STATEMENT OF BASIS

Watervliet Arsenal
Main Manufacturing Area
Watervliet, Albany County
EPA No. NY7213820940 / Site No. 401034A

August 2012

SECTION 1: INTRODUCTION

The New York State Department of Environmental Conservation (Department) has determined that hazardous wastes and/or hazardous constituents were released into the environment at the Main Manufacturing Area (MMA) of the Watervliet Arsenal (WVA), located in the City of Watervliet, Albany County, New York (facility). The Department has selected the proposed final corrective measures for the facility. The proposed corrective measures are intended to attain the cleanup objectives identified for this facility for the protection of public health and the environment. This Statement of Basis identifies the proposed corrective measures, summarizes the other alternatives considered, explains the reasons for selecting the proposed remedy, and solicits public involvement in the selection of corrective measures. The Department will select final corrective measures only after the public comment period has ended and the information submitted during this time is reviewed and considered in the decision-making process.

The purpose of this Statement of Basis is to provide an opportunity for the public to be informed of and to participate in the development of the remedial program for the facility. Public input on all potential remedial alternatives, and on the information that supports the alternatives, is an important contribution to the corrective measure selection process. The Department may modify the proposed remedy or select another remedy based on new information and/or public comments. The Statement of Basis summarizes and highlights key information from the RCRA Facility Investigation (RFI) and the Corrective Measures Study (CMS) reports, but is not a substitute for these documents. The RFI and CMS reports and the administrative record are more complete sources of information regarding the corrective measures. These documents may be reviewed at the document repository identified in Section 2, below.

SECTION 2: CITIZEN PARTICIPATION

The Department encourages the public to review and comment on all of the corrective measure alternatives described in this document and on any additional options not previously identified and/or studied. Public input on all potential remedial alternatives, and on the information that supports the alternatives, is an important contribution to the corrective measure selection process. The Department may modify the proposed remedy or select another remedy based on new information and/or public comments. Therefore, the public is encouraged to review and comment on the proposed remedy identified herein. The Department will address all comments received during the public comment period in the Response to Comments document. The preferred remedy in the Statement of Basis is a preliminary determination. Should another option be selected as the remedy based on public comment, new information, or a re-evaluation of existing information, any significant differences from this Statement of

Basis will be explained in the Response to Comments document. The Response to Comments will be sent to any person who requests such notice.

A public comment period has been set from August 20, 2012 to September 19, 2012.

In lieu of, or in addition to the submission of written comments, any interested person may request a public hearing. Any request for a public hearing must be in writing and must state the nature of the issues proposed to be raised in the hearing.

All comments and/or requests for a public hearing must be submitted no later than **September 19, 2012** to the attention of**:**

Larry Alden
NYSDEC
DER, Remedial Bureau B
625 Broadway, 12th Floor
Albany, NY 12233-7016

E-mail: ljalden@gw.dec.state.ny.us

Document Availability

This document summarizes information that can be found in greater detail in the administrative record for the facility. The administrative record contains many reports, including investigations and sampling results which the Department used to select the proposed final corrective measures. A list of all reports is referenced in Appendix A of this Statement of Basis and the referenced reports are available for review. The public is encouraged to review these documents, which are available at the following repository:

Watervliet Public Library
1501 Broadway
Watervliet, New York 12189-2895
Telephone: (518) 274-4471

To Receive Site Citizen Participation Information by Email

Please note that the Department's Division of Environmental Remediation (DER) is "going paperless" relative to citizen participation information. The ultimate goal is to distribute citizen participation information about contaminated sites electronically by way of county email listservs. Information will be distributed for all sites that are being investigated and cleaned up in a particular county under the State Superfund Program, Environmental Restoration Program, Brownfield Cleanup Program, Voluntary Cleanup Program, and Resource Conservation and Recovery Act Program. We encourage the public to sign up for one or more county listservs at http://www.dec.ny.gov/chemical/61092.html.

SECTION 3: FACILITY BACKGROUND

Site Description and History

Location: The Watervliet Arsenal (WVA) is a 140-acre government-owned installation under the command of the U.S. Army Tank-Automotive and Armaments Command. Located in the City of

Watervliet, New York, the WVA is situated on the western shore of the Hudson River five miles north of the City of Albany.

Site Features: The Watervliet Arsenal currently consists of two primary areas: the Main Manufacturing Area (MMA) (125 acres), where manufacturing and administrative operations occur, and the Siberia Area (15 acres), which is primarily used for the storage of raw and hazardous materials, finished goods, and supplies brought from the MMA.

The Siberia Area was addressed in a separate Statement of Basis issued by the Department in September 2008.

The MMA is bounded on the east by Broadway (Route 32) and a six-lane highway (I-787), which separate the WVA from the Hudson River. Residential/light commercial properties are located along the northern and southern site boundaries. To the west of the MMA are: residential properties; the Siberia Area of WVA, which extends into the Town of Colonie; commercial properties; lands formerly owned by the Delaware and Hudson Railroad; and Canadian Pacific railroad tracks.

The Main Manufacturing Area ranges in elevation from approximately 18 feet above mean sea level at the eastern site boundary along the Hudson River to approximately 75 feet in the area of Buildings 135 and 125, in the southwestern portion of the site. Topography at the site generally slopes gently to the east and west, away from the topographic high. The topography of some areas of the MMA is believed to have been significantly altered through filling and construction activities at the site (i.e., road construction and building foundation construction).

Current Zoning/Use: The Watervliet Arsenal is zoned industrial.

Historical Use: The WVA is a national registered historic landmark, and was established in 1813 with the purchase of 12 acres of land by the U.S. War Department. The original purpose of the WVA was to distribute supplies (i.e., ammunition, harnesses, and gun cartridges) to troops along the northern and western frontiers. The Erie Canal, formerly located in the eastern portion of the MMA, was built between 1817 and 1824. The canal was abandoned and relocated to Waterford in 1922 and was filled in with dirt, brick, and other fill material in the early 1940s.

Over the years, the main function of the WVA changed from the production of small arms ammunition, cannon cartridges, and leather goods to the production of the nation's first 16-inch gun. The WVA currently manufactures large caliber cannons and mortars. Manufacturing operations at the MMA include forging and machining of gun tubes, chrome plating, heat treating, and materials testing. An on-site industrial wastewater treatment plant treats acidic rinse waters from chromium plating operations and soluble waste oils from machining operations. Past operations at the MMA included solvent degreasing of machined materials, chromium wastewater collection and treatment (from plating operations), and storage of metal chips coated with cutting oils.

Site Geology and Hydrogeology: A majority of WVA is underlain by recent alluvial deposits. These deposits may be underlain by the Normanskill Shale, which is comprised of minor mudstone and sandstone and is dark gray to black in color. However, based on recent field observations, and the absence of sandstone, it is likely that the bedrock beneath the site is the Snake Hill Formation, which is comprised mainly of dark gray shale. This unit lies stratigraphically above the Normanskill Shale. During the site investigations, highly weathered shale was encountered from approximately one to 18 feet below ground surface (bgs). In general, competent bedrock was encountered from approximately 12 to 18 feet bgs.

Groundwater flow at the Main Manufacturing Area is primarily controlled by bedrock surface topography. The most prominent feature on the potentiometric surface is a hydraulic divide running roughly north to south through Buildings 135 and 130, in the western portion of the site. The position of this divide follows the bedrock ridge identified in the area of these buildings, and the site topographic high in the southwest corner of the Main Manufacturing Area. Groundwater to the east of this divide flows eastward towards the Hudson River. Groundwater to the west of this divide flows westward towards the Siberia Area.

A site location map is attached as Figure 1 and a facility map is attached as Figure 2.

SECTION 4: ENFORCEMENT STATUS

6NYCRR Part 373 includes RCRA Corrective Action. This requires owners and/or operators of hazardous waste treatment, storage and disposal facilities to investigate and, when appropriate, remediate releases of hazardous wastes and/or constituents to the environment. In relation to this facility, the Department, in conjunction with the United States Environmental Protection Agency Region 2 (USEPA) issued an Administrative Order on Consent (Order) to the WVA pursuant to Section 3008(h) of the Resource Conservation and Recovery Act (RCRA), as amended by the Hazardous and Solid Waste Amendments of 1984, 42 U.S.C. §6901, and Section 71-2727 of the New York State Environmental Conservation Law. This order, which was effective October 12, 1993, required the WVA to identify and fully investigate the nature, rate of migration, and extent of contamination at the facility through a RCRA Facility Investigation (RFI), evaluate potential corrective measures through a Corrective Measures Study (CMS), and implement these remedies as Interim and Final Corrective Measures.

SECTION 5: RCRA FACILITY INVESTIGATION (RFI)

The RCRA Corrective Action process began with investigations to evaluate potential areas of the facility that may have been impacted by hazardous wastes and/or hazardous constituents. Based on the results of investigations, the Department has determined that hazardous wastes and/or hazardous constituents have been released at the facility. The impact of releases of hazardous wastes and/or hazardous constituents at the facility were characterized and evaluated.

Manufacturing operations at the MMA include forging and machining of gun tubes, chrome plating, heat treating, and materials testing. An on-site industrial wastewater treatment plant treats acidic rinse waters from chromium plating operations and soluble waste oils from machining operations. Past operations at the MMA included solvent degreasing of machined materials, chromium wastewater collection and treatment (from plating operations), and storage of metal chips coated with cutting oils.

Surface soil contamination is generally not present since the majority of process areas at MMA are covered by asphalt, concrete, or buildings. Subsurface soil contamination is primarily related to the presence of polynuclear aromatic hydrocarbons (PAHs) and metals. Chromium and arsenic were the primary inorganic contaminants detected in the subsurface soil samples. Groundwater contamination in the MMA is primarily chlorinated volatile organic compounds (CVOCs). The presence of these compounds in groundwater is assumed to be from vapor degreasing operations conducted in the MMA prior to 1982. Petroleum, oils, and lubricants (POLs) associated with historic machining operations are also present beneath some of the manufacturing buildings as light non-aqueous phase liquids (LNAPL).

The analytical data collected for the facility includes the following:

	VOCs	SVOCs	Inorganics	Pesticides	PCBs
Soil	X	X	X	X	X

Groundwater	X	X	X	X	X
Soil Vapor	X				
Indoor Air	X				

Notes:
VOCs – Volatile Organic Compounds
SVOCs – Semi-Volatile Organic Compounds
PCBs – Polychlorintated Biphenyls

The data have identified contaminants of concern. A “contaminant of concern” is a hazardous waste that is sufficiently present in frequency and concentration in the environment to require evaluation for remedial action. Based on the results, the Department determined that corrective measures were required to address some of the areas investigated. The RCRA Facility Investigation Report contains a full discussion of the data. The nature and extent of contamination and environmental media requiring action are summarized in **Exhibit A**.

The contaminants of concern identified at this facility are:

1. Soil – Metals (arsenic, chromium, lead, mercury), SVOCs (benzo(a)anthracene, benzo(a)pyrene)
2. Groundwater – VOCs (1,1,1-trichloroethane, 1,1-dichloroethane, 1,1-dichloroethene, 1,2-dichloroethene, trichloroethene, vinyl chloride)
3. Soil Vapor – VOCs (carbon tetrachloride, chloromethane, trichloroethene, tetrachloroethene)
4. Indoor Air - VOCs (trichloroethene)

As illustrated in Exhibit A, the contaminants of concern exceed the cleanup objectives for:

1. Soil – NYCRR Part 375 Soil Cleanup Objectives
2. Groundwater – NYSDEC Class GA Groundwater Standards & Guidance Values
3. Soil Vapor & Indoor Air – NYSDOH Guidance for Evaluating Soil Vapor Intrusion in the State of New York

SECTION 6: INTERIM CORRECTIVE MEASURES

If at any time during an investigation, it becomes apparent that corrective actions should be taken to immediately address the spread of contamination, interim corrective measures must be taken. The design emphasis is to construct an Interim Corrective Measure (ICM) as close as possible to a permanent system or final remedy. The Department has determined that the ICMs are protective to human health and the environment, and could serve as part of the Final Corrective Measures at the facility.

The following ICMs have been completed at the facility based on conditions observed during the RFI.

Building 25 Groundwater Enhanced Bioremediation ICM

Based on data collected during the RFI and long-term monitoring (LTM) program, aquifer conditions at Building 25 were generally favorable for the degradation of CVOCs in both the overburden and bedrock groundwater via reductive dechlorination. For reductive dechlorination to completely degrade CVOCs, the geochemical conditions in the subsurface must be ideal. Testing performed prior to the ICM, found that a lack of an energy source in the subsurface could potentially limit the microbial processes that result in complete reductive dechlorination. The injection of Hydrogen Release Compound (HRC®) was therefore selected as an interim corrective measure to enhance the natural attenuation processes in the overburden and bedrock groundwater at Building 25 by adding an energy source to the system. The HRC® was injected into the overburden and bedrock in the area east of Building 25 in February 2004.

Approximately 1,350 pounds of HRC® was injected in the overburden, and approximately 2,600 pounds of HRC® was injected into the bedrock.

The HRC® was successfully delivered and distributed into the overburden and bedrock groundwater as shown by the detection of HRC® at the most downgradient well (MW-7) (Figure 3). The ICM results showed that the geochemistry and presence of electron donors in the groundwater at Building 25 after the completion of the injections were adequate for reductive dechlorination. The concentrations of CVOCs in the groundwater decreased by 31 to 99 percent, depending on the sampling location. In addition, the relative proportion of the parent CVOC (i.e., tetrachloroethene or trichloroethene) decreased by more than 38 percent at all locations. Based on the data collected during and after the ICM, the injection of HRC® was successful in promoting the biodegradation of CVOCs in both the overburden and bedrock groundwater through reductive dechlorination. Trends in the concentration of daughter products and the concentrations of dissolved gases in the groundwater indicate that complete degradation of the CVOCs is still occurring more than 7 years after the ICM injections. More importantly, CVOC concentrations in the most downgradient monitoring well (MW-7) were significantly reduced to concentrations less than NYSDEC Class GA Groundwater Standards.

These results indicate that biodegradation of the CVOCs in the groundwater at Building 25 will continue in the future. This conclusion has been supported by groundwater results from groundwater monitoring events conducted from 2006 through 2011.

Building 40 Bedrock Groundwater In-Situ Chemical Oxidation ICM

Extensive hydrogeologic characterization investigations were performed in the bedrock aquifer in the Building 40 area during the RFI studies. These investigations revealed that dissolved-phase CVOC concentrations indicating the potential presence of dense non-aqueous phase liquid (DNAPL) were present in bedrock groundwater. The original source of the CVOCs in the bedrock groundwater is presumed to be located in the northeastern portion of Building 40. Since significant CVOC concentrations were not detected in the overburden soil in this area, it is possible that the release occurred through a subsurface storm sewer that was once connected to floor drains in the building.

Although fractures provide the only pathway for advective transport of groundwater and CVOCs through the bedrock aquifer, the ratio of the void space due to the presence of fractures to the bulk rock volume ("fracture porosity") is several orders of magnitude less than the matrix porosity of the rock itself – meaning that the capacity of the rock matrix to store CVOCs is orders of magnitude greater than the storage capacity in the fractures. This matrix storage capacity creates a diffusive gradient by which CVOCs present at high concentrations in the fractures can diffuse into the bedrock pore spaces. Thus, although DNAPL may still exist in some fractures, the majority of the DNAPL that was initially present in the fractures has likely dissipated due to dissolution and diffusive mass transfer to the rock matrix -- causing nearly all the VOC mass to now reside in the rock matrix and not in the bedrock fractures. This concept has been confirmed by the presence of high concentrations of CVOCs in bedrock core samples obtained during the RFI studies. Given these data, and the lack of any current surficial sources, it is presumed that the shale bedrock itself is the continuing source of the CVOCs in the groundwater.

The Building 40 bedrock groundwater in-situ chemical oxidation (ISCO) ICM included injections of sodium permanganate (hereafter referred to as permanganate) and groundwater sampling at the WVA property boundary (Figure 4). The Corrective Action Objective (CAO) for the ICM was to reduce the concentration of hazardous constituents (CVOCs) in groundwater migrating from the site to New York State Class GA Standards. However, given the likely presence of DNAPL in the fractured rock at the site, it was recognized that the achievement of the CAO may require an extensive time period and may not be achievable using currently available technologies.

The ICM was initiated in September 2004 with injections of permanganate on the west side (upgradient) of Building 40. Full scale injections into all injection wells were initiated in August 2005. The maximum permanganate distribution in the property boundary monitoring wells was achieved during the first full-scale injection event in August 2005 when permanganate was delivered to nine of the 18 compliance monitoring zones. Beginning with the November 2005 injection event, and in subsequent injection events, injection well clogging (presumably from the formation of manganese dioxide precipitates) limited the amount and/or rate of oxidant that could be delivered to the injection wells. Clogging in the injection wells was accompanied by a decrease in permanganate distribution in the compliance monitoring zones

The results of the ICM showed that the permanganate injections had not decreased groundwater VOC concentrations at the property boundary to less than NYSDEC Class GA standards/guidance values. This was likely due to the persistent clogging problems that likely resulted from the oxidation of the injected permanganate mass to insoluble precipitates through interaction with the rock matrix, specifically the reduced sulfur (i.e., pyrite), present in the rock. This interaction with the bedrock greatly limited the effectiveness of the permanganate injections.

Vapor Intrusion Interim Corrective Measures

The WVA performed a vapor intrusion investigation within, and adjacent to, the MMA. A total of 26 buildings in the MMA were sampled during the investigation. Nine buildings were found to require mitigation based on the exceeding of sub-slab soil vapor or indoor guidance values for CVOCs. These buildings are shown on Figure 5 and summarized in the table below.

Building	Impacted Media	Target CVOCs
20	Sub-Slab Soil Vapor	PCE, TCE, 1,1,1-TCA
21	Sub-Slab Soil Vapor	TCE
22	Sub-Slab Soil Vapor	TCE
25	Indoor Air, Sub-Slab Soil Vapor	TCE, 1,1,1-TCA
40	Indoor Air, Sub-Slab Soil Vapor	PCE, TCE
114	Indoor Air, Sub-Slab Soil Vapor	PCE, TCE
120	Sub-Slab Soil Vapor	PCE, Carbon Tetrachloride
121	Sub-Slab Soil Vapor	TCE
130	Sub-Slab Soil Vapor	TCE

Interim corrective measures were conducted for each of these buildings to mitigate the soil vapor impacts. For all buildings except Building 40, the ICMs consisted of the installation and operation of subsurface depressurization systems (SSDSs). Due to the large differences in the size, layout, and use of the buildings, the type of and operational parameters for the SSDSs varied from building to building.

The SSDSs in the eight buildings were installed and activated in 2010. The systems are operating as designed and are successfully mitigating vapor intrusion into the buildings. Monitoring and maintenance of the systems will be continued by the WVA.

Due to the construction and age of the Building 40 foundation (field stone with partial basement), the use of subsurface depressurization was not applicable. Therefore, indoor air filtration was utilized as the mitigation measure for the Building 40 indoor air. The mitigation measure consisted of the installation of eight air filtration units (AFUs) in the impacted areas of the building. These units consisted of 1,000 to 2,000 cubic feet per minute (CFM) capacity AFUs equipped with granular activated carbon/permanganate filter media for CVOC treatment. The AFUs were installed in 2006 and were activated in January 2007. The WVA monitors the operation of the units during monthly inspections and during semi-annual filter media testing. Filter media is replaced based on the results of the testing.

SECTION 7: CORRECTIVE MEASURES STUDY (CMS)

Potential final corrective action measures for the facility were identified, screened, and evaluated in the CMS report. To be selected, the proposed final corrective measures must be protective of human health and the environment, be cost-effective, comply with other statutory requirements, and utilize permanent solutions, alternative technologies, or resource recovery technologies to the maximum extent practicable. The final corrective action measures for the facility must address potential routes of exposure to humans and the environment and attain the cleanup objectives identified for the facility, which are presented in **Exhibit B**.

A summary of the corrective measure alternatives that were considered for the facility is presented in **Exhibit C**. Cost information is presented in the form of present worth, which represents the amount of money invested in the current year that would be sufficient to cover all present and future costs associated with the alternative. This enables the costs of remedial alternatives to be compared on a common basis. As a convention, a time frame of 30 years is used to evaluate present worth maintenance. A summary of the Proposed Corrective Measure Alternatives Costs is included as **Exhibit D**.

7.1: Evaluation of Corrective Measure Alternatives

A detailed discussion of the evaluation criteria and comparative analysis is included in the final CMS report.

The general performance standards for corrective measures that must be satisfied in order for an alternative to be considered for selection are listed below.

1. Protection of Human Health and the Environment. This criterion is an overall evaluation of each alternative's ability to protect public health and the environment.

2. Achieve Cleanup Objectives for the Contaminated Media. – This criterion evaluates the ability of alternatives to achieve the cleanup objectives established for the facility.

3. Remediate the Sources of Releases. – This criterion evaluates the ability of the alternatives to reduce or eliminate to the maximum extent possible further releases.

4. Comply with Standards for Management of Wastes. – This criterion evaluates how alternatives assure that management of wastes during corrective measures is conducted in a protective manner.

The next five selection criteria are used to compare the positive and negative aspects of each of the remedial alternatives.

5. Long-term Effectiveness and Permanence. This criterion evaluates the long-term effectiveness of the remedial alternatives after implementation. If wastes or treated residuals remain on-site after the selected remedy has been implemented, the following items are evaluated: 1) the magnitude of the remaining risks, 2) the adequacy of the engineering and/or institutional controls intended to limit the risk, and 3) the reliability of these controls.

6. Reduction of Toxicity, Mobility or Volume. Preference is given to alternatives that permanently and significantly reduce the toxicity, mobility, or volume of the wastes at the facility.

7. Short-term Impacts and Effectiveness. The potential short-term adverse impacts of the remedial action on the community, the workers, and the environment during the construction and/or implementation are evaluated. The length of time needed to achieve the cleanup objectives is also estimated and compared against the other alternatives.

8. Implementability. The technical and administrative feasibility of implementing each alternative are evaluated. Technical feasibility includes the difficulties associated with the construction of the remedy and the ability to monitor its effectiveness. For administrative feasibility, the availability of the necessary personnel and materials is evaluated along with potential difficulties in obtaining specific operating approvals, access for construction, institutional controls, and so forth.

9. Cost-Effectiveness. Capital costs and annual operation, maintenance, and monitoring costs are estimated for each alternative and compared on a present worth basis. Although cost-effectiveness is the last balancing criterion evaluated, where two or more alternatives have met the requirements of the other criteria, it can be used as the basis for the final decision.

SECTION 8: ELEMENTS OF THE PROPOSED CORRECTIVE MEASURE

The basis for the Department's proposed corrective measure is set forth in **Exhibit E**.

The elements of the proposed corrective measure are as follows:

Building 25 Groundwater

Based on the results of the investigations at the site, the ICM that has been performed, and the evaluation presented here, the Department is proposing No Further Action with continued long-term monitoring of the ongoing natural attenuation as the proposed final corrective measure for the groundwater at Building 25. Based on the results and conclusions from the Enhanced Bioremediation Interim Corrective Measure, the proper geochemistry and nutrient supply necessary for sustaining natural attenuation of CVOCs is present. The CVOCs in the groundwater at Building 25 are also localized to the Pilot Study Area and are not migrating beyond the WVA property; therefore, the proposed final corrective measure should achieve CAOs for the groundwater at Building 25 over the long term.

Building 40 Groundwater

Based on the results of the ICM and subsequent technology review, the Department has determined that achievement of the CAO for the Building 40 bedrock groundwater is not technically feasible using currently available technologies. It is therefore recommended that No Further Action beyond natural attenuation, documented through long-term groundwater monitoring, be selected as the final corrective measure for the Building 40 bedrock groundwater since there are no known exposure pathways, except vapor intrusion (see below)..

Vapor Intrusion

Based on the results of the investigations at the site, the ICM that has been performed, and the evaluation presented here, the Department is proposing No Further Action with continued operation and monitoring of the subsurface depressurization systems (SSDSs) as the final corrective measure for vapor intrusion in Buildings 20, 21, 22, 25, 114, 120, 121, and 130.

The proposed final corrective measure chosen for indoor air for Building 40 is to continue to operate the indoor air filtration units used to treat the air in this building.

Site Management/Land Use Controls

The selected remedy recognizes the remediation of the site completed by the ICMs described in Section 6. Site management and land use controls (LUCs) are necessary to protect public health and the environment from contamination remaining at the site after the ICMs.

The selected remedy includes a Site Management Plan which will be developed to include:

- Provisions for the continued proper operation and maintenance of the components of the remedy;
- Measures for controlling future excavation and other actions that could otherwise disturb residual subsurface contamination. Excavated soil would be tested, properly handled to protect the health and safety of workers and the nearby community, and would be properly managed in a manner acceptable to the Department;
- Provisions to maintain a site cover, which may consist either of the structures such as buildings, pavement, and sidewalks comprising the site development, or a minimum one-foot soil cover in areas where the upper foot of exposed surface soil will exceed the applicable soil cleanup objectives;
- A long-term monitoring program for groundwater and indoor air;
- Land use restrictions, including restrictions on groundwater use, and an acceptable method for evaluating potential impact that the remaining contaminants have on future development;
- Periodic certification to EPA and NYSDEC, submitted by a professional engineer or environmental professional acceptable to NYSDEC, stating that the LUCs put in place are unchanged from the previous certification, and that nothing has occurred that would impair the ability of the control to protect public health or the environment or constitute a violation or failure to comply with the site management plan.

LUCs will be maintained until the hazardous substances reach levels that allow unlimited use and unrestricted exposure or until the Department determines that continued operation is technically impracticable or not feasible.

TACOM is responsible for implementing the LUCs with regard to the property. If the property is transferred out of federal ownership, it is the Department's intention that all continuing LUCs, reporting requirements, and any other obligations relating to the property will be satisfied through the United States' conveyance of a deed restriction/environmental easement prior to any such transfer of any deed to the property.

While it is the Department's intention that any such deed restriction/environmental easement would require that the transferee (and subsequent transferees) to satisfy all of TACOM 's obligations relating to the property, TACOM acknowledges that, notwithstanding this intention, it (or any other successor federal entity on behalf of the United States) remains ultimately responsible for satisfying the remedial obligations set forth in this Statement of Basis relating to the property if any subsequent transferee fails to satisfy the remedial obligations in this regard.

Cost

The cost to construct the remedy (the Interim Corrective Measures) was **$3,247,000** and the estimated average annual cost after construction of the remedy is **$112,000**. The estimated present worth cost to implement the remedy, including the cost of long-term monitoring which began in 1999, is **$6,909,000**.

STATEMENT OF BASIS

Exhibits A through E

Watervliet Arsenal
Main Manufacturing Area
Watervliet, Albany County
EPA No. NY7213820940 / Site No. 401034A

August 2012

Exhibit A

Nature and Extent of Contamination

This section describes the findings of the RCRA Facility Investigation for all environmental media that were evaluated. As described in Section 5, samples were collected from various environmental media to characterize the nature and extent of contamination.

For each medium, a table summarizes the findings of the investigation. The tables present the range of contamination found at the facility in the media and compares the data with the applicable standards, criteria, or guidance (SCGs) for the facility. The contaminants are arranged into four categories: volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), pesticides/polychlorinated biphenyls (PCBs), and inorganics (metals and cyanide). For comparison purposes, the SCGs are provided for each medium that allows for unrestricted use. For soil, the Restricted Use SCGs are also presented.

Solid Waste Management Units (SWMUs) / Areas of Concern (AOCs)

A SWMU includes any discernible unit at which solid wastes have been placed at any time, irrespective of whether the unit was intended for the management of hazardous or solid wastes. Such units include any area at the facility where solid wastes have been routinely and systematically released. An AOC is an area at the facility, or an off-site area, which is not at the time known to be SWMU, where hazardous wastes and/or constituents are present or are suspected to be present as a result of a release from the facility. Solid wastes are defined in 6 NYCRR Part 371.1(c) and hazardous wastes are defined in 6 NYCRR Part 371.1(d).

There were 24 Solid Waste Management Units (SWMUs) identified the MMA (Figure 6). The nature and extent of contamination at the MMA SWMUs is discussed below.

SWMU No. 1 - Sludge Drying Beds: There are five sludge drying beds at the industrial wastewater treatment plant, which was built in 1970 (Building 36). In 1975, one of the beds was converted to an emergency holding tank that was determined to be a surface impoundment as stated in 40 CFR Part 260.10. Hazardous waste was stored in this bed for periods greater than 90 days, which necessitated the application for a Part B Permit upon the enactment of the RCRA regulations. WVA formally closed the bed in October 1987. Changes in the closure rules required additional soil removal for clean closure. WVA performed this additional work in January 1994. The Department accepted the clean closure in a letter dated May 3, 1994 and no further action was required.

SWMU No. 4 - Demolished Cyanide Treatment Facility: The cyanide treatment facility (located in the former Building 110A) was constructed in 1969 and operated until 1978. The piping and tanks for the facility were above ground. Use of the cyanide treatment facility was discontinued in 1978 when cyanide plating rinse waters were sent to the WVA Industrial Wastewater Treatment Plant (see SWMU 6) through a newly constructed dedicated sewer (see SWMU 20). The cyanide treatment facility (and associated pipes and tanks) was demolished in 1981 as part of a WVA modernization project. Analytical results from soil and groundwater samples collected during the RFI indicated that elevated levels of cyanide were not present in the vicinity of the former facility. This SWMU was therefore identified as not being a source of contamination and no further actions were required.

SWMU No. 5 - Building 25: A self-contained vapor degreaser unit located in the southeast quadrant of Building 25 was installed around 1970 and ceased operation in 1982. The original degreaser used for cleaning small metal components in Building 25 was tetrachloroethene (PCE), which was eventually replaced by trichloroethene (TCE) and 1,1,1-trichloroethane (1,1,1-TCA). Potential releases of these chlorinated solvents to the soil and groundwater at Building 25 could have been through vents in the exhaust system, spills, and disposal of spent solvents. Chlorinated volatile organic compounds (CVOCs), including PCE, TCE, and 1,1,1-TCA were discovered in downgradient groundwater monitoring wells in 1986 and also in soil and groundwater samples collected during the RFI. This SWMU was addressed by the ICM described in Section 6.

SWMU No. 6 - Wastewater Treatment Plant: An on-site treatment facility (Building 36) that treats mainly acid rinse waters (acidic chromium metal plating wastes) and soluble waste oil was constructed in 1969 and put on-line in 1970. In accordance with a RCRA exemption de-listing the waste, the sludge generated from the facility is dewatered and disposed in an industrial non-hazardous waste landfill. Treated effluent is discharged into the Hudson River (WVA Outfall 002) in accordance with a State Pollutant Discharge Elimination System (SPDES) permit. In January 1996, there was evidence of a leak in the underground single-walled transfer line from the indoor clarifiers to the outside sludge drying beds. Remedial actions included soil removals. In 1996, the broken transfer line was replaced with a 12,000 gallon waste soluble oil underground storage tank (UST). Analytical results from soil and groundwater samples collected during other investigations indicated that RCRA-listed metals (i.e., chromium) were not present in the vicinity of the former facility. No further remedial activity is required for this SWMU.

SWMUs Nos. 7 through 14 - Underground Waste Oil Storage Tanks (USTs): Eight USTs in the MMA were designated for waste oil storage, but were reportedly used to store hydraulic oil, lubricants, non-chlorinated degreasing solvents, chlorinated solvents, and skim oil, which were produced during various manufacturing activities that took place at WVA. All eight USTs were removed and/or replaced and no significant residual contamination remained after removal and/or replacement of any of the USTs. No further action is required for these SWMUs.

SWMU 15 - UST 13: This SWMU is the former location of a leaking 1,000-gallon underground waste oil storage tank located east of Building 15. The UST was removed and replaced in 1995. The site was closed clean and approved by the Department in February 1995. No further action is required for this SWMU.

SWMU 16 - UST 23: This SWMU is the former location of a 1,000-gallon waste oil storage tank in the west central portion of Building 35. The UST was removed in 1994 and replaced with a new tank and piping located in another section of Building 35 (Note: The new UST was removed in 2010 and was not replaced). Composite soil samples that were collected from the excavation pit showed no reportable detections for VOCs and semi-volatile organic compounds (SVOCs). The excavated pit was backfilled with clean sand. No further action is required for this SWMU.

SWMU 17 - UST 25: This SWMU is a 5,000-gallon waste oil storage tank located east of Building 36. The line and the tank were certified as being free of any leaks based on two tightness tests conducted on January 10, 1995 and February 22, 1996. No further action is required for this SWMU.

SWMU No. 19 - Outfall No. 003: Outfall 003 is the main WVA outfall to the Hudson River. This outfall includes the effluent from the industrial wastewater treatment plant. Prior to the construction of the plant in 1970 and the cyanide treatment plant in 1978, waste was discharged directly to the Hudson River via this outfall. This outfall is monitored in accordance with the WVA's SPDES permit, which is regulated by the Department. It was determined prior to the RFI that no hazardous materials remained in this outfall. No further action is required for this SWMU.

SWMU No. 20 - Industrial Sewers: There are three types of waste lines that convey waste material to the on-site treatment plant in separate industrial sewers: acid rinse water, soluble waste oil, and cyanide rinse water. The acid rinse water and soluble sewers were installed in the early 1970s. The cyanide rinse water sewers were installed in the late 1970s and put on-line in 1978. Use of the cyanide rinse water sewers was discontinued in 1994 when cyanide plating operations ended and the sewers were disconnected from the plating operations. In May 1993, during preventive maintenance, a number of potential leaking points were detected on the chromic acid rinse water line. Extensive line repair, soil removal, and groundwater extraction and monitoring were subsequently performed and all of the waste lines were upgraded in 1993 and 1994. Additional RFI activities, which included groundwater sampling, were initiated in 2000 to evaluate whether additional releases had occurred in the past. Contaminants of concern (COCs) were not detected in the groundwater. No further remedial activity is required for this SWMU.

SWMU No. 21 - Building 132 Incinerator: The Building 132 incinerator was built in 1944 and used to dispose of non-hazardous waste, primarily consisting of waste paper and office trash until 1975, when the incinerator was decommissioned. Subsequently, the building was used for the storage of pesticides and insecticides. This practice was ended in the 1990s when the WVA switched to the use of an outside contractor for pest and weed control services. The building is currently used for the storage of non-manufacturing recycling materials (i.e., paper) before shipment off-site. Based on RFI groundwater and soil results that did not indicate the presence of contamination at concentrations greater than guidance levels, no further action is required for this SWMU.

SWMU No. 25 - Erie Canal: The former Erie Canal passed through the eastern portion of MMA. The Canal was built between 1817 and 1824. When present, the canal provided transportation, power, and water for fire protection for the WVA until the canal was relocated to Waterford in 1922. The old canal was filled in with dirt, brick, portions of the canal structure, and other unknown fill materials around 1940 during the World War II expansion at the WVA. In 1993, WVA personnel observed machining coolant oil seeping into an excavation in the area of the waste oil line at Manhole 43, which is located within the area of the former Erie Canal. Approximately 15 to 30 yards of soil were excavated and a soil sample was collected, showing no evidence of contamination at concentrations greater than guidance values. Soil borings were completed in the former canal during a preliminary investigation conducted in1990 and during the RFI in 1997. These samples indicated that the canal fill materials were predominantly silt and clay in nature. Analysis of a soil sample collected from 20 feet under pavement revealed petroleum and lead contamination at concentrations greater than guidance values. However, contamination was not encountered outside of the canal fill area or in groundwater samples downgradient of the canal. Based on these data, no further remedial activity is required for this SWMU.

SWMU No. 26 - Building 35 Process Pit: Manufacturing activities conducted at Building 35 include chrome plating, cadmium-cyanide plating (discontinued in 1994), magnaflux testing, heat treatment, and cannon tube machining. The main waste types generated at Building 35 include water soluble cutting oil, combustible waste oil, metal chips, magnaflux testing oil, and process water from the chrome plating operations. The Building contains four process pits that have been used primarily for chrome plating of 155 mm and 8-inch cannons. Today, only two of the process pits are used for the chrome plating of cannon tubes. During the late 1980s, one of the original pits, the West pit, was converted to a furnace pit to be used for heat treatment of cannon tubes and is still currently being used for this purpose. The fourth pit is currently decommissioned. In 1987, during the conversion of the chrome plating pit to the furnace pit, petroleum, oils, and lubricants (POLs) were observed to be seeping through cracks in the concrete walls and accumulating in the furnace pit. Various investigations have been conducted to assess the soil and water contamination from POLs due to the manufacturing processes at Building 35. The investigations found that the source of the oil found in the furnace pit was probably a result of machining oils leaking from the machinery in Buildings 35 and the adjacent Building 110. A passive recovery pump was installed in January 1999 to test the viability of Light Non-Aqueous Phase Liquid (LNAPL) recovery. LNAPL recovery was found to be minimal with no effect on the presence or distribution of the

LNAPL. Based on groundwater and soil results that do not indicate the presence of contamination at concentrations greater than guidance levels, and that the distribution of LNAPL is stable and does not extend beyond the footprint of Building 35, no further remedial activity is required for this SWMU.

SWMU No. 27 - Building 135 Process Pit: Building 135 was constructed in 1943 in the southwest corner of the MMA. The main shop floor area of the building is divided into five bays. A High Bay section is located at the south end of Building 135, rising approximately 50 feet above the rest of the building to facilitate lifting cannon tubes into and out of three pits: the Cold Works Pit, the Furnace Pit, and the Shrink Pit. The main waste types generated at Building 135 include water soluble cutting oil, combustible waste oil, and metal chips from milling operations. Capacitors in the building that had contained polychlorinated biphenyls (PCBs) have been removed and replaced. Machines containing hydraulic oil with PCBs have been drained, flushed, and refilled with hydraulic oil containing less than 50 milligrams per liter (mg/l) PCBs.

The main focus of the Building 135 investigation was the Shrink Pit, which is located in the southeast corner of the building and is constructed in shale bedrock. The Shrink Pit houses three furnaces, an elevator, a metal staircase for access, a wet pit (commonly referred to as the “Blue Lagoon”) and a dry pit at the bottom. At its deepest point, the Shrink Pit is 100 feet deep and at its widest point is 51.5 by 40.5 feet wide (at the shop floor level). Drainage chases were installed around the perimeter wall of the Shrink Pit to collect groundwater for use in the shrinking process and were connected to the wet pit by a network of pipes. Groundwater that accumulates in the wet pit is pumped and discharged through Outfall 004 to the storm sewer at the southern side of the building. This discharge is monitored by the NYSDEC under the WVA SPDES Permit.

Various investigations have been conducted to assess the soil and water contamination from POLs due to the manufacturing processes at Building 135. As a result of the investigation, the petroleum in Building 135 was identified as containing compounds characteristic of refined petroleum lubricating oil and that the presence of LNAPL in the Blue Lagoon is most likely from POLs leaking from the machinery in Building 135. Based on groundwater and soil results that did not indicate the presence of contamination at concentrations greater than guidance levels, and the lack of LNAPL in surrounding wells, no further action is required for this SWMU.

SMWU - Vapor Degreaser Units: Six vapor degreaser units located in Buildings 20, 25, 40, 110, 120, and 130, were used for removing protective oil coatings from the surfaces of metal parts. The vapor degreaser units were exhausted to the atmosphere and were shut down periodically to remove accumulated sludges and oils. The units used chlorinated solvents, including tetrachloroethene (PCE), trichloroethene (TCE), and/or 1,1,1-trichloroethane (1,1,1-TCA). Based on the results of the RFI, no further action is required for the vapor degreaser units at Buildings 20, 110, 120, and 130. Corrective measures for the vapor degreaser units in Buildings 25 and 40 are discussed herein.

SWMU - Chip Handling Areas: Two chip handling facilities, the Building 132 South Chip Handling Area and the Building 123 Chip Handling Area were designated as SWMUs. The exact dates of operation for both chip handling areas is unknown, but the chip handling area at Building 132 is believed to have been operational in the mid to late 1950s. The storage capacity of both areas is estimated to have been up to 80 tons, or approximately 40 cubic yards. Waste steel chips were generated and placed in these areas directly on the ground. Various cutting oils coated the chips, which according to WVA, “dripped off or washed off during storm events.”

Various pre-RFI investigations have been conducted in these areas to assess the soil and water contamination due to the chip handling facility activities, as well as the environmental effects of an 8,000-gallon fuel oil release near Building 121. In November 1992 and 1993 soil characterization activities were conducted at the Building 132 South Chip Handling Facility. These reports confirmed that soils in this area were contaminated with total petroleum hydrocarbons. As a result of a natural gas line being installed to the WVA's boiler plant, the contaminated soils were excavated, removed, and disposed off-site. As a result of the presence of LNAPL observed in wells, piezometers, and test pits installed in the vicinity of the Building 123 Chip Handling Area, two interceptor trenches were installed in 1975 and 1976. The interceptor trenches were removed at some point prior to the RFI and LNAPL is no longer present in the area. No further actions are required for this SWMU.

SWMU - Chrome Plating Pit Areas: The basic function of the Chrome Plating Pits is to collect spillage and drainage from the chromium plating vessels and manganese phosphate lines which contain caustic cleaners, electro-polishing, rinse water, and plating/coating solutions. The sump liquid and cyanide spillage and drainage is separately pumped and delivered to the industrial waste treatment plant. Waste placed into these pits include chromic acid and other plating fluids, such as caustic cleaners; sulfuric and phosphoric acids; cadmium, nickel, copper, manganese phosphate plating/coating solutions and rinse waters. The Chrome Plating Areas are located in Building 35 and, formerly, in Building 110. No further actions are required for this SWMU.

SWMU - Chrome Plating Scrubbers: Air exhaust scrubbers are used to remove contaminants entrained in the exhaust air from chrome plating operations (primarily chromic acid condensate) prior to discharge to the atmosphere. The scrubbers are located at Buildings 35 and 114 (used for laboratory testing only). The water used to remove the contaminants from the air stream is automatically discharged to the wastewater treatment plant. No further actions are required for this SWMU.

In summary, all the SWMUs mentioned above, with the exception of SWMU No. 5 - Building 25 and SWMU -Vapor Degreaser Units (specifically the units in Buildings 25 and 40) have been addressed. SWMU No. 5 and the vapor degreasing units in Buildings 25 and 40 are the subject of this Statement of Basis. Although no further actions are required at the majority of the SWMUs, if conditions change in the future (e.g., demolition of a building or discovery of contaminated soil during excavation for utilities) these SWMUs can be reopened for additional remedial work.

Areas of Concern

The areas of concern (AOCs) identified in the MMA as a result of the investigations are shown on Figure 7 summarized below. All of the AOCs are categorized within the Vapor Degreaser Units SWMU. The AOCs identified at the facility were addressed by the ICMs described previously.

Groundwater

Groundwater samples were collected during the RFI, the Long-Term Monitoring (LTM) program, and the various CMS studies. The nature of the groundwater contamination in the MMA is primarily related to the presence of chlorinated volatile organic compounds (CVOCs), which were used prior to 1982 in vapor degreasing operations. Groundwater containing CVOCs at concentrations greater than SCGs is found at or near the following buildings:

1. Building 25
2. Building 40
3. Building 114

Building 25

Groundwater contamination is primarily located east and southeast of Building 25, coincident with the groundwater flow direction in this area of the MMA. The contamination primarily consists of PCE, TCE, vinyl chloride (VC), 1,1-dichloroethane (1,1-DCA), and 1,1,1-TCA, which exceed the corresponding NYSDEC Class GA Standards in the overburden, weathered bedrock, and bedrock groundwater.

Based on the results of the RFI, the horizontal extent of groundwater CVOC contamination is limited to an approximately 0.4-acre area. Based on downgradient monitoring, the CVOCs are not migrating beyond the former Erie Canal or the WVA property boundary.

Building 40
Groundwater contamination at Building 40 primarily consists of PCE and cis-1,2-dichloroethene (cDCE), with a lesser percentage of TCE and VC. All of these contaminants are found in the bedrock groundwater. Overburden groundwater is not impacted. Based on the results of the RFI, LTM program, and the various CMS studies, the horizontal extent of bedrock groundwater contamination is present in an approximately 2.0-acre area that extends southeast from Building 40 to the eastern WVA boundary and, presumably, beyond the site boundary to the Hudson River. The RFI and CMS studies revealed that the majority of the CVOC mass is entrained in the bedrock matrix. The exact source of the CVOCs in the groundwater at Building 40 is not known. However, there are no known continuing surface sources of CVOCs in the groundwater in the Building 40 area.

Building 114 Area
Groundwater contamination in the Building 114 area primarily consists of PCE and cis-1,2-dichloroethene (cDCE), with a lesser percentage of TCE and VC. All of these contaminants are found in the bedrock groundwater. Overburden groundwater is not impacted. Based on the results of the RFI and LTM program, and the various CMS studies, the horizontal extent of bedrock groundwater contamination is limited to a small area near monitoring wells WVA-MW-52 and WVA-MW-64. Based on the RFI studies at Building 40, it is assumed the that the majority of the CVOC mass at this location is also entrained in the bedrock matrix. The exact source of the CVOCs in the groundwater at Building 114 is not known and there are no known continuing surface sources of CVOCs in the groundwater in the area.

Soil Vapor
In accordance with the directive by the NYSDEC and the New York State Department of Health (NYSDOH), the WVA performed vapor intrusion investigations within, and adjacent to, the MMA from 2007 through 2008. The purpose of the investigation was to assess whether CVOCs were present in the sub-slab soil vapor beneath, and the indoor air within, buildings located in the MMA, including those that once contained degreasing operations, as well as three off-site private residences along the southeastern WVA property boundary. The evaluation also assessed whether soil vapor at the WVA southern property boundary contained CVOCs. A total of 25 buildings in the MMA were sampled during at least one of the two investigation phases. Based on the results of the investigations, corrective measures were found to be required for Buildings 20, 21, 22, 25, 114, 120, 121, and 130 due to the presence of CVOCs in soil vapor and/or indoor air at concentrations greater than guidance values. In addition, due to the presence of CVOCs in the bedrock groundwater to the east of Building 40, the extent and concentration of VOCs in the indoor air within and the soil gas beneath Building 40 was investigated in a separate investigation. The investigation found that CVOCs were present in the soil vapor and indoor at concentrations greater than guidance values and corrective measures were required.

Groundwater

Groundwater samples were collected from overburden and bedrock monitoring wells during the RFI and subsequent Long Term Monitoring (LTM) program, which was begun in 1999. A summary of groundwater samples collected from the MMA during this time is provided below.

Table 1 – Summary of Groundwater Sampling Results

Detected Constituents	Concentration Range Detected (ppb)[a]	SCG[b] (ppb)	Frequency Exceeding SCG

Detected Constituents	Concentration Range Detected (ppb)[a]	SCG[b] (ppb)	Frequency Exceeding SCG
VOCs			
1 1 1-Trichloroethane	0.5 - 100	5	69 / 947
1 1 2 2-Tetrachloroethane	0.4 - 4	5	0 / 768
1 1 2-Trichloroethane	ND	5	0 / 768
1 1-Dichloroethane	0.5 - 26	5	45 / 947
1 1-Dichloroethene	0.4 - 36	5	23 / 907
1 2-Dichloropropane	ND	5	0 / 768
1,2-Dichloroethane	ND	5	0 / 768
2-Butanone (MEK)	0.8 - 17,000	50	4 / 939
4-Methyl-2-Pentanone (MIBK)	0.5 - 8	5	1 / 761
Acetone	ND	50	0 / 72
Benzene	0.3 - 47	1	4 / 908
Bromodichloromethane	1 - 9	50	0 / 892
Bromoform	ND	50	0 / 767
Bromomethane	0.5 - 2	5	0 / 769
Carbon Disulfide	0.3 - 22	60	0 / 919
Carbon Tetrachloride	1 - 5	5	0 / 769
Chlorobenzene	0.2 - 4	5	0 / 880
Chloroethane	2 - 7	5	2 / 840
Chloroform	0.2 - 630	7	27 / 959
Chloromethane	0.5 - 42	5	2 / 768
cis-1 2-Dichloroethene	0.3 - 16,000	5	192 / 890
cis-1 3-Dichloropropene	ND	5	0 / 768
Dibromochloromethane	0.5 - 1	50	0 / 808
Ethylbenzene	0.4 - 1	5	0 / 840
Methylene Chloride	0.2 - 1,400	5	21 / 958
Tetrachloroethene	0.4 - 110,000	5	88 / 958
Toluene	0.1 - 2	5	0 / 840
trans-1 2-Dichloroethene	0.2 - 200	5	49 / 947
Trichloroethene	0.1 - 21,000	5	230 / 958
Trichlorofluoromethane	2 - 5	5	0 / 836
Vinyl Chloride	0.3 - 8,300	2	173 / 958
Xylenes (total)	0.4 - 22	5	1 / 780
SVOCs			
1 2 4-Trichlorobenzene	ND	5	0 / 430
1 3-Dichlorobenzene	ND		0 / 399
1 4-Dichlorobenzene	ND	4.7	0 / 430
1,2-Dichlorobenzene	ND	4.7	0 / 430
2 2-oxybis (1-chloropropane)	ND		0 / 237
2 4 6-Trichlorophenol	ND		0 / 399
2 4-Dichlorophenol	ND		0 / 399
2 4-Dimethylphenol	0.2 - 0.2		0 / 430
2 4-Dinitrophenol	ND		0 / 399

Detected Constituents	Concentration Range Detected (ppb)[a]	SCG[b] (ppb)	Frequency Exceeding SCG
2 4-Dinitrotoluene	ND	5	0 / 399
2 6-Dinitrotoluene	55 - 55	5	1 / 399
2-Chloronaphthalene	ND		0 / 397
2-Chlorophenol	ND		0 / 395
2-Methylnaphthalene	0.7 - 2		0 / 433
2-Nitrophenol	ND		0 / 399
3 3-Dichlorobenzidine	ND	5	0 / 399
4 6-Dinitro-2-methylphenol	ND		0 / 399
4-Bromophenyl phenyl ether	ND		0 / 399
4-Chloro-3-methylphenol	0.6 -890		0 / 566
4-Chlorophenyl phenyl ether	ND		0 / 399
4-Nitrophenol	ND		0 / 399
Acenaphthene	0.1 - 12	20	0 / 567
Acenaphthylene	4 - 16		0 / 466
Anthracene	0.02 - 300	50	1 / 575
Benzidine	ND	5	0 / 399
Benzo(a)anthracene	0.8 - 360	0.002	9 / 575
Benzo(a)pyrene	0.1 - 140		0 / 575
Benzo(b)fluoranthene	0.09 - 190	0.002	10 / 576
Benzo(g,h,i)perylene	32 - 32		0 / 474
Benzo(k)fluoranthene	0.06 - 200	0.002	7 / 567
Bis(2-chloroethoxy)methane	ND	5	0 / 407
Bis(2-chloroethyl)ether	ND	5	0 / 399
bis(2-Chloroisopropyl)ether	ND		0 / 162
Bis(2-ethylhexyl)phthalate	0.1 - 4,200	50	5 / 578
Butyl benzyl phthalate	0.08 - 6	50	0 / 544
Chrysene	0.2 - 310	0.002	14 / 576
Dibenzo(a h)anthracene	1 0- 10		0 / 474
Diethyl phthalate	0.09 - 4	50	0 / 577
Dimethyl phthalate	0.8 - 2	50	0 / 544
Di-n-butyl phthalate	0.08 - 2	50	0 / 551
Di-n-octyl phthalate	0.03 - 240	50	1 / 567
Fluoranthene	0.06 - 6,900	5	6 / 575
Fluorene	0.09 -1,600	50	2 / 575
Hexachlorobenzene	ND	0.35	0 / 399
Hexachlorobutadiene	ND	5	0 / 399
Hexachlorocyclopentadiene	ND	5	0 / 399
Hexachloroethane	ND	5	0 / 399
Indeno(1 2 3-cd)pyrene	27 - 86	0.002	2 / 474
Isophorone	ND	50	0 / 399
Naphthalene	0.06 - 2	10	0 / 570
Nitrobenzene	ND	5	0 / 399
N-Nitrosodimethyl amine	ND		0 / 636
n-Nitroso-di-n-propylamine	ND		0 / 399

Detected Constituents	Concentration Range Detected (ppb)[a]	SCG[b] (ppb)	Frequency Exceeding SCG
N-Nitrosodiphenyl amine (1)	0.5 - 0.5		0 / 229
Pentachlorophenol	3 - 3	1	1 / 399
Phenanthrene	0.06 - 2,600	50	2 / 575
Phenol	0.2 - 3	1	3 / 430
Pyrene	0.04 - 5,300	50	3 / 575
Metals			
Aluminum	561 - 108,000		0 / 5
Arsenic	0.005 - 744	25	14 / 197
Barium	0.0421 - 31,400	1,000	29 / 199
Cadmium	0.2 - 427	5	19 / 160
Calcium	14,900 - 467,000		0 / 5
Chromium	0.0414 - 19,600	50	66 / 211
Cyanide	ND	200	0 / 69
Hexavalent Chromium	0.009 - 17,410	50	2 / 69
Iron	880 - 471,000		0 / 74
Lead	0.005 - 5,570	25	39 / 200
Magnesium	12,700 - 125,000		0 / 5
Manganese	45 - 27,200	300	4 / 5
Mercury	0.04 - 0.41	0.7	0 / 184
Potassium	5,050 -67,200		0 / 5
Selenium	1.5 - 14	10	1 / 186
Silver	0.007 - 104	50	1 / 183
Sodium	32,900 - 141,000	20,000	5 / 5
Zinc	75 - 9,190	2,000	1 / 5
Pesticides/PCBs			
4,4'-DDD	0.0015 - 14	0.3	1 / 132
4,4'-DDE	0.00089 - 2.6	0.2	1 / 132
4,4'-DDT	0.0021 - 3.9	0.2	1 / 132
Aldrin	0.00095 - 0.061		0 / 132
alpha-BHC	0.0025 - 0.0025	0.01	0 / 68
alpha-Chlordane	0.00072 - 3	0.05	1 / 68
beta-BHC	0.007 - 0.007	0.04	0 / 132
delta-BHC	0.0012 - 0.039	0.04	0 / 132
Dieldrin	0.0008 2- 0.02	0.004	5 / 132
Endosulfan I	0.0013 -0.0022		0 / 68
Endosulfan II	0.0029 - 0.016		0 / 68
Endosulfan sulfate	0.0037 -0.018		0 / 68
Endrin	0.00061 - 0.15		0 / 68
Endrin Aldehyde	0.0015 -0.22	5	0 / 132
Endrin Ketone	0.001 - 0.009	5	0 / 132
gamma-BHC (Lindane)	0.013 -0.15	0.05	1 / 132
gamma-Chlordane	0.00053 - 2	0.05	2 / 136
Heptachlor	0.0014 - 6.6	0.04	3 / 132
Heptachlor Epoxide	0.00072 - 0.048	0.03	1 / 68

Detected Constituents	Concentration Range Detected (ppb)[a]	SCG[b] (ppb)	Frequency Exceeding SCG
Methoxychlor	0.017 - 0.017	35	0 / 68
Aroclor-1254	0.022 - 0.31		0 / 68
Aroclor-1260	0.059 - 0.15	0.3	0 / 68

a - ppb: parts per billion, which is equivalent to micrograms per liter, ug/L, in water.

b- SCG: Standard Criteria or Guidance - Ambient Water Quality Standards and Guidance Values (TOGs 1.1.1), 6 NYCRR Part 703, Surface water and Groundwater Quality Standards, and Part 5 of the New York State Sanitary Code (10 NYCRR Part 5).

ND – Not Detected.

Blank space – No standard.

Groundwater contamination identified during the RFI was addressed by the ICMs described herein.

Soil

Surface and subsurface soil samples were collected at the facility during the RFI. Surface soil samples were collected from a depth of 0-2 inches to assess direct human exposure; however, the extent of surface soil sampling was limited as the majority of the MMA investigation area is covered by asphalt and/or concrete. Subsurface soil samples were collected to assess soil contamination impacts to groundwater. A summary of soil samples collected during the RFI is presented below.

Table 2 – Summary of Soil Sampling Results

Detected Constituents	Concentration Range Detected (ppm)[a]	Unrestricted SCG[b] (ppm)	Frequency Exceeding Unrestricted SCG	Restricted Use SCG[c] (ppm)	Frequency Exceeding Restricted SCG
VOCs					
1,1,1-Trichloroethane	0.002 - 0.018	0.68	0 / 61	500	0 / 61
1,1-Dichloroethane	0.001 - 0.001	0.237	0 / 61	240	0 / 61
1,2-Dichloroethene (total)	0.004 - 0.115	0.25	0 / 61	500	0 / 61
2-Butanone	0.005 - 0.039	0.12	0 / 61	500	0 / 61
Benzene	0.0006 - 0.003	0.06	0 / 61	44	0 / 61
Bromodichloromethane	0.24 - 0.24				
Carbon Disulfide	0.0006 - 0.03				
Chloroform	0.002 - 1.8	0.37	1 / 61	350	0 / 61
cis-1,2-Dichloroethene	0.002 - 0.078	0.25	0 / 61	500	0 / 61
Ethylbenzene	0.002 - 0.003	1	0 / 61	390	0 / 61
Methylene Chloride	0.001 - 0.018	0.05	0 / 61	500	0 / 61
Tetrachloroethene	0.002 - 0.025	1.3	0 / 61	150	0 / 61
Toluene	0.001 - 0.04	0.7	0 / 61	500	0 / 61
Trichloroethene	0.002 - 0.43	0.47	0 / 61	200	0 / 61
Vinyl Acetate	0.002 - 0.002				
Vinyl Chloride	0.015 - 0.015	0.02	0 / 61	13	0 / 61
Xylene (total)	0.003 - 0.026	0.26	0 / 61	500	0 / 61

Detected Constituents	Concentration Range Detected (ppm)[a]	Unrestricted SCG[b] (ppm)	Frequency Exceeding Unrestricted SCG	Restricted Use SCG[c] (ppm)	Frequency Exceeding Restricted SCG
SVOCs					
2-Methylnaphthalene	0.01 - 8.6		0 / 66		0 / 66
4-Chloro-3-methylphenol	0.16 - 0.26		0 / 66		0 / 66
Acenaphthene	0.004 - 30	20	1 / 66	500	0 / 66
Acenaphthylene	0.01 - 1.8	100	0 / 66	500	0 / 66
Anthracene	0.005 - 30	100	0 / 66	500	0 / 66
Benzo(a)anthracene	0.002 - 20	1	7 / 66	5.6	7 / 66
Benzo(a)pyrene	0.002 - 14	1	8 / 66	1	8 / 66
Benzo(b)fluoranthene	0.002 - 11	1	7 / 66	5.6	1 / 66
Benzo(g,h,i)perylene	0.007 - 9.9	100	0 / 66	500	0 / 66
Benzo(k)fluoranthene	0.002 - 12	0.8	7 / 66	56	0 / 66
bis(2-Ethylhexyl)phthalate	0.024 - 6.8		0 / 66		0 / 66
Butylbenzylphthalate	0.013 - 0.75		0 / 66		0 / 66
Chrysene	0.002 - 27	1	7 / 66	56	0 / 66
Di-n-butylphthalate	0.006 - 2.5		0 / 66		0 / 66
Di-n-octyl phthalate	0.006 - 0.097		0 / 66		0 / 66
Dibenzo(a,h)anthracene	0.01 - 0.95	0.33	5 / 66	0.56	2 / 66
Diethylphthalate	0.006 - 0.53		0 / 66		0 / 66
Fluoranthene	0.002 - 58	100	0 / 66	500	0 / 66
Fluorene	0.011 - 47	30	1 / 66	500	0 / 66
Indeno(1,2,3-cd)pyrene	0.011 - 7.9	0.5	7 / 66	5.6	0 / 66
Naphthalene	0.005 - 1.6	12	0 / 66	500	0 / 66
Phenanthrene	0.006 - 140	100	1 / 66	500	0 / 66
Pyrene	0.004 - 58	100	0 / 66	500	0 / 66
Metals					
Arsenic	1.3 - 111	13	15 /65	16	9 / 65
Barium	44.7 - 2910	350	5 / 65	400	5 / 65
Cadmium	0.4 - 5	2.5	3 / 19	9.3	3 / 19
Chromium	8.9 - 237	30	9 / 66	1500	0 / 66
Lead	7.2 - 17800	63	29 / 65	1000	1 / 65
Mercury	0.1 - 1	0.18	15 / 25	2.8	0 / 25
Selenium	0.3 - 11	3.9	6 / 53	1500	0 / 53
Silver	0.2 - 2	2	1 / 3	1500	0 / 3
Pesticides/PCBs					
alpha-BHC	0.00054 - 0.00054	0.02	0 / 40	0.6	0 / 40
beta-BHC	0.0044 - 0.0044	0.036	0 / 40	3	0 / 40
delta-BHC	0.0022 - 0.012	0.04	0 / 40	500	0 / 40
Heptachlor	0.00083 - 0.0021	0.042	0 / 39	15	0 / 39
Heptachlor Epoxide	0.0013 - 0.0013				
Aldrin	0.0018 - 0.016	0.005	1 / 40	0.68	0 / 40
Dieldrin	0.00036 - 0.012	0.005	1 / 40	1.4	0 / 40

Detected Constituents	Concentration Range Detected (ppm)[a]	Unrestricted SCG[b] (ppm)	Frequency Exceeding Unrestricted SCG	Restricted Use SCG[c] (ppm)	Frequency Exceeding Restricted SCG
Endrin	0.0024 - 0.021	0.014	1 / 40	89	0 / 40
Endrin Ketone	0.0033 - 0.0033				
Endosulfan II	0.0013 - 0.0039	2.4	0 / 39	200	0 / 39
Endosulfan Sulfate	0.00042 - 0.0024	2.4	0 / 40	200	0 / 40
4,4'-DDE	0.0002 - 1.7	0.0033	6 / 40	62	0 / 40
4,4'-DDD	0.0011 - 0.027	0.0033	2 / 39	92	0 / 39
4,4'-DDT	0.00059 - 0.013	0.0033	2 / 38	47	0 / 38
Methoxychlor	0.0055 - 0.011				
Aroclor-1254	0.023 - 0.27	0.1	1 / 40	1	0 / 40
Aroclor-1260	0.0035 - 0.024	0.1	0 / 40	1	0 / 40

a - ppm: parts per million, which is equivalent to milligrams per kilogram, mg/kg, in soil;

b - SCG: Part 375-6.8(a), Unrestricted Soil Cleanup Objectives.

c - SCG: Part 375-6.8(b), Restricted Use Soil Cleanup Objectives for the Protection of Public Health for Commercial Use, unless otherwise noted.

Blank space – No standard for this compound.

No soil contamination of concern was identified during the RFI. The presence of some metals at concentrations greater than SCOs is likely associated with historic manufacturing and fill activities at the site and not single point releases of hazardous constituents. Since the WVA is a limited access industrial facility that is not open to the general public, and since the majority of the samples exceeding SCOs were either at depth and/or beneath areas of asphalt and/or concrete, no remedial alternatives need to be evaluated for soil.

Surface Water

There is no surface water within the MMA.

Sediments

There are no areas of sediment within the MMA.

Soil Vapor

The potential for soil vapor intrusion resulting from the presence of facility-related soil or groundwater contamination was evaluated by the sampling of soil vapor, sub-slab soil vapor under structures, and indoor air inside structures. As discussed herein, soil vapor investigations were conducted at 25 buildings within the MMA and 3 off-site residences located adjacent to the facility.

Based on the concentrations detected, and in comparison with the NYSDOH Soil Vapor Intrusion Guidance, soil vapor contamination identified during the RFI was addressed during the ICMs described herein.

Exhibit B

SUMMARY OF THE CLEANUP OBJECTIVES

The goal for the corrective measure program is to restore the facility to pre-disposal conditions to the extent feasible. At a minimum, the corrective measures shall eliminate or mitigate all significant threats to public health and the environment presented by the contamination identified at the facility through the proper application of scientific and engineering principles.

The established cleanup objectives for this facility are:

Soil: Part 375-6.8(b), Restricted Use Soil Cleanup Objectives for the Protection of Public Health for Commercial Use

Groundwater: NYS Groundwater Standards (6 NYCRR Part 700), Division of Water TOGS

Summary of Environmental Impacts and Human Exposure Pathways

This section lists the current or potential environmental impacts and human exposures to persons at or around the facility that may result from the contamination. A more detailed discussion of the human exposure pathways can be found in the RFI and CMS Reports (or appropriate document) available at the document repository. An exposure pathway describes the means by which an individual may be exposed to contaminants originating from the facility.

Groundwater
- Human Health
  - Prevent direct contact with, or inhalation of volatiles from, contaminated groundwater.
- Environment
  - Prevent the discharge of contaminants to surface water at concentrations exceeding applicable standards.
  - Remove the source of groundwater or surface water contamination.

Soil Vapor
- Human Health
  - Mitigate impacts to public health resulting from existing, or the potential for, soil vapor intrusion into buildings at a facility.

Exhibit C

Description of Remedial Alternatives

In development of the Interim Corrective Measures, the following alternatives were considered based on the cleanup objectives (see Exhibit B) to address the contaminated media identified at the facility as described in Exhibit A.

The detailed analysis of the alternatives is provided in the approved final Corrective Measures Study Report.

Bedrock Groundwater (Buildings 25 and 40)

Various remedial technologies were evaluated to determine the potential of achieving site remedial objectives using both conventional and innovative remedial alternatives. The applications of potential remedial alternatives were screened according to geologic and hydrogeologic conditions, the nature of contamination, engineering requirements, and implementability. Final selected technologies were based on the ability to achieve the CAOs, the physical constraints of the impacted areas, and the limitations imposed by operations at the MMA.

Corrective measures technologies were chosen for groundwater that could potentially meet the CAOs. The following corrective measures technologies were retained for consideration for the Building 25 and Building 40 bedrock matrix and/or groundwater.

1. Natural Attenuation;
2. Containment;
3. In-Situ Treatment;
4. In-Situ Thermal Remediation (ISTR); and
5. No Action.

Natural Attenuation

Natural attenuation may be considered for remediation of contaminants in groundwater and saturated soils if site-specific factors support its use. Target contaminants for natural attenuation are VOCs, SVOCs, and fuel hydrocarbons. Fuel and halogenated VOCs (chlorinated solvents) are so far the most commonly evaluated contaminants for natural attenuation. Natural attenuation would involve the degradation of CVOCs in the overburden and bedrock groundwater by naturally occurring processes (i.e., biodegradation). Such degradation is monitored over time under the long-term monitoring program at both Building 25 and Building 40. The presence of PCE breakdown products, TCE, cDCE, and VC indicates natural attenuation is ongoing in the overburden and bedrock groundwater at Building 25 and in the bedrock groundwater at Building 40. In addition, the presence of the organism *dehalococcoides ethegenes*, which is capable of completely degrading CVOCs, has been confirmed in bedrock groundwater samples collected from the Building 25 and Building 40 areas.

Although natural attenuation of CVOCs in groundwater at Building 25 and Building 40 is occurring, by itself, the process has not significantly reduced the concentration of CVOCs in the groundwater, although it has likely limited its lateral extent. However, through bedrock matrix diffusion, the migration of CVOCs in the groundwater has been attenuated. Even though the natural attenuation processes have served to reduce the mass and extent of CVOCs in the overburden and bedrock groundwater and could potentially result in the achievement of CAOs, the rate at which they currently occur is slow and would not result in a measurable decrease in contaminant mass or groundwater concentration in the near future. Given this, natural attenuation, by itself, was eliminated from further consideration. Natural attenuation coupled with a more effective source treatment technology, however, was retained for further consideration.

Containment

Containment includes in-situ and ex-situ treatments, such as extraction and barrier technology (i.e., slurry wall/vertical barrier and permeable barrier walls) that would be employed to prevent contaminants from entering adjacent properties and essentially “contain” the contaminant plume. The most widely used containment method is groundwater extraction and treatment. Groundwater extraction would involve the use of one or more wells to intercept and remove groundwater containing CVOCs from the subsurface. Groundwater extracted from the subsurface would then be treated at the surface and discharged under the appropriate discharge permit. Groundwater extraction would be accompanied by long-term groundwater monitoring to evaluate the degree to which CVOCs are removed from the subsurface and to evaluate the rebound in CVOC concentrations after the cessation of pumping.

Similar to natural attenuation, the use of containment technologies, such as groundwater extraction and treatment, by itself, would result in a reduction in groundwater CVOC concentrations at the property boundary and prevent migration of the groundwater plume to adjacent properties, but would do little to reduce CVOC mass in the shale bedrock matrix. As such, groundwater concentrations would be expected to rebound to near their pre-remediation concentrations upon shutdown of the containment remedy since CVOC source concentrations in the shale bedrock aquifer would be relatively unaffected by extraction of the groundwater.

A USEPA study of 28 sites at which groundwater containment remedies have been implemented found that, while 21 of 25 sites have met plume containment goals, only two of 28 sites have met their aquifer restoration goals. These data indicate that, while containment remedies are viable remedies to eliminate potential exposure pathways, they are not effective source treatment technologies and are not suitable at sites where the source of the contamination has not been remedied. Therefore, the use of containment technologies (i.e., groundwater extraction and treatment) for Buildings 25 and 40 bedrock groundwater was eliminated from consideration.

In-Situ Treatment – Enhanced Bioremediation, Hydrogen Release Compound

In-situ treatments involve the addition of amendments to destroy CVOCs or promote their enhanced degradation. These technologies typically require long-term groundwater monitoring to verify the degradation of the CVOCs and to evaluate when or if additional injections are required. Enhanced bioremediation is one typical in-situ treatment in which indigenous or inoculated microorganisms (e.g., fungi, bacteria, and other microbes) degrade (metabolize) organic contaminants found in groundwater, converting them to innocuous end products. Nutrients (e.g., carbon, oxygen, nitrates) or other amendments may be used to promote and accelerate the ongoing bioremediation and contaminant desorption from subsurface materials.

There are four major processes that enhance bioremediation: nutrient injection, oxygen enhancement with hydrogen peroxide, nitrate enhancement, and bio-augmentation. At the MMA, nutrient injection was considered as a possible remedial technology for Building 25, specifically, the injection of hydrogen release compound (HRC®) into the subsurface. Hydrogen release compound is an environmentally safe polylactate ester that supplies additional carbon to the subsurface to be used by anaerobic microorganisms. When HRC® becomes hydrated, lactic acid is slowly released to the subsurface, which begins various biochemical reactions. In anaerobic environments, microorganisms, such as acetogens, metabolize the lactic acid provided by the HRC®, producing low concentrations of dissolved hydrogen. The hydrogen is then used by other subsurface organisms (reductive dehalogenators) to strip CVOCs of their chlorine atoms and allow for biological degradation. Nutrients can be injected either in the source area to remove contaminant mass or as a barrier to prevent ongoing migration of a contaminant plume.

Bioremediation techniques have been successfully used to remediate soils, sludges, and groundwater contaminated with petroleum hydrocarbons, solvents, pesticides, wood preservatives, and other organic chemicals. Bench- and pilot-scale studies have demonstrated the effectiveness of anaerobic and aerobic microbial degradation of halogenated and non-halogenated organic compounds in groundwater. Based on the longevity, implementability, and cost of injecting HRC® in the subsurface, use of HRC®, accompanied by long-term natural attenuation was retained for further consideration.

In-Situ Treatment – Chemical Oxidation, Fenton's Reagent
In-situ chemical oxidation (ISCO) treatments involve the delivery and distribution of oxidants and other amendments (e.g., catalysts) into the subsurface to chemically transform organic contaminants of concern into innocuous end products such as carbon dioxide (CO_2), water, and inorganic compounds which are more stable, less mobile, and/or inert. The primary advantages of ISCO technologies are their relatively lower capital cost and shorter treatment times than extraction technologies. Since the reaction occurs nearly immediately, treatment is also far more rapid than biological techniques.

Hydrogen peroxide-based Fenton's reagent is a well-documented and effective in-situ chemical oxidation treatment. Fenton's reagent is a solution that is formed on-site by mixing hydrogen peroxide (H_2O_2) and a ferrous iron (Fe^{+2}) catalyst together to produce hydroxyl radicals ($OH\bullet$), which act as a very powerful nonspecific oxidizing agent. Because hydrogen peroxide degrades rapidly in the environment, excess oxidant in the subsurface does not represent an environmental impact. However, the complete oxidation of contaminants requires sufficient time so that residual compounds are completely removed from the contaminant stream. Therefore, Fenton's reagent is most effective for dissolved phase contamination in groundwater. Fenton's reagent can be used to treat a wide variety of organic and inorganic contaminants in soil and groundwater, including chlorinated solvents, petroleum hydrocarbons, PAHs, SVOCs, pesticides, PCBs, phenolics, wood preservatives, and ordnance compounds. The use of Fenton's reagent in fractured bedrock has been limited, but when used during field studies the oxidant has been successful. However, the use of fast-reacting chemical oxidants such as Fenton's reagent at the MMA would have an effect similar to that of groundwater extraction, in that the CVOCs in the bedrock fractures and overburden would be removed, but there would be little treatment of the CVOC mass in the shale bedrock matrix source. Given this, the use of Fenton's reagent was eliminated from consideration.

In-Situ Treatment – Chemical Oxidation, Potassium and Sodium Permanganate
Potassium permanganate is a solid and is typically mixed with water to create a 2 to 5 percent solution on-site, while sodium permanganate is a 40 percent solution that is sent to the site containerized in a 55-gallon drum. Typical concentrations for sodium permanganate solutions injected into the subsurface are 5 to 20 percent, depending on the site characteristics. Potassium and sodium permanganate have the same oxidative capabilities, but sodium permanganate is 10 times more soluble than potassium permanganate and is more concentrated. Permanganate is a weaker oxidizer than hydroxyl radicals, but is more stable in the subsurface and has been shown to remain active in the subsurface for months after injection.

Since potassium and sodium permanganate are relatively stable and can remain active in the subsurface for months after injection, they can diffuse into media with low permeabilities (i.e., clay and porous rock) over time, further enhancing oxidant/contaminant contact and destroying CVOC mass in the matrix. Application of excess potassium and sodium permanganate can allow for diffusion of permanganate into the matrix at the same time as contamination is diffusing out of the matrix (i.e., the reactants will be moving toward each other) adding to the treatment of the CVOC mass in the rock matrix. Since the permanganate is applied in-situ directly to the contaminant, the oxidant should not cause vertical movement of the contaminant, which is often a concern with other remediation technologies. Pilot studies utilizing permanganate in fractured bedrock have been limited due to the inherent complications of injecting into fractured bedrock. However, based on the stability and longevity of permanganate in the subsurface, use of permanganate, accompanied by long-term natural attenuation was retained for further consideration.

In-Situ Treatment – Iron Injection, Zero-Valent Iron and Nanoscale Zero-Valent Iron

Zero-valent iron (ZVI) has been used and well-studied in permeable reactive barriers (PRBs) for groundwater treatment for almost 20 years. PRBs were not considered as a viable remediation technology for the groundwater at Building 25 and Building 40 because a majority of the CVOC contamination is located in the bedrock. For a PRB to be successful, the contact between the barrier and the contaminant is critical for remediation. Because the groundwater flow in bedrock fractures is unpredictable, contact with the groundwater plume may be limited and an unknown volume of the plume may pass by the barrier, resulting in some of the contaminant not being treated. Thus, trenching and constructing a PRB would not be cost effective or the best remedy for the treatment of this particular groundwater contaminant plume.

ZVI and nanoscale zero-valent iron (NZVI) colloids can be utilized in the Building 25 and Building 40 overburden areas, but as injected materials, not as a PRB. ZVI and NZVI are injected in the source area or down gradient of the flow path of a contaminant plume, allowing the water portion of the source area or plume to passively move through the injected material while the contaminants react with the colloids within the slurry. Once the contaminants come in contact with the ZVI or NZVI slurry, the reactions that occur break the contaminant down into harmless products or immobilize the contaminants by precipitation or sorption. At both Building 25 and Building 40 at the MMA, most or all of the CVOC contamination is located in the bedrock. Therefore, the most appropriate remedy to successfully treat the contaminated plume in the bedrock would need to address the VOC mass in fractures as well as the VOCs in the rock matrix. ZVI and NZVI are not well suited for treating CVOCs concentration in the bedrock matrix. Given this, the use of iron injections was eliminated from consideration.

No Action

A no action response would include no remedial measures or monitoring. There are no inherent costs associated with a no action remedial response for a contaminated groundwater plume. The no action alternative would be the same as natural attenuation, without monitoring, to demonstrate reductions in CVOC concentration. As such, a no-action response was not considered further.

Evaluation Criteria

Based on the evaluation of the above-mentioned technologies for the treatment of CVOCs in the groundwater at Buildings 25 and 40, the most beneficial and cost-effective in-situ remedial technologies for corrective measures were enhanced bioremediation through the injection of HRC® into the overburden and bedrock at Building 25, and ISCO through the injection of potassium and sodium permanganate into the bedrock at Building 40. Both remedial technologies were selected in conjunction with subsequent natural attenuation of the CVOCs in groundwater. The remaining technologies were eliminated from consideration for the reasons summarized below. In general, these remedial technologies were eliminated based on their inability decrease the CVOC concentrations in the bedrock matrix (source area).

- Containment: May prevent off-site migration, but treatment time not acceptable (typically on the order of hundreds of years for bedrock sites). Also no impacted downgradient receptors that would drive the need for containment.
- Fenton’s Reagent (ISCO Treatment): Oxidant is fast-reacting and does not remain in the subsurface for long periods of time.
- Iron Injection: Not capable of treating bedrock matrix contamination.
- No Action: Impacted areas where contamination remains must be monitored to ensure that potential receptors are not affected.

Both remedial technologies were implemented to address groundwater contamination at their respective locations as Interim Corrective Measures.

Vapor Intrusion

The following corrective measures technologies were retained for consideration for buildings impacted by soil vapor intrusion of chlorinated VOCs.

1. Subsurface Depressurization;
2. Positive Pressure; and
3. Air Filtration.

Subsurface Depressurization

Subsurface depressurization systems (also commonly referred to as sub-slab depressurization systems) are the most common remedy for vapor intrusion mitigation. Buildings typically have a lower air pressure than the surrounding soil, particularly in the basement, creating a pressure gradient into the building that allows vapor intrusion to occur. A subsurface depressurization system creates a negative pressure field beneath the building, thereby preventing flow of vapors into the building. Subsurface depressurization systems can either be passive or active. An active system achieves lower subsurface air pressure by using a fan to draw air up from below the slab, while a passive system achieves lower subsurface air pressure by using only the convective flow of air created by connecting the sub-slab environment directly to the atmosphere.

Both active and passive systems have to be checked and maintained regularly to make sure they are performing as designed, although maintenance of active systems is more involved than that of passive systems. The period of performance for these systems is indefinite unless the source of the vapors is completely eliminated. Subsurface depressurization systems were considered to applicable to Buildings 20, 21, 22, 25, 114, 120, 121, and 130 as these buildings were built with relatively modern foundations that included concrete slabs. However, subsurface depressurization was not considered to be applicable to Building 40 as it has an early 1800s field-stone foundation and earthen floors – most of which are no longer accessible due to modifications to the building over the last 200 years.

Positive Pressure

Heating, Ventilation, and Air Conditioning (HVAC) system modifications may be implemented to maintain adequate positive pressure within at least the lowest level of a structure (and all levels in contact with soil) to mitigate vapor intrusion. Older structures, however, rarely exhibit the requisite air tightness to make this approach cost effective. If sufficient positive pressure within the structure can be consistently maintained, then advective flow from the subsurface into the structure can be effectively eliminated. Most forced air heating and cooling systems only operate as needed. To implement positive-pressure vapor intrusion mitigation, the HVAC systems would require modification to run continuously to maintain a constant pressure within the structure. Due to the age of the affected building in the MMA, which is greater than 50 years at a minimum, as well as the lack of forced air HVAC systems in most of the building, positive pressure mitigation was not considered to be applicable.

Air Filtration

The term air filtration is used as a general term to incorporate all remedial technologies in which air is passed through a filter (typically particulate filters or granular activated carbon and/or reactive media) to remove contaminants prior to discharge back into the space. In buildings, the filters can be incorporated as modules into an existing HVAC system or be installed within stand-alone air filtration units that recirculate air within the building.

Indoor air filtration was considered to be applicable for the mitigation of vapor intrusion in Building 40 since the use of subsurface depressurization and/or HVAC modification were not considered to be applicable to the building. However, modification of the existing HVAC systems in the building to include filters was not possible due to limitation on the capacity of the air handlers and the distribution of the system in affected areas of the building. Therefore, the installation of stand-alone air filtration units placed in, and/or ducted to, the affected areas of the building, was selected as the corrective measure for vapor intrusion mitigation in Building 40.

Both remedial technologies were implemented to address vapor intrusion at their respective locations as Interim Corrective Measures.

Exhibit D

Corrective Measure (CM) Alternative Costs

Corrective Measure Alternative	Capital Cost	Annual Costs	Total Present Worth
Bldg. 25 HRC® Groundwater Enhanced Bioremediation	$157,000 (a)	Included in LTM CM	-
Bldg. 40 Bedrock Groundwater Permanganate In-situ Chemical Oxidation	$2,130,000 (a)	Included in LTM CM	-
Vapor Intrusion Mitigation	$960,000 (a)	$54,000	$830,000(c)
Long Term Groundwater Monitoring	$1,940,000(b)	$58,000	$892,000(c)

Notes:
(a) Alternatives have already been implemented as ICMs.
(b) Included Long-Term Monitoring conducted from 1999 through present. LTM was implemented in 1999 at the request of the NYSDEC to document groundwater conditions during the planning and implementation of pilot studies and ICMs.
(c) Since capital costs have already been expended, the present worth calculation is only for the annual costs over a 30-year period using a 5% discount rate.

Exhibit E

SUMMARY OF THE PROPOSED FINAL CORRECTIVE MEASURES

The Department is proposing the following final corrective measures for the WVA MMA.

1. Building 25 Groundwater

Based on the results of the investigations at the site, the enhanced bioremediation ICM that has been performed, and the evaluation presented here, the Department is proposing No Further Action with continued long-term monitoring of the ongoing natural attenuation as the proposed final corrective measure for the groundwater at Building 25. Based on the results and conclusions from the Enhanced Bioremediation Interim Corrective Measure, the proper geochemistry and nutrient supply necessary for sustaining natural attenuation of CVOCs is present. The CVOCs in the groundwater at Building 25 are also localized to the Pilot Study Area and are not migrating beyond the WVA property; therefore, the proposed final corrective measure should achieve CAOs for the groundwater at Building 25 over the long term.

The Building 25 groundwater corrective measure will protect human health and the environment by monitoring CVOC concentrations greater than the CAOs in the groundwater limited to the small area east and southeast of Building 25 to ensure that VOCs do not migrate to potential receptors beyond the WVA property boundary. The corrective measure will reduce concentrations of CVOCs in the groundwater and prevent further migration of CVOCs in the groundwater.

2. Building 40 Groundwater

Based on the results of the permanganate ICM and subsequent technology review, the Department has determined that achievement of the CAO for the Building 40 bedrock groundwater is not technically feasible using currently available technologies. It is therefore recommended that No Further Action beyond natural attenuation, documented through long-term groundwater monitoring, be selected as the final corrective measure for the Building 40 bedrock groundwater since there are no known exposure pathways, except vapor intrusion (see below). The area is served by public drinking water supplies; therefore no one is using the contaminated groundwater.

The Building 40 groundwater corrective measure will protect human health and the environment by monitoring CVOC concentrations greater than the CAOs to ensure that VOCs do not migrate beyond their current extent and/or increase in magnitude. Under the corrective measure, concentrations of CVOCs in the groundwater will eventually be reduced and further migration of CVOCs in the groundwater offsite will diminish through continuing degradation of PCE and TCE through natural attenuation processes to non-toxic byproducts, ultimately reducing both the concentration and mass of the contaminants in the groundwater. There are no known off-site receptors that are impacted by groundwater from the Building 40 area.

3. Vapor Intrusion

Based on the results of the investigations at the site, the ICM that has been performed, and the evaluation presented here, the Department is proposing No Further Action with continued operation and monitoring of the subsurface depressurization systems (SSDSs) as the final corrective measure for vapor intrusion in Buildings 20, 21, 22, 25, 114, 120, 121, and 130.

The proposed final corrective measure chosen for indoor air for Building 40 is to continue to operate the indoor air filtration units used to treat the air in this building.

The Department believes that this remedy is protective of human health and the environment and satisfies the cleanup objectives described in Exhibit B. There are currently no unmonitored structures in the vicinity of the contamination, nor are any structures likely planned for the future due to the location of the site adjacent to I-787 and the Hudson River**.**

4. Site Management Plan

A Site Management Plan is required, which includes the following:

a. A Land Use Control Plan that identifies all use restrictions and engineering controls for the site and details the steps and media-specific requirements necessary to ensure the land use controls remain in place and effective:

This plan includes, but may not be limited to:

- an Excavation Plan which details the provisions for management of future excavations in areas of remaining contamination;
- descriptions of any land use and groundwater use restrictions;
- maintaining a site cover to allow for industrial use of the site. Any site redevelopment will maintain a site cover, which may consist either of the structures such as buildings, pavement, and sidewalks comprising the site development, or a soil cover in areas where the upper one foot of exposed surface soil will exceed the applicable soil cleanup objectives (SCOs). Where a soil cover is required it will be a minimum of one foot of soil, meeting the SCOs for cover material as set forth in 6 NYCRR Part 375-6.7(d) for industrial use. The soil cover will be placed over a demarcation layer, with the upper six inches of the soil of sufficient quality to maintain a vegetation layer. Any fill material brought to the site will meet the requirements for the identified site use as set forth in 6 NYCRR Part 375-6.7(d);
- a provision for evaluation of the potential for soil vapor intrusion for any buildings developed on the site, including provision for implementing actions recommended to address exposures related to soil vapor intrusion;
- provisions for the management and inspection of the identified engineering controls;
- maintaining site access controls and Department notification; and
- the steps necessary for the periodic reviews and certification of the land use controls.

b. A Monitoring Plan to assess the performance and effectiveness of the remedy.

The plan includes, but may not be limited to:

- monitoring of groundwater and indoor air to assess the performance and effectiveness of the remedy;
- a schedule of monitoring and frequency of submittals to the Department;
- monitoring for vapor intrusion for any buildings occupied or developed on the site, as may be required .

Basis for Selection

The proposed final corrective measures are based on the results of the RFI, CMS, ICMs, and the evaluation of alternatives. A summary of the correctives measures as they compare to the evaluation criteria is provided below.

Building 25 Groundwater

1. **Protection of Human Health and the Environment**: The Building 25 groundwater corrective measure will protect human health and the environment by monitoring CVOC concentrations greater than the CAOs in the groundwater limited to the small area east and southeast of Building 25 to ensure that VOCs do not migrate to potential receptors beyond the WVA property boundary. The corrective measure will reduce concentrations of CVOCs in the groundwater and prevent further migration of CVOCs in the groundwater offsite.
2. **Achievement of Corrective Action Objectives**: This corrective measure will achieve the CAOs by continuing to degrade PCE and TCE through natural attenuation processes to non-toxic byproducts (i.e., carbon dioxide and ethene), ultimately reducing both the concentration and mass of the contaminants in the groundwater.
3. **Source Remediation**: This corrective measure will reduce the concentrations and mass of CVOCs in the overburden and bedrock groundwater in the Building 25 area. The CVOCs in the groundwater are most likely a product of a vapor degreaser that was located in Building 25. This vapor degreaser has been removed and has not been a contributing source of CVOCs to the groundwater for some time.
4. **Long-term Effectiveness**: This corrective measure will be effective over the long term since there is no longer a contributing source of CVOCs to the subsurface in the Building 25 area and CVOC concentrations greater than the CAOs will continue to decrease through natural attenuation. Long-term monitoring will document the progress of CVOC reduction to concentrations less than CAOs.
5. **Reduction of Toxicity, Mobility, and Volume**: This corrective measure will reduce the toxicity, mobility, and volume of the CVOCs in the overburden and bedrock aquifers by reducing the CVOC mass, and subsequently reducing concentrations in the groundwater.
6. **Short-term Effectiveness**: This corrective measure was effective in the short-term in reducing many of the groundwater concentrations to less than CAOs during the Pilot Study and will continue to be effective in sustaining these concentrations.
7. **Implementability**: The in-situ treatment conducted during the Pilot Study and subsequent long term groundwater monitoring demonstrated that an environment conducive to the natural attenuation of CVOCs is present in the Building 25 area and that CVOC concentrations are decreasing over time.

Building 40 Bedrock Groundwater

1. **Protection of Human Health and the Environment**: The Building 40 groundwater corrective measure will protect human health and the environment by monitoring CVOC concentrations greater than the CAOs to ensure that VOCs do not migrate beyond their current extent and/or increase in magnitude. The corrective measure will reduce concentrations of CVOCs in the groundwater and prevent further migration of CVOCs in the groundwater offsite other than diffuse discharge to the Hudson River. There are no known off-site receptors of groundwater from the Building 40 area.
2. **Achievement of Corrective Action Objectives**: This corrective measure may achieve the CAOs in the long term by continuing to degrade PCE and TCE through natural attenuation processes to non-toxic byproducts (i.e., carbon dioxide and ethene), ultimately reducing both the concentration and mass of the contaminants in the groundwater.
3. **Source Remediation**: Limited source remediation (to the extent practicable and feasible) was accomplished through the implementation of the permanganate corrective measures. However, the bedrock matrix will continue to act as source of contamination to the bedrock groundwater. Remediation of the bedrock source area is not feasible using current technologies. The natural attenuation remedy will further remediate the source by degrading CVOCs as they back-diffuse to the groundwater from the bedrock matrix.
4. **Long-term Effectiveness**: The corrective measure will be effective over the long term in that CVOC source concentrations will be reduced, thereby reducing the concentration of CVOCs in the groundwater over the long-term

5. **Reduction of Toxicity, Mobility, and Volume**: The corrective measure will reduce the toxicity, mobility, and volume of the CVOCs in the bedrock aquifer by reducing the CVOC mass in the shale bedrock matrix and, subsequently, in the bedrock groundwater.
6. **Short-term Effectiveness**: The corrective measure will have limited effectiveness in the short-term, but will be able to document any changes in groundwater conditions.
7. **Implementability**: The source remediation ICM has been completed and long-term monitoring is already underway.

Vapor Intrusion

1. **Protection of Human Health and the Environment**: The indoor air and soil vapor corrective measures will protect human health and the environment by preventing the intrusion of soil vapor containing VOCs into building or, in the case of Building 40, by removing VOCs that migrate to the indoor air from the subsurface.
2. **Achievement of Corrective Action Objectives**: The CAOs will be achieved by removing VOCs that migrate to the indoor air from the subsurface and by preventing their migration into buildings.
3. **Source Remediation**: The vapor intrusion corrective measures are not source remediation technologies. Source remediation will be accomplished in the long term through the natural attenuation of the CVOCs in the underlying groundwater.
4. **Long-term Effectiveness**: The corrective measure will be effective over the long term through continuous operation of the mitigation systems, as documented by the ongoing operations and monitoring program.
5. **Reduction of Toxicity, Mobility, and Volume**: The corrective measure will reduce the toxicity and mobility of the CVOCs by removing/preventing indoor air impacts from CVOCs, thereby preventing exposure.
6. **Short-term Effectiveness**: This corrective measure has been effective in the short-term by preventing CVOCs from impacting indoor air.
7. **Implementability**: The mitigation systems have already been installed and are currently operating.

APPENDIX A

ADMINISTRATIVE RECORD

Administrative Record

Watervliet Arsenal
Main Manufacturing Area
Watervliet, Albany County
EPA No. NY7213820940 / Site No. 401034A

August 2012

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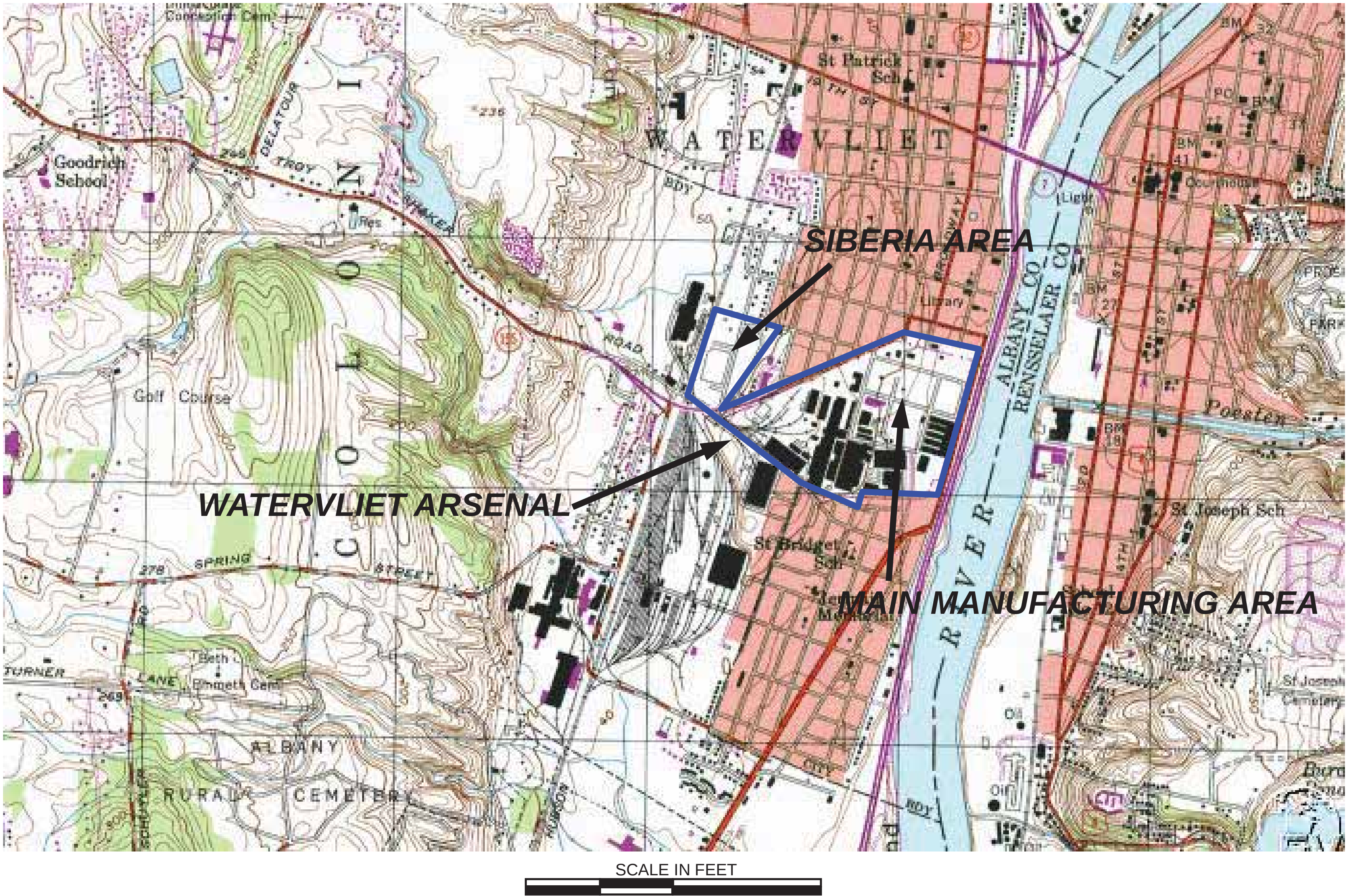


SOURCE: U.S.G.S 7.5 MIN. TROY SOUTH QUADRANGLE

DEPARTMENT OF ENVIRONMENTAL CONSERVATION · NEW YORK STATE

CORRECTIVE MEASURES STUDY
MAIN MANUFACTURING AREA, WATERVLIET ARSENAL,WATERVLIET, NEW YORK

SITE LOCATION

FIGURE 1

3

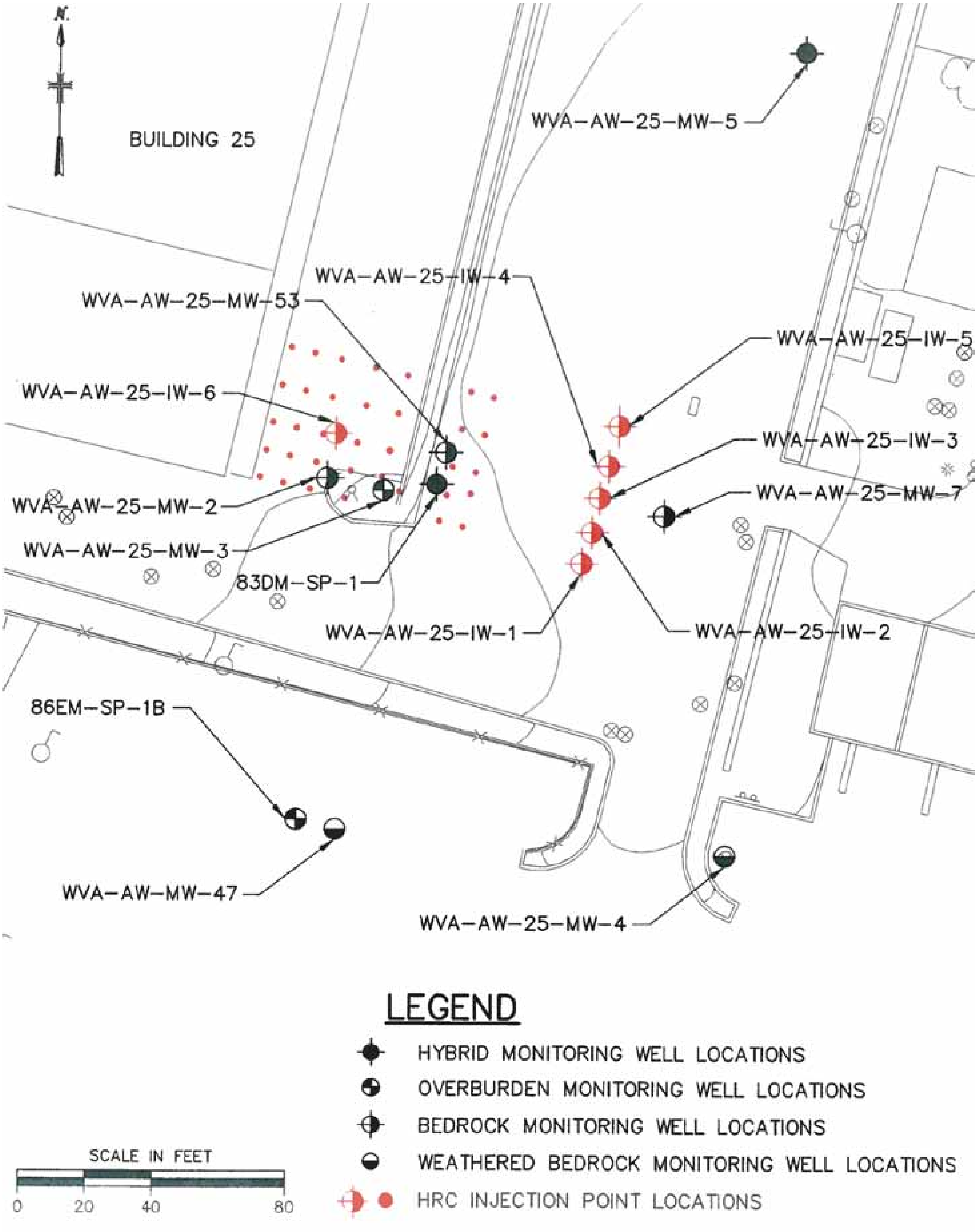
M:\GISMOD\WatervlietArsenal\InstallationSiteMap.mxd

WATERVLIET ARSENAL
WATERVLIET, NEW YORK
INSTALLATION SITE MAP

0 0.1 0.2 0.4
Miles

MALCOLM PIRNIE, INC.

FIGURE 2



WATERVLIET ARSENAL
MAIN MANUFACTURING AREA

BUILDING 25 ICM AREA

FIGURE 3

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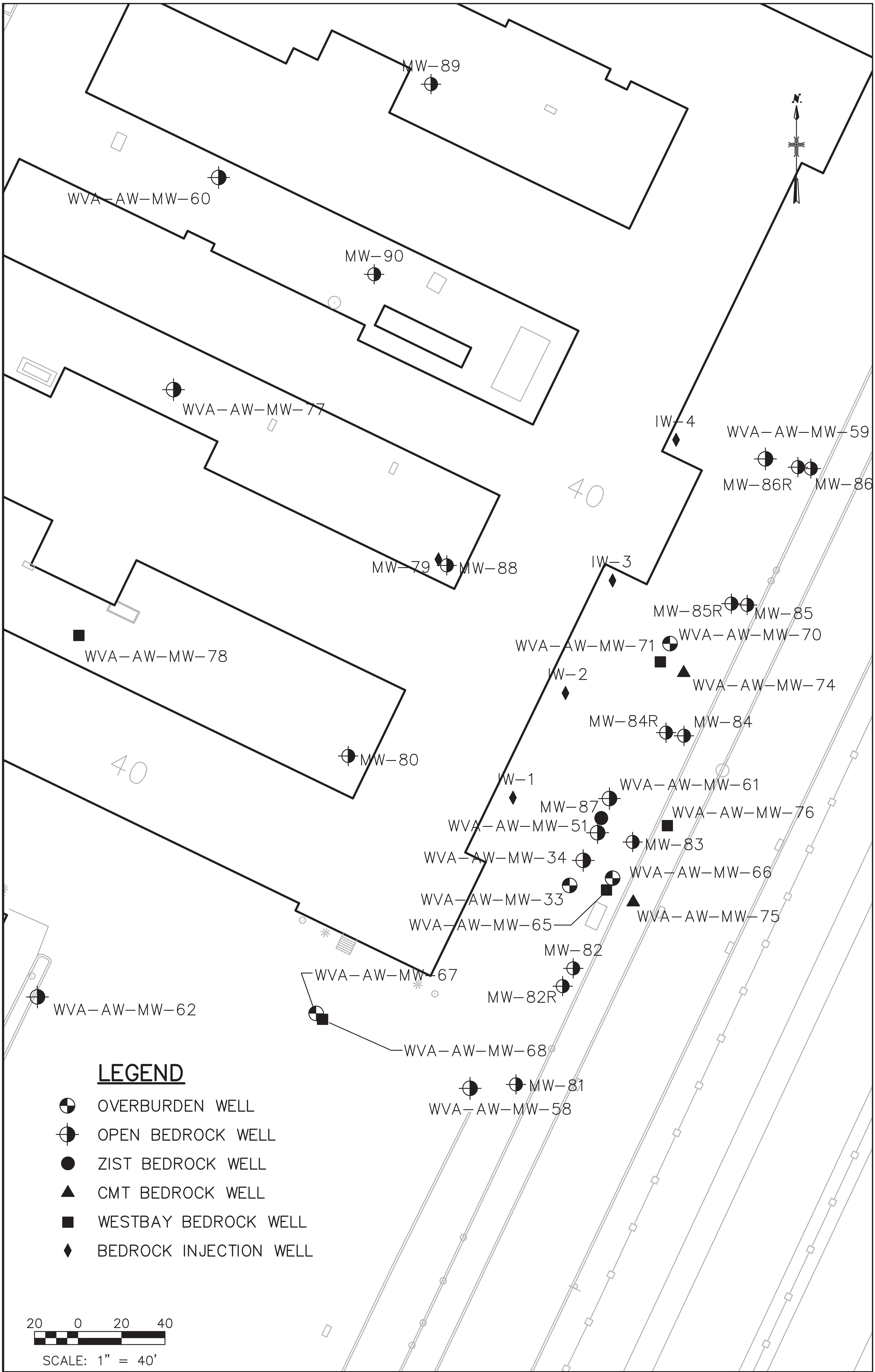
User:LaPlante Spec:PIRNIE STANDARD File:I:\ACAD\PROJ\0285\939\FIGURE 1-3.DWG Scale:1:1 Date:10/17/2008 Time:14:47 Layout:Layout1



WATERVLIET ARSENAL
MAIN MANUFACTURING AREA

MONITORING AND INJECTION WELL LOCATIONS (BUILDING 40)

MALCOLM PIRNIE, INC.

FIGURE 4

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WATERVLIET ARSENAL MAIN MANUFACTURING AREA
WATERVLIET, NEW YORK
VAPOR INTRUSION CORRECTIVE MEASURES LOCATIONS

MALCOLM PIRNIE, INC.

FIGURE 5

MMA SWMUs

Building 15: 15

Buildings 20, 120, and 130: Vapor Degreaser Units

Building 25: 5, 14, and Vapor Degreaser Units

Building 35: 13, 16, 26, Chrome Plating Pit Areas, and Chrome Plating Scrubbers

Building 36: 1, 6 and 17

Building 40: 19** and Vapor Degreaser Units

Building 44: 12

Building 110: 4*, 10, 11, Vapor Degreaser Units, Chrome Plating Pit Areas, and Chrome Plating Scrubbers

Building 114: Chrome Plating Scrubbers

Building 115: 9

Building 123: Chip Handling Facility Areas

Building 132: 21 and Chip Handling Facility Areas

Building 135: 8 and 27

Former Erie Canal Area: 25

Notes:

* Building 110A was demolished as part of the REARM project and no longer exists.

** SWMU 19 is for outfall 003, which is located east of Building 40.

420 210 0 420
Feet

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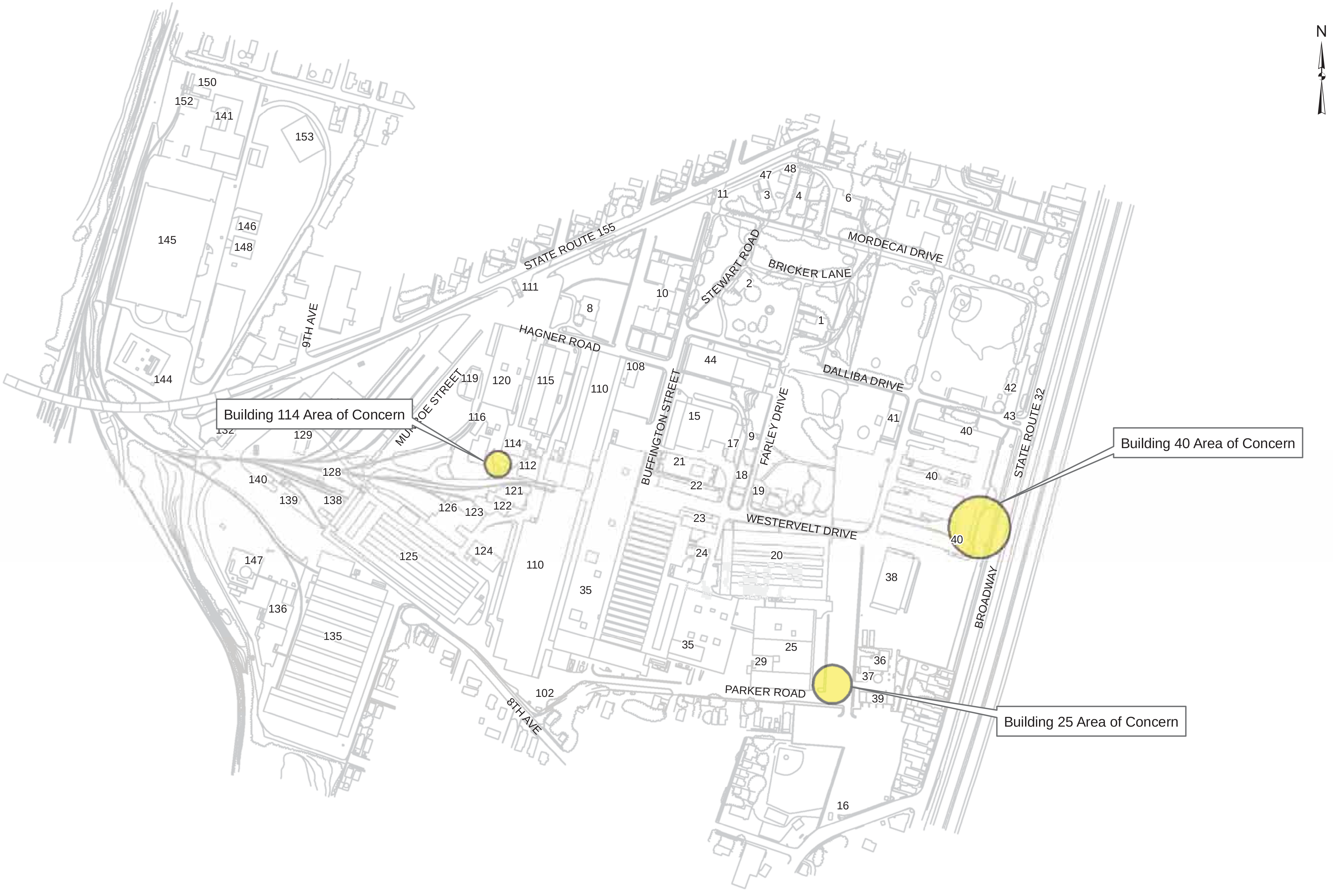
CORRECTIVE MEASURES STUDY
WATERVLIET ARSENAL, MAIN MANUFACTURING AREA, WATERVLIET, NEW YORK

SOLID WASTE MANAGEMENT UNIT (SWMU) LOCATIONS

FIGURE 6



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WATERVLIET ARSENAL
WATERVLIET, NEW YORK
MAIN MANUFACTURING AREA - AREAS OF CONCERN

0 0.1 0.2 0.4
Miles

MALCOLM PIRNIE, INC.

FIGURE 7