CORRECTIVE MEASURES STUDY REPORT

TECUMSEH REDEVELOPMENT SITE
LACKAWANNA, NEW YORK

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Prepared for:

Tecumseh Redevelopment Inc.
(Site No. 915009)

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1.0 INTRODUCTION

This Corrective Measures Study (CMS) Report has been organized into two volumes: Volume 1 contains the text, tables, figures, and plates; and Volume 2 contains appendices (in electronic format). This Report represents the third major revision.

The first draft of the CMS Report was submitted to the New York State Department of Environmental Conservation (NYSDEC or Department) in December 2011 in accordance with the Corrective Measures Study Work Plan (Work Plan) incorporated into the Corrective Measures Study Order on Consent (CMS Order; File No. 03-73) between Tecumseh Redevelopment, Inc. (Tecumseh) and the NYSDEC effective June 30, 2009. In July 2012 the NYSDEC provided a substantial number of comments, requested substantial additional remedial investigations beyond those specified in the Work Plan, and requested a Comprehensive Groundwater Quality Assessment.

The second major revision of the CMS Report was submitted to the NYSDEC in October 2014 to incorporate the additional investigations, the Comprehensive Groundwater Quality Assessment, and responses to Department comments. In January 2015 a Supplement to the 2014 CMS Report was submitted to the Department evaluating alternative cover configurations for the Solid Waste Corrective Management Unit (SW-CAMU) and re-assessing localized secondary and tertiary groundwater impacts and alternative corrective measures in Groundwater Discharge Sub-Areas 2A, 2B and 3A. In December 2018, the Department submitted detailed written comments on the 2014 CMS Report and the January 2015 Supplement. Detailed responses to the Department's latest comments were submitted in February 2019, along with a commitment by Tecumseh to revise the CMS a third time, consistent with the latest comments, responses, and groundwater quality data.

1.1 Background and Property Ownership

Tecumseh purchased approximately 1,030 acres of property located along the west side of NYS Route 5, Lackawanna, New York (referred to as the Tecumseh Property or Tecumseh Site) comprising a significant portion of the former Bethlehem Steel Corporation ("BSC", "Bethlehem Steel" or "Bethlehem") – Lackawanna Facility (referred to as the former BSC Property or former BSC Site) that was the subject of an Administrative Order

on Consent entered into between Bethlehem Steel and the United States Environmental Protection Agency (USEPA), dated August 1990 (Docket No. II RCRA-90-3008(h)-0201). Figures 1-1 and 1-2 are Site regional and vicinity maps.

In 2001, Bethlehem Steel filed for bankruptcy protection. In April 2003, Tecumseh, then a wholly-owned subsidiary of International Steel Group (ISG), acquired the Tecumseh Property pursuant to an Asset Purchase Agreement (APA) that was approved by the United States Bankruptcy Court for the Southern District of New York (Case Nos. 01-15288 (BRL) through 01-15302, 01-15308 through 01-15315 (BRL), Jointly Administered) in an "Order Authorizing (I) Sale of Certain of Debtors' Assets Free and Clear of Liens, Claims, and Encumbrances…" (the "Bankruptcy Order"). Tecumseh thereafter voluntarily assumed certain of Bethlehem Steel's obligations under the 1990 Administrative Order On Consent to complete the RFI at the Tecumseh Property.

Tecumseh, however, is not the owner of several portions of the former BSC Lackawanna Facility that were included in the scope of the 1990 USEPA Order. All the manufacturing operations formerly owned by BSC on the east side of NYS Route 5 are now owned in part by Great Lakes Industrial Development (former Hot and Cold Rolling Mills), Metalico (former Galvanizing Mill) and Republic Engineered Products, Inc (former Bar Mill). Approximately 232 acres of property on the west side of NYS Route 5 were sold by BSC prior to the April 2003 APA and that, upon information and belief, are currently owned by Gateway Trade Center, Inc. (including the Gateway Metroport Canal and surrounding lands that serve as the Port of Buffalo) and Genesee & Wyoming, Inc. (rail yard). In 2012, Tecumseh Redevelopment Inc., now a wholly-owned subsidiary of ArcelorMittal USA Inc., sold an approximately 45-acre parcel to Welded Tube USA. In 2017, Tecumseh sold approximately 147 acres along the eastern portion of the property in Business Park Phases I and II to the Buffalo and Erie County Industrial Land Development Corporation (ILDC) following partial or complete cleanup under the New York State Brownfield Cleanup Program (BCP). Tecumseh is also in the process of completing the sale and transfer of an additional approximately 90 acres in Business Park Phase II to ILDC as well as Parcels III-2, III-4 and III-9 totaling approximately 44 acres to other private entities associated with the development of solar electric generation facilities. Figure 1-3 shows the former BSC-Lackawanna Facility and current ownership of subparcels.

1.2 RCRA Facility Investigation (RFI)

Under terms of the 1990 USEPA Order, Bethlehem Steel agreed to perform a RCRA Facility Investigation (RFI) to identify the nature and extent of any release(s) of hazardous constituents from 104 Solid Waste Management Units (SWMUs). The potential impacts on water and sediment quality in six surface water bodies (watercourses) located on or adjacent to the former BSC-Lackawanna Facility were also to be addressed in the RFI. As the RFI Report was incomplete when Tecumseh acquired (most of) the former BSC-Lackawanna Facility in 2003, Tecumseh immediately initiated efforts to expeditiously complete the RFI. The Final RFI Report (dated October 2004) submitted to USEPA in January 2005 (Ref. 1) recommended 38 SWMUs and three watercourses (i.e., Smokes Creek, Blasdell Creek, and the South Return Water Trench) for further evaluation with a Corrective Measures Study (CMS). In a letter dated May 17, 2006, USEPA identified five additional SWMUs and two additional watercourses for further evaluation in the CMS. All other SWMUs identified by USEPA in the 1990 Order were determined by USEPA to require no further assessment as they did not pose a significant potential risk to public health or the environment. In August 2006, USEPA deemed the provisions of the 1990 Order to be satisfied and Tecumseh's obligations under the 1990 Order terminated.

1.3 Site History, Use, and Associated SWMUs

The former BSC-Lackawanna Facility was used for iron and steel production since the beginning of the 20th century. Steel-making operations were discontinued by the end of 1983 and by the mid-1990s most of the steel-making facilities on the west side of Hamburg Turnpike (NYS Route 5) had been demolished. In September 2001, BSC's coke oven operation was terminated leaving only a Galvanized Products Division operating by BSC on the east side of NYS Route 5. Galvanizing and cold-rolling operations located on the east side of NYS Route 5 were acquired by ISG pursuant to the asset purchase agreement that was approved by the Bankruptcy Court in April 2003. ISG subsequently merged first with Mittal Steel USA and later with Arcelor Steel Corporation to become ArcelorMittal USA (ArcelorMittal), the current parent corporation of Tecumseh.

The Galvanizing and Cold Mills were operated by ArcelorMittal-Lackawanna through March 2009 when production ceased. The Mills were subsequently decommissioned with complete shutdown of all operations October 1, 2009. In December 2010, all ArcelorMittal

Lackawanna property related to the Galvanizing and Cold Rolling Mills east of NYS Route 5 was sold to Great Lakes Industrial Development, LLC (GLID). Tecumseh and ArcelorMittal have never operated any manufacturing or waste treatment, storage, or disposal (other than remediation operations) at the Tecumseh Site; generated any wastes at the Tecumseh Property; or disposed any hazardous or solid wastes at the Tecumseh Property.

As shown on Figure 1-4 and Plate 1-1, the Tecumseh Property can generally be subdivided into the following sub-parcels based on former manufacturing operations, historic, current, and planned uses:

- Slag Fill Areas (SFA) (approx. 379 acres, excluding Steel Winds I & II, Coal & Ore Handling, and former Petroleum Bulk Storage and Coke & Coke By-Products Plant)
- Steel Winds I (approx. 29 acres)
- Steel Winds II (approx. 14 acres)
- Coal, Coke and Ore Handling and Storage Area (approx. 137 acres)
- Former Petroleum Bulk Storage (Tank Farm) Area (approx. 68 acres)
- Former Coke Plant and By-Products Facilities (approx. 45 acres)
- Business Park Phases I, IA, II, and III (approx. 405 acres combined, including the approximately 326 acres sold to others)
- Watercourses on or adjacent to the Tecumseh Property

Each of the above sub-parcels that comprise the Tecumseh Property as well as the separate former Lackawanna Galvanizing Division property east of Route 5 is further described below.

1.3.1 Slag Fill Area

Bethlehem Steel Company and predecessor companies initial steel-making facilities were built along the Lake Erie shoreline in the City of Lackawanna and Town of Hamburg. During the time of BSC's integrated steel-making operations, the facility and operating lands were extended into Lake Erie by placing blast furnace iron-making slag as well as open hearth furnace and basic oxygen furnace steel-making slag along the shoreline. As a result, approximately 672 acres of man-made historical filled land were authorized by New York State and the United States Army Corps of Engineers (USACE) to be placed into Lake Erie

and deeded to BSC and predecessors under a series of land patent grants (an in some instances time extensions to complete the required filling) from circa 1900 until 1968. Large portions of the man-made lands were used for coal, ore, and petroleum handling and storage; steel, coke and by-products manufacturing; and most recently for wind energy development. The remaining otherwise undeveloped portion (379 acres) of the man-made historical fill area along the lakefront is herein referred to as the Slag Fill Area (SFA). This land filling activity was conducted in an area of the lake that had already included two Federal dumping grounds used for the disposal of contaminated USACE dredge spoils and other materials from the Buffalo Harbor, Buffalo River, and Black Rock Canal by the USACE and possibly others (see Section 4.2 for additional details). Figure 1-4 shows the location of the SFA.

Bethlehem Steel records and aerial photographs from 1938 to the present indicate that the SFA was also historically used by Bethlehem Steel for the management of solid wastes and disposal of miscellaneous fill materials, including sludge from wastewater treatment plants; sludge, dust, and liquids from iron-making, steel-making, steel-forming, steel-finishing, and coke-making operations; dredge spoils from Smokes Creek; and construction and demolition debris from Bethlehem Steel's former operations and structures at the Site. As shown on Figure 1-4, five SFA zones have been designated. Slag in southernmost SFA Zone 1 contains predominantly iron-making or blast furnace slag that has been reclaimed for beneficial use as a building aggregate. There are no SWMUs requiring further assessment in SFA Zone 1. Iron slag reclamation in SFA Zone 1 was discontinued on a commercial scale in 2006 as removal was substantially completed to elevations generally at or below 585 feet North American Vertical Datum 1988[1] (<10 feet above Lake Erie mean water level). SFA Zone 2, the elevated fill area located adjacent to the south bank of Smokes Creek, contains 13 SWMUs that required further assessment in the CMS. Several of the Zone 2 SWMUs contain large quantities of mill scale that may potentially be reclaimed as a raw material for steel making. Although Agitator Sludge SWMU S-24 is not within Zone 2 (see Figure 1-4), the waste materials identified within this unit are similar to the materials

[1] All elevations in this report are referenced to the North American Vertical Datum 1988 unless specified otherwise.

placed within the Acid Tar Pits (ATP) SWMUs S-11 and S-22; therefore, SWMUs S-11, 22 & 24 are referred to collectively as the "ATP SWMU Group" and are all included within Zone 2 discussions below. SFA Zones 3, 4, and 5 located north of Smokes Creek contain predominantly steel-making (BOF) slag that is being reclaimed for beneficial reuse (from areas outside the boundaries of the SWMUs). Appendix A of the CMS Work Plan (Ref. 2) includes the Beneficial Use Determination (BUD) approvals for the Tecumseh Site. There are 11 SWMUs in Zones 3 and 4 that required further assessment in the CMS.

1.3.2 Steel Winds I

SFA Zones 3, 4 and 5 also contain an approximate 29-acre parcel that was leased to BQ Energy, LLC in 2006 for the development as a wind energy facility (also referred to as Steel Winds I) under a Brownfield Cleanup Agreement (BCA) with the New York State Department of Environmental Conservation (NYSDEC). Steel Winds I contains eight wind turbines with a combined nominal electric generation capacity of 20 megawatts (MW). There are no SWMUs on this parcel that require further assessment in the CMS. The investigation and remediation of this parcel was completed under the NYSDEC Brownfield Cleanup Program (BCP). NYSDEC issued a Certificate of Completion (COC) for the Steel Winds I leased parcel on December 18, 2007 and groundwater monitoring continues in accordance with the Site Management Plan.

1.3.3 Steel Winds II

In May 2011, Tecumseh entered into a lease agreement with First Wind to develop an additional five wind turbines on the Tecumseh Site along the waterfront. One of the Steel Winds II wind turbines was constructed in SFA Zone 5, four in SFA Zone 1, and one immediately south of the Tecumseh Property on Gateway Trade Center property. Overhead electrical power lines and poles from these wind turbines cross Tecumseh Property to transmit the power into the regional utility grid.

1.3.4 Coal, Coke, and Ore Handling & Storage Sub-Area

The Coal, Coke, and Ore Handling & Storage Sub-Area (also referred to as the coal storage field) covers approximately 137 acres and is located immediately east of Highway #11 and west of the former Coke Plant. The northern end of the coal storage field contains

two SWMUs (S-19 & S-25) that required further assessment in the CMS. Approximately 20 acres of the northern end of the coal storage field and adjacent coal handling facilities (i.e., thaw shed, car dumper, rail lines, and maintenance garage) are currently licensed by Tecumseh to South Buffalo Railway for intermodal (rail to truck) handling and storage of coal.

Approximately 40 acres at the southern end of the coal storage field was licensed by Tecumseh to Erie County for short-term emergency storage and processing of wood debris and wood chips generated from the massive cleanup after the October 2006 snow storm. That license was transferred to Zoladz Construction who continues to process wood debris to produce wood fuel and landscaping mulch.

1.3.5 Former Petroleum Bulk Storage Sub-Area

Located immediately south and east of the Coal, Coke, and Ore Handling & Storage Area is the former Petroleum Storage Area and surrounding lands that cover approximately 68 acres (see Figure 1-4). This area formerly contained large aboveground steel storage tanks, pipelines, and a pump station that stored and conveyed petroleum products used throughout the former steel and coke manufacturing facilities. Some tar and coke plant by-products may have been stored or mixed by BSC with the petroleum in these tanks or pipelines. This area contains three SWMUs (P-8, P-74, and P-75) that required further assessment in the CMS. Many of the tanks were removed by BSC and all remaining aboveground storage tanks (ASTs) were removed by Tecumseh following appropriate treatment and disposal of their contents.

1.3.6 Former Coke Plant and By-Products Facility Sub-Area

The former Coke Plant and associated coke by-products manufacturing facilities occupy approximately 45 acres along the western side of the Gateway Metroport Ship Canal. There are 15 SWMUs that required further assessment on this portion of the Tecumseh property.

1.3.7 Business Park Phases I, IA, II, & III

Business Park Phases I, IA, II & III are planned unit developments totaling approximately 405 acres on the eastern portion of the Site along Hamburg Turnpike (NYS

Route 5). This area of the Tecumseh Property was formerly used by BSC for steel manufacturing. The Business Park Areas of the Tecumseh Property have been substantially remediated by Tecumseh and/or others under the New York State BCP and sold or leased/licensed for varied commercial and industrial uses including lumber transloading (RSI); railroad; manufacturing (Welded Tube USA); solar electric power (Steel Sun, LLC and Steel Sun 2, LLC); Artmeier Supply; and Buffalo and Erie County Industrial Land Development Corporation (see Figure 1-3). There were no SWMUs located in the Business Parks that require further assessment in the CMS and, as such, these areas are not discussed further herein.

1.3.8 Watercourses

USEPA identified five watercourses as requiring further assessment in the CMS: Smokes Creek, Blasdell Creek, the Gateway Metroport Ship Canal, the North Return Water Trench (NRWT); and the South Return Water Trench (SRWT) (see Plate 1-1).

Smokes Creek is a natural water body that flows across the Site from east to west bisecting the Tecumseh Property and draining into Lake Erie (see Plate 1-1). Smokes Creek originates as two branches: the north branch, which drains a portion of West Seneca, Lackawanna, and Orchard Park, New York; and the south branch, which drains areas in Lackawanna and Orchard Park. The north and south branches of the Creek join in Lackawanna and become one prior to flowing under the Conrail Rail Spur, then eventually Route 5, and flowing through the Tecumseh Property to Lake Erie. Smokes Creek is classified by the NYSDEC as a Class C stream, which is defined as suitable for fish propagation and survival with water quality expected to be suitable for primary and secondary contact recreation, although private property ownership and physical impediments may limit public access for these purposes.

Blasdell Creek originates as two branches (north and south) flowing west toward Lake Erie. The two branches flow through the Metalico (former Galvanizing Plant) and Republic Engineered Products property before combining near State Route 5.

The Gateway Metroport Ship Canal (or Ship Canal), formerly known as the Lackawanna Ship Canal, is in the north central portion of the former BSC Site, west of State Route 5, and east of the Coke Oven Area. The Ship Canal and historic ore dock and storage areas were constructed between 1901 and 1903. The Ship Canal is approximately 4,000 feet

long and 200 feet wide with an average water depth of 25 to 30 feet. The Ship Canal and surrounding property was sold by BSC to Gateway Trade Center, Inc. in 1985. It was never owned or operated by Tecumseh or ArcelorMittal USA. Gateway Trade Center currently owns and operates the Ship Canal and the surrounding property, which encompasses a portion of SWMU S-26 on the northwest perimeter of the Canal (see Section 4.6.5 for a detailed description of this unit). SWMU S-26 was determined by USEPA and NYSDEC to require further assessment in the CMS.

The NRWT and the SRWT are both man-made drainage channels that originate in the area of the former 32-inch Finishing Mill (approximately 1,500 feet north of the intersection between Site Highways 2 and 7). The NRWT is located east of the Boiler House No. 3 in Business Park Phase IA and flows north across Gateway Metroport property where it discharges to the outfall located near the confluence of the Union Ship Canal and Buffalo Outer Harbor. The SRWT flows from its northern origination point approximately 5,000 feet south to its outfall discharge point in Smokes Creek.

1.3.9 Galvanizing Plant

SWMU-73 was the only solid waste management unit located within the former ArcelorMittal Lackawanna Galvanizing Plant (current Metalico Property) on the east side of State Route 5 (see Plate 1-1). This unit consists of two separate and distinct areas the Former Drum Storage Area and Flander's Field. The Former Drum Storage Area, located east of the Strip and Plate Mill Buildings in the northeast corner of the Galvanizing Plant Area, consisted of several discontinuous areas where drums were previously stored. The stored materials and upper four feet of soil/fill were removed by BSC in 1983 to construct a hydrogen gas plant at that location. Flander's Field, located south of the Galvanizing Mill, is where soil/fill excavated from the Former Drum Storage Area was subsequently placed by BSC. In March 2007, these stockpiled soil and fill materials were removed by Tecumseh as an Interim Corrective Measure (see Section 2.0 for additional detail) and therefore require no further action under the CMS.

1.4 Corrective Measures Study (CMS) Area

The portion of the Tecumseh Property addressed by the CMS is approximately 489-acres located entirely in the City of Lackawanna, New York and encompasses the 43

SWMUs and 5 watercourses identified in the RFI and/or by USEPA as requiring further assessment. Figures 1-2, 1-3, and 1-4 and Plate 1-1 graphically depict this portion of the larger Tecumseh Property hereinafter referred to as the CMS Area. An Order on Consent was executed by Tecumseh Redevelopment Inc. and the NYSDEC effective June 30, 2009 for the performance of the RCRA CMS consistent with applicable Federal and New York State regulations.

1.5 Legal Issues and Tecumseh's Limited Environmental Liability

As noted in Section 1.1, Bethlehem Steel filed for bankruptcy protection in 2001 and Tecumseh acquired the CMS Area and the larger Tecumseh Property pursuant to an APA between Bethlehem Steel and ISG that was approved by the Bankruptcy Court in April 2003. As set forth in recent communications with the NYSDEC by Tecumseh's legal representatives, including a February 19, 2019 letter from Harter Secrest & Emery LLP (Tecumseh's Legal Letter; see Appendix B), Tecumseh's position is that relevant language in the APA, the Bankruptcy Court order approving the APA, applicable RCRA statutory and regulatory provisions, pertinent case law, and the RCRA and operational history of the CMS Area serve to limit Tecumseh's environmental liability in certain key respects. Specifically, Tecumseh does not have RCRA corrective action liability beyond the obligations that it voluntarily assumed under existing orders with the NYSDEC and Tecumseh has limited liability for "off-site" contamination. Nevertheless, Tecumseh remains committed to fulfilling its obligations under the CMS Order and moving forward with implementation of final corrective measures as described in Tecumseh's Legal Letter.

Other than the following summary of pertinent background facts, this CMS Report will not address legal issues discussed at length in Tecumseh's Legal Letter.

1.5.1 RCRA History of the CMS Area

At the time of Tecumseh's acquisition in 2003, all steel-making and coke operations and all related hazardous waste storage, treatment, and disposal had been discontinued. Thus, Tecumseh never owned or operated an active RCRA hazardous waste management facility or treatment, storage or disposal facility (TSDF) as those terms are defined in Section 370.2(b) of 6NYCRR Part 370. Tecumseh is merely the present-day owner of a property that was formerly an active and operating TSDF for a brief period and had RCRA interim status

when owned and operated by Bethlehem Steel.[2] The relevant facts regarding the RCRA history of the CMS Area are summarized below.

- In November 1980, Bethlehem Steel submitted a Part A hazardous waste management facility RCRA application to the USEPA. Bethlehem Steel never received a Part B permit for the site and thus the NYSDEC maintains that portions of the property are subject to "interim status" and corrective action pursuant to the RCRA 42 U.S.C.§3901 et seq. and the regulations promulgated thereunder.
- The use and operation of the following three hazardous waste management units (HWMUs) that were the basis for Bethlehem Steel's RCRA interim status ceased long before Tecumseh acquired the CMS Area in 2003.
    - *SWMU S-13/HWMU-1A, the Tar Sludge Surface Impoundment.* This SWMU was used from circa 1978 to circa 1982. Closure and post-closure were performed by Bethlehem under a Consent Agreement with USEPA (apparently with some NYSDEC involvement), and installation of a final cover system was completed in 1988.
    - *SWMU S-16/HWMU-1B, the Lime Stabilized Waste Pickle Liquor Sludge Landfill.* This SWMU was apparently used from circa 1973 to circa 1981**.** In addition, the type of waste in this SWMU ("lime stabilized waste pickle liquor from the iron and steel industry") was delisted as a hazardous waste, on an industry-wide basis, by the USEPA in 1984. Thus, it appears that after 1984 this SWMU was no longer regulated as a RCRA HWMU and should have been eliminated from consideration as grounds for Bethlehem Steel's interim status.
    - *SWMU S-1/HWMU-2, the Ammonia Still Lime Sludge Impoundment.* Use of this HWMU presumably ceased when steel-making operations were discontinued in 1983 or perhaps earlier. In addition, the waste in this SWMU ("ammonia still lime sludge") was delisted as a hazardous waste, on a site-specific basis, by the USEPA in 1996. Thus, it appears that after 1996 this SWMU was not a regulated RCRA HWMU and should have been eliminated from consideration as grounds for Bethlehem's interim status.

[2] Thus, based on the applicable statutory and regulatory provisions and relevant case law (see *Matter of Thompson Corners, LLC v. New York State Dep't of Envtl. Conservation*, 113 A.D. 3d 81 (3d Dep't. 2014)), Tecumseh does not have RCRA corrective action obligations beyond what it has voluntarily assumed. See Tecumseh's Legal Letter for further discussion.

- In August 1990, the EPA issued to Bethlehem Steel an Administrative Order on Consent Docket, No. II RCRA 90-3008(h)-0201, pursuant to Section 3008(h) of RCRA, which required Bethlehem Steel to conduct a RCRA Facility Investigation ("RFI"). As noted above, the RFI was not completed by Bethlehem Steel.
- In October 2001, Bethlehem Steel filed for protection under the United States Bankruptcy Code. In April 2003, the Bankruptcy Court approved the sale of certain Bethlehem Steel assets, including the Tecumseh Property, to ISG pursuant to the APA. In the Bankruptcy Order approving the APA, the Bankruptcy Court found and determined that (1) ISG was a "good faith purchaser" under section 363(m) of the Bankruptcy Code; (2) transfer of Bethlehem's assets to ISG would vest ISG with all right, title, and interest in those assets "free and clear" of any other interests, claims or liens – including any claims arising under successor liability; and (3) ISG would not have entered into the APA if the assets were not transferred "free and clear" or if ISG could be liable in the future for any liabilities of debtor (i.e., Bethlehem), including environmental liabilities. Appendix A includes a copy of the Bankruptcy Order. In May 2003, ISG acquired the Tecumseh Property from Bethlehem Steel and immediately transferred the property to Tecumseh.
- As noted in Section 1.2, soon after acquiring the Tecumseh Property, Tecumseh completed the RFI that USEPA required of Bethlehem Steel pursuant to the 1990 Order on Consent. The RFI had languished for years while the property was owned by Bethlehem Steel. On January 7, 2005, Tecumseh completed and submitted the RFI to the NYSDEC and USEPA. On August 21, 2006, USEPA notified Tecumseh that the obligations under the 1990 Order on Consent had been satisfied and the Order was terminated. The results of the RFI confirmed that there had been a release of hazardous waste or constituents into the environment and that a Corrective Measures Study must be performed.
- In June 2009, Tecumseh and the NYSDEC entered into the CMS Order pursuant to which Tecumseh committed to conduct a Corrective Measures Study with respect to the 43 SWMUs and 5 watercourses identified in the RFI and/or by USEPA as requiring further evaluation. As explained in Section 1.0, starting in late 2011, Tecumseh submitted several prior versions of this CMS Report and the NYSDEC provided several rounds of comments, including most recently in December 2018.

1.5.2 Tecumseh's Voluntary RCRA Corrective Action Work

In addition to voluntarily completing the RFI and undertaking the CMS as noted above (both of which have involved significant effort over many years), Tecumseh has aggressively pursued and implemented a variety of interim corrective measures (ICMs),

expedited corrective measures (ECMs), and final corrective measures for certain watercourses, high-priority SWMUs and/or operable units (OUs) while overall remedies are being evaluated via the CMS process. Section 2 provides detailed discussions of the following high-level summary of the substantial work completed by Tecumseh to date:

1. Benzol Yard Groundwater ICM (SWMU P-11), with implemented completed by Tecumseh in 2005.
2. Galvanizing Plant Area ICM (SWMU P-73), with implementation completed by Tecumseh in January 2008.
3. Smokes Creek Lower Reach Floodway Dredge ICM, with implementation completed by Tecumseh in February 2009.
4. Five Million Gallon Storage Tank ICM, with implementation completed by Tecumseh in June 2009.
5. ATP SWMU Group Expedited Corrective Measure (SWMUs S-11, S-22 and S-24), with implementation substantially completed by Tecumseh in December 2012.
6. 30-Inch Coke Oven Gas Pipeline ICM, with implementation completed by Tecumseh in October 2015.
7. ATP SWMU Group Exterior Groundwater Corrective Measure, with implementation substantially completed by Tecumseh in October 2015.
8. Operable Units 2 and 3 (SWMUs P-18, S-18 and P-9), with implementation substantially completed by Tecumseh in September 2016.
9. Operable Unit 4 (Coke Plant By-Products SWMU Group) Groundwater Corrective Measure, with implementation substantially completed by Tecumseh in March 2019.
10. Benzol Plant Source Area Control ICM, with implementation substantially completed by Tecumseh in March 2019.

1.5.3 Tecumseh's Limited Responsibility for Off-Site Impacts

Tecumseh has limited responsibility for off-site impacts based on the provisions in the APA**,** the Bankruptcy Court order approving same**,** and relevant case law[3]. Specifically, Tecumseh's liability is limited to off-site disposal or migration, if any, that has occurred since

[3] See *Severstal Sparrows Point, LLC v. USEPA*, 794 F. Supp. 2d 624 (D. Md. 2011).

it acquired the Tecumseh Property in 2003, and Tecumseh has no responsibility for off-site environmental conditions that existed prior to its acquisition (refer to Tecumseh's Legal Letter for further discussion). Thus, the scope of any further RCRA corrective action obligations that Tecumseh voluntarily assumes, including with respect to off-site watercourses, must be consistent with its limited responsibility for off-site impacts.

2.0 ICMs, ECMs & OPERABLE UNITS

2.1 Interim Corrective Measures

Interim corrective measures (ICMs) are remedial measures that are undertaken at one or more SWMUs before or during performance of a Corrective Measures Study (CMS) in order to control or mitigate the release of hazardous constituents into the environment and/or to reduce the potential for human or biological exposure. Generally, ICMs may be implemented to affect partial and/or short-term remedies while more comprehensive corrective measures are being evaluated or as fast-tracked permanent remedies at high priority SWMUs and water bodies. Under either circumstance, the ICM is considered a valuable tool to expedite the remedial process when the need for remedial action and/or the remedy selection is readily apparent. Six such ICMs have been voluntarily undertaken at the Site by Tecumseh addressing four SWMUs and one water body in accordance with individual Orders on Consent with the NYSDEC as further described below.

2.1.1 Benzol Plant ICM (SWMU P-11)

The RFI determined that groundwater quality in an approximate one to two-acre portion of the former Benzol Plant Tank Storage Area (SWMU P-11) was significantly degraded from the presence of light non-aqueous phase liquid (LNAPL) and volatile organic constituents (VOCs – primarily benzene, toluene, and xylenes) that were migrating away from the SWMU. Recognizing the need for expedient action to address this SWMU, Tecumseh voluntarily proposed and implemented a fast-tracked ICM to design, construct, and operate:

- 11 groundwater and LNAPL collection wells;
- A 30-gpm aqueous-phase treatment system;
- A 1,000-scfm gaseous-phase catalytic oxidizer;
- Two infiltration galleries to recharge treated groundwater and flush residual light oil from the shallow slag/fill.

The semi-continuous batch treatment system initially consisted of a shallow tray air stripper to remove over 99% of VOCs from the groundwater coupled to a catalytic oxidizer to incinerate the stripped VOCs from the air stream. An Order on Consent was executed by

NYSDEC and Tecumseh in November 2004 with system start-up in April 2005; the system continues to operate except for the catalytic oxidizer, the operation of which was discontinued following NYSDEC approval and construction of an elevated exhaust stack. The Benzol Plant ICM has removed over 36,000 pounds of VOCs from the groundwater (aqueous and non-aqueous phases) between 2005 and 2018, while effectively collecting, shrinking, and controlling off-site migration of the groundwater plume. All major requirements of the Benzol Plant ICM Order have been satisfied and operation, maintenance, and monitoring are on-going.

The ICMs at the Benzol Yard are being supplanted by implementation of Operable Unit No. 4 (OU-4) as a final expedited corrective measure (ECM) for the Benzol Yard groundwater and the broader roughly 27-acre Coke By-Products SWMU Sub-Area (see Section 2.3 for additional OU-4 details) that was substantially completed in March 2019. OU-4 incorporates the existing 11 Benzol Yard ICM groundwater collection wells with another 41 new groundwater collection wells in the more expansive Coke By-Products Sub-Area around the Benzol Yard and conveys the substantially higher flows to a new Groundwater Treatment Building. The OU-4 Consent Order dated September 11, 2017 terminated the Benzol Yard groundwater ICM Consent Order.

2.1.2 Benzol Plant Source Control ICM

An evaluation of source area controls was performed in the Coke By-Products Sub-Area and documented in a report by Benchmark/TurnKey dated May 2018. The Report determined that a portion of the former Benzol Plant was the only identified significant on-going source of groundwater contamination in the Coke By-Products Sub-Area and recommended a soil vacuum extraction (SVE) system be implemented to remove VOCs from the vadose and smear zones in combination with the OU-4 groundwater pumping system (to expose the smear zone) and LNAPL recovery (by skimming from selected groundwater extraction wells). The SVE system is comprised of a series of vertical extraction wells manifolded to a trailer-mounted SVE regenerative blower and other process equipment. The blower in the SVE trailer creates a negative pressure (vacuum) to accelerate vaporization of LNAPL and VOC-impacted moisture from slag/fill pores and conveyance via PVC piping to the SVE trailer from which it is directed to a biofilter for treatment prior to discharge to the atmosphere. A low-permeability geo-composite liner and vegetated soil

cover system were constructed to limit the leakage of ambient air into the system and prevent direct contact with impacted soil/fill. While Tecumseh proposed the source controls as part of the OU-4 final corrective measures, the Department approved them as a separate ICM in a Consent Order (File No. 18-23) that was executed in November 2018 with a required substantial completion date of March 2019. The SVE system is fully operational.

2.1.3 Five-Million Gallon Storage Tank ICM

A five-million gallon AST in the Former Petroleum Storage Area was used to contain approximately 350,000 gallons of wastewater that was accumulated from various process sumps, piping, vessels, and secondary containment by Bethlehem Steel and more recently by Tecumseh in conjunction with plant decommissioning activities. An Order on Consent was executed by NYSDEC and Tecumseh in March 2006 to implement an ICM to treat the contents of the AST and discharge the treated effluent to on-site groundwater; however, the ICM order expired prior to completion of treatment and discharge. Subsequently, an alternative approach, discussed with and approved by the NYSDEC Division of Water, involved transferring the pre-treated wastewater within the AST to the Galvanizing Mill process wastewater treatment facility (a.k.a. Water Quality Control Station No. 7) on the east side of Route 5 where it was combined with other Galvanizing Plant process wastewater for treatment and discharge to Smokes Creek under SPDES Permit No. NY-0001368. Transfer and treatment of the AST wastewater was concluded on March 30, 2009. Demolition and removal of the steel tank structure began in May 2009. The tank steel was cut down to 12-inch high side walls to allow containment of the residual settled solids within the tank until characterization, dewatering/solidification, and off-site transportation and disposal of the sludge at a commercial solid waste landfill could be accomplished. The (initial) demolition and off-site recycling of the steel scrap was completed by June 1, 2009. The residual settled solids remaining in the base of the tank were mixed with sawdust to eliminate all free liquids as required by the landfill. Removal of the solidified settled solids was completed on December 11, 2009. Approximately 87 tons of the solid waste were removed and disposed at the Waste Management, Inc. Chaffee Landfill. According to the NYSDEC letter in Appendix B, the objectives of this ICM Order have been satisfied and the Consent Order has been terminated.

2.1.4 Galvanizing Plant Area ICM (SWMU P-73)

SWMU P-73 is comprised of two areas; the Former Drum Storage Area and Flander's Field, both located off the Tecumseh property on the east side of Route 5 at the former ArcelorMittal Lackawanna Galvanized Products Division plant site and Republic Steel's Bar Mill (both designated as the East Plant Area) (see Plate 1-1). The Former Drum Storage Area, located immediately east of the former ArcelorMittal's Strip and Plate Mill Buildings in the northeast corner of the East Plant Area, was used to store drums. The Former Drum Storage Area is comprised of several discontinuous areas where drums were stored and is bounded by a fence on the east side and by roads along the other perimeters. All stored materials were removed from the East Plant Area in 1983. A portion of this area is currently occupied by a hydrogen gas plant (Linde Plant) constructed in 1990. The second area, Flander's Field, located south of Republic's Galvanizing Bar Mill in the southeast corner of the East Plant Area approximately 3,700 feet south of the Former Drum Storage Area, was used as a storage area for excavated soil from the Former Drum Storage Area.

SWMU P-73 (Former Drum Storage Area) was once a receiving area for raw material drummed products used by the Strip Mill Division from the late 1940s through 1983. Materials typically received were lubricants, oils, grease, soap, and chemical additives. The area also served as a transfer point for empty drums that were either returned to vendors or sent to the steel making division to be scrapped. Periodic inventories of the drums were taken; however, these inventories were not retained as permanent records. Beginning in 1982, this area was no longer used for storage as the drums were delivered directly to their respective operating areas. In 1983, outside contractors were hired to identify the contents of the drums, analyze the material if necessary, and properly dispose of the drums off-site.

In anticipation of construction of the Linde gas plant in 1989, three geotechnical soil borings were advanced to 40 fbgs within the Former Drum Storage Area. Boring logs described a thin fill (sand and slag) layer underlain by silty clay at approximately 4 to 5 fbgs. The silty, clayey, and sandy materials below the fill extended to approximately 40 fbgs and no analytical samples were collected. In 1989, the upper layer of soil/fill was excavated from the Former Drum Storage Area to make room for a foundation associated with a hydrogen gas plant. The excavated soil/fill was relocated to Flander's Field south of the Galvanizing Mill in the southeast corner of the East Plant Area where it remained in numerous small stockpiles until 2006/07.

Flander's Field sampling was conducted in May 1989, August 1989, February 1995, and December 2000 by BSC, and subsequently by Tecumseh in November 2006. Additional soil stockpile sampling was conducted in February 2007 in order to complete the analytical requirements for full waste characterization. The initial sampling events at the Former Drum Storage Area were conducted to assess and characterize the Site under the RFI program, therefore sample locations and parameters were dictated by Work Plans developed and approved by the NYSDEC specifically to meet the requirements of that program. The November 2006 and February 2007 sampling events were conducted to assess the soil for the purpose of characterizing and documenting the soil/fill constituents for disposal. Soil samples were analyzed for several compounds in addition to TCLP and SPLP. Based on the results of TCLP and SPLP testing, soil samples did not exhibit hazardous waste characteristics and the soil/fill was therefore approved for off-site disposal to a commercial sanitary landfill.

SWMU P-73 is the only SWMU on the operational portion of the former ArcelorMittal property that was recommended for further action in the approved RFI Report. In October 2006, Tecumseh proposed and NYSDEC approved an ICM to address the cleanup of this SWMU, which eliminated the need to address this singular "orphan" SWMU within the Corrective Measures Study Order. Tecumseh completed excavation and removal of 1,135 tons of soil/fill from the Flander's Field Area as an ICM in March 2007. Soil/fill was transported to Modern Landfill, a NYSDEC-permitted sanitary landfill located in Model City, New York, for disposal. A closeout report summarizing these activities was submitted to the NYSDEC in December 2007. The NYSDEC subsequently issued a letter dated January 2, 2008 (see Appendix B) stating that "No Further Action" was required for this SWMU.

2.1.5 Smokes Creek – Lower Reach Floodway Dredge ICM

Smokes Creek can be divided into two sections on the Tecumseh Site: the upper reach from Route 5 to the bridge on Site Highway 9 measuring approximately 3,900 feet; and the lower reach from the Site Highway 9 Bridge to Lake Erie measuring approximately 2,600 feet. As part of the U.S. Flood Control Act of 1960 (Public Law No. 86-645), the USACE in the 1960s undertook channel improvements in Smokes Creek from its outlet to Lake Erie across the entire nearly one mile lower reach of the Creek on the former BSC-

Lackawanna (now Tecumseh) Property and further upstream to beyond the confluence of the North and South Branches in the City of Lackawanna (see Plate 1-1). Flood improvements to the lower reach of the Creek were constructed by BSC in accordance with its Lake Erie land grants from New York State (the Land Patent Agreements), as this portion of Smokes Creek and the adjacent lands were reclaimed from Lake Erie by placement of slag/fill by BSC. BSC was obligated to maintain the flood channel along the lower reach and the NYSDEC was obligated to maintain the flood channel along the upper reach of the Creek in accordance with an Operation and Maintenance Manual issued by the USACE in May 1972. However, little if any maintenance of the flood channel was performed by either BSC or the NYSDEC since that time. Tecumseh, as successor and assign to BSC on this property, has effectively assumed the maintenance obligations for the lower reach of the Smokes Creek flood channel on Land Patent lands. Since acquiring the property in 2003, Tecumseh has periodically performed maintenance dredging at the Creek mouth or outlet at Lake Erie and clearing of woody growth from Creek banks under nationwide permits issued by the USACE.

In early 2007, the USACE determined that sediment accumulated in Smokes Creek, particularly the lower reach was reducing the hydraulic flood flow capacity and contributing to the expansion of the 100-year flood plain in the City of Lackawanna First Ward. To circumvent potential expansion of the 100-year floodplain into the City's First Ward and to fulfill Tecumseh's flood channel maintenance obligations, Tecumseh promptly submitted to NYSDEC an ICM Work Plan in May (revised September 2008) to dredge the lower reach of the Creek and restore the flood channel design elevations and cross-sectional area. Pre-dredge sampling and characterization of shallow sediments (i.e., above the floodway elevation) and bathymetric survey of the lower reach of the Creek was performed by Tecumseh in June 2007, and later in December 2007 on the upper reach. Much of the sediment contaminants detected in the lower reach of Smokes Creek is believed to have migrated from three SWMUs (i.e., the Acid Tar Pit SWMUs S-11 and S-22, and the Agitator Sludge SWMU S-24) located adjacent to the Creek (see Plate 1-1). In September 2008, the NYSDEC approved the Smokes Creek ICM Work Plan and entered an Order on Consent for Tecumseh to implement the ICM.

Tecumseh immediately implemented the ICM, beginning hydraulic and mechanical dredging in October 2008. The ICM was completed in February 2009 after approximately

42,800 cubic yards of sediment were removed and placed into the USACE's Confined Disposal Facility (CDF) No. 4 located adjacent to the northern CMS Area and Tecumseh Property boundary.

In April 2009, post-dredging surface sediment samples were collected in the lower reach of the Creek at the same 10 locations as pre-dredge sediment characterization samples. The results were transmitted to the NYSDEC in June 2009. The NYSDEC confirmed in a letter dated February 8, 2011 (see Appendix B) that Tecumseh satisfied the terms of the Smokes Creek ICM Work Plan as required by the Order on Consent and accordingly, Tecumseh's obligations under the Order were terminated.

2.1.6 30-Inch Coke Oven Gas Pipeline ICM (SWMU P-76)

A buried 30-inch diameter cast iron pipeline was identified on the Business Park-Phase III portion of the Tecumseh property (outside the CMS Area) in spring 2013 during infrastructure improvements undertaken in support of Brownfield redevelopment work by Welded Tube USA on former Tecumseh BCP Site III-7. In the summer of 2013, Welded Tube USA removed the portion of the gas line that traversed its property under its Brownfield Cleanup Agreement. In addition, an approximate 300-foot long section of the gas line was concurrently removed by Tecumseh from the CMS buffer zone located along the northern bank of the SRWT to the southern limit of a new potable water line crossing. This gas line removal work is documented in the November 2013 Final Engineering Report for the Welded Tube USA parcel (Ref. 3).

Based on the elevated levels of naphthalene and benzene[4] in condensate residuals within the pipeline, the NYSDEC determined that the residuals represent source material per 6NYCRR Part 375-1.2 and must be removed from the remainder of the Site to the extent feasible. The NYSDEC designated the remaining coke gas piping within the CMS Area as SWMU P-76. In June 2015, Tecumseh and the NYSDEC entered into an ICM Consent Order (FileNo. 14-23) for remediation of SWMU P-76 Former Coke Oven Gas Lines (Ref. 4). In October 2015, Tecumseh completed cleaning and removal of approximately 910 liner feet of underground coke gas pipelines and 200 liner feet of above-

[4] Analysis of the semi-solid residuals within the piping indicated that the material did not exceed characteristic hazardous waste criteria per 40 CFR Part 261. Analytical results are presented in Appendix A of the ICM Work Plan.

grade piping. Another 135 linear feet of underground piping and five concrete vaults were cleaned in place. The approximate 135 cubic yards of dewatered sediment removed from the pipes was consolidated into the ATP-ECM containment cell for final disposal.

2.2 Expedited Corrective Measures

Expedited corrective measures (ECMs), like ICMs, are remedial measures that are undertaken at one or more SWMUs before or during performance of a CMS in order to more promptly control or mitigate the release of hazardous constituents into the environment and/or to reduce the potential for human or biological exposure. Unlike ICMs, which may be short-term or intermediate remedies, ECMs are considered long-term final remedies. The ECM is considered a valuable tool to expedite the remedial process at high-priority SWMUs when the need for remedial action and/or the final remedy selection is readily apparent. Two ECMs have been proposed and voluntarily undertaken by Tecumseh at the Site addressing six SWMUs (SWMUs S-11, S-21, S-22, S-24, P-9 and P-18) and two AOCs (A & D) in accordance with individual Orders on Consent with the NYSDEC as further described below.

2.2.1 Expedited Corrective Measures for the ATP SWMU Group

In order to promptly mitigate the continued migration of contaminants from the Acid Tar Pit (ATP) SWMUs to Smokes Creek via groundwater discharge and surface water flow, and thereby avoid recontamination of the Creek sediment, an ECM, as presented in the April 2010 Expedited Corrective Measure Work Plan – Acid Tar Pit SWMU Group (Ref. 5), was undertaken by Tecumseh. This ATP SWMU Group was also considered a high-priority for expedited remediation due to the nature and significant quantities of the wastes deposited there. As such, and at the request of NYSDEC, a Focused CMS was completed by Tecumseh in May 2009 (Ref. 6), to evaluate remedial alternatives to address SWMUs S-11, S-22, and S-24. *Alternative 4 – Excavate SWMU S-24, Consolidate and Construct Combined In-Place ATP Containment System* was selected as the preferred remedy. The preferred remedy, as further detailed in the implementation Work Plan and design documents, called for containment system construction in three phases: Phase I – site clearing, grading, and construction of a soil-bentonite slurry wall surrounding SWMUs S-11 & S-22 and keyed into the native glaciolacustrine silty-clay confining unit; Phase II – excavation, transport, and

consolidation of the Agitator Sludge residuals from SWMU S-24 into the containment cell and placement of a multi-layer geosynthetic membrane, drainage, and vegetated soil RCRA final cover system; and Phase III – construction of a groundwater/leachate collection, pretreatment, and conveyance system. The ATP containment system physically isolates the solid SWMU waste/fill from the environment and contains the aqueous groundwater constituents immediately surrounding them by maintaining an inward hydraulic gradient. Groundwater/leachate from within the ATP containment cell is removed by several pumped wells with on-site pretreatment consisting of oil/water separation, neutralization, air stripping of volatile organic constituents, and filtration followed by sewer conveyance to the Erie County Sewer District (ECSD) No. 6 publicly owned treatment works (POTW) in Lackawanna for final biological treatment and discharge to Smokes Creek.

A Consent Order (File No. 10-09) to implement the ATP-ECM was executed by Tecumseh and the NYSDEC on May 10, 2010. Initial clearing and grading of the ATP SWMU Group Area was performed in October 2010. Phase I slurry wall construction began in April 2011, was completed in October 2011 and is documented in a June 2012 Construction Completion Report (CCR) approved by NYSDEC June 28, 2012. Slurry wall construction through the cemented slag and fill material proved extremely difficult necessitating several changes to the design, construction means and methods, and construction schedule in order to complete.

Fast-tracked construction of the Phase III groundwater collection, conveyance, and pretreatment facilities proceeded next beginning in October 2011 with substantial completion and start-up in December 2012. The change of sequencing of Phases II and III was done with NYSDEC approval to expedite the overall project implementation schedule by allowing sooner start and completion of the Phase III activities in the late fall and winter when Phase II waste consolidation and liner construction could not be performed. Earlier completion of Phase III also facilitated earlier groundwater and surface water withdrawal from within the containment cell for hydraulic control.

In April 2011, while pursuing NYSDEC approval of the ATP-ECM Phase II SWMU S-24 waste/fill consolidation and final cover system design, the concept of consolidating additional SWMU waste/fill into the ATP containment cell (see Section 2.3.2 below for additional details) was considered as a supplemental expedited corrective measure. Design details related to the concept of consolidating additional SWMU waste/fill (e.g., SWMUs P-

18 and others) into the ATP continued to be developed and discussed until the concept was approved by the NYSDEC in May 2012 as a revised "interim" cover system design that would place a final geocomposite clay liner (GCL) and low linear density polyethylene liner (LLDPE) on the side slopes of the containment cell with consolidated SWMU S-24 waste/fill leaving the top only with interim slag or soil cover. SWMU S-24 waste/fill consolidation and Phase II interim final cover construction began in July 2012 and was substantially completed in November 2012. SWMU S-24 backfill and restoration was subsequently completed in 2013. Containment cell modifications were made in the summer of 2014 to improve management of impacted storm water from within the containment cell and on-site pre-treatment.

Following NYSDEC's decision to allow consolidation of additional SWMU waste/fill into the ATP containment cell and issuance by NYSDEC of a final Statement of Basis for Operable Units Nos. 2 and 3 in June 2015, the final cover system of the ATP containment cell was implemented as part of OU-3. The final closure of the ATP containment cell was substantially completed in November 2015 and documented in the CCR for OUs-2 & -3 dated January 2016.

2.3 Operable Units

Operable Units (OUs) are a special type of expedited corrective measures. Operable Units are considered final and permanent remedial measures that are generally undertaken at one or more SWMUs prior to completion of a CMS and/or prior to implementation of a comprehensive Corrective Action Plan (CAP) in order to more promptly control or mitigate the release of hazardous constituents into the environment and/or to reduce the potential for human or biological exposure from one or more SWMUs when the need for remedial action and/or the remedy selection is readily apparent for those SWMUs. The unique aspect of this waste management policy tool is to allow the consolidation of several similar wastes, similar to the concept of a Corrective Action Management Unit (CAMU), within a single area of contamination to avoid the "generation" of wastes and related regulatory requirements under RCRA. Three such Operable Units have been proposed and implemented by Tecumseh as further described below.

2.3.1 Operable Units Nos. 1 (OU-1) / 4 (OU-4)

Tecumseh proposed Operable Unit OU-1 to address groundwater collection and treatment within two high priority SWMUs referred to as the Benzol Yard (SWMU P-11) and Old Benzol Yard (SWMU P-11A) located within the Coke Plant By-Products Facility Sub-Area. In January 2014, Tecumseh submitted to NYSDEC an Expedited Corrective Measure Work Plan (ECM) for Operable Unit OU-1 (Ref. 7). During a March 5, 2014 meeting and subsequent comment letter dated March 6, 2014, NYSDEC indicated its general concurrence with the approach "*as a high priority and as a critical component of the CMS*." The letter further commented that "*For the Department to consider this the final action for groundwater, the groundwater extraction/treatment system(s) shall be adequate to capture contaminants between SWMU P-11 and P-11A and any other source areas within the Coke Oven area and along the Gateway Metroport (Canal). Also for this to be considered a final remedy for groundwater, the source areas contained within the Coke Oven Plant Area will need to be addressed.*" During the March 14, 2014 meeting, TurnKey agreed to revise the ECM Work Plan in accordance with those comments and NYSDEC committed to determining the appropriate administrative/regulatory mechanism for approving OU-1 as a final corrective measure. A draft report by Benchmark/ TurnKey entitled *"Evaluation of Groundwater Corrective Measures – Coke Plant By-Products SWMU Group"* that assessed alternative remedial technologies, documented bench- and pilot-scale treatability studies, modeled groundwater collection and presented a preliminary remedial design to NYSDEC in May 2016. Following responses to NYSDEC comments, the Evaluation was revised and finalized in August 2016. The NYSDEC subsequently renamed OU-1 as OU-4 and issued the Statement of Basis in March 2017. A Consent Order for Coke Oven Area Groundwater Corrective Action (File No. 16-55) was executed in September 2017 calling for augmenting the existing 11 ICM groundwater pumping wells in the Benzol Yard (SWMU P-11) with an additional 14 pumping wells plus an additional 27 pumping wells in the northern portion of the OU-4 Area in and around the "Old" Benzol Yard (SWWU P-11A). The existing Benzol Yard ICM groundwater treatment system and south infiltration gallery has been decommissioned following construction and start-up of the new OU-4 groundwater treatment system in March 2019. The OU-4 groundwater treatment building contains two parallel treatment systems or "trains" with the south groundwater treatment train consisting of an oil-water separator, bag filtration and shallow tray air stripper with approximately double the flow capacity at 60-gpm maximum flow (44-gpm

modelled steady-state flow to achieve the design capture); and an independent northern groundwater treatment train with a 40-gpm maximum flow (25-gpm modelled steady-state flow) with bag filter, shallow tray air stripper plus a granular activated carbon adsorption system to treat the higher phenolic and naphthalene constituent concentrations. Both treatment trains have chemical feed for foam and scale control in the strippers, flow meters, totalizers, and programable logic control and alarm systems. Construction of the OU-4 groundwater collection and treatment system was substantially completed in March 2019 in accordance with the Order and is currently fully operational.

2.3.2 Operable Unit No. 2 (OU-2) and No. 3 (OU-3)

The ATP-ECM was implemented in a phased design-build approach during the period of July 2010 through November 2012 as follows: Phase I-Slurry Wall Containment; Phase II-Agitator Sludge Waste Consolidation and Interim Cover System; and Phase III-Groundwater/Leachate Collection, Conveyance, & Pretreatment. Fast-tracked construction of the Phase III groundwater collection, conveyance, and pretreatment facilities preceded Phase II beginning in October 2011 through substantial completion and start-up in December 2012. The change of sequencing of Phases II and III was done to expedite the overall project implementation schedule by allowing a sooner start and completion of the Phase III activities in the late fall and winter when Phase II waste consolidation and liner construction could not be performed. Earlier completion of Phase III also facilitated earlier groundwater/leachate and surface water withdrawal from within the containment cell for hydraulic control.

In April 2011, while pursuing NYSDEC approval of the ATP-ECM Phase II SWMU S-24 waste/fill consolidation and final cover system design, the concept of consolidating additional compatible waste/fill from certain other CMS Area SWMUs into the ATP was first proposed by Tecumseh to be implemented as an expedited corrective measure. Design details related to the concept of consolidating additional SWMU waste/fill (e.g., SWMUs P-18, S-18, P-9 and P-76) into the ATP continued to be developed and discussed as Operable Unit Nos. 2 and 3.

Operable Unit No. 2 consists of the stabilization and removal of the waste/fill from SWMUs P-9, P-18 and S-18, the transportation and consolidation of those stabilized wastes into the ATP containment cell, and the installation of a groundwater collection system

external to the ATP-ECM containment cell to remediate the groundwater contamination that had migrated from SWMUs S-11 and S-22 prior to implementation of the ATP-ECM slurry wall containment.

In addition to the wastes consolidated into the ATP (described above), a beneficial use determination (BUD) was submitted to and approved by the NYSDEC for the wastes in SWMU S-21 and from sediments in the South Return Water Trench to be used as interim cover in the ATP (NYSDEC approval letter dated June 14, 2012). The entire waste pile from SWMU S-21 was removed and reused as interim cover. Additionally, approximately 570 CY of sediments from the SRWT were removed from the area where the East Harbor Lead railroad tracks cross the SRWT (approximately 200 feet long by 26 feet wide by 3 feet deep) of the SRWT had the sediments removed for the installation of a culvert pipe for the crossing. These sediments were used also as interim cover.

Operable Unit No. 3 consists of the completion of the multi-layer final cover system over the consolidated waste/fill in the center of the ATP containment cell. SWMU S-24 waste/fill consolidation and Phase II interim final cover construction began in July 2012 and was substantially completed in November 2012. Containment cell modifications were made in the summer of 2014 to improve management of impacted storm water from within the containment cell and on-site pre-treatment.

Benchmark prepared an engineering report for the consolidation of the additional SWMU wastes from S-18, P-9 and P-18 in October 2014. This engineering report and subsequent revisions resulted in the NYSDEC issuing an Explanation of Significant Differences dated May 2015 allowing the ATP-ECM Order (File No. 10-9) to be Amended to include OU-2 and OU-3. The "*Final Statement of Basis Corrective Measures Selection Operable Unit No. 2- Solid Waste Management Units S-18b/c, P-9 P-18*" in June 2015. which allowed Tecumseh to proceed with the design/build remedial activities associated with those SWMUs. The corresponding engineering reports, drawings and specifications were submitted in July 2015. Shortly thereafter in August 2015 the NYSDEC and Tecumseh executed Amendment No.1 to the ATP SWMU Group Corrective Action Order on Consent (File No. 10-09).

The ATP SWMU Group Operable Unit No. 2 Engineering Report for External Groundwater Corrective Measures was submitted in February 2014 and approved by the NYSDEC in June 2014. The report proposed the installation of four groundwater collection

wells north of the ATP Containment Cell in order to hydraulically contain residual groundwater contamination observed in that vicinity. Recovered contaminated groundwater external to the ATP containment cell is conveyed via a double-contained force main to the existing ATP groundwater pre-treatment system.

The construction sequence for OU-2 and OU-3 as required in the Order was completed as follows:

- The OU-2 external groundwater system was implemented and operational in October 2015;
- The OU-2 waste stabilization (approximately 11,035 cubic yards) and consolidation into the ATP-ECM containment cell was completed in November 2015;
- The OU-3 consolidated final cover system was completed by July 2016;

The CCR for OU-2 and OU-3 was submitted and subsequently approved by NYSDEC in August 2016.

3.0 CORRECTIVE MEASURES STUDY OBJECTIVES

3.1 Purpose and Scope of the CMS

The portion of the Tecumseh Property addressed by the CMS is the approximately 489-acre sub-parcel in the City of Lackawanna, New York that encompasses the 43 SWMUs and five watercourses identified in the RFI and/or by USEPA as requiring further assessment. Plate 1-1 graphically depicts this sub-parcel hereinafter referred to as the CMS Area. An Order on Consent was entered into by Tecumseh Redevelopment Inc. and the NYSDEC effective June 30, 2009 for the performance of the RCRA CMS consistent with applicable Federal and New York State hazardous waste regulations. A CMS Work Plan (Ref. 2) was appended to and became part of the Order that fully delineates the purpose and scope of the CMS to:

- Identify data gaps and gather additional information to determine if corrective measures were necessary, and/or to properly evaluate remedial alternatives for a SWMU, group of SWMUs, or watercourse.
- Define site-specific corrective measure objectives for SWMUs and/or environmental media.
- Identify cost-effective remedial alternatives that could meet defined cleanup objectives and reliably protect public health and the environment for SWMUs or SWMU Groups and watercourses requiring further assessment.
- Evaluate identified remedial alternatives using the following performance criteria:
    - Overall Protectiveness of Public Health and the Environment
    - Standards, Criteria, and Guidance
    - Long-Term Effectiveness and Permanence
    - Reduction of Toxicity, Mobility or Volume of Contamination through Treatment
    - Short-Term Impacts and Effectiveness
    - Implementability
    - Cost Effectiveness
    - Land Use
    - Community Acceptance
- Recommend specific remedies that:
    - Are protective of public health and the environment

- Attain applicable media cleanup standards
- Control the source(s) of releases
- Comply with applicable waste management standards

Due to the massive size of the Tecumseh CMS Area, large number of SWMUs, and the diverse mix of waste materials and associated constituents of interest that vary by SWMU, water body, and environmental media (i.e., slag/fill, sediment, groundwater, and surface water), corrective measure objectives are herein identified and evaluated by: individual SWMUs; groups of SWMUs (if they contained similar wastes and constituents or were spatially proximate); Area or Sub-Area of the Site (as in the case of groundwater); or environmental media (as each media has different standards, regulations, guidelines, and remedial methods). Media-specific and other site-specific corrective measure objectives that address the entire CMS Area or portions of the CMS Area outside the boundaries of individual SWMUs are further discussed below.

3.2 Site-Specific Soil/Slag/Fill Management Objectives

Practically the entire Tecumseh CMS Area is situated on Land Patent parcels that were reclaimed from Lake Erie by placement of contaminated USACE sand/dredge spoils by the USACE and subsequent deposition of steel-making slag and historical fill from former Bethlehem Steel operations (i.e., iron-making, steel-making, steel-forming, steel-finishing, and coke-making); building demolition; and sediment dredged from Smokes Creek. The total quantity of fill material contained in the CMS Area is estimated at approximately 20 million cubic yards including slag, dredge spoils and other fill above the mean Lake elevation inclusive of SWMU waste/fill. The 43 SWMUs that received or may have received solid wastes containing hazardous substances from BSC's former steel-making operations SWMUs and identified by the USEPA as requiring further assessment in the CMS represent a small fraction of the CMS Area. While the RFI, coupled with the preceding RCRA Facility Assessment (RFA; Ref. 8), has determined that these 43 SWMUs represent the known areas where solid and hazardous wastes were disposed or handled on the CMS Area, it is reasonable to expect based on the vast size and scope of former manufacturing operations and decades of unregulated waste management that some solid waste, steel/coke manufacturing raw materials, by-products or associated petroleum or hazardous substances

may be intermittently dispersed in the vast soil/slag/fill mass outside the boundaries of these SWMUs. Recent practical experience during subsurface excavations related to the Steel Winds wind energy project and slag reclamation in SFA Zones 3, 4, and 5 validate those expectations.

An interim Soil/Fill Management Plan (SFMP) was developed (see Appendix D) with the purpose of addressing potentially contaminated soil/slag/fill if encountered on the CMS Area during future redevelopment or slag reclamation activities, outside the known or defined boundaries of the SWMUs requiring further assessment in the CMS. Potentially contaminated soil/slag/fill identified by field screening would be sampled and analyzed to verify concentrations of constituents of interest. Contaminated soil/slag/fill found to exceed site-specific action levels (SSALs) would then be appropriately handled and/or disposed on-site or off-site.

This SFMP applies to all soil/slag/fill handling during CMS Area redevelopment activities including, but not limited to:

- Clearing and site grading.
- Infrastructure construction (e.g., roads, waterline, sewers, electric cable).
- Foundation excavation.
- Slag reclamation/scrap recovery operations.

The SFMP provides protocols for the proper handling of CMS Area soil/slag/fill during redevelopment activities, including:

- Field screening, identifying, sampling, analyzing, handling, and disposing potentially impacted soil/slag/fill.
- Sampling, analyzing, and determining acceptability of soil/slag/fill from off-site borrow sources for use as subgrade and surface soil/slag/fill.
- Erosion and dust control measures.
- Access controls.
- Health and safety procedures for subsurface construction work and the protection of the surrounding community.
- Environmental easements.
- Notification and reporting requirements

The SFMP will become part of the Institutional and Engineering Control Plan discussed in Section 6.6.1 of this report.

3.3 Groundwater Quality Objectives

USEPA and NYSDEC general groundwater remediation goals are stated, respectively, in the "Handbook of Groundwater Policies for RCRA Corrective Action" (updated 4/20/2000) and DER 10, "Technical Guidance for Site Investigation and Remediation" (May 2010) and summarized as follows:

- Short-term groundwater goals include preventing, minimizing or eliminating (1) current or near-future unacceptable exposures to humans or ecologic receptors to contaminated groundwater; (2) sources of groundwater contamination; and (3) the spread of contaminated groundwater above levels of concern.
- Long-term or final groundwater goals are to (1) protect human health and the environment; (2) achieve media cleanup objectives appropriate to the assumptions regarding current and reasonably expected land uses and current and potential uses of water resources; and (3) remediate the sources of releases so as to eliminate or reduce further releases of hazardous wastes or hazardous constituents that may pose a threat to human health or the environment.

Site-specific groundwater quality considerations for the CMS Area include its current uses for wind energy production; multi-modal transportation and raw material storage, and; slag, concrete, and wood debris reclamation/beneficial reuse. Reasonably anticipated and acceptable future uses of the CMS Area are delineated as "Heavy Industrial" by the City of Lackawanna Zoning Ordinance. Tecumseh has also discussed and is considering the potential for limited public access to portions of Smokes Creek and Slag Fill Area (SFA) Zone 2 of the CMS Area following completion of final corrective measures in those locations.

The CMS Area groundwater does not impact any off-site lands and only discharges to the adjacent surface water bodies of Smokes Creek, Lake Erie, and the Gateway Metroport Ship Canal. The remainder of surrounding Tecumseh and former Bethlehem Steel properties are currently subject to institutional control that prohibits groundwater withdrawal and use. Therefore, in the CMS Area, exceedance of the NYSDEC Class GA Groundwater Quality Standards/Guidance Values (GWQSs/GVs) at the CMS Area and/or property boundary in and of itself does not constitute a threat to public health or the environment.

The above-referenced State and Federal guidance documents further state that "groundwater cleanup objectives are best expressed in terms of groundwater cleanup levels, point of compliance and remediation time frames" and should consider the impact of contaminated groundwater discharging to surface water on surface water quality. Due to this Site's unique environmental setting and history, controlling the quality and quantity of contaminated groundwater discharging from the Site to the degree necessary to protect the quality of surface water in the adjacent Smokes Creek and Lake Erie consistent with the current and reasonably anticipated future water resource uses is the site-specific long-term groundwater cleanup goal.

The Comprehensive Groundwater Quality Assessment (May 2014) and this CMS Report address all the above-stated goals and considerations with the primary groundwater quality objective of protecting public health and the environment by reducing further releases of constituents of concern from on-site sources (i.e., SWMUs) of groundwater contamination to surface waters to the degree necessary to protect the water quality of these surface water resources.

A fundamental objective of the RFI, which was deemed complete by NYSDEC and USEPA in 2006, is to define the nature and extent of contamination in environmental media, including groundwater. Initially in 2009 and 2010, additional groundwater investigations were completed by Tecumseh to update the groundwater quality data base (as most of the RFI data reflected 1999 and 2000 conditions) and to fill in data gaps identified in the CMS Work Plan to facilitate remedy selection. Subsequently, additional groundwater investigations deemed necessary by NYSDEC were undertaken by Tecumseh in 2011 and Comprehensive Groundwater Quality Assessments were compiled by Tecumseh in 2012, 2013, and 2014 to:

- Compare groundwater quality under, and adjacent to individual SWMUs or SWMU groups to the NYSDEC Class GA GWQSs/GVs
- Assess changes in groundwater quality over time
- Improve the estimated quantities of waste/fill in SWMUs
- Prepare and update groundwater isopotential maps
- Prepare geologic cross-sections
- Compare SWMU waste/fill characteristics to adjacent or downgradient groundwater impacts

- Assess the potential for SWMU waste/fill to impact groundwater
- Calculate mass loadings of constituents of concern (COCs) in groundwater to adjacent surface water bodies

The results of these groundwater investigations and comprehensive groundwater assessments are presented in Section 4. Where individual SWMUs or SWMU Groups are identified as known or potential source areas of groundwater contamination, alternative source area controls in the form of cover systems, consolidation in CAMUs or ATP-ECM, or excavation and off-site disposal are assessed in Section 5. Where groundwater quality is more severely impacted relative to GWQSs/GVs or more broadly impacted as a contaminant plume or mass loading to a surface water body, alternative groundwater controls are assessed in Section 5.

3.4 Environmental Indicators

According to the USEPA, Environmental Indicators (EIs) are short-term objectives used by the RCRA Corrective Action Program to track progress at corrective action sites in environmental terms. EIs are a means of evaluating and reporting the acceptability of current environmental conditions at corrective action facilities. They also provide an opportunity for facilities and regulators to show meaningful progress. EIs are interim milestones and not final remedy or site closure goals. EPA developed two EIs to indicate the quality of the environment during the Corrective Action process:

- The "Current Human Exposures Under Control" or Human Exposures EI ensures that people near a facility are not exposed to unacceptable levels of contaminants. This EI only considers human exposures under current land and groundwater use conditions and does not consider potential future use conditions or ecological receptors.
- The "Migration of Contaminated Groundwater Under Control" or Groundwater EI ensures that contaminated groundwater does not spread and further contaminate groundwater resources.

Intermediate performance goals can often serve as helpful milestones between short-term and final cleanup goals. EPA and the general scientific community recognize that achieving cleanup goals for contaminated groundwater can be very challenging. For some facilities, these challenges can appear to be so insurmountable that moving directly to final

cleanup goals (e.g., returning all contaminated groundwater to its maximum beneficial use) diminishes the ability of regulators and facilities to identify a realistic path forward. For these facilities, EPA recommends developing a series of facility-specific intermediate performance goals designed to promote continuous progress toward the final cleanup goals.

Final remedies address long-term issues (e.g., potential future human exposure scenarios, future land and groundwater uses and ecological receptors) to meet the RCRA Corrective Action Program's overall mission to protect human health and the environment. The USEPA defines the following two long-term goals:

- "Final Remedy Construction" is met when a site completes construction of the final remedy designed to achieve long-term protection of human health and the environment. This goal may be met even if final cleanup levels have not yet been reached but the constructed final remedy must be enough to show progress toward those cleanup levels with time. For example, a constructed final remedy may be a groundwater treatment system that will ensure that groundwater meets cleanup goals with time.
- "Performance Standards Attained" is met when the remedies that were selected for the protection of human health and the environment are fully implemented; cleanup levels must be attained. This goal may be reached with or without controls or additional long-term stewardship actions in place to be sure human health and the environment remain protected in perpetuity.

The following sections compare the ICMs, ECMs and OUs to short-term protective (EIs), intermediate performance, and final cleanup goals to determine whether further remedial actions are warranted.

3.4.1 Interim Corrective Measures

The 5-million gallon storage tank, SWMU P-73, Smokes Creek lower reach floodway dredging, and SWMU P-76 ICMs have been deemed complete by NYSDEC. The Benzol Plant ICM (i.e., SWMU P-11), although initially constructed as a short-term remedy has been incorporated into the final OU-4 groundwater remedy for the expanded former Coke By-Products Sub-Area completed in March 2019. Construction of the Benzol Plant source control ICM was also completed in March 2019.

3.4.2 Expedited Corrective Measures and Operable Units

The final remedy construction of expedited corrective measures for the ATP SWMU Group and Operable Unit Nos. 2 & 3 was completed in July 2016. These ECMs and OUs permanently and finally addressed SWMUs S-11, S-21, S-22, S-24, P-09, P-18 and AOCs A & D and associated groundwater impacts in Groundwater Discharge Sub-Areas (GDS) 2A, 2B, and 3A. .

The final remedial construction of OU-4 addressing the Coke Plant By-Products Facility Sub-Area groundwater was completed in March 2019.

3.4.3 Current CMS Area Environment Conditions

Based on the completed ICMs, ECMs and OUs, the current human exposures are under control for the CMS Area considering the current commercial and industrial land use and that groundwater use is prohibited for the CMS Area and surrounding property. The migration of contaminated groundwater is under control since the completed and on-going ICMs, ECMs and OUs ensure contaminated groundwater does not spread and further contaminate groundwater or surface water resources. Once Tecumseh completes the corrective measures presented in Section 5.5, the USEPA's long-term goal of final remedial construction will be met for the CMS Area thereby achieving long-term protection of human health and the environment.

3.5 Corrective Action Management Units (CAMUs)

The concept of a Corrective Action Management Unit (CAMU) is embodied in the RCRA Hazardous and Solid Waste Amendments of 1984 (HSWA Amendments) that allows for the consolidation and management of remediation wastes from several SWMUs in one or more locations to reduce its volume, toxicity, and/or mobility. On August 22, 2000, the USEPA published a rule (65 FR 51080) referred to as the CAMU Amendments that effectively "grandfathered" any "substantially complete" CAMU applications received by USEPA or an authorized state such as New York within 90 days of the rulemaking. Consequently in New York, a CAMU implemented pursuant to such a grandfathered application would be subject to the existing CAMU regulations set forth in 6 NYCRR Part 373-2.19.

On November 16, 2000, Bethlehem Steel, as the waste generator and owner the subject property at that time, submitted an application for two CAMUs to be located in the Slag Fill Area-Zone 2: a Solid Waste (SW) CAMU into which solid waste would be consolidated and contained; and a Hazardous Waste (HW) CAMU into which characteristic hazardous waste would be consolidated and contained. In a letter dated November 17, 2000, the NYSDEC deemed the CAMU application substantially complete and advised that the proposed CAMUs are subject to the 1993 CAMU regulations. The NYSDEC's letter went on to clarify that CAMU design requirements should be addressed in the CMS. Accordingly, Tecumseh has developed conceptual designs of the CAMUs consistent with the 1993 regulations and the BSC completed applications as part of this CMS. Tecumseh's intentions to pursue implementation of the CAMUs were clearly articulated in the CMS Work Plan that was approved by NYSDEC and incorporated by reference into the CMS Consent Order. This CMS also identifies which SWMU waste/fill materials may be placed into each of the CAMUs. The CAMU application and related NYSDEC correspondence is included in Appendix B.

To demonstrate that the selection of the CAMUs is not presumptive, a stand-alone report entitled "Excavation and Off-Site Waste Disposal Evaluation" was prepared by Tecumseh at the request of the NYSDEC and was included in the CMS Work Plan (as Appendix C, Ref. 2) and has been included as Appendix E of this Report. Since the CMS Work Plan approval, the NYSDEC issued DER-31/Green Remediation Program Policy in August 2010 in order to minimize the environmental footprint of clean up actions. The excavation and off-site waste disposal evaluation for all SWMU wastes includes an estimated 74,600 tandem truckloads for a total round trip total of 150,000 truck trips to and from the Site. Assuming a 30 mile one-way trip to the off-site disposal facility, this would consume approximately 562,500 gallons of diesel fuel (8 miles per gallon), which in turn would generate 12,487,000 pounds of carbon dioxide gas (EPA estimates 22.2 pounds of CO_2 generated per gallon of diesel fuel burned) and related traffic, dust, and air emissions. In addition, a substantial number of truckloads of clean soil may need to be imported for final cover purposes. This alternative would permanently use and displace 1.5 million tons of valuable landfill airspace, causing ancillary environmental issues due to reduced landfill capacity. On the basis of this evaluation and the Green Remediation policy, the off-site disposal alternative was and is deemed infeasible due to multiple reasons including:

ineffective protection of public health and the environment due to residual levels of contamination in the saturated soil/slag and sand/dredge spoil units; lack of reduction of toxicity or volume; significant short-term impacts to the community; excessive generation of greenhouse gases and fuel consumption; and cost.

In the NYSDEC December 11, 2018 letter to Tecumseh submitting comments on the 2014 CMS Report it stated: "The Department will consider consolidation/regrading of the…solid waste already located in SFA Zone 2…into a SW-CAMU. Since the proposed SW-CAMU is unlined and no containment wall is proposed, the groundwater collection and treatment alternative outlined in the *Supplement to CMS Report* would need to be revised to provide a more robust design that minimizes the discharge of any contaminated groundwater to the surrounding surface water bodies. Now…the Department has determined that consolidation of additional solid wastes from SWMUs in other SFA Zones into the SW-CAMU is not a viable alternative to managing these wastes." In Tecumseh's February 15, 2019 letter responding to this and other NYSDEC comments, Tecumseh reiterated its strong desire and regulatory basis to allow consolidation of additional solid wastes from SWMUs in other SFA Zones into the SW-CAMU and proposed to evaluate a much more robust SW-CAMU conceptual design in the revised CMS including:

- Construction of a liner over SFA Zone 2 SWMU wastes prior to consolidation of other SWMU wastes.
- Leachate collection over the existing waste fill liner.
- Recycling/reuse, solidification/stabilization, dewatering and/or treatment of specific SWMU waste/fill in-place within SFA Zone 2 to reduce the potential for contaminant migration.
- Recycling/reuse, solidification/stabilization, or treatment of specific SWMU waste/fill from outside SFA Zone 2 prior to consolidation into the SW-CAMU to reduce the volume and/or toxicity of the waste and mobility of waste constituents.
- More robust groundwater dewatering and/or treatment in and under SFA-Zone 2.
- Re-grading and stabilization of the western and northern shoreline bluffs to meet the GEI geotechnical report (2013) slope recommendations.

The primary criterion for evaluating the above additional remedial alternatives and proposed enhancements to the SW-CAMU design coupled with the consolidation of SWMU waste/fill from beyond SFA Zone 2 will be protection of groundwater and adjacent surface water quality.

We can conceive of no better remedy for many of the SWMUs than consolidation and disposal of wastes from outside SFA Zone 2 into the SW-CAMU as land disposal requirements, minimum technology requirements, and TENORM requirements that may apply to off-site disposal, coupled with significant transportation to out-of-state commercial permitted treatment, storage and disposal facilities (TSDFs) will add significant costs with little or no incremental environmental benefit.

TENORM is an acronym for Technologically Enhanced Naturally Occurring Radioactive Material. Almost all rock and rock aggregate exhibit low levels of naturally occurring radioactivity (NORM). When these natural materials are "technologically enhanced", as in the steel-making process where limestone, iron ore and other materials are melted together and where slag is the by-product, some of the slag and some steel may contain elevated radiologic characteristics that may affect disposal and reuse opportunities in New York and other states. New York State solid waste regulations (NYCRR Part 360) specifically prohibit land disposal of TENORM waste.

Tecumseh continues to advocate for a comprehensive remedy for the CMS Area inclusive of the SW-CAMU as provided for in the CMS Work Plan and Order. The environmental benefit and precedent for use of CAMUs to consolidate and manage wastes from multiple locations on the large site has already been approved by the Department and demonstrated in the CMS Area through implementation of OU-2 and OU-3 whereby wastes from several SWMUs outside SFA Zone 2 were consolidated into the ATP-ECM containment cell in SFA Zone 2 following stabilization/ solidification, as appropriate. The Department has already expressed its approval for containing substantial quantities of SWMU wastes in-place in SFA Zone 2. The additional quantities of solid waste from outside SFA Zone 2 that are proposed to be consolidated into the SW-CAMU are small in comparison with much lower contaminant concentrations and corresponding less potential to impact groundwater and adjacent surface water quality. The substantial additional environmental protections offered herein from additional liners, leachate collection, waste stabilization/solidification, and slope stabilization make the substantially-improved SW-

CAMU an appropriate permanent remedy fully protective of public health and the environment. The consolidation of SWMU wastes from around the CMS Area into SFA Zone 2 where most of the SWMU waste volume currently exists improves the potential for reuse and redevelopment of a larger portion of the CMS Area.

This revised CMS Report will evaluate the more robust SW-CAMU conceptual design presented above in concert with consolidation of SWMU waste/fill, with or without stabilization/solidification as appropriate. The HW-CAMU will not be evaluated in this revised CMS Report as agreed with NYSDEC in connection with implementation of OU-2.

4.0 SUMMARY OF RFI FINDINGS & ADDITIONAL CMS AREA CHARACTERIZATION

4.1 Overview

In addition to the 43 SWMUs and 5 watercourses identified by USEPA and NYSDEC as requiring further assessment in the CMS, the following nine discrete areas of concern (AOCs) were identified during CMS characterization activities:

- AOC A, B, and C – Lead-impacted areas within SWMU S-18
- AOC D – Tar-impacted area north of SWMU S-23
- AOC E – Small tar-impacted area north of SWMU S-14
- AOC F – Tar-impacted area identified in SFA Zone 5 during slag reclamation activities
- AOC G – Tar-impacted area identified in SFA Zone 5 during Steel Winds II WT-9 foundation excavation activities
- AOC H – Tar-impacted area proximate to utility pole B-24 during Steel Winds II construction activities
- AOC I – Tar-impacted area proximate to utility pole C-23 during Steel Winds II construction activities

The SWMUs, watercourses, and AOCs assessed in this CMS are depicted in Table 4-1 and identified in Plate 1-1. Except for AOC A, all AOCs were remediated in accordance with the Soil Fill Management Plan (see Appendix D). AOC-A is directly associated with SWMU S-18 and is the area within and extending slightly beyond the RFI-defined limits of the SWMU containing about 1,800 CY of solid waste/fill with lead in excess of Part 375 ISCOs (see Section 4.3.3.9).

Additionally, the RFI confirmed the presence of dredge spoils historically placed in the near-shore open waters of Lake Erie by the USACE and other government agencies or contractors in the Federal Dumping Ground (see Plate 4-1) intermingled with the native sand deposits beneath and adjacent to the slag/fill in the western portion of the CMS Area. The dredge spoils are contaminated with elevated levels of many of the same compounds of concerns detected in the 43 SWMUs, including SVOCs, VOCs and heavy metals (see Section 4.2 for additional details). Due to their intermingled nature, the USACE dredge spoil

sediment and native sand deposits are hereinafter discussed as a single combined hydrogeologic unit where they co-exist in Slag Fill Area-Zones 2, 3 and 4 along the western portion of the CMS Area. Also, each AOC is discussed within the SFA Zone or CMS subarea in which they are located.

Groundwater quality is discussed in Section 4.8 including identification of known or suspected sources to have significantly contributed to such groundwater impacts (i.e., upgradient SWMUs and/or USACE dredge spoil sediments). SWMU boundaries as shown in figures/plates within this report are approximate as initially defined in the RFI and reflect changes based on additional investigations (if any) conducted during the CMS. Additionally, the boundary and location of the USACE dredge spoil dumping grounds shown in figures/ plates within this report is approximated based on an April 1937 USACE map obtained by BSC and clearly shows the former dumping grounds lay beneath much of the western portion of the CMS Area.

Each SWMU and watercourse discussion that follows includes information from the RFI as well as the results of supplemental investigations performed in accordance with the CMS Work Plans to better quantify the lateral and vertical extent of impacts and/or to characterize slag/fill materials for the purpose of evaluating corrective action alternatives as subsequently presented herein as Section 5. Plates 4-2 through 4-17 present sampling locations and Tables 4-2 through 4-36 summarize the data from RFA, RFI, and CMS samples collected from various media (i.e., groundwater from monitoring wells, subsurface slag/fill from borings/test pits, sediment, and surface water samples from watercourses, etc.) in and around the CMS Area.

Analytical results within this document have been compared to the most recent NYSDEC Standards, Criteria and Guidance (SCG) documents in accordance with NYSDEC DER-10/Technical Guidance for Site Investigation and Remediation (Ref. 9), including: 6NYCRR Part 375 Industrial Soil Cleanup Objectives (ISCOs) and Protection of Groundwater SCOs (December 2006) for soil/fill (Ref. 10); NYSDEC Class "GA" Groundwater Quality Standards/Guidance Values (GWQS/GV) as per Technical & Operational Guidance Series 1.1.1 (June 1998, January 1999 Errata, April 2000 Addendum, and June 2004 Addendum) for groundwater (Ref. 11); 40 CFR §261.24 for Toxicity Characteristic Leaching Procedure (TCLP) limits for waste/fill; and NYSDEC Screening and Assessment of Contaminated Sediment (June 24, 2014) for sediments in the waterbodies

(Ref. 12). In addition, and where appropriate, Commissioners Policy-51 (CP-51) was used (e.g., total PAHs in soil/fill).

Supporting documentation for the CMS investigations described within this report are provided as appendices and include:

- Appendix F – Laboratory analytical data reports
- Appendix G – Borehole and well construction logs
- Appendix H – Well development and sampling logs

4.2 Federal Dredge Spoil Dumping Ground

Historical documents indicate that the USACE deposited contaminated dredge spoils off the former BSC Lackawanna Facility shoreline from circa 1900 to 1949 (see Figure 4-1). According to Appendix E.3 of the RFI, URS Corporation was retained by BSC and performed an investigation of the CMS shoreline area in 2000 (Ref. 13; partially included in Appendix U). The scope of work conducted during September and October 2000 included installation of three groundwater monitoring wells and eight triplet (24 total) piezometer along the Lake Erie shoreline; measurement of water levels; sampling and analysis of seven soil samples from soils believed to be dredge spoils; and a historical document review of USACE files. Information related to the USACE dredge spoil disposal area was obtained from Appendix G of the RFI entitled Investigation of Dredge Spoils Dumping at Bethlehem Steel Corporation's Lackawanna Facility, prepared by URS Corporation in January 2001 and revised October 2002 (Ref. 14; partially included in Appendix U).

Due to the saturated condition of the dredge spoils, their proximity to Lake Erie, and the type and level of contamination, this material warrants special consideration as a source of groundwater and surface water contamination in the context of the CMS. As such and throughout this report, this unit is referred as the USACE sand/dredge spoils deposit or USACE dredge spoil sediments. This unit is considered separate and distinct from the native sand deposits except where they co-exist in Slag Fill Area-Zones 2, 3 and 4 along the western portion of the CMS Area. Neither BSC nor Tecumseh are responsible for either the generation or disposal of this waste and the hazardous constituents contained within. However, groundwater remedial alternatives will address all groundwater constituents in the CMS Area.

A summary of this investigation, its findings, and why the USACE dredge spoils are considered one of the primary potential contributors to groundwater impacts observed within the sand/dredge spoil unit along the western portion of the CMS Area is presented below. Most of the wells and piezometers installed during the URS investigation were destroyed in subsequent years by wave erosion and ice sheet advancement onto the shoreline.

From September to October 2000, the RFI shoreline subsurface investigation consisted of eight shoreline borings advanced through unconsolidated slag/fill and sand/ dredge spoil deposits to the underlying lacustrine clay unit to characterize the underlying sediments and to assess the presence of USACE dredge spoils (see Plate 4-1). Upon completion, three nested piezometers (shallow [S], medium [M], and deep [D]) were installed within each boring to provide additional hydrogeologic information in support of the RFI (screened 8-12, 17-22, and 25-31 fbgs). Piezometers P-25 thru P-32 (S/M/D) are shown on Plate 4-1. Three distinct subsurface units were identified: slag/fill (approximately 15 to 24 feet thick), mixed silts and sands (approximately 6 to 13 feet thick), and silty clay (lacustrine sediments) (greater than 17 feet thick). The mixed silt and sand unit was determined to be consistent with dredge spoil sediments and the observed thickness was within the reported range of dredge spoil disposal as measured by the USACE 1936 (and later 1948) soundings of the dredge spoil surface.

Sediment samples were collected below the slag/fill unit within the then suspected dredge spoil horizon for laboratory analysis from borings P-25 (20-22'), P-28 (25-28'), P-29 (18-20'), P-30 (28-30'), P-31 (28-30'), and P-32 (23-24' and 24-28') based on visual, olfactory, or PID evidence of contamination. Results of these analyses are shown on Plate 4-1 and Table 4-2. As presented in Table 4-2, many of the compounds detected in the sand/dredge spoil unit at concentrations above 6NYCRR Part 375 Protection of Groundwater Soil Cleanup Objectives (SCOs) are the same as those found in slag/fill groundwater and many SWMU waste/fill samples characterized during the RFI and CMS (e.g., VOCs, SVOCs, and heavy metals), supporting the argument that dredge spoils are potential contributors to groundwater contamination. However, compounds not associated with historic BSC operations, but identified in sediments from the Buffalo River and Buffalo Harbor, were also detected in the shoreline sediments, including Michlers Base and aniline, both of which were continuously produced for more than 110 years and openly discharged to the Buffalo River

thereby "fingerprinting" or identifying the contaminant source as the USACE dredge spoils. Recovered core samples also confirmed the presence of prior disturbance via USACE dredge spoils intermixed with native sands and silt below the slag/fill unit. Indications of prior disturbance included variable sediment texture, a mottled matrix, and contorted to massive bedded structure as well as the presence wood fibers and fragments, leaf matter, angular rock fragments and the occasional occurrence of coal and glass fragments within the sediment matrix (Ref. 14).

Historical information from a 1983 USACE Supplemental Information Report (Ref. 15) indicated that dredge spoils were taken from Federal navigation channels in the Buffalo area (e.g., the Buffalo Harbor, Buffalo River, Black Rock Canal, and other inactive hazardous waste disposal sites contributing impacts to these channel sediments) by the Federal government and placed in two "dumping grounds" offshore of the then BSC facility via open lake disposal (see Plate 4-1). According to a memo by W.E. Durell dated February 2, 1949, approximately 614,000 CYs of contaminated USACE dredge spoils had been placed in the Federal dumping grounds prior to BSC's April 15, 1949 Riparian Grant Line approval (see Plate 4-1). The timing, together with Plate 4-1A, firmly establishes that contaminated USACE dredge spoils were dumped on the floor of Lake Erie before it was covered with slag/fill during the westward extension of the shoreline into Lake Erie by BSC. A sediment sampling and analysis report prepared by EEI Consultants for the USACE in 1986 (Ref. 16) described sediments from the Buffalo Harbor and Buffalo River as having "petroleum odors, sheens, and the presence of wood and leaf matter." Because of potential contamination issues related to dredged spoils, the USACE currently describes the practice of open lake disposal as unacceptable due to the uncontrolled release of pollutants and resultant adverse environmental impacts (Ref. 15, USACE 1983).

In 1985, USGS's *Preliminary Evaluation of Chemical Migration to Groundwater and the Niagara River from Selected Waste Disposal Sites* (Ref. 17) presented an evaluation of 138 known toxic waste sites along the Niagara River including the Buffalo area. This document includes an extensive discussion of the chemistry of wastes disposed by Buffalo-area industries and of sediment placed into containment sites as a result of USACE dredging operations. The report provides important information regarding the chemical characteristics of the USACE dredge spoils that may have been placed in the former USACE dumping grounds, nearly half of which underlies the western portion of the CMS Area. The purpose stated in the report

indicates that "*The project was limited to preliminary investigations only and was not designed to assess the actual effect of groundwater contamination on the Niagara River nor establish whether contamination migration has actually occurred.*" The document also states that the BSC site has a major potential for contaminant migration to groundwater and off-site to Lake Erie; however, the investigation was limited to a literature review. According to the document, BSC is identified for major migration potential based on available geohydrologic and chemical data and off-site contaminant migration data reported or observed. The USGS document references a 1981 Dames and Moore report for BSC in which a chemical-dispersion analysis was completed to evaluate the dilution of maximum cumulative concentrations of constituents into Lake Erie. The resulting concentrations of lead, phenol, chloride, sulfate, cyanide and pH in Lake Erie are low; however, the BSC site is listed as having a major potential for contaminant migration to Lake Erie.

The USGS Report (Table 21) identifies three dredge spoil containment sites (i.e., Times Beach, Small Boat Harbor and Buffalo Harbor) adjacent to CMS Study area as also having a major potential for contaminant migration to groundwater and off-site based on geohydrologic and chemical data, which further substantiates the information presented in the 1983 USACE Supplemental Information Report discussed above.

- Times Beach – Analytical data (minimum, maximum and mean) from 16 sediment samples indicate elevated levels of metals and organics (PCBs naphthalene, aniline, PAHs). Three groundwater samples and one surface water sample collected by USGS contained notable detections of arsenic, barium, cadmium, chromium, benzene and chlorobenzene.
- Small Boat Harbor – Three groundwater samples and one surface water sample collected by USGS contained notable detections of arsenic, cadmium, chromium, lead, benzene and chlorobenzene.
- Buffalo Harbor – Three groundwater samples and one surface water sample collected by USGS contained notable detections of cadmium, chromium, lead, benzene and chlorobenzene.

A November 1991 document prepared for the Small Boat Harbor Site #915127 provides dredge spoil data collected from the Small Boat Harbor Confined Disposal Facility (CDF) by USACE in 1986 and Niagara Frontier Transportation Authority (NFTA) in 1987. As summarized in Tables 1-8 of the document (included in Appendix U), metals, naphthalene and phenol concentrations exceed the Part 375 protection of groundwater

SCOs and lead, mercury, PCBs, and (1,2- and 1,4-) dichlorobenzene concentrations exceed Part 375 ISCOs. Although the dredge material within the CDF did not exhibit the toxicity characteristic of hazardous waste, the material contains a diverse mixture of hazardous substances at concentrations that led the USEPA to categorize the dredge spoils as "heavily polluted" and prompt the USACE to discontinue open lake dumping.

The dredge spoils present beneath the CMS Area are likely very similar in chemical characteristics to those present in the three contaminant sites, which supports the position that the dredge spoils present below the CMS Area are a potential source of contamination to Lake Erie.

Based on physical and chemical analysis, BSC's investigation confirmed the presence of contaminated USACE dredge spoils beneath the slag/fill unit along the western portion of the CMS Area (see Plates 4-1 and 4-1A). The investigation also confirmed dredge sediments contaminated by numerous industrial sources, unrelated to BSC, were imported and placed along the western shoreline of the former BSC property and are now buried and intermingled with native beach sand deposits beneath the slag/fill unit. As a result, the potential impact of subsequent slag/fill (and SWMU waste) disposal operations on groundwater quality within the contaminated sand/dredge spoils unit in the western portion of the CMS Area cannot be ascertained with certainty. Because of this uncertainty, the USACE dredge spoils are considered a potential source of groundwater contamination within the sand/dredge spoils unit beneath the slag/fill unit in the western portion of the CMS Area. For this reason, both the USACE dredge spoil sediments and nearby SWMUs were both assessed as potential sources of groundwater impacts as discussed in Section 4.8.

4.3 Slag Fill Areas

Essentially, the entire CMS Area is underlain by slag, contaminated USACE sand/dredge spoils, and other industrial fill deposited directly into Lake Erie and/or along the former shores of Lake Erie. The Slag Fill Areas (SFAs) Zone 2 as identified in the RFI and depicted in Figure 1-4, comprise the portion of the CMS Area south of Smokes Creek. SFAs 3, 4 and 5 comprise the portion of the CMS north of Smokes Creek. Since the RFI did not identify any SWMUs within SFA Zone 1, this portion of the SFA is not included in the CMS Area nor addressed in this CMS Report. Similarly, the RFI did not identify any SWMUs requiring further assessment within SFA Zone 5. SFA Zones 2, 3, and 4 were

historically used by Bethlehem Steel for management of waste materials, including wastewater treatment plant sludge; other sludge, dusts, and liquids from iron-making, steel-making, steel-forming, steel-finishing, and coke-making operations; and dredged sediments from Smokes Creek. Appendix N contains SWMU surface and subsurface soil sample RFI analytical data tables with comparisons to Part 375 ISCOs and Protection of Groundwater SCOs.

4.3.1 SFA Zone 2 SWMUs

SFA Zone 2 contains 12 SWMUs that were segregated into three distinct SWMU groups for purposes of this CMS based on their historical uses: the Impoundments SWMU Group (also referred to in the RFI as SWMU Group SFA-1) comprised of SWMUs S-1 through S-6, S-7/S-20, S-8, and S-27; the ATP SWMU Group comprised of SWMUs S-11, S-22, and S-24 (actually located on the north bank of Smokes Creek across from S-11 and S-22)); and orphan SWMU S-21 (see Plate 4-2). The Acid Tar Pit (ATP) SWMU Group Phases I (Slurry Wall), II (SWMU S-24 Consolidation & Final Cover), and III (Groundwater/ Leachate Pre-Treatment System) have been previously addressed under a separate Order on Consent as an expedited corrective measure (ECM); as such, alternative remedial measures for the ATP SWMU Group are not evaluated in the context of this CMS. However, remedial alternatives associated with the other SFA Zone 2 Impoundment SWMU Group are addressed in the context of the CMS.

4.3.1.1 The Impoundments (SWMU Group SFA-1)

The nine impoundments that collectively comprise SWMU Group SFA-1 are located atop an elevated slag/fill area approximately 50 to 60 feet above mean Lake elevation, and immediately south of Smokes Creek and east of Lake Erie (see Plate 4-2). Groundwater within this elevated slag and waste/fill area generally flows west toward Lake Erie with a northern flow component near and toward Smokes Creek. Each impoundment is constructed primarily of slag with some intermingled demolition debris (i.e., bricks/concrete) and a perimeter slag berm generally with varying degrees of vegetative cover. The RFI data collected from the Impoundment SWMUs was comprehensive and no further investigation was called for in the CMS Work Plan. A brief description of each SWMU within SFA Zone 2 and other pertinent findings follows as excerpted from the RFI:

- **SWMU S-1** is approximately 2 acres in size with an average distance of 7 feet from the top of the perimeter berm to the surface of the waste/fill. According to the RFI, the waste/fill within this Unit consists primarily of water quality station sludge that contains iron oxides, rolling oils, lubricants, and water from steel rolling and finishing; none of which exhibited hazardous waste characteristics by TCLP (Ref. 1). The maximum depth of waste/fill within the Unit is approximately 24 feet. Groundwater is approximately 55 fbgs (average elevation of 572.4 feet). The surface of S-1 consists of ponded surface water and black oily mill scale and sludge. No vegetation is present within the Unit. According to NYSDEC, a total of 17 drums were removed from SWMU S-1 in 2000 after they were discovered during a sampling program. Ten drums did not contain any material while the remaining seven contained material that was visibly different from the sludge in the impoundment. Four of the seven drums failed TCLP (three for benzene and one for lead) and they were characterized as hazardous waste.[5] Accumulated floating oil product has been periodically removed from the surface water via an oil skimmer or vacuum truck typically between May and October. Since June 2004, over 500 gallons of oil/water has been removed from this SWMU and disposed off-site.
- **SWMU S-2** is approximately 2 acres in size with an average distance of 4 feet from the top of the perimeter berm to the surface of the waste/fill. According to the RFI, the waste/fill within this Unit primarily consists of BOF and blast furnace final thickener sludge, iron oxides, lime, iron hydroxide sludge, oil, and grease; none of which exhibited hazardous waste characteristics by TCLP (Ref. 1). The maximum depth of waste/fill within the unit is approximately 27 feet. Groundwater is approximately 50 fbgs (average 571.5 feet). Approximately 70% of the surface is covered with vegetation intermixed with debris. There is no standing surface water within the impoundment.
- **SWMU S-3**, known as the Ammonia Still Lime Sludge (ASLS) Impoundment, is approximately 3.52 acres in size. The depth from the top of the perimeter berm to the surface of the waste/fill ranges from 5 to 15 feet with an average fill depth of approximately 22 feet. The Unit contains approximately 118,000 CY of mixed ASLS (less than 2% by volume) and blast furnace and Basic Oxygen Furnace (BOF) sludge. As the ASLS is a listed waste (K060), this Unit was formerly designated as a Hazardous Waste Management Unit (HWMU-2) but has since been delisted by the USEPA. Although several VOCs and semi-volatile organic compounds (SVOCs) were detected in subsurface waste/fill (and to a lesser

[5] Information provided by NYSDEC in December 11, 2018 comment letter and February 15, 2019 response to request for clarification; documentation of drum removal and sampling activities has not been provided to Tecumseh.

extent surface waste/slag/fill), the concentrations were well below their respective Part 375 ISCOs. Lead was the only metal detected at concentrations exceeding its respective Part 375 ISCO in both surface and subsurface slag/waste/fill. No PCBs were detected. The fill surface is flat, covered with vegetation, and surrounded by slag access roads. Groundwater monitoring has been conducted from adjacent monitoring wells since 1985. Historical trend analysis indicates a decreasing or neutral trend for benzene, toluene, total xylenes, and naphthalene; the primary constituents of concern. Groundwater is approximately 56 fbgs (average 573.0 feet).

- **SWMU S-4** is approximately 2.5 acres in size with an average distance of 23 feet from the top of the perimeter berm to the surface of the waste/fill. According to the RFI, the waste/fill within this Unit primarily consists of Smokes Creek dredge spoils which did not exhibit hazardous waste characteristics by TCLP (Ref. 1). RFI core samples exhibited petroleum- and tar-like odors at depth, and benzene, naphthalene, PAHs and lead were detected at concentrations above Protection of Groundwater SCOs. The maximum depth of fill is approximately 38 feet. Groundwater is approximately 53 fbgs (average 573.6 feet). The spoils consist of Smokes Creek dredge waste/fill covered with mature trees and other vegetation and bounded by slag access roads.
- **SWMU S-5** is approximately 1.5 acres in size with an average distance of 10 feet from the top of the perimeter berm to the surface of the waste/fill. According to the RFI, the waste/fill within this Unit primarily consists of water quality station sludge that contains iron oxides, rolling oils, lubricants, and water from steel rolling and finishing operations; none of which exhibited hazardous waste characteristics by TCLP (Ref. 1). The maximum depth of waste/fill within the Unit is approximately 21 feet. Groundwater is approximately 50 fbgs (574.8 feet). The south portion of the SWMU contains black, oily mill scale and sludge, while the north end contains ponded surface water with reeds and phragmites. Similar to SWMU S-1, this Unit is checked periodically between May and October for accumulated oil. To date, insufficient accumulation of floating oil on the surface water within this SWMU has precluded removal.
- **SWMU S-6** is approximately 1.5 acres in size with an average distance of 7 feet from the top of the perimeter berm to the surface of the waste/fill. According to the RFI, the waste/fill within this Unit primarily consists of BOF final thickener and wastewater treatment sludge; none of which exhibited hazardous waste characteristics by TCLP (Ref. 1). The maximum depth of waste/fill is approximately 34 feet. Groundwater is approximately 65 fbgs (average 574.1 feet). The waste/fill surface is flat and composed of brown/red iron-rich BOF dust collector material.

- **SWMU S-7/S-20** is approximately 4 acres in size with an average distance of 14 feet from the top of the perimeter berm to the surface of the waste/fill. According to the RFI, the waste/fill within this Unit primarily consists of BOF final thickener and wastewater treatment sludge; none of which exhibited hazardous waste characteristics by TCLP (Ref. 1). The maximum depth of waste/fill is approximately 41 feet. Groundwater is approximately 54 fbgs (average 574.0 feet). The surface of the impoundment is partially covered with non-vegetated, test pads that slope approximately 8 feet from the southwest to the northeast. These test pads were used to evaluate, on a pilot basis, alternate means of stabilizing the waste/fill with various amounts of Portland cement, slag, and other materials. The unit is bounded on the east, west, and south sides by gravel access roads.
- **SWMU S-8** was never used for waste disposal and remains empty except for some small quantity of debris apparently dumped there. The impoundment is approximately 2.7 acres in size and measures approximately 330 feet wide by 360 feet long at the top. The base measures approximately 150 feet wide by 170 feet long. This impoundment is approximately 70 feet deep with steep interior slopes of approximately 1.5:1.
- **SWMU S-27** is approximately one acre in size with an average distance of 7 feet from the top of the perimeter berm to the surface of the waste/fill. According to the RFI, the waste/fill within this Unit primarily consists of dried mill sludge, iron-rich sand filtered backwash sludge, and waste oil; none of which exhibited hazardous waste characteristics by TCLP (Ref. 1). The surface of the waste/fill within this Unit slopes approximately 30 feet from north to south. Dried mill scale and sludge from SWMU S-1 allegedly have been transferred and piled on the surface of this Unit to provide additional capacity in S-1. Groundwater is approximately 55 fbgs (average 572.4 feet). The slope is uniform to undulating and mostly covered with vegetation. The waste/fill is medium to dark brown where exposed with miscellaneous debris.

None of the RFI soil/fill samples collected and analyzed from any of the nine SWMU Group SFA-1 Impoundments exhibited hazardous waste characteristics. Arsenic was detected in waste/fill at several locations (highest concentration was 74.4 mg/kg) well below the site-specific SCO of 118 mg/kg (refer to Section 5.3.1). The observed concentrations are considered typical of steel slag. A comparison of the RFI waste/fill data to ISCOs revealed that only 5 of the 52 RFI waste/fill sample locations had exceedances for constituents of concern: total PAHs were greater than the CP-51 total PAH guidance for non-residential sites of 500 mg/kg in surface (SWMU S-1) and subsurface (SWMU S-5) waste/fill;

naphthalene concentrations in surface (SWMU S-1) and subsurface (SWMU S-5) waste/fill exceeded the ISCO of 1,000 mg/kg; benzo(a)pyrene concentrations in surface waste/fill (SWMUs S-8 and S-27) slightly exceeded the ISCO of 1.1 mg/kg; and lead concentrations slightly exceeded the ISCO of 3,900 mg/kg in SWMU S-3 subsurface fill).

4.3.1.2 SWMU S-21

SWMU S-21, also known as the Scrap Melter Dust Storage Area, is in the eastern portion of SFA Zone 2, south of the ATP SWMU Group (see Plate 4-2). Prior to removal of the waste/fill from this SWMU as discussed in Section 2.3.2, SWMU S-21 was a mostly vegetated roughly conical pile (approximate 50-foot diameter by 12-foot high) of fine-grained and dark reddish-brown scrap melter precipitator dust (iron oxide dust) with an estimated volume of 200 CY. The pile was located within a 2- to 3-foot high bermed area measuring approximately 100 feet wide by 240 feet long with ground surface elevation around the base of the pile at approximately 600 feet. Groundwater is approximately 25 fbgs (average 575.3 feet). To a limited extent, the vegetative cover had stabilized the pile.

The RFI data collected from SWMU S-21 was deemed sufficient based on the nature and limited quantity of waste so no further investigation was called for in the CMS Work Plan. The waste/fill does not exhibit hazardous waste characteristics; arsenic exceeded the Part 375 ISCO at 60.5 mg/kg in one of two waste/fill samples but was well below the site-specific SCO of 118 mg/kg. SWMU S-21 precipitator dust was issued a Beneficial Use Determination (BUD) by the Department on June 14, 2012 for reuse as interim cover in the ATP containment cell. As described in the 2016 CCR for the ATP SWMU Group ECM (Ref. 18), approximately 200 CY of residual waste/fill from SWMU S-21 was placed in the ATP containment cell in October 2015.

4.3.2 SFA Zone 3 SWMU

SWMU S-10, also known as the Slag Quench Area J, is the only SWMU in SFA Zone 3 that is being addressed in this CMS.

4.3.2.1 SWMU S-10 – Slag Quench Area J

SWMU S-10 is located approximately 600 feet north of Smokes Creek and approximately 1,000 feet east of Lake Erie (see Plate 4-2). SWMU S-10 is a sparsely vegetated, approximately 2.7-acre depression excavated into the surrounding slag/fill

measuring approximately 525 feet long, 225 feet wide, and 5 to 20 feet deep (el. 580 to 595 feet). The sidewalls of this SWMU are nearly vertical except at the northern end where a vehicle access ramp leads to the base of the depression. Remnants of former quench water piping are visible on the south and west walls of the excavation.

Molten slag was transported via ladle-carriers from the BOF shop to four slag dumping platforms positioned around SWMU S-10. Molten slag was poured from these platforms into SWMU S-10 and sprayed initially with plant water (i.e., non-potable Lake Erie water) and, in later years, with weak ammonia liquor (WAL) from the coke ovens (sometimes supplemented with Benzol Plant process water) to cool the slag. A 100,000-gallon AST located adjacent to SWMU S-10 stored the WAL mixture before it was sprayed on the hot slag. As indicated in the RFA, BSC officials estimated approximately 800,000 gallons of WAL and Benzol Plant wastewater were used to quench slag between 1970 and 1983. WAL typically contained trace amounts of phenols, ammonia, and cyanide, while the Benzol Plant process water contained various VOC compounds (e.g., benzene, toluene, and xylenes), naphthalene, and various phenolic compounds (Ref. 8). Constituents in the cooling waters that did not evaporate infiltrated into the porous slag/fill. Rainfall and, to a very limited extent, storm water runoff that entered the Unit both during and for decades following its final use in 1983, also infiltrated the slag/fill along its base.

Samples of the slag/fill collected and analyzed from the base of the Unit during the RFI did not contain constituents known to be present in the WAL or Benzol Plant process water. Arsenic was detected in 2 of the 5 samples collected, at concentrations in excess of the Part 375 ISCO but typical for steel slag and below the site-specific SCO of 118 mg/kg. The slag/fill samples collected from SWMU S-10 did not exhibit hazardous waste characteristics based on TCLP analysis. The contaminants in the WAL and Benzol Plant process water have been detected in groundwater monitoring wells downgradient of SWMU S-10.

As liquid, not solid, wastes were disposed in SWMU S-10 over three decades ago, the slag/fill in the pit is not likely a current or on-going source of contamination as substantiated from the test pit analytical data. Groundwater data from adjacent and downgradient monitoring wells is adequate to evaluate and select a remedy.

4.3.2.2 Summary

Table 4-3 summarizes the constituents detected in surface and subsurface soil/fill at concentrations that exceed Part 375 ISCOs. Section 5 develops and evaluates corrective measures to address these exceedances.

4.3.3 SFA Zone 4 SWMUs

SFA Zone 4 includes the following nine SWMUs that are identified below and discussed within this section (see Plates 4-3, 4-4, 4-5, and 4-6):

- S-12 – Asbestos Landfill L
- S-13 – Coal Tar Sludge (Hazardous Waste Management Unit 1B)
- S-14 – General Rubble Landfill N
- S-15 – General Rubble Landfill O
- S-16 – Lime Stabilized Spent Pickle Liquor (SPL) Sludge/Slag Landfill Basin (Hazardous Waste Management Unit 1A)
- S-17 – Vacuum Carbonate Blowdown Landfill Q
- S-18 – Lime Dust and Kish Landfill R
- S-23 – Tar Pit Adjacent to Lime Stabilized SPL Sludge Landfill
- S-28 – Drum Landfill

4.3.3.1 SWMU S-12 – Asbestos Landfill L

SWMU S-12, also known as Asbestos Landfill L, is located north of Smokes Creek, along the southwest edge of SFA Zone 4 and measures approximately 100 feet long by 25 feet wide with a bottom (base of waste/fill) elevation of 578 feet (Ref. 1) (see Plate 4-3). The RFI reported an approximate 5-foot separation between the landfilled materials and groundwater in this area. The 2007 topographic survey indicates that the highest elevation of the landfill cover system is approximately 585 feet. This Unit is an asbestos landfill (Permit No. 2278; Facility No. 15S12) designed and operated from 1980 until steel-making operations ceased in 1983, exclusively for the disposal of asbestos-containing material (ACM) generated during the repair and/or replacement of asbestos insulation by Bethlehem Steel from steel mill operations. ACM disposed within this Unit included pipe and coke oven battery insulation placed in plastic bags, tagged, and sealed prior to disposal. An estimated 450 CY of ACM were placed in the landfill. The facility was permitted by NYSDEC under

NYS Environmental Conservation Law, Article 27, Title 7, Part 360, which allowed no RCRA hazardous wastes or petroleum products to be placed in the Unit. The operation permit expired on June 13, 1981 and was not renewed.

According to the RFI, this Unit was backfilled with ACM to approximately 7 fbgs then covered with a 2- to 3-foot layer of granular slag. A 5-foot slag berm surrounds the landfill on three sides, with the remnants of the construction access ramp on the north side (see Plate 4-3). Surface water runoff is minimized by the surrounding berm and the existing topography of the landfill cover.

No additional investigation of this Unit was called for in the CMS Work Plan. Observations of the cover system by field personnel during the CMS identified some surficial erosion to the slag/fill cover system, as shown in the representative photograph on Plate 4-3. However, no exposure of the asbestos waste or plastic bags was observed.

4.3.3.2 SWMU S-13 – Hazardous Waste Management Unit 1A

SWMU S-13, also known as the Tar Sludge Surface Impoundment or Hazardous Waste Management Unit (HWMU) 1A, is in the south central portion of SFA Zone 4. The Unit measures approximately 290 feet long, 160 feet wide, 13 feet deep; and rises to a maximum height of approximately 8 feet above surrounding grade (see Plate 4-3). The ground surface around the landfill is at an approximate elevation of 609 feet. Groundwater is approximately 38 fbgs (average 571 feet).

According to the RFI, this Unit was operated by Bethlehem Steel as a HWMU from 1978 to 1982 for disposal of an estimated 5,600 CY of coal tar tank bottoms, ammonia absorber acid, and tar decanter sludge. The tar sludge that looks like cured asphalt was stabilized with slag and/or coal fines prior to placement into the Unit. The decanter tank tar sludge meets the definition of a listed hazardous waste (K087) and contains elevated concentrations of VOCs (BTEX) and SVOCs (including naphthalene and PAHs). Unit closure and post-closure were performed by Bethlehem Steel under a Consent Agreement with USEPA and NYSDEC approval. Construction of a multi-layered RCRA final cover system was completed by Bethlehem Steel in October 1988 consisting of:

- A slag layer to raise the elevation of the cell to promote drainage off the SWMU with a 2:1 side slope and a 4% slope across the top.

- A 2-foot layer of clay compacted and tested to have a hydraulic conductivity of less than 1E-8 centimeters per second (cm/s).
- A 60-mil high density polyethylene (HDPE) geomembrane.
- A 1.5-foot soil vegetative layer to assist with plant growth.
- A 0.5-foot topsoil layer that was seeded, fertilized, and mulched.

No additional slag/fill or waste/fill characterization data were collected from this Unit as part of the RFI or this CMS. Groundwater is currently monitored on an annual basis at one upgradient (MW-1U1) and three downgradient (MW-1D2, MW-1D3, and MW-1D4) monitoring wells (see Plate 4-3). The cover system will be inspected during the 2019 annual sampling event and warning signs replaced as needed. Section 4.8 provides further discussion of groundwater in the vicinity of this Unit.

4.3.3.3 SWMU S-14 – General Rubble Landfill N

This Unit is in the northwestern portion of SFA Zone 4 on the west side of Site Highway 11 and immediately north of SWMU S-23 (see Plate 4-4). The SWMU is an above-grade mound that, according to the RFI, contains approximately 57,000 CY of brown, fine- to coarse-grained sand and gravel-like material with scrap metal, construction debris (i.e., bricks, concrete, plastic pipe), wood, slag, and glass (see representative photographs on Plate 4-4). Vegetation is primarily located on the top of the SWMU, while approximately 50 percent vegetative cover exists on the steeply sloped sides (typical slope of 1H:1V to 2H:1V around the perimeter except in the northwest where the slope is typically 6H:1V). SWMU S-14 is roughly oval measuring approximately 450 long at the base, 300 feet long at the top, 130 feet wide, with a maximum elevation of 655 feet. The base is at elevation nominally 610 to 620 feet, covering approximately one acre, overlies approximately 50 feet of slag/fill. Based on groundwater elevations measured in the nearest monitoring wells (approximate elevation of 570 feet), groundwater is approximately 40 to 50 fbgs from the apparent base of the mound.

In December 2010, 10 test pits (S14-TP-1 through S14-TP-09, S14-TP-2A, and S14-TP-5A) were excavated to depths ranging between 15 and 19 feet into the Unit to better characterize and delineate the lateral and vertical extent of the waste/fill in the Unit (see Plate 4-4 for locations) in accordance with the CMS Work Plan. Table 4-4 summarizes the observations and measurements made during test pit excavations. The samples obtained

from the test pits indicate that the Unit is comprised of slag/fill intermixed with debris consisting of brick, steel, plastic, cable, and miscellaneous waste/fill.

Table 4-5 summarizes the results of slag/fill sample analysis from both the CMS and RFI sampling events. These data show that SVOCs are the only parameters analyzed that exceed the Part 375 ISCOs in subsurface fill. Total PAHs exceeded the CP-51 total PAH guidance for non-residential sites of 500 mg/kg in a centralized location proximate to S14-TP-01, -02, -02A, and -03 (see Plate 4-4). Arsenic concentrations in subsurface waste/fill were detected in excess of the ISCO but were less than the site-specific SCO of 118 mg/kg. Based on the aerial and vertical extent of observed SVOC impacts, the quantity of waste/fill in this SWMU is estimated at 16,000 CY. Waste/fill samples collected and analyzed in the RFI did not exhibit hazardous waste characteristics.

4.3.3.4 SWMU S-15 – General Rubble Landfill O

SWMU S-15, also known as the General Rubble Landfill O, is located in the northwestern portion of SFA Zone 4, on the west side of Site Highway 11, and immediately south of SWMU S-28 approximately 650 feet from the Lake Erie shoreline (see Plate 4-3). The SWMU is a small sparsely vegetated fill pile containing approximately 1,000 CY of slag and scrap material from steel production as well as brick rubble, scrap billets, steel and iron buttons, and some tires (see representative photographs on Plate 4-3). The SWMU is roughly oval measuring approximately 150 long, 60 feet wide, and 1.5 to 4 feet above surrounding grade. The base overlies approximately 50 feet of slag/fill. Groundwater is approximately 25 fbgs at the base of the pile. Analytical testing of slag/fill samples from this Unit performed during the RFI did not exceed the Part 375 ISCOs and did not exhibit hazardous waste characteristics.

4.3.3.5 SWMUs S-16 & S-23 – Lime Stabilized Pickle Liquor & Adjacent Tar Pit

SWMU S-16, also known as the Lime Stabilized Pickle Liquor (SPL) Landfill or Hazardous Waste Management Unit (HWMU) 1B, and SWMU-23, also known as the Tar Pit Adjacent to SWMU S-16, are located north of Smokes Creek in the central portion of SFA Zone 4 Sub-Area (see Plate 4-5). Due to their proximity and therefore interdependent disposition, SWMUs S-16 and S-23 have been combined in the context of this CMS as a single SWMU Group. Representative photographs of these SWMUs are also included in Plate 4-5. During the CMS, a tar waste was identified in shallow slag/fill immediately north

of the RFI-defined limits of SWMU S-23. AOC-D was created to identify this location which contained similar waste material (e.g., tar-impacted slag). AOC-D is therefore included with this SWMU Group and discussed further below.

SWMU S-16 covers approximately 0.25 acres and, according to the RFI, was used to neutralize spent pickle liquor (SPL) by pouring the SPL on the in-situ slag, which is over 40 feet thick at this location. The quantity of SPL treated in this manner is not well defined; however, the nominal quantity of SPL generated during the 1973 to 1981 time period that SPL was reported to be treated in this SWMU was on the order of 127,000 gallons per week. The estimated volume of slag impacted by the SPL was 5,900 CY (Ref. 1). A "temporary" 30-mil reinforced polyvinyl chloride (PVC) cover was placed over SWMU S-16 by Bethlehem Steel in June 1986 to limit surface water infiltration. Sometime in late 2005, the PVC cover was destroyed by a severe wind event. No additional investigation of SWMU S-16 was called for in the CMS Work Plan or performed as part of this CMS.

RFI results of Extraction Procedure (EP) toxicity testing (the procedure for determining whether a waste exhibited the hazardous waste characteristic prior to November 1986 when replaced by TCLP) performed on composite waste/fill samples collected from SWMU S-16 did not exhibit hazardous waste characteristics[6]. Additionally, waste/fill samples tested for total constituent analysis in the RFI were all below the Part 375 ISCOs[7]. As documented in a USEPA June 5, 1984 regulatory amendment to 40 CFR 261.3(c)(2), lime stabilized waste pickle liquor sludge from the iron and steel industry was removed from the hazardous waste list on an industry-wide basis.

SWMU-23 is an irregularly shaped Unit surrounding SWMU S-16 on three sides that was historically used to dispose coal tar by-products from coke plant operations and tar tank cleaning, which was typically mixed with coke breeze prior to disposal in a slag pit. The pit was subsequently covered with slag to a maximum elevation of approximately 4 feet above

[6] EP Toxicity testing included analysis for arsenic, barium, cadmium, chromium, lead, mercury, selenium, silver, nickel, and cyanide. The sampling and analysis were completed by BSC as documented in a Delisting Petition in 1984.

[7] Total constituent analysis included arsenic, barium, cadmium, chromium, lead, mercury, selenium, silver, nickel, cyanide, sulfide, total organic carbon, and tetrachloroethene.

surrounding grade. The depth to groundwater is approximately 25 feet below the base of the SWMU S-23.

RFI TCLP results from SWMU S-23 waste/fill samples collected and analyzed in 1994 indicated that the material within this Unit exhibited hazardous waste characteristics for benzene. However, pre-disposal waste characterization of remediated soil/fill related to the 2007 Steel Winds I utility trenching (described in more detail later in this section) indicated that the material associated with this Unit did not exhibit hazardous waste characteristics and was subsequently recycled as non-hazardous. RFI waste/fill samples from SWMU S-23 analyzed for VOCs and total metals were all below Part 375 ISCOs; however, several PAHs were reported at concentrations above their individual Part 375 ISCOs and the CP-51 total PAH guidance for non-residential sites of 500 mg/kg. Table 4-6 summarizes the RFI analytical data.

Per the CMS Work Plan and as part of the CMS in January 2011, 13 test trenches were advanced along the originally defined perimeter of SWMU S-23, as shown on Plate 4-5 and summarized in Table 4-7, in order to better delineate the vertical and horizontal extent of waste/fill within SWMU S-23. Five waste/fill samples were collected from varying intervals within these SWMU S-23 test trenches for TCL VOC and SVOC analyses. These samples are considered representative of the slag/fill immediately below the visually-identified waste and did not contain detectable benzene concentrations except for one sample (S23-TP-15) that contained an estimated benzene concentration of 0.013 mg/kg, which is well below the Part 375 Protection of Groundwater SCO. Therefore, VOC waste/fill constituents do not appear to have migrated in significant quantity from the waste/fill deposited in the Unit.

Visually-impacted (i.e., black tar-like) material was identified within 10 of the 13 test trenches excavated. Once visually-impacted material was identified, each test trench was advanced horizontally until the lateral fill limits were determined. Plate 4-5 illustrates the revised approximate extent of SWMU S-23 based on field observations and the analytical data collected. Waste/fill results from samples collected during the CMS delineation of SWMU S-23 are summarized on Table 4-6. As indicated, no VOCs were detected in slag/fill above the Part 375 ISCOs. Total PAH concentrations were less than the CP-51 total PAH guidance for non-residential sites of 500 mg/kg except for test trench samples S23-TP-02 (2,084 ppm in the 5 to 14 fbgs interval) and S23-TP-08 (503 ppm in the 6 to 11 fbgs

interval). A paint filter analysis performed on the waste/fill indicated that free liquid did not flow from the slag/fill matrix and that the material is suitable for disposal in a solid waste landfill.

The revised waste limits of SWMU S-23 reside in an area covering approximately 33,000 SF at depths between 1 and 17 fbgs, with an average thickness of 6 feet, suggesting a waste volume of approximately 7,500 CY. A discussion of groundwater in the vicinity of SWMUs S-16 and S-23 and the surrounding Groundwater Discharge Sub-Area 4A is discussed in Section 4.8.

4.3.3.6 SWMU S-17 – Vacuum Carbonate Blowdown Landfill Q

SWMU S-17, also known as the Vacuum Carbonate Blowdown Landfill Q, is located north of Smokes Creek in the central portion of SFA Zone 4 covering approximately 0.2 acres (see Plate 4-5). SWMU S-17 consists of two parallel, northwest-southeast oriented trenches (identified as east and west) measuring approximately 300 feet long, 6 to 10 feet wide, and 2 to 4 feet deep terminating in the north at the base of a slag pile. A former railroad bed separates the east and west trenches with a second railroad bed bordering the eastern trench. The railroad beds are elevated approximately 3 to 4 feet above grade. The western side of this unit is bounded by piles of slag gravel elevated approximately 3 to 10 feet above grade. Sparse vegetation covers approximately 75 percent of this Unit.

From the early 1960s to 1983, rail tank cars of spent carbonate waste containing thiocyanate, cyanide, and selenium liquid from a coke oven gas desulfurization (Koppers) process were transported to SWMU S-17 where the liquid was placed in the trenches. The quantity of waste material placed in this Unit is not known.

No solid waste was found in the trenches during the RFI; however, 18 test pits were excavated, and three soil borings were advanced to define the limits of the SWMU based on field observations. Waste/fill samples collected during the RFI identified only mercury at a concentration in excess of its Part 375 ISCO at depth (6-7 fbgs); however, the samples did not exhibit hazardous waste characteristics. The likely source of the mercury was mercury-containing instruments. Cyanide, thiocyanate, and selenium were not considered constituents of concern related to this Unit based on RFI concentrations of waste/fill reported below the ISCOs and Protection of Groundwater SCOs as well as groundwater concentrations below the GWQSs. The lack of cyanide in SWMU S-17 waste material as well as downgradient

groundwater indicates further evaluation is not warranted. No further assessment was called for in the CMS Work Plan; therefore, no additional investigation was performed during the CMS.

4.3.3.7 SWMU S-18 – Lime Dust and Kish Landfill R

As discussed in Section 2.3.2 and more fully in Section 4.3.3.9, all known hazardous waste materials in SWMU-18 (AOCs B & C) were treated, excavated and consolidated into the ATP containment cell for final disposal in 2015 as part of OU-2. SWMU S-18, also known as the Lime Dust and Kish Landfill R, is an irregularly shaped area located in the northwest portion of SFA Zone 4 (see Plate 4-6). This Unit consists of approximately 40 exposed piles of disposed lime dust and Kish placed on the slag/fill surface (see representative photographs on Plate 4-6). Located in the central portion of the Unit there is a sloped mound of lime, Kish, and slag/fill measuring approximately 150 feet long, 75 feet wide, and 1 to 9 feet high above surrounding grade. During the CMS, the subsurface extent of the waste/fill was determined to be approximately 2 fbgs. Groundwater is approximately 35 to 40 feet below the bottom of these piles.

According to the RFI, two waste products of the BOF process, lime dust (calcium oxide) and Kish (consisting primarily of carbon fines), were placed in this Unit from 1966 to 1983. Lime and Kish disposal within SWMU S-18 ceased in 1983 along with steel-making operations. The RFA discusses Basic Oxygen Furnace operations and waste residuals, estimating 91,000 pounds per year of lead-bearing dust from the alloying operation was disposed in the SFA from 1974 to 1982. The wastes generated in 1982/83 were reportedly shipped off-site for disposal as D008 hazardous waste.

Sampling and testing results on fill samples from the RFI indicated elevated levels of lead present in the Kish piles with two samples exhibited hazardous waste characteristic for lead (see Table 4-8). The CMS Work Plan called for a test pit investigation to further characterize and delineate the extent of lead-impacted waste/fill in this Unit; therefore, 35 test pits were excavated in January/February 2011. The CMS test pits revealed lime and Kish waste/fill extending up to 2 feet below surrounding grade with a distinct boundary from the underlying slag (see representative photograph of typical slag/fill profile on Plate 4-6). Based on this vertical assessment, test pit samples were obtained from the 0 to 1 fbgs and 2 fbgs intervals at each test pit location. All 35 samples were analyzed for total lead for the 0 to 1

fbgs interval, six of which were selected for TCLP analysis. Thirteen of the 35 samples collected from the 0 to 2 fbgs interval were selected for total lead analysis based on elevated lead results within the 0 to 1 fbgs interval. Table 4-8 summarizes the analytical results and test pit locations, as shown on Plate 4-6. Table 4-9 summarizes the observations and measurements made during test pit excavations.

As shown on Table 4-8, 12 of the 35 waste/fill samples analyzed from the 0 to 1 fbgs interval exceeded the Part 375 ISCO for lead. None of the samples analyzed from 2 fbgs exceeded this standard. As shown on Plate 4-6, there are three AOCs identified within this Unit with elevated lead. As discussed above and in in Section 4.3.3.9, AOC-B and AOC-C were remediated in 2015. The remaining material in the SWMU consists of approximately 1,800 CY of soil/fill in AOC-A containing lead at concentrations greater than the ISCO and an estimated 2,400 CY of spent lime, for a total estimated residual volume of non-hazardous fill materials associated with SWMU S-18 of 4,200 CY.

4.3.3.8 SWMU S-28 – Drum Landfill

SWMU S-28, also known as the Drum Landfill, is in the southwestern portion of SFA Zone 4 Sub-Area between SWMU S-13 (Tar Decanter Sludge Landfill/HWMU 1A) to the north and SWMU S-15 (General Rubble Landfill O) to the south (see Plate 4-3). SWMU S-28 is identified in the RFA (Ref. 8) as a pit; however, currently the unit is relatively flat and moderately vegetated. The pit was identified in a September 1981 aerial photograph as an extension of SWMU S-13 (Tar Decanter Sludge Landfill). According to the RFI, SWMU S-28 was taken out of service before it was used. Aerial photographs indicate the excavation was backfilled sometime between September 1982 and March 1983. A recent aerial photograph is also provided in Plate 4-3.

During the RFI, five test trenches (TP-1 through TP-5) spaced approximately 25 feet apart covering an area approximately 100 feet by 80 feet were excavated from west to east within the Unit to confirm the presence or absence of suspected buried drums within SWMU S-28. Slag/fill samples were field screened with a PID; readings above background levels were only detected in trench TP-4 along a 40-foot section, approximately 6 to 10 fbgs. A naphthalene-type odor was observed in trenches TP-3, TP-4, and TP-5. No drums or evidence of decomposed drums were identified.

Two waste/fill samples, one each from trenches TP-4 and TP-5, were collected for TCLP and total VOC, SVOC, metals, and cyanide analyses. The trench TP-4 slag/fill sample was collected at approximately 6 fbgs. The trench TP-5 sample was collected at approximately 8 fbgs. Neither waste/fill samples exhibited hazardous waste characteristics. The trench TP-4 sample contained only arsenic at a concentration of 27.2 mg/kg, which is above its Part 375 ISCO but well below the site-specific SCO of 118 mg/kg. No further investigation during the CMS was called for in the CMS Work Plan.

4.3.3.9 Areas of Concern

Five small localized AOCs were identified within SFA Zone 4 of the CMS Area, including AOCs-A, -B, and -C within SWMU S-18; AOC-D north of SWMU S-23 identified in 2006 during the Steel Winds I utility excavation; and AOC-E located north of SWMU S-14 also identified during the Steel Winds I underground utility excavation.

AOCs-A, -B, and -C: Lead-Impacted Areas within SWMU S-18

During the CMS, three lead-impacted AOCs were identified within SWMU S-18 (see Plate 4-6). The largest area, AOC-A, includes those CMS waste/fill sample locations with lead concentrations in excess of the Part 375 ISCO but not exhibiting hazardous waste characteristics based on TCLP. AOC-A is estimated to contain 1,800 CY of Kish waste/fill impacted with lead above the ISCO but does not exhibit hazardous waste characteristics. As described in the July 2016 Construction Completion Report (CCR) for Operable Unit 2 & 3 ECM (Ref. 18), an estimated 160 CY of residual waste from AOC-B and 320 CY of waste/fill from AOC-C were mechanically mixed in-situ with Portland cement across the impacted area in one 30-inch lift using a tracked hydraulic excavator. Following confirmatory samples to verify TCLP lead<5 mg/L, the stabilized residuals were placed into the ATP containment cell for final disposal on October 12, 2015. Final restoration of AOC-B and AOC-C included grading the perimeter of the excavations with a tracked dozer to achieve 2:1 slopes to eliminate slip, trip and fall hazards. All work was completed by November 4, 2015.

AOCs-D and -E: Steel Winds I Utility Trench Excavation

Prior to the CMS and during utility trenching activities between wind turbines WT-7 and WT-8 for the Steel Winds I project in November 2006, three tar-impacted areas were

identified (two of which are included within AOC-D and one separate, localized area within AOC-E). These impacted areas were located east of the BCP Steel Winds parcel and within SFA Zone 4, just north of SWMU S-23 (see Plate 4-5). Delineation of these tar-impacted AOCs was subsequently performed. The first area within AOC-D measured approximately 20 feet wide by 25 feet long by 6 inches thick and the other approximately 15 feet wide by 50 feet long by 3 inches thick. The orphan AOC-E measured approximately 30 feet wide by 20 feet long by 3 feet thick. Once delineated, all visually tar-impacted material from each excavation was placed on and covered with poly-sheeting.

In May 2007, representative aliquots from all three spoil piles were composited and submitted for waste characterization analysis (specifically, TCLP VOCs, TCLP SVOCs, RCRA metals, corrosivity, reactivity, and flashpoint). Analytical results indicated that the stockpiled tar-impacted material did not exhibit hazardous waste characteristics. From late July to early August 2007, based on this waste profile, approximately 545 tons of tar-impacted material was transported to Piney Creek L.P. (Piney Creek), a 32-megawatt net capacity electric generating plant located in Clarion, Pennsylvania, and reused as an alternate waste fuel by co-combustion with coal.

To further delineate the vertical and horizontal extent of those tar-impacts identified in 2007, 10 additional test trenches were advanced north of SWMU S-23 in January 2011, as shown on Plate 4-5 and summarized in Table 4-7. Delineation of the western perimeter of AOC-D was precluded by the presence of SWMU S-14, a sheer-walled monolith of slag/fill and debris (see representative photographs on Plate 4-5). Two slag/fill samples were collected from varying intervals within these test trenches for TCL VOC and SVOC analyses. As with the samples collected for SWMU S-23, one of the samples was representative of the waste material and the other collected just outside the identified limits of visually identified waste.

Visually impacted (i.e., black tar-like) fill material was identified within 4 of the 10 test trenches excavated. Once visually impacted fill material was identified, each test trench was advanced horizontally until the lateral waste/fill limits were determined. Plate 4-5 illustrates the approximate extent of AOC-D based on field observations and the analytical data collected. Table 4-6 summarizes the slag/fill results from CMS samples collected both within and beneath the visually impacted interval to delineate AOC-D. As indicated, no VOCs were

detected above the Part 375 ISCOs and total PAH concentrations were less than the CP-51 total PAH guidance for non-residential sites of 500 mg/kg.

The limits of the waste/fill within AOC-D are not well defined beneath SWMU S-14 to the west, but based on the known limits, approximately 10,000 SF of aerial extent with an average thickness of 6 feet, suggests a waste volume of approximately 2,500 CY. As such, the areal coverage and volume of associated waste for AOC-D may increase slightly due to this uncertainty. Section 4.8 includes a discussion of groundwater quality in the vicinity of AOC-D.

4.3.4 SFA Zone 5

There were no SWMUs identified within SFA Zone 5 during the RFI. Two small localized AOCs were identified within SFA Zone 5, including AOC-F encountered and remediated during slag reclamation activities in 2010; and AOC-G identified during Steel Winds II foundation excavation activities at WT-9.

4.3.4.1 AOC-F: Iron City Slag Reclamation

During slag reclamation activities in March 2010, a deposit of tar-impacted slag was encountered and reported to the NYSDEC (see Plate 4-7). This area of concern, herein identified as AOC-F, was subsequently delineated via test pits in June 2010 and determined to be approximately 80 feet wide by 90 feet long by 4 feet deep. Based on the test pit delineation, excavation of tar-impacted slag was performed in September 2010 following consultation with the NYSDEC until visual, olfactory, and PID evidence indicated the impact had been removed. Approximately 1,065 CY of tar-impacted slag material was excavated and transported via tandem dump truck to the ATP-ECM Containment Cell where it was placed and temporarily covered with a minimum of 6 inches of soil until construction of the ATP final cover system occurs in 2012. Plate 4-7 includes representative photographs.

4.3.4.2 AOC-G: Steel Winds II WT-9 Foundation Excavation

During wind turbine WT-9 foundation excavation activities in October 2011, a small, localized deposit of tar-impacted slag/fill was encountered and reported to the NYSDEC (see Plate 4-7). This area, herein identified as AOC-G, was subsequently remediated following consultation with the NYSDEC until visual, olfactory, and PID evidence indicated

the impact had been removed. Approximately 1.5 CY of tar-impacted slag material was excavated and transported via tandem dump truck to the center of the ATP-ECM Containment Cell where it was ultimately spread out to match the existing grade and covered with a minimum 6-inch temporary soil cover.

4.3.5 Summary

Table 4-3 summarizes the constituents detected in surface and subsurface soil/fill at concentrations that exceed Part 375 ISCOs. Section 5 develops and evaluates corrective measures to address these exceedances.

4.4 Coal, Coke, and Ore Handling & Storage Sub-Area

There are two SWMUs located within the Coal, Coke, and Ore Handling & Storage Sub-Area: Murphy's Mountain Landfill AA (S-19) and the Landfill/ Impoundment: Under North End of Coal Pile/Handling Storage Area (S-25). Each SWMU is discussed separately below. Appendix N contains SWMU surface and subsurface soil sample RFI analytical data tables with comparisons to Part 375 ISCOs and Protection of Groundwater SCOs.

4.4.1 SWMU S-19 – Murphy's Mountain Landfill AA

SWMU S-19, also known as Landfill AA (Murphy's Mountain), is an oval-shaped pile located immediately west of the Coke Oven coal storage area and east of Highway 11 (see Plate 4-8). The pile consists of approximately 51,000 CY of steel-making slag reclamation debris, measuring approximately 15 feet high, 1,300 feet long (north to south), and 350 feet wide (east to west). This Unit covers approximately 10 acres and is sparsely vegetated. The east slope of the pile is steeper than the west slope; both sides reveal traces of lump ore, ore pellets, slag, and construction debris on their surfaces. Groundwater in the underlying fill unit is approximately 27 fbgs.

This Unit was constructed as a windbreak by Bethlehem Steel in 1980 to reduce fugitive dust emissions from coal storage piles located adjacent and east of the pile. The slag/fill material was transported from SFA Zone 5 via off-road trucks and bulldozed with a steeper slope on the east side (leeward) and a shallower slope on the west side (windward).

Analytical testing of slag/fill samples from SWMU S-19 collected during the RFI did not identify any exceedances of the Part 375 ISCOs except for a slight exceedance of

benzo(a)pyrene at one surface (0-0.5 fbgs) and one subsurface location (4-14 fbgs). Although arsenic (S19-3, 54.6 mg/kg, 0-0.5 feet) exceeded the ISCO in 1 of the 9 slag samples tested, the concentration is well below the site-specific SCO of 118 mg/kg. TCLP analytical results from the RFI indicated that the waste/fill samples do not exhibit hazardous characteristics. SPLP results from three surface samples indicate an exceedance of the GWQS for methylene chloride, believed to be a laboratory introduced contaminant. SPLP results in one subsurface (8-10 fbgs) sample exceeded GWQS for ethylbenzene, toluene and xylene. Additional sampling was not called for in the CMS Work Plan nor was any performed during the CMS.

4.4.2 SWMU S-25 – Landfill/Impoundment under North End of Coal Pile

SWMU S-25 is a roughly circular area measuring approximately 280 feet in diameter (approximately 1.4 acres) located at the northern end of the coal storage area west of Coke Oven Battery No. 8 (see Plate 4-8). This SWMU was identified from 1951, 1955, and 1959 historical aerial photographs as possibly containing pits or depressions. Closer inspection and consultation with employees familiar with operations in that area during the RFI led to the conclusion that this SWMU was, in fact, a pile roughly circular in shape, surrounded by a depression, where materials were removed for metals reclamation. This pile is not observed in aerial photographs after 1961.

Currently, the SWMU is generally flat with no indication of depressed topography and covered at the surface by coal fines. Groundwater beneath this unit is present in two distinct units; the fill unit and the underlying sand unit.

The RFI included collection and testing of four slag/fill samples from this Unit. Analytical testing of slag/fill samples from this Unit did not exhibit any exceedances of the Part 375 ISCOs. Additional investigation was not called for in the CMS Work Plan nor was any performed during the CMS.

4.4.3 Summary

Table 4-3 summarizes the constituents detected in surface and subsurface soil/fill at concentrations that exceed Part 375 ISCOs. Section 5 develops and evaluates corrective measures to address these exceedances.

4.5 Tank Farm SWMU Group Sub-Area

SWMUs P-8, P-74, and P-75 are collectively known as the Tank Farm SWMU Group or Sub-Area (see Plate 4-9). The RFA identified SWMU P-8 as the Waste Oil Storage Tanks within the Tank Farm, P-74 as the Waste Piles within the Tank Farm, and SWMU P-75 as the Tank Farm. The Tank Farm SWMU Group is in the central portion of the CMS Area, north of Smokes Creek and west of Highway 9, and consists of approximately 18.7 acres with a 6- to 10-foot high perimeter slag/fill berm. Table 4-10 summarizes the 21 aboveground storage tanks (ASTs) formerly located within the Tank Farm Sub-Area, including seven large tanks (Nos. 1 through 7) and 14 small tanks (Nos. 1 through 11, 15, 16, and 31).

Concrete tank foundation pads are all that remain of the former tanks. The remainder of the Tank Farm Sub-Area surface is primarily slag/fill with some coal and coal fines. Some scrub vegetation exists throughout the Tank Farm Sub-Area as well as on the containment berms. Petroleum-like surficial staining (suspected No. 6 fuel oil) was observed at three locations (approximately 120 SF; 1,200 SF and 2,300 SF) beneath areas where overhead piping once existed (see Plate 4-9). The former Coke Oven Laboratory building is the only remaining large structure within the Tank Farm Sub-Area.

SWMU P-74 formerly consisted of four small waste piles placed within SWMU P-75 containing tank bottoms material cleaned from the Tank Farm tanks in 1987. During the CMS, the locations and remnants of the waste piles described in the RFI could not be confirmed via visual assessment (e.g., RFI reported thin, hardened lenses of asphalt-like material at the surface). The location of these piles, however, are included on Plate 4-9 based on RFI drawings and have been identified herein as SWMU P-74A, P-74B, P-74C, and P-74D.

SWMU P-8 is in the southeastern area of the Tank Farm (P-75), and historically contained two steel ASTs (Nos. 1 and 2) located approximately 125 feet east of Tar Tank No. 5 (see Plate 4-9). Total capacity for each tank was 210,000 gallons. The ASTs were historically used for storage of a variety of petroleum products including No. 6 fuel oil and waste oils. During the winter of 1994/1995, both tanks were emptied, cleaned, dismantled, and recycled for scrap. Currently, two concrete pads are all that remain of these tanks.

During the RFI, eight surface slag/fill (four from 0-0.5 fbgs and four from 0-1.0 fbgs), three composite subsurface (2-6, 4-8, and 1-10 fbgs), and four grab subsurface (two

from 4-6 fbgs, one from 8-10 fbgs, and one from 6-8 fbgs) samples were collected from SWMU P-75. Appendix N contains SWMU surface and subsurface soil sample RFI analytical data tables with comparisons to Part 375 ISCOs and Protection of Groundwater SCOs. Examination of the RFI results indicated no VOCs detected above the Part 375 ISCOs; several PAHs exceeded their respective individual Part 375 ISCOs; four surface slag/fill and two subsurface slag/fill samples exceeded the CP-51 total PAH guidance for non-residential sites of 500 mg/kg; and mercury was detected above the Part 375 ISCO at only one surface slag/fill location. Although arsenic concentrations exceeded the Part 375 ISCO at surface and subsurface slag/fill locations, concentrations were below the site-specific SCO of 118 mg/kg. Only one subsurface slag/fill RFI sample (P75-B01 from 4-6 fbgs) exhibited elevated TCLP benzene.

During the CMS, however, test pit P75-TP-53 was advanced in the vicinity of this RFI boring (P75-B01) and subsurface slag/fill samples from the same interval (4-6 fbgs) were determined not to exhibit hazardous waste characteristics based on TCLP analysis. The difference between the RFI and CMS TCLP lead results could be a function of constituents leaching over time, degradation of the waste and/or heterogeneity of the waste; however, the CMS sample is considered representative of the soil/fill material in this area of the Tank Farm.

RFI surficial slag/fill samples detected the presence of total PAHs in excess of the CP-51 total PAH guidance for non-residential sites of 500 mg/kg at locations P-74A, P-74C, and P-74D. These same surficial slag/fill samples did not exhibit hazardous waste characteristics. Arsenic exceeded the Part 375 ISCO at locations P-74B (90.3 mg/kg) and P-74D (35 mg/kg); however, these concentrations are below the site-specific SCO of 118 mg/kg. Mercury exceeded the Part 375 ISCO at locations P-74A (10.5 mg/kg) and P-74C (6.2 mg/kg). VOCs were well below Part 375 ISCOs.

RFI waste profile characterization of petroleum products contained within SWMU P-8 Tanks No. 1 and 2 indicated that the stored materials were not characteristically hazardous based on TCLP analysis. During the RFI, two surface (0-0.5 fbgs), two composite subsurface (12-18 fbgs and 2-12 fbgs), and two grab subsurface (16-18 fbgs and 4-6 fbgs) slag/fill samples were collected from SWMU P-8. Examination of the RFI results indicated: no VOCs detected above the Part 375 ISCOs; several PAHs exceeded their respective individual Part 375 ISCOs; both surface slag/fill and one subsurface slag/fill sample

exceeded the CP-51 total PAH guidance for non-residential sites of 500 mg/kg; and mercury was detected above the Part 375 ISCO at only one surface slag/fill location. Although arsenic concentrations exceeded the Part 375 ISCO at one surface slag/fill and one subsurface slag/fill location, concentrations were below the site-specific SCO of 118 mg/kg. All slag/fill samples were determined not to exhibit hazardous waste characteristics.

From July to August 2010 in support of the CMS Work Plan, 41 initial test pits (P75-TP-1 through P75-TP-41) and 63 delineation test pits (identified by letters A, B, C, etc.) were excavated within the Tank Farm Sub-Area as shown on Plate 4-9 to better delineate the impacts from petroleum products in surface and unsaturated subsurface slag/fill. An additional 13 test pits (P75-TP-42 through P75-TP-54) were then excavated in January 2011 as part of a CMS supplemental test pit investigation. Visual observations for the presence of dark tar or heavy petroleum oil staining as well as hand-held PID readings were the primary tools used to delineate the extent of contamination. Table 4-11 summarizes the observations and measurements made during these test pit excavations. Slag/fill samples were tested for TCL VOCs (Method 8260) and SVOCs (Method 8270) and total RCRA metals (Method 6010B). Soil/fill samples were collected from visually impacted and non-impacted locations to characterize both observations. Certain visibly impacted slag/fill samples were also tested for TCLP benzene and ignitability to assess whether the visibly impacted slag/fill exhibited hazardous waste characteristics. The samples were collected from test pits with observed NAPL impact, two from test pit P75-TP-53 (1-4 fbgs and 4-8 fbgs) and one from P75-TP-54 (3-4 fbgs) as shown on Plate 4-9. Table 4-12 summarizes the slag/fill analytical data.

In general, slag/fill in the Tank Farm Sub-Area consists of varying percentages of slag, coal, and coke fines with occasional pieces of steel and miscellaneous debris. The slag/fill extends to depths of 10 to 40 fbgs based on borings completed for the CMS and RFI. Observations during CMS test pit excavations identified a smaller localized presence of non-aqueous phase liquid (NAPL), primarily along the eastern boundary of the Tank Farm Sub-Area, which appears to be confined in the unsaturated zone of the slag/fill. Plate 4-9 delineates the areas of visual NAPL impact and staining.

Slag/fill samples were selected for analytical testing to better define the nature and degree of petroleum impacts to slag/fill (see Plate 4-9). Representative visibly impacted slag/fill samples were selected from heavily impacted slag/fill (NAPL present; test pit shown in red on Plate 4-9), visually-impacted slag/fill (without NAPL), and slag/fill that was not

impacted. Table 4-12 summarizes the results of CMS slag/fill testing. In general, the analytical results correlate well with the visual assessment: all of the CP-51 total PAH guidance exceedances for non-residential sites of 500 mg/kg occurred in slag/fill samples with heavy petroleum impacts (e.g., P75-TP-02; 1-12 fbgs and P75-TP-09; 1-6 fbgs); slag/fill samples with marginal visual impact (e.g., P75-TP-7B; 2-7 fbgs) did not show PAHs in excess of the CP-51 total PAH guidance for non-residential sites of 500 mg/kg; and slag/fill samples with no visual impacts (e.g., P75-TP-48; 0-15 fbgs and P75-TP-52; 0-16 fbgs) did not show elevated concentrations of any compound analyzed in excess of the individual Part 375 ISCOs (including the CP-51 total PAH guidance for non-residential sites of 500 mg/kg). The VOCs and SVOCs detected in visibly impacted slag/fill are generally consistent with the petroleum products stored in the former tanks. VOCs detected in slag/fill did not exceed the Part 375 ISCOs. RCRA metals were tested on nine slag/fill samples. Mercury exceeded the Part 375 ISCO in sample P-75-TP-02 (1-12 fbgs). Arsenic exceeded the Part 375 ISCO in two samples; however, the concentrations were below the site-specific SCO of 118 mg/kg.

Sample P75-B01 (4-6 fbgs) from the RFI exhibited hazardous waste characteristics for benzene. As part of the CMS investigation, one test pit was excavated to verify this previous result and to better define the extent of impacts. Test pit P75-TP-53 was excavated in the proximate area of RFI boring P75-B01, and samples were obtained from two depth intervals (1-4 fbgs and 4-6 fbgs) for analysis of TCLP benzene and ignitability. The results did not exhibit hazardous waste characteristics for benzene or ignitability. Ignitability testing was also performed for sample P75-TP-54 (3-4 fbgs), where heavy petroleum impacts were observed; the sample did not exhibit the ignitability characteristic.

The volume of SVOC-impacted slag/fill in this area exceeding the Part 375 ISCOs is estimated at approximately 60,000 CY based on lateral and vertical extent as shown on Plate 4-9: approximately 31,350 CY from the 0 to 4 fbgs interval; 14,250 CY from the 4 to 8 fbgs interval; and 14,400 CY from the 8 to 12 fbgs interval.

4.5.1 Areas of Concern

Two AOCs were identified along the eastern edge of the Tank Farm Sub-Area during installation of electric transmission poles for the Steel Winds II project in October 2011. AOC-H and AOC-I were identified as small, localized deposits of tar-impacted slag/fill and reported to the NYSDEC (see Plate 4-9). Subsequently, each AOC was remediated following

consultation with the NYSDEC until visual, olfactory, and PID evidence indicated the impact had been removed. Approximately 85 CY of tar-impacted slag material was excavated and transported to the ATP-ECM Containment Cell where it was consolidated with other waste fill for final disposal as part of OU-2.

4.5.2 Summary

Table 4-3 summarizes the constituents detected in surface and subsurface soil/fill at concentrations that exceed Part 375 ISCOs. Section 5 develops and evaluates corrective measures to address these exceedances.

4.6 Former Coke Plant & By-Products Sub-Area

The former coking and by-products operations located in the northeast corner of the CMS Area and adjacent to the Gateway Metroport Ship Canal (see Plates 4-10 through 4-14) operated from 1903 until metallurgical coke production ceased in September 2001. From 1903 to 1922, regenerative coke ovens without by-product recovery were operated at the Site. Since 1920, nine by-product coke oven batteries were constructed and operated at the Site; no more than seven batteries were operated at one time. From 1978 to 2001, operations were limited to three batteries (Nos. 7, 8, and 9).

SWMUs identified in the RFI as requiring further assessment and associated with the Coking and By-Products Facilities include three subgroups that reflect similar operations, proximate locations, and/or similar waste/fill characteristics are listed below.

- Quench Pit SWMU Sub-Group P-1 through P-6
  - P-1 – Quench Water Pit, North Station
  - P-2 – Quench Water Pit, Arctic Station
  - P-3 – Quench Water Pit, Central Section
  - P-4 – Quench Water Pit, A Station
  - P-5 – Quench Water Pit, B Station
  - P-6 – Lime Sludge Settling Basin
- SWMU Sub-Group P-7, P-9, & P-10
  - P-7 – Abandoned Lime Sludge Settling Basin
  - P-9 – Abandoned Tar Decanter Sludge Pits
  - P-10 – Contaminated Soil Near Ball Mill

- Benzol Plant Storage SWMU Sub-Group
  - P-11 – Benzol Plant Tank Storage Area
  - P-11A – Old Benzol Plant Tank Storage Area
  - P-12 – Spill Cleanup Soil Storage Area
- P-18 – Blast Furnace Cooling Tower and Hot and Cold Wells
- S-26 – Fill Area Near Coke Battery No. 8

These SWMUs have been grouped in the CMS based on their proximate locations and/or association with former Coke Plant and By-Product Facility operations and/or waste disposal procedures by BSC. One additional Unit (i.e., Old Benzol Plant Tank Storage Area designated as SWMU P-11A) was identified during the CMS and herein added to the Coke and By-Products SWMU Group list. Appendix N contains SWMU surface and subsurface soil sample RFI analytical data tables with comparisons to Part 375 ISCOs and Protection of Groundwater SCOs.

4.6.1 Quench Pit SWMU Sub-Group

SWMUs P-1 through P-5 encompass the five Coke Oven Quench Water Pits used to receive and recycle quench water used in coke-making operations at the Site until September 2001 when coke-making operations ceased. These five SWMUs are in the Coke Oven Sub-Area between Site Highways 8 and 9, west of the Coke Ovens, and approximately 500 feet west of the Ship Canal (see Plate 4-10). SWMU P-6, which has been added to this SWMU group because of its similar construction and function, is known as the Lime Sludge Settling Basin located west of the Ship Canal in the central Coke Oven Area. All six SWMUs in this Sub-Group are open top, reinforced, and mostly below grade concrete structures containing water and coke product residuals and sediment. In July 2011, all six SWMUs were identified in the field, photographed, and sounded for volume of water and sediment determinations. Table 4-13 summarizes the dimensions, capacity, and accumulated water/sediment volumes of the six concrete structures. Plate 4-10 presents representative photographs.

A brief description, historical use, and RFI analysis of each SWMU follows:

- *SWMU P-1*: This quench water pit is located immediately southwest of Coke Oven Battery No. 7 and is approximately 75 feet long, 15 feet wide, and 11 fbgs with 18-inch thick reinforced concrete walls. Approximately 60,000 gallons of water and approximately 105 CY of sediment are contained within this SWMU.

The top of the pit lies approximately 3.5 feet above existing grade. While in operation from 1970 to 2001, SWMU P-1 collected quench water from Coke Oven Battery No. 7.

- *SWMU P-2*: This quench water pit is located northwest of Coke Oven Battery No. 8 and is approximately 77 feet long, 16.5 feet wide, and 10 fbgs with 12-inch thick reinforced concrete walls. Approximately 24,000 gallons of water is contained within this SWMU. Recoverable quantities of solid residuals (sediment) were not identified. The top of the pit lies approximately 3.5 feet above existing grade. While in operation from 1952 to 2001, SWMU P-2 collected quench water from Coke Oven Battery No. 8.
- *SWMU P-3*: This quench water pit is located at the southwest corner of Coke Oven Battery No. 9 and is approximately 160 feet long, 11 feet wide, and 15 fbgs with 18-inch thick reinforced concrete walls. Approximately 20,000 gallons of water is contained within this SWMU. Recoverable quantities of solid residuals (sediment) were not identified. This pit was constructed in 1919 to collect quench water from Coke Oven Battery Nos. 1, 2, and 3, which were constructed in the early 1920s, until the pit was taken out of service in the early 1970s; around the time Battery No. 1 was replaced with Battery No. 9. The pit was later used as a collecting pit for water from the wharf sump pump, a receiver for non-contact cooling water from a coal-handling fire pump, and a low-flow continuous discharge point from two small-diameter plant water lines to prevent freezing of those lines.
- *SWMU P-4*: This quench water pit is in the central portion of the Coke Oven Area, midway between the Crusher Building and the Salt House Exhauster Building. This pit is approximately 51 feet long, 9 feet wide, and 10 fbgs with 12-inch thick reinforced concrete walls. Approximately 10,500 gallons of water is contained within this SWMU. Recoverable quantities of solid residuals (sediment) were not identified. The top of the pit lies approximately 3.5 feet above existing grade. While in operation, SWMU P-4 collected quench water from Coke Oven Battery Nos. 3, 4, 5, and 9. This pit was taken out of service in 1990, following the dismantling of batteries Nos. 3, 4, and 5 and the shutdown of Battery No. 9.
- *SWMU P-5*: This quench water pit is located at the southern end of former Coke Oven Battery No. 6 and is approximately 50 feet long, 15 feet wide, and 13 fbgs with 18 inch thick reinforced concrete walls. Approximately 17,000 gallons of water and approximately 90 CY of sediment are contained within this SWMU. The top of the pit lies approximately 2 feet above existing grade. While in operation from the early 1940s until the late 1970s, SWMU P-5 collected quench water from Coke Oven Battery Nos. 5 and 6. In 1985, Coke Batteries No. 5 and No. 6 were demolished leaving only this pit. In late 1985 or early 1986, area storm

water was directed to this pit. From 1989 to 2001 when the plant closed, condensate from a steam-energized water heater within the Coke Oven office was also discharged to the pit.

- *SWMU P-6:* This pit is 95 feet long, 10 feet wide, and 14 fbgs. The reinforced concrete walls are 12-inches thick and extend approximately 3 feet above grade. Approximately 90,000 gallons of water is contained within this SWMU. Recoverable quantities of solid residuals (sediment) were not identified. This pit was used for the settling of ammonia still lime sludge (ASLS) prior to 1983. In 1983, BSC began using soda ash instead of lime. This pit was taken out of service in 1994.

In July 2011 and again in July 2014, field reconnaissance of SWMUs P-1 through P-6 was performed. Although some spalling and chipping was observed, this aboveground and exposed surfaces part of the reinforced concrete structures surrounding all six SWMUs appears to restrict storm water run-on and/or run-off from occurring. No visible cracks or deterioration were noted in any of the concrete structures. Impounded surface water observed within each pit is believed to be mostly the result of stored precipitation or possibly groundwater seepage, as these pits have been inactive for more than a decade. Water within SWMUs P-2 through P-6 appears black while water within SWMU P-1 was covered with green algae.

Grab samples of water from SWMUs P-1 through P-6 were obtained by TurnKey in July 2014. Samples were tested for Priority Pollutant VOCs, SVOCs, total metals, cyanide, nitrogen (ammonia), and total phenolics. Table 4-14 summarizes the analytical results.

All detected concentrations were below 1 mg/L except for ammonia (40 mg/L) and zinc (3.346 mg/L) in SWMU P-2. Solid (e.g., sediment) residual samples from the pits were not collected during the RFI. Residual solids, where recoverable amounts were present (i.e., in SWMUs P-2 and P-5), were collected during the July 2014 site reconnaissance. Testing included TCL VOCs, TCL SVOCs, TAL metals, and cyanide.

Table 4-15 summarizes the analytical results of the residuals testing. The concentrations of detected compounds fall below the ISCOs except for benzo(a)pyrene and arsenic. However, using the site-specific values of 500 mg/kg for total PAHs and 118 mg/kg for arsenic, all results meet the site-specific SCOs.

The RFI data included sampling of near surface slag/fill samples proximate to P-1 to P-6; there were no exceedances of the Part 375 ISCOs.

4.6.2 SWMU Sub-Group P-7, P-9, & P-10

As described in Section 2.3.2, approximately 1,200 CY of the hazardous waste/fill material in SWMU P-9 and a portion of the SWMU P-10 waste that overlaid SWMU P-9 were treated with Portland cement in October 2015 to reduce the TCLP benzene concentrations to below 0.5 mg/L (refer to Plate 4-11). Once the treatment objective was met, the treated waste/fill was loaded, transported and consolidated with other waste/fill in the ATP containment cell for final disposal as part of OU-2. The SWMU was backfilled with BUD-approved slag to existing grade in October 2015.

This SWMU Sub-Group consists of the Abandoned Lime Sludge Settling Basin (P-7), Abandoned Tar Decanter Sludge Pit (P-9), and Contaminated Soil near the former Ball Mill (P-10), and is located west of the Ship Canal in the central Coke By-Products Sub-Area (see Plate 4-11).

SWMUs P-7 and P-9 containment structures consist of below ground reinforced rectangular concrete pits that were decommissioned and backfilled in 1960. Due to nearby tar decanter tank demolition activities in November 2005 and the resulting heavy equipment traffic, both SWMUs were unidentifiable from the surface during the CMS. A test pit investigation (described later in this section) of these SWMUs exposed the tops of each pit, and field measurements and representative slag/fill samples were obtained. Field measured dimensions when compared with the record drawings allowed the accurate identification of each Unit. Perched water and sloughing of loose slag/fill within each Unit precluded visual confirmation of a concrete bottom; however, a hard and resistant bottom was encountered. SWMUs P-7 and P-9 are further described below.

- *SWMU P-7*: Field measurements confirmed that the walls of this SWMU are 18 inches thick. Record drawings indicate an 18-inch thick floor and a pit that is divided east and west into two sections of equal size. The dimensions of P-7 are 42 feet long by 28 feet wide by 14 feet deep (from grade), for an estimated volume of residuals of 510 CY.
- *SWMU P-9*: Field measurements confirmed that the walls of this SWMU are 12 inches thick. Record drawings indicate an 18-inch thick floor. The dimensions of P-9 are approximately 51 feet long by 37 feet wide by 14.5 feet deep (from grade), for an estimated volume of residuals of 1,000 CY.

When these Units were active, the walls of the pits extended approximately 3 feet above existing grade. Grade elevation on the record drawings was shown to be 583 feet, which is consistent with the current ground elevations in this portion of the CMS Area.

SWMU P-10 covered an area measuring approximately 20 feet by 30 feet, where a tar spill occurred in the 1980s. At that time, the tar and impacted slag/fill was removed, recycled by blending with coal, and used in the Coke Ovens. In July 1994, this area was covered with an asphalt pad measuring 30 feet wide and 35 feet long, with an earthen berm on the north, south, and west sides. In November 2005, demolition activities related to the adjacent tar decanters and associated piping obscured any evidence of the asphalt pad and perimeter berms. The field location of this SWMU could only be approximated based on the known location of nearby SWMUs P-7 and P-9 and record drawings indicating the location of the former Ball Mill.

As called for in the CMS Work Plan, a test pit investigation of SWMUs P-7 and P-9 was performed in January 2011. Initially, surficial material was removed from both concrete structures in order to locate and survey the subsurface concrete walls of each SWMU. One test pit (P7-TP-01) was excavated near the center of SWMU P-7 pit (see Plate 4-11). As described in Table 4-16, the fill materials observed within SWMU P-7 included 2-feet of coal and coke fines on top of sand and gravel sized-slag with petroleum-like odors extending to a depth of 9.5 fbgs. As previously stated, perched water and sloughing of loose slag/fill within the Unit prevented visual confirmation of a concrete bottom although a hard, resistant bottom was confirmed. Two composite samples of pit residuals were collected for TCL VOC (Method 8260B) and TCL SVOC (Method 8270C) analysis; one from SWMU P-7 (2 to 9.5 fbgs).

As shown on Table 4-17, surface fill samples collected during the RFI from SWMU P-7 indicated several individual PAHs above the Part 375 ISCOs although the total PAH concentration was below the CP-51 total PAH guidance for non-residential sites of 500 ppm. Subsurface fill sample results reported during the CMS investigation, however, were all well below Part 375 ISCOs. RFI testing also included TCLP analysis of two subsurface fill samples (14-14.5 fbgs and 14-15.2 fbgs), which indicated that the residuals of SWMU P-7 do not exhibit hazardous waste characteristics.

During the RFI, one surface fill sample (0 to 2 fbgs) was collected from SWMU P-10 and analyzed for TCL VOCs, TCL SVOCs, TAL metals, and TCLP. Only total PAHs (587

mg/kg) exceeded the CP-51 total PAH guidance for non-residential sites of 500 ppm. The fill sample did not exhibit hazardous waste characteristics. Additional sampling of SWMU P-10 was not called for in the CMS Work Plan nor was any performed. In July 2011 during additional site reconnaissance of nearby SWMUs, residual tar blebs were observed at the surface east of the decommissioned tar decanter tanks in the general vicinity of SWMUs P-7 and P-10. Upon further visual assessment, the blebs appeared to be relatively small and localized. It is suspected these blebs are remnants of the November 2005 tar decanter decommissioning activities performed immediately west of their location.

4.6.3 Operable Unit 4, formerly Benzol Plant Storage Group (SWMUs P-11, P-11A, & P-12)

SWMUs P-11, P-11A & P-12 are part of the larger Coke Plant By-Products SWMU Group and have been addressed as Operable Unit 4 (OU-4) as discussed in Section 2.3.1. The final remedy for the groundwater associated with this SWMU Group is to pump contaminated groundwater from the area of the Benzol Yard (P-11 and P-12) and the general area of the Old Benzol Yard (P-11A), treat the groundwater, maintain hydraulic control over the OU-4 area (i.e., maintain an inward gradient from the Gateway Metroport Ship Canal toward the collection wells, westerly), and treat the source areas. The CCR for OU-4 will describe the remedy in detail. Below is a description of the SWMUs associated with OU-4 prior to its implementation.

4.6.3.1 SWMU P-11 – Benzol Plant Tank Storage Sub-Area

SWMU P-11, also known as the Benzol Plant Tank Storage Sub-Area, is located within the Benzol Plant facility (see Plate 4-12). The Benzol Plant, located at the southern end of the Coke Division facility, measures approximately 300 feet wide (east to west), 425 feet long (north to south), and covers approximately 3 acres. The surface of this portion of the Coke By-Products Sub-Area is generally flat and covered with coal, coke fines, and slag. All the ASTs associated with this Unit have been removed. Two below-grade structures remain; the South Sump and Pit #17.

Pit #17 is a rectangular, concrete pit approximately 46 feet long by 19 feet wide by 12.5 feet deep. This pit housed the Coke Oven gas seal condensate holding tank (approximately 20,000 gallons) until the tank was decommissioned by Bethlehem Steel in

September 2000. The South Sump, located adjacent to and similar dimension as Pit #17, is constructed of steel-lined concrete and was used as an oil water separator for light oil recovery process water. The South Sump was covered with a vapor-tight roof until it was decommissioned in September 2000. In August 2001, the South Sump was pumped out, cleaned with high-pressure water, and the roof was reinstalled.

The former Benzol Plant, operated from the 1930s through April 1999, was designed to recover commercial quantities of benzene, toluene, and xylene (light oils) from coke oven off-gas. It is well documented that leaking underground and above-ground product lines and accidental spillage of product from tanks and load-out stations resulted in the extensive subsurface fill and groundwater contamination in this Sub-Area.

RFI slag/fill and groundwater sampling and analysis occurred between 1995 and 1998. Slag/fill samples were generally collected from the smear zone or below the water table except for one surficial sample, P11-1 (0-0.5 fbgs). There were no exceedances of the Part 375 ISCOs at P-11-1 (0-0.5 fbgs), SB-09 (6-8 fbgs), SB-10 (4-6 fbgs), SB-11 (4-6 fbgs), RW-1 (2-4 fbgs), RW-2 (2-4 fbgs), and RW-3 (1-3 fbgs). The sample from P-11-1 (0-0.5 fbgs) did not exhibit hazardous waste characteristic via TCLP. Plate 4-12 shows the locations of RFI boring, monitoring well, piezometer, waste water, and surface slag/fill samples. Appendix N contains SWMU surface and subsurface soil sample RFI analytical data tables with comparisons to Part 375 ISCOs and Protection of Groundwater SCOs.

Construction and start-up of an ICM consisting of a groundwater collection and treatment system was completed in May 2005. Details of the ICM, which has been operating semi-continuously with minor shutdowns for repair and maintenance, are provided in Section 2.1.1 of this report. Since May 2005, the Benzol Plant ICM has effectively maintained hydraulic capture of the contaminant plume as evidenced by isopotential maps prepared from field-measured groundwater elevations. The overall shape and size of the capture zone changes very little from year to year indicating that the ICM collection system consistently continues to maintain effective groundwater capture at the Unit. The latest semi-annual report (August 2018) is included as Appendix I and includes the groundwater contour map for the Benzol Plant, VOC concentrations from groundwater samples, and time versus concentration plots since start-up. Table 4-18 provides a summary of the impressive contaminant cumulative mass removal of aqueous phase liquid (26,800 pounds) and LNAPL (10,000 pounds) contamination totaling 36,800 pounds as of April 2018.

Upon completion of the 13th year of ICM remediation, comparisons of LNAPL and dissolved phase recovery rates between the first three years of operation (e.g., 2005 through 2008) and the remaining 10 years (e.g., 2009 through 2018) indicate the following:

- LNAPL recovery has attenuated over the 13 years of ICM operation, with the greatest amount of recovery occurring over the first three years (roughly 5,800 pounds or 58% of the total recovered LNAPL mass), moderating for three years (nearly 1,000 pounds or 10%), modestly increasing again over the next three years (approximately 2,100 pounds or 21%, then dropping off over the last four years (only 1,150 pound or 11% of the total recovered LNAPL mass).
- As with the LNAPL, the greatest amount of aqueous phase recovery occurred over the first three years of operation (approximately 7,800 pounds or 29% of the total recovered aqueous phase mass), moderating for three years (nearly 5,200 pounds or 19%), modestly increasing again over the next three years (approximately 6,400 pounds or 24%), then fluctuating over the last four years (7,400 pounds or 28% of the total recovered aqueous phase mass).

4.6.3.2 SWMU P-11A – "Old" Benzol Plant Tank Storage Sub-Area

SWMU P-11A was not defined during the RFA or RFI studies, although it was referred to in the RFI (Ref. 1). A review of BSC historic archived drawings identified the original site of the Benzol Plant within the Coke-By Products Sub-Area, just east of the Ammonium Sulphate Storage Building (see Plate 4-10). According to the Engineering and Mining Journal, the Lackawanna Steel Company began operations of the original Benzol Plant in May 1915 (Ref. 19). This Unit hereafter referred to as the "Old Benzol Plant Area" or SWMU P-11A, was shown on two archived site drawings (September 1922 and May 1927). The CMS Work Plan called for the advancement of three deep borings within the Coke By-Products Sub-Area to identify and confirm the confining layer identified during the RFI. Due to the central location of this Unit within the Coke By-Products Sub-Area, this portion of the CMS investigation is discussed within this Section.

In April 2010, a drilling investigation was performed at SWMU P-11A by advancing four deep borings (CBA-B-01, CBA-B-02/MWN-67A, CBA-B-03A/MWN-68A, CBA-B-03B, CBA-B-04 and CBA-B-05) into the native clay confining unit (see Plate 4-10). Undisturbed soil samples were collected from borings CBA-B-01 (41.5 fbgs), CBA-B-02 (35.5 fbgs), and CBA-B-03B (16.5 fbgs) for Atterberg Limits (ASTM D4813), undisturbed hydraulic conductivity (ASTM D5084), and grain size (ASTM D422) analysis to determine

the physical characteristics of the native clay confining unit identified beneath the Coke By-Products Sub-Area (as well as the majority of the Tecumseh Site). In-situ hydraulic conductivity was determined at boring locations CBA-B-01 (41.5 fbgs), CBA-B-02 (35.5 fbgs), and CBA-B-03 (16.5 fbgs) to be 5.6E-08, 1.1E-07, and 3.8E-08 cm/sec, respectively. These hydraulic conductivities confirm the RFI characterization of this unit as a confining unit with very low hydraulic conductivity. Observed in boring CBA-B-04 were elevated PID readings (6-18 fbgs) and strong petroleum odor and sheen (6-12 fbgs). Petroleum-like odor was observed in boring CBA-B-05 (2-12 fbgs). Appendix G2 includes the soil borehole and well construction logs.

The lithology beneath the Coke By-Products Sub-Area is characterized by fill materials including slag, concrete, coke fines, and coal intermingled with coal and coke fines between 4.0 and 15.5 feet thick (from grade). Peat underlies the fill across much of this Sub-Area. Below the peat, or absent of peat, is a layer of silty sand interbedded with clay. A native clay confining unit underlies the entire Sub-Area with varying thickness of approximately 33 feet at the south end to approximately 26 feet at the northern end of SWMU P-11A. This confining unit has a very low average hydraulic conductivity of 6.8E-08 cm/sec as determined by three undisturbed soil samples (previously mentioned above). The RFI identified the top of bedrock in the nearby Ship Canal (southern end) at approximately 510 feet (one of two east-west trending valleys in the bedrock at the Site; Ref. 1) and within nearby bedrock monitoring well MWN-25D (northern end of SWMU P-11A) at approximately 544 feet. The CMS Work Plan did not identify any soil/fill characterization needs in this area; therefore, no samples were collected.

The CMS groundwater investigation of this Unit and vicinity is discussed in Section 4.8.

4.6.3.3 SWMU P-12 – Spill Cleanup Soil Storage Sub-Area

SWMU P-12 is located immediately outside the southeast corner of the Benzol Plant facility (see Plate 4-12). This Unit, used as a one-time surface storage area for 368 tons of oil-contaminated material generated during the cleanup of a 1987 "debenzolized" wash oil spill, is a rectangular area measuring approximately 30 feet wide by 40 feet long. At the time of staging, the Unit was an at-grade area surrounded on the north, west, and east sides by a 5-foot high concrete wall and on the south by a slightly elevated asphalt road (approximately 6

inches higher than the SWMU surface). The west wall has since been demolished. SWMU P-12 is a flat area covered with slag fines and moderately vegetated. The contaminated slag temporarily stored in this SWMU has been removed; therefore, no waste currently exists within this Unit.

Two slag/fill samples were analyzed during the RFI, both from the 0-0.5 fbgs interval; none of the parameters exceeded Part 375 ISCOs. The samples were also analyzed via TCLP and did not exhibit hazardous waste characteristics. Once SPLP sample analyzed for benzene exceeded the GWQS indicating the potential benzene to leach from SWMU P-12 into groundwater. Appendix N contains SWMU surface and subsurface soil sample RFI analytical data tables with comparisons to Part 375 ISCOs and Protection of Groundwater SCOs.

4.6.3.4 Benzol Plant Storage Group Summary

As outlined in Sections 2.1.1 and 2.3.1, the ICMs at the Benzol Yard were supplanted by implementation of Operable Unit No. 4 (OU-4) as a final expedited corrective measure (ECM) for the Benzol Yard groundwater and the broader roughly 27-acre Coke By-Products SWMU Sub-Area. Construction of the OU-4 groundwater system was substantially completed in March 2019 and is currently fully operational. As discussed in Section 2.1.2, the SVE system for source control is also fully operational.

4.6.4 SWMU P-18 – Blast Furnace Cooling Tower and Hot and Cold Wells

As described in Section 2.3.2, approximately 9,135 CY of sediment/wastes, containing TCLP lead concentrations >5mg/L, were hydraulically dredged from the SWMU P-18 Hot and Cold Wells (and the Wet Well that existed between the two SWMUs between August and October 2015 (see Plate 4-13) as part of OU-2. The sediments were dewatered, treated (stabilized/ solidified) with Portland cement to lower the TCLP lead concentrations to <5 mg/L, loaded, transported and placed in the ATP containment cell. Both SWMUs and the Wet Well were backfilled with BUD-approved slag and maintenance dredged granular sediments from Smokes Creek with NYSDEC approval by April 2016. Additional details regarding the dredging, dewatering, treatment and placement in the ATP of the SWMU P-18 wastes are provided in the July 2016 CCR for OUs 2 & 3 ECMs (Ref. 18).

SWMU P-18 is located at the south end of the Ship Canal (see Plate 4-13). The Cold Well area (P-18A) is located at the southwest corner of the Canal. The Hot Well area (P-18B) is located south of the Canal. The Hot and Cold Wells consisted of below-grade water-filled sheet pile lined containments that were nominally 39 feet deep according to Bethlehem Steel design drawings. The Hot Well was an irregular shape measuring approximately 130 feet across the longest section and 16 feet across the narrowest section. The Cold Well was rectangular in shape measuring approximately 173 feet long by 23 feet wide. SWMU P-18 is underlain by low permeability soils (over 30 feet of lacustrine clays and dense glacial till) and surrounded by a steel sheet piling keyed into the bedrock[8].

As described in the 2016 CCR for ATP SWMU Group ECM, the implemented corrective measure for SWMU P-18 involved removal of the waste/sediment deposits using hydraulic dredging equipment, dewatering the dredged sediment spoils, stabilizing the dewatered dredge spoils (to TCLP lead <5 mg/L), and solidifying the stabilized, dewatered dredge spoils for consolidation with other SWMU waste/fill for final disposal in the ATP containment cell. Dredging work commenced on August 25, 2015 and transportation of all dewatered/stabilized waste/sediment to the ATP containment cell was completed on October 30, 2015. Backfilling of the Hot and Cold Wells commenced on November 25, 2015 and was completed by the end of April 2016.

4.6.5 SWMU S-26 – Fill Area near Coke Battery No. 8

SWMU S-26 is an approximately 7.5-acre area located adjacent to and northwest of the Ship Canal generally occupying the area between former Coke Oven Battery Nos. 7 and 8 and the Ship Canal (see Plate 4-14). The Unit is split between two properties; approximately 3.3 acres on the Tecumseh Site and 4.2 acres on the adjacent Gateway property. Gateway purchased this portion of the property in 1985 from BSC along with the Ship Canal, the property to the east that formerly contained the storage yard and the blast furnaces, and a strip of land (approximately 100 feet wide) along the western and southern edges of the Canal (including SWMU S-26G). The CMS is focused on the approximate 3.3-

[8] Per BSC record drawing #288709 for WQCS#9; shows sheet piles for hot and cold wells extending down to top of rock (shale) at an elevation of approximately 510 feet.

acre portion on the Tecumseh property (hereafter referred to as SWMU S-26T). The portion of SWMU S-26 on Gateway property is hereafter referred to as SWMU S-26G. Surface drainage is generally west to east toward the Ship Canal with some drainage near the northern property boundary toward the Buffalo Outer Harbor to the north.

In addition to two RFI borings (S26-1 and S26-2 advanced to 30 fbgs), 13 CMS borings (S26-B-01 through S26-B-13) were advanced to further assess the character and extent of subsurface soil/fill impacts within SWMU S-26T, as shown on Plate 4-14. Borings S26-B-01 to S26-B-03 were completed in December 2006 and borings S26-B-04 to S26-B-13 were completed in September 2010. Borings were advanced between 14 and 30 fbgs. Soil/fill samples from select borings were submitted for analytical testing based on visual and olfactory observations and PID screening. Selected soil/fill samples were analyzed for TCL VOCs (Method 8260B), TCL SVOCs (Method 8270C), and inorganic compounds (arsenic, barium, cadmium, chromium, and lead via Method 6010B, and mercury via Method 7471). Table 4-19 summarizes the slag/fill analytical data and Plate 4-14 shows the locations and representative photographs. Groundwater assessment for this Unit is discussed in Section 4.8.

Soil/fill in SWMU S-26T is primarily slag with coke fines, coal, brick, and other miscellaneous fill extending to a depth of 12 to more than 20 fbgs. Only boring S26-B-03 identified the presence of coal-tar at a depth of 4 to 7 fbgs. This boring was proximate to a 60-inch diameter Industrial Water System pipeline that provides fire protection and cooling water for Republic Engineered Products (bar mill), Great Lakes Industrial Development (located in the former ArcelorMittal Cold Mill) and Metalico (located in the former ArcelorMittal Galvanizing Mill) off the Tecumseh property on the east side of Route 5. Beneath the soil/fill is an interbedded native soil/sediment unit of clayey silt and silty sand (occasionally with intermingled peat) underlain by a silty clay confining unit identified in all but two CMS borings. Bedrock was not encountered during the investigation of SWMU S-26T. Appendix G3 includes boring logs for S26-B-01 through S26-B-13.

The analytical results from subsurface soil/fill samples obtained within the limits of S-26T indicate SVOCs (primarily PAHs) as the only compounds exceeding their respective Part 375 ISCOs with total PAH concentrations ranging between 0.35 and 2,900 mg/kg; excluding results from boring S26-B-3. Results from boring S26-B-3 (6-8 fbgs) indicate that although coal tar is present (total PAHs of 240,000 mg/kg), it is limited in vertical extent to

that interval as evidenced by significantly reduced concentrations with depth; the soil/fill sample collected from 10-12 fbgs in this boring contained total PAHs of 2,200 mg/kg and a composite sample from 14 to 30 fbgs contained only 7.2 mg/kg total PAHs. The tar impacts at S26-B-03 are also limited in horizontal extent as evidenced by surrounding soil/fill samples collected from borings S26-B-04, SB26-B-06, and SB26-B-07 with reported PAH concentrations two orders of magnitude less than S26-B-03. Although arsenic was the only metal detected above the Part 375 ISCO (S26-B-3 at 6 to 8 fbgs), the concentration of 40 mg/kg is well below the site-specific SCO of 118 mg/kg.

4.6.6 Summary

Table 4-3 summarizes the constituents detected in surface and subsurface soil/fill at concentrations that exceed Part 375 ISCOs. Section 5 develops and evaluates corrective measures to address these exceedances.

4.7 Watercourses

There are six distinct surface water bodies on or proximate to the former BSC Site, four of which required further assessment during the CMS, including: Smokes Creek (the lower reach was addressed as an ICM and discussed in Section 2.1.5); the Gateway Metroport Ship Canal (formerly the Lackawanna Ship Canal); the North Return Water Trench (NRWT); and the South Return Water Trench (SRWT). Blasdell Creek, the fifth proximate water body, is discussed in Section 4.7.5. Lake Erie, the sixth proximate surface water body, did not require further assessment and is therefore not discussed herein.

4.7.1 Smokes Creek

On the Tecumseh Site, Smokes Creek (SC) is divided into two sections for maintenance and discussion purposes the Upper Reach (SCUR) from State Route 5 to the bridge on Site Highway 9, measuring approximately 3,900 feet; and the Lower Reach (SCLR) from the Highway 9 Bridge to Lake Erie, measuring approximately 2,600 feet (see Plate 4-15). Flow in the Creek is typically from east to west emptying into Lake Erie except on rare occasions when significant storm, wind surge, ice jam, and Lake seiche events occur that may temporarily reverse flow direction. Smokes Creek is a NYSDEC Class C stream, which is defined as suitable for fish propagation and survival with water quality expected to be

suitable for primary and secondary contact recreation, although other factors, such as property ownership and access, may limit the use for these purposes.

For all sediment sample locations identified within this section: Table 4-20 summarizes SCLR pre- and post-ICM analytical data; Table 4-21 summarizes SCUR analytical data; and Plate 4-15 shows the sample locations and representative photographs.

4.7.1.1 Lower Reach

As discussed in Section 2.1.5, SCLR was voluntarily dredged by Tecumseh as an ICM in 2008 to remove accumulated sediment for environmental contaminant reduction and restoration of the flood flow capacity of the stream channel, thereby reducing the encroachment of the 100-year flood plain into the City's First Ward. Pre- and post-ICM sediment samples were collected from the same 10 locations spaced equidistant from each other along the SCLR identified as SC-SED-01 through SC-SED-10 on Plate 4-15. Adjacent core pairs (e.g., SC-SED-01/02, SC-SED-03/04, SC-SED-05/06, SC-SED-07/08, and SC-SED-09/10) were composited for SVOC (Method 8270C), PCB (Method 8082), cyanide (Method 9012A), total organic carbon (TOC) (Method Lloyd Kahn), and metal (Method 6010B/7471A) analysis. In addition, discrete samples were collected from all 10 sampling locations during the pre- and post-ICM events for VOC (Method 8260B) analysis to avoid handling losses. Sediment existing above the SCLR design elevations was targeted during pre-ICM sampling, whereas post-ICM sampling targeted sediment existing at the design elevations. SCLR pre-ICM samples were collected in June 2007 followed by post-ICM sampling in April 2009.

Table 4-20 presents a comparison between pre- and post-ICM dredging analytical results for sediment samples collected from the SCLR and provides calculated average concentrations. The analytical data is also compared to the 2014 NYSDEC Freshwater Sediment Guidance Values (SQVs). Based on this comparison, it is apparent that a significant reduction of VOC, SVOC, PCB, and total metal impacts to sediment were removed and floodway design elevations were restored as a result of the ICM dredging. Specifically, total VOCs were reduced by 95% and all individual VOC concentrations are Class A. One post-ICM sample had two individual PAH concentrations exceed the PAH SGVs presented in Table 7 of the 2014 guidance. However, using the site-specific total organic carbon (TOC) of 9.32% and adjusting the SGVs, both naphthalene and

phenanthrene concentrations fall below their respective PAH SGV. After dredging, the sediment in 4 of the 5 sample locations is considered Class C for lead and Class B for the other metals. In general, the concentrations of the other metals are on the lower end of the Class B range.

4.7.1.2 Upper Reach

In December 2007 and in support of the NYSDEC's planned maintenance dredging of the upper reach of Smokes Creek, Tecumseh voluntarily performed a bathymetric survey. Based on that bathymetric survey, in was estimated that approximately 40,340 CY of sediment requires dredging to restore the upper reach to design floodway elevations. Concurrently in December 2007, SCUR sediment samples were collected from 11 locations primarily targeting the section downstream of the SRWT and identified as SC-SED-11 through SC-SED-22 (see Plate 4-15). As such and like the SCLR, adjacent core pairs SC-SED-11 through SC-SED-18 (e.g., SC-SED-11/12, SC-SED-13/14, SC-SED-15/16, SC-SED-17/18) collected downstream and west of the SRWT were composited for SVOC, PCB, cyanide, TOC, and metal analysis. East of the SRWT, sediment cores SC-SED-19 through SC-SED-22 were collected as discrete grab samples for those same parameters, with one exception; location SC-SED-21 was not sampled due to inadequate sediment recovery. Discrete samples collected from 10 of the 11 locations were analyzed for VOCs.

Pre-dredge analytical results and average concentration for each parameter in the upper reach are presented in Table 4-21. The pre-dredge sediment at all upper reach locations was considered Class A for VOCs. Two individual PAHs exceed the PAH SGVs presented in Table 7 of the 2014 guidance. However, using the site-specific TOC to adjust these SGVs, only phenanthrene remained slightly above its PAH SGV at one location (24 mg/kg compared to the SGV of 23 mg/kg). The pre-dredge sediment in the upper reach was considered Class A for PCBs except for one location. Six of seven sample locations were considered Class C for lead. Cadmium (one location), chromium (one location) and silver (two locations) concentrations are also considered Class C; the remaining metals/locations were considered Class A or B. Mercury concentrations in two locations barely exceed the SGV of 0.2 mg/kg for Class B. The types of contamination identified in the sediments of Smokes Creek (e.g., VOCs and PAHs) are commonly found in urban

watershed areas. These sampling and analytical results are reflective of sediment that were removed during maintenance dredging by the NYSDEC.

On June 3, 2014, Tecumseh submitted a Work Plan to perform pre-dredge sediment sampling of the SCUR(referred to as the Middle Reach by NYSDEC) to characterize the chemical and physical composition of shallow bottom sediment that would remain below the 1965 Flood Control Project design elevation following NYSDEC's maintenance dredging. The sediment quality data would be used to evaluate whether additional corrective measures beyond the planned maintenance dredging may be warranted. NYSDEC's August 18, 2014 comment letter rejected the Work Plan based on concerns over sampling locations, depths and parameters. Since the NYSDEC did not approve this Work Plan, Tecumseh did not perform the pre-dredge sediment sampling. NYSDEC completed the dredging work in 2015.

4.7.1.3 2013 Sediment Assessment Report (Weston) and Dredging Basis of Design (URS)

Tecumseh reviewed the *Sediment Assessment Report, Smokes Creek, Niagara River Area of Concern, Lackawanna, Erie County, New York* prepared by Weston Solutions, Inc. in March 2012 (the Weston Report) for the USEPA Great Lakes National Program Office. In September 2013, the NYSDEC notified Tecumseh that the Weston Report had been finalized in January 2013. In its letter dated September 26, 2013, NYSDEC stated that "*The data from the Weston Report, collected during November 2010 and November 2011, conclusively showed that the petroleum discharging into the Creek was confined almost exclusively to the middle and lower reaches of the Creek, thus linking the source of the petroleum to Tecumseh's property."* Tecumseh repudiated this statement in its November 1, 2013 response letter (see Appendix B) based on misrepresentations and errors in the Weston Report regarding the depth to sediment, sediment thickness, and sample elevations within Creek. The Weston Report was provided by NYSDEC to URS Corporation to assist with its Basis of Design Report prepared in July 2013 for NYSDEC and the Dormitory Authority of New York State (DASNY). The Basis of Design Report presents the basis of the proposed design for the dredging/excavation and vegetation removal necessary to restore the original hydraulic capacity of Smokes Creek. In January 2014, URS Corporation finalized the design drawings and specifications for the Smokes Creek maintenance dredging and vegetation clearing flood control project. The sediment removal activities by the NYSDEC was completed in 2015.

According to the City of Lackawanna Local Waterfront Revitalization Program (May 2018 Preliminary Draft), the results of the USEPA 2011 sediment sampling in Smokes Creek indicated that the overall sediment quality is not likely to cause chronic toxicity to sediment-dwelling organisms; however, some metals and organic substances were found to be present at elevated levels.

4.7.1.4 2014 Contaminant Source Reassessment Report (E&E)

Tecumseh reviewed the *Draft Niagara River Area of Concern (AOC) Contaminant Source Reassessment Report for Erie and Niagara Counties, New York* prepared by Ecology & Environment (E&E) Engineering, PC and provided by NYSDEC in February 2014 (see Appendix J). The Report was funded by a Great Lakes Restoration Initiative grant from the USEPA to NYSDEC. The purpose of the grant is to reassess the sources of contamination that may have contributed to beneficial use impairments (BUIs) within the Niagara River AOC. The more apparent intended purpose of the NYSDEC was to annex Smokes Creek to the Niagara River AOC, which it apparently was successful in convincing the USEPA to do so based on the erroneous data, findings, and conclusions of the E&E Report as substantiated below:

- The contaminant loading estimates in the Report for most upstream and off-site wastewater treatment plant point sources were based on dry weather conditions and therefore do not address combined sewer overflows and consequently are significantly understated.
- The Report's contaminant loading estimates from Smokes Creek are significantly overstated based on erroneous flow estimates. The Report noted that long-term average daily flow rates were not available due to the lack of stream gauging stations in the Creek. Difficulties were noted in the Report with the Creek velocity and cross-section methods used (which are notoriously inaccurate). The resulting estimated flow rates of 217 MGD to 413 MGD far exceed the historical long-term average flow of 32.2 MGD. Furthermore, the historic average flow is also overstated as it includes the Erie County Sewer District No. 6 effluent; historic SPDES discharges to Smokes Creek from the former ArcelorMittal Lackawanna Galvanizing Division Water Quality Station No. 7 were eliminated in 2010 when the Division shut down operations; and SPDES discharge from the Tecumseh Industrial Water System were reduced by approximately 25 MGD in 2010 due to the Galvanizing Mill shut-down.

- The Report's contaminant loading estimates from Smokes Creek are significantly overstated due to sampling methods used in the Report. As the samples collected were both during wet weather conditions and not filtered, they contained suspended sediment that can come from shoreline erosion, storm outfalls, combined sewer overflows, or re-suspended Creek bottom sediment. The E&E Report fails to mention the Federal dredge spoil dumping grounds adjacent to the lower reach of Smokes Creek as a potential source of these same chemicals. Section 4.2 of the CMS Report describes why the dredge spoils are considered one of the primary contributors to groundwater impacts observed within the sand/dredge spoil unit along the western portion of the CMS Area. While not specifically addressed in the CMS or the E&E Report, the larger portion of the Federal dredge spoil dumping ground located west of the former Bethlehem Steel property in the open waters of Lake Erie are documented as significant sources of the same stated compounds of concern.
- The Report states (on page 7-7): *"Most of the organic loading associated with Smoke Creek, particularly at the downstream location, was from benzene and naphthalene. The presence of these chemicals is consistent with the historical use of the Bethlehem Steel property through which the Creek flows. The majority of the NRTMP loading associated with Smoke Creek was from lead, which is also consistent with the historical use of the Bethlehem Steel property."*
- The limited number of samples collected in order to characterize Smokes Creek water quality and sample collection methods compromise the data integrity and are not representative of either average or seasonal variations. For example, naphthalene was detected in Smokes Creek during only one of the two sampling events at only the downstream sample location and is reported as an estimated concentration (1.7 µg/L) by the laboratory, yet the above quoted Study findings relied on this data to allege the former Bethlehem Steel property as the primary source.
- Although historical loading to Smokes Creek and Blasdell Creek measured from direct outfalls from the former Bethlehem Steel property contained elevated quantities of lead (estimated at 70.2 pounds per day (*Niagara River Toxics Management Plan Report*, Chapter II, Point Source Discharges, October 1984)), it is stated in the Report that: "*The termination in 1983 of steelmaking operations at the Bethlehem Steel Corporation Plant will relegate much of the toxic substances data developed by both the EPA and DEC to historical status.*"
- Lead was not detected above the laboratory method detection limit of 3 µg/L in either the upstream or downstream sampling locations. Samples collected in April 2013 from both the downstream and upstream locations contained similar concentrations of lead (8.7 µg/L and 7.4 µg/L). The upstream sample is located approximately 1,700 feet upstream of the former Bethlehem Steel property;

therefore, the former Bethlehem Steel property is not considered the primary source of this lead impact. In addition, the contaminant mass loading calculated for lead from the non-point source assessment of the former Bethlehem Steel property is 0.0078 pounds/day, substantially less than the 9.8 to 15 pounds/day of contaminant source loading calculated for the two sampling locations from Smokes Creek.

4.7.1.5 Great Lakes Legacy Act/Niagara River Area of Concern

The Niagara River Area of Concern (NR-AOC) extends from Smokes Creek near the southern end of the Buffalo Harbor, north to the mouth of the Niagara River at Lake Ontario. Historic municipal and industrial discharges and waste disposal sites have been a source of contaminants to the Niagara River. A long history of development has also changed the original shoreline along much of the river, affecting fish and wildlife habitat. Habitat degradation and the survival of aquatic life in the NR-AOC have been impaired by toxic chemicals such as PCBs, mirex, chlordane, dioxin, dibenzofuran, hexachlorocyclohexane, PAHs, and pesticides. Fish migration from Lake Ontario has an influence on the Niagara River community as does the related effects of invasive species. Sources and loadings of pollutants causing use impairments in the Niagara River include these sediments as well as inactive hazardous waste sites, combined sewer overflows, and other point and non-point sources. Contamination originating from discharges within Lake Erie's watershed contributes to effects in the Niagara River and Lake Ontario. These sources and river shoreline practices both contribute to the identification of use impairments for which remedial action is being taken to restore and protect beneficial uses.

For over two decades, the Niagara River has been the focus of attention between four environmental agencies in the United States and Canada ("the Four Parties"). On February 4, 1987, the Four Parties signed a Declaration of Intent (DOI) to achieve significant reductions of toxic chemical pollutants in the Niagara River. The DOI outlined the principles and activities to be followed and was combined with a detailed annual work plan that forms the Niagara River Toxics Management Plan (NRTMP).

The Four Parties agreed on a specific list of 18 'priority toxics' targeted for reduction through the NRTMP. A key sub-objective and milestone of the NRTMP DOI was to achieve a 50% reduction of 10 specific priority toxics believed to be from significant Niagara River sources by 1996. Overall, the NRTMP has met its 50% reduction goal for the 10 targeted priority toxics, and some by more than 75% through actions addressing point and

non-point sources of toxic contamination. In 1996, the Four Parties re-affirmed their commitment to the NRTMP in a Letter of Support that called for continued reductions of toxic pollutants to achieve ambient water quality that will protect human health, aquatic life, and wildlife, and while doing so, improve and protect water quality.

A November 2010 report prepared by Environment Canada (EC) (R.B Hill and P. Klawunn) observed the following long-term loading trends:

- Most of the 72 analytes have a downward trend and are not exceeding the strictest agency criteria.
- Certain PAH class compounds show upward trends most recently.
- Most of the compounds that still exceed the strictest agency criteria show downward trends.
- Niagara-on-the-Lake (NOTL) appears to have a greater number of compounds with a downward trend.

According to the March 27, 2013 Annual Status Update prepared by USEPA Region 2 and NYSDEC Region 9, 21 of the 26 identified priority hazardous waste non-point source sites have been addressed. The remaining five sites, including the former Bethlehem Steel site, have remedial actions pending or underway. The Annual Status Update Report summarized the data obtained during EC's 2004/2005 Upstream/Downstream (U/D) Monitoring Program, which indicated 6 of the 18 priority toxics (i.e., mercury, arsenic, lead, chlordane, octachlorostyrene (OCS), and benzo(a)anthracene) were below the strictest criteria at both Fort Erie (FE) and NOTL, the two primary sampling stations of EC's monitoring program. The downward trends of most compounds at NOTL suggest sources from the Niagara River watershed are being reduced or eliminated and existing management actions under the NRTMP are working. The data did show that further study and evaluation is needed to identify, characterize, and eliminate certain sources of PAH class compounds, specifically benzo(a)pyrene and benzo(b/k) fluoranthene (the three remaining specific priority toxics of the 10 identified for 50% reduction by 1996). The remaining priority toxics that require further reduction are chrysene, dieldrin, DDTs, and toxaphene.

Of these remaining seven priority toxics of concern, only PAHs have been detected on the Tecumseh CMS Area and indeed are ubiquitous in the environment. Section 4.8.8

presents the estimated current loadings to Lake Erie as well as the reduction in loadings following the proposed remedial actions.

4.7.2 Gateway Metroport Ship Canal

The Gateway Metroport Ship Canal (Ship Canal) is approximately 4,000 feet long and 200 feet wide, running north to south and opening at the northern end to the Buffalo Outer Harbor in Lake Erie (see Plate 4-16). The average water depth is approximately 25 feet, and the volume of water within the canal is approximately 140 million gallons. The Ship Canal, located in the north central portion of the Site, mid-way between Route 5 and Lake Erie, was initially constructed to provide a minimum 22-foot depth to accommodate the large Lake freighters requiring access to the plant.

In addition to the canals functioning as a port for transferring materials, it was formerly used by BSC as a receiving water body for various liquid discharges from the blast furnaces and coking operations (e.g., outfalls). Specific discharges and the estimated period of use identified in the RFI include:

- Coking Operations
  - Treated weak ammonia liquor (WAL), from 1920 to 1970
  - Quench water from coke-making operations, duration unknown
  - Ammonium sulfate crystallizer cooler tower blowdown, 1920 to 1982
  - Final cooler cooling tower blowdown, 1920 to the mid-1980s
  - Benzol plant waste water, from 1920 to 1970
- Blast Furnaces
  - Overflow from thickeners, 1922 to 1983
- Sinter Plant
  - Thickener overflow, 1950 to 1983
- Three oil spills (one, 20-gallon release in 1980 from the locomotive shop and two releases in 1983 (100- and 250-gallons) from the Coke Ovens) were reported to the U.S. Coast Guard and cleaned up by BSC.

In 1985, Gateway Trade Center (Gateway) purchased and took control of the canal and surrounding property from BSC. BSC discharges to the canal subsequent to the property transfer and identified in RFI from 1985 to 2001 include:

- A chlorine release in 1990 during a pilot zebra mussel control program was reported to the NYSDEC and corrective actions implemented to prevent future releases.
- In February 1997, 1,500 gallons of coal tar was spilled into the canal from a ruptured valve in a coal tar storage tank through SPDES Outfall #401. The release was reported to the U.S. Coast Guard and NYSDEC and subsequently cleaned up.
- As of 1992, BSC discontinued the discharge of any process water to the canal.
- From 1992 to 2001, discharges consisted of non-contact cooling water and storm water runoff through 12 SPDES outfalls and by 1996, the number of outfalls had been reduced to four.

Since their land and facilities purchase in 1985 until the last few years, Gateway has operated the canal as an active port for the storage and shipping of salt, coal, and petroleum coke. Several years ago, the Canal and other Gateway assets are believed to have been acquired by New Enterprise Limestone Corporation. Bilge water and/or surface water discharges from these operations to the canal from 1985 to the present are not known.

As a result of the shutdown of the Coke Ovens in 2001, significant reduction in water withdrawal from and return to the canal resulted in a lower complete exchange of water in the canal (approximated to be once every 3.4 days during active plant operations). Once Pump House No. 1 was shut down in 2001, the only water flowing into the canal came from groundwater infiltration, precipitation, sheet flow, and natural processes (e.g., wind and rising and falling Lake levels) with the Buffalo Outer Harbor receiving the net balance.

The Canal proper and essentially all the surrounding land is not and has never been owned or operated by Tecumseh. Tecumseh has not directly discharged any waters to the Canal from the CMS Area or its other nearby property since its purchase of lands from BSC in 2003. In 2005, Tecumseh proposed and implemented the Benzol Yard ICM shortly after acquiring the Site to control and mitigate the potential for contaminated groundwater in the Coke Plant By-Products Subarea to contaminate the surface water and sediment in the Ship Canal. Tecumseh recently completed implementation of OU-4 corrective measures and the Benzol Yard source control ICM under NYSDEC consent orders. Following completion of these corrective measures, the potential for contaminated groundwater in DSA 5 to contaminate surface water and sediments within the Ship Canal will be fully mitigated.

Historically, the USACE dredged the Canal in 1971, 1974, 1977, and 1981 to remove the buildup of bottom sediments. The dredged material was taken to the USACE Confined Disposal Area (CDA) No. 4 located northwest of the Site (see Plate 1-1). Quantities and analytical testing that may have been performed by the USACE is not known. The most recent dredging according to the RFI was completed in summer 2000, when the owner/operator at that time , Gateway, commissioned the USACE to dredge up to 20,000 CY of sediment from the Canal to maintain navigation depths between July 5 and September 20, 2000. Dredged sediments were placed into the CDA No. 4 located immediately north of SFA Zone 5 and the Coke Plant Sub-Areas.

The surface waters and sediments from the Ship Canal were sampled during the RFI in the mid-1990s along five transects in the Ship Canal and reflect coke and steelmaking operational discharges up to that time. As the Canal sediment characterized in the RFI were removed subsequently during the summer 2000 dredging by the USACE, it is not representative of current conditions and therefore not presented or discussed in this CMS.

Gateway and subsequently New Enterprise Limestone, haveowned the Canal since 1985 and has been responsible for its operation and maintenance over the last 26 years. Any impacts to the Canal surface water and sediment contributed by Gateway, beyond those identified during the RFI, cannot be determined and are clearly not Tecumseh's responsibility.

4.7.2.1 Canal Sediment Sampling Results

Tecumseh conducted additional Canal sediment sampling in November 2009 to characterize existing conditions subsequent to the last maintenance dredging in 2000. Sampling consisted of four equidistant transects across the width of the Ship Canal, identified as GSC-SED-1 through 4 (see Plate 4-16). At each transect, two representative grab samples (A and B) were collected approximately one third of the distance from the eastern Canal sheet piled wall and the other one third of the distance from the western Canal wall for TCL VOC (Method 8260B) analysis. Representative aliquots from each transect grab location were composited (GSC-SED-1A/1B, GSC-SED-2A/2B, GSC-SED-3A/3B, and GSC-SED-4A/4B) for TCL SVOC (Method 8270C), PCB (Method 8082), RCRA Metals (Method 6010B/7471), and TOC (Lloyd Kahn) analysis. As shown on Plate 4-16, composite samples GSC-SED-1 through GSC-SED-4 were collected progressively from the

southern to the northern end of the Ship Canal. Table 4-22 presents the results of the November 2009 sediment sampling and compares the data to the 2014 NYSDEC SQVs.

As summarized in Table 4-22, the 2009 CMS sediment results indicate the presence of VOCs (total) concentrations ranging from 0.03 to 0.17 mg/kg with an average concentration of 0.07 mg/kg; all sediment sampled is Class A for VOCs. Total SVOCs (primarily PAHs) ranged from 52 mg/kg to 214 mg/kg. Three of the four locations had individual PAHs that exceed their respective PAH SGV. However, using the site-specific TOCs and adjusting the SGVs, all PAH concentrations fall below their respective PAH SGV. PCBs ranged from 0.10 mg/kg to 0.34 mg/kg; all locations are considered Class B sediment for PCBs. Six of the eight total metals were detected at all four CMS sediment locations; cyanide, however, was only detected at 2 of the 4 locations. All four sample locations are considered Class C for lead and two locations are all considered Class C for mercury. The sediment is considered Class B for arsenic, cadmium, chromium and mercury (for the other two locations). The average TOC concentration of 102,000 mg/kg is considered representative of significant organic content, most of which is assumed to be naturally occurring.

As part of the Niagara River Area of Concern (AOC) project, NYSDEC performed sediment sampling along the Ship Canal in June 2016. These results were provided to Tecumseh by NYSDEC via email on February 15, 2019. Based on the results of the 2016 tributary sediment screening assessment, NYSDEC submitted a request to USEPA to add the Ship Canal to the Niagara River AOC. Comparing the sediment concentrations to the 2014 NYSDEC SGV, the sediment is considered Class C for total PAHs. Using an average TOC concentration of 102,000 mg/kg from the 2009 sampling, since TOC data was not provided for the 2016 sampling event, the PAHs that consistently exceed their respective adjusted SGVs are fluoranthene, naphthalene, phenanthrene and pyrene. Several other PAHs periodically exceed their respective adjusted SGVs. The sampling depths vary by location and include 0-10", 0-12", 0-18", 0-20", 0-60", 10-28", 12-36" and 20-36". Because of this variability, it is not possible to determine which depth contains the highest concentrations. The sediment is considered either Class A or B for cadmium, chromium and copper; the locations with two sampling horizons are Class A for the deeper sample. The sediment is considered Class B for mercury (deeper horizon sample is Class A). The sediment is considered both Class B or C for lead and zinc (again, the deeper horizon is

Class A); the highest lead and zinc concentrations were observed in the 0-20" sample. The sediment is considered Class A and B for total PCBs, with the highest concentrations observed at the north end of the Canal.

4.7.2.2 Canal Surface Water Results

In December 2007, surface water from the Ship Canal was collected and analyzed for TCL VOC (Method 8260B), TCL SVOC (Method 8270C, base-neutrals only), total metals (calcium, iron, magnesium, manganese, potassium, and sodium via Method 6010B), ammonia, hardness, chemical oxygen demand (COD), total alkalinity, total dissolved solids, total Kjeldahl nitrogen, TOC, total phosphorous, and total suspended solids analysis. Table 4-23 presents the results of the December 2007 surface water sampling.

Surface water results presented in Table 4-23 indicate low concentrations of acetone (a common laboratory contaminant) and benzene; both concentrations were well below their respective Class D Surface Water Standards. Although di-n-butyl phthalate was the only SVOC detected, it was also detected in the associated blank, indicating the presence of this compound was due to substandard laboratory cleaning methods. Surface water samples indicate the Ship Canal water is moderately hard and is considered typical of Lake Erie surface water quality.

4.7.3 North Return Water Trench

The North Return Water Trench (NRWT) has a north-south orientation and is in the northern half of the Tecumseh property, east of the Ship Canal and south of the Union Ship Canal and Buffalo Outer Harbor, and approximately 1,000 feet east of the CMS Area proper. The NRWT is a man-made drainage channel constructed between 1922 and 1938 for the purpose of draining a historic marshy area east of the Ship Canal as well as to serve as a process water and storm water drainage conduit for steel-making facilities formerly located east of the trench and west of Route 5 (see Plate 4-17). The southern portion (approximately 1,400 linear feet) of the NRWT is located on the Tecumseh property bounded by Business Park Phase IA. This Business Park is being voluntarily cleaned up by Tecumseh under the NYSDEC Brownfields Cleanup Program as there are no SWMUs requiring further assessment located therein. The northern portion of the NRWT (approximately 1,800 linear feet) is located Buffalo and Erie County Industrial Land Development lands (200 ft) and the

remainder (1,600 ft) on New Enterprise Limestone's property. The portion of the NRWT on Gateway property has never been under the ownership of Tecumseh, and was not investigated during the CMS (e.g., sampled). A visual site reconnaissance, as called for in the CMS Work Plan, was performed in July 2011 to determine physical access points into the enclosed trench and visually determine, if feasible, the presence and quantity of remaining sediment. The CMS Work Plan also called for an inspection of the trench to confirm if, how, and where the trench is plugged and the condition of the plug. The CMS reconnaissance findings are presented below.

The trench measures approximately 3,200 feet long, with an average width of 8 to 10 feet and an average depth of 8 to 10 feet. The southernmost 400 feet of the trench located on Tecumseh property is open and constructed of brick and concrete. The next 1,000 feet is covered with a concrete roof, which is open at regular intervals of 8 to 12 feet to allow visual inspection from the surface, with sides that are lined with brick and reinforced concrete. These openings appear as a series of pits from grade level. During the CMS reconnaissance of the NRWT in July 2011, however, the three northernmost openings located on Tecumseh property were completely covered by an encroaching slag/fill pile on the adjacent New Enterprise Limestone property to the west (see photographs on Plate 4-17). The next 1,650 feet of the trench on New Enterprise Limestone's property is completely covered by a concrete roof and although not physically inspected due to safety concerns, the sides are presumed to be lined with brick and concrete (according to historic drawings). The final 150 feet of the NRWT was historically uncovered, approximately 25 feet wide, and lined with a sheet pile bulkhead on each side.

For all CMS NRWT surface water and sediment sample locations identified below, Table 4-24 summarizes the surface water analytical data, Table 4-25 summarizes the sediment analytical data, and Plate 4-17 shows the sample locations.

In December 2006, one water and four sediment sample locations were planned to further assess the surface water and sediment quality within the NRWT, identified as NRWT-SURFACE WATER and NRWT-SED-1 to NRWT-SED-4. Samples were obtained from all locations (except NRWT-SED-2, due to lack of residuals at this location) for TCL VOC (Method 8260B), TCL SVOC (Method 8270C-base/neutrals only), PCB (Method 8082, sediment only), and total metal (Method 6010B/7471/7470) analysis. Sediment samples were spaced to provide a reasonable characterization across the accessible areas of

the NRWT on Tecumseh's property. Trench integrity, presence of water, and flow were also recorded during this investigation. The sediment was collected with a Ponar dredge, so the samples are representative of the approximate upper 6 inches.

As in the RFI, surface water levels within the trench were approximately 1 to 8 feet below the surrounding groundwater table, indicating that the groundwater was not infiltrating into the trench. In July 2011, little to no water was observed within the trench due mainly to plugging of the historic discharge laterals. The observed water did not appear to be flowing and is attributed to precipitation and minimal groundwater infiltration. The trench structures, including the concrete walls extending 1 to 3 feet above grade around the open southern portions of the trench, appeared to be intact thus reducing surface water run-off to the trench. As previously discussed, the three northern-most openings to the trench are covered with encroaching slag/fill pile from the New Enterprise Limestone property to the west.

As shown on Plate 4-17, two surface water and three sediment samples were obtained during the RFI from the NRWT between 1992 and 1994. As summarized in the September 2004 Watercourse Assessment Report for the NRWT (Ref. 20; included as Appendix K), no SVOCs were detected in the two rounds of surface water samples; two VOCs (benzene at 0.0002 mg/L and methylene chloride at 0.0008 mg/L) were detected in the 1994 sample; and chromium (1992) and lead (1992 and 1994) were detected. Based on the 1992 TCLP analysis, none of the sediment samples exhibited the characteristics of hazardous waste. Analytical results for the 1994 sediment samples (see Appendix N) indicated one VOC (total xylene at 0.0055 mg/kg) in sample NRS-2 (near former Power House No. 1); 16 SVOCs [ranging from 2.5 mg/kg dibenz(a,h)anthracene in NRS-3 (north end) to 550 mg/kg of phenanthrene in NRS-2]; and metals (0.58 mg/kg mercury and 99.6 mg/kg lead in NRS-3). An Eckman dredge sampler was used during the RFI; therefore, the samples are likely representative of the upper 6 inches of sediment. Comparing the 1994 RFI sediment data to the 2014 NYSDEC SGVs indicates most of the sediment would have been considered Class B for PAHs. The sediment would have been considered Class A for arsenic (one location), chromium, and nickel; Class B for arsenic (one location), lead, and mercury (one location); and Class C for mercury (one location).

The CMS surface water analytical data from 2006 presented in Table 4-24 indicates VOCs, SVOCs, and total metals were non-detect except methylene chloride (0.0024 mg/L;

estimated), a common laboratory contaminant, and total barium (0.34 mg/L). The sediment data summarized on Table 4-25 is compared to the 2014 NYSDEC SGVs. The sediment is considered Class A for VOCs and SVOCs (even without adjusting individual PAH SGVs using site-specific TOC concentrations). For total PCBs, the sediment is considered Class B at 2 of the 3 locations and Class C at one location. The sediment at the southernmost sample location is considered Class C for arsenic, cadmium, chromium, lead and mercury. The sediment at the other two locations is primarily Class B except for lead (Class C at one location) and mercury (Class C at both locations). RFI sample NRS-2 is nearby CMS sample NRWT-SED-2; however, a sample could not be collected at this location during the CMS due to insufficient sediment. Therefore, no comparison between RFI and CMS concentrations can be reasonably made.

Based on the July 2011 visual reconnaissance and concurrent interview with a Gateway representative, it was determined that collection of additional sediment samples for the Gateway/New Enterprise Limestone portion of the NRWT was not feasible. Three trench openings historically located north of the Powerhouse (and on Tecumseh property) were observed to be covered with an encroaching slag/fill pile owned and maintained by Gateway (see Plate 4-17). The NRWT is suspected of being plugged at these locations; however, the integrity of the plug could not be determined. There are no additional openings to the trench along the approximate 1,500 feet located on New Enterprise Limestone's property. The northernmost 150 feet was altered by Gateway to allow better truck access to nearby buildings. Approximately 100 feet of aboveground sheet piles were cut to match the existing grade and the trench retro-fitted with a 48-inch steel pipe and backfilled. Only the last 50 feet (or so) remain of the above-grade sheet piles and the terminus of the installed pipe was observed to be partially submerged and open to the Union Ship Canal and Buffalo Outer Harbor. In 2011, no flow was observed coming from the pipe. On behalf of Tecumseh, TurnKey contacted the New Enterprise Limestone representative on numerous occasions in April 2019 to request access to their property in order to inspect the outfall pipe and observe any discharge from the NRWT. TurnKey received no response.

4.7.4 South Return Water Trench

The South Return Water Trench (SRWT) is a man-made surface drainage channel constructed prior to 1920, which has maintained the same path and discharge point since at

least 1938. The trench is oriented north to south and located in the southern half of the Tecumseh property; south and east of and approximately parallel to the Ship Canal; 1,250 feet west of Route 5; and approximately 1,400-feet east of the CMS Area proper (see Plate 4-17). The trench originates between the existing former Blowing Engine House No. 3 building and the demolished 32-inch Finishing Mill, flowing southerly where it discharges into Smokes Creek through monitored SPDES Outfall 226. Like the NRWT, the SRWT is surrounded by Business Park lands that are being voluntarily cleaned up by Tecumseh under the NYSDEC Brownfields Cleanup Program as there are no SWMUs requiring further assessment located therein.

The SRWT is approximately 5,000 feet of unlined open channel (except for a 2-road and 1-road/railroad bridge) with an average depth of 8 to 10 feet to the base of the channel. Water depths vary but are typically on the order of 1 to 3 feet deep. The northern portion is approximately 8 to 10 feet wide while the southern portion is approximately 30 feet across. The northern most 1,400 feet of the trench are open and constructed of brick and concrete. The next 200 feet are covered by the intersection of Site Highways 2 and 7 followed by approximately 900 feet of sheet piled walls with an open bottom. The next 2,200 feet widens to approximately 30 feet across with unsupported soil/slag/fill banks. This stretch is occasionally supported by concrete riprap or sheet piling including one road and one railroad bridge crossing for the East Harbor Lead railroad line. (The East Harbor Lead bridge crossing is where the approximate 570 CY of sediments were removed from the bottom and sides of the SRWT and a culvert was installed in 2013 as described in Section 2.3.2.) The final 200 feet begins with a bridge (Site Highway 4) followed by sheet piled sides to maintain flow into Smokes Creek. This SRWT discharge point, identified as monitored SPDES Outfall 226, has monthly flow monitoring measurements at the outfall weir near the confluence of Smokes Creek and the SRWT; the average flow rate based on monthly measurements in 2018/19 ranged between 3 and 5 million gallons per day (MGD). The flow in the SRWT can reverse such that water flows from Smokes Creek to the SRWT during times of high-water elevations in the Creek which result from high precipitation/runoff events (Ref.: National Flood Insurance Rate Map for the City of Lackawanna, New York Erie County dated May 2, 2018).

During the RFI, groundwater measurements in nearby monitoring wells and piezometers were compared to the surface water within the SRWT. Water levels within the

SRWT were lower than the adjacent groundwater table indicating an inward gradient toward the trench, suggesting that the SRWT acts as a groundwater discharge. RFI sediment sampling was conducted at four locations using an Eckman dredge sampler; therefore, the samples are likely representative of the upper 6 inches of sediment. Comparing the 1994 RFI sediment data (see Appendix N) to the 2014 NYSDEC SGVs indicates the sediment would have been considered Class A for VOCs and individual PAHs. Most of the sediment would have been considered Class A for cadmium, nickel, and silver; Class B for arsenic and chromium; and Class C for lead. Arsenic, chromium, mercury and nickel concentrations at one location each classify the sediment as Class C.

The CMS Work Plan called for further assessment of the SRWT to determine the quality of sediment and surface water within the trench. Consequently, in late September/ early October 2009, three surface water samples (SRWT-SW-1 to -SW-3) were collected along the SRWT at the locations shown on Plate 4-17 for TCL VOC (Method 8260B), TCL SVOC (Method 8270C, base-neutrals only), RCRA metals (Method 6010B/7471), plus cyanide (Method 9012A) analysis. Concurrently, 17 near-surface sediment samples (SRWT-SED-1 through 17) were collected using a Ponar dredge from the locations shown on Plate 4-17. Grab samples from each location were collected for TCL VOC analysis (Method 8260B). Adjacent sample pairs (e.g., SRWT-SED-1/2, -4/5, -6/7, -8/9, -10/11, -12/13, -14/15, and -16/17) were composited for non-volatile analysis. Grab sample SRWT-SED-3 was collected for discrete non-volatile analysis. Altogether, 17 sediment samples were analyzed for VOCs (Method 8260B) and nine samples were analyzed for TCL SVOCs (Method 8270C, base neutrals only), RCRA metals (Method 6010B/7471) plus cyanide (Method 9012A), PCBs (Method 8082), and TOC (Method Lloyd Kahn). Table 4-26 summarizes the surface water analytical data and Table 4-27 summarizes the sediment analytical data from the CMS. Table 4-28 summarizes the data collected by USEPA in November 2011. Three locations along the SRWT were sampled at multiple depth intervals at each location for analysis of TCL SVOCs (Method 8270C), PAHs (Method EPA-34), PCBs (Method 8082), RCRA Metals (Method 6010B/7471A), diesel range organics (DRO), oil range organics (ORO) and TOC.

Although the SRWT is not a classified water body, surface water results collected from the SRWT are compared to the NYSDEC Ambient Water Quality Standards for a Class C water body, which is Smokes Creek's classification (see Table 4-26). For those

compounds where more than one value is listed based on specific water use, the most stringent limitation was used. There were no exceedances of these surface water quality standards except for cyanide in all three surface water samples and mercury in samples SRWT-SW-2 and SRWT-SW-3. The surface water samples were analyzed for total cyanide whereas the standard applies to free cyanide; therefore, a direct comparison is not applicable. Similarly, total mercury was analyzed, and the standard applies to dissolved mercury. The results of the surface water sample (SRWT-SW-1) at the confluence with Smokes Creek contained the lowest level of cyanide and mercury was not detected.

Comparing the CMS sediment data summarized on Table 4-27 to the 2014 NYSDEC SGVs, the sediment is considered Class A for VOCs. Two individual PAH concentrations slightly exceed the individual SGVs presented in Table 7 of the 2014 guidance. However, using the site-specific TOC and adjusting the SGVs, both fluoranthene and phenanthrene concentrations fall below their respective SGVs. For total PCBs, most of the sediment is considered Class A; only 3 of the 9 sample locations are at the lower end of the range for Class B. For RCRA metals, the sediment varies along the length of the SRWT but on average is considered Class A for silver (only one location is Class B); Class B for cadmium, chromium, mercury and silver, and Class C for arsenic and lead. TOC concentrations detected in SRWT sediment were almost twice that of Smokes Creek sediment (upper and lower reach). Higher TOC in sediment is generally considered desirable to make inorganic sediment constituents less bioavailable for uptake.

Similar concentrations of various parameters have been detected in the SRWT (2009 and 2011) and off-site upstream locations in Smokes Creek, which illustrates "background" sediment concentrations outside the influence of the CMS Area.

4.7.5 Blasdell Creek

Although impacts to sediment along Blasdell Creek adjacent to and downstream of the former Bar Mill were identified in the RFI (as compared to upstream sediment), Tecumseh and/or its parent company ArcelorMittal Steel USA never owned or operated the former Bar Mill, as it was sold by BSC in 1995 to Republic Technologies, Inc. Tecumseh has not controlled any discharges to Blasdell Creek and is therefore not responsible for any corrective measures with respect to Blasdell Creek. In addition, the RFI did not identify any SWMUs requiring further assessment proximate to Blasdell Creek. For these reasons,

additional assessment of Blasdell Creek was not called for in the CMS Work Plan and none was performed during the CMS. As Blasdell Creek is considered by Tecumseh to be outside the context of the CMS, Blasdell Creek was not evaluated further in the CMS.

4.8 CMS Area-Wide Comprehensive Groundwater Quality Assessment

4.8.1 Purpose & Scope

Groundwater characterization of the former Bethlehem Steel Property was performed in 1999 and 2000 as part of the RFI. During the CMS, and consistent with the CMS Work Plan and several subsequent CMS Area-wide groundwater monitoring events (including most recently in January 2019), additional groundwater data was collected from locations throughout the CMS Area to better assess and update groundwater quality and aquifer characteristics in the vicinity of certain SWMUs that required further assessment, and adjacent to surface water bodies that receive discharges from groundwater. Based on NYSDEC comments on the draft CMS Report (dated 2011) and as agreed upon by NYSDEC and Tecumseh, a round of CMS Area-wide groundwater sampling and analysis was performed in February/March 2012 in accordance with the Long-Term Groundwater Monitoring (LTGWM) Plan. This additional groundwater data was compiled and summarized along with existing RFI and CMS groundwater data to comprehensively assess groundwater quality and temporal changes over the entire CMS Area and was presented in the Groundwater Quality Assessment Report dated October 2012.

In a letter dated January 22, 2013, the NYSDEC commented on the 2012 Report requesting additional assessments of:

- Groundwater isopotential data;
- Geologic cross-sections;
- Spatial groundwater constituent distribution;
- Groundwater constituent loadings to adjacent water bodies; and
- Identification of SWMUs that may be significantly impacting groundwater in the CMS Area.

Following several meetings and discussions to clarify specific NYSDEC requirements, the scope of the Comprehensive Groundwater Quality Assessment was agreed upon and initiated. The 2013 Groundwater Quality Assessment Report was subsequently prepared and submitted on August 23, 2013.

In a February 27, 2014 comment letter, the NYSDEC rejected the 2013 Groundwater Quality Assessment Report stating that it did not substantially address the previous comments of the Department nor did the Report address metals, which the Department then considered additional COCs[9]. Tecumseh agreed to again revise the 2013 Groundwater Assessment Report to:

- Further substantiate certain statements and findings regarding groundwater quality improvements and observed reductions in groundwater contaminant mass loadings to surface water bodies subsequent to the RFI;
- Incorporate total metals analyses and mass loadings; and
- Incorporate responses to the NYSDEC February 2014 comments.

In 2014, groundwater samples were collected from 132 monitoring wells, including several newly installed wells within the CMS Area, and were analyzed to update the Groundwater Quality Assessment Report.

In addition to the groundwater monitoring events discussed above, the following groundwater data was also incorporated into the CMS Area-Wide Comprehensive Groundwater Quality Assessment:

- Semi-annual (2003 through 2008) and annual (2009 through 2018) groundwater monitoring data from HWMU-1 and HWMU-2.
- Annual (2014 through 2018) groundwater monitoring data from the ATP-ECM (OU-2 and -3).
- April 2013 performance monitoring event data from the former Benzol Plant Sub-Area (SWMU P-11).

[9] Upon consultation with NYSDEC, groundwater compounds of concern (COCs) are defined as any compound or analyte detected in the groundwater above its respective GWQS/GVs in at least one monitoring well location within the CMS Area. However, the primary COCs for groundwater are benzene, toluene, ethylbenzene, total xylene, naphthalene, barium, and total phenolic compounds (TPC).

- January 2019 groundwater monitoring data collected from 39 existing monitoring wells in key CMS Area locations.

The following sub-sections include:

- A general discussion of the CMS Area geology and hydrogeology, including primary groundwater flow directions within the slag/fill, sand, sand/USACE dredge spoil, and bedrock units, hydraulic gradients (both horizontal and vertical), and groundwater recharge/discharge areas (Sections 4.8.3 through 4.8.6);
- An evaluation of the overall CMS Area groundwater quality compared to the RFI (Section 4.8.7);
- A discussion of recent groundwater data compared to the NYSDEC Class GA Groundwater Quality Standards/Guidance Values (GWQSs/GVs) per Technical Operational Guidance Series 1.1.1 for Ambient Water Quality Criteria (Section 4.8.7);
- Geologic cross-sections as they relate to groundwater quality (i.e., primary COC profiles) within each geologic unit (Sections 4.8.7.2.1 through 4.8.7.2.7)
- A detailed presentation and discussion of past (RFI) and current (CMS) non-point groundwater contaminant mass loadings to adjacent surface water bodies from shallow water-bearing slag/fill, native sand, and sand/USACE dredge spoil units (see Section 4.8.8);
- An evaluation of SWMUs and other potential sources of all identified COC contamination in groundwater (see Sections 4.8.8.4.1 through 4.8.8.4.6); and
- A summary of the comprehensive groundwater quality assessment for the CMS Area (see Section 4.8.9).

4.8.2 Data Presentation

A summary of monitoring wells sampled during the CMS groundwater monitoring events including dates of sample collection, water-bearing unit, and laboratory analysis are presented in Table 4-29. Groundwater elevations measured on January 4, 2019 are summarized in Table 4-30. Groundwater data collected from the CMS Area during the RFI (1999/2000) through the 2019 sampling event has been compared to the GWQSs/GVs for compounds detected and presented in Tables 4-31 through 4-36 by Groundwater Discharge Sub-Areas (DSAs). Groundwater data obtained from the RFI (by others) is presented to compare trends in groundwater quality over time. Tables 4-37 through 4-45 are calculation tables of historic RFI and the most recent mass loadings of COCs in CMS Area groundwater

to adjacent water courses. COCs known to be present (based on RFI or CMS data) in SWMU waste/fill and USACE dredge spoils in excess of the NYSDEC Part 375 ISCOs and Protection of Groundwater SCOs, are summarized by groundwater DSA in Tables 4-3 and 4-46, respectively, for the express purpose of identifying potential groundwater contaminant "source areas" within the CMS Area. Table 4-47 presents a summary of identified potential source areas (i.e., SWMUs and/or sand/USACE dredge spoils) where both the individual GWQS/GV and the Protection of Groundwater SCOs within the suspected upgradient source were exceeded.

Data, both RFI and CMS, are presented graphically in various plates and figures, as follows.

- Plate 4-18 shows the locations of the nine geologic cross-sections A-A' through I-I' in plan view.
- Plate 4-19 presents the shoreline segments used for the RFI and CMS mass loading calculations and the areas associated with each of the six DSAs (DSA-2A, -2B, -3A, 4B, and -5).
- Plates 4-20 through 4-22 present the groundwater isopotential maps for the slag/fill, native sand/sand/dredge spoil, and bedrock units, respectively based upon the most recent groundwater elevation data.
- Plate 4-23 illustrates, by color, across the CMS Area where groundwater quality has generally improved or declined since the 1999/2000 RFI.
- Plates 4-24 through 4-29 illustrate, by color, where and to what relative degree primary COC concentrations in the most recently available groundwater data either meet or exceed their respective GWQS/GVs.
- Figures 4-1 through 4-54 present the geologic cross-sections for A-A' through I-I' identified on Plate 4-18 and are intended to be used with primary COC concentrations on plan view Plates 4-24 through 4-29. The cross-section figures present the primary COCs in a color-coded format with monitoring wells presented in the cross-section figures color-coded to correspond to the primary COC concentrations presented in Tables 4-31 through 4-36.[We note that the color code Green was added to wells on Figures 4-1 through 4-54 to represent current or recent concentrations that are at or below their respective Class GA GWQS/GV. Those wells without a color code were not recently sampled.
- Figure 4-55 is the legend and notes for Figures 4-1 through 4-54

4.8.3 CMS Area Geology & Hydrogeology

Data collected during the RFI and confirmed during the CMS indicate that the CMS Area is entirely overlain with man-made deposits (slag/fill unit); thickest near the Lake (up to 100 feet thick) and thinning to the east near the Ship Canal (10 feet thick). Underlying the slag/fill unit are four to five distinct geologic units, listed in stratigraphic order (top to bottom): native sand and/or peat (eastern portion of the CMS Area); intermixed native sand with USACE dredge spoils (western portion of the CMS Area, see Plate 4-1); lacustrine silt and clay; glacial till; and shale or limestone bedrock.

The natural subsurface geology underlying the slag/fill is primarily lake sediments (blanket sands and beach ridges), with occasional peat deposits, underlain by lacustrine silts and clays and/or glacial tills, overlying bedrock (see geologic cross section Figures 4-1 through 4-55). The lake sediments in the western portion of the CMS Area have been intermixed with Buffalo River and Buffalo Harbor dredge spoils deposited by the USACE from circa 1900 to 1949 prior to slag and waste filling.

The granular slag/fill and sand/USACE dredge spoil deposits act as a hydraulically connected unconfined groundwater unit. The lacustrine clay and glacial till act as an aquitard hydraulically separating the unconfined units from the upper bedrock groundwater.

The low-permeability silty clay and glacial till present throughout most of the CMS Area ranges in thickness from 2 to 50 feet. The in-situ vertical hydraulic conductivity (Kv) determined during the RFI was confirmed during the CMS by collecting three undisturbed native clay confining unit samples from beneath the Coke By-Products area. The average Kv of the three samples was 6.8E-8 cm/sec (see Section 4.6.3.2).

The CMS Area hydrogeology is dominated by the lakeshore setting and the characteristics of the overburden material (e.g., slag/fill, native sand, and sand/USACE dredge spoils). The native sand unit (eastern portion of the CMS Area) ranges in thickness from approximately 2 to 20 feet whereas the anthropogenic sand/USACE dredge spoil unit (western portion of the CMS Area) ranges in thickness from approximately 6 to 13 feet. The lower portion of the slag/fill and native sand (or sand/USACE dredge spoil) units combined comprise a low-yielding (less than 5 gpm), shallow, unconfined water table groundwater unit under the entire CMS Area. The average saturated thickness ranges from approximately 8 feet (DSA 5) to 25 feet (DSA 2A).

Of the 160 existing monitoring wells within the CMS Area, 99 are screened in the slag/fill unit, 8 are screened in the native sand or sand/USACE dredge spoil unit, 5 are screened in the clayey silt or till unit, 4 are screened in the peat layer, 39 are screened across multiple units (i.e., fill/clay, sand/clayey silt, sand/clay, fill/sand/clayey silt, peat, clayey silt, or till), and 5 are screened within the bedrock. The hydrogeologic units screened by each well are presented in Tables 4-29 and 4-30.

Across the entire CMS Area overlying the sand/USACE dredge spoil unit (western portion) and near shore lake deposits (eastern portion) are millions of cubic yards[10] of man-made slag/fill consisting of iron-making and steel-making slag with interspersed cinders, coke, ash, brick, and steel construction debris deposited from decades of steel plant operations.

As presented in Section 4.2, the sand/USACE dredge spoil deposits are contaminated with many of the same COCs contained in CMS Area SWMU waste/fill, primarily PAHs and metals. The volume of sand/dredge spoil deposits dumped by the USACE into Lake Erie has been approximated as follows:

- Based on USACE records, dredge spoils within the former Federal dumping grounds are estimated to be 11.5 million cubic yards (CYs). Of that amount, roughly one third (or 3.26 million CYs)[11] lies beneath slag/fill placed by Bethlehem Steel in the western portion of the CMS Area.
- The remaining approximate 8.28 million CYs of USACE dredge spoil material remains uncovered in Lake Erie potentially acting as a source for documented contamination to Lake Erie and the Niagara River basin irrespective of any potential loadings from the CMS Area SWMUs and/or AOCs that are present within the slag/fill unit and above the water table.

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[10] Current slag reclamation operations are conducted by Iron City Recovery, LLC under license agreement with Tecumseh Redevelopment Inc. and are confined to the northern SFA Zones 4 and 5 Sub-Areas away from SWMUs, where significant recoverable and reusable slag deposits remain. As slag continues to be reclaimed, the total quantity has diminished somewhat and varies with time.

[11] Based on total acreage (±715 acres) of Federal Dumping Ground areas shown on April 24, 1937 Buffalo Harbor Dumping Ground Drawing and average thickness (10 feet) of dredge spoils (Sediment Unit #2) presented in Section 2.3 of the October 2002 Investigation of Dredge Spoils Dumping (Appendix G of the RFI).

- Comparatively, approximately 870,000 CYs of waste/fill material exist within the CMS Area associated with SWMUs or roughly 7.6% of the total dredge spoils openly dumped into Lake Erie by the USACE.

Based on the hydrogeologic assessment presented in the RFI, the representative average hydraulic conductivity of the slag/fill unit is 2.04 x 10^{-2} cm/sec (6.693 x 10^{-4} ft/sec) and 2.02 x 10^{-3} cm/sec (6.630 x 10^{-5} ft/sec) in the sand and sand/USACE dredge spoil units, roughly an order of magnitude difference.

The shallow groundwater unit (slag/fill and sand/USACE dredge spoils) is underlain by an aquitard consisting primarily of lacustrine silt/clay and glacial till units ranging in thickness from 2 to more than 50 feet. This relatively ubiquitous confining unit results in a significant degree of hydraulic separation between the unconfined water table and the bedrock groundwater unit (Ref. 1). Only two small areas of the CMS Area were identified during the RFI to be absent of this confining unit: Tank Farm Area (in the vicinity of Wells MWN-17A and MWN-17B) and an area near the mouth of Smokes Creek. These two areas represent less than one percent of the total CMS Area. The in-situ vertical hydraulic conductivity (K_V) determined during the RFI (average K_V=6.00E-8 cm/sec) was confirmed during the CMS with three undisturbed samples collected from the native silt/clay confining unit beneath the Coke By-Products Area with an average K_V of 6.80E-8 cm/sec (see Section 4.6.3.2).

A peat layer of variable thickness is thick (up to 18 feet) and extensive in DSA 5 on the west side of the Gateway Metroport Canal underlying the Coke Plant By-Product Sub-Area and pinches out to the north and west (see geologic cross-sections G-G' and H-H'). In this location the peat layer acts in conjunction with the lacustrine silt/clay and glacial till as an aquitard. Elsewhere on the CMS Area the peat, if present, is not extensive and only occasionally deposited above, below or adjacent to the sand/spoils with only minor localized effects on groundwater flows.

Below the aquitard is a confined groundwater unit within the uppermost portion of the bedrock.

4.8.4 Groundwater Discharge Sub-Areas

Groundwater Discharge Sub-Areas (DSAs) were developed during the RFI that separated the Bethlehem Steel Property into ten distinct DSAs. Groundwater flow patterns

within the unconfined saturated slag/fill and sand/USACE dredge spoil units of the CMS Area (Plates 4-20 and 4-21) indicate influence from nearby water courses (Smokes Creek, Lake Erie and Ship Canal) on the groundwater flow patterns. Groundwater divides and flow boundaries separate the CMS Area into six distinct groundwater DSAs identified as DSA 2A, 2B, 3A, 4A, 4B, and 5 as shown on Plate 4-18. The boundaries and nomenclature of these DSAs have been adopted from the RFI with one exception; DSA 5 in the vicinity of SWMU P-11 has been modified to more appropriately reflect the groundwater capture zone created by the Benzol Plant ICM groundwater collection system after 2005 and most recently in 2019 by the more extensive OU-4 groundwater collection system. The adjacent receiving surface water body and areal extent of the six DSAs within the CMS Area are identified in the table below.

Groundwater Discharge Sub-Area	Receiving Surface Water Body	Approx. Area (Million Sq. Ft.)	Approx. Area (Acres)
2A	Lake Erie	2.15	49.36
2B	Smokes Creek	1.34	30.76
3A	Smokes Creek	1.99	45.68
4A	Lake Erie	16.75	384.53
4B	Lake Erie (via Outer Harbor)	2.23	51.19
5	Lake Erie (via Ship Canal)	1.05	24.10

These six DSAs are discussed in the context of the CMS.

- DSAs 2A and 2B encompass SFA Zone 2 Sub-Area
- DSA 3A includes the southern portions of SFA Zone 3 Sub-Area and the Tank Farm Sub-Area
- DSA 4A includes the majority of SFA Zone 3 Sub-Area, the Tank Farm Sub-Area, and the Coal, Coke & Ore Handling and Storage Sub-Area as well as the SFA Zone 4 Sub-Area and southern half of SFA Zone 5 Sub-Area
- DSA 4B includes the northern half of SFA Zone 5 Sub-Area and the northern portion of the Coal, Coke & Ore Handling and Storage Sub-Area
- DSA 5 includes the Coke Plant & By-Products Facility Sub-Area

Currently, regularly scheduled groundwater quality and flow monitoring activities are being conducted at the HWMUs 1A, 1B, and 2 (SWMUs S-13, S-16, and S-03, respectively), Steel Winds I, OU-4 (which includes the Coke By-Products Sub-Area including SWMUs P-

11 & P-11A), and ATP-ECM Containment Cell (SWMU S-11 and S-22). The monitoring of these Sub-Areas and SWMUs will continue in accordance with each respective closure/post-closure OM&M Plan and will be incorporated into the CMS Area LTGWM program. Historical groundwater analytical trends associated with these Sub-Areas and SWMUs are addressed herein by DSA in the following sections as appropriate.

4.8.5 Groundwater Flow

Groundwater elevations measured in January 2019 were used to prepare current isopotential maps of the slag/fill; native sand and sand/dredge spoil; and bedrock unit groundwater within the CMS Area (see Plates 4-20, 4-21, and 4-22, respectively). Borehole logs and well installation details for CMS monitoring wells are presented in Appendix G.

In general, groundwater flows westerly towards Lake Erie and locally (in DSA 2B and 3A) towards Smokes Creek. However, the presence of the surface water bodies (Smokes Creek and Ship Canal) have an influence on the groundwater flow adjacent to these surface water bodies as shown on Plates 4-20 and 4-21. This is apparent for both the slag/fill and native sand and sand/USACE dredge spoil unit.

DSA 2B also has a northerly groundwater flow component, while DSA 3A has a southerly groundwater flow component due to Smokes Creek. DSA 4B also has a northerly groundwater flow component due to the presence of Lake Erie to the north of the CMS Area. DSA 5 primarily has an easterly groundwater flow direction due to the presence of the Ship Canal immediately to the east.

The groundwater contours on Plates 4-20 and 4-21 do not reflect the effects of the 41 new pumping wells installed within OU-4 which began operation in March 2019 after the groundwater elevations were collected in January 2019. Groundwater pumping associated with the Benzol Plant ICM is reflected in the contours. The purpose of the OU-4 pumping wells is to provide more extensive hydraulic control of the groundwater throughout the entire Coke Plant By-Products Sub-Area in the eastern portion of DSA 4A and the south and central portion of DSA 5.

There are four localized groundwater mounds and two areas of groundwater depressions in the slag/fill unit. Two localized groundwater mounds are located in DSA 2B in the vicinity of the ATP-ECM Containment Cell, one is located in DSA 4A in the vicinity

of HWMU 1B, and one is located in DSA 5 (the Coke Plant By-Products Sub-Area). The groundwater depressions are located north of ATP-ECM and the Benzol Plant ICM.

The localized groundwater mounding outside and south of the ATP-ECM is a result of the ATP-ECM containment system which sheds surface water runoff to the perimeter and impedes horizontal groundwater flow due to the slurry wall surrounding it. Groundwater within the ATP-ECM containment system is purposefully depressed by three interior pumping wells. The groundwater depression on the northern side of the ATP-ECM results from the four exterior pumping wells installed in 2015 to capture contaminants that migrated away from the ATP area prior to implementing the ECM.

The mounding in the vicinity of HWMU 1B is a result of the degradation of the temporary cover system that is allowing infiltration to occur. An engineered cover system has been proposed to be installed over HMWU 1B as part of the final remedial proposed in the CMS.

The mound located along the boundary of DSA 4A and DSA 5 is attributable to several factors, including:

- The peat ridge (see geologic cross-sections G-G' and H-H');
- The thin thickness of the slag/fill water-bearing unit; flat surface topography;
- Treated groundwater recharge from the Benzol Yard ICM;
- Leakage from the Industrial Water System; and
- Possibly the presence of the steel sheeting along the canal inhibiting horizontal flow to the east.

The native sand and sand/USACE dredge spoil unit isopleth map (Plate 4-21) also indicates a few groundwater mounding areas, like the slag/fill unit, but does not indicate groundwater depressions. One groundwater mound is in DSA 2B the vicinity of the ATP-ECM and two are located near the boundary of DSA 4a and 5. The rational for the mounding is the same discussed above for the slag/fill unit mounding for these respective areas.

Where the native sand or sand/USACE dredge spoils units are co-located along the western portion of the CMS Area, they collectively act as one hydrogeologic unit. Plates 4-20 and 4-21 indicate similar groundwater elevations and flow patterns. The RFI estimated

that 90 to 100% of the unconfined groundwater flow occurs through the slag/fill unit in the eastern portion of the CMS Area where the native sand unit is much thinner or absent.

Groundwater elevation data within the bedrock unit of the CMS Area is limited to five bedrock monitoring wells, however it is apparent that bedrock groundwater under the CMS Area flows westerly toward Lake Erie (see Plate 4-22).

Horizontal and vertical hydraulic gradient calculations are presented in Appendix L, based on the January 2019 water level measurements. The average westward horizontal hydraulic gradient across the CMS area towards Lake Erie within the slag/fill unit groundwater is currently approximately 0.0016 ft/ft versus 0.0029 ft/ft during the RFI. The average westerly horizontal hydraulic gradient south of Smokes Creek is 0.0022 ft/ft and the average westerly horizontal hydraulic gradient north of Smokes Creek is 0.012 ft/ft. The average horizontal hydraulic gradient towards Smokes Creek is 0.0087 ft/ft.

The average current westerly hydraulic gradient calculated for the sand unit was 0.0017 ft/ft versus 0.0026 ft/ft during the RFI. The average westerly horizontal hydraulic gradient south of Smokes Creek is 0.0024 ft/ft and the average westerly horizontal hydraulic gradient north of Smokes Creek is 0.013 ft/ft. The average horizontal hydraulic gradient towards Smokes Creek is 0.0095 ft/ft. The hydraulic gradients of the slag/fill and sand units are similar, further supporting that the two units act as one unconfined hydraulically connected unit. Localized areas of groundwater mounding were not used in the calculations.

Vertical hydraulic gradients were calculated during the CMS for 41 paired monitoring wells as follows (see Appendix L):

- 20 paired wells slag/fill to sand: 13 paired wells exhibited downward or no vertical gradient and 7 exhibited upward gradient.
- 8 paired wells slag/fill to clay: 7 paired wells exhibited downward vertical gradient and 1 exhibited an upward gradient.
- 1 paired well slag/fill to till that exhibited a downward gradient.
- 4 paired wells slag/fill to bedrock all of which exhibited a downward gradient.
- 3 paired wells fill to peat all of which exhibited a downward gradient.
- 4 paired wells sand to bedrock: 3 paired wells exhibited downward vertical gradient and 1 exhibited an upward gradient.
- 1 paired well clay to till that exhibited a downward vertical gradient.

Most of the CMS Area groundwater exhibits a downward hydraulic gradient, which is reflective of recharge (32 of the 41 paired wells).

Horizontal and vertical gradient flow directions are shown on geologic cross-sections presented in Figures 4-1 through 4-54.

4.8.6 Groundwater Recharge and Discharge

Recharge to the ground surface of the CMS Area and the upper unconfined groundwater is from rainfall and snowmelt. Most, if not all, precipitation infiltrates to the subsurface. Little to no runoff occurs, and if present, is eventually intercepted by one of the adjacent water bodies (Smokes Creek, Ship Canal, Lake Erie, or the Buffalo Outer Harbor). While some vegetation exists on the surface in portions of the CMS Area, it is generally sparse and hence evapotranspiration is considered minimal. Because the surface conditions of the CMS Area are relatively uniform (i.e., material types, vegetative cover, paved roads, site structures, topography, etc.) a uniform recharge rate of 1.25 feet/year was determined during the RFI. This rate was used in the groundwater discharge calculations discussed below and in Section 4.8.8 to calculate contaminant mass loadings in groundwater discharged from each DSA to adjacent water courses.

Groundwater discharge rates to each adjacent water body were calculated assuming the discharge rate was equal to the surface recharge for each DSA. The area of each DSA determined during the RFI was multiplied by the annual recharge rate of 1.25 feet/year to obtain the discharge rates of each DSA (see Table 4-37). Discharge rates calculated for each DSA were generally the same as those calculated during the RFI except for DSA 2B, 4A and 5 5 due to the pumping wells installed north of the ATP-ECM and throughout OU-4. The discharge rates for these two DSAs have been adjusted to account for groundwater that is extracted, treated and does not discharge to the adjacent surface water body. The average pumping rate for ATP wells is approximately 4,500 gpd and for the OU-4 wells is approximately 100,000 gpd.

4.8.7 Assessment of CMS Groundwater Quality

A comprehensive assessment of groundwater quality in the CMS Area is presented in this sub-section through the comparisons of temporal trends in primary COC concentrations and other detected constituents where appropriate in groundwater relative to

GWQSs/GVs; the lateral and vertical distribution of groundwater constituents; and constituent mass loading to adjacent water bodies.

4.8.7.1 Comparison of Past (RFI) to Current (CMS) Groundwater Quality Data

A summary of the comparison of the most recent CMS data available (2010 through 2019) to RFI data (1999 to 2000) is illustrated on Plate 4-23 for 123 wells in which both RFI and CMS data were available. The monitoring locations on Plate 4-23 are color-coded according to the following criteria: **green** indicates the recent groundwater quality generally improved (i.e., primary COC concentrations reduced by about 50% or more); yellow indicates the recent groundwater quality did not change by more than 50%; and **red** indicates the recent groundwater quality generally declined (i.e., primary COC concentrations increased by 50% or more). No color indicates that no comparative groundwater quality data was available to make an assessment at those well locations. Examination of Plate 4-23 indicates overall groundwater quality across the CMS Area has generally improved, except in a few localized areas. Of the 123 wells in which comparative data was available, the groundwater quality at 69 locations (56%) improved, 42 locations (34%) remained essentially the same, and 12 locations (10%) decreased.

Tables 4-31 through 4-36 summarize RFI and CMS groundwater analytical data by DSA relative to NYSDEC GWQSs/GVs. Exceedances of GWQSs/GVs are color coded in the tables as follows: no color indicates the concentration reported was below the GWQS/GV; **blue** indicates a reported concentration above the GWQS/GV up to 10 times the GWQS/GV; yellow indicates a reported concentration greater than ten times the GWQS/GV up to 100 times the GWQS/GV; **red** indicates a reported concentration greater than one hundred times the GWQS/GV; and **purple** indicates a location where pH was measured greater than 12.5.

Plates 4-24 through 4-29 present a colorimetric representation of recent groundwater data for primary COC concentrations (benzene, ethylbenzene, toluene, total xylene, naphthalene and total phenols) relative to their corresponding GWQS/GV using the same color scheme as the tables, which the exception that **green** indicates the COC was below its comparative GWQS/GV and non-color indicates that no data was available for that well location. CMS COC concentrations elevated above their respective GWQSs/GVs are presented by DSA below.

- DSA 2A (Table 4-31): Concentrations above the GWQSs/GVs identified within this DSA include pH, 1,1-dichloroethane, 1,2,4-trimethylbenzene, 1,2-dichloroethane, 1,3,5-trimethylbenzene, benzene, ethylbenzene, toluene, total xylenes, acenaphthene, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, biphenyl, chrysene, fluorene, indeno(1,2,3-cd)pyrene, naphthalene, phenanthrene, arsenic, barium, chromium, lead, selenium, and total phenolics.
- DSA 2B (Table 4-32): Concentrations above the GWQSs/GVs identified within this DSA include 1,2-dichloroethane, benzene, ethylbenzene, styrene, cis-1,2-dichlorothene, toluene, trans-1,2-dichloroethene, trichloroethene, total xylenes, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, bis(2-ethylhexyl)phthalate, chrysene, indeno(1,2,3-cd)pyrene, naphthalene, arsenic, barium, chromium, lead, selenium, cyanide, and total phenols.
- DSA 3A (Table 4-33): Concentrations above the GWQSs/GVs identified within this DSA include pH, 1,2,4-trimethylbenzene, benzene, ethylbenzene, toluene, styrene, total xylenes, acenaphthene, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, biphenyl, chrysene, fluorene, indeno(1,2,3-cd)pyrene, naphthalene, phenanthrene, arsenic, lead, selenium, cyanide, and total phenolics.
- DSA 4A (Table 4-34): Concentrations above the GWQSs/GVs identified within this DSA include pH, 1,2,4-trimethylbenzene, 1,2-dichlorobenzene, 1,3,5-trimethylbenzene, acetone, benzene, chlorobenzene, cis-1,2-dichloroethene, ethylbenzene, isopropylbenzene, styrene, toluene, trans-1,2-dichloroethene, trichloroethene, vinyl chloride, total xylenes, acenaphthene, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, biphenyl, bis(2-ethylhexyl)phthalate, chrysene, fluorene, indeno(1,2,3-cd)pyrene, naphthalene, phenanthrene, arsenic, barium, selenium, and total phenolics.
- DSA 4B (Table 4-35): Concentrations above the GWQSs/GVs identified within this DSA include pH, benzene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, indeno(1,2,3-cd)pyrene, benzo(a)anthracene, chrysene, , and total phenols.
- DSA 5 (Table 4-36): Concentrations above the GWQSs/GVs identified within this DSA include pH, 1,2,4-trimethylbenzene, acetone, benzene, ethylbenzene, styrene, toluene, total xylenes, acenaphthene, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, fluorene, biphenyl, chrysene, indeno(1,2,3-cd)pyrene, naphthalene, phenanthrene, arsenic, barium, chromium, cyanide, and total phenols.

4.8.7.2 Geologic Cross-Sections with Groundwater Primary COC Profiles

Geologic cross-sections were prepared from RFI and CMS boring logs/well completion details at the locations shown on Plate 4-18. The locations of the cross-sections within the CMS Area and groundwater data presented within (primary COCs) were determined following several meetings with NYSDEC. Cross-sections were prepared to present the spatial relationship of each SWMU, monitoring wells, and surface water bodies relative to their hydrogeologic setting as well as to graphically present groundwater concentration associated with certain monitoring wells for primary COCs. Figures 4-1 through 4-54 present Cross-Sections A-A' through I-I', for primary COCs (benzene, ethylbenzene, toluene, total xylenes, naphthalene, and total phenols), and should be reviewed in conjunction with Plates 4-24 through 4-29, respectively. Figure 4-55 presents the legend and notes associated with the cross-section figures.

The screened interval of monitoring wells along each cross-section have been color-coded to correlate with the most recent data available for primary COC concentrations at that location based upon the data presented in Tables 4-31 through 4-36. The color code is as follows: **green** indicates the most recent concentration was below the GWQS; **blue** indicates a reported concentration above the GWQS/GV up to 10 times the GWQS/GV; **yellow** indicates a reported concentration greater than 10 times the GWQS/GV up to 100 times the GWQS/GV; **red** indicates a reported concentration greater than 100 times the GWQS/GV. A detailed discussion of each cross-section and the reported CMS groundwater concentrations are presented in the following sections.

4.8.7.2.1 Sections A-A', B-B', & C-C'

As presented on Plate 4-18, geologic cross-section A-A' is the southernmost section orientated west to east from Lake Erie across DSA 2A to well pair MW-12A/12B. Cross-section B-B' is also within DSA 2A (north of A-A') orientated west to east from Lake Erie to well MWS-29. Cross-section C-C' (north of B-B' meandering between DSAs 2A and 2B) is orientated west to east from Lake Erie through the ATP-ECM to well pair MWS-20A/20B. Figures 4-1 through 4-18 illustrate the profiles for the primary COCs in groundwater across these three cross-sections.

Elevated concentrations of the primary COCs were detected in the groundwater south of Smokes Creek in DSA 2A and 2B. Of the elevated concentrations detected, the

highest concentrations were noted in wells that were installed with the saturated sand/USACE dredge spoil unit and/or the slag/fill and sand/USACE dredge spoil units. A few wells of note are:

- Cross-section A-A': MWS12B
- Cross-section B-B': MW2D2B, MW-2U1B, MW-2D2D
- Cross-section C-C': MWS-14B, MWS-01B.

Upward and downward gradients shown on the sections indicate potential "mixing" of impacted sand/USACE dredge spoil unit groundwater with slag/fill groundwater.

Elevated primary COCs were also consistently noted in slag/fill wells MWS-01 and MWS-11A, and bedrock well MW-2D2D. Contaminants present in MWS-01 and MWS-11A may be attributed to contamination from the ATP prior to the implementation of the ECM at that location, or possibly SWMUs -03, -04, and -08 in the vicinity of the two wells.

Well MW-2D2D was installed roughly 16 feet into a petroliferous shale unit adjacent to fill unit well MW-2D2 and sand/USACE dredge spoil unit well MW-2D2B. The RFI reported a downward vertical gradient from the overlying slag/fill and USACE sand/dredge spoil units to the bedrock at this location, which was confirmed during the CMS. Due to the petroliferous composition, it is not at all uncommon to see elevated naturally occurring VOCs (primarily BTEX) and SVOCs (primarily petrogenic PAHs) present in groundwater of these formations. There were no observations of impact above GWQS/GVs within the slag/fill unit at this well triplet location (e.g., MW-2D2). As such, the impacts observed at this location may be downward migration of contaminants from overlying contaminated sand/USACE dredge spoil unit; however, based on the concentrations, it is suspected these impacts are primarily naturally occurring, and as such are not proposed to be addressed as part of the CMS comprehensive groundwater remedy.

4.8.7.2.2 Section D-D'

Geologic cross-section D-D' is the western-most cross-section parallel to Lake Erie and begins at the southern CMS boundary of SFA Zone 2. It is orientated south to north through DSAs 2A, 2B, across Smokes Creek through DSA 3A, and into DSA 4A ending at well WT1-07 (see Plate 4-18). Figures 4-19 through 4-24 illustrate the profiles of the primary COCs in groundwater across this section. Examination of cross-section D-D' indicates that

elevated primary COCs are occasionally observed in slag/fill, the higher concentrations are primarily within the sand/USACE dredge spoil unit, similar to cross-sections A-A', B-B' and C-C'. A few wells of note are MW2D2B (sand/USACE dredge spoil unit), MWS-01 (slag/fill unit), MWS-01B slag/fill and USACE sand dredge spoil units), MWN-01 (slag/fill), MWN-01B (slag/fill and sand/USACE dredge spoil units), and WT1-07 (slag/fill unit).

This hydrogeologic profile also indicates that Smokes Creek is a "gaining" stream in the CMS Area. That is, the overlying slag/fill unit groundwater discharges to the Creek. Impacts associated with MWS-01, MWS-01B, MWN-01B may be attributing to contaminant loadings. The sand/dredge spoil unit underlying the slag/fill does not appear to be hydraulically connected to the Creek; therefore; the groundwater impacts associated with the sand/USACE dredge spoil unit in the vicinity of the Creek are not likely to directly enter the Creek, but could contribute due to upward vertical gradient noted from MWN-01B to MWN-01 into the slag/fill unit.

4.8.7.2.3 Section E-E'

Geologic cross-section E-E' is on the north side of Smokes Creek. It begins at Lake Erie within DSA 4A and is orientated west to east ending in DSA 3A at well MWN-81A (see Plate 4-18). Figures 4-25 through 4-30 illustrate the profile of the primary COCs in groundwater across this section.

Three wells, WT1-07, MWN41A and MWN-85A, consistently had primary COCs detected above their respective GWQS/GV, with less frequent exceedances at MWN-16A/16B, -37A and -81A. Wells WT1-07 and MWN-41A are located downgradient of SWMU S-10, while MWN-16A/16B are immediately upgradient of SWMU-S-10. As discussed in Section 4.3.2.1, SWMU S-10 was a slag quench area which received quench water (WAL and Benzol Plant wastewater) to quench slag between 1970 and 1983. Contaminants that have been detected downgradient and adjacent to the SWMU S-10 pit are similar to those identified in the WAL and wastewater used in the quenching process. The pit and/or slag/fill present within the pit is not a current or on-going source of contamination (quenching process was stopped over 35 years ago), but is considered to be the former source of the contaminants identified at these well locations.

Elevated concentrations of primary COCs detected in the slag/fill unit at MWN-37A, -81A and 85-A are likely associated with the Tank Farm SWMU Group (see Section 4.5).

The groundwater impacts are attributed to spills and releases of petroleum and possibly coke plant by-products formerly stored and handled in the above-ground tanks, piping, and pumping systems that were in this vicinity.

4.8.7.2.4 Section F-F'

Geologic cross-section F-F' is orientated south to north, beginning in DSA 2B, just north of the ATP-ECM at well pair MWS-18A and -18C, across Smokes Creek into DSA 3A, transects the Tank Farm SWMU Group, and ends in DSA 4A at well MWN-39A (see Plate 4-18). Figures 4-31 through 4-36 illustrate the profile of each of the COCs in groundwater across this section.

The highest concentrations of primary COCs (greater than 100 times their GWQS/GV), specifically benzene and naphthalene, were detected in the wells screened in the slag/fill and slag/fill and sand unit just north of the ATP-ECM (MWS-18A and MWS-18C) and within the Tank Farm SWMU Group area (MWN-89A and MWN-91A). Although the concentrations detected at MWN-18A and MWN-18C are greater than 100 times their GWQS/GV for benzene, the concentrations have significantly decreased by 2 to 3 orders of magnitude since the ATP-ECM was implemented. Additionally, four pumping wells were installed downgradient (north) of ATP-ECM area (between the containment cell and Smokes Creek) in 2015 to address groundwater impacts from the ATP before it was contained.

Elevated concentrations of primary COCs were also consistently detected in Wells MWN-17A, -17B, -85A, -86A and 39A. Like Wells MWN-89A and MWN-91A, these detections are attributed to the Tank Farm SWMU Group.

4.8.7.2.5 Section G-G'

Geologic cross-section G-G' is orientated west to east beginning at Lake Erie within DSA 4A, runs east through DSA 5 and ends at the eastern side of the Ship Canal (see Plate 4-18). Figures 4-37 through 4-42 illustrate the profile for the primary COCs in groundwater across this cross-section.

The highest concentrations of primary COCs (greater than 100 times their GWQS/GV) were detected at one location, MWN-66A, which is in DSA 5 in the slag/fill unit. This well is also located within the capture zone of the OU-4 groundwater pumping area initiated in March 2019 to prevent contaminant migration to the Ship Canal in this area.

Elevated concentrations of primary COCs were also consistently detected in slag/fill unit well MWN-03 and in slag/fill and sand units well MW-1U1. MWN-03 is located downgradient of HWMU 1A and had shown a decrease in concentration since the RFI. Well MW-1U1 is in the central portion of DSA 4A and has also shown a decrease in concentration since the RFI. Contaminants at this location may be due to the impacted groundwater migration from SWMU P-11A (Old Benzol Plant) prior to implementation of OU-4 in this area.

The reference on geologic cross-section figures for G-G' to "oily liquid" at well MW-1D4 refers to a note on the borehole log of "trace black oily liquid" observed at approximately 25 fbgs at the time of installation. This well has been monitored on a quarterly, semi-annual, and now annual basis since 2003 as part of the HWMU 1A groundwater monitoring program and no oily liquid or sheen have been observed within this well nor do the groundwater concentrations support this observation.

4.8.7.2.6 Section H-H'

Geologic cross-section H-H' is located on the eastern side of DSA 4A beginning at well pair MWN-19A and -19B and is orientated south to north along the boundary between DSA 4A and 5 ending at well MWN-68A (see Plate 4-18). Much of the cross-section (95%) transects the Coke Plant By-Products Sub-Area (see Section 4.6.3). Figures 4-43 through 4-48 illustrate the profiles of the primary COCs in groundwater across this section.

Elevated concentrations of benzene (slag/fill Wells MWN-19A, MWN-21A, MWN-21C, MWN-75A, and MWN-76A), toluene (slag/fill Well MWN-75A), total xylenes (slag/fill Wells MWN-21-C, MWN-75A, and MWN-76A), naphthalene (slag/fill Wells MWN-75A and MWN-76A), and total phenols (slag/fill Wells MWN-19A, MWN-21B, MWN-21C, MWN-75A and MWN-76A) are present in groundwater along this cross-section. The final groundwater remedy for the Coke By-Products Sub-Area (OU-4) was not yet fully implemented and was not operational when the most recent groundwater data was collected in January 2019. The OU-4 final groundwater remedy is expected to address groundwater impacts in the Coke Plant By-Products Sub-Area. The Benzol Yard source area ICM consisting of a soil vapor extraction system which also became operation in March 2019 is also expected to remove the primary VOC contaminant source and thereby further improve groundwater quality in the Benzol Yard (SWMU P-11).

4.8.7.2.7 Section I-I'

Geologic cross-section I-I' is oriented west to east within DSA 4A transecting HMWU 1B from Lake Erie to well MWN-12 (see Plate 4-18). Figures 4-49 through 4-54 illustrate the profiles of the primary COCs in groundwater across this section. Elevated concentrations of benzene, ethylbenzene, toluene, total xylenes, and naphthalene were observed in downgradient slag/fill well MW-1D1 from SWMUs S-16 (HWMU 1B) and S-23. Total phenolics were observed in slag/fill Well MWN-12. Because these impacts are upgradient of SWMUs S-16 and S-23, they are not attributed to those two Units; rather they are considered localized impacts to that well.

4.8.8 COC Mass Loadings from CMS Area Groundwater to Adjacent Water Bodies

Groundwater is not used on-site as there is a deed restriction prohibiting groundwater use. There are no off-site receptors of CMS Area groundwater other than the adjacent surface water bodies. Therefore, the primary measure of the potential impact of non-point groundwater discharge upon the downgradient surface water quality is contaminant mass loadings in groundwater from the CMS Area.

Estimates of COC mass loadings in non-point groundwater discharges from the CMS Area to adjacent surface water bodies were performed for each DSA. The same procedures used in the RFI were employed with recent CMS groundwater quality data to facilitate a direct comparison. The derivation and summary of groundwater volumetric discharge by DSA is presented in Table 4-37 based upon long-term rainfall infiltration. The values in Table 4-37 were originally derived in the RFI and remain relatively unchanged for the CMS except for DSA 2B (ATP-ECM), 4A (western portion of OU-4) and 5 (eastern portion of OU-4), where active groundwater pumping has been implemented as a part of the final remedies in those areas. The DSA volumetric flows were apportioned to shoreline segments based upon the cross-sectional area of each segment (see Tables 4-38 and 4-39). Plate 4-19 presents the shoreline segments used for the RFI and CMS mass loading calculations. While in most cases the segment lengths in the RFI and CMS are identical, the saturated thicknesses summarized in Tables 4-38 and 4-39 vary based on historic groundwater elevations observed during the RFI and more current observations in the CMS. As the lateral flow is either through the native sand and slag/fill units (eastern portion of the CMS Area)

or sand/USACE dredge spoil and slag/fill units (western portion of the CMS Area), the discharge rates are also apportioned to each hydrologic unit along each segment. A comparison of the volumetric flow rates by segment based on RFI data (see Table 4-40) to CMS data (see Table 4-41) show only minor changes in DSA 2A, 3A, and 4B. Due to the active groundwater pumping associated with ATP-ECM in DSA 2B, and OU-4 in DSA 4A and 5, there is a decrease in the discharge from DSAs 2B, 4A, and 5 in the segments where active pumping is occurring.

Upon consultation with the NYSDEC and in addition to the primary COCs (BTEX, naphthalene, and total phenols) which represent the highest contaminant loadings, compounds/analytes exceeding individual GWQSs/GVs from at least one well location during the CMS were considered and used to perform the mass loading calculations. The COC list includes additional VOCs (besides BTEX), individual PAHs (besides naphthalene), and selected RCRA metals (arsenic, barium, lead, and mercury). The mass loading of each of the COCs in groundwater to surface water by shoreline segment and hydrogeologic unit based on past RFI and current CMS data are summarized respectively in Tables 4-42 and 4-43 and then compared in Table 4-44.

The calculated mass loadings from the slag/fill unit are considered conservative estimates (i.e., likely higher than actually loadings entering the water body) since the wells selected average approximately 200 feet from the edge of the surface water body and the actual discharge from groundwater to the surface water body may extend some distance from the shoreline where further natural attenuation (particularly of VOCs) may occur. Similarly, the mass loadings calculated for SVOCs (primarily PAHs) and metals are also conservatively overstated as these compounds have low water solubility and a substantial portion of the concentrations of these compounds detected in groundwater samples are associated with fine particulates. The particulate fraction is not mobile in the subsurface porous media and only the filtered or soluble portion of the metals and SVOCs can migrate to adjacent water bodies. To illustrate this point, the groundwater sample collected from well MWS-01B during the CMS was filtered for metals due to high turbidity. A comparison of total metals to the dissolved fraction indicates that only approximately 25% of the total metals were soluble and therefore mobile in the saturated subsurface porous media.

Although not a conventional practice, groundwater samples collected from four wells MW-2D2B (in DSA 2A), MWS-01B (in DSA 2B), MWN-01B (in DSA 3A) and

MWN05B (in DSA 4A) during the January 2019 sampling event for both unfiltered and filtered SVOC analysis. Unfiltered analysis was for TCL SVOCs via Method 8270 and filtered analysis was for PAHs compounds only via Method 8270. The purpose of collecting and analyzing both filtered and unfiltered samples was to determine what portion of SVOCs present in some wells are associated with fine particulate matter that is drawn into the well from the surrounding soil/fill. The premise being that particulate-based SVOCs would not be mobile in the subsurface environment, while the soluble (non-filterable) fraction would be mobile in the subsurface environment..

Results of the unfiltered analysis are included in the groundwater summary tables for the respective DSA (Tables 4-31 through 4-34). A comparison of the unfiltered versus the filtered total PAH concentrations indicated that on average approximately 48% of the total PAHs present were soluble. The comparison for naphthalene only indicated 49% was soluble. The comparison for Total PAHs without naphthalene indicate 31% was soluble as shown in the table below:

Sample Location	Soluble Percentage of Total PAHs in Filter vs. Unfiltered Sample	Soluble Percentage of Naphthalene in Filtered vs. Unfiltered Sample	Soluble Percentage of PAHs without Naphthalene in Filtered vs. Unfiltered Sample
MW-2D2D	47%	56%	10%
MWS-01B	61%	68%	12%
MWN-01B	29%	22%	76%
MWN-05B	47%	50%	27%

This data suggests that the calculations of SVOC mass loadings in groundwater to adjacent water bodies using (unfiltered) low-flow sampling techniques are conservatively high because the particulate fraction (approximately 48-49%) is not mobile in the subsurface saturated environment at the Site.

4.8.8.1 Historic (RFI) COC Mass Loadings from CMS Area Groundwater to Adjacent Water Bodies

Table 4-42 summarizes the COC mass loadings for the entire CMS Area by DSA using the historic RFI groundwater data from 1999 to 2000. As expected, RFI mass loadings calculated during the CMS using the RFI data were generally consistent with those reported in the RFI. Relatively similar RFI mass loading results indicate that the CMS mass loading

calculations used for the CMS groundwater data, presented in the next section, are accurate and repeatable predictions. Slight deviations identified between the reported RFI mass loadings and those calculated as part of the CMS are discussed in Section 4.8.8.3.

4.8.8.2 Current COC Mass Loadings from CMS Area Groundwater to Adjacent Water Bodies

Table 4-43 summarizes the COC mass loadings in groundwater from the entire CMS Area by DSA using the current (CMS) groundwater quality data. Table 4-45 summarizes the COC mass loadings from the entire CMS Area to each surface water body receptor. As discussed in Section 4.8.5 and presented in Table 4-45, most of the COC mass in groundwater in the eastern portion of the CMS Area is representative of and flows from the slag/fill unit to water bodies adjacent to the CMS Area and can be attributed primarily to SWMU waste/fill. CMS mass calculations of DSAs 2B and 3A to Smokes Creek presented in Table 4-45B illustrate this flow and mass differential as nearly 97% of VOCs, 94% of SVOCs, and 75% of metals are attributed to the slag/fill unit and SWMUs within it. However, in the western portion of the CMS Area where the sand/USACE dredge spoil unit underlies the slag/ fill unit (e.g., DSAs 2A, and 4A) approximately 72% of VOCs, 64% of SVOCs, and 71% of metals are attributed to the sand/USACE dredge spoils unit (see Table 4-45A).

The calculated mass loadings for each COC by DSA are relatively small with an average of only 0.037 lbs/day ranging from a minimum value of non-detect (several VOCs, SVOCs, and cadmium) to a maximum value of 1.7 lbs/day (barium), 74% of which is attributed to shoreline segments MWN-02 (6%) and MWN-05B (68%). As illustrated on Table 4-45, each COC is weighted statistically as a percentage of the total mass loading by DSA by compound group (e.g., VOCs, SVOCs, metals). Compounds that represent the greatest percentages are shown with the highest data gradient bars in Table 4-45, including benzene, ethylbenzene, toluene, total xylenes, naphthalene (and other PAHs), barium, cyanide, and total phenols. These same compounds are also highlighted with similar data gradient bars in Table 4-43 for the current (CMS) mass loading data representing their respective percentages in order to determine which DSA shoreline segment is the predominant contributor of each compound. Those compounds without a data gradient bar in either table were not statistically large enough to receive one. By using this method of

percent contribution, it is clear to assess where and to what extent the mass loadings are attributable. Mass loading results by adjacent water body are discussed below.

Contaminant mass discharge from CMS Area groundwater to Lake Erie occurs directly through DSA 2A south of Smokes Creek and DSAs 4A and 4B north of Smokes Creek. DSA 2A includes a portion of the groundwater discharge from SFA Zone 2, while DSA 4A receives flow from SFA Zones 3, 4, and 5. Contaminant loadings to Lake Erie from the CMS Area also occur indirectly from: DSA 2B and 3A via Smokes Creek; and DSA 5 via the Ship Canal, however only the direct loadings to Lake Erie are discussed here and as illustrated in Table 4-45A. COC loadings from DSAs 2A, 4A, and 4B to Lake Erie are dominated by benzene, total xylenes, naphthalene, and barium. The greatest loadings to the Lake from these DSAs are associated with the sand/USACE dredge spoils unit, which generally has higher COC groundwater concentrations, is hydraulically connected, and therefore higher discharge rates to the Lake than the overlying slag/fill unit (see Figures 4-1 through 4-30, 4-37 through 4-42, and 4-49 through 4-54).

Contaminant mass discharge from groundwater to Smokes Creek occurs directly through DSAs 2B (southern bank) and 3A (northern bank) only. As illustrated in Table 4-45B, COC loadings from DSAs 2B and 3A to Smokes Creek are dominated by benzene, naphthalene, barium, and cyanide (south bank only). For both DSAs, the greatest loadings to the Creek are associated with the slag/fill unit, which generally has higher COC groundwater concentrations, is hydraulically connected, and therefore higher discharge rates to the Creek than the underlying sand/dredge spoil and till units (see Figures 4-19 through 4-24 and 4-31 through 4-36).

Contaminant mass discharge from groundwater to the Ship Canal originates entirely from DSA 5 primarily in the slag/fill units (see Figures 4-37 through 4-48). Due to the 37 OU-4 pumping wells initiated in DSA 5, mass loadings to the Ship Canal have been significantly decreased. The relatively minor COC loadings from DSA 5 to the Ship Canal are dominated by acetone, benzene, total xylenes, bis(2-ethylhexyl)phthalate, barium, and chromium. However, the mass loadings for the compounds and analytes identified, when compared to those across the CMS Area, are not considered statistically significant (see Tables 4-43 and 4-45).

4.8.8.3 Comparison of Past (RFI) to Current COC Mass Loadings from CMS Area Groundwater to Adjacent Water Bodies

Table 4-44 presents the percent change from past (RFI) to current (CMS) mass loadings for each COC by DSA hydrogeologic unit: if it decreased or only increased 20% or less compared to the RFI the value is shaded **Green** and if it increased by more than 20% compared to the RFI the value is shaded **Red**. Overall, a comparison of past (RFI) versus current (CMS) contaminant loadings presented in Table 4-44 illustrate substantial reductions over time with an average reduction of approximately 61% for the COCs within the slag/fill, native sand, sand/dredge spoil, and till units for the six DSAs with a few exceptions. Localized loading increases (greater than 20%) were observed for:

- Trichloroethene in DSA 2A slag/fill
- Cyanide in DSA 2B slag/fill
- Arsenic, chromium and lead in DSA 2B sand/USACE dredge spoil units
- Selenium in DSA 3A slag/fill unit
- Arsenic and lead in DSA 3A till unit
- Benzene, toluene, fluorene, and phenanthrene in DSAs 4A sand/USACE dredge spoil units

While calculating mass loadings, it was determined that some of the shoreline segment lengths used in the RFI were not reproducible according to current site drawings. As such, in order to make the comparison of historic (RFI) to current (CMS) loadings comparable along each shoreline segment, RFI loadings were recalculated along revised segment lengths consistent with the CMS. Each deviation from the RFI was documented and is summarized in Appendix M and Table 4-38. Even with these shoreline segment length adjustments, calculated RFI mass loadings compared favorably to those reported in the RFI.

Other notable deviations between RFI and CMS loading calculations occurred in DSA 5. Three monitoring wells used for loading calculations during the RFI were not sampled during the CMS because they were either located off-site (MWN-08A, MWN-34A) and/or could not be located (MWN-52A). Existing wells MWN-66A, MWN-67A, and MWN-68A, sampled during the CMS, were selected based on their proximity to the RFI wells along the eastern property line adjacent to the Ship Canal. Using these three CMS wells

required a revision of the shoreline segments compared to those same values determined during the RFI. Shoreline sections and saturated thicknesses for the RFI and CMS wells are presented in Tables 4-38 and 4-39, respectively. Furthermore, very significant differences in groundwater concentrations are observed between the RFI and different CMS wells. CMS wells MWN-66A, MWN-67A, and MWN-68A are in the central portion of the impacted area of SWMU P-11A (i.e., highest groundwater concentrations), whereas wells MWN-08A, MWN-34A, and MWN-52A are located on the downgradient edge (i.e., lowest concentrations) adjacent to the Ship Canal. However, due to the initiation of the pumping wells in OU-4 in March 2019 (final groundwater remedy), which has captured groundwater associated with MWN-66A and -67A, the elevated COC loadings associated with these wells are not currently discharging to the Ship Canal.

During the remediation of SWMU S-24 well MWN-44A was decommissioned. Replacement wells MWN-94A was installed as a replacement for well MWN-44A. MWN-94A was sampled in 2019and used to calculate CMS loadings to Smokes Creek as MWN-44A data was from 2012. We note that there was not a significant difference in the MWN-44A and MWN-94A analytical results. We note that MWN-94B was used in lieu of MWN24B to perform the loading calculations as MWN-94B is screened is the sand unit and MWN-24B was screened in the till unit.

4.8.8.3.1 Reductions in COC Mass Loadings from CMS Area Groundwater to Lake Erie

Based on a comparison of the CMS mass loading calculations to the past RFI loadings, substantial reductions in mass loadings to Lake Erie from DSAs 2A, 4A, and 4B were observed over the past 20 years, including:

- 46% of VOCs (predominantly BTEX)
- 61% of SVOCs (predominantly naphthalene)
- 62 % of Total Phenols
- 54% of arsenic
- 49% of barium
- 76% of chromium
- 62% of lead
- 42% of selenium

The significant reductions can be attributed to natural attenuation of VOCs over the intervening 20 years, remedial activities completed at SWMU S-21, AOC-B, -C, -F and -G; however, it may also be indirectly related to the corrective measures at the ATP SWMU Group.

4.8.8.3.2 Reductions in COC Mass Loadings from CMS Area Groundwater to Smokes Creek

Based on a comparison of the recent (CMS) mass loading calculations to the past (RFI) loadings, profound reductions in mass loadings to Smokes Creek from DSAs 2B and 3A were observed over the past 20 years, including:

- 99% of VOCs (predominantly benzene)
- 78% of SVOCs (predominantly naphthalene)
- 91% of Total Phenols
- 67% of arsenic
- 77% of barium
- 72% of chromium
- 17% of selenium

For unknown reasons, cyanide showed an increase in mass loading over the same period, primarily at MWS-02.

The substantial reductions in VOC loadings may be partially attributed to natural attenuation over the same 20-year period, however the majority of the reductions are attributed to the completion of the ATP-ECM slurry wall and pumping wells within DSA 2B as evidenced by February 2012 pre-slurry wall groundwater analytical results versus April 2018 post-slurry wall results for MWS-18A, -18C, -19A and -19B (see Table 4-32). A direct comparison of these two events indicates a substantial improvement in groundwater quality outside and north of the ATP Containment Cell with an average total VOC reduction of 98% in the 6 years since the ATP-ECM was implemented.

4.8.8.3.3 Reductions in COC Mass Loadings from CMS Area Groundwater to the Ship Canal

Because different wells were used to calculate the mass loadings than those used during the RFI for DSA 5, a direct comparison between RFI loadings to CMS loadings in

DSA 5 is not appropriate. Even though a direct comparison between the CMS and RFI cannot be made, active ICM has been operating in the Benzol Plant (SWMU P-11) since April 2005 and in March 2019 an additional 41 pumping wells were initiated (27 of which are in DSA 5) as part of the final groundwater remedy. From start-up through April 2014, product thickness has significantly decreased in the monitoring points historically containing measurable product and at some monitoring locations, no measurable product continues to be observed. Also, since start-up, a total mass of aqueous- and non-aqueous-phase VOC contamination removed from the groundwater and recycled since start-up is approximately 36,000 pounds (or 18 tons, see Section 2.1.1). This quantity is significant and has substantially improved groundwater quality in the vicinity of SWMU P-11 in addition to the pumping wells installed and operating within OU-4 (see Section 2.3.1).

4.8.8.4 Assessment of Potential Sources of CMS Area Groundwater Impacts to Surface Water Bodies

In order to establish potential sources for groundwater impacts to adjacent surface water bodies, a two-step screening process was performed. First, waste/fill and USACE dredge spoil analytical results were compared to the Part 375 Protection of Groundwater SCOs in Table 4-46. This table only identifies possible sources within the CMS Area (e.g., SWMUs, AOCs, and/or sand/USACE dredge spoils). The second step included an attempt to make the potential connection to downgradient groundwater impacts and subsequent mass loadings, which are presented in Table 4-47, where those compounds detected at concentrations exceeding the Protection of Groundwater SCOs and the GWQSs/GVs are highlighted **blue**. Downgradient monitoring wells potentially impacted from SWMUs and AOCs used for this comparison are also presented. The highlighted compounds and associated SWMU, AOC, or sand/USACE dredge spoil material were all considered potential sources of groundwater impact contributing mass loadings to adjacent water bodies. Although VOC impacts to downgradient groundwater quality can only be potentially attributed to the SWMUs and AOCs within the CMS Area, the potential contribution of SVOCs (particularly PAHs) and metals from these potential sources is a bit more uncertain.

As established in Section 4.2, contaminated dredge spoils from the Buffalo River and Buffalo Harbor were deposited by the USACE on the bottom of Lake Erie along the western portion of the CMS Area prior to slag/fill deposition by Bethlehem Steel (and their

predecessors). The degree to which the dredge/spoils were impacted with VOCs is not quantifiable as VOCs have a higher solubility versus those of SVOCs and metals. This high solubility combined with the high degree of mixing upon disposal and being fully saturated for approximately70 to 120 years, would have easily reduced or eliminated the potential source of VOCs to CMS Area groundwater from the sand/USACE dredge spoil unit. The impacts associated with hydrophobic organic compounds SVOCs (particularly PAHs) and metals in the sand/USACE dredge spoil unit, however, have persisted, albeit slightly degraded, over time due to their lower solubilities and high affinity for subsurface particles that may alter the mobility of those contaminants. The dredge spoil analytical results from Bethlehem's 2000 investigation indicate several PAHs and metals exceeding the Protection of Groundwater SCO (see Table 4-2) that were also identified exceeding the GWQSs/GVs in sand/USACE dredge spoil unit groundwater during the recent CMS Area groundwater assessment (see Tables 4-31 to 4-36).

The ubiquitous presence of the USACE dredge spoils under the slag fill in the western portion of the CMS Area (see Plate 4-1), adds a degree of bias to the calculation of contaminant mass loadings theoretically emanating from the CMS Area because:

- They contain many of the same COCs[12] present in SWMUs waste/fill (particularly SVOCs, and to a lesser extent BTEX and heavy metals) that are intermingled with the natural sand unit beneath the slag/fill unit where all the SWMU waste was deposited; and
- The presence of massive quantities of these same dredge spoils along the entire CMS Area shoreline extending out into the Lake, significantly complicates the identification of potential upgradient and upland sources of contamination from the CMS Area.

Therefore, non-point contaminant mass loadings, particularly for SVOCs, calculated from the sand/USACE dredge spoil groundwater unit underlying a large portion of the CMS Area to Lake Erie can only be partially attributed to SWMU waste/fill in the slag/fill

[12] Table 4-2 demonstrates the dredge spoil deposits contain concentrations of BTEX, SVOCs, cadmium and mercury at concentrations above NYSDEC Protection of Groundwater SCOs which, by definition, means these constituents, if in direct contact with groundwater, could potentially impact groundwater quality.

groundwater unit. Based on the current loading evaluation performed in Section 4.8.8.2 and presented in Table 4-45, the following conclusions can be made:

- Lake Erie: Approximately 72% of VOCs, 64% of SVOCs (including total phenolic compounds), and 71% of total metals loadings in the groundwater discharged to Lake Erie from the CMS Area is attributed to the sand/USACE dredge spoil unit with the remainder attributed to the slag/fill unit.
- Smokes Creek: Approximately 97% of VOCs, 94% of SVOCs, 75% of total metals, and 99% of the cyanide (primarily MWS-02) loadings in CMS Area groundwater discharged to Smokes Creek are attributed to the slag/fill unit. Approximately 1% of VOCs, approximately 6% of SVOCs, and 24% of the total metals in CMS Area groundwater discharged to Smokes Creek is attributed to the sand/USACE dredge spoil unit. Approximately 2% of VOCs, <1% of SVOCs, and 1% of total metals in CMS Area groundwater discharged to Smokes Creek is attributed to the native sand unit.
- Ship Canal: The total calculated mass loading discharged to the Ship Canal are through the slag/fill unit.

The potential sources of groundwater impact by DSA that have been identified above the Part 375 ISCO (Table 4-3) and above the Part 375 Protection of Groundwater SCOs (Table 4-46) are highlighted in Table 4-47 and discussed in the following sections. As a general comment, elevated barium concentrations in the groundwater may be attributed with the presence of steel slag deposits overlying the entire CMS Area.

4.8.8.4.1 Potential Groundwater Contaminant Sources in DSA 2A

As presented in Table 4-47, potential sources of groundwater impact associated with DSA 2A include SWMUs S-1, S-2, S-3, S-4 (southern portion), S-5, S-6, S-7/S-20, and S-8 (southern portion), S-11/S-22 (ATP SWMU Group), and USACE dredge spoils. Potential VOC sources may be attributed to SWMUs S-1, S-5, S-6, S-7/S-20,S-11/S-22; SVOCs sources may be attributed to SWMUs S-1, S-3, S-8, S-11/S-22, and USACE dredge spoils; and, metals sources may be attributed to SWMUs S-2, S-3, and S-7/S-20.

Based on the calculations presented in Table 4-45, the following COC mass loading percent contributions are estimated for DSA 2A:

Compound	Slag/Fill	Sand/USACE Dredge Spoils
VOCs	9%	91%
SVOCs	41%	59%
T. Metals	88%	12%
Cyanide	Not analyzed	Not analyzed
Total Phenols	15%	85%

The slag/fill unit is the highest contributor if total metals for DSA 2A, likely due to the presence of barium from the steel making slag. The higher percentages of VOCs, SVOCs and total phenols are discharged from the sand/USACE dredge spoil unit in DSA 2A.

SWMU S-4 (southern portion) was identified as a potential source because it contains Smokes Creek dredge spoils. Nearby well MW-2D4, no longer exhibits groundwater exceedances for VOCs, SVOCs, metals or total phenols.

SWMU S-8 was identified as a potential source of PAH groundwater impact, however, this Unit has never been used to contain waste of any kind and the soil/fill concentrations from a sample from the bottom of the Unit were only slightly above the Protection of Groundwater SCOs for benzo(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, and chrysene (see Appendix N). Nearby groundwater well MWS-11A historically had GWQS exceedances for those compounds but not in the latest 2018 sampling event. MWS-11A also had GWQS exceedances for benzene, naphthalene and total phenols, which could be from another unknown source.

SWMUs S-11/S-22 (ATP SWMU Group) was identified as the primary source for VOCs and SVOCs in DSA 2A groundwater which migrated from these SWMUs prior to implementing the ATP-ECM which has significantly improved groundwater quality in its vicinity.

SWMUs S-1, S-2, S-3, S-5, S-6, and S-7/S-20 were identified as a potential additional secondary source(s) for VOCs, SVOCs and/or metals.

4.8.8.4.2 Potential Groundwater Contaminant Sources in DSA 2B

As presented in Table 4-47, potential sources of groundwater impact associated with DSA 2B include SWMUs S-4 (northern portion), S-8 (northern portion), S-11/S-22 and USACE dredge spoils. Potential VOC sources may be attributed to the ATP SWMU Group

(SWMUs S-11 and S-22); SVOCs sources may be attributed to the ATP SWMU Group (SWMUs S-11 and S-22) and USACE dredge spoils; and, metals sources may be attributed to the ATP SWMU Group (SWMUs S-11 and S-22). Based on the calculations presented in Table 4-45, the following table represents the relative distribution of COC mass loadings in DSA 2B groundwater by water bearing unit:

Compound	Slag/Fill	Sand/USACE Dredge Spoils	Sand
VOCs	97%	<1%	3%
SVOCs	96%	4%	0%
T. Metals	64%	35%	1%
Cyanide	99.8%	Not analyzed	<1%
Total Phenols	59%	42%	<1%

Based on percent contribution of DSA 2B, most of the VOCs, SVOCs, total metals and cyanide are discharged from the slag/fill unit.

SWMU S-4 (northern portion) may be the potential source for VOCs and SVOCs detected in downgradient wells MWS-01 and -01B. Well MWS-01B is also partially screened within the sand/USACE dredge spoil unit.

Although the northern portion of SWMU S-8 is included within DSA 2B, no samples were collected in the northern portion of this Unit during the RFI. As previously stated, SWMU S-8 has never been used to contain waste of any kind.

The ATP-ECM containment cell slurry wall has been in place since Fall 2011. A direct comparison between the February 2012 and April 2018 events indicates a substantial improvement in groundwater quality outside and north of the ATP Containment Cell with an average total VOC reduction of 98% in the past six years. Implementation of the external groundwater collection system north of the ATP containment cell in 2015 has further improved groundwater quality in DSA 2B.

4.8.8.4.3 Potential Groundwater Contaminant Sources in DSA 3A

As presented in Table 4-47, potential sources of groundwater impact associated with DSA 3A include the southern portion of the Tank Farm SWMU Group (SWMUs P-8, P-74D, P-75), S-10, and USACE dredge spoils. Potential VOC sources may be attributed to the Tank Farm and S-10 and SVOCs sources may be attributed to the Tank Farm and

USACE dredge spoils. A potential source for metals impacts did not need to be considered. Based on the calculations presented in Table 4-45, the following COC mass loading percent contributions are estimated for DSA 3A:

Compound	Slag/Fill	Sand/USACE Dredge Spoils	Sand
VOCs	94%	6%	ND
SVOCs	93%	7%	<1%
T. Metals	95%	3%	2%
Cyanide	ND	100%	Not analyzed
Total Phenols	86%	14%	ND

Most impacts are discharged from the slag/fill unit within DSA 3A.

SWMU S-24 was remediated in 2012 and is presented in Table 4-46 for completeness. The VOC, SVOC, and arsenic impacts associated with this Unit and highlighted in the table have been substantially remediated and are no longer considered a potential source of downgradient groundwater impact from DSA 3A.

S-10 is considered a potential former groundwater contamination source due to former use as a slag quench area which received quench water (WAL and Benzol Plant wastewater) to quench slag between 1970 and 1983. Contaminants that have been detected downgradient (MWN-01 and MWN-01B and MWN-23B and adjacent to the S-10 pit are similar to those identified in the WAL and wastewater used in the quenching process. The pit and/or slag/fill present within the pit is not a current or on-going source of contamination as the quenching process was stopped over 35 years ago.

4.8.8.4.4 Potential Groundwater Contaminant Sources in DSA 4A

As presented in Table 4-47, potential sources of groundwater impact associated with DSA 4A include SWMUs P-75 (Tank Farm), S-10, S-14, S-15, S-17, S-18 (including AOCs A, B, and C), S-23, and S-28 and USACE dredge spoils. Potential VOC sources may be attributed to the SWMU P-75, S-14, and S-23; SVOCs sources may be attributed to SWMUs P-75 (Tank Farm), S-10, S-14, S-15, S-17, S-18 (including AOCs A, B, and C), S-23, and S-28 and USACE dredge spoils. A potential source for metals impacts did not need to be considered. Based on the calculations presented in Table 4-45, the following COC mass loading percent contributions are estimated for DSA 4A:

Compound	Slag/Fill	Sand/USACE Dredge Spoils
VOCs	31%	69%
SVOCs	34%	66%
T. Metals	19%	81%
Cyanide	Not analyzed	Not analyzed
Total Phenols	46%	54%

The majority of VOC, SVOC, and total metals impacts are discharged from the sand/ USACE dredge spoils unit within DSA 4A. The discharge of total phenols is split between the slag/fill unit and sand/USACE dredge spoils unit.

As stated in Section 4.8.8.4.3, S-10 is considered a potential former groundwater contaminant source due to former use as a slag quench area but is not a current or on-going source of contamination (quenching process was stopped over 35 years ago).

Regarding SWMU S-19, a few SVOCs were detected above their respective Protection of Groundwater SCOs from samples collected from S-19. The compounds detected in the soil samples were not detected in the groundwater at MWN-14A or -14B, adjacent to S-19. Estimated concentrations (J-flagged) of low-level VOCs (ethylbenzene, toluene, xylene) were also detected in SPLP analysis during RFI, however, the low concentrations detected do not warrant SWMU S-19 being considered is a source.

4.8.8.4.5 Potential Groundwater Contaminant Sources in DSA 4B

As presented in Table 4-47, the potential sources of groundwater impacts associated with DSA 4B include SWMU S-26 and the USACE dredge spoils both for SVOCs only.

Although there were no sand or sand/USACE dredge spoils unit wells installed within DSA 4B, it is assumed that one or both units are present beneath the slag/fill unit based on the boring logs of nearby wells. As such, the percent contribution for any of these units could not be determined. However, the mass loadings that were calculated for the slag/fill unit within DSA 4B only represent <1% of VOCs, SVOCs, total metals, and Total Phenols calculated for the entire CMS Area.

4.8.8.4.6 Potential Groundwater Contaminant Sources in DSA 5

As presented in Table 4-47, potential sources of groundwater impact associated with DSA 5 include SWMUs P-11, P-11A, P-12, and S-26. Potential VOC sources may be attributed to the SWMUs P-11, P-11A, and P-12; SVOCs sources may be attributed to P-

11A and SWMU S-26; and cyanide sources may be attributed to former P-18. We note that P-18A/B and P-9 were previously excavated and consolidated into the ATP-ECM in 2015.

As reported in the RFI and upon examination of boring logs, the sand unit is not present in the eastern portion of DSA 5. As such, the mass loadings discharged from this DSA are wholly attributed to the slag/fill unit toward the Ship Canal.

Although lead is the primary impact to sediment within P-18 with concentrations exceeding the Protection to Groundwater SCO, lead was not identified in downgradient groundwater at a concentration above the GWQS; however, cyanide was. As such, SWMU P-18 is not considered a potential source of lead impacts to the Ship Canal.

Due to the ICM operating at SWMU P-11 (12 pumping wells) and the recent installation and startup (March 2019) of an additional 40 wells as part of the final groundwater remedy for OU-4, a significant amount (approximately 18 tons to date) of groundwater impacts (primarily BTEX) has been removed.

The USACE dredge spoils are not present beneath this DSA and were therefore not considered as a potential source of groundwater impacts to the adjacent Ship Canal from DSA 5.

4.8.9 Summary of CMS Area-Wide Groundwater Quality Assessment

As shown on Plates 4-20 through 4-22, groundwater flow within the CMS Area is primarily westerly (DSA 2A, 4a and portions of 4B) with influences from the water bodies (Smokes Creek (DSA 2B and 3A), Ship Canal (DSA 5), and presence of Lake Erie north of the CMS Area (DSA 4B). This does not appear to have changed significantly since the 1999/2000 RFI except for localized impacts from groundwater corrective measures.

Overall, groundwater quality has dramatically improved within the CMS Area since the 1999/2000 RFI. Of the 123 wells in which comparative data was available, the groundwater quality at 69 locations (56%) improved, 42 locations (34%) remained the same, and only 12 locations (10%) decreased. Specific areas which have shown groundwater quality improvements include:

- West of SWMUs S-2, S-3 and S-4 (DSA 2A)
- North and west of the ATP-ICM along Smokes Creek (DSA 3A)

- Within former SWMU S-24 which was consolidated into the ATP containment cell (DSA 3A)
- West of SWMUs S-12, S-13, S-15, and S-28 (DSA 4A)
- Vicinity of Benzol Yard ICM and OU-4 (DSA 4A and DSA 5)
- Western portion (DSA 4B)

Areas that have shown a decline in groundwater quality include:

- South of ATP-ICM
- South of SWMU P-74D
- Vicinity of S-10
- West of SWMUs S-16 and S-23

The primary COCs which represent the most significant concentrations in the groundwater are benzene (Plate 4-24, DSA 2A, 2B, 4A, 5), naphthalene (Plate 4-28, DSA 4A and 5), and total phenols (Plate 4-29, DSA 2A, 2B, 3A, 4A and 5). Calculations of current mass loadings of these same COCs in CMS Area groundwater to adjacent surface water body receptors (i.e., Lake Erie, Smokes Creek, and the Ship Canal) generally show dramatic reductions compared to historical RFI data (see Table 4-44) as shown in the table below.

Compound	Total Slag/Fill Loadings	Total Sand/Dredge Spoil Loadings
Benzene	-99%	40%
Naphthalene	-82%	-32%
Total Phenols	-73%	-63%

Benzene loadings did increase in the sand/USACE dredge spoils unit, specifically in DSA 4A (MWN-02B).

The most recently available CMS data identified main groundwater quality impacts within the Coke Plant By-Products Sub-Area, ATP-ECM and Tank Farm SWMU Group. Groundwater impacts in the Coke By-Products Sub-Area had been partially addressed by the Benzol Yard ICM implemented in 2005 and since have been fully addressed by the implementation of the OU-4 final groundwater corrective measures completed in march 2019. Four pumping wells have also been installed in 2015 north of and external to the ATP-ECM to collect and treat impacted groundwater that had migrated from SWMUs S-11

and S-22 prior to the construction of the ATP containment cell and are further reducing the loadings to Smokes Creek.

As presented in Section 4.8.8.4, several SWMUs (and AOCs) as well as historic sand/USACE dredge spoils have been identified as potential upgradient sources for groundwater quality impairment within the CMS Area. The supplemental CMS investigations, groundwater sampling, and calculated mass loadings have provided qualitative and quantitative results sufficient to evaluate additional remedial alternatives that will be protective of human health and the environment.

Close inspection of Table 4-45 presents the calculated current mass loadings in CMS Area groundwater to adjacent water bodies for VOCs at 0.14 lbs/day, SVOCs at 0.32 lbs/day, total metals at 1.8 lbs/day, cyanide at 0.44 lbs/day, and total phenols at 0.05 lbs/day. The following table presents the relative distribution of current COC mass loadings between the major hydrogeologic units (i.e., slag/fill and sand/USACE dredge spoils).

Water Body & DSAs	Compound Group	Slag/Fill	Sand/USACE dredge spoils	Sand
Lake Erie (2A, 4A, 4B)	VOCs	28.1%	71.9%	--
	SVOCs	36.0%	64.0%	--
	T. Metals	28.9%	71.1%	--
	Cyanide	Not analyzed	Not analyzed	Not analyzed
	Total Phenols	48.2%	51.8%	--
Smokes Creek (2B and 3A)	VOCs	96.7%	1.2%	2.1%
	SVOCs	94.3%	5.7%	0.02%
	T. Metals	75%	23.8%	1.3%
	Cyanide	99.5%	0.23%	0.27%
	Total Phenols	77.0%	23.0%	0.04%
Ship Canal (5)	VOCs	100%	--	--
	SVOCs	100%	--	--
	T. Metals	100%	--	--
	Cyanide	100%	--	--
	Total Phenols	100%	--	--

It is apparent that the majority of groundwater VOC, SVOC, total metal, and half of the total phenol loadings are being discharged from the sand/USACE dredge spoil unit to Lake Erie. Conversely, the majority of VOC, SVOC, total metal, cyanide, and total phenol loadings are being discharged from the slag/fill unit to Smokes Creek, predominantly from residual impacts of the pre-slurry walled ATP Containment Cell. Similarly, loadings to the

Ship Canal are being discharged from the slag/fill unit, predominantly from SWMU P-11 (Benzol Plant) and to a lesser extent SWMU P-11A (Old Benzol Plant).

The predominant COCs identified based on their percent contribution to the total mass being discharged from the CMS Area to adjacent water bodies include benzene, (to a lesser extent toluene and total xylenes), naphthalene, barium, cyanide (localized), and total phenols. Tables 4-45A-D illustrate the percent contribution of each of these compounds by shoreline segment and DSA. Based on the groundwater assessment and Table 4-4-47, below is a brief summary of potential upgradient source areas by DSA:

- DSA 2A: Potential sources of groundwater impact associated with DSA 2A include SWMUs S-1, S-2, S-3, S-4 (southern portion), S-5, S-6, S-7/S-20, and S-8 (southern portion), S-11/S-22 (prior to ATP-ICM), and USACE dredge spoils. Potential VOC sources may be attributed to SWMUs S-1, S-5, S-6, S-7/S-20, and S-11/S-22; SVOCs sources may be attributed to SWMUs S-1, S-3, S-11/S-22 USACE dredge spoils; and, metals sources may be attributed to SWMUs S-2, S-3, and S-7/S-20.
- DSA 2B: Potential sources of groundwater impact associated with DSA 2B include SWMUs S-4 (northern portion), S-11/S-22 (prior to ATP-ICM) and USACE dredge spoils. Potential VOC sources may be attributed to the SWMUs S-11/S-22; SVOCs sources may be attributed to the SWMUs S-11/S-22) and USACE dredge spoils; and, metals sources may be attributed to the SWMUs S-11/S-22 and S-4.
- DSA 3A: Potential sources of groundwater impact associated with DSA 3A include the southern portion of the Tank Farm SWMU Group (SWMUs P-8, P-74D, P-75), S-10, former S-24, and USAS-10; and SVOCs sources may be attributed to the Tank Farm, S-10, and USACE dredge spoils.
- DSA 4A: Potential sources of groundwater impact associated with DSA 4A include SWMUs P-75 (Tank Farm), S-10, S-14, S-15, S-17, S-18 (including AOCs A, B, and C), S-23, S-28 and USACE dredge spoils. Potential VOC sources may be attributed to the SWMU P-75, S-14, and S-23; SVOCs sources may be attributed to SWMUs P-75 (Tank Farm), S-10, S-14, S-15, S-17, S-18 (including AOCs A, B, and C), S-23, and S-28 and USACE dredge spoils.
- DSA 4B: Potential sources of groundwater impact associated with DSA 4B include western portion of SMWU S-26 and USACE dredge spoils which underlie this DSA. Potential VOC sources may be attributed to SWMU S-26 and potential sources of SVOCs may be attributed to S-26 and USACE dredge spoils.

- DSA 5: Potential sources of groundwater impact associated with DSA 5 include SWMUs P-11, P-11A, P-12, P-18, and S-26. Potential VOC sources may be attributed to the SWMUs P-11, S-11A, and P-12; SVOCs sources may be attributed to SWMU S-26; and cyanide sources may be attributed to P-18.

The USACE dredge spoils deposited on the lakebed prior to slag/fill deposition by Bethlehem Steel not only underlie the slag/fill but also extend along the entire CMS Area shoreline and some 3,000 feet west out into Lake Erie (see Plate 4-1). The "off-shore" USACE dredge spoils are considered "off-site" for purposes of the RFI and CMS and have not specifically been characterized or addressed herein. However, based upon the characterization of the same materials deposited in the sand/USACE dredge spoil unit underlying the western portion of the CMS Area and the massive quantities of dredge spoils alleged to have been deposited there over many decades, these "off-shore" USACE dredge spoils represent an off-site source of the same COCs to the Lake Erie environment as those observed during the CMS. Furthermore, these off-shore USACE dredge spoils are saturated, unconfined, and uncontrolled.

4.9 Soil Vapor Intrusion

Several structures remain within the CMS Area, some of which are periodically occupied and used for various commercial purposes, while others are slated for demolition (see Plates 1-1, 4-9, and 4-10). These include:

- Coke Oven Lab – Unoccupied, to be demolished
- Storage Pump House – Unoccupied, to be demolished
- Benzol Building – Unoccupied, to be demolished
- Compressor & Booster Station – Unoccupied, to be demolished after decommissioning of active Electrical Substation 6J
- South Welfare Building #1 – Unoccupied, to be demolished
- Coke Oven Carpenter Shop – Unoccupied, potential future reuse
- Sulfur Plant – Unoccupied, to be demolished
- Coke Oven Office – Unoccupied, records storage with potential future reuse
- Coke Oven Repair Shop – Currently used intermittently for equipment storage and repair

- Thaw Shed – Currently leased along with Car Dumper premises, not occupied
- Mobile Equipment Garage – Currently leased with car dumper and intermittently used as a maintenance shop for coal handling operations
- Car Dumper Building – Currently leased and occupied (open air), used periodically for coal transloading (rail to truck) operations
- Substation No. 7 – Currently leased and used by Car Dumper for coal handling operations
- Welfare and Drive House – Currently leased with car dumper and intermittently used as storage for coal handling operations
- Screening & Crushing Building – Currently leased with car dumper and used for coal handling operations
- Breaker Building – Unoccupied, to be demolished
- Mixer Building – Unoccupied, to be demolished
- Fire House (north of Mixer Building) – Unoccupied, to be demolished
- Former Substation 8D – Unoccupied, to be demolished
- North Welfare Building – Unoccupied, to be demolished
- Former Coke Oven Batteries (No. 7, 8, and 9) – Unoccupied and partly demolished; remainder to be demolished
- Various coal conveyors and junction houses – Currently licensed and used for coal handling related to Car Dumper operations
- Truck Scale House (junction of Highways #2 and #11) – Occupied, used for slag reclamation activities

The NYSDOH Guidance for Evaluating Soil Vapor Intrusion (SVI) in the State of New York, dated October 2006 (Ref. 21) provides a decision matrix to address current and potential exposures related to soil vapor intrusion within existing and future planned structures for four compounds: carbon tetrachloride, tetrachloroethene (PCE), 1,1,1-trichloroethane (1,1,1-TCA), and trichloroethene (TCE). NYSDOH has published numerous updates to the 2006 guidance document, with the most recent in May 2017 adding 1,1-dichlororethene and cis-1,2-dichloroethene (Matrix A), methylene chloride (Matrix B), and vinyl chloride (Matrix C) to the SVI decision matrices. NYSDOH has also provided air guideline values for indoor air for several compounds including PCBs (1 ug/m^3). Although the compounds above were not identified as constituents of concern throughout the CMS

Area, installation of a vapor barrier beneath any future structure designated for occupancy will be recommended as a conservative measure to protect building occupants against potential sub-slab vapor intrusion. The locations where significant VOCs were detected in subsurface fill and/or groundwater are shown on Plate 4-30. These VOC-impacted portions of the CMS Area would be subject to indoor air mitigation should occupied buildings be constructed. Outside of these areas, SVI will be assessed based on soil and groundwater samples collected proximate to planned occupied buildings as discussed in the CMS Work Plan.

The RFI Human Health Risk Assessment (HHRA) identified cancer and non-cancer indoor air health risks for future commercial and industrial workers, primarily from benzene, naphthalene and PAH exposure. These risks were primarily identified at SWMUs SFA-1, SFA-2, S-23, S-24 and the Tank Farm (P-8, P-74 and P-75) for screening level cancer risk and the remaining SWMUs for non-cancer risks (refer to RFI Table 5-4).

4.10 Site-Wide Slag/Fill

Although the vast quantity of historic slag/fill surrounding the SWMUs in the CMS Area has never been a consideration addressed by the RFA, RFI, or CMS Work Plan, this section discusses the slag/fill, its constituents, and the potential risks to public health and environment.

According to the National Slag Association, since iron and steel slag is generated in a 3,000°F furnace, VOCs and SVOCs are not present in iron and steel slag. Chemically, iron and steel slag consist primarily of oxides of calcium, iron, silicon, aluminum, magnesium, and manganese in complexes of calcium silicates, alumino-silicates, and alumino-ferrite. These compounds are generally like those found in the natural environment. The metals in slags are fused together and tightly bound and are therefore not readily liberated from the slag particle or easily leached into the environment. A Steel Slag Coalition consisting of a group of 63 steel makers and slag processing companies was formed to test iron and steel slag from 73 different generating sources. In 2002, environmental scientists and toxicologists completed an industry-wide Human Health and Ecological Risk Assessment (HERA; Ref. 22). Based on worst case exposure assumptions, the HERA demonstrated that iron and steel slag poses no meaningful threat to human health or the environment when used in a variety of residential, agricultural, industrial, and construction applications. Consequently, the metals in

the slag matrix are not readily available for uptake by humans, other animals, or plants; do not bioaccumulate in the food web; and are not expected to bio-concentrate in plant tissue. The HERA found that leaching of metals from slag did not exceed USEPA TCLP criteria and, thus, applications of steel slag are not expected to impact groundwater.

In December 2011, an HHRA (Ref. 23) was conducted to evaluate the potential for adverse human health risks associated with the use of iron and steel slag. This HHRA updates, and supersedes, previous assessments as it is based on new slag characterization data and the most current risk assessment guidance, including the new exposure models and toxicity information. The 2011 HHRA confirmed the previous assessment finding that commercial and construction uses of steel industry slags do not pose a health risk. Appendix O includes the 2002 HERA and the 2011 HHRA in regard to the potential for leaching of mineral and waste constituents from the slag/fill into the groundwater and subsequently into Lake Erie. The 2014 Comprehensive Groundwater Quality Assessment (GWQA) Report (Ref. 24) identified three significant localized groundwater impact areas associated with nearby SWMU waste material within the saturated slag/sand unit interface, not the slag material in general. Groundwater impacts observed outside these localized areas were identified within the underlying sand/dredge spoil unit and not within the overlying slag/fill. These sand/dredge spoil unit impacts are related to historic Buffalo River and Harbor dredge spoil deposition by the USACE that occurred prior to slag filling activities. The Comprehensive GWQA Report did not identify any significant groundwater impacts by compounds of concern associated with slag deposits outside of SWMUs. All data presented in the Comprehensive GWQA Report already reflects the impacts slag/fill has on Site groundwater.

According to the RFI, the composition of slag is predominately iron and calcium, with lesser quantities of magnesium, manganese, phosphorous, carbon, sulfur, and other minor constituents, none of which are considered a significant threat to downgradient receptors. A BUD was issued by the NYSDEC in September 2006 for all steel/blast furnace slag at the Site confirming this conclusion.

5.0 DEVELOPMENT AND EVALUATION OF CORRECTIVE MEASURE ALTERNATIVES

In this section, alternative corrective measures are evaluated relative to site-specific Remedial Action Objectives (RAOs) and applicable, relevant and appropriate environmental and public health regulatory Standards, Criteria and Guidance (SCGs) in the context of current and reasonably anticipated future uses of the CMS Area of the Tecumseh Site as planned and specified in the CMS Work Plan attached to CMS Order On Consent executed by both NYSDEC and Tecumseh Redevelopment Inc. on June 29, 2009. Additional remedial alternatives as addressed in the NYSDEC comment letter dated December 11, 2018 and responded to by Tecumseh on February 15, 2019 are also evaluated in this section. Organization of this section generally follows the format provided in Section 4 by addressing SWMUs and watercourses requiring further assessment by Sub-Areas of the CMS Area. Recommended corrective measures are presented following the evaluation of alternatives for each SWMU, SWMU group, Groundwater Discharge Area or Sub-Area.

5.1 Current and Reasonably Anticipated Future Use

The development, screening, evaluation, and selection of corrective measure alternatives needs to consider both the current as well as the reasonably anticipated future land use pursuant to State and Federal regulations (6NYCRR Part 375). Practically the entire CMS Area is situated on Land Patent parcels that were reclaimed from Lake Erie first by placement of dredge spoils by the USACE and subsequently by deposition of iron- and steel-making slag, solid and hazardous wastes, and historical fill from former Bethlehem Steel and predecessor company operations, building demolition, and sediment dredged from Smokes Creek. The total quantity of fill material (primarily slag) contained within the CMS Area is estimated at approximately 20 million cubic yards. There are existing deed restrictions on the CMS Area as well as surrounding Tecumseh property (filed by BSC on February 20, 1996) that limit future development to non-residential industrial and certain commercial uses for manufacturing, assembling, warehousing, and related railroad, port, and shipping; and restrict the use of groundwater to installation of wells for monitoring or remediation. Furthermore, the City of Lackawanna recently enacted zoning for the Bethlehem Redevelopment Area, which restricts the former Bethlehem Steel lands within

the CMS Area to heavy industrial, green, and intermodal future uses (see Plate 5-1). The current land uses within the boundaries of the CMS Area that are grandfathered under the City Zoning include:

- Slag Reclamation: Since 1984, steel-making slag deposited in the northwestern slag/fill areas (SFA Zones 3, 4, and 5 Sub-Areas) along the lakeshore have been reclaimed for beneficial reuse as an aggregate for road base, structural fill, and in asphalt manufacture. Slag reclamation operations are permitted under a BUD in accordance with 6NYCRR Part 360 Solid Waste Management Regulations. Current slag reclamation operations are conducted by Iron City Recovery, LLC under license agreement with Tecumseh Redevelopment Inc. and are confined to the northern SFA Zones 4 and 5 Sub-Areas away from SWMUs, where significant recoverable and reusable slag deposits remain.
- Wood Mulching: The Zoladz Construction Co., Inc. (Zoladz), under license agreement with Tecumseh Redevelopment Inc., conducts a wood (primarily tree branches and tree debris) grinding and mulching operation in the south and central portion of the Coal/ Coke/Ore Storage and Coal Handling Sub-Area. No storage or handling of wastes is known to have occurred there.
- Rail to Truck Transloading (Rail Car Dumper): Genesee & Wyoming Inc. (formerly South Buffalo Railroad Company) leases a portion of the CMS Area from Tecumseh Redevelopment Inc. to operate coal handling facilities. The leased facilities and equipment include the rail car dumper; associated buildings (including the maintenance garage and Thaw Shed); associated railroad tracks; coal handling equipment and conveyors; and electrical transmission, distribution and conversion equipment. The coal handling facilities are used for the transloading (i.e., between rail, truck and water) and temporary storage of non-hazardous bulk materials, which includes and is limited to coal, coke (including petroleum coke), and lime. Vehicular access to the leased premises is via the main paved access road leading from Gate 2 at the foot of Ridge Road.
- Steel Winds I & II Wind Energy Facilities: Niagara Wind and successor companies currently own and operate eight wind turbine generators referred to as Steel Winds I along the lakeshore on approximately 29 acres leased from Tecumseh that were "carved out" of the CMS Area, and which were remediated under the NYSDEC Brownfield Cleanup Program. An expansion project constructed a few years later places one additional wind turbine (Wind Tower #9) within the boundary of the CMS Area (SFA Zone 5 Sub-Area) on lands leased from Tecumseh.

- Steel Winds Utility Easement Areas: Overhead electric utility line easements for the wind turbines cross the CMS Area, but are purposefully located at a distance from SWMUs requiring further assessment.

5.2 Development of RAOs & GRAs

The development of a comprehensive Corrective Action Plan for the CMS Area involves development of site-specific Remedial Action Objectives (RAOs) that mitigate all significant public health and adverse environmental impacts associated with residual wastes and fill from historical Bethlehem Steel operations as identified in the RFI and CMS in the context of current and reasonably anticipated future (non-residential) land uses. The former heavy industrial nature of the CMS Area (and consistent with the existing deed restrictions and zoning) coupled with the large quantity of deposited wastes and historic fill on the large CMS Area that is relatively isolated from residential and commercial areas dictates the development of RAOs consistent with these conditions. As such, the RAOs that have been developed for the CMS Area are to:

- Mitigate potential environmental impacts resulting from migration of waste/fill contamination to Site groundwater and adjacent surface water bodies.
- Mitigate potential health risks resulting from direct adult human contact with impacted waste/fill. As discussed in Section 4, surficial contamination exist in the Tank Farm SWMU group, Coke By-Products Sub-Area, SWMU S-18 (Lime Kish Landfill), certain portions of the impoundments area in SFA Zone 2, and possibly SWMU P-10.
- Implement engineering and institutional controls to assure that the CMS Area is not used in a manner inconsistent with the reasonably anticipated future land use scenarios, and that the selected corrective action remedies remain protective of public health and the environment.
- Mitigate potential health risks resulting from intrusion of non-chlorinated VOC (e.g., BTEX) vapor intrusion into existing and future buildings that would include full-time occupancy of workers in the CMS Area. The locations within the CMS Area that contain elevated VOCs in the soil/fill and/or groundwater and where commercial or industrial buildings are reasonably expected to remain or be constructed are generally found in the Coke By-Products and Former Tank Farm Sub-Areas.

General Response Actions (GRAs) are developed as potential means to achieve the site-specific RAOs. GRAs form the foundation for the identification and screening of

remedial technologies and corrective measure alternatives. GRAs that might be considered applicable to the impacted media within the CMS Area include:

- Excavation and consolidation of certain SWMU waste/fill in on-site SW-CAMU (based on waste volume and characteristics).
- Excavation and off-site disposal of certain SWMU waste/fill in a commercial treatment, storage, and disposal facility (TSDF) for SWMUs containing waste/fill that is otherwise not suitable for consolidation into the on-site SW-CAMU (based upon waste volume and characteristics).
- Containment in place (i.e., under an existing or improved cover system) of waste/fill for certain individual SWMUs or SWMU Groups.
- In-situ or ex-situ treatment, stabilization and/or solidification of certain SWMU waste/fill to render it suitable for consolidation into the SW-CAMU or off-site transportation and disposal.
- Groundwater collection, control and/or treatment where significantly impacted or contributing unacceptable mass loadings to adjacent surface waters..
- Monitored natural attenuation for groundwater impacts that are not significantly contributing to the impairment or degradation of adjacent surface water quality and/or are otherwise impracticable to control or treat.

5.3 Identification of Standards, Criteria and Guidance

This sub-section provides a summary of standards, criteria, and guidance (SCGs) that are considered applicable or relevant and appropriate to remediation of the CMS Area. Applicable SCGs pertain to cleanup standards, standards of control, and other substantive requirements, criteria, or limitations promulgated under NY State or Federal environmental, public and worker health, or facility siting laws that specifically address hazardous substances, pollutants, contaminants, remedial actions, locations, or other specific circumstances at the CMS Area.

Relevant and appropriate SCGs pertain to cleanup standards, standards of control, or other substantive requirements, criteria, or guidance issued by NYSDEC, NYSDOH, USEPA or other State or Federal agencies that, while not "applicable" to a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance, address circumstances sufficiently similar to those that may be encountered at the CMS Area.

The chemical-, action-, and location-specific SCGs that may be applicable, relevant, or appropriate to remedy selection for the CMS Area are presented below and summarized in Tables 5-1 through 5-3. In each case, the identified SCGs are generally limited to regulations or technical guidance in lieu of the environmental laws from which they are authorized, as the laws are typically less prescriptive in nature and are inherently considered in the regulatory and guidance evaluations.

5.3.1 Chemical-Specific SCGs

Chemical-specific SCGs are usually health- or risk-based concentrations in environmental media (e.g., air, soil, water) or methodologies that, when applied to site-specific conditions, result in the establishment of concentrations of a chemical that may be found in or discharged to the ambient environment. The determination of potential chemical-specific SCGs for a site is based on the nature and extent of contamination; potential migration pathways and release mechanisms for site contaminants; the presence of human receptor populations; and the likelihood that exposure to site contaminants will occur. This information was provided through the investigations performed during the RFI and CMS, as well as the associated risk assessments. RFI/CMS sampling events included the collection and analysis of surface waste/fill, subsurface waste/fill, sediment, surface water, and groundwater samples. Table 5-1 presents a list of chemical-specific NY State and Federal SCGs that may be applicable or relevant and appropriate to the CMS Area.

The primary chemical-specific SCGs used herein for assessing remedial alternatives for waste/fill in the CMS Area are the Soil Cleanup Objectives (SCOs) specified under 6NYCRR Part 375-6.8(b). For most surface waste/fill in the CMS Area, the restricted protection of public health Industrial-Use Soil Cleanup Objectives (ISCOs) and the Protection of Groundwater SCOs specified in Table 375-6.8(b) would apply (for all parameters except for site-specific arsenic and PAHs objectives as discussed further below) consistent with current zoning and reasonably anticipated future uses. For portions of the CMS Area immediately adjacent to Smokes Creek and possibly in SFA-Zone 2 where public access may be granted by Tecumseh following completion of all corrective measures, the Commercial-Use SCOs (CSCOs) would apply to surface soil/slag/fill as well as any imported soils to be used in the upper 12-inches of a final cover system.

Site-specific SCOs have been developed for arsenic and PAHs in surface waste/fill for certain SWMUs that may be contained in-place. Surface soil/fill concentrations that meet the NYSDEC Part 375-6.8(b) ISCOs as well as the Protection of Groundwater SCOs but exceed the site-specific SCOs for arsenic and/or total PAHs may remain in-place without additional soil or slag cover provided the: arsenic concentration is below 118 mg/kg, total PAH concentration is less than 500 mg/kg, waste/fill is not grossly impacted, and subject location is not occupied, leased, or otherwise being actively used. Appendix P presents the statistical analysis to support the site-specific arsenic SCO, as well as the basis for the total PAH SCO adapted from the NYSDEC's Commissioner's Policy CP-51/Soil Cleanup Guidance (October 21, 2010).

Where surface waste/fill concentrations in SWMUs, either prior to or following excavation, exceed the Part 375 ISCOs or the site-specific SCOs for arsenic (118 mg/kg) or total PAHs (500 mg/kg), they may be covered by material that meets the requirements of the generic soil cleanup table for the applicable site use; that is, a minimum of 1 foot of BUD slag, or vegetated soil that meets the requirements set forth in DER-10. Remedial alternatives will be evaluated for those areas where subsurface waste/fill concentrations exceed Part 375 Protection of Groundwater SCOs and elevated concentrations of the same contaminants are detected in nearby groundwater (see Table 4-47). Exposed surface soil/slag/fill (i.e., not covered by structures or paving) on remediated SWMUs or other locations within the CMS Area that are leased, sold, or otherwise transacted in the future for commercial, industrial or passive recreational uses must meet the applicable SCO in Part 375 6.8(b) consistent with that use prior to occupancy and consistent with the site-specific Soil/Fill Management Plan (SFMP), environmental easement and/or other institutional controls to be developed as part of the comprehensive Corrective Action Plan. Borrow soils that will be imported for use on the CMS Area for final cover system construction must meet Part 375 CSCOs consistent with DER-10 requirements.

Surface and subsurface waste/fill that exhibits the characteristics of a hazardous waste (e.g., TCLP concentrations exceed the standards), as well as waste/fill deemed grossly impacted, may be considered for excavation and placement into the planned on-site SW-CAMU (following solidification or stabilization as appropriate and as approved by the Department); off-site disposal in a commercial TSDF (with or without stabilization/ solidification if required); or, at a minimum, contained in-place under a suitably designed and

constructed low-permeability geomembrane and soil cover system. According to 6NYCRR Part 375-1.2(u), "Grossly contaminated media means soil, sediment, surface water or groundwater which contains sources or substantial quantities of mobile contamination in the form of NAPL, as defined in subdivision 375-1.2(ac), that is identifiable either visually, through strong odor, by elevated contaminant vapor levels or is otherwise readily detectable without laboratory analysis." As an example, tar-impacted soil/fill would be considered for off-site disposal at a commercial TSDF or, if adequately solidified or stabilized and approved by the Department, considered for consolidation into the SW-CAMU or similar closed in-place SWMU. Characteristic hazardous waste that is rendered non-hazardous will also be candidate material for consolidation into the SW-CAMU provided treatment and disposal conform with the requirements set forth in 6NYCRR 376.2-376.4.

Sediment in the waterbodies has been compared to the guidance values set forth in the NYSDEC Division of Fish, Wildlife and Marine Resources, Bureau of Habitat, *Screening and Assessment of Contaminated Sediment* dated June 24, 2014 (Ref. 12). Management and disposal of impacted sediment would effectively be the same as impacted soil/fill discussed above.

5.3.2 Location-Specific SCGs

The location of the CMS Area is a fundamental determinant of its impact on public health and the environment. Location-specific SCGs are restrictions placed on the concentration of hazardous substances or the conduct of activities solely because they are in a specific location. Some examples of these unique locations include floodplains, wetlands, historic places, and sensitive ecosystems or habitats. Table 5-2 presents the location-specific SCGs that may be applicable or relevant and appropriate to the CMS Area.

5.3.3 Action-Specific SCGs

Action-specific SCGs generally are generally regulations or guidance applicable to remedial activities applicable to different environmental media (e.g. groundwater, surface water, storm water, soil, or air). Table 5-3 presents the action-specific SCGs that may be applicable or relevant and appropriate to the CMS Area.

5.4 Development and Screening of Corrective Measure Alternatives

Section 4.0 of the CMS Work Plan presented and described proposed corrective measure alternatives identified as potentially feasible remedial approaches to address the known or suspected adverse environmental or public health impacts associated with each SWMU, SWMU group, and watercourse identified as requiring further assessment in the CMS Area. The CMS Work Plan also described the methodology, considerations, and criteria to be used to evaluate alternatives and recommend corrective measures. The CMS Consent Order states that only alternative corrective measures identified in the CMS Work Plan need be evaluated.

The supplemental data/information collected during the CMS, together with comments received from the Department, were used to refine or modify corrective measure alternatives previously identified in the approved CMS Work Plan or add new alternatives for each SWMU, SWMU Group, and watercourse requiring further assessment, as appropriate and discussed below in Section 5.5. An explanation will be given in the following sub-sections if alternatives presented in the CMS Work Plan have not been evaluated herein.

5.5 Evaluation of Corrective Measure Alternatives

NYSDEC's DER-10 Technical Guidance for Site Investigation and Remediation (May 2010) has been followed for remedy evaluation. In addition to achieving RAOs, the corrective measure alternatives are evaluated against the following criteria consistent with 6NYCRR Part 375-1.8(f):

- **Overall Protectiveness of Public Health and the Environment**. This criterion is an evaluation of the remedy's ability to protect public health and the environment, assessing how risks posed through each existing or potential pathway of exposure are eliminated, reduced, or controlled through removal, treatment, engineering controls, or institutional controls.
- **Compliance with Standards, Criteria, and Guidance (SCGs)**. Compliance with SCGs addresses whether a remedy will meet applicable environmental laws, regulations, standards, and guidance.
- **Long-Term Effectiveness and Permanence**. This criterion evaluates the long-term effectiveness of the remedy after implementation. If wastes or treated residuals remain on-site after the selected remedy has been implemented, the following items are evaluated: (i) the magnitude of the remaining risks (i.e., will

there be any significant threats, exposure pathways, or risks to the community and environment from the remaining wastes or treated residuals), (ii) the adequacy of the engineering and institutional controls intended to limit the risk, (iii) the reliability of these controls, and (iv) the ability of the remedy to continue to meet RAOs in the future.

- **Reduction in Toxicity, Mobility, or Volume of Contamination through Treatment**. This criterion evaluates the remedy's ability to reduce the toxicity, mobility, or volume of CMS Area contamination. Preference is given to remedies that permanently and significantly reduce the toxicity, mobility, or volume of the wastes within the CMS Area. Projections of anticipated reductions to groundwater contaminant loadings to surface waters resulting from alternative corrective measures will be presented.
- **Short-Term Impacts and Effectiveness**. Short-term effectiveness is an evaluation of the potential short-term adverse impacts and risks of the remedy upon the community, the workers, and the environment during construction and/or implementation. This includes a discussion of how the identified adverse impacts and health risks to the community or workers within the CMS Area of the Site will be controlled, and the effectiveness of the controls. This criterion also includes a discussion of engineering controls that will be used to mitigate short term impacts (i.e., dust control measures), and an estimate of the length of time needed to achieve the remedial objectives.
- **Implementability**. This criterion evaluates the technical and administrative feasibility of implementing the remedy. Technical feasibility includes the difficulties associated with the construction and the ability to monitor the effectiveness of the remedy. For administrative feasibility, the availability of the necessary personnel and material is evaluated along with potential difficulties in obtaining specific operating approvals, access for construction, etc.
- **Cost-Effectiveness**. Capital (construction), and annual operation, maintenance, and monitoring (OM&M) costs are estimated for each alternative corrective measure and presented on a present worth basis as summarized in Tables 5-4 through 5-8. Appendix Q contains the detailed cost estimates for each alternative, excluding the no action alternative. The estimated quantities of impacted material to be excavated have been increased by 10 to 25 percent to account for contingency and excavation inefficiencies. This percent increase varies such that smaller, more defined areas require a lower contingency factor compared to larger, less defined areas. The costs presented for each alternative corrective measure involving excavation reflect these increased quantities.
- **Community Acceptance**. This criterion evaluates the public's comments, concerns, and overall perception of the remedy. As it is difficult if not impossible

to anticipate community input, rather than doing so this criterion is more appropriately deferred to community outreach and solicitation of input through distribution of fact sheets and NYSDEC decision documents and possibly by public meetings as deemed appropriate by NYSDEC.

- **Land Use**. This criterion requires that the reasonable anticipated future land use be factored into the evaluation. The 6 NYCRR 375-1.8(f)(9) identifies 16 criteria that must be considered. The reasonably anticipated future land use of the CMS Area in an industrial capacity is further discussed in Appendix R. As acceptable future uses of the CMS Area have already been codified by local City of Lackawanna Zoning Ordinance for the Bethlehem Redevelopment Area (Section 230-17), it is not discussed further in this CMS unless remedial alternatives are inconsistent with acceptable uses as specified in the Zoning Ordinance.

The no further action alternatives being considered in the following sub-sections are default or baseline conditions against which the other alternative corrective measures are compared. The no further action alternative is not a null hypothesis or static condition in the context of groundwater quality, but rather an assessment of continued monitored natural attenuation of groundwater contaminants based on established site-specific temporal trends. Tables 5-4 through 5-8 summarize the evaluation of the following alternatives using the criteria outlined above.

5.5.1 Selection of Corrective Measures Alternatives

Table 5-9 provides a summary of the recommended corrective measures and estimated costs for the entire CMS Area by Sub-Area, by individual SWMU, water course, and Groundwater Discharge Sub-Area (DSA). A description of the recommended alternatives, the rationale supporting recommended corrective measure alternatives, and additional conceptual design details, where appropriate, are provided below and depicted graphically in Plate 5-2. In some instances, the recommended corrective measure(s) is beyond what is required to meet applicable and relevant regulatory standards, criteria, and guidance (SCGs). In other instances, at specific SWMUs or for specific parameters in one or more environmental media (e.g., soil/slag/fill, sediment, groundwater), the recommended corrective measure(s) may vary from SCGs based on site-specific considerations of: nature and extent of contamination; background concentrations; potential exposure pathways; existing and future use; and existing or planned institutional and engineering controls to be incorporated into a CMS Area-wide environmental easement. When reviewed collectively,

the recommended corrective measures detailed in this Section represent a comprehensive remedy of the broad and complex nature of the environmental conditions at the Site that are fully protective of the public health and the environment. The NYSDEC is responsible for final remedy selection following solicitation and consideration of community and other stakeholder input.

Tecumseh proposes to implement recommended corrective measures on an expedited basis and under separate or amended Consent Orders as approved by the Department.

5.5.2 Site-Wide Alternative Corrective Measures

As evaluated in the CMS Work Plan, the removal and off-site disposal for all the SWMU waste/fill in the CMS Area (estimated at over 1,500,000 tons) has been ruled-out from further consideration as this alternative would not restore the CMS Area to pre-existing conditions; not address saturated zone (groundwater) impacts on-site; render dredge spoil wastes underlying slag/fill exposed and more mobile in the environment; result in significant short-term impacts to the community and air quality from emissions and significant truck traffic; be extremely difficult to implement; the significant fossil fuel consumption related to excavation and transportation which is inconsistent with NYSDEC's Green Policy; and be excessively costly. Appendix E includes the Excavation and Off-Site Waste Disposal Evaluation from the CMS Work Plan. As such, this site-wide off-site disposal alternative is not discussed further within this CMS; however, off-site disposal of any hazardous waste will be considered on a SWMU by SWMU basis. For organization purposes, the SWMUs being evaluated are grouped by SFAs, but alternatives typically evaluated by individual SWMU considering each SWMUs unique attributes. One notable exception is the impoundments in SFA Zone 2 that have common or substantially the same proposed remedies due to their common attributes.

Groundwater corrective measures are evaluated based on the groundwater discharge areas in Section 5.5.11 as groundwater impacts are typically a result of more than one SWMU source and typically require implementation downgradient and at distance from the SWMU source(s).

5.5.3 Alternative Corrective Measures for SWMUs Identified as Groundwater Contamination Sources

An assessment of which SWMUs have the potential to impact groundwater quality was discussed in Section 4.8 and is summarized in Table 4-47. SWMUs and/or SWMU Groups deemed potential groundwater contaminant sources in Table 4-47 will be evaluated for the following alternatives:

- Cover or contain in place
- Excavate and consolidate within the SW-CAMU (with or without solidification/stabilization , as appropriate)
- Excavate and dispose in off-site commercial TSDF
- Groundwater collection, control and/or treatment
- No further action will be recommended for SWMUs that are not listed on Table 4-47 or where final remedies have already been implemented under existing consent orders and therefore deemed not to be active groundwater contamination sources

5.5.4 SFA Zone 2 Sub-Area Alternative Corrective Measures

The Zone 2 SWMUs consist of S-1, S-2, S-3, S-4, S-5, S-6, S-7, S-8, S-20, and S-27 (collectively referred to as "the impoundments"); SWMUs S-11 and S-22 that have been remediated as part of the ATP-ECM (refer to Section 2.2.1); and SWMU S-21 that has been implemented by consolidating the waste into the ATP containment cell (refer to Section 2.3.2). Therefore, this sub-section deals solely with closure of the impoundments (Refer to Plate 5-3 for the existing conditions in this area). As discussed in the CMS Work Plan, the off-site disposal of the waste materials in the impoundments was ruled-out as a viable alternative.

Section 2.3 of the CMS Work Plan presents the regulatory basis that allows for wastes excavated from several SWMUs throughout the CMS Area to be consolidated and managed collectively in two RCRA Corrective Action Management Units (CAMUs). The HW-CAMU has been eliminated from further consideration based on the construction of the ATP containment cell along with the consolidation of wastes from several other SWMUs into the ATP (i.e., implementation of OU-2). The "grandfathered" SW-CAMU is a key element of the recommended corrective measures for this CMS sub-area under the RCRA regulations.

Table 5-10 summarizes the SWMU waste/fill sources and quantities proposed for consolidation and final disposition in the SW-CAMU or off-site commercial TSDF.

Alternative groundwater corrective measures in SFA Zone 2, which address groundwater impacts from these SWMUs in Groundwater Discharge Areas 2A and 2B, are presented in Section 5.5.11.

5.5.4.1 SW-CAMU and Impoundments Closure

Fundamental to the comprehensive CMS Area-wide remedial approach on the Tecumseh Site is the proposed construction of a SW-CAMU for managing certain SWMU solid waste/fill on-site. The SW-CAMU application originally submitted by Bethlehem Steel and approved by NYSDEC in 2000 as well as an additional smaller and technologically enhanced SW-CAMU design are developed and evaluated below.

Alternative 1: Grandfathered SW-CAMU

On November 16, 2000 application was made by Bethlehem Steel pursuant to 6 NYCRR Part 373-2.19 to designate two Corrective Action Management Units (CAMUs) at the Site to consolidate and contain remediation waste. The design criteria outlined in the "*Solid Waste CAMU Design and Performance Standard*" of the Bethlehem Steel application was subsequently deemed substantially complete by NYSDEC, effectively "grandfathering" the Solid Waste (SW)-CAMU design under the 1993 regulations. The approximately 24-acre SW-CAMU proposed to consolidate solid wastes from several SWMUs around the Site within SWMUs S-1, S-2, S-3, S-4, S-5, S-6, S-7, S-20, and S-27 located in the western portion of SFA Zone 2 (see Figure 5-1) and construct a low-permeability final cover system over the consolidated waste.

The western (Lake Erie) side of the SW-CAMU consists of a steep slag slope bluff that was made from emptying ladles containing molten slag and other fill materials to form steeply-sloped berms surrounding impoundments into which SWMU wastes were subsequently deposited by Bethlehem Steel (refer to Plate 5-3). The perimeter slag/fill berms extend from the top elevation of 625 to 635 feet to elevation 585 feet at the toe of the slope near the Lake Erie shoreline (approximately 14 feet above the Lake Erie average water level). Cross-sections have been prepared that show the slag slope along the western portion of the impoundments area including SWMUs S-1 to S-4 (see Figures 5-2 and 5-3). The narrowest slag berm width or thickness at the top of deposited SWMU waste to outside edge of slag

slope ranges from approximately 45 feet adjacent to SWMU S-2 to 80 feet adjacent to SWMU S-4. The slag berm width at the bottom of the waste deposited in the SWMUs range from 105 feet adjacent to SWMU S-2 to 193 feet adjacent to SWMU S-4.

Tecumseh commissioned a study of the slope and foundation stability of the existing perimeter slag bluffs along the western (Lake Erie) and northern (Smokes Creek) portion of the proposed SW-CAMU and an erosion and revetment assessment for the slag beachfront extending approximately 1,700 LF along Lake Erie (refer to Appendix S). The slope and foundation assessments were completed using current site conditions and modeled future conditions of the closed SW-CAMU. The results of the static stability analyses indicate that the bluff should have a maximum slope of 1.5H:1V by placing additional granular fill along the outward (western) slag bluff slope to achieve an adequate factor of safety against sliding for proposed slope geometry and SWMU fill geometry and rapid fill loading (temporary) conditions, provided there is no additional fill added along the northern portion of the SW-CAMU bluff in SWMU S-4. The results of the earthquake stability analysis (pseudo static) indicated acceptable factors of safety at all cross-sections provided there is no filling along the northern bluff of the proposed SW-CAMU (i.e., in SWMU S-4).

Post-earthquake stability analyses indicated that an adequate factor of safety against slope stability failure for post-earthquake condition is met at all cross-sections modeled except at SWMU S-1. During detailed design of the SW-CAMU, the geotechnical engineer will further analyze the static and dynamic stability of the bluffs or modify the proposed final western slag bluff grading adjacent to SWMU S-1 to assure an adequate factor of safety against slope stability failure for post-earthquake condition.

Shoreline protection at the toe of the slag/fill bluff in Slag Fill Area-Zone 2 adjacent to the proposed SW-CAMU was evaluated by a coastal engineering firm familiar with conditions in Lake Erie (refer to Appendix S). The evaluation is based upon the 100-year design lake storm levels, and wave action along the east shoreline of Lake Erie (western bluff of the SW-CAMU), assessed sediment transportation and deposition rates, beach down-cutting and horizontal bluff recession. The coastal engineer concluded that the shoreline revetment should consist of placement of large armor stone at the toe of the re-graded slope extending upward to elevation 595 feet International Great Lakes Datum (IGLD85) in the and southern and central portions of the SW-CAMU area and to elevation 590 feet IGLD85 at the north end of the bluff proximate to Smokes Creek (see Figures 5-4 and 5-5). To

protect the slag bluff from wave run-up, rip rap extends above the armor stone an additional 10 feet (i.e., to elevation 605 feet IGLD85 in the south and central sections and to elevation 600 feet IGLD85 in the north section). In the northern portion of the revetment, the designer indicated that the armor stone could be replaced with rip rap as shown on Figure 5-4. As an alternate design to the armor stone, a roller compacted concrete (RCC) revetment may also be considered for shoreline protection which would be constructed to the same elevations. The selected shoreline system will be constructed above the USACE designated Ordinary High Water Mark, El. 573.4 feet IGLD85 (573.46 feet NAVD88) and east of the outermost Riparian Grant line south of Smokes Creek established by Bethlehem Steel with the New York State Department of State on January 2, 1959.

This alternative proposes existing waste along the western and northern slag bluff in SWMUs S-1, S-2, S-3 and S-4 be pulled back such that a minimum separation distance of 50 feet exists from the waste to the outside edge of bluff (refer to Figures 5-2 and 5-3). The top of waste elevation along the inside perimeter of the SWMUs be lowered further to accommodate storm water drainage swales along the perimeter of the cover system.

An additional approximately 27,000 to over 150,000 CY of solid waste excavated from various SWMUs across the CMS Area would be consolidated into the SW-CAMU along with the approximately 875,000 CY of waste/fill already contained in SWMUs S-1, S-2, S-3, S-4, S-5, S-6, S-7, S-20 & S-27. The estimated range of SWMU waste/fill volume proposed to be consolidated into the SW-CAMU is large because excavation quantities will vary according to the lateral and vertical extent of impacts as well as the amount of slag reclaimed from the SWMUs. The waste will be placed away from the bluffs in order to create the minimum slopes of 4% to promote positive drainage off the final cover system. The maximum slope of the final cover system will be 4H:1V.

The final cover system design will be consistent with the grandfathered SW-CAMU application as approved by NYSDEC (i.e., including 0.5-foot vegetated topsoil layer, a 1-foot barrier protection layer, a geomembrane liner, a 0.5 foot geotextile cushion, and grading soil), except as shown on Figure 5-6, the proposed cover system also includes a geosynthetic drainage layer similar to that used in the ATP-ECM cover system. The additional geosynthetic drainage layer will provide more stability to the final cover by alleviating pore water pressure build-up in the cover system. An analysis of the water infiltration through the proposed cap was made using the numerical model "Hydrologic Evaluation of Landfill

Performance" (HELP). The estimated infiltration through the deposited waste/fill under existing conditions through the footprints of SWMUs S-1, -2, -3, -4, -5, -6, -7/20, and -27 was estimated to be 4,673,000 gallons of water per year. The SW-CAMU post-cover condition estimate for infiltration through the SW-CAMU cover system and underlying deposited waste/fill is 8,400 gallons per year representing a 99.82% reduction in the rate of leachate production (refer to Table 5-11), which will in turn reduce the loading of COCs from this area to groundwater and surface water (i.e., Smokes Creek and Lake Erie).

The final cover system grading plan will incorporate hummocky profile to provide a more natural and aesthetic landscape conducive to wildlife habitat and potential passive recreational uses such as hiking and wildlife observation. The perimeter of the SW-CAMU will remain close to existing grades and will be reduced in areas such that the bluff elevation will be no higher than 630 feet. The bluff will be graded to permit maintenance vehicle access and to prevent storm water from running-off the final cover and eroding the western Lake Erie slope and the northern Smokes Creek slope. A system of perimeter drainage swales and culvert pipes will be designed to convey storm water runoff from the SW-CAMU to a detention basin in (unfilled) SWMU S-8, east of SWMU S-6. Storm water peak runoff flows will be stored, equalized, and released from the retention/detention ponds in a controlled and reduced manner. Most stormwater is expected to infiltrate to the groundwater through the bottom and sides of the detention basin(s). However, for extreme precipitation events, excess stormwater would be outlet to Smokes Creek or to the SFA Zone 1 Sub-Area where the storm water will infiltrate the groundwater table due to the granular pervious nature of the iron slag materials present.

Alternative 2: Close In-Place SWMUs S-1, S-2, S-3, S-4, S-5, S-6 and Reduced SW-CAMU Footprint Enhanced with Base Liner and Leachate Collection System

This alternative includes closure of SWMUs S-1, S-2, S-3, S-4, S-5, and S-6 in-place with the same cover system and lake shore revetment as in Alternative 1 above (refer to Figure 5-7). These impoundments cover approximately 11.5 acres. The final surface grades of the SWMUs will be modified by the addition of approximately 15,000 to 94,000 CY of waste from SWMU S-27, water quality sludge and mill scale to be excavated from SWMU S-7/20 to construct the SW-CAMU base liner and leachate collection system, and construction and demolition (C&D) debris generated from structures scheduled for demolition on the

Tecumseh property. The balance of the fill material needed to achieve a minimum 4% slope on the finished grade for positive drainage will be obtained from slag generated from grading modifications to the impoundment area (or other areas of the Tecumseh site). This alternative would locate the SW-CAMU within the footprint of SWMUSs S-7 and S-20 which would serve as the containment cell for consolidation and final disposal of the solid wastes generated from the remediation of the other SWMUs (estimated at 27,000 to over 115,000 CY) over the approximately 875,000 CY of waste/fill already contained in SFA Zone 2. The estimated range of SWMU waste/fill volume proposed to be consolidated into the SW-CAMU is large because excavation quantities will vary according to the lateral and vertical extent of impacts as well as the amount of slag reclaimed from the SWMUs. In this alternative, the SWMU waste/fill to be consolidated into the SW-CAMU would be placed in an engineered containment cell that will fully encapsulate the relocated wastes and include a low-permeability geocomposite liner system, leachate collection system, and a low-permeability geocomposite cover system (refer to Figures 5-6 and 5-6A). As such, the SW-CAMU would be reduced in area from the "grandfathered" size of approximately 24 acres in the NYSDEC-accepted CAMU Application to approximately 4.3 acres. Plate 5-4 illustrates the revised SW-CAMU footprint and closure plan for the other impoundments under this alternative. The slope of the SW-CAMU final cover system would be 25% maximum and 4% minimum.

Alternative 3: Excavation and Off-Site Disposal

The estimated costs for removal of all solid waste/fill in the CMS area and off-site disposal of the same was estimated to be in excess of $116,000,000 of which nearly $100,000,000 was estimated for removal of the wastes in SWMUs S-1, S-2, S-3, S-4, S-5, S-6, S-7, S-20, & S-27 (refer to Appendix E). This alternative was previously deemed infeasible due to factors including ineffective protection of public health and the environment, implementability issues, and excessive cost. As stated in Section 5.5.2, this previous assessment included in the CMS Work Plan was deemed infeasible.

Comparison of SW-CAMU and SFA Zone 2 Impoundments Corrective Action Alternatives

Referring to Table 5-4, Alternatives 1 and 2 are protective of public health and the environment (in concert with groundwater remediation). Alternative 2 provides additional

environmental protection of a low-permeability bottom liner and a leachate collection system that will enable collection of contaminated stormwater and leachate during the intervening couple of year period when waste/fill is consolidated into the SW-CAMU, and and smaller but longer-term leachate production after the final cover system installation. The SW-CAMU under Alternative 2 (Figure 5-7) is a significantly smaller (i.e., 4.3 acres) footprint than Alternative 1 (i.e., 24 acres). By having a reduced footprint for the SW-CAMU, the impoundment area can be used for passive remediation (not simply one single hump) with a more natural park-like setting with gentle elevation grades and trees and vegetation. The SW-CAMU under Alternative 2 would be a minimum of 500 feet east of Lake Erie and 700 feet south of Smokes Creek. Alternative 2 is more cost-effective than Alternative 1.

Recommended SW-CAMU and SFA Zone 2 Impoundments Corrective Measures and Conceptual Design

The recommended remedial alternative is *Alternative 2: Close In-Place SWMUs S-1, S-2, S-3, S-4, S-5, S-6 and Reduced SW-CAMU Footprint Enhanced with Base Liner and Leachate Collection Systems* as shown on Plate 5-4. A critical component of the overall recommended Corrective Measure Plan for the CMS Area involves excavation of solid wastes from several SWMUs for transportation, consolidation, and permanent management/ disposal in a centralized on-site SW-CAMU to be constructed in the elevated portion of SFA Zone 2 Sub-Area located 700 feet south of Smokes Creek and 500 feet east of Lake Erie. The proposed SW-CAMU footprint (SWMUs S-7 & S-20) covers an area of approximately 4.3 acres. The impoundment area (SWMUs S-1 through S-6) covers an area of about 11.5 acres. Both the impoundments and the SW-CAMU will be closed in place using a low-permeability geocomposite cover. The proposed final cover system for the impoundments will consist of seven mounds (two mounds will be formed in SWMU S-3 to provide a more natural appearance) of varying heights by relocating 15,000 to 94,000 CY of slag/fill waste from SWMUs S-27, S-7 & S-20, and C&D debris from the Tecumseh Site.

The SW-CAMU will consist of one mound, the height of which will vary depending upon the quantity of waste to be consolidated, which is expected to range from 27,000 to 115,000 CY as shown on Plate 5-4. The cover system around the impoundments and SW-CAMU will be connected by a series of stormwater swales that will direct runoff to a detention basin located in the footprint of SWMU S-8. A series of interconnecting

roads/walking paths will be built for operation and maintenance; two vehicular access roads will be provided to access the top of the bluff, one on the north side and another on the south (the south access currently exists). Trees and other vegetation will be planted strategically along the perimeter access roads to provide a more natural setting and improved wildlife habitat. The proposed cover system design for the SW-CAMU incorporates flexibility in cover system grades of not less than 4% to a maximum of 25% to accommodate this broad range of potential material to be placed in the SW-CAMU. The first year of construction would consist of building the lake shore revetment, and dewatering the wastes in SWMUs S-1 and S-5, grading along the perimeter of the impoundment area to lower the ground elevations and flatten steep slopes, and subgrade grading in the SWMUs to be closed in-place (SMWUs S-1 to S-6). During the second construction season the lake shore revetment would be completed, the stormwater detention basin and storm water perimeter swales constructed; subgrade preparation including waste will be pulled back from the western edge of the bluff in SWMUs S-1, S-2, S-3, and S-4 (and the northern edge of the bluff in SWMU S-4) and waste/fill from SWMUs S-7/20 and S-27 would be consolidated; the closure and shaping of the SWMU S-1 through S-6 will be started. During the third and fourth construction seasons, the impoundment closure would be completed, the SW-CAMU liner and leachate collection system will be built and consolidation of SWMU wastes from the CMS area begun. During the fifth, sixth and seventh construction seasons the consolidation of SWMU wastes into the SW-CAMU will be completed and construction of the SW-CAMU final cover system, and landscaping completed to allow for the impoundment areas to be used for passive recreation and wildlife habitat.

Remedial construction work is expected to occur between April and November but could start earlier and extend later depending on weather conditions. By sequentially closing the impoundments first followed by SW-CAMU construction and waste consolidation, liner, leachate and cover construction will facilitate quicker remedy implementation, minimize the "footprint" associated with waste consolidation, and thereby improve stormwater management, odor and air quality controls related to those corrective measures. Subgrade preparation for the impoundment closure and SW-CAMU would consist of clearing and grubbing vegetation (trees, brush, grass, and topsoil) from the limits of the cover system footprint; woody vegetation will not be placed in the impoundments or the SW-CAMU. Subgrade preparation will include pulling back existing waste along the western and northern

slag bluff in SWMUs S-1, S-2, S-3, and S-4 such that a minimum separation distance of 50 feet exists from the waste to the outside edge of the bluff. The top of waste elevation along the inside perimeter of the SWMUs will be lowered further to accommodate storm water drainage swales along the perimeter of the cover system. The base of the waste/fill to be consolidated therein would be at an elevation of approximately 615 to 623 (top of existing fill grade) providing an approximate 45-foot vertical separation from the groundwater table.

All standing (waste)water present within SWMUs S-1 and S-5, estimated at approximately 575,000 gallons based on information within the RFI (Ref. 26), would be removed prior to placing subgrade fill material. Removed wastewater would be treated on-site and discharged to an infiltration basin located on SFA Zone 2 east or north of the impoundments. The temporary on-site contaminated stormwater and leachate treatment system would consist of oil/water separation, bag filtration, and granular activated carbon. (see Plate 5-4).

The western slag slope of the SFA Zone 2 Sub-Area drops steeply from the upper perimeter adjacent to the SWMUs S-1, S-2, S-3 and S-4 toward Lake Erie and the sandy beach some 40 to 50 feet below. The SFA Zone 2 Sub-Area was created by BSC depositing ladles of molten slag by-product from decades of iron and steel production thus forming a very dense quasi-monolithic structure that is resistant to weathering and erosion. The top of slope around the impoundments and SW-CAMU would be graded to permit maintenance vehicle access with perimeter guard rails, slag berms, or concrete barriers where appropriate, and sloped to prevent storm water from eroding the perimeter slag slopes. A revetment on the western steep slag slope will be installed consisting of large armor stone at the toe of the re-graded slope extending upward to elevation 595 feet International Great Lakes Datum (IGLD85) in the southern and central portions of the SW-CAMU area and to elevation 590 feet IGLD85 at the north end of the bluff proximate to Smokes Creek. To protect the slag bluff from wave run-up, rip rap will extend above the armor stone an additional 10 feet (i.e., to elevation 605 feet IGLD85 in the south and central sections and to elevation 600 feet IGLD85 in the north section).

One or more storm water detention basin(s) will be constructed north of the SW-CAMU in what is currently SWMU S-8 to store and equalize peak (non-contaminated) storm water runoff flows from the impoundment and SW-CAMU final vegetated cover systems. The combined storage volume of all retention basins will be designed to hold the

24-hour, 25-year storm event. Due to the pervious nature of the slag that will be used to construct the stormwater detention basins, they will be designed to infiltrate a portion of the retained stormwater through the bottom and sides. A control and overflow structure will control the discharge from the basins for extreme precipitation events to outlet to Smokes Creek. Stormwater will be conveyed to the detention basins via lined drainage swales and/or pipe.

Concurrent with construction of the revetment, initial grading of the impoundments (SWMUs S-1 to S-6), and initial storm water drainage improvements (as a high priority Year One and Two activities) would occur. The SW-CAMU would be operated as a solid waste management facility for a period of 2 to 3 years following base liner, leachate collection and treatment systems construction. the estimated time to consolidate the solid waste/fill from various SWMUs further identified in this Section and located throughout the CMS Area. As the SW-CAMU will consist of only one cell (i.e., SWMUs S-7/-20), a more detailed fill progression plan will be prepared and updated annually throughout the operational life of the SW-CAMU to describe the nature and location of the materials to be consolidated, treatment of the wastes as necessary, expected volumes of waste to be deposited, leachate/ (contaminated)stormwater treatment, and planned closure of the containment cell. The working face of fill being consolidated into the SW-CAMU would be compacted and minimized to control dust and minimize contaminated storm water within the CAMU. Consistent with the grandfathered CAMU application, the final cover system will consist of a geotextile cushion, a geosynthetic (HDPE) liner, and an 18-inch thick soil cover system (see Figure 5-6). This final cover system will significantly reduce and effectively control precipitation from infiltrating the consolidated waste and entering the underlying groundwater far below.

Minimal gas generation quantities are expected due to the inorganic nature of the fill as well as the 40 to 50 years of weathering. However, gas venting is planned and will consist of one gas vent per acre located near the high points of the final cover system (apex of the hummocks) with a 50-foot square (i.e., 2,500 SF) geo-composite drainage layer installed under the barrier layer and around each gas vent. A geosynthetic drainage layer atop the geosynthetic liner is designed to relieve the pore pressure in the overlying vegetated soil barrier protection layer and would be installed around the perimeter of each cell in the impoundment and SW-CAMU and extend up the consolidated waste/fill slope of the cover

system a minimum of 25 feet. The geosynthetic drainage layer would be self-contained by wrapping a 4-inch perforated HDPE pipe at the top of the 25-foot slope to limit intrusion of fines into the drainage grid. The drainage grid would be discharged into the perimeter swales described below.

The surface of the SW-CAMU and impoundment cover systems will be fertilized and seeded with a conservation mix for development of grasses and non-woody vegetation requiring minimal maintenance for erosion control, evapotranspiration, and wildlife habitat. The final grading plan will incorporate a hummocky design to provide a more natural and aesthetic landscape consistent with wildlife habitats and conducive to potential passive recreational activities (e.g., hiking, biking, wildlife viewing).

The impoundment closure and SW-CAMU will function to consolidate significant volumes of SWMU waste/fill (some of which may be stabilized or solidified) currently scattered across the approximately 489-acre CMS Area into a much smaller, centralized, and engineered on-site containment unit making management, maintenance, and monitoring of the waste residuals in the future much more effective. Furthermore, by consolidating the vast majority of all SWMU waste/fill totaling approximately 875,000 CY under a low-permeability geo-composite cover system, this recommended corrective measure is projected to reduce groundwater loadings of COCs from these SWMU sources by approximately 99.8%. By installing a liner, leachate collection system and geo-composite liner (thereby encapsulating all relocated SWMU wastes), the potential impacts of leachate from the SWMU wastes proposed to be consolidated into the SW-CAMU is expected to be minimal (i.e., reduce infiltration through the SW-CAMU by >99.8%). Solidification/stabilization of certain consolidated SWMU wastes will even further reduce the potential for migration of leachable contaminants to groundwater

The estimated present worth cost of the impoundment closure and SW-CAMU is approximately $17.5 million, including a projected $4.5 million for construction of the revetment; $11.54 million for closure of the impoundments and construction of the SW-CAMU; $870,000 for the present worth of the 7-year operational period; and $610,000 for the present worth of the 30-year post-closure OM&M period.

5.5.4.2 SWMU S-8

SWMU S-8 is an empty impoundment formed from perimeter deposition of slag fill currently covered by sparse vegetative growth consisting of trees, bushes, and grass that was initially anticipated for use as a dredge spoil disposal area while Bethlehem Steel owned and operated the property. SWMU S-8 was considered as an option for the SW-CAMU when the original application for a CAMU was made in 2000 in the event additional volumes of solid waste were generated that required consolidation in the SW-CAMU. This is no longer an option for the SW-CAMU as there is enough capacity to place solid wastes planned to be incorporated into the smaller preferred enhanced SW-CAMU to be located within the footprint of SWMUs S-7/20. SWMU S-8, located in the SFA Zone 2 Sub-Area, is devoid of SWMU wastes. The volumetric capacity of this empty impoundment is unnecessary for incorporation into the SW-CAMU to contain the projected quantities of solid waste/fill expected to be excavated from SWMUs located throughout the CMS Area. SWMU S-8 is planned to be regraded and used as a stormwater detention pond as described in the preceding section. The ground elevations along the top of the bluff around SWMU S-8 is currently at approximately 650 feet and the inside and outside slopes are very steep (greater than 45 degrees). The objective is to lower the top of bluff around the north and east sides of S-8 to approximately elevation 610± and to lower the internal and external slopes to less than 25 degrees The shaping and grading of SWMU S-8 will be completed using the SFMP (Appendix D).

Therefore, other than relocating the deminimus quantities of construction and demolition debris from SWMU S-8 into the SFA Zone 2 impoundments to be closed, no further action is the recommended alternative for this SWMU as there was only one slight exceedance of the ISCOs and the SWMU was not used for disposal of SWMU waste.

5.5.4.3 SWMU S-21

As described in Section 4.3.1.2, the final remedy for SWMU S-21 has been completed; therefore no alternative corrective measures are considered..

5.5.4.4 ATP-ECM and OU-2

The ATP-ECM containment cell and waste consolidation final remedy has been implemented as described in Section 2.3.2; therefore, no further remedial alternatives are considered.

5.5.5 SFA Zone 3 Sub-Area Alternative Corrective Measures

SWMU S-10 is a sparsely vegetated, 2.36-acre former slag quench pit excavated into the surrounding slag/fill measuring approximately 525 feet long, 225 feet wide, and 5 to 20 feet deep. The walls of this SWMU are nearly vertical except the northern end, which is a vehicle access ramp leading to the base of the depression. Benzo(a)pyrene was detected in one surface soil/fill sample at a concentration (1.4 mg/kg) slightly above the ISCO (1.1 mg/kg). The contaminants in the waste ammonia liquor (WAL) and Benzol Plant process water previously used to quench molten slag at this SWMU have been detected in groundwater monitoring wells downgradient of SWMU S-10. As liquid, not solid, wastes were disposed in SWMU S-10 over three decades ago, the slag/fill in the pit is not considered a current or on-going source of contaminant migration to groundwater as substantiated from the test pit analytical data. Table 5-4 summarizes the evaluation of the following alternatives for SWMU S-10 using the criteria outlined in Section 5.5. A description of each alternative is provided below.

Alternative groundwater corrective measures in SFA Zone 3, addressing groundwater impacts on Groundwater Discharge Areas 3A and 4A, are presented in Section 5.5.11.

Alternative 1: No Further Action

No further action would consist of leaving this area as-is without employing any remedial action on the slag/fill in this SWMU.

Alternative 2: Cover In-Place

While there is only one slight exceedance of the ISCOs, there were no exceedances of the site specific SCOs and no residuals (solid waste) present in SWMU S-10, this pit presents a physical safety concern from the nearly vertical nature of the side slopes. This alternative would entail grading the sides to eliminate the potential safety hazards using slag adjacent to the Unit to flatten the side slopes (minimum 3H:1V).

Alternative 3: Excavate and Consolidate into SW--CAMU

SWMU S-10 is an empty pit. Since there are no residuals to be removed from the pit, this alternative was not evaluated further.

Comparison of Corrective Action Alternatives for SWMU S-10

Referring to Table 5-4, Alternatives 1 and 2 are equally protective of public health and the environment from a chemical exposure perspective. Alternative 2 provides added protection from the physical hazard by eliminating the vertical drop and steep side slopes. The cost of Alternative 2 is significantly greater than the no further action alternative.

Recommended Corrective Measures for SWMU S-10

The recommended corrective measure for SWMU S-10 is *Alternative 2: Cover In-Place*, which consists of grading the sides of the pit to create stable and safe side slopes using adjacent slag/fill as required to achieve final design grades. While the no action alternative is adequately protective of the environment, the recommended alternative offers additional protection of public health by eliminating the physical hazard posed by the deep depression, is compliant with the SCGs, provides a long-term permanent solution, and is readily implementable. Short-term risks to workers would be effectively control through use of PPE and safe work practices. The estimated capital cost for this alternative is approximately $134,000. The elevation of the top of this SWMU is nominally 610 feet and it resides in the Iron City slag recovery zone; therefore, this area could be made available for slag reclamation.

5.5.6 SFA Zone 4 Sub-Area Alternative Corrective Measures

The SFA Zone 4 Sub-Area includes the following nine SWMUs identified below and individually discussed:

- S-12 – Asbestos Landfill L
- S-13 – Coal Tar Sludge (Hazardous Waste Management Unit 1B)
- S-14 – General Rubble Landfill N
- S-15 – General Rubble Landfill O
- S-16 – Lime Stabilized Spent Pickle Liquor (SPL) Sludge/Slag Landfill Basin (Hazardous Waste Management Unit 1A)
- S-17 – Vacuum Carbonate Blowdown Landfill Q
- S-18 – Lime Dust and Kish Landfill R (includes AOCs A to C)
- S-23 – Tar Pit Adjacent to Lime Stabilized SPL Sludge Landfill (includes AOC-D)

- S-28 – Drum Landfill

The approximate lateral and vertical extent, estimated quantities, and characteristics of the fill within SWMUs S-14, S-16, S-18, and S-23 were further delineated in Section 4. The following sub-sections present and evaluate remedial alternatives for the above-listed SFA Zone 4 Sub-Area SWMUs. Table 5-5 summarizes the evaluation of the following alternatives using the criteria outlined in Section 5.5. A description and comparison of each alternative is provided below for each Unit.

5.5.6.1 SWMU S-12 – Asbestos Landfill

SWMU S-12 is a permitted asbestos landfill reported to contain approximately 450 CY of bagged asbestos waste approximately 5 feet above the water table. The existing cover system consists of a 1- to 3-foot thick cover of fine slag across the top of the landfill surface. Observations of the cover system by field personnel during the CMS identified surficial erosion to the slag cover system; however, no exposure of the asbestos waste or plastic bags was observed.

Alternative 1: No Further Action

The no further action alternative would leave the bagged asbestos waste contained in the Unit with no additional remedial action. Maintenance of the slag cover would be required throughout the post-closure period to prevent direct future exposure and/or migration of asbestos-containing materials (ACM) from the Unit.

Alternative 2: Excavate and Consolidate in SW-CAMU

This alternative would consist of excavating and moving the asbestos waste to the SW-CAMU. Excavation of the asbestos waste would be a complicated procedure with significant potential for release of currently bagged asbestos fibers to workers, the public, and surrounding soil/fill during the excavation, handling, and transport of the asbestos fill. Excavation and subsequent handling would be accomplished mechanically under a steady wetting of the waste and may be augmented by additional short-term controls (e.g., tent, air handling, dust suppression techniques) to remove the bagged asbestos prior to transportation. Personal protective equipment (PPE), including respirators, and personal decontamination procedures would be employed to protect workers and the community air

monitoring plan implemented to protect the public. Solidification/stabilization technologies could be implemented to minimize the potential release of asbestos fibers during excavation and handling the waste. Even with appropriate engineering controls and PPE during short-term excavation and handling, some asbestos will escape into the air and surrounding environment. Human health impacts wound be manageable as there is no direct exposure to the public in this location of the Site.

Alternative 3: Upgrade Cover System

This alternative involves grading and/or filling in the depression formed when the asbestos landfill was created and providing a Part 360 compliant cover system. Post-closure care will involve annual inspections, cap mowing/maintenance, and reporting. This will significantly reduce the potential for either direct contact or migration of asbestos waste from the Unit in the future and is considered a permanent remedy. This alternative is implementable without short-term releases or exposures to bagged asbestos containing materials.

Alternative 4: Excavation and Off-Site Disposal

This alternative is similar to Alternative 2 except the waste would be transported off-site for disposal in a commercial sanitary landfill. The trucks would need to be covered and the excavated waste stabilized/solidified to prevent asbestos from escaping during transport.

Comparison of Corrective Action Alternatives for SWMU S-12

Referring to Table 5-5, Alternative 1 is currently protective of public health and the environment but is not considered a permanent remedy as the existing cover is eroded and may eventually result in direct exposure and/or release of asbestos from the Unit. Alternatives 2 and 4 involve short-term exposure risks to workers and the environment related to the significant potential for release of asbestos during excavation, transportation, and placement in the SW-CAMU. Alternatives 2 and 4 facilitate reuse and redevelopment of this portion of the CMS Area, while Alternative 3 does not. Alternative 3 provides a level of permanence and long-term protection roughly equivalent to Alternatives 2 and 4 at a significantly lower cost and with no significant short-term exposure risks. Alternative 4 would result in the greatest short-term CO_2, particulate and greenhouse gas emissions from

heavy equipment involved with excavation, transportation, and placement of the waste/fill. Alternative 2 would result in slightly less emissions due to shorter transportation, followed by Alternative 3 with no excavation or transportation, and Alternative 1 would result in no emissions.

Recommended Corrective Measures for SWMU S-12

The recommended corrective measure for the Asbestos Landfill (SWMU S-12) is *Alternative 2: Excavate and Consolidate in SW-CAMU*. It provides for consolidating the stabilized/solidified asbestos to the centralized SW-CAMU for permanent on-site containment. This will facilitate future slag reclamation and redevelopment on and near the SWMU S-12 portion of the CMS Area, and will be easier and less costly to administer and monitor, than if the asbestos were to remain at its current location. While Alternative 2 is more costly to construct than the other Alternatives it is fully protective of public health and the environment. The Alternative will consist of exposing the bagged asbestos, excavation of the asbestos waste, using dust suppression to limit potential for friable asbestos to affect the workers, solidification/stabilization of the waste to mitigate asbestos release during excavation and transportation, PPE for the construction personnel, and ambient air monitoring to assure mitigation of asbestos release during handling. The SWMU and surrounding area would be re-graded to remove slip/trip fall hazards. The estimated present worth cost of Alternative 2 is approximately $73,000. O&M costs associated with these wastes are provided with the O&M for the Impoundments and SW-CAMU closure.

5.5.6.2 SWMU S-13 – Coal Tar Sludge Landfill (HWMU-1A)

SWMU S-13, also known as the Tar Sludge Surface Impoundment or HWMU 1A, is located north of Smokes Creek in the south-central portion of the SFA Zone 4 Sub-Area. SWMU S-13 occupies approximately one acre and contains a reported 5,600 CY[13] (Ref. 1) of tar decanter sludge, coal tar tank bottoms, and ammonia absorber acid tar wastes that were stabilized/solidified with slag and coal fines prior to disposal under NYSDEC Solid Waste Management Facility Permit Number 2206. There are over 20 feet separating the base of fill

[13] Using the dimensions of SWMU S-13 as reported in the RFI, the calculated volume of waste in SWMU S-13 is approximately 23,000 CY.

and groundwater. The cover system over the waste in SWMU S-13 consists of a 9-foot thick multilayer low-permeability cap that includes a coarse slag sub-base to raise the elevation of the cell to promote positive drainage off the SWMU; 2 feet of low-permeability clay (compacted and tested to have a hydraulic conductivity $<1x10^{-7}$ cm/sec); a 60-mil high density polyethylene (HDPE) geomembrane over the clay; 1.5 feet of barrier protection soil; and 6 inches of topsoil with vegetated cover. The cover system is maintained and in good condition.

Unit closure was completed in October 1988 by BSC under a Consent Order Agreement with USEPA and NYSDEC. The closure of this SWMU was approved by NYSDEC on January 23, 1989 when its post-closure period began. Per 6NYCRR 363-9.6, post-closure maintenance and monitoring will continue. As presented in the 2018 Annual Groundwater Quality Monitoring Report for HWMUs 1 and 2 submitted March 6, 2019, contaminant concentrations in all nearby groundwater monitoring wells are trending downward and approaching the GWQSs except for benzene in Well MW-1U1 (decreasing trend but above the GWQS), naphthalene in Well MW-1D2 (decreasing trend but above the GWQS) and TRP in all wells (increasing trend).

Alternative 1: No Further Action

The no-further action alternative would entail continuing post-closure care. Warning signage around the perimeter of this landfill would be replaced as warranted.

Alternative 2: Excavate, Transport and Dispose at Off-Site TSDF

This alternative would consist of excavating and transporting the approximately 5,600 CY (to 23,000 CY) of stabilized waste/fill to an off-site TSDF. Non-contaminated slag from the cap and side slopes would be removed to access the contaminated slag in a safe manner and staged alongside the excavation for subsequent use as backfill. The tar-impacted slag would be field screened to determine whether the waste exhibits radiological characteristics requiring special handling and disposal. This alternative includes 2 options for the waste disposal; Option 1 would be off-site disposal as hazardous waste at a commercial TSDF; and Option 2 assumes the waste is TENORM and therefore must be transported out of NYS to a TSDF that is permitted to manage and landfill the TENORM waste. Once the destination is determined for the waste, it would be loaded into trucks (or rail), transported and disposed

as hazardous waste in an off-site TSDF. Upon completion of the removal action, the excavation would be backfilled and/or re-graded with the non-impacted slag to surrounding grade. PPE and personal decontamination procedures would be employed to protect workers and the community air monitoring plan would be implemented to protect the public during excavation and handling of the waste/fill.

Alternative 3: Cover In-Place

A comprehensive engineered low-permeability geocomposite cover system is already in place and in good condition. As such, Alternative 3 was not evaluated further.

Comparison of Corrective Action Alternatives for SWMU S-13

Referring to Table 5-5, Alternatives 1 and 2 are both permanent remedies protective of public health and the environment. Alternative 2 provides a greater degree of environmental protection in that there will be a bottom liner and leachate collection system in the off-site commercial TSDF. Alternative 2 would also result in short-term impacts such as odors; VOC and particulate (dust) releases; and potential short-term releases of soluble waste constituents to groundwater from contact of storm water with waste during excavation and transportation. Alternative 2 also results in short-term CO_2, particulate (i.e. fugitive dust) and greenhouse gas emissions from heavy equipment involved with excavation, transportation, and placement of the waste/fill in the off-site TSDF. Existing localized impacts (i.e., VOCs) to groundwater quality in the immediate vicinity of this SWMU would remain but do not represent significant contaminant concentrations or mass loadings to adjacent surface water and would be expected to naturally attenuate over time with both alternatives. Alternative 1 has a substantially lower cost (approximately $31,000) than Alternative 2 ($13,000,000 to $43,000,000).

Recommended Corrective Measures for SWMU S-13

The recommended corrective measure for SWMU S-13 is *Alternative 1: No Further Action*, with continued monitoring and cap maintenance. The recommended alternative is protective of public health and the environment and is a long-term permanent remedy, as evidenced by the decreasing and/or asymptotic VOC and PAH concentrations in

downgradient monitoring wells. The estimated operating, maintenance and monitoring cost is approximately $31,000 over the course of a nominal 30-year period.

5.5.6.3 SWMU S-14 – General Rubble Landfill N

SWMU S-14 is an elevated slag/fill area located adjacent to the Iron City Slag Reclamation Sub-Area and contains massive quantities (at least 57,000 CY above the base of the unit) of fine to coarse-grained slag with reclaimable steel slag, construction debris (i.e., bricks, concrete, plastic pipe), wood, glass and scrap metal. The elevation at the top of the SWMU is approximately 655 feet and the base of the SWMU is approximately 610 to 620 feet. The slopes around the SWMU are generally between 1H:1V to 2H:1V except in the northwest portion of the SWMU where the slope is more gradual (6H:1V). Within the SWMU footprint, the estimated volume of waste/fill ranges between 16,000 CY of PAH-impacted slag/fill (above 500 mg/kg PAHs) to 57,000 CY of slag/fill in the pile above elevation 610 feet (i.e., nominal base of the pile).

Based on groundwater elevations measured in the nearest monitoring wells (el. ~570 feet), groundwater is approximately 40 to 50 feet below the base of the SWMU fill mound. As noted in Section 4.3.3.3 and based on test pit investigations conducted as part of this CMS, an estimated minimum of 16,000 CY of subsurface slag with total PAHs above 500 mg/kg has been delineated in a location near the center of the SWMU as shown on Plate 4-4. Both visual and olfactory evidence of impact was noted in the slag/fill within the PAH-impacted interval (see Plate 4-4). Although Protection of Groundwater SCOs were exceeded for BTX and PAHs in the impacted slag/fill samples, slag/fill samples collected below the impacted interval in two locations showed no impact. Table 4-47 indicates that similar constituents were observed in groundwater samples from nearby wells WT8-01 and WT8-02. Groundwater corrective measures beyond source controls are not warranted for this SWMU.

Alternative 1: No Further Action

No further action would entail leaving the slag and waste/fill undisturbed in-place and with no further remedial action.

Alternative 2: Excavate and Consolidate PAH-Impacted Waste/Fill in SW-CAMU

This alternative includes mechanical excavation of approximately 16,000 CY of PAH-impacted waste/fill for consolidation into the SW-CAMU as a scheduled corrective measure. The approximately 41,000 CY of unimpacted slag estimated to be present in the SWMU would be reclaimed and recycled in accordance with a NYSDEC-approved soil/fill management plan and Iron City's Beneficial Use Designation (BUD) over a number of years, possibly beyond the proposed 7-year CMS implementation period. Any impacted slag or waste encountered after the SW-CAMU is closed would require off-site transportation and disposal in a commercial TSDF. Any excavation below the surrounding grades would be graded to a maximum slope of 3H:1V for safety.

Alternative 3: Cover In-Place with Part 360 Equivalent Cover (Low-Permeability Geosynthetic Cap)

This alternative includes re-grading the portion of the SWMU in order to install a low-permeability geo-composite cover system equivalent to the cover system recommended for the SW-CAMU. This would include a 6-inch topsoil layer, 12-inch barrier protection layer, geosynthetic drainage layer, 40-mil HDPE liner, and 6-inch bedding layer. The existing condition infiltration rate (170,000 gal per year) would be decreased to approximately 310 gallons per year (a reduction of 99.82%, as shown on Table 5-12). Thus, the water-soluble contaminant loadings to the groundwater from waste/fill materials from this SWMU would be expected to be reduced be over 99% and the COC loading to Lake Erie that were derived from this area would also be reduced by 99.82%.

Alternative 4A: Excavation and Off-Site Disposal

This alternative includes excavation of the SWMU S-14 mound (57,000 CY) containing scrap steel, slag, and fill, loading and transporting the waste off-site for disposal at a NYS commercial TSDF (Option 1). Option 2 for this alternative is the same as Option 1, but assumes the waste is TENORM and therefore must be transported out of NYS to a TSDF that is permitted to accept the TENORM waste.

Alternative 4B: Slag/Scrap Steel Reclamation, Excavation and Off-Site Disposal

This alternative includes slag and steel reclamation for approximately 41,000 CY of unimpacted slag/fill, excavation, loading, transporting and off-site disposal of approximately 16,000 CY of PAH-impacted slag/fill. This alternative includes 2 options for the waste

disposal; Option 1 would be off-site disposal as non-hazardous waste at a NYS commercial TSDF; and Option 2 assumes the waste is TENORM and therefore must be transported out of NYS to a TSDF that is permitted to manage and landfill the TENORM waste.

Comparison of Corrective Action Alternatives for SWMU S-14

Referring to Table 5-5, Alternative 1 is not protective of public health and the environment. Although primarily in the subsurface where direct contact is not a complete exposure pathway, the CP-51 total PAH concentration of 500 mg/kg is exceeded at five sample locations between 0 and 16 fbgs. Alternatives 2, 3, 4A and 4B are permanent remedies and are protective of public health and the environment. Alternatives 2, 4A and 4B will permanently remove the wastes from this SWMU, and Alternative 3, reduces the amount of rainfall infiltration through the waste/fill by over 99%. The reduction in groundwater loadings of the mobile SVOCs contained in SWMU S-14 waste/fill, particularly naphthalene, would be projected to be proportionate to the reduction in infiltration and associated impacts to groundwater. Alternatives 2, 3, 4A and 4B would all eliminate direct exposure risks and stormwater erosion migration. Alternatives 2, 3, 4A and 4B would result in short-term impacts due to releases and exposures to construction workers during excavation and residual handling and transport; however, these impacts would be mitigated by using standard PPE and safe work practices. Alternatives 2, 4A and 4B also offers the environmental benefit of reclaiming a greater amount of steel scrap and slag as compared to the other alternatives and includes placement of the impacted SWMU wastes in the SW-CAMU or off-site TSDF, which will have a liner and leachate collection system thereby virtually eliminating any further impacts to groundwater. Such additional steel and slag reclamation would reduce the mining and use of iron ore and limestone stone materials that the reclaimed slag would replace as well as reduce greenhouse gas emissions from iron ore and gravel mining and steel manufacturing (as supplanted by steel scrap reclaimed and recycled). The cost of implementing Alternatives 2, 3, 4A and 4B are much greater than the no further action alternative. The cost for Alternative 2 ($365,000) is similar to Alternative 3 ($260,000) but much less than Alternatives 4A (range of costs between $7,700,000 and $50,000,000) and Alternative 4B ($2,800,000 and $15,000,000).

Recommended Corrective Measures for SWMU S-14

The preferred corrective measure for this Unit is *Alternative 2: Excavate and Consolidate PAH-Impacted Waste/Fill in SW-CAMU*. The estimated cost to implement this alternative is $365,000. This alternative is a permanent remedy that is protective of public health and the environment as the PAH-impacted fill will be relocated on-site to the SW-CAMU where the waste will be sandwiched between the low-permeability cap and liner and have leachate collection. The potential loading of COCs to groundwater and surface water (Lake Erie) in Groundwater DSA 4A from the PAH-impacted waste/fill in SWMU S-14 will be eliminated by this corrective measure.

SWMU S-14 is adjacent to the Iron City slag reclamation area and therefore reclamation of residual slag/fill materials is appropriate for consideration. Any solid waste encountered during slag reclamation would be placed in the SW-CAMU during its proposed several year operation period. If slag reclamation occurs after the SW-CAMU has been closed, solid waste encountered during reclamation operations would be handled in accordance with the Soil/Fill Management Plan (see Appendix D) and disposed off-site in a commercial TSDF.

5.5.6.4 SWMU S-15 – General Rubble Landfill O

SWMU S-15 is a small pile (approximately 150 feet by 60 feet) of randomly deposited materials comprised of approximately 1,000 CY of shallow and randomly deposited scrap metal, brick rubble, scrap billets, steel and iron buttons, and tires intermingled with slag/fill. The base overlies approximately 50 feet of slag/fill, and groundwater is approximately 25 fbgs at the base of the pile. Analytical testing of slag/fill samples from this SWMU during the RFI did not show any exceedances of the Part 375 ISCOs (only benzo(a)anthracene was detected in one surface sample at a concentration slightly above the Protection of Groundwater SCO) nor did the material exhibit hazardous waste characteristics. Therefore, this SWMU represents potential "nuisance" conditions as opposed to an environmental concern.

Alternative 1: No Further Action

This alternative would leave the debris in place without corrective measures to remove the nuisance conditions.

Alternative 2: Remove Debris for Salvage with Unsalvageable C&D Debris to SFA Zone 2 Impoundments

This alternative would consist of salvaging scrap metal materials, excavating, and consolidating the C&D debris into one or more of the SFA Zone 2 impoundments prior to placement of the final cover system; and off-site recycling of waste tires. The steel slag/fill could be reclaimed and reused commercially under the existing BUD for structural fill or replacement aggregate in road or parking lot construction. Once completed, this SWMU area would be available for slag reclamation or redevelopment.

Alternative 3:Remove Debris for Salvage with Unsalvageable C&D Debris to TSDF

This alternative is essentially the same as Alternative 2 with Off-site disposal of C&D debris.

Alternative 4: Cover In-Place

This alternative would consist of salvaging scrap metal and waste tires. The remaining residuals consisting of concrete and miscellaneous debris would be graded and covered beneath a 1-foot BUD-approved slag cap.

Comparison of Corrective Action Alternatives for SWMU S-15

Referring to Table 5-5, Alternative 1 is not protective of public health and the environment as the nuisance condition remains. Alternatives 2 3 and 4 are equally protective of public health and the environment due to the nature of these fill materials. Alternatives 2, 3 and 4 eliminate the nuisance conditions associated with tires and other solid waste debris consistent with SCGs as well as any potential contribution to groundwater contamination. The cost for salvaging and relocating the solid waste materials to the SFA Zone 2 impoundments under the final cover system with off-site disposal or recycling of the waste tires (Alternative 2) is more cost-effective than Alternatives 3 or 4.

Recommended Corrective Measures for S-15

The recommended corrective measure for SWMU S-15 is *Alternative 2: Remove Debris for Salvage with Unsalvageable C&D Debris to SFA Zone 2 Impoundments*. Scrap metal would be salvaged and recycled. Debris would be consolidated into one or more of the SFA Zone 2

impoundments prior to closure. Tires would be transported off-site to a recycling facility; thereby removing the nuisance condition. The steel slag in this area could be reclaimed and reused commercially under the existing BUD for structural fill or replacement aggregate in road and or parking lot construction. The cost to implement this recommended corrective measure is estimated at $26,000 (exclusive of SFA Zone 2 impoundment cover system construction and OM&M costs accounted for separately). This area would then be available for slag reclamation or redevelopment.

5.5.6.5 SWMUs S-16 & S-23 (AOC-D) – HWMU 1B and Adjacent Tar Pit

Due to their proximity, SWMUs S-16 (HWMU 1B) and S-23 have been combined in the context of this CMS as a SWMU Group. SWMU S-16 covers approximately 0.25 acres and is surrounded on three sides by SWMU-23. SWMU S-16 contains an estimated 6,000 CY of spent pickle liquor (SPL)-impacted slag. SWMU S-16 was covered with a polyvinyl chloride liner in the 1980s, which was destroyed by wind in 2005. Results of RFI testing on samples obtained from the SWMU S-16 waste slag/fill material did not indicate any exceedances of the ISCOs nor did they exhibit hazardous waste characteristics per the Extraction Procedure (EP) Toxicity Test Method.

As presented in the 2018 Annual Groundwater Quality Monitoring Report for HWMUs 1 and 2 submitted March 6, 2019, contaminant concentrations in all adjacent groundwater monitoring wells are trending downward and approaching the GWQSs except for Well MW-1D1 (increasing trends for benzene, ethylbenzene, toluene, total xylene, TCE, naphthalene). TCE concentration have been below the GWQS in Well MW-1D7 since 2012 with the following trends observed for each daughter product: cis-1,2-DCE is decreasing, trans-1,2-DCE fluctuates but the trend remains neutral, and vinyl chloride has increased slightly. The identified trend at well MW-1D1 appears to begin in late 2005 coincident with the destruction of the "temporary" 30-mil reinforced polyvinyl chloride (PVC) cover (installed in June 1986) by a severe windstorm. Due to the lack of a surface moisture barrier and the proximity of this well to the Unit, infiltrating precipitation through the contained waste/fill to downgradient well MW-1D1 is the suspected cause for this trend.

SWMU-23 is an irregular shaped fill area covering approximately 0.85 acres with waste deposited to depths between 1 and 17 fbgs, with an average thickness of approximately 6 feet. The estimated volume of tar waste deposited in this SWMU is

approximately 9,500 CY inclusive of Area of Concern "D" (AOC-D). The waste/fill is covered with slag of varying thickness. TCLP test results completed in 2007 indicated that the tar waste does not exhibit hazardous waste characteristics; however, two tar samples collected from SWMU S-23 during the RFI did exhibit hazardous waste characteristic for benzene. Slag samples beneath and adjacent to the tar waste in SWMU S-23 did not contain significant concentrations of VOCs (e.g., benzene) as discussed in Section 4.3.3.5; however, benzene, toluene, xylene, and PAHs were detected at concentrations above Protection of Groundwater SCOs. Subsurface waste/fill and, to a lesser extent, surface waste/fill contained concentrations of PAHs above ISCOs; the CP-51 total PAH concentration of 500 mg/kg was also exceeded. The waste/fill in SWMU S-23 was characterized as sludge/tar-like waste with olfactory evidence of impact.

For SWMU S-23 RFI and CMS sampling, the Part 375 Protection of Groundwater SCOs were exceeded for several VOCs (benzene, toluene, and xylene), PAHs, phenol, and mercury. One surface composite sample collected from SWMU S-16 exceeded the Protection of Groundwater SCO for cyanide. As indicated in Table 4-479, the constituents detected in downgradient monitoring wells above GWQS and in waste/fill above Protection of Groundwater SCOS are VOCs (i.e., benzene, toluene, xylene) and PAHs (i.e., anthracene, chrysene, and naphthalene).

Alternative 1: No Further Action

No further action would entail leaving the waste/fill in place.

Alternative 2: Excavate, Transport and Dispose Tar-Impacted Waste/Fill Off-Site

Alternative 2 would include excavation of approximately 6,000 CY of fill from SWMU S-16 that does not appear to exhibit hazardous waste characteristics. The depth of excavation for SWMU S-16 would be on the order of 40 fbgs, which should be technically feasible but is expected to be very slow and difficult. A large degree of over-excavation is anticipated in order to ensure a safe work environment and would likely result in some limited waste/fill in narrow "stringers" at depth along sidewalls of the excavation. Attempting to excavate these stringers could significantly increase the volume and cost. This alternative includes 2 options for the waste disposal; Option 1 would be off-site disposal as hazardous waste at a commercial TSDF; and Option 2 assumes the waste is TENORM and

therefore must be transported out of State to a TSDF that is permitted to manage and landfill the TENORM waste.

Under this alternative, the hazardous waste/fill from SWMU S-23, which would require simultaneous excavation of co-located SWMU S-16, would likely result in some comingling of the wastes. This alternative includes two options for the waste disposal as described above for the S-16 waste. The approximately 9,500 CY of waste/fill from SWMU S-23 (inclusive of AOC-D) would also be transported to an off-site TSDF for treatment and subsequent landfilling. Upon completion of the removal action, both excavated SWMUs would be re-graded to a maximum slope of 3H:1V. The removal of these two SWMUs and the AOC-D would effectively eliminate related tar waste contaminant loadings to groundwater and surface water in the vicinity of these SWMUs.

Alternative 3: Contain In Place Under Geo-composite Cover System

As the waste is greater than 10 feet above the water table, grading and capping of the waste with a geo-composite cover system (similar to that of the impoundments) would significantly mitigate potential leaching of deposited tar constituents to the groundwater. The existing condition for SWMU S-16, SWMU S-23, and AOC-D (i.e., no cover) has an estimated infiltration rate of 480,000 gallons per year (refer to Table 5-13). Placement of a geosynthetic cover over the waste would be expected to reduce the infiltration to approximately 860 gallons per year which in turn is expected to reduce loadings of COCs to groundwater and surface water from SWMUs S-16 and S-23 waste/fill by over 99%. This alternative includes grading the waste/fill and surrounding slag/fill to provide positive surface drainage from the low- permeability cover system. The non-hazardous tar waste from AOC-D would be excavated and consolidated in the SWMU S-23 footprint proximate to SWMU S-16 to provide a more confined area for the RCRA cover system and to provide materials to improve the grades so that positive drainage will be provided. The excavation of AOC-D will include backfilling the excavation to the surrounding grade with processed BUD-approved slag or another non-impacted on-site slag/fill. The geo-composite cover system would include the following elements from bottom to top: 6-inch geotextile cushion, 40-mil HDPE geomembrane, geosynthetic drainage layer, 12-inch barrier protection soil layer, and 6-inch topsoil layer. The topsoil would be seeded, fertilized, and mulched to promote vegetative growth. Maintenance of the final cover system is included for the 30-year

post-closure care period. Groundwater monitoring would be conducted on a CMS Area-wide basis in accordance with NYSDEC-approved LTGWM Plan. Warning signage around the perimeter of the landfill would be replaced as warranted.

Comparison of Corrective Action Alternatives for SWMUs S-16, S-23 and AOC-D

Referring to Table 5-5, Alternative 1 is not protective of public health or the environment due to the significantly damaged condition of the existing cover system and the presence of potentially hazardous waste/fill at or near the surface of the Unit that appear to be migrating to groundwater. Alternatives 2 and 3 are equally protective of public health and the environment and considered permanent and compliant with SCGs and would reduce contaminant loading to the groundwater and surface water by over 99%. Alternative 2 offers additional long-term protections as compared to Alternative 3 in that the wastes are relocated to an off-site TSDF which would include leachate collection, and low-permeability bottom liners. Alternative 2 results in: greater short-term impacts associated with potential constituent releases during excavation and handling; greater greenhouse gas emissions; and significantly higher costs ($9,000,000 to $35,000,000) as compared to Alternative 3 ($501,000).

Recommended SWMUs S-16, S-23 and AOC-D Corrective Measures e

The recommended alternative for SWMUs S-16 & S-23 is *Alternative 3: Construct Geocomposite Cover System* and includes relocating the non-hazardous tar waste/fill from AOC-D and consolidating it into the SWMU Group prior to construction of the proposed cover system. The elevation of this area would be raised by placement of AOC-D and possibly other slag/fill to provide maximum 4H:1V side slopes with a minimum 4% slope across the top. The base of the waste/fill is approximately 25 feet above the water table. Grading and capping of the waste with a low-permeability geosynthetic and vegetated soil cover system will reduce the percolation of precipitation through the waste from an estimated 480,000 gallons per year to approximately 860 gallons per year, which in turn will reduce the loading of COCs from the SWMU area to the groundwater and surface water (Lake Erie) by over 99%. Localized impacts to groundwater quality will be monitored in accordance with the LTGWM Plan (see Appendix T) and are expected improve and naturally attenuate following

closure. The geosynthetic cover system is similar to that proposed for the ATP cover system and would include the following elements from bottom to top:

- 6-inch geotextile cushion layer
- Geosynthetic clay liner (GCL)
- 40-mil linear low density polyethylene (LLDPE) geomembrane barrier layer
- Geocomposite drainage layer around the lower 25 feet of the cover perimeter
- -inch barrier protection soil layer
- 6-inch topsoil layer, seeded, fertilized, and mulched to promote vegetative growth

Routine inspection and maintenance of the vegetated final cover system are included for the 30-year post-closure care period. Institutional controls beyond the engineering controls would also be required.

The estimated present worth cost of Alternative 3 is approximately $501,000 including a projected $470,000 for capital expenditures and $31,000 for the present worth of 30 years of cover system maintenance. Groundwater monitoring costs are included with CMS Area-Wide groundwater costs under the LTGWM Plan.

5.5.6.6 SWMU S-17 – Vacuum Carbonate Blowdown Landfill Q

SWMU S-17 consists of two parallel, shallow trenches excavated in the underlying slag/fill. As discussed in Section 4.2.3.6, the non-hazardous waste disposed in the trenches was a spent carbonate waste liquid that commonly contained thiocyanate, cyanide, and selenium. The only waste/fill constituents detected above ISCOs were benzo(a)pyrene in two waste/fill samples from 0-3 fbgs and mercury in 1 out of 4 waste/fill samples at a subsurface depth of 6-7 feet. The presence of mercury, which was not a known constituent of the process waste stream, represents a localized de minimis condition likely the result of a broken manometer; mercury was not detected in the nearest downgradient well (MWN-12). The benzo(a)pyrene concentrations were only slightly above the ISCO and an order of magnitude lower than the Protection of Groundwater SCO. Four additional PAHs and cadmium were detected slightly above Protection of Groundwater SCOs but only benzo(a)anthracene was detected at an estimated concentration above GWQS in downgradient well MWN-12.

Alternative 1: No Further Action

No further action would entail leaving the SWMU as-is with no additional remedial actions.

Alternative 2: Placement of Supplemental Slag Cover

This alternative includes grading the area and adding a minimum of 12 inches of additional BUD-approved slag cover to the trenches to reduce the potential for direct exposure. The cover system would be maintained for as long as the waste remains on-site.

Alternative 3: Excavate and Dispose Off-Site at TSDF

This alternative includes mechanical excavation of mercury-impacted slag/fill, and includes 2 options for the waste disposal; Option 1 would be off-site disposal as non-hazardous waste at a NYS commercial TSDF; and Option 2 assumes the waste is TENORM and therefore must be transported out of NYS to a TSDF that is permitted to manage and landfill the TENORM waste. The volume of mercury-impacted slag/fill is not known; however, for costing purposes, 1,000 tons was assumed. Once the mercury-impacted slag/fill is removed and the post-excavation sampling confirms the removal is complete, the area would then be graded. The elevation of this area is nominally 610 feet. The area resides in the Iron City slag recovery zone and would be made available for slag reclamation and/or redevelopment.

Comparison of Corrective Action Alternatives for S-17

Referring to Table 5-5, Alternatives 1, 2, and 3 are equally protective of public health and the environment; however, Alternatives 2 and 3 significantly reduces direct exposure potential as well as the physical hazards associated with the trenches. Alternative 3 is advantageous as the area surrounding this SWMU could potentially be used for heavy industrial redevelopment and/or made available for slag reclamation. The estimated cost to implement Alternative 3 ranges from $82,000 to $1,200,000 and is more expensive than Alternative 2 ($47,000).

Recommended Corrective Measures for SWMU S-17

The preferred alternative for this SWMU is *Alternative 3: Excavate and Dispose Off-Site,* which would entail excavation of the mercury-impacted slag/fill, stabilizing/solidifying it (if necessary), assessing the radiological characteristics of the slag/fill and transporting the slag/fill off-site to a TSDF. Confirmatory sampling will be done on the bottom and sides of the excavation to assure the residual slag/fill mercury levels meet the ISCOs. The excavation will be filled using the surrounding slag/fill, and the area will be graded to a maximum slope of 3H:1V slopes to remove slip/trip/fall hazards. The estimated cost to implement this alternative is $82,000 to $1,200,000 depending upon TENORM considerations.

5.5.6.7 SWMU S-18 (AOCs A to C) – Lime Dust and Kish Landfill R

SWMU S-18 is an irregularly shaped area located in the northwest portion of SFA Zone 4 Sub-Area. As described in Section 4.3.3.9, approximately 480 CY of TCLP lead hazardous waste (D008) from AOC-B (160 CY) and AOC-C (320 CY) were treated with cement to solidify the leachable lead, loaded, transported and placed in the ATP Containment cell in October 2015. Residual wastes remaining in SWMU S-18 consists of 1,800 CY of slag/fill containing lead at concentrations exceeding the ISCO in AOC-A and 2,400 CY of fill/soil solid waste containing lime in AOC-A and SWMU S-18. Protection of Groundwater SCOs were exceeded for: benzo(a)anthracene, chrysene, lead, and selenium in subsurface waste/fill samples S18-B01 (2-4 fbgs) and S18-B02 (2-3 fbgs); and cadmium, lead, nickel, and selenium in surface waste/fill sample S18-KISH.

Alternative 1: No Further Action

No further action would entail leaving the waste in-place with no remedial action on the waste/fill in this SWMU.

Alternative 2: Excavate and Consolidate Lead-Impacted Waste and Lime Waste in SW-CAMU

The remainder of the untreated waste/fill in SWMU S-18 (estimated 4,200 CY) that does not exhibit hazardous waste characteristics (TCLP lead <5 mg/L), but contains total lead in excess of the ISCO, as well as lime waste, would be excavated and transported to the SW-CAMU for placement within the cell (i.e., sandwiched between the low-permeability cap and liner with leachate collection). Perimeter and bottom samples will be collected from the

area to assure that all remaining subsurface slag/fill materials contain lead at concentrations less than the ISCO.

This SWMU is adjacent to the Iron City slag reclamation area. The ground surface elevation after removal of the waste will be approximately 610 feet. Slag reclamation is permitted to proceed to 585 feet. Thus, after the waste has been removed, this Sub-Area may be subject to slag reclamation and/or redevelopment. Post-excavation backfilling of the area will not be necessary. Grading will be completed using existing materials to reduce the slopes to less than 3H:1V to remove physical safety hazards, and to reduce erosion potential.

Alternative 3: Excavate Lead–Impacted Waste/Fill and Lime Waste and Dispose Off-Site

This alternative includes mechanical excavation of lead-impacted slag/fill and lime waste. There are 2 options for the waste disposal; Option 1 would be off-site disposal as non-hazardous waste at a NYS commercial TSDF; and Option 2 assumes the waste is non-hazardous TENORM and therefore must be transported out of NYS to a TSDF that is permitted to manage and landfill the TENORM waste. Once the wastes are removed, the area will be graded to eliminate slip/trip/fall hazards. The elevation of this area is nominally 610 feet. The area resides in the Iron City slag recovery zone and would be made available for slag reclamation and/or redevelopment.

Alternative 4: Low-permeability Cover System

Provide a low-permeability geocomposite cover system consisting of 30 mil geocomposite clay liner (GCL), non-woven geotextile layer for cushion to protect GCL and 1 foot of slag over the entire SWMU S-18 inclusive of AOC-A footprint with no slag reclamation or redevelopment in and around the Unit. Prepare subgrade using existing slag/fill materials to create positive drainage from cover system.

Comparison of Corrective Action Alternatives for SWMU S-18 (AOCs A to C)

Referring to Table 5-5, Alternative 1 is not protective of public health or the environment as soil/fill within this area has elevated lead concentrations exceeding the ISCO. Alternatives 2 3, and 4 are is fully protective of public health and the environment. Alternatives 2 and 3 provide the highest degree of environmental protection as the slag/fill will be encapsulated in the SW-CAMU or TSDF between the low-permeability cap and liner

with leachate collection In general, Alternatives 2, 3 and 4 are equally implementable and permanent but Alternative 4 requires long-term maintenance. Alternative 4 eliminates, or at least complicates, the potential to reclaim and recycle some of the adjacent steel and slag, which eliminates the associated environmental benefit of reducing the: use of a readily available but nevertheless irreplaceable limestone and iron ore resources and amount of energy used and greenhouse gases emitted from the mining and processing of those natural resources. Furthermore, Alternative 2 is the most cost-effective ($117,000), Alternative 4 is $601,000 and Alternative 3 is the most costly alternative at $646,000 to $3,700,000).

Recommended Corrective Measures for SWMU S-18 (AOCs A to C)

The recommended alternative for this SWMU is *Alternative 2: Excavate and Consolidate Lead-Impacted and Lime Waste in SW-CAMU*. Once the SW-CAMU is constructed and ready to receive waste, the non-hazardous waste/fill containing lead in excess of the ISCO (est. 1,800 CY) and the lime piles (est. 2,400 CY) would be excavated from the Unit and concurrently consolidated into the SW-CAMU Removing the lead- and lime-impacted waste/fill from SWMU S-18 and placing it in a low-permeability lined cell with leachate collection and low-permeability cap will eliminate any potential loadings to groundwater and surface water (Lake Erie) from this SWMU.

The capital cost associated with Alternative 2 is estimated at $117,000. The fractional OM&M costs related to the managing the waste in the SW-CAMU is accounted for under that remedial alternative.

SWMU S-18 is adjacent to the Iron City slag reclamation area and therefore reuse of the massive quantities of steel slag/fill material deposited in, under, and adjacent to this SWMU is deemed appropriate, would help conserve natural stone resources, and displace iron ore mining and greenhouse gas emissions proportional to scrap metal recovered, consistent with NYSDEC Green Initiatives. The slag/fill surface elevation after removal of the waste will be approximately 610 feet, and slag reclamation is permitted to proceed to 585 feet once the area has been remediated. Any waste/fill encountered during subsequent slag reclamation would be handled in accordance with the Soil/Fill Management Plan (see Appendix D) and consolidated into the SW-CAMU during its proposed 7-year operation period; thereafter, the waste would be disposed off-site in a commercial TSDF.

5.5.6.8 SWMU S-28 – Drum Landfill

SWMU S-28 slag/fill characterization did not identify drums or waste residuals in SFA Zone 4 Sub-Area. Samples of the slag/fill identified only one exceedance of the ISCOs; benzo(a)pyrene was detected at a concentration (1.7 mg/kg) slightly above its ISCO (1.1 mg/kg) in one sample collected from 8-8.5 fbgs. There were no exceedances of the Protection of Groundwater SCOs or site-specific SCOs for arsenic and PAHs. As such, the only alternative considered and recommended for this SWMU is no further action. This SWMU lies with the limits of the Iron City slag reclamation area. The ground elevation is approximately 610 feet, leaving approximately 25 feet of slag beneath and adjacent to this SWMU for potential reclamation. The Soil/Fill Management Plan would be followed during slag reclamation. Slope stability for adjacent SWMU S-13 would be taken into consideration during slag reclamation.

5.5.7 Coal, Coke, and Ore Handling & Storage Sub-Area Alternative Corrective Measures

Only two SWMUs in this portion of the CMS Area, S-19 (Murphy's Mountain) and S-25 (Landfill/Impoundment) were identified by USEPA as requiring further assessment in the CMS. Table 5-6 summarizes the evaluation of the following alternatives using the criteria outlined in Section 5.5. A description of each alternative is provided below.

5.5.7.1 SWMU S-19 – Murphy's Mountain

SWMU S-19 contains approximately 51,000 CY of steel-making slag mixed with varying amounts of construction and demolition debris, measuring as much as 15 feet high, 1,300 feet long (north to south), and 350 feet wide (east to west). This unit covers approximately 10 acres and is sparsely vegetated. As indicated in Section 43.1, analytical testing of slag samples from this SWMU identified only one constituent, benzo(a)pyrene, in one surface sample (0-0.5') and one subsurface slag/fill sample (4-14 fbgs) slightly above its ISCO. The Protection of Groundwater SCOs were slightly exceeded for three PAHs, nickel, and selenium.

Alternative 1: No Further Action

No further action entails performing no remedial action on the waste/fill in this SWMU.

Alternative 2: Excavate, Reclaim Slag/Scrap Metal and Relocate Unsuitable Materials to SW-CAMU

Alternative 2 entails excavating the slag/fill using the Soil/Fill Management Plan (SFMP Appendix D) for use as on-site backfill or sold. Any impacted slag/fill that is visibly stained, produces elevated PID readings, and/or exhibits olfactory characteristics will be managed as per the SFMP. Presumably, some of the soil/fill from this SWMU will be relocated to the SW-CAMU (or sent off-site to a TSDF), once it is ready to receive waste deposition. The estimated volume of impacted soil/fill materials in this SWMU ranges up to 10,000 CY that would be relocated to the SW-CAMU.

Alternative 3: Cover In-Place

Alternative 3 entails grading and covering the SWMU with 1 foot of BUD-approved slag.

Alternative 4: Excavate, Transport and Dispose Off-Site

This alternative includes mechanical excavation of the slag/fill mound with two options for the waste disposal; Option 1 would be off-site disposal as non-hazardous waste at a NYS commercial TSDF; and Option 2 assumes the waste is TENORM and therefore must be transported out of NYS to a TSDF that is permitted to manage and landfill the TENORM waste. Once the wastes are removed, the area will be graded to eliminate slip/trip/fall hazards and would be available for redevelopment.

Comparison of Corrective Action Alternatives for SWMU S-19

No further action is an appropriate alternative as only one constituent was detected at a concentration slightly above its ISCOs and there are minimal potential impacts to groundwater from identified constituents in the residuals tested. Alternative 2 is an equally acceptable option by excavating the slag/fill from SWMU S-19 for reclamation and scrap steel recovery in accordance with the Site Management Plan. The cost for Alternative 2 is $310,000 for relocating the unsuitable fill to the SW-CAMU. Alternative 3 ($350,000) is approximately the same in cost as Alternative 2, and Alternative 4 ($7,000,000 to $45,000,000) is more costly than the other three alternatives and does not provide any added benefit.

Recommended Corrective Measures for SWMU S-19

The preferred corrective measure for SWMU S-19 is either *Alternative 1: No Further Action* or *Alternative 2: Excavate, Reclaim Slag/Scrap Metal and Relocate Unsuitable Materials to SW-CAMU* Only one constituent in one surface sample (0-0.5') and one subsurface (4-14 fbgs) slag/fill sample slightly exceeded its ISCO, and there were no exceedances of site-specific SCOs. Compounds that exceeded the protection of groundwater SCOs have not been identified in groundwater, and thus do not present a threat to groundwater. Both alternatives are protective of public health and the environment; long term and permanent remedies; and readily implementable. The benefit of Alternative 2 includes opening-up 10 acres of property for redevelopment. These fill materials would be handled in accordance with the Soil/Fill Management Plan. The costs associated with Alternative 2 is $310,000 for disposal of an estimated 10,000 CY of the fill materials in the SW-CAMU.

5.5.7.2 SWMU S-25 – Landfill Impoundment under North End of Coal Pile

SWMU S-25 is located at the northern end of the coal storage area west of Coke Oven Battery No. 8, comprises an area of approximately 1.4 acres and was reportedly used for storage of scrap metal (Ref. 1). SWMU S-25 fill/soil characterization did not identify any exceedances of the ISCOs or site-specific SCOs. Only cadmium and silver in subsurface slag/fill were detected at concentrations slightly above the Protection of Groundwater SCOs; however, neither of these constituents was detected in the downgradient groundwater.

Alternative 1: No Further Action

No further action entails performing no remedial action on the waste/fill in this SWMU.

Alternative 2: Excavate, Transport and Dispose Off-Site

There are no materials in this SWMU that need to be remediated. As such, this alternative is not considered further.

Comparison of Corrective Action Alternatives for SWMU S-25

No further action is the recommended alternative for this SWMU. There is no cost associated with Alternative 1.

Recommended Corrective Measures for SWMU S-25

The recommended corrective measure for SWMU S-25 is *Alternative 1: No Further Action*. Samples of slag/fill from this SWMU did not contain any suspect fill materials, exceedances of the ISCOs, or site-specific SCOs. Only cadmium and silver in the subsurface were detected at concentrations above the Protection of Groundwater SCOs; however, neither of these constituents was detected in the downgradient groundwater. There is no cost associated with the no further action alternative. This area may be redeveloped in accordance with City zoning requirements.

5.5.8 Tank Farm SWMU Group Sub-Area Alternative Corrective Measures

The Tank Farm SWMU Group Sub-Area consists of SWMUs P-8 (Waste Oil Storage Tanks), P-74 (Solid Fuel Mix Storage Piles A, B, C, and D), and P-75 (Tank Storage Area for No. 6 Fuel Oil and Petroleum Tar). The former waste oil storage tanks (P-8) and waste piles (P-74) were removed by BSC or more recently by Tecumseh as ICMs. This SWMU Group occupies a total of approximately 18.6 acres and contains petroleum residuals (primarily No. 6 fuel oil) in slag/fill. The slag deposited throughout the SWMU Group appears to have been placed in molten form based on the massive nature of the slag layers and the degree of difficulty of excavation. PAHs are the primary compounds that exceed ISCOs and the CP-51 total PAH concentration of 500 mg/kg in surface and subsurface slag/fill in all three SWMUs. Mercury concentrations exceeded the ISCOs in 5 of the 28 slag/fill samples tested (one subsurface and four surface samples). Benzene did not exceed its ISCO in any slag/fill samples, although several locations exceeded the Protection of Groundwater SCO. One slag/fill sample from the RFI (P75-B01; 4-6') exhibited hazardous waste characteristics for benzene (TCLP of 0.69 mg/L); however, two CMS slag/fill samples (i.e., P75-TP-53; 1-4 fbgs and 4-6 fbgs) from the same Sub-Area and depth were tested and did not exhibit hazardous waste characteristics for benzene.

Based on observations made during the exploratory work, the PAH exceedances occur in areas where NAPL (free-product) or "heavily" stained slag/fill was observed. The slag/fill contains "bedding" planes or fractures between successive deposits of slag that do not appear to be well connected, similarly to massive bedrock with secondary porosity (e.g., fractures). NAPL (liquid petroleum product) pockets reside within these fractures and when

the pockets were exposed during test pit explorations, small amounts of contained NAPL were observed to seep on the sidewall of the excavation in a few locations. The total quantity of "grossly impacted" slag/fill above the water table is estimated at approximately 22,000 to 55,000CY, residing at varying intervals from ground surface to a depth of approximately 16 fbgs. Approximately 4 acres are grossly impacted compared to the entire 18.6-acre SWMU.

Groundwater quality in the vicinity of this SWMU Group is impacted by VOCs (benzene, toluene, and xylenes) and one SVOC (naphthalene). Groundwater remedial alternatives are presented in the Area-Wide Groundwater Alternative Corrective Measures Section 5.5.11. Table 5-6 summarizes the evaluation of the slag/fill alternatives using the criteria outlined in Section 5.5.

Slag/Fill Corrective Measure Alternatives

A description of each alternative related to managing the contaminated slag is provided below.

Slag/Fill Alternative 1: No Further Action

No further action would entail leaving the waste in-place with no remedial action to be performed on the slag residuals in this SWMU.

Slag/Fill Alternative 2: Excavate Petroleum Impacted Slag/Fill and Consolidate in SW-CAMU, Excavate Mercury-Impacted Slag/Fill and Dispose Off-Site

This alternative includes excavation of petroleum-impacted slag/fill that is visually stained and/or contains NAPL from the unsaturated zone (depth of impact varies between 0 and 16 fbgs) as well as slag/fill with total PAH concentrations greater than 500 mg/kg. It is estimated that 22,000 to 55,000 CY of impacted slag exist throughout the SWMU over an approximate 4-acre area. Approximately 1,170 CY of mercury-impacted slag/fill would be excavated and disposed off-site; 4 of the 5 sub-areas impacted by mercury are co-located with PAH-impacted slag/fill. Excavation of the slag/fill while technically feasible will be extremely difficult due to the massive and cemented nature of the slag. Based on recent experience during the ATP-ECM excavation effort, concrete busters or explosives would likely be required to remove the cemented slag and an estimated 12 months would be required to excavate the slag from the SWMU, transport it and consolidate it into the SW-

CAMU. Excavated slag that contains free-NAPL product would be stabilized with high carbon content fly ash or another stabilizing agent (e.g., Portland cement, lime kiln dust, mill scale). The petroleum-impacted slag waste would be consolidated into the SW-CAMU where the groundwater would not be impacted by the waste as it would be stabilized and encapsulated (geo-composite soil liner, leachate collection system and low-permeability geo-composite cap). The excavation in the Tank Farm would be regraded and partially backfilled with BUD-approved slag or other non-impacted on-site slag/fill (i.e., meeting ISCOs and site-specific SCOs), assume 10,000 CY of import required. Accounting for contingency and excavation inefficiencies, the volume for ex-situ treatment and disposal of petroleum- and PAH-impacted slag/fill is estimated to range between 25,000 and 70,000 CY. Accounting for contingency and excavation inefficiencies, the volume for off-site disposal of mercury-impacted slag/fill is estimated at 1,800 CY.

Slag/Fill Alternative 3: Excavate Petroleum-Impacted and Mercury-Impacted Slag/Fill and Dispose Off-Site

Alternative 3 is similar to Alternative 2 except that the petroleum impacted slag/fill would be transported off site for disposal. There are two options for disposal; Option 1 would be off-site disposal as non-hazardous waste at a NYS commercial TSDF; and Option 2 assumes the waste is TENORM and therefore must be transported out of NYS to a TSDF that is permitted to manage and landfill the TENORM waste. Once the wastes are removed, excavations would be backfilled with slag meeting ISCOs or other select fill and this area would be available for redevelopment.

Comparison of Slag/Fill Corrective Action Alternatives for Tank Farm SWMU Group

Performing no further action (Alternative 1) on the slag/fill is not protective of public health or the environment. Alternatives 2 and 3 are protective of public health as direct contact with the petroleum-impacted slag/fill would be eliminated, and the waste would be relocated either on-site or off-site into a containment cell with low-permeability liner and cap with leachate collection. Alternative 2 is much more cost effective ($5,100,000 to $6,400,000) than Alternative 3 ($13,000,000 to $66,000,000).

Recommended Slag/Fill Corrective Measures for the Tank Farm SWMU Group

The preferred corrective measures for this SWMU Group is *Slag/Fill Alternative 2: Excavate Petroleum Impacted Slag/Fill and Consolidate in SW-CAMU, Excavate Mercury-Impacted Slag/Fill and Dispose Off-Site*. These corrective measures include excavation of an estimated 25,000 to 70,000 CY of slag/fill from depths ranging from ground surface to the water table (16 fbgs). The extent of excavation will be determined based on the extent of slag/fill in the vadose zone that is visibly impacted with petroleum or tar. The impacted slag/fill would be stabilized with an amendment, such as Portland cement. Once the slag/fill is stabilized, the treated residuals would be loaded, and transported for relocation into the SW-CAMU where the wastes will be encapsulated (sandwiched between low-permeability geo-composite liner and cap with interior leachate collection). The mercury-impacted slag/fill (1,800 CY) would be excavated, treated (if necessary), loaded into dump trucks or rail for transportation to a TSDF. Bottom and sidewall samples will be taken from the mercury excavations to assure that residual mercury concentrations meet the ISCOs. A bench-and/or pilot-scale treatability study would be completed on the petroleum-impacted slag/fill to determine an appropriate stabilization agent (e.g., flay ash, cement) and mix proportions to render any free product relatively immobile prior to disposition into the SW/CAMU. Following excavation, these areas of the Tank Farm Sub-Area would be regraded to eliminate major depressions and physical hazards. The present worth capital cost for the preferred alternative ranges between $5,100,000 and $6,400,000. O&M costs associated with these wastes are provided with the O&M for the SW-CAMU closure. Groundwater corrective measures in the vicinity of the Tank Farm is discussed under Section 5.5.11.

5.5.9 Former Coke Plant & By-Products Facility Sub-Area Alternative Corrective Measures

5.5.9.1 SWMU Group P-1 to P-6

This SWMU Group consists of six pits, five of which (P-1 to P-5) were used for coke quenching and one (P-6) was used for lime sludge settling. All six pits are open topped concrete underground storage containers containing water. Pits P-1 and P-5 contained recoverable quantities of residuals (sediment). As discussed in Section 4.6.1, chemical

concentration in the residual samples from SWMUs P-1 and P-5 all meet the site-specific SCOs.

Table 4-13 summarizes the pit dimensions and estimated volume of water and sediment in each SWMU. The walls of Pits P-1 to P-6 extend 2 to 3 feet above ground surface.

Alternative 1: No Further Action

No further action would entail leaving the water and residuals in-place with no remedial action.

Alternative 2: Clean-Out Pits and Consolidate in SW-CAMU

This alternative includes pumping and pre-treating the approximate 220,000 gallons of water from Pits P-1 to P-6. Pre-treatment would be performed, if required, prior to conveying the water to the sanitary sewer with ECSD No. 6 approval. Once the water is treated and discharged, residuals present in the pits (estimated at 195 CY) would be removed from all six pits for solidification/consolidation in the SW-CAMU. After removal of the water and residuals, the pits would be backfilled with BUD-approved slag or other non-impacted on-site slag/fill (i.e., meeting ISCOs and site-specific SCOs).

Alternative 3: Backfill Quench Pits

This alternative includes pumping and pre-treating the water, if required, as described for Alternative 2. The pits would be backfilled with BUD-approved slag.

Alternative 4: Excavate and Dispose Off-Site

Alternative 4 is the same as Alternative 2 except that the solid waste residuals in the pits would be loaded and transported off-site for disposal as non-hazardous waste at a commercial TSDF. There are two options for the waste disposal; Option 1 would be off-site disposal as non-hazardous waste at a NYS commercial TSDF; and Option 2 assumes the waste is TENORM and therefore must be transported out of NYS to a TSDF that is permitted to manage and landfill the TENORM waste.

Comparison of Corrective Action Alternatives for SWMU Group P-1 to P-6

Referring to Table 5-7, Alternative 1 is not protective of public health due to the potential physical hazard of falling into the pits. Alternatives 2, 3 and 4 are both equally protective of public health and the environment; Alternative 3 is more cost-effective than Alternatives 2 or 4.

Recommended Corrective Measures for SWMU Group P-1 to P-6

The recommended corrective measure for this SWMU Group is *Alternative 3: Backfill Quench Pits* Solid residuals did not contain any suspect fill materials, exceedances of the site specific SCOs, or the Protection of Groundwater SCOs for constituents detected in downgradient groundwater. This alternative includes pumping, pretreating (if necessary), conveying, and discharging approximately 220,000 gallons of water from SWMUs P-1 to P-6 to the surrounding ground surface to infiltrate the local groundwater. The pits would then be backfilled with BUD-approved slag or other non-impacted on-site slag/fill (i.e., meeting ISCOs and site-specific SCOs). The capital cost for implementing Alternative 3 is estimated at $139,000. There are no OM&M costs associated with this alternative.

5.5.9.2 SWMU Group P-7/P-10 (Formerly P-7/P-9/P-10)

As described in Section 2.3.2, SWMU P-9 waste and waste from the southern 20-foot portion of SWMU P-10 overlying SWMU P-9 was treated as part of OU-2 and consolidated into the ATP Containment Cell in 2015. SWMU P-9 was backfilled and graded; therefore, this SWMU is remediated along with the southern portion of SWMU P-10. As such, this SWMU group consists of the waste in P-7 and the northern portion of P-10, which resides north of P-9 and partially overlies SWMU P-7. SWMUs P-7 and P-10 are in the central portion of the Coke Plant By-Products Sub-Area, adjacent and east of the former tar decanters. SWMU P-7 is a below-grade reinforced concrete pit measuring approximately 42 feet long, 28 feet wide, and 21 feet deep. The pit was filled with slag in approximately 1960 by BSC and contains approximately 800 CY of slag/fill. The surface slag/fill sample (0-0.5 fbgs) collected during the RFI identified several PAH concentrations above the ISCOs but total PAHs were below the 500 mg/kg SCO. The subsurface slag/fill sample (0-9.5 fbgs) collected during the CMS did not identify any exceedances of the ISCOs.

The unremediated portion of SWMU P-10 is an area approximately 20 feet by 10 feet that resides partially over SWMU P-7 and extends beyond the southern portion of P-7 to the northern edge of SWMU P-9 where a surficial tar spill occurred over an area approximately 20 feet by 30 feet. Impacted slag (and the tar) were excavated and recycled by blending with coal during the 1980s. In July 1994, following waste/fill excavation, this area was covered with an asphalt pad. On July 15, 1994, one sample collected from beneath the pad between 0 and 2 fbgs contained total PAHs above 500 mg/kg. During the CMS the field location of this SWMU could only be approximated because the November 2005 demolition activities related to the adjacent tar decanters and associated piping obscured any evidence of the asphalt pad and perimeter berms. In July 2011 during additional site reconnaissance of nearby SWMUs, residual tar blebs were observed at the surface east of the decommissioned tar decanter tanks in the general vicinity of SWMUs P-7, P-9, and P-10. Upon further visual assessment, the blebs appeared to be relatively small and localized within the area delineated on Plate 4-11. It is suspected these blebs are remnants of the November 2005 tar decanter decommissioning activities performed immediately west of their location.

The tar blebs are scattered across the area shown on Plate 4-11, which equals approximately 5,000 square feet (not including the P7 and P9 pits). The depth of impact is likely surficial and conservatively assumed to extend 1 fbgs. Therefore, the estimated volume of impacted slag/waste/fill associated with this SWMU is approximately 185 CY. Accounting for contingency and excavation inefficiencies, the volume is approximately 280 CY. It will not be possible to access the SWMU P-7 waste without disturbing the SWMU P-10 contaminated waste/fill and, as such, SWMU P-10 waste/fill outside of SWMU P-9 footprint will be handled with SWMU P-7 wastes.

Groundwater impacts, if any, from SWMUs P-7, P-9, and P-10 are being handled pursuant to OU-4, which encompasses groundwater impacts in the Coke Oven and By-Products Sub-Area. As such, the remedial alternative discussed below only concern the solid residuals contained in the SWMUs.

Alternative 1: No Further Action

The no further action alternative would not include any remediation of this SWMU Group.

Alternative 2: Excavate, Solidify/ Stabilize (if necessary), Consolidate Residuals in SW-CAMU

Alternative 2 would include excavating the pit contents from SWMU P-7 (est. 800 CY) and removing the top foot of material from SWMU P-10 and surrounding areas (that reside outside of SWMU P-9 footprint) (est. 200 CY) for consolidation into the SW-CAMU beneath the low-permeability geosynthetic cover.

Water contained in the SWMU P-7 (estimated 26,000 gallons) would be pumped, conveyed to the OU-4 groundwater treatment system where it would be batch fed to the system for treatment and re-infiltration to the groundwater. SWMU P-7 would be backfilled with BUD-approved slag.

Alternative 3: Construct Geocomposite Cover System

Alternative 3 would include leaving the SWMU Group residuals in-place and covering them with a geocomposite cover system.

Alternative 4: Excavate and Dispose Off-Site at TSDF

Alternative 4 is the same as Alternative 2 except waste would be sent off-site for disposal at a commercial TSDF. There are two options for the waste disposal; Option 1 would be off-site disposal as non-hazardous waste at a NYS commercial TSDF; and Option 2 assumes the waste is TENORM and therefore must be transported out of NYS to a TSDF that is permitted to manage and landfill the TENORM waste.

Comparison of Corrective Action Alternatives for SWMU Group P-7/10

Referring to Table 5-7, Alternative 1 is not protective of public health due to the presence of elevated PAH levels in the surface of SWMUs P-7 and P-10. Alternatives 2, 3, and 4 are protective and implementable; although, Alternative 3 requires administrative, engineering, and institutional controls that would not be required for Alternatives 2 and 4. Alternative 2 ($88,000) is less costly than 3 ($110,000) and 4 ($205,000 to $788,000). The cost for Alternative 2 does not include the incremental costs associated with construction, operation, closure, and post-closure costs associated with the SW-CAMU.

Recommended Corrective Measures for SWMU Group P-7/10

The recommended corrective measure for this SWMU Group is *Alternative 2: Excavate, Solidify/Stabilize (if necessary) and Consolidate Residuals in SW-CAMU*. In order to access the waste in the pit, it is necessary to excavate the SWMU P-10 area due to its location over and between the pits and, as such, and portions of SWMU P-10 outside the limits of SWMU P-9 would be handled in a similar fashion to the SWMU P-7 slag. The hardened tar residuals comprising SWMU P-10 include the approximate top foot of material over the approximate 5,000 square foot area (est. 200 CY).

The waste/slag/fill excavated from SWMUs P-7 and P-10 would be transported and consolidated in the SW-CAMU. If necessary, the residuals in SWMU P-7 will be dewatered (water would be conveyed and treated at the OU-4 groundwater treatment plant using the northern treatment train followed by infiltration. The residual material excavated may also be solidified with Portland cement or fly ash. The residuals would be transported and consolidated in the SW-CAMU. F. Upon completion of the removal action, the pit would be backfilled to grade with on-site slag meeting ISCOs (and site-specific SCOs), brick, or crushed concrete.

The capital cost for excavation and transportation of SWMUs P-7/P-10 waste/fill for consolidation in the SW-CAMU, is estimated at $88,000 (excluding fractional OM&M and closure cost for the SW-CAMU which is separately accounted for).

5.5.9.3 Operable Unit 4: Coke Plant By-Products Solid Waste Management Group (Formerly Benzol Plant Storage Group, SWMUs P-11, P-11A, & P-12)

The Benzol Plant Storage Group is located near the southern limits of the former Coke Plant defined as Operable Unit 4 and consists of nearly 27 acres of land, buildings, structures, roadways and other sparsely vegetated areas. OU-4 contains two SWMUs identified in the RFI: the approximately 3-acre Benzol Plant Tank Storage Sub-Area (SWMU P-11) where groundwater was significantly impacted from Benzol product (primarily benzene, with lesser concentrations of toluene, xylenes, and other VOCs in dissolved and light NAPL) spills and leaks; and the much smaller and less impacted Spill Cleanup Soil Storage Sub-Area P-12 (Refer to Plate 4-12). These areas were subject to a 2005 ICM Consent Order between Tecumseh and NYSDEC. The ICM has been supplemented by OU-4 as the final groundwater corrective measure for the Coke Plant By-Product SWMU, as

described more fully in Section 2.3.1. Source area control for the Benzol Plant sub-area consists of a series of vertical extraction wells manifolded to a trailer-mounted SVE regenerative blower has been installed as an ICM in area of SWMU P-11 and was fully operational as of March 2019 as described in Section 2.1.2. The purpose of this source control is to create negative pressure in the vadose (above the water table) zone to accelerate vaporization of LNAPL and VOC-impacted moisture from the slag/fill pores and conveyance via piping to the SVE trailer from which it is exhausted to a biofilter for air emissions control prior to discharge to the atmosphere. The Benzol Yard has been capped with a low-permeability geosynthetic cover and a minimum of one foot of vegetated soil over the area of the apparent source(s) to prevent short-circuiting of the SVE extraction wells to ambient air and to prevent direct contact with the underlying impacted slag/fill. A third sub-area, referred to as the "Old" Benzol Plant Tank Storage Sub-Area, has been added during the CMS as SWMU P-11A. As discussed previously, OU-4 addresses groundwater contamination in the Coke Oven and By-Products Sub-Area that encompasses SWMUs P-11, P-11A, and P-12.

There are two apparent primary sources for the groundwater contamination identified in the former Benzol Plant (Ref. 25). The first is the former Benzol Yard (SWMU P-11) which contained many above-ground storage tanks (ASTs), underground storage tanks (USTs), two above-ground process tanks and one above-ground Coke Oven gas seal condensate holding tank, and associated piping within the area of the SWMU P-11 footprint. The second apparent source area is proximate to recovery well RW-2 where coke by-products were transferred to rail cars that loaded from the west side of the former Benzol Yard. These source areas are being addressed by the SVE system described previously. The Benzol Yard has been capped with a low permeability geosynthetic cover and a minimum of one foot of soil.

The potential former sources of groundwater contamination from the Old Benzol Plant (SWMU P-11A) are likely similar to that identified for SWMU P-11, mainly accidental spillage during product loading or handling, or leaking aboveground or below-ground pipelines and valves. The facilities associated with SWMU P-11A have been demolished and/or abandoned since approximately 1930. As the concentration of groundwater contaminants in the vicinity of SWMU P-11A are much lower than SWMU P-11, and LNAPL has not been observed in any monitoring wells or piezometers in this area with the

exception of well MWN-26C, there are no widespread or significant identified contaminant source areas associated with SWMU P-11A.

Slag/fill samples collected during the RFI (refer to Appendix N) indicated that 8 of the 14 subsurface slag/fill RFI samples (SB-01 through SB-08) detected benzene (and to a lesser extent toluene and xylene) at concentrations above the ISCO, and 5 of the 14 subsurface slag/fill RFI samples detected naphthalene at concentrations that exceed the CP-51 and total PAH concentration of greater than 500 mg/kg. Most of the samples that exceeded these SCOs were collected in the Benzol Yard between 4 and 8 fbgs, which is within the groundwater smear zone. Oil was observed on the water surface within the boring as well as saturating the fill matrix.

Table 5-7 summarizes the evaluation of the following alternatives using the criteria outlined in Section 5.5 for the slag/fill in OU-4. A description of each alternative is provided below and assumes that the soil vapor extraction will be continued to remove VOCs from the vadose and smear zones in the Benzol Yard in combination with groundwater pumping (to expose the smear zone) and LNAPL recovery (by skimming from selected groundwater extraction wells).

Alternative 1: No Further Action

The no further action alternative would involve taking no further remedial action to address source area slag/fill. The SVE system would continue to operate until the Benzol Yard groundwater contaminant source area was deemed adequately addressed.

Alternative 2A: Vegetated Soil Cover

Covering the remainder of the approximate 27-acre OU-4 sub-area where hardscape or cover does not exist with a minimum one foot vegetated soil cover system to prevent direct contact with the slag/fill with continued groundwater pump and treatment. Prior to cover placement, the surface slag/fill/soils would be inspected to assess for evidence of tar-impacted soil/fill that would be either relocated to the SW-CAMU or sent off-site for disposal at a commercial TSDF. This evaluation will be made using the SFMP in Appendix D and would include visual (staining), odors, and PID measurements to determine whether there are impacts. Impacted surface soil/fill would then be excavated, characterized and handled per the SFMP. The SVE system will be operated to continue the removal of VOCs

from the subsurface vadose zone within the Benzol Yard (P-11) until the contaminant source area was deemed adequately addressed. In the event that the SVE system is found not to have adequately addressed the Benzol Yard source area, the SVE system would be decommissioned and the remaining unsaturated impacted soil/fill would be excavated, treated, stabilized/solidified and either disposed on-site in the SW-CAMU or off-site in a commercial TSDF.

Alternative 2B: BUD-Approved Slag Cover

Alternative 2B is the same as 2A except that BUD-approved slag would be used in lieu of a vegetated cover system.

Alternative 3: Excavation, Treatment and Off-Site Disposal.

This alternative would consist of excavating contaminated slag/fill from the OU-4 area, treating the soil on-site likely using forced-vented biopiles with air discharge controls and then loading and transporting the treated materials off-site (which may involve TENORM considerations). The excavation of the slag fill would be extremely difficult and complicated by the presence of numerous underground massive foundations (footers, basements, and pilings), abandoned utilities (sanitary storm, electric, water) and active utilities including the force main for the OU-4 groundwater collection system and the Industrial Water Line. As the source areas are mostly non-specific in the OU-4 area (e.g., results of spills and leaks from facilities that have been removed) without any identifiable location, the excavation would necessarily require complete removal of the source materials throughout the OU-4 area where the groundwater is heavily contaminated. And groundwater pumping would need to continue after the removal action as the groundwater contamination would remain. As such, this alternative is not considered practical or necessary as the OU-4 pumping system will prevent further migration of the VOC contamination.

Comparison of Corrective Action Alternatives for OU-4 Sub-Area Slag/Fill

Referring to Table 5-7, Alternative 1 is not protective of public health or the environment as there are surficial areas of contamination in the OU-4 area. Alternatives 2A and 2B are both protective of human health and the environment in combination with the

groundwater pump and treatment. Alternative 2A ($1,680,000) is more expensive than Alternative 2B ($1,040,000).

Recommended Slag/Fill Corrective Measures for OU-4 Sub-Area

The recommended corrective measure for OU-4 slag/fill is *Alternative 2A: Vegetated Soil Cover,* which would include clearing, grubbing and grading areas not covered by hardscape, buildings to remain, roadways, existing foundations, etc. (estimated at 20 acres). The grades will be modified to provide a more natural hummocky appearance prior to installing the cover system. A minimum one-foot vegetated soil cover system will be installed to prevent direct contact with the existing slag/fill. Prior to cover placement, the surface slag/fill/soils will be inspected to assess for evidence of materials that should be either relocated to the SW-CAMU or sent off-site for disposal at a commercial TSDF. This evaluation will be made using the SFMP in Appendix D and would include visual (staining), odors, and PID measurements to determine whether there are impacts. Impacted materials would then be excavated, characterized and handled per the SFMP. The area will be hydroseeded and trees planted to provide a more parklike setting. Installation of trees such as hybrid poplars will also provide an added benefit of phytoremediation of the benzene, toluene and naphthalene contaminants in the groundwater. The present worth cost of this alternative is $1,680,000 with total capital cost of $1,640,000 and annual OMM costs of $31,000 over the 30-year maintenance period.

5.5.9.4 SWMU P-18 – Blast Furnace Cooling Tower & Hot/Cold Wells

As discussed in Section 4.6.4, the final remedy for this SWMU was completed and therefore will not be discussed further.

5.5.9.5 SWMU S-26 – Fill Area near Coke Battery No. 8

SWMU S-26 is a slag/fill area that covers approximately 7.5 acres at the northeastern corner of the CMS Area near Coke Battery No. 8. The SWMU is split between two properties formerly owned and operated by Bethlehem Steel: approximately 3.3 acres on the Tecumseh Site in the CMS Area and 4.1 acres on the adjacent Gateway Property along the western side of the Gateway Metroport Canal. Bethlehem Steel sold Gateway their portion of this SWMU in the late 1980s and it was never owned or operated by Tecumseh. The CMS addresses only Tecumseh's property (hereafter referred to as SWMU S-26T). Tar was

identified in one sample (S26-B-03) at a depth of approximately 4 to 7 fbgs. This sample location is proximate to an active 60-inch industrial water line that serves as fire protection for local businesses. The volume of tar waste in this area is de minimis and groundwater impacts in this area are not significant or widespread. Evidence of impact in the soil borings included elevated PID readings (maximum of 257 ppm), mothball odor, and sheen in the smear and saturated zones. Subsurface impacts to 16 fbgs include total PAHs above 500 mg/kg and exceedances of the Protection of Groundwater SCOs for BTEX and PAHs. Plate 4-14 shows the approximate 0.5 acre areal extent of subsurface slag/fill impacts. Groundwater was observed at 6 fbgs in this boring during the December 2006 investigation; however, groundwater was observed at 10 fbgs in surrounding borings during the September 2010 investigation.

Alternative 1: No Further Action

This alternative includes no remedial action on the tar residuals in this SWMU.

Alternative 2: Excavation and Off-Site Disposal at TSDF

This alternative would include excavation of the waste/fill to 16 fbgs as shown on Plate 4-14, including the tar waste proximate to the 60-inch industrial water line. As this steel water line is old, excavation without damaging or taking the water line out of service for several days or weeks and associated fire protection could not be guaranteed. Dewatering of the waste/fill would likely be required, followed by on-site treatment in the ou-4 treatment system. The excavated waste/fill (estimated at 20,000 CY, including contingency and excavation inefficiencies) would be disposed off-site at a commercial TSDF. There are two options for the waste disposal; Option 1 would be off-site disposal as non-hazardous waste at a NYS commercial TSDF; and Option 2 assumes the waste is TENORM and therefore must be transported out of NYS to a TSDF that is permitted to manage and landfill the TENORM waste.

Alternative 3: Excavate and Consolidate in the SW-CAMU

This alternative is the same as Alternative 2 except the waste/fill would be relocated into the SW-CAMU.

Comparison of Corrective Action Alternatives for SWMU S-26

Referring to Table 5-7, Alternative 1 is considered protective of public health and the environment as the impacted waste/fill is at depth and appears to be of very limited extent with no significant observed downgradient groundwater quality impacts. Alternatives 2 and 3 are protective of public health and the environment but present technical implementability issues related to ensuring the 60-inch industrial water line is not damaged or out-of-service for an extended period by the excavation which would disrupt fire protection of many on- and off-site structures. Alternative 1 has no cost, Alternative 3 ($1,170,000) is substantially more cost-effective than Alternative 2 ($3,600,000 to $18,200,000).

Recommended Corrective Measures for SWMU S-26

The recommended alternative for SWMU S-26 is *Alternative 1: No Further Action,* which is protective of public health and the environment. The compounds detected in groundwater are limited to low levels of PAHs which do not migrate in groundwater. PAH detections in the slag/fill are at depth and thus there is no direct contact exposure scenario.

5.5.9.6 SWMU P-76 – 30-Inch Coke Oven Gas Pipeline ICM

A buried 30-inch diameter cast iron pipeline was identified on the Business Park-Phase III portion of the Tecumseh property (outside the CMS Area) in spring 2013 during infrastructure improvements undertaken in support of Brownfield redevelopment work by Welded Tube USA on former Tecumseh BCP Site III-7. In the summer of 2013, Welded Tube USA removed the portion of the gas line that traversed its property under its Brownfield Cleanup Agreement. In addition, an approximate 300-foot long section of the gas line was concurrently removed by Tecumseh from the CMS buffer zone located along the northern bank of the SRWT to the southern limit of a new potable water line crossing. This gas line removal work is documented in the November 2013 Final Engineering Report for the Welded Tube USA parcel (Ref. 3).

Based on the elevated levels of naphthalene and benzene in condensate residuals within the pipeline, the NYSDEC determined that the residuals represented source material per 6NYCRR Part 375-1.2 and, as such, required removal to the extent feasible. Within the CMS Area, the remaining underground coke gas pipelines were designated as SWMU P-76. On June 4, 2014, NYSDEC approved the April 2014 ICM Work Plan for SWMU P-76

Former Coke Oven Gas Lines (Ref. 4). In June 2015, Tecumseh and the NYSDEC entered into an ICM Consent Order (File No. 14-23) for remediation of SWMU P-76 Former Coke Oven Gas Lines (Ref. 4). In October 2015, Tecumseh completed cleaning and removal of approximately 910 liner feet of underground coke gas pipelines and 200 liner feet of above-grade piping. Another 135 linear feet of underground piping and five concrete vaults were cleaned in place. The approximate 135 cubic yards of dewatered sediment removed from the pipes was consolidated into the ATP-ECM containment cell for final disposal. No further corrective action is required for this SWMU.

5.5.10 Water Courses Alternative Corrective Measures

5.5.10.1 Smokes Creek

An ICM was completed in 2009 by Tecumseh in the Lower Reach of Smokes Creek by dredging sediments deposited above the initial flood protection project (mid-1960s) design elevation. Both hydraulically and mechanically dredged sediments were transported and deposited in the USCOE CDF at the north side of the Tecumseh property. Characterization of residual sediment in the Lower Reach of Smokes Creek following completion of the ICM dredging shows similar constituents and concentrations to those that exist in the Upper Reach.

Lower Reach Alternative 1: No Further Action

Under this alternative, no further work would be warranted on Smokes Creek sediments by Tecumseh (other than maintenance dredging that involves biennial mechanical dredging of accumulated sediments at the Lake Erie outlet to maintain the navigability and flow characteristics of the Creek, which is not subject to this CMS). Tecumseh last performed the maintenance dredging near the mouth of the Creek in February 18-22, 2019 under a nationwide permit issued by the USACE.

Upper Reach Alternative 1: Maintenance Dredging

Maintenance dredging of the Upper Reach of Smokes Creek to restore the floodway was performed under the direction of NYSDEC in 2015 in accordance with its maintenance obligations to the USACE. Although no post-dredge sampling was conducted, it is

anticipated that residual contaminant concentrations in the Upper Reach are at acceptable background levels fully protective of public health and the environment.

5.5.10.2 Gateway Metroport Ship Canal

Gateway, the current owner/operator of the Gateway Metroport Canal, has been actively operating and managing the Canal since 1985 and has been responsible for its maintenance and upkeep over the ensuing 26 years. Tecumseh has never owned or operated this Canal. The sediment and surface water sampling and analysis performed within the Gateway Metroport Ship Canal, and presented in Section 4.7.2, is the full extent of Tecumseh's responsibility for this water course under the CMS. Gateway Metroport is responsible for routine navigational maintenance dredging in the Canal.

5.5.10.3 North Return Water Trench

The North Return Water Trench (NRWT) is a man-made drainage channel oriented north-to-south and located in the northern half of the Site. It currently does not serve to drain any significant water from the Site and is blocked-off on the Gateway property. The sides of the trench are concrete or brick-lined. Details from BCS records show the base of the trench as concrete or wood planks. Portions of the NRWT are covered with concrete/asphalt. The residual materials in the NRWT were sampled and analytical testing did not show significant concentrations of detected compounds.

Alternative 1: No Further Action

This alternative would include no remedial action on the sediments in this watercourse.

Alternative 2: Remove Debris

For that portion of the NRWT located on Tecumseh property, Alternative 2 would mechanically remove the debris (brick, wood, concrete, scrap steel, and other non-impacted C&D materials) that represents a nuisance condition. The non-putrescible debris would be consolidated in the SW-CAMU and putrescible debris would be transported off-site to a C&D landfill or solid waste disposal facility. The trench would be filled to grade with BUD-slag or general fill meeting ISCOs, and a concrete bulkhead would be installed at the north end on Tecumseh property.

Comparison of Corrective Action Alternatives for NRWT

Referring to Table 5-8, Alternative 2 is protective of public health and the environment as there were no exceedances of the SCOs and implementation removes solid waste materials that represent a nuisance condition and removes a physical hazard by backfilling the trench. Alternative 1 is not protective of public health and the environment. The present worth cost of Alternative 2 is $183,000.

Recommended Corrective Measures for NWRT

The recommended corrective measure for the NRWT is *Alternative 2: Remove Debris*, which would involve mechanically removing the debris (brick, wood, concrete, scrap steel, and other non-impacted C&D materials) from the trench with disposal of the non-putrescible debris in the SW-CAMU and the putrescible wastes, if any, off-site at a C&D landfill or commercial solid waste landfill. The trench would be backfilled with BUD slag or general fill meeting ISCOs. The cost for debris removal and backfilling is estimated at approximately $183,000.

5.5.10.4 South Return Water Trench

The SRWT is a man-made drainage channel approximately 5,000 feet in length, oriented north to south, located in the southern half of the Site discharging to Smokes Creek. Similar concentrations of various parameters have been detected in the SRWT (2009 and 2011) and off-site upstream locations in Smokes Creek, which illustrates "background" sediment concentrations outside the influence of the CMS Area.

Total organic carbon concentrations detected in SRWT sediment were almost twice that of Smokes Creek sediment (Upper and Lower Reaches).

Table 5-8 summarizes the evaluation of the following alternatives using the criteria outlined in Section 5.5. A description of each alternative is provided below.

Alternative 1: No Further Action

This alternative includes no remedial action on the sediments in the SRWT.

Alternative 2: Dredge Sediment and Consolidate in SW-CAMU or CDF

This alternative would entail mechanical dredging to remove the impacted sediments. It is anticipated that the sediments would be disposed in the SFA Zone 2 Sub-Area SW-

CAMU or CDF at the north end of the Tecumseh property. Contingency costs are included for off-site disposal. There is an estimated 4,000 CY per vertical foot of excavation along the approximately 5,000-ft waterway. Assuming 2 feet of sediment were removed, approximately 8,000 CY of sediment would be generated.

Remediation would proceed from the northern end of the trench working southerly toward Smokes Creek. Temporary silt curtain barriers would be established 100 feet downstream of the work area to limit migration of sediment and turbid water. Soft sediments would be removed to a nominal depth of 2 feet. Confirmatory testing would be performed to verify that cleanup is complete. The bottom and sides of the SRWT would be restored using filter fabric and 1 foot of BUD-Approved 3"-plus slag.

Alternative 3: Contain In-Place

This alternative would include removing the wood debris, rough grading, and in-place capping of contaminated sediments. The cap would consist of geotextile covered with a 6- to 12-inch layer of large stone over the sediment. The base of the stream would be graded to support placement of the geotextile. Silt curtains, used to limit impacts, would be laid down in the water and stone would be mechanically placed into the watercourse as cover material.

Comparison of Corrective Action Alternatives for SRWT

Referring to Table 5-8, Alternative 1 is not protective of public health and the environment due to elevated levels of contaminants in the sediment. Alternative 2 and 3 are fully protective of public health and the environment. Alternatives 2 and 3 both have short-term impacts on the aquatic wildlife in the SRWT. The cost of Alternative 2 is $690,000 to relocate the sediments to the SW-CAMU, which is more cost-effective than off-site disposal in the USACE CDF ($1,370,000) but is more costly than Alternative 3, cover in-place ($331,000).

Recommended Corrective Measures for SRWT

The preferred corrective measure for the SRWT is *Alternative 2: Dredge Sediment and Consolidate in SW-CAMU*, which is protective of public health and the environment. Implementing this alternative would be initiated by establishing the depth of dredging at several transects along the SRWT alignment. Several cells would need to be constructed

along the SRWT on Tecumseh property to allow the sediments to dewater prior to relocating the sediment to the SW-CAMU. Dewatered sediments would then be transported to the SW-CAMU and placed in the containment cell (sandwiched between the low-permeability cap and liner with leachate collection). The bottom and sides of the SRWT will be restored by placing filter fabric and 12 inches of 2-inch+ sized slag. The estimated cost to implement this recommended corrective measure is $690,000 for on-site disposal in the SW-CAMU and approximately $1,370,000 to dispose the sediments off-site in the USACE CDF #6.

5.5.11 CMS Area-Wide Groundwater Alternative Corrective Measures

Groundwater quality within the CMS Area is to be addressed by groundwater discharge sub-area (DSA) as previously discussed in Section 4.8.7.

Based on a thorough groundwater quality investigation and assessment during the RFI and substantially supplemented during the CMS, groundwater downgradient of certain SWMUs or SWMU Groups and located along receptor surface water bodies at the perimeter of the CMS Area was identified as being impacted and requiring groundwater treatment or controls. As detailed in Section 4.8, the groundwater quality in portions of several DSAs (i.e., DSAs 2A, 2B, 3A, 4A and 5) has been adversely impacted from past waste disposal by Bethlehem Steel Corporation in various SWMUs as well as prior disposal by USACE of dredge spoils along the western portion of the CMS Area. The following SWMU groups or DSA have already been adequately addressed as part of ICMs, ECMs or Operable Units under NYSDEC Consent Orders and therefore do not require further evaluation in this section as part of the site-wide groundwater evaluation:

- **ATP SWMU Group Area (SWMUs S-11, S-22 & S-24)**: These SWMUs were considered high-priority for expedited remediation due to the nature and significant quantities of wastes. In order to promptly mitigate the continued migration of contaminants from the ATP SWMUs to Smokes Creek (DSAs 2B and 3A) an ECM was implemented as described in Section 2.2.1. Historically, groundwater flow within DSA 2B is predominantly in the northerly direction towards Smokes Creek.

  In October 2011, this groundwater flow pattern within DSA 2B was altered by the completion of a slurry wall keyed into the underlying low permeable soils to create a perimeter around SWMU S-11/22 (ATP containment cell). Three interior

extraction wells were installed within the ATP containment cell to create an inward groundwater gradient within the containment cell. The groundwater/ leachate collection, pretreatment, and conveyance systems were constructed and have been operational since December 2012. The ATP containment system physically isolates the ATP SWMU Group wastes from the environment and contains the aqueous groundwater constituents immediately surrounding them by maintaining an inward hydraulic gradient across the slurry wall.

In October 2015, four groundwater collection wells north of the ATP Containment Cell were installed to hydraulically contain residual groundwater contamination detected in that vicinity prior to reaching Smokes Creek. The recovered contaminated groundwater external to the ATP containment cell is conveyed via a double-contained force main to the existing ATP groundwater pre-treatment system.

Groundwater/leachate from the internal and external collection systems are pretreated on-site via neutralization and air stripping of VOCs followed by sewer conveyance to the ECSD No. 6 publicly owned treatment works (POTW) in Lackawanna for final biological treatment with eventual discharge to Smokes Creek upstream from the CMS area.

Annual groundwater monitoring of the ATP wells is required by the ATP OM&M Plan.

- **Benzol Plant Tank Storage Areas (SWMU P-11 & P-11A) and Operable Unit No. 4**: Groundwater in the vicinity of SWMU P-11 was determined to be significantly degraded and migrating away in a westerly (DSA 4A) and easterly off-site (DSA 5) toward the Ship Canal (DSA 5). An ICM was implemented in 2005 consisting of 11 groundwater extraction/treatment and LNAPL removal wells to address groundwater in area of SWMU P-11.

  The ICM, as described in Sections 2.1.1 and 5.5.9.3, continues to operate and has demonstrated effective capture and treatment of aqueous and non-aqueous contamination as well as partial control of the groundwater plume. Similar alternatives are presented in Section 5.5.9.3 to address the shallow groundwater in the vicinity of SWMU P-11A, also within DSA 5. Tecumseh proposed and has implemented Operable Unit OU-4 to address groundwater collection and treatment within the Coke Plant By-Products Facility Sub-Area and all the SWMUs therein.

  The ICMs at the Benzol Yard have been supplanted by implementation of Operable Unit No. 4 (OU-4) as a final expedited corrective measure (ECM) for the Benzol Yard groundwater and the broader roughly 27-acre Coke By-Products SWMU Sub-Area (see Section 2.3.1 for additional OU-4 details) that was substantially completed in March 2019. OU-4 incorporates the existing 11 Benzol

Yard groundwater collection wells with 41 new groundwater collection wells in the more expansive Coke By-Products Sub-Area around the Benzol Yard and conveys the substantially higher flows to a new Groundwater Treatment Building. The OU-4 Consent Order dated September 11, 2017 terminated the Benzol Yard groundwater ICM Consent Order.

The following groundwater monitoring on or adjacent to portions of the CMS Area and within certain individual SWMUs is already in progress in accordance with their respective post-closure requirements:

- **Hazardous Waste Management Unit (HWMU) 1A (SWMU S-13)**: As discussed in Section 4.3.3.2, SWMU S-13 is a closed in-place HWMU with a NYSDEC-approved closure and post-closure plan. The groundwater for this SWMU will continue to be monitored on an annual basis in accordance with the December 2017 Groundwater Monitoring, Sampling, and Analysis Plan (Ref. 27). SWMU S-13 lies within Groundwater DSA 4A, which flows toward Lake Erie.
- **HWMU 1B (SWMU S-16)**: As discussed in Section 4.3.3.5, SWMU S-16 is a closed in-place HWMU with a NYSDEC-approved closure and post-closure plan. The groundwater for this SWMU will continue to be monitored on an annual basis in accordance with the December 2017 Groundwater Monitoring, Sampling, and Analysis Plan (Ref. 27). SWMU S-16 lies within Groundwater DSA 4A, which flows toward Lake Erie.
- **HWMU 2 (SWMU S-3)**: SWMU S-3 covers approximately 3.52 acres and contains ammonia still lime sludge (ASLS) (less than 2% by volume) and furnace sludge. As ASLS was a listed waste (K060), SWMU S-3 was formerly designated as a HWMU 2 but has since been delisted by the USEPA. Groundwater monitoring of this SWMU has been routinely performed since 1985. SWMU S-3 lies within Groundwater DSA 4A, which flows toward Lake Erie.
- **Benzol Plant Tank Storage Areas (SWMU P-11 & P-11A) and Operable Unit No. 4:** The ICMs at the Benzol Yard have been supplanted by implementation of Operable Unit No. 4 (OU-4) as a final expedited corrective measure (ECM) for the Benzol Yard groundwater and the broader roughly 27-acre Coke By-Products SWMU Sub-Area. OU-4 pumping wells are addressing impacted groundwater present in both DSA 4A (flowing westerly) and 5 (flowing easterly to the Ship Canal).

Groundwater monitoring objectives for the entire CMS Area are addressed in the revised Long-Term Groundwater Monitoring (LTGWM) Plan presented as Appendix T. The objectives of the proposed LTGWM Plan are to monitor:

- Downgradient groundwater quality and projected contaminant loadings discharged from the entire CMS Area to adjacent surface water bodies Lake Erie, Smokes Creek, and the Ship Canal.
- Post-remedial efficacy of final corrective actions following their implementation.

Table 5-8 summarizes the evaluation of the following three groundwater remedial alternatives for the entire CMS Area (minus the specific areas described above) using the criteria outlined in Section 5.5. In evaluating both alternatives, it is assumed the February 1996 Deed Restrictions (institutional controls) filed by BSC that prohibit the extraction or use of groundwater on the Site, except for the purpose of monitoring, treating, or remediating, will remain in effect indefinitely.

Alternative 1: No Further Action

The no further action alternative does not include groundwater treatment or monitoring (i.e., the LTGWM Plan would not be implemented), outside of the proposed SWMU-specific groundwater remedial efforts and existing post-closure requirements already in progress as discussed above.

Alternative 2: Monitored Natural Attenuation

Monitored natural attenuation (MNA) involves execution of the revised LTGWM Plan, as approved by the Department for the CMS Area. The VOCs (including naphthalene) present in groundwater are organic molecules capable of being degraded by natural processes over time. By removing residual wastes from various areas throughout the CMS Area and consolidating the wastes into central disposal areas (i.e., SW-CAMU), migration of contaminants into the groundwater will be reduced. The MNA alternative does not involve proactive remedial measures but instead relies on periodically monitoring the contamination to verify that natural attenuation is occurring. The results of groundwater monitoring well sampling would be used to evaluate statistical trends in groundwater VOC concentrations over time.

These modifications have been incorporated into Table 1 of the LTGWM Plan (see Appendix T). The 30-yr present worth cost for implementation of the LTGWM Plan is estimated at $976,000.

Alternative 3: Secondary and Tertiary Groundwater Extraction & Treatment

Secondary and tertiary groundwater extraction & treatment involves and extraction and treatment of impacted groundwater at locations within the CMS area that:

1) Have migrated from sources of groundwater contamination prior to implementation of SWMU and/or primary groundwater corrective measures (e.g., secondary groundwater extraction & treatment); or
2) Were strategically selected to decrease contaminant mass loadings to surface water bodies (e.g., tertiary groundwater extraction & treatment).

Plate 5-2 identifies the seven locations where secondary and tertiary groundwater extraction & treatment are proposed to be implemented. These areas are discussed below by DSAs.

DSA 2A – Monitoring well MW-2D2B is present within the sand/USACE dredge spoil unit within DSA 2A along Lake Erie. Monitoring well MW-2D2B has been identified as a downgradient well associated with several potential groundwater contaminant sources (i.e., SWMUs S-2, -3, S-7/S-20 and USACE dredge spoils) within DSA 2A. Elevated primary COCs in groundwater include BTEX, naphthalene and total phenols. By installing four new pumping wells to capture the contaminated groundwater associated with the sand/USACE dredge spoil unit in the vicinity of MW-2D2B, it is estimated that the COC mass loadings in groundwater from DSA 2A to Lake Erie would further decrease (see Table 4-48 for detail) as follows:

- BTEX: 93% reduction
- Naphthalene: 63% reduction
- Barium: 12% reduction
- Total Phenols: 85% reduction

For this alternative contaminated groundwater from the four new wells would be pumped and conveyed via force main to the existing ATP-ECM groundwater pre-treatment system (discussed in greater detail later in this section). The ATP pretreatment system discharges to the Plant sewer for conveyance to the ECSD #6 publicly operated sewerage system in accordance with an Industrial Discharge Permit for final biological treatment and ultimate discharge to Smokes Creek in accordance with a NYSDEC-issued SPDES discharge permit.

DSA 2B – Monitoring wells MWS-01 and MWS-02 are present within the slag/fill unit and MWS-01B is present within the sand/dredge spoil unit within DSA 2B along the south side Smokes Creek. Monitoring well MWS-01 and MWS-01B has been identified as downgradient wells associated with the northern portion of SWMU S-4 and MWS-01B has also been associated with the USACE dredge spoils. MWS-02 is a downgradient well from ATP-ECM (S-11/22) along the southern bank of Smokes Creek. Elevated primary COCs include BTEX, naphthalene, total phenols, and cyanide (MWS-02). By installing six additional pumping wells as part of this alternate to capture the contaminated groundwater associated with the slag/fill and sand/dredge spoil units in the vicinity of MWS-01/-01B, and -02, it has been estimated that the COC mass loadings in DSA 2B groundwater to Smokes Creek would further decrease (see Table 4-48 for detail) as follows:

- BTEX: 31% reduction
- Naphthalene: 99% reduction
- Total Phenols: 97% reduction
- Cyanide: 96% reduction
- Barium: 67% reduction

The contaminated groundwater extracted from these new pumping wells would be conveyed via a small-diameter HDPE force main to the existing ATP groundwater pre-treatment system and subsequently to the ECSD #6 public sewerage system for final biological treatment prior to discharge to Smokes Creek.

The main contributing segment for mass loadings of benzene to Smokes Creek in DSA 2B is MWS-18A, located north and outside of the ATP SWMU Group Area. As discussed above, four exterior pumping wells were installed north of ATP containment cell, of which one is upgradient and one is downgradient of MWS-18A. Since the initiation of the exterior pumping wells outside of the containment area in October 2015, there has been a 73% decrease in benzene levels compared to the April 2018 annual sampling data and has been addressed as part of OU-3 groundwater remedy.

DSA 3A – Monitoring wells MWN-01 and MWN-01B are present in the slag/fill and slag/fill and sand/USACE dredge spoils units, respectively, within DSA 3A along the north bank of Smokes Creek. Monitoring wells MW-01 and -01B have been identified as downgradient wells associated with potential sources SWMU S-10 and USACE dredge

spoils, respectively, within DSA 3A. Elevated primary COCs present in these monitoring wells include BTEX, naphthalene, and total phenols. By installing 2 additional pumping wells as part of this alternative to capture the contaminated groundwater associated with the slag/fill and sand/dredge spoil units in the vicinity of MWN-01 and -01B, it has been estimated that the COC mass loadings in DSA 3A groundwater to Smokes Creek would be further reduced as follows (see Table 4-48 for details) :

- BTEX: 69% reduction
- Naphthalene: 95% reduction
- Total Phenols: 97% reduction
- Cyanide: 100% reduction

Monitoring wells MWN-17A and MWN-17B are also present in the slag/fill and slag/fill and sand/dredge spoils units, respectively, within the DSA 3A, and are downgradient (south) of SWMU P-74D (which is a part of the larger Tank Farm Area (SWMU P-75) partial present in DSA 3A as well). Elevated COCs present in these monitoring wells include benzene, toluene, xylene, naphthalene, and total phenols. Groundwater associated with these wells also has a pH of 12.5 or higher. By installing three additional pumping wells to capture the contaminated groundwater associated with the slag/fill and sand/dredge spoil units south of SWMU P-8 and P-74D will improve groundwater quality along the north bank of Smokes Creek. Although, groundwater wells MWN-17A and -17B are not used as part of the mass loading calculations to Smokes Creek, the secondary effects of these pumping wells will be seen in the mass loadings associated with MWS-94A and MWN-94B which are approximately 400 feet downgradient along Smokes Creek and will further decrease COC mass loadings in DSA 3A groundwater to Smokes Creek by an unquantified amount.

Under this alternative contaminated groundwater collected from the above five additional pumping wells within DSA 3A would be conveyed via a small-diameter HDPE force main to the existing ATP groundwater pre-treatment system and subsequently to the ECSD #6 public sewerage system.

SMWUs P-8 and S-24 have also been identified as potential sources within DSA 3A. No further groundwater remedial action is needed for SWMU S-24 as the source of contamination was removed and consolidated with the ATP-ECM in 2014. SWMU P-8

waste fill has been proposed for excavation and consolidation within the SW CAMU (see Plate 5-2 and discussed in Section 5.5.8). Other similar excavation and consolidation is also proposed for other areas within SWMU P-75. These activities will remove the source of groundwater contamination in this approximate 18-acre area which will improve groundwater quality. No other groundwater corrective measures are proposed for DSA 3A.

DSA 4A – Monitoring wells MWN-02, -02B, and WT1-07 are present in the slag/fill and sand/dredge spoils units within the southwestern portion of DSA 4A along the Lake Erie shoreline. These monitoring wells are downgradient from potential sources SWMU S-10 and USACE dredge spoils (MWN-02B and WT1-07). Elevated COCs in these monitoring wells include BTEX, naphthalene, and total phenols. By installing seven additional pumping wells as part of this alternative to capture the contaminated groundwater associated with the slag/fill and sand/dredge spoil units in the vicinity of these monitoring well, it has been estimated that the COC mass loadings in DSA 4A groundwater to Lake Erie could be further reduced as follows:

- BTEX: 40% reduction
- Naphthalene: 17% reduction
- Total Phenols: 49% reduction
- Barium: 7% reduction

The contaminated groundwater extracted from these seven additional pumping wells would be conveyed via a small diameter HDPE force main to the existing ATP groundwater pre-treatment system and subsequently to the ECSD #6 public sewerage system.

Monitoring wells MWN-15A and MWN-15B are present in the slag/fill and slag/fill, sand/USACE dredge spoil and peat units, respectively, in the eastern portion of DSA 4A approximately 300 feet west of OU-4. Elevated primary COCs at these monitoring wells include benzene, toluene, xylene, naphthalene, and total phenols. These contaminants are likely associated with groundwater plume migration from The Coke Plant By-Products Sub-Area (SWMUs P-11 and P-11A) prior to the implementation of the Benzol Plant ICM in 2005 and OU-4 more recently in March 2019.

The installation of 4 additional pumping wells as part of this alternative to capture the contaminated groundwater associated with the slag/fill and sand/USACE dredge spoil units west of the Coke Plant By-Products Sub-Area will improve groundwater quality within the

western portion of DSA 4A migrating westerly towards Lake Erie. Although, groundwater monitoring wells MWN-15A and -15B are not Site perimeter wells used as part of the groundwater mass loading calculations to Lake Erie, the secondary effects of these pumping wells will be seen in the long-term mass loadings associated with downgradient well MWN-02, -02B, -03, -03B located approximately 2,100 feet downgradient. The contaminated groundwater that would be extracted from these 4 additional pumping wells as part of this alternative would be conveyed via a small diameter HDPE force main to the northern leg of the OU-4 groundwater treatment system (with GAC to handle the phenol), which has a capacity of approximately 40 gpm, is currently operating at approximately 25 gpm and would be able to handle additional groundwater from the four additional pumping wells proposed.

Proposed SWMU waste/fill to be consolidated from areas within DSA 4A (S-12, S-14, S-15, S-18, and S-75) and placement within the SW CAMU will remove sources of contamination located throughout DSA 4A and improve groundwater quality at downgradient locations MWN-03, -05A, WT8-01, and WT8-02. SWMUs S-16 and S-23 will received a permanent cover system that will eliminate groundwater infiltration in this area. Groundwater infiltration contact with the contaminants is likely the source of contaminants detected in the groundwater downgradient (MWN-04) of these locations.

The existing ATP groundwater pre-treatment system is currently receiving, on average, 4,500 gallons per day from the three interior and four exterior groundwater extraction wells associated with the ATP SWMU. The existing BSA permit for the pre-treatment system currently allows for up to 24,000 gallons per day discharge. Therefore, on average, there is an additional 19,500 gallons per day capacity which could be conveyed to the ATP pre-treatment system from the 22 additional groundwater collection wells installed in DSAs 2A, 2B, 3A and 4A with this alternative and in accordance with the existing ECSD #6 industrial discharge permit .

DSA 5 – Other than the continued operation of the OU-4 groundwater extraction and treatment system, no additional groundwater corrective measures are proposed for DSA 5. Low levels of benzene and PAHs were detected in the groundwater at MWN-45A and -47A, which are downgradient of SMWU P-18; and low levels of PAHs were detected in MWN-07 which is down gradient of SMWU S-26. No groundwater exceedances were

associated with MWN-52A and -52B, which are also downgradient of S-26. These areas do not warrant corrective measures.

Comparison of CMS Area-Wide Groundwater Corrective Action Alternatives

Referring to Table 5-8, Alternatives 1, 2 and 3 are protective of public health, as use of groundwater on the CMS area and the entire former Bethlehem Steel property is restricted to remedial purposes only under a deed restriction. Alternatives 2 and 3 are more protective of the environment. Alternatives 1, 2 and 3 are mostly compliant with the SCGs (i.e., NYSDEC QGWQS) at the property line. Alternatives 2 and 3 will have long-term effectiveness and permanence. Alternatives 2 and 3 will both reduce the toxicity, mobility and volume of contaminants present in groundwater, but more so with Alternative 3 due to the active pumping and treatment. There are no short-term impacts associated with Alternatives 1, 2 or 3, but Alternatives 2 and 3 meet the short-term goals discussed in Section 3.3. There are no technical or administrative implementability issues associated with Alternatives 1, 2 or 3. There are no costs associated Alternative 1. The aggregate, long-term cost of Alternative 2 to implement the LTGWMP to assess monitored natural attenuation is $976,000 and the costs associated with the installation of the 26 extraction wells and associated conveyance to the existing treatment systems associated with ATP and OU-4 are $1,410,000. The costs for treatment of groundwater are covered under the ATP and OU-4 OM&M.

Recommended Corrective Measures for CMS Area-Wide Groundwater

The preferred corrective measure for the CMS Area-Wide Groundwater is a combination of *Alternative 2: Monitored Natural Attenuation* and *Alternative 3: Secondary and Tertiary Groundwater Extraction & Treatment,* which are protective of public health and the environment and would be monitored to assess their protectiveness. Implementing these alternatives would allow for the secondary and tertiary extraction and treatment of impacted groundwater from DSA 2A, 2B, 3A and 4A and thereby substantially reduce the COC mass loadings to Smokes Creek and Lake Erie from the Site. Implementation of these recommended groundwater corrective measures coupled with the source control measures associated with recommended consolidation of SWMU wastes into the SW CAMU, removal and off-site disposal, or close/cover in placed will further enhance long-term groundwater

quality within the CMS Area. The estimated long-term cost to implement Alternative 3 is $1,410,000 and the estimated long-term cost to implement Alternative 2 is $976,000. The costs for treatment of additional collected groundwater are covered under the ATP and OU-4 OM&M estimates.

5.5.12 Sub-Slab Depressurization

As discussed in Section 5.5.11, there are elevated concentrations of VOCs in subsurface fill and/or groundwater in certain discrete portions of the CMS Area. As such, a sub-slab depressurization (SSD) system will be required in new or existing buildings, to be occupied on a full-time basis, within these areas (see Plate 4-30).

5.5.13 Coke Plant Demolition of Structures and Miscellaneous Site Work

The following unoccupied, outdated and unsafe structures, located within the Coke Plant Sub-Area of the CMS Area, are slated for demolition (see Plates 1-1, 4-9, and 4-10):

- Coke Oven Lab
- Storage Pump House
- Benzol Building
- Compressor & Booster Station (portion not related to active Electrical Substation 6J which shall remain)
- South Welfare Building #1
- Sulfur Plant
- Breaker Building
- Mixer Building
- Fire House (north of Mixer Building)
- Former Substation 8D
- North Welfare Building
- Former Coke Oven Batteries (No. 7, 8, and 9)

Prior to demolition, an asbestos survey will be required, and some abatement is likely within certain structures. During demolition, the non-salvageable demolition debris that is not used for subsurface backfill would be consolidated in the SW-CAMU. Following

demolition, pits, and trenches would be backfilled with crushed concrete slag or bricks from the demolitions and covered with 12 inches of BUD slag.

5.5.14 Summary of Projected COC Loadings in CMS Area Slag/Fill Groundwater to Adjacent Surface Waters Following Implementation of Recommended Corrective Measures

In order to quantify future loadings of primary COCs in CMS Area groundwater that are projected to result from the implementation of all the recommended corrective measures (i.e., both groundwater and SWMU recommended corrective measures), the current primary COC mass loadings in CMS Area slag/fill groundwater (Table 4-43) were revised by applying the estimated percent reductions of primary COC mass loadings in groundwater along each DSA shoreline segment. For example, for DSA shoreline segments downgradient of the SWMUs to be contained within the SW-CAMU, a reduction of groundwater mass loadings equal to the 99.8% steady-state reduction in infiltration was projected. Where groundwater collection and controls have been recommended in the secondary and tertiary proposed groundwater extraction locations in DSAs 2A, 2B, 3A and 4A, 100% reduction was projected. These calculations are presented in detail in Table 5-14. The COC mass loading in groundwater that are projected to be reduced are highlighted in blue on Table 5-14.

These projected primary COC loadings in CMS Area slag/fill and sand/dredge spoil units groundwater to all adjacent surface water bodies as well as the percent reduction relative to current loadings is summarized below:

Primary COCs	Projected COC Mass Loading in CMS Area Groundwater to Adjacent Water Bodies (lbs/day)			Total Projected Loading to All Water Bodies (lbs/day)	Percent Reduction Relative to Current Loading
	Lake Erie	Smokes Creek	Ship Canal		
Benzene	0.00480	0.00161	ND	0.0064	90%
Ethylbenzene	0.0000005	ND	ND	0.0000005	100%
Toluene	0.00289	0.00001	ND	0.0029	69%
Total xylene	0.00267	0.00005	ND	0.0027	93%

Naphthalene	0.0771	0.0010	ND	0.0781	60%
Barium	1.39	0.003	0.002	1.402	18%
Cyanide	NA	0.00213	0.00263	0.0048	99%
Total Phenols	0.021	0.00008	ND	0.0211	56%

The projected COC mass loadings in groundwater are for steady-state conditions and will take years to achieve. Recommended groundwater controls will take less time to establish hydraulic capture or control resulting in quicker improvements to groundwater quality and quicker reductions in COC mass loading in Site groundwater to surrounding water bodies.

Examination of the Table 5-14 and the above summary table illustrate the following salient points:

- The collective implementation of all recommended corrective measures for both SWMUs and groundwater are projected to significantly reduce the mass loading of the primary COCs benzene, ethylbenzene, toluene, naphthalene, and cyanide, and total phenols in all CMS Area slag/fill and sand/USACE dredge spoil unit groundwater to all adjacent water bodies by approximately 90%, 100%, 69%, 93%, 60%, 99% and 56%, respectively.
- Implementation of OU-4 will effectively eliminate measurable COC mass loadings from Coke Plant By-Products Area and DSA 5 groundwater to the Ship Canal and eliminate mass loading of VOCs, SVOCs, and total phenols.
- The implementation of all recommended corrective measures will significantly reduce the mass loadings to surface water bodies adjacent to the CMS Area, which would meet the long-term groundwater quality objectives of both NYSDEC DER-10 and USEPA EIs, discussed in Sections 3.3 and 3.4, respectively.

5.5.15 Summary of Projected Costs for Recommended Corrective Measures

The net present worth cost estimated to implement the recommended corrective measures is $32,400,000 to $34,500,000 consisting of $26,900,000 to $29,000,000 in capital cost and $5,400,000 in operation and maintenance costs (refer to Table 5-9). The operation and maintenance costs include $1,500,000 each ($3,000,000) for the OMM associated with the ATP-ECM groundwater treatment and OU-4-ECM groundwater treatment. The net present worth was calculated using a 5% discount factor.

6.0 CORRECTIVE MEASURES IMPLEMENTATION AND DOCUMENTATION

6.1 CMS Report

Following NYSDEC review and comments, if offered, TurnKey will promptly respond to Department comments and, if requested by the Department, revise and finalize the CMS Report. The CMS Report, in its current form or as further revised, will be presented to the public for review and comment. Any public comments will be considered by NYSDEC prior to Department issuance of a Statement of Basis selecting comprehensive corrective measures for the remainder of the 43 SWMUs and 5 watercourses identified in the RFI and/or by USEPA as requiring further assessment that have not already been addressed by Tecumseh through Consent Orders as ICMs, ECMs and Operable Units. Appendix V includes an electronic copy of this CMS Report.

6.2 Order(s) on Consent

Upon submittal of the final CMS Report, Tecumseh will have satisfied its obligations under Order on Consent No. 03-73 signed June 29, 2009. Upon NYSDEC acceptance of the final CMS Report and following Department issuance of a Statement of Basis selecting final corrective measures, the CMS Order will be vacated and, presumably, new Order(s) on Consent between Tecumseh and NYSDEC will be executed for implementation of a comprehensive Corrective Action Plan, or operable units thereof, and associated operation, maintenance, and monitoring (OM&M) activities in the CMS Area.

6.2.1 Financial Assurance

An updated Financial Assurance cost estimate is expected to be a component of the new Order on Consent. The Financial Assurance will be amended to include costs associated with the approved corrective measures as well as associated post-remedial OM&M. The Financial Assurance estimate will be revised at the end of each year during Corrective Measures design and construction as designs are finalized for various corrective measures, cost estimates are refined and updated and as funds are expended. At the end of the construction period and following approval of the final Site Management Plan (SMP) and

filing of the Environmental Easement, the post-remedial OM&M cost estimate will be updated and revised. Tecumseh will annually submit to NYSDEC for review and approval adjusted closure, post-closure care, custodial care and corrective measures cost estimates including supporting justification to account for inflation and changes in facility conditions. Each annual adjustment to the post-closure and custodial care cost estimates will reflect the cost for a combined 30-year period from the date of each annual adjustment.

6.3 Corrective Measures Implementation

An estimated 7-year period is anticipated for construction of the recommended corrective measures. Because of the large magnitude of the CMS Site, corrective measures will be implemented on an area-by-area (i.e., operable unit) basis either by SWMU, SWMU Group, CAMU, groundwater discharge area or water body. Each operable unit will be approached with separate design documents, construction, and documentation.

6.4 Corrective Measures Documentation

6.4.1 Construction Completion Reports

In accordance with NYSDEC's DER-10 Technical Guidance for Site Remediation (Ref. 9), construction completion reports (CCRs) are required to document the implementation of remedial actions undertaken for an operable unit or SWMU. As such, a CCR will be prepared at the conclusion of corrective measures undertaken within each SWMU as described in Section 6.3. The CCRs submitted for the CMS Area will be incorporated/referenced in the Corrective Measures Completion Report when issued at the conclusion of all corrective measures.

The CCRs will describe the activities completed in accordance with the approved remedial design or remedial action work plan and provide the data to support the construction activities completed. The CCRs will be prepared in a format based on available NYSDEC templates. Specifically, the CCRs include:

(1) A description of the remedy, as constructed, pursuant to the decision document or work plan.

(2) A summary of all remedial actions completed, including:

a. A description of any problems encountered during construction and their resolution.

b. A description of changes to the design documents and why the changes were made.

c. Quantities and concentrations of contaminants removed or treated.

d. A listing of the waste streams, quantity of materials disposed, and facility where such materials were disposed.

e. Boundaries of the real property subject to the environmental easement or deed restriction or other institutional controls.

f. Restoration actions.

(3) A list of the remedial action objectives applied to the remedial action.

(4) Tables and figures containing all pre- and post-remedial data keyed appropriately so that completion of the remedial action is documented. The figures will clearly indicate the volume of contaminated soil or sediment that was remediated, as well as contamination remaining at the Site to be managed by the SMP.

(5) A detailed description of the applicable areas of remedial action compliance (e.g., fugitive dust/particulate monitoring, community air monitoring).

(6) Record drawings documenting "As-Built" conditions and bearing a NYS Professional Engineer's stamp and signature on each drawing should be provided and include:

a. Any permanent structures including, without limitation, caps, slurry walls, treatment units, piping and instrumentation diagrams, or other remedial structures that will remain in place after completion of the remedial action; areas of changed conditions or removals; and mitigation measures in place to address exposures related to soil vapor intrusion.

b. All soil removals, indicating the surveyed limits of the excavation and location of all final documentation samples.

c. All underground storage tank removals. A site plan showing the location, including GPS level of accuracy for latitude and longitude, of the tanks removed or abandoned in place and the extent of any soil removal.

d. Any permanent survey markers for horizontal and vertical control needed for site management are to be shown on a site survey prepared by a NYS licensed land surveyor and include with the "as-built" drawings.

(7) Identification of the applicable institutional controls employed along with a copy of the environmental easement or other institutional controls that apply.

(8) For active groundwater remedial actions, the CCR will also include figures representative of flow conditions immediately preceding initiation of the remedial action and flow conditions representative of pumping conditions during the remedial action.

The following documentation, as applicable to the project, is to be submitted with the CCR. This information is to be included by reference and provided as an electronic data summary (ESD) not as an attachment or appendix to the CCR:

(1) All fully executed manifests documenting any off-site transport of waste material.

(2) Results of all analyses, including laboratory data sheets and the required laboratory data deliverables.

The final CCR submitted to NYSDEC for approval will be prepared, stamped, certified, and signed by a New York licensed Professional Engineer.

6.4.2 Corrective Measures Completion Report

A Corrective Measures Completion Report will be prepared to document implementation of one or more components of the Site corrective action program and is a mandatory prerequisite to issuance of a closure letter. Report(s) also include the necessary certification for the remedial program. The scope of Report will vary depending on the way the remedial program was implemented. Due to the extensive corrective measures anticipated to be implemented over several years, we anticipate multiple Reports will be prepared. For multiple operable units undertaken to implement the overall remedial program for a site the Report will:

(1) Summarize the results of all corrective measure CCRs.

(2) Identify each operable unit and describe how the overall remedial program for the Site has addressed the operable unit.

(3) Provide all data and information describing the final remedial action implemented in accordance with the information detailed in Section 6.4.1.

(4) Include data and figures identifying where contamination remains at the Site that needs to be addressed in the SMP.

(5) Describe any institutional controls required, including mechanisms to implement, maintain, monitor, and enforce such controls.

(6) Identify the Site boundaries and include by reference the SMP.

(7) Provide the certification for the remedial program.

In addition to complying with the CCR requirements in Section 6.4.1, the Report must also include the documentation for the remedial program necessary to support the certification requirements. Where the decision document, remedial work plan, or other document for the Site identifies a time frame, the following certification is to be made: "*The data submitted demonstrates that the remediation requirements set forth in the decision document for the site have been, or will be, achieved in accordance with the time frames, if any, in the decision document, or any subsequently approved work plans.*" Where this certification applies, the Report must identify the applicable timeframe and data evaluated and discuss how the data supports this certification.

For all sites with institutional controls, the Report must:

(1) Describe any institutional controls required, including mechanisms to implement, maintain, monitor, and enforce such controls.

(2) Document that any institutional controls, engineering controls, and/or any operation and maintenance requirements applicable to the site are contained in an environmental easement created and recorded pursuant to ECL 71-3605 or any other DEC-approved process, and that any affected local governments, as defined in ECL 71-3603, have been notified that such easement has been recorded.

The Report will reference the SMP and describe the financial assurance mechanisms in place. The SMP must be approved and the environmental easement or deed restriction executed prior to NYSDEC approval of the Report.

6.4.3 Site Management Plan

An SMP will be prepared and submitted concurrent with completion of the corrective measures for the entire CMS Site. The purpose of the SMP is to assure that proper procedures are in place to provide for long-term protection of public health and the environment after remedial construction is complete. The SMP will be prepared following the NYSDEC template and must be approved prior to the approval of the Corrective Measures Completion Report.

The SMP will include, as required for the site remedy, up to three separate plans summarized as follows:

(1) Institutional and Engineering Control (IEC) Plan.

(2) Monitoring Plan. The monitoring plan is required when it is necessary to monitor and report the performance and/or effectiveness of the remedy.

(3) Operation, Maintenance and Monitoring (OM&M) Plan. The OM&M Plan is required where the remedial program includes the operation and maintenance of a component of the remedy.

The functional equivalent of an SMP currently exists for the CMS Site. The following sections describe the existing components of the SMP as well as what additions will be made to the SMP at the conclusion of the remedial program for the entire CMS Site. The SMP will be submitted to the NYSDEC for approval and attachment to the Environmental Easement upon approval of all CCRs.

6.4.3.1 Institutional and Engineering Control Plan

A site-wide deed restriction currently exists for the Tecumseh site to limit groundwater use for potable purposes and use of the Site to industrial applications.

Upon completion of the final corrective measures, an Environmental Easement will be prepared and may include, but not be limited to:

(1) The existing groundwater deed restriction.

(2) Limitations for future use of the Site to restricted (commercial or industrial) applications.

(3) A final updated Site survey.

(4) Any other exclusion for Site use such as prohibiting Site development over specific areas where materials have been capped in place.

(5) Requirements for a vapor barrier beneath any new structures erected on the property to eliminate sub-slab vapor mitigation, and an evaluation of subsurface soil and groundwater conditions beneath the planned building to determine the need for an active sub-slab depressurization system.

(6) The approved SMP.

Benchmark will prepare an Institutional and Engineering Control Plan that will include a complete description of all institutional and/or engineering controls employed at the Site, including the mechanisms that will be used to continually implement, maintain,

monitor, and enforce such controls. Plans for implementation of the engineering and institutional controls may include:

(1) Soil management that details procedures for handling soil excavated during maintenance or redevelopment of the site. A Soil/Fill Management Plan (SFMP) for the CMS Area is included as Appendix D. To comply with DER-10, the SFMP will be renamed to Excavation Work Plan (EWP) and updated as required.

(2) Installation/operation of a vapor barrier and, if necessary, a sub-slab vapor depressurization system to address vapor intrusion.

(3) Engineering control inspection plans for the remedy as implemented or to be installed as part of the Site development, such as for a cap or cover system.

(4) A periodic review report that includes the institutional controls and engineering controls (IC/ECs) certification as well as all other reporting of the IC/ECs, site monitoring, and/or operation and maintenance of the remedy.

6.4.3.2 Institutional Control and Engineering Control Certification

Upon approval of the final SMP and following the first year of post-remedial operation, Tecumseh will complete and submit to the NYSDEC an Annual Periodic Review Report (PRR). The annual report will be consistent with the requirements of DER-10. The IC/EC Certification will clearly identify the periodic review period and certify that:

(1) The institutional controls and/or engineering controls employed at the Site are:

a. Unchanged from the date the control was put in place, unless otherwise approved by the NYSDEC.

b. In place and effective.

c. Performing as designed.

d. Nothing has occurred that would impair the ability of the controls to protect the public health and environment.

e. Nothing has occurred that constitutes a violation or failure to comply with any operation and maintenance plan for such controls.

(2) Use of the Site complies with the environmental easement.

(3) Access to the Site will be provided to the NYSDEC to evaluate the remedy and verify continued maintenance of such controls.

(4) If a financial assurance mechanism is required, the mechanism remains valid and sufficient for the intended purpose.

Since the remedy requires both institutional and engineering controls, the certification must be made by a qualified environmental professional. If engineering evaluations are required, the certification will be made by a licensed Professional Engineer.

6.4.3.3 Site Monitoring Plan

The Site Monitoring Plan will consist of a sampling and analysis plan for monitoring groundwater designed to:

(1) Assess the remedy's compliance with groundwater standards.

(2) Evaluate Site information periodically to confirm that the remedy continues to be effective for the protection of public health and the environment.

(3) Prepare the necessary reports of the results of this monitoring for a period determined by the NYSDEC.

A LTGWM Plan has been prepared for the Site to monitor the effectiveness of the source area removals, treatment, and controls to be implemented during the CMS (see Appendix T). Downgradient groundwater quality and flow will be monitored along the perimeters (i.e., surface water discharge areas) of the Site with intermittent spatial monitoring of cross- and upgradient groundwater throughout the interior of the Site for completeness. Groundwater monitoring will include all completed and to-be-completed CMS operable units to assess their effectiveness in collecting, containing, and/or controlling impacted groundwater flows, as necessary.

Indirectly, LTGWM is already being conducted for some areas of the Site. Post-closure activities are currently being conducted at the HWMUs 1A, 1B, and 2 (SWMUs S-13, S-16, and S-03, respectively), and the Benzol Yard (SWMU P-11), which are effectively monitoring downgradient groundwater quality and flow across much of the Lake Erie discharge boundary and a small portion of the Ship Canal discharge area. Although groundwater monitoring is being performed to satisfy the post-closure requirements of those units, the data collected will be incorporated into the CMS site-wide LTGWM Plan for completeness. Once the final corrective measures are selected, groundwater quality and flow monitoring will be initiated and incorporated into the site-wide LTGWM Plan.

6.4.3.4 Operation, Maintenance, & Monitoring Plan

OM&M Plans will be prepared when any mechanical or physical components of the remedial program require operation and maintenance. Such components of the remedial program include air, groundwater, soil, and/or water treatment systems; groundwater or leachate collection and/or extraction systems; gas venting/treatment systems and soil vapor intrusion mitigation measures or other components of the remedial system, including engineered caps and soil covers. At the conclusion of the corrective measure for each operable unit, an OM&M Plan will be prepared and implemented. In accordance with Section 6.2.3 of DER-10 (Ref. 9), OM&M Plan(s) for the various Operable Units on the Site will:

(1) Be a sufficiently complete description of the steps necessary to allow individuals unfamiliar with various SWMUs, SWMU Groups, and Operable Units or ECMs across the Site to operate and maintain the mechanical and physical components of the numerous corrective measures to be, or already, implemented for the Site, including OM&M manuals as needed.

(2) Include information on considerations for optimization of the systems.

(3) Require the collection of data to allow:

   a. The calculation and reporting of contaminant mass recovered, treated, or destroyed by the operating system(s); and/or

   b. To document and report that the system(s) is/are achieving the design performance standards.

(4) Include provision for periodic updating during use, to reflect:

   a. Changes in site conditions.

   b. The manner in which the remedy is operated and maintained.

   c. Optimization or other changes to the system(s).

(5) Incorporate the relevant portions of other documents, such as:

   a. Manufacturer O&M manuals, including instructions for operating and maintaining the equipment, equipment catalog-cuts, and/or any component- or process-specific special procedures.

   b. Specifications from the contract documents, shop drawing, or "as-built" drawings.

c. Any applicable requirements of federal, state, and local regulations (e.g., building or fire codes, utility requirements).

(6) Include a health and safety plan (HASP).

7.0 SCHEDULE

Design and construction of the corrective measures recommended in Section 5 for the CMS Area are proposed to be implemented over a 7-year period following NYSDEC approval of the final CMS Report and execution of new Corrective Action Order(s) On Consent between NYSDEC and Tecumseh Redevelopment Inc. A detailed implementation schedule and Work Plan would be incorporated into the Order(s).

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