCC or SRS.
- Soil concentrations for CCPW metals in the unsaturated zone are in compliance with the DIGWSSLs and the site-specific IGWSRS-GAGs.

On this basis, PPG, the responsible party, has demonstrated compliance with the applicable remediation requirements for the soils in ASM AOC ASM-1, and no further action with regard to AOC ASM-1 is needed. PPG requests the closure of AOC ASM-1 by the NJDEP through the issuance of a Consent Judgment Compliance Letter.

9.2 Groundwater

This RAR only addresses the RA of soil at ASM (AOC ASM-1). CCPW and MGP-impacted groundwater within the GA Group Sites is being tracked under the Site 114 PI Number G000005480. The status of the GA Group Sites groundwater contamination and plans for groundwater RA are documented in the *Groundwater Remedial Investigation Report, Draft*, submitted on October 1, 2018 (AECOM, 2018d). A separate RAR will be prepared and submitted to document the groundwater RA at the GA Group Sites.

10.0 References

AECOM, 2009. *Remedial Investigation Report – Non-Residential Chromate Chemical Production Waste Sites, Sites 114, 132, 133, 135, 137, and 143*. December 2009.

AECOM, 2010a. *Field Sampling Plan – Quality Assurance Project Plan PPG Non-Residential and Residential Chromium Sites, Hudson County, New Jersey*. June 2010.

AECOM, 2010b. *Revision of the Air Monitoring Workplan for Ground Intrusive Activities at the Garfield Avenue Site in Jersey City, New Jersey* (AMP) and applicable AMP Amendments (28, 30, and 31). December 2010.

AECOM, 2011a. *Soil Remedial Investigation Work Plan – Sites 114, 132, 133, 135, 137, 143 and Site 186*. March 2011.

AECOM, 2011b. *Draft Remedial Investigation Report – Soil Garfield Avenue Group Non-Residential CCPW Sites 114, 132, 133, 135, 137, 143 and 186*. November 2011.

AECOM, 2012a. *Remedial Investigation Report – Soil Garfield Avenue Group Non-Residential CCPW Sites 114, 132, 133, 135, 137, 143 and 186*. February 2012.

AECOM, 2012b. *Technical Execution Plan, Southwestern Area Soil Excavation; PPG Site 114 – Garfield Avenue, Jersey City, New Jersey*. March 9, 2012.

AECOM, 2012c. *Receptor Evaluation Report, Rev. 3, Non-Residential Chromate Chemical Production Waste Sites 114, 132, 133, 135, 137, 143 and 186 Jersey City, New Jersey*. March 20, 2012.

AECOM, 2012d. *Draft Remedial Action Work Plan (Soil), Rev. 2, Garfield Avenue Group – Sites 114, 132, 133, 135, 137 and 143, Jersey City, New Jersey*. April 17, 2012.

AECOM, 2012e. *Final Technical Execution Plan, Southwestern Area Soil Excavation, PPG Site 114 – Garfield Avenue, Jersey City, New Jersey*. April 23, 2012.

AECOM, 2014. *Draft Remedial Action Work Plan (Soil) Rev. 3, Garfield Avenue Group – Sites 114, 132, 133, 135, 137 and 143, Jersey City, New Jersey*. December 5, 2014.

AECOM, 2017a. Memorandum entitled *Al Smith Moving Property - Proposed Terminal Excavation Elevations Submittal.* January 31, 2017.

AECOM, 2017b. *Progress Report for Groundwater Pilot Study and FerroBlack®-H Amended Backfill Permits-By-Rule - 2016 Fourth Quarter (October to December)*. February 2017.

AECOM, 2017c. *Technical Execution Plan, Al Smith Moving Property - Soil Excavation, Jersey City, New Jersey. March 1, 2017*

AECOM, 2017d. Memorandum entitled *Al Smith Moving Property - Proposed Terminal Excavation Elevations Submittal (Revision 1).* March 31, 2017.

AECOM, 2017e. Email RE: *RE: ASM-006: Al Smith Moving Property – Proposed TEE Submittal*. May 3, 2017.

AECOM, 2017f. *Technical Execution Plan (Revision 1), Al Smith Moving Property - Soil Excavation, Jersey City, New Jersey.* May 12, 2017.

AECOM, 2017g. Email RE: *ASM-007: Al Smith Moving Technical Execution Plan Submittal*. June 2, 2017.

AECOM, 2017h. *Restoration Technical Execution Plan, Garfield Avenue Group (Revision 1)*. August 2017.

AECOM, 2017i. Memorandum entitled *Response to NJDEP/Weston's Comments on PPG's ACO/JCO Parameters List (Revision 0)*. October 2, 2017.

AECOM, 2017j. Memorandum entitled *Response to NJDEP/Weston's 08/31/17 Comments and the City of Jersey City/ERFS's 09/12/17 Comments on the Restoration Technical Execution Plan, Garfield Avenue Group (Revision 1)*. October 16, 2017.

AECOM, 2017k. *Capillary Break Design Final Report (Revision 2)*. December 2017.

AECOM, 2018a. *Final Remedial Action Work Plan (Soil) Rev. 3, Garfield Avenue Group Sites, Jersey City, New Jersey*. May 15, 2018.

AECOM, 2018b. *Supplemental Soil Remedial Investigation Report, Final Revision 1, PPG Garfield Avenue Group, Hudson County Chromium Sites, Jersey City, New Jersey*. August 30, 2018.

AECOM, 2018c. *Final Remedial Action Work Plan (Soil) Rev.4, Garfield Avenue Group Sites, Jersey City, New Jersey*. September 27, 2018.

AECOM, 2018d. *Groundwater Remedial Investigation Report, Draft*. October 1, 2018.

AECOM, 2018e. *Caven Point Avenue and Pacific Avenue Delineation Data Package.* October 4, 2018.

AMEC, 2014. *Remedial Investigation Report Former Halladay Street Gas Works Jersey City, New Jersey*. May 2014.

City of Jersey City, 2009. *Canal Crossing Redevelopment Plan*. Division of City Planning. January 28, 2009.

CMX, 2007. *Remedial Investigation Report, Former Halladay Street Gas Works, Jersey City, New Jersey*. December 2007.

CMX, 2008. *Remedial Investigation Report Addendum, Supplemental Offsite Soil Sampling, Former Halladay Street Gas Works, Jersey City, New Jersey*. July 2008.

ENSR, 2003. *Remedial Investigation Work Plan - Site 114*. April 2003.

ENSR, 2006a. *Remedial Investigation Report - Site 114*. March 2006.

ENSR, 2006b. *Remedial Investigation Work Plan – Site 114 (Off Site)*. March 2006.

ENSR, 2006c. *Remedial Investigation Work Plan – Sites 132, 133, 135, 137 and 143*. September 2006.

ERFS, 2018a. Email RE: *City Comments to GAG-002: FINAL Remedial Action Work Plan (Soil) Rev. 3, Garfield Avenue Group Sites*. August 21, 2018.

ERFS, 2018b. Email RE: *GAG-002: Final Remedial Action Work Plan (Soil) Rev. 4, Garfield Avenue Group Sites*. October 10, 2018.

NJDEP, 1981. N.J.A.C. 7:18 - *Regulations Governing the Certification of Laboratories and Environmental Measurements*. Adopted effective August 6, 1981. Readopted effective October 23, 2013. Last amended September 4, 2018.

NJDEP, 1990. *Administrative Consent Order*. July 19, 1990.

NJDEP, 1993a. N.J.A.C. 7:26C – *Administrative Requirements for the Remediation of Contaminated Sites*. Adopted effective May 17, 1993. Readopted July 11, 2018. Last amended August 6, 2018.

NJDEP, 1993b. N.J.A.C. 7:26E – *Technical Requirements for Site Remediation*. Adopted effective June 7, 1993. Most recently readopted May 7, 2012. Last amended August 6, 2018.

NJDEP, 2001. N.J.A.C. 7:9D – *Well Construction and Maintenance; Sealing of Abandoned Wells*. Adopted effective September 4, 2001. Readopted effective January 31, 2014. Last amended January 2, 2018.

NJDEP, 2002. NJDEP Office of Data Quality *SOP 5.A.16, Rev 1 Quality Assurance Data Validation of Analytical Deliverables for Inorganics (based on USEPA SW-846 Methods)*. May 2002.

NJDEP, 2005. NJDEP *Field Sampling Procedures Manual*. August 2005, Last updated April 2011.

NJDEP, 2007. NJDEP Memorandum from Lisa P. Jackson to Irene Kropp, Subject: *Chromium Moratorium*. February 8, 2007.

NJDEP, 2008a. N.J.A.C. 7:26D – *Soil Remediation Standards*. Adopted effective June 2, 2008. Readopted effective April 27, 2015. Last amended September 18, 2017.

NJDEP, 2008b. NJDEP *Chromium Soil Cleanup Criteria*. September 2008, revised April 2010.

NJDEP, 2009. NJDEP Office of Data Quality *SOP 5.A.10, Rev 3 SOP for Analytical Data Validation of Hexavalent Chromium – for USEPA SW-846 Method 3060A, USEPA SW-846 Method 7196A and USEPA SW-846 Method 7199*. September 2009.

NJDEP, 2012a. Letter from Thomas J. Cozzi to M. Michael McCabe, Subject: *Technical Execution Plan – Southwestern Soil Excavation PPG Site 114 - Garfield Avenue, Jersey City, New Jersey*. March 27, 2012.

NJDEP, 2012b. Letter from Thomas J. Cozzi to M. Michael McCabe, Subject: *Remedial Action Work Plan (Soil), Rev. 2, Garfield Avenue Group – Sites 114, 132, 133, 135, 137 and 143, Jersey City, New Jersey*. May 11, 2012.

NJDEP, 2012c. *Technical Guidance for the Attainment of Remediation Standards and Site-Specific Criteria*. September 2012.

NJDEP, 2013. Letter from Thomas Cozzi to M. Michael McCabe, Subject: Re: *Updated Method to Determine Compliance with the Department's Chromium Policy, Garfield Avenue – Sites 114, 132, 133, 135, 137, and 143, Jersey City, NJ*. August 13, 2013.

NJDEP, 2015. *Fill Material Guidance for SRP Sites Version 3.0.,* April 2015.

NJDEP, 2016. Memorandum from Diane Groth to David Doyle, Subject: *PPG Garfield Avenue Group Sites, Adjacent Streets and Nearby Properties, Jersey City, NJ: Alternative Soil Remediation Standard for Vanadium*. December 28, 2016.

NJDEP, 2018a. Letter from Wayne C. Howitz to Ronald J. Riccio Esq., Subject: *Supplemental Soil Remedial Investigation Report – Soil, Garfield Avenue Group Non-Residential Chromate Chemical Production Waste Sites - 114, 132, 133, 135, 137, 143, and Adjacent Properties and Roadways, Final Revision 1, PPG Garfield Avenue Group, Hudson County Chromium Sites, Jersey City, New Jersey*. October 22, 2018.

NJDEP, 2018b. Letter from Wayne C. Howitz to Ronald J. Riccio Esq., Subject: *Remedial Action Work Plan (Soil) Rev. 4, Garfield Avenue Group Sites, Jersey City, Hudson County, New Jersey*. November 9, 2018.

Riccio, 2019. Letter from Ronald J. Riccio to The Honorable Jeffrey R. Jablonski, P.J. Ch., Subject: *PROGRESS REPORT (August 1, 2018 through the date of this Report): New Jersey Department of Environmental Protection, et al. v. Honeywell International, Inc., et al. v. City of Jersey City, et al., Superior Court of New Jersey, Chancery Division, Hudson County, Civil Action No. HUD-C-77-05; Partial Consent Judgment Concerning the PPG Sites (the "JCO").* January 24, 2019.

Stanford, S.D., 1995. *Surficial Geology of the Jersey City Quadrangle, Hudson and Essex Counties, New Jersey*. Department of Environmental Protection, Division of Science and Research, New Jersey Geological Survey. 1995.

Superior Court of New Jersey Law Division – Hudson County, 2009. *Partial Consent Judgment Concerning the PPG Sites*. New Jersey Department of Environmental Protection and the Administrator of the New Jersey Spill Compensation Fund, Plaintiffs, v. Honeywell International, Inc., Occidental Chemical Corporation and PPG Industries, Inc., Defendants, v. City of Jersey City, Jersey City Municipal Utilities Authority, Jersey City Incinerator Authority, and New Jersey Turnpike Authority, Third Party Defendants. Filed June 26, 2009.

Weston, 2017a. Email RE: ASM-006: Al Smith Moving Property - Proposed TEE Submittal. March 3, 2017.

Weston, 2017b. Email RE: ASM-007: Al Smith Moving Technical Execution Plan Submittal. March 31, 2017.

Weston, 2017c. Email RE: ASM-006: Al Smith Moving Property - Proposed TEE Submittal. April 20, 2017.

Weston, 2017d. Email RE: ASM-007: Al Smith Moving Technical Execution Plan Submittal. May 25, 2017.

Weston, 2018a. Email RE: G*AG RAWP finalization*. February 28, 2018.

Weston, 2018b. Email RE: *RE: GAG-002: FINAL Remedial Action Work Plan (Soil) Rev. 3, Garfield Avenue Group Sites*. July 12, 2018.