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FMC

FMC Corporation
Middleport, New York

CORRECTIVE MEASURES STUDY (CMS) REPORT

Tributary One and Flood Plain South of Pearson/Stone Roads Study Area – Operable Unit 6 (OU6)

Draft November 2017

With Contributions By:

GEI Consultants

RAMBOLL ENVIRON

CORRECTIVE MEASURES STUDY (CMS) REPORT

Tributary One and Flood Plain South of Pearson/Stone Roads Study Area – Operable Unit 6 (OU6)

Prepared for:

FMC Corporation

Middleport, New York

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Date:

Draft November 2017

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ACRONYMS, ABBREVIATIONS, AND UNITS OF MEASURE

Agencies	NYSDEC and USEPA
AOC	Administrative Order on Consent
ATSDR	Agency for Toxic Substances and Disease Registry
CAMU	Corrective Action Management Unit
CAO	Corrective Action Objective
CFR	Code of Federal Regulations
CMA	Corrective Measures Alternative
CMI	Corrective Measures Implementation
CMS	Corrective Measures Study
COI	constituent of interest
COPEC	constituent of potential ecological concern CSF cancer slope factor
CSM	conceptual site model
DER	Division of Environmental Remediation
DSOB	Draft Statement of Basis
EC	engineering control
EPC	exposure point concentration
ESI	Eastern Surface Impoundment
FEMA	Federal Emergency Management Agency
FMC	FMC Corporation
FWRIA	Fish and Wildlife Resource Impact Analysis
HHRA	Human Health Risk Assessment
HQ	Hazard Quotient
IC	institutional control
ICM	Interim Corrective Measure
IRM	Interim Remedial Measure
LOAEL	Lowest Observed Adverse Effect Level
MCIG	Middleport Community Input Group
mg/kg	milligrams per kilogram
NOAEL	No Observed Adverse Effect Level

NPDES	National Pollutant Discharge Elimination System
NWP	Nationwide Permit
NYCRR	Compilation of the Rules and Regulations of the State of New York
NYSDEC	New York State Department of Environmental Conservation
NYSDOH	New York State Department of Health
OU6	Operable Unit 6
RCRA	Resource Conservation and Recovery Act
RfC	reference concentration
RFI	RCRA Facility Investigation
RME	Reasonable Maximum Exposure
SCO	Soil Cleanup Objective
SPDES	State Pollutant Discharge Elimination System
SWPPP	Storm Water Pollution Prevention Plan
TCEQ	Texas Commission of Environmental Quality
URF	unit risk factor
USACE	United States Army Corps of Engineers
USEPA	United States Environmental Protection Agency
WSI	Western Surface Impoundment
WTP	water treatment plant
WWTP	waste water treatment plant

EXECUTIVE SUMMARY

FMC Corporation (FMC) has completed an evaluation of corrective measures alternatives (CMAs) for a portion of its Middleport, New York facility ("Facility") off-site study area identified as Tributary One and Flood Plain South of Pearson/Stone Roads ("Tributary One South Study Area"), also known as Operable Unit 6 (OU6) (Figure 1). Investigation, monitoring, and remedial activities have been implemented by FMC since 1991 to address constituents in soil and other environmental media at the Facility and off-site areas under the terms and conditions of the Administrative Order on Consent (AOC), Docket No. II RCRA-90-3008(h)-0209, effective July 2, 1991, entered into by FMC, the New York State Department of Environmental Conservation (NYSDEC), and the United States Environmental Protection Agency (USEPA) (NYSDEC and USEPA referred to herein as "the Agencies"). The Facility and off-site areas are being addressed in a phased approach in which separate study areas and/or environmental media have been organized into eleven operable units (OUs).

By letter dated May 3, 2010, the Agencies, in consultation with the New York State Department of Health (NYSDOH), communicated their final approval of the *RCRA Facility Investigation Report Volume V – Tributary One and Flood Plain South of Pearson/Stone Roads* (RFI Report Volume V) and their determination that a corrective measures study (CMS) is required to address the presence of FMC-related constituents (primarily arsenic) in soil and sediment within OU6. FMC accordingly submitted the draft *Corrective Measures Study (CMS) Work Plan – Tributary One and Flood Plain South of Pearson/Stone Roads* (CMS Work Plan) in July 2011.

By letter dated January 20, 2016, the Agencies, in consultation with the NYSDOH, provided FMC with comments on the CMS Work Plan and requested submittal of a draft CMS Report for OU6 ("CMS Study Area"). On February 22, 2016, FMC and the Agencies met to discuss the Agencies' comments on the draft CMS Work Plan and the Agencies' request for a draft CMS Report in accordance with Attachment II (Scope of Work for Corrective Measures Study) of the AOC, and certain understandings were reached, as summarized in FMC's March 1, 2016 letter. This report presents the findings of the CMS that was completed in accordance with the understandings reached during the February 22nd meeting and confirmed by FMC's letter dated March 1, 2016.

Description of CMS Study Area

FMC and predecessor companies operated the Facility for the manufacturing and/or formulation of agricultural products since the 1920s. Manufacturing ceased in 1985. Since that time, FMC has only conducted formulating and packaging operations. Past releases have resulted in the occurrence of FMC-related constituents in soil, sediment, surface water, and groundwater at the Facility and off-site areas.

The predominant constituent of concern within OU6 is arsenic in soil and sediment. Arsenic is a naturally occurring element present in soil due to geological background and use of man-made products. In western New York, there is evidence suggesting arsenical pesticides were used in some fruit orchards. Therefore, the local background concentration of arsenic in soil is a key consideration in delineation of arsenic concentrations which could potentially be attributable to releases from the Facility.

Tributary One begins at the Middleport Reservoir, south of the Village of Middleport, and flows through the village, beneath the Erie Canal aqueduct, and then northeast to its confluence with Jeddo Creek. The

CMS Study Area includes the stream and associated banks and flood plain downstream of the former FMC outfall at the Francis Street bridge, and extending approximately two miles downstream to Stone Road (Figure 1). As documented in RFI Report Volume V, the extent of the CMS Study Area was delineated based on the soil and sediment arsenic data distribution, surface topography, stream and surface water drainage hydrology, and historical land use. Additional arsenic analytical delineation data and stream characterization information was collected in 2016 and is documented in: *Operable Unit 6 (OU6) Reach T1 Interim Corrective Measure (ICM) Pre-Design Report* (Pre-Design Report; May 2017) and *2016 North of Canal Data Summary Report* (Data Summary Report; October 2017) included as part of this CMS Report.

OU6 Reach T1 Interim Corrective Measure (ICM)

On November 24, 2015, representatives from FMC, the Agencies, and the NYSDOH met to discuss the Agencies' October 21, 2015 letter inviting FMC to discuss implementation of an ICM, under Section VI.6(e) of the above-referenced AOC, for OU6. During the November 24th meeting, it was agreed that FMC would submit a proposed approach for an ICM of Reach T1, the upstream portion of OU6 between Francis Street and the Erie Canal (Figure 1). FMC's proposed approach for an ICM was submitted on January 22, 2016 and accepted by the Agencies on February 3, 2016. Additional site-specific information and data needed to evaluate possible ICMs for Reach T1 were collected in 2016 and summarized in the Pre-Design Report, which included a proposed ICM Scope of Work for Reach T1.

By letter dated April 19, 2017, the Agencies conditionally accepted the Pre-Design Report and proposed ICM Scope of Work, and requested preparation and submission of an ICM Work Plan (including a detailed design to implement the ICM). Following discussion between FMC and the Agencies, the Pre-Design Report was revised by FMC and accepted by the Agencies by email dated May 24, 2017. The detailed design to implement the ICM, including a proposed schedule to initiate the ICM in 2018, is presented in the *Operable Unit 6 (OU6) Reach T1 Interim Corrective Measure (ICM) Work Plan* (ICM Work Plan; Draft August 2017). By letter dated September 22, 2017, the Agencies provided FMC with comments on the ICM Work Plan. In accordance with Section XI, Item 1 of the AOC, FMC requested a meeting to discuss the comments, by letter dated October 6, 2017.

Overview of CMS Process

The CMS included soil/sediment sampling; a fish and wildlife resource impact analysis (FWRIA) field study; site-specific human health and ecological risk assessments; identification and development of CMAs; evaluation of the CMAs; and justification/recommendation of a CMA for the CMS Study Area.

In March 2009, the Agencies established final site-specific Corrective Action Objectives (CAOs) for soil and sediment in FMC's off-site study areas, including OU6, after consultation with FMC and the public. The purpose of CAOs is to guide the Agencies' corrective measures decision making pursuant to the AOC. The Agencies' final CAOs include an obligation to:

- focus on "FMC-related contamination," meaning the incremental contamination above background;
- state that final corrective action should not be dictated by certain laws, rules and regulations, including Action Levels;
- state that the final corrective action off-site study areas must be based on site-specific data, including site-specific risk assessments and current and reasonably anticipated future land uses;

- seek to achieve a reduction in health risk to a residual risk within a "range appropriate for residential communities" (e.g., acceptable residual lifetime cancer risk as $1x10^{-4}$ to $1x10^{-6}$) that meet the Agencies' risk criteria specified in the final corrective action objectives; and
- establish site-specific background concentrations as a "point of departure" or "starting point" for corrective action decisions.

Risk Assessments

Collectively, the human health risk assessment (HHRA) and FWRIA demonstrate that corrective measures are not necessary for soil/sediment arsenic in the OU6 CMS Study Area beyond implementation of the ICM (as described in the ICM Work Plan), with one exception. For current land uses, post-ICM estimated human health risks are below or within the acceptable values identified in the site-specific CAOs issued by the Agencies, for all receptors and properties. The same is also true in consideration of potential future land uses, except for Property BH3 when residential use is conservatively considered for this unimproved Village-owned property.

Identification and Description of the Corrective Measures Alternatives (CMAs)

CMAs were developed incorporating the following retained corrective measures technologies: no further action; monitored natural recovery; institutional controls; engineering controls; bank stabilization; sediment collection; and soil/sediment removal and disposal.

Use of a Corrective Action Management Unit (CAMU) located on the Facility or use of appropriate off-site commercial disposal facilities were considered for disposal options. A detailed description and evaluation of these disposal options is presented in the *Corrective Measures Study (CMS) Report – Suspected Air Deposition and Culvert 105 Study Areas* (Draft May 2011), and an excerpt is provided in Appendix C. For the purposes of the CMS, both the CAMU and an off-site disposal option have been included in the CMAs, as described below.

During the RFI, a soil arsenic concentration of 20 milligrams per kilogram (mg/kg) was used for delineation purposes. The Agencies have asserted that a soil arsenic concentration of 20 mg/kg generally represents the upper limit of local background for residential properties. The 20 mg/kg concentration is not necessarily a “remediation” criterion or standard, as stated in RFI Report Volume V, approved by the Agencies. CMAs adopting a universal 20 mg/kg soil arsenic concentration goal or a 20 mg/kg soil arsenic concentration goal with “flexibility” (NYSDEC 2013) do not produce any measurable or meaningful difference in human health or environmental risk when compared to CMAs identified herein and are not necessary to achieve the CAOs established by the Agencies pursuant to the AOC. Consequently, those CMAs were not evaluated further in the CMS.

The CMAs listed below have been identified and developed to address the presence of potentially FMC-related arsenic in OU6 (Figures 3 through 6).

- Alternative 1 (also referred to as CMA 1) – Complete Reach T1 ICM Soil/Sediment Removal as proposed in the ICM Work Plan
- Alternative 2 (also referred to as CMA 2) – CMA 1, plus institutional controls at Property BH3
- Alternative 3 (also referred to as CMA 3) – CMA 1, plus soil/sediment removal (24-inches deep) in designated areas north of the Erie Canal and construct sediment traps

- Alternative 4 (also referred to as CMA 4) – Same as CMA3, plus soil/sediment removal (24-inches deep) in stream bed and banks in designated areas upstream of the sediment traps

A remedial design has already been developed for CMAs 1 and 2. CMAs 3 and 4 would require remedial design and pre-design activities for the area north of the Erie Canal. The remedial design would include technical drawings, plans and specifications, as well as other project specific plans necessary to implement the construction activities. Pre-design activities necessary to support the remedial design for CMAs 3 and 4 would also be conducted.

The major differences between the four CMAs are identified below:

CMA	1	2	3	4
Estimated Volume of Soil/Sediment Removal (cubic yards)	13,450	13,450	58,200	72,200
Total Estimated Area of Soil/Sediment Removal (acres)	1.9	1.9	15.8	20.1
Estimated Number of Construction Seasons (May to November) to Complete	2	2	6	8
Estimated Length of Stream Disturbed	1,600	1,600	4,800	7,400
Number of Properties to be Remediated	17	18	36	50
Note: The number of properties to be remediated includes properties where soil/sediment removal will occur, and those where ICs will be required (Property BH3 under CMA 2, as well as properties where sediment traps will be located, and access provided for periodic removal of accumulated sediment under CMAs 3 and 4, as needed).				

CMA Evaluation Criteria

The CMAs were evaluated based on the ability to attain the site-specific CAOs using the following criteria specified in the CMS Work Plan:

1) Community/Property Owner Acceptance

2) Technical (effectiveness, performance, reliability, implementability and safety)

3) Environmental (potential short- and long-term beneficial and adverse impacts on the environment)

4) Human Health (short-term (i.e., risks during implementation) and long-term (i.e., after implementation)

5) Institutional (consideration of federal, state, and local rules and regulations)

6) Cost (capital, engineering and long-term maintenance)

7) Green Remediation Practices (net environmental benefit)

Summary of Justification and CMA Recommendation

The recommended CMA for the CMS Study Area and justification for the recommended CMA are based on the detailed evaluation of alternatives using the CAOs and the applicable evaluation criteria.

All of the CMAs, except CMA 1, protect human health by achieving acceptable long-term human health risks (i.e., estimated excess lifetime cancer risks are within or below the range of 10^{-4} and 10^{-6}, and the non-cancer hazard indices are below the target value of 1). CMA 1 protects human health by achieving acceptable long-term human health risks, except with respect to the hypothetical future residential use of a single undeveloped property (BH3) owned by the Village. While all of the CMAs protect the environment by achieving acceptable ecological risks, CMA 1 and CMA 2 do not address potential downstream migration and, therefore, do not satisfy CAO 1.E. Since all of the corrective measures alternatives retained for analysis in this CMS satisfactorily protect human health and the environment, the remaining evaluation criteria take on added significance.

All of the CMAs, except CMA 1, protect human health and the environment with respect to FMC-related contamination, in accordance with, and/or consideration of applicable, or relevant and appropriate laws, rules and guidance, using site-specific data and information, supported by multiple lines of evidence, including site-specific risk assessment, and based on current and reasonably anticipated future land use. The remedial-decision making process embodied in the CMS is consistent with the AOC, the CAOs, and federal law, and does not default to New York State's rules and guidance concerning the remediation of historical contamination that presumptively require the excavation and removal of all soil with arsenic concentrations above background levels. For the FMC Middleport Project, the Agencies have asserted that a soil arsenic concentration of 20 mg/kg generally represents the upper limit of local background for residential properties. CMAs based on that site-specific residential background value of 20 mg/kg have been screened out of the final CMS analysis because: (i) they are not necessary to achieve the CAOs established by the Agencies pursuant to the AOC; and (ii) those types of alternatives necessarily compare unfavorably to CMAs 1 through 4 on every other substantive evaluation criteria. Consequently, those CMAs were not evaluated further in this CMS.

CMAs 3 and 4 satisfy more evaluation criteria than the other CMAs. CMA 1 satisfies the least number of evaluation criteria. CMAs 1 and 2 provide no remediation in the CMS Study Area north of the Erie Canal and therefore compare less favorably to CMAs 3 and 4 in meeting CAO 1.E ("…eliminate, reduce, or control the potential for migration FMC-related contaminants in soil and/or sediment"). The downstream sediment traps/basins included in CMAs 3 and 4 offer a potential remedial option that could be implemented in the event that an upstream property owner(s) does not provide access required for the CMI phase.

CMA 4 removes approximately 25% greater volume of soil/sediment than CMA 3, resulting in proportionately greater ecological and short-term public and worker safety risks, although such risks would be minimized by adherence to applicable rules and regulations and best management practices during construction. CMA 4 provides the maximum reduction in exposure with time and minimum exposure to contaminants, meeting the preference for CMAs identified in the AOC (Attachment II [Scope of Work for Corrective Measures Study], page 12).

CMAs 3 and 4 were assessed as moderate for the green remediation practices criterion, primarily due to the amount of soil/sediment to be removed and transported. Likewise, CMAs 3 and 4 were assessed as moderate for the technical criterion for short-term safety criteria.

The soil/sediment which would be generated by implementation of the CMA is well-suited to disposal in a commercial landfill or placement in CAMU located on the Facility. Final decisions regarding management of remediation wastes will be determined during the corrective measures implementation (CMI) phase. This phase includes activities associated with planning, designing, constructing and maintaining the selected remedy, and associated community participation and outreach activities.

On the basis of the detailed evaluation and critical comparison of alternatives, FMC recommends CMA 4 as the preferred final corrective measure for OU6.

1 INTRODUCTION

FMC Corporation (FMC) prepared this *Corrective Measures Study Report, Tributary One and Flood Plain South of Pearson/Stone Roads Study Area – Operable Unit 6 (OU6)* (CMS Report) for an off-site portion of its facility located in Middleport, New York. Specifically, the CMS Report addresses the off-site study area identified as Tributary One and Flood Plain South of Pearson/Stone Roads ("Tributary One South Study Area"), also known as Operable Unit 6 (OU6) (Figure 1). This area is referred to hereafter in this report as the "CMS Study Area."

The CMS Report was prepared under the terms and conditions of the Administrative Order on Consent (AOC) [Docket No. II RCRA-90-3008(h)-0209] entered into by FMC, the New York State Department of Environmental Conservation (NYSDEC), and the United States Environmental Protection Agency (USEPA) (the latter two entities collectively referred to herein as "the Agencies"), effective July 2, 1991 (USEPA et al., 1991). Pursuant to Section VI.3.d of the AOC and the understandings reached between FMC and the Agencies during a February 22, 2016 meeting to discuss the Agencies' comments on the draft *Corrective Measures Study (CMS) Work Plan – Tributary One and Flood Plain South of Pearson/Stone Roads* (CMS Work Plan), the CMS Report identifies and screens corrective measures technologies, develops and evaluates corrective measures alternatives (CMAs), and provides a recommended CMA with supporting justification under the Resource Conservation and Recovery Act (RCRA) Corrective Action program. Development and evaluation of CMAs was conducted within the framework of site-specific Corrective Action Objectives (CAOs) issued by the Agencies (Appendix A).

1.1 Overview

FMC owns and operates a pesticide formulating facility located in the Village of Middleport and the Town of Royalton, Niagara County, New York ("Facility", "Plant" or "Site"). FMC and predecessor companies operated the Facility for the manufacturing and/or formulation of agricultural products since the 1920s. Manufacturing ceased in 1985. Since that time, FMC has only conducted formulating and packaging operations at the Facility. Past releases have resulted in the occurrence of FMC-related contamination at the Facility and off-site study areas. Investigation, monitoring, and remedial activities have been implemented by FMC since 1991 to address constituents in soil and other environmental media at the Facility and off-site areas under the terms and conditions of the AOC. The Facility and off-site areas are being addressed in a phased approach in which separate study areas and/or environmental media have been organized into eleven operable units (OUs). The CMS Study Area that is the subject of this report represents one of the 11 OUs.

Details of the investigation and monitoring activities, to date, within the CMS Study Area are presented in the reports listed below.

- *RCRA Facility Investigation Report Volume I – Background and Related Information* (RFI Report Volume I), dated September 2009 (Arcadis and AMEC Geomatrix September 2009)
- *RCRA Facility Investigation Report Volume V – Tributary One and Flood Plain South of Pearson/Stone Roads* (RFI Report Volume V) (Arcadis June 2010)

- *Operable Unit 6 (OU6) Reach T1 Interim Corrective Measure (ICM) Pre-Design Report* (Pre-Design Report; Arcadis May 2017)
- *2016 North of Canal Data Summary Report* (Data Summary Report; Arcadis October 2017; Appendix B)

As discussed more fully in RFI Report Volume V, the extent of the CMS Study Area was delineated based on the soil and sediment arsenic data distribution, surface topography, stream and surface water drainage hydrology and historical land use. The CMS Study Area includes approximately 4.5 miles of stream banks (combined length of both sides of the stream) and all or portions of 62 properties located along Tributary One and its flood plain, as described in RFI Report Volume V. Tributary One begins at the Middleport Reservoir, south of the Village of Middleport, and flows through the village, beneath the Erie Canal aqueduct, and then northeast to its confluence with Jeddo Creek. The upstream portion of the CMS Study Area between Francis Street and the Erie Canal is referred to as “Reach T1” and includes 26 properties. Figure 1 shows the CMS Study Area boundaries (approximately 46 acres).

1.2 CMS Activities

CMS activities identified in the CMS Work Plan are listed below, along with a summary of the current status of the listed activities:

- Community participation (on-going)
- Risk assessments (presented in this CMS Report)
- Identification, description, and screening of corrective measures technologies (presented in this CMS Report)
- Identification and development of Corrective Measures Alternatives (CMAs) (presented in this CMS Report)
- Evaluation of the CMAs (presented in this CMS Report)
- Justification and recommendation of a CMA (presented in this CMS Report)
- Reports, including deliverables required for the OU6 Reach T1 ICM (previously submitted), and Draft and Final CMS Reports

Submittal of the draft CMS Report is one of several steps in completing the CMS Report for the CMS Study Area and in the Agencies’ selection of a final corrective measure(s) for the CMS Study Area. This process generally consists of the following:

- Corrective Action Objectives - The Agencies, in consultation with the NYSDOH, issued the CAOs, by letter dated March 26, 2009, after consultation and review by FMC and the public. The purpose of CAOs is to guide the Agencies’ corrective measures decision making pursuant to the AOC (see Appendix A).
- CMS Work Plan - The CAOs formed a basis for the CMS Work Plan. By letter dated January 20, 2016, the Agencies, in consultation with the NYSDOH, provided FMC with comments on the CMS Work Plan and requested submittal of a draft CMS Report for OU6 (“CMS Study Area”) that complies

with Attachment II (Scope of Work for Corrective Measures Study) of the AOC. On February 22, 2016, FMC and the Agencies met to discuss the Agencies' comments on the draft CMS Work Plan and request for a draft CMS Report, and reached certain agreements during the meeting. Those agreements were documented in a FMC letter dated March 1, 2016.

- Draft CMS Report – This report presents the findings of the CMS that was completed in accordance the understandings reached during the February 22, 2016 meeting between FMC and the Agencies.
- Draft CMS Report Public Comment Period – The Agencies will hold a 45-day public comment period and public meeting on the "final" draft CMS Report, which will include the recommended corrective measures.
- Agencies' Draft Statement of Basis – The Agencies will consider and respond to public comments on the draft CMS Report and will issue a Draft Statement of Basis (DSOB) that identifies FMC's recommended corrective measures and/or the Agencies' preliminary selection of corrective measures.
- DSOB Public Comment Period – The Agencies will hold a 45-day public comment period and public meeting on the Agencies' preliminary selection of corrective measures.
- Agencies' Final Selection of Corrective Measures – The Agencies will consider and respond to public comments on the (DSOB) and will select the final corrective measure for the CMS Study Area. The Agencies may then request that FMC issue a Final CMS Report incorporating comments from the Agencies on the draft CMS Report and the Agencies' final selected corrective measures. The Agencies will issue a Final Decision/Statement of Basis and responsiveness summary.

1.3 Corrective Action Objectives and CMS Evaluation Criteria

The Agencies developed the CAOs in consultation with FMC and the public (which included consultation and invitation for comments). By letter dated March 26, 2009 (provided in Appendix A of this CMS Report), the Agencies, in consultation with the New York State Department of Health (NYSDOH), issued final CAOs for off-site soil and sediment corrective measures studies, excluding the FMC Facility and the FMC-owned North Railroad Property. As stated in the Agencies letter (Appendix A), the purpose of CAOs is to guide the Agencies' corrective measures decision making pursuant to the AOC. The Agencies' final CAOs include an obligation to:

- focus on "FMC-related contamination," meaning the incremental contamination above background;
- state that final corrective action should not be dictated by certain laws, rules and regulations, including generic Action Levels or soil cleanup levels;
- state that the final corrective action off-site study areas must be based on site-specific data, including site-specific risk assessments and current and reasonably anticipated future land uses;
- seek to achieve a reduction in health risk to a residual risk within a "range appropriate for residential communities" (e.g., acceptable residual lifetime cancer risk as $1x10^{-4}$ to $1x10^{-6}$) that meet the Agencies' risk criteria specified in the final corrective action objectives; and

- establish site-specific background concentrations as a "point of departure" or "starting point" for corrective action decisions.

Based on the CAOs, as described in the CMS Work Plan, site-specific CMAs were developed and evaluated consistent with the AOC.

The CMAs were evaluated based on the extent to which each CMA meets the CAOs and against the seven evaluation criteria listed below.

1) Community/Property Owner Acceptance
2) Technical (effectiveness, performance, reliability, implementability and safety)
3) Environmental (potential short- and long-term beneficial and adverse impacts on the environment)
4) Human Health (risks during and after implementation)
5) Institutional (consideration of federal, state, and local rules and regulations)
6) Cost (capital, engineering and long-term maintenance)
7) Green Remediation Practices (net environmental benefit)

In this CMS Report, the results of detailed and comparative evaluations of the CMAs, based on the achievement of the CAOs and the above criteria, are used to justify and recommend the corrective measures for the CMS Study Area.

1.4 Report Organization

This CMS Report is organized as follows:

Title		Purpose
Executive Summary		
Section 1	Introduction	Provides background information and describes the purpose of this CMS Report
Section 2	Community Participation	Identifies the objectives and minimum community participation activities for this project
Section 3	CMS Study Area Description	Provides a detailed description of the CMS Study Area
Section 4	Identification, Description, and Screening of Corrective Measures Technologies	Identifies and provides a detailed description of the corrective measures technologies considered, and evaluates and screens these technologies

Title		Purpose
Section 5	Detailed Descriptions of Corrective Measures Alternatives	Provides a detailed description of each CMA
Section 6	Risk Assessment	Presents a summary of the human health and ecological risk assessments
Section 7	Evaluation of Corrective Measures Alternatives	Presents the seven criteria required to evaluate the CMAs, followed by the evaluation of CMAs using these criteria
Section 8	Justification and Recommendation of the Corrective Measures Alternative	Presents the justification and recommendation of the CMA for the CMS Study Area
Section 9	References	
Appendices	Various titles	Present technical and administrative details of the CMS Study Area, including the Agencies' CAOs, site-specific human health risk evaluation, site-specific fish and wildlife resource impact analysis, and other supporting information used in the CMS

2 COMMUNITY PARTICIPATION

2.1 Communications Program Overview

FMC is committed to involving the Middleport community, affected property owners, local officials, and others potentially affected by the project. One of the Agencies' CAOs specifically addresses community participation:

> "Inform and engage affected property owners and local residents in meaningful participation throughout the cleanup process, including the CMS, the corrective measures, design, and implementation phases."

The project-specific community participation activities for the OU6 CMS will be conducted in accordance with USEPA's January 2017 RCRA Public Participation Manual and as required by the Agencies CAO 3 (see Appendix A).

Goals of FMC's community participation program are as follows:

- **Provide Information -** Balanced and objective information will be provided to assist the community and stakeholders in understanding the project scope of work, the problems, and the process for addressing the problems, and the alternatives and the solutions to the problems. Information will be provided to the public and stakeholders by fact sheets, newsletters, web sites, open houses, availability sessions, and/or meetings.
- **Obtain Feedback -** Community and stakeholder feedback on the project scope of work, the problems, the process for addressing the problems, the alternatives and solutions to the problems will be obtained. Comments and feedback will be obtained by maintaining open communications; holding public comment periods, public information sessions, and/or public meetings; conducting surveys; community-wide mailings with return/reply comment cards and/or web-site discussion forums.
- **Provide Opportunities for Involvement –** Opportunities will be provided to the community and stakeholders for involvement during the implementation of the project and not just at the end of the project. Opportunities will be provided by holding meetings, workshops, information sessions and/or public meetings. Surveys or other forms of outreach may also be used to solicit information regarding activities conducted by residents within the study area.

2.2 Document Repositories

Project-related documents are available in hard copy document repositories located at:

1. **Royalton Hartland Community Library**
   9 South Vernon Street
   Middleport, NY 14105
   (716) 735-3281
   Hours: Mon.-Thu. 11am-5pm & 7-8:30pm; Sat. 11am-4pm; Fri. & Sun. closed
   http://royhartcommunitylibrary.com

2. **NYSDEC Region 9 Office**
   270 Michigan Avenue
   Buffalo, NY 14203
   (716) 851-7200
   Hours: Mon.-Fri. 8:30am-4:45pm
   http://www.dec.ny.gov/about/619.html

3. **FMC Community Office**
   8 South Vernon Street
   Middleport, NY 14105
   (716) 735-9769
   Hours: Mon., Tue., Thu. 9am-2pm or by appointment

Project updates and documents are also available electronically on the following websites:

1. FMC's Middleport website: http://www.fmc-middleport.com/
2. Middleport Community Input Group (MCIG) website: http://middleport-future.com/
3. NYSDEC's website: http://www.dec.ny.gov/chemical/54220.html

In addition, FMC's Community Liaison, at 8 South Vernon Street in Middleport, is available to discuss the CMS process and answer questions. Paper copies of major reports are available at this location for review by the community.

2.3 Project Contact List

Key project contact are as follows:

Organization	Contact	Phone Number/Email
FMC Middleport Community Office	Jessica Heideman FMC Community Liaison	716-735-9769 jessica.heideman@fmc.com
FMC Corporation – Philadelphia Office	Nick Schapman Project Coordinator	513-218-4222 nicholas.schapman@fmc.com
NYSDEC – Albany Office	Nate Freeman Project Coordinator	518-402-9767 nathan.freeman@dec.ny.gov
NYSDOH – Albany Office	Stephanie Selmer Public Health Specialist	518-402-7860 beei@health.state.ny.gov
USEPA – Region 2 Office	Michael Infurna Project Coordinator	212-637-4177 infurna.michael@epa.gov

A list of OU6 property owners, property residents/occupants, local officials from the Village of Middleport and the Towns of Royalton and Hartland, and other stakeholders has been prepared and is available upon request.

2.4 Project-Specific Communication Activities

Specific community outreach and property access activities associated with the OU6 CMS field activities conducted in 2016 are summarized in the Data Summary Report (Appendix B).

After submittal of the Draft CMS Report, the following community outreach activities may be conducted by FMC:

- Provide updates (e.g., newsletters, fact sheets, letters) to affected property owners and/or project-specific stakeholders;
- Place the Draft CMS Report in the document repositories and post on the aforementioned project websites;
- Meet with project-specific stakeholders to review the CMS and/or solicit comments/input and/or otherwise provide opportunities (e.g., public meetings, information sessions) for the project-specific stakeholders to discuss and comment on the Draft CMS Report; and
- Document public and project-specific stakeholders' comments and responses to comments, as necessary and appropriate.

After Agencies approval of the Draft OU6 CMS Report, the Agencies and/or FMC may conduct the following communication activities, consistent with USEPA's January 2017 RCRA Public Participation Manual:

- Preparation and distribution of fact sheet regarding the Draft CMS Report and/or the Agencies' DSOB to the OU6 contact list.
- Placement of Draft CMS Report and DSOB in the document repositories.
- Public Comment Period – The Agencies will hold a 45-day public comment period and public meeting on the "final" Draft CMS Report, which will include FMC's recommended corrective measures and/or on the Agencies DSOB that identifies the Agencies' preliminary selection of corrective measures.
- Agencies' Final Selection of Corrective Measures – The Agencies will consider and respond to public comments on the DSOB and/or Draft CMS Report and will select the final corrective measure for the CMS Study Area. The Agencies will issue a Final Statement of Basis (Agencies' selected corrective measures) and responsiveness summary.

3 CMS STUDY AREA DESCRIPTION

3.1 CMS Study Area

The CMS Study Area includes approximately 4.5 miles of stream banks (combined length of both sides of the stream) and all or portions of 62 properties located along Tributary One and its flood plain, as described in RFI Report Volume V. As discussed more fully in RFI Report Volume V, the extent of the CMS Study Area was delineated based on the soil and sediment arsenic data distribution, surface topography, stream and surface water drainage hydrology and historical land use. The upstream portion of the CMS Study Area between Francis Street and the Erie Canal is referred to as "Reach T1." Figure 1 shows the CMS Study Area boundaries (approximately 46 acres).

3.2 Tributary One

Tributary One of Jeddo Creek is fed by the Middleport Reservoir (within the Town of Royalton) south of the Village of Middleport and runs northerly from the reservoir approximately 6.75 miles through the Town of Royalton, the Village of Middleport, the Town of Hartland, and into the Town of Ridgeway until its confluence with Jeddo Creek. For the purposes of FMC's RCRA corrective action program, Tributary One and its flood plain located downstream of the FMC Facility Outfall 001 was divided into two study areas: 1) Tributary One South of Pearson/Stone Roads (which is the subject of RFI Report Volume V and this CMS Report) (OU6); and 2) Tributary One North of Pearson Road and east of Stone Road (which will be the subject of RFI Report Volume VI when it is completed) (OU7). The section of Tributary One south of Francis Street (immediately upstream of the FMC Facility outfall) has been studied to characterize upstream or background sediment conditions in the stream.

In the early 1990s, the NYSDEC reclassified Tributary One from a Class D intermittent flow stream to a Class C surface water, which is defined by the NYSDEC Water Quality Regulation as (6NYCRR Part 701):

> *The best usage of Class C waters is fishing. These waters shall be suitable for fish propagation and survival. The water quality shall be suitable for primary and secondary recreation, although other factors may limit the use for these purposes.*

Within the CMS Study Area, the width of Tributary One ranges from approximately 5 to 30 feet and its average base flow depth is between 0.5 and 1 foot. The banks of Tributary One are highly variable, ranging from less than 1 foot in height in low lying areas to more than 10 feet (retaining walls) in highly modified areas within the Village of Middleport. Parts of the stream bank have riprap or other protective devices in some of the areas located south of Sherman Street through which the tributary flows. The bottom characteristics of Tributary One vary and range from almost 100% bedrock to thin sediments with a substantial fraction of fine-grained material.

RFI Report Volume V Figure 2.3 identifies historical land uses for areas along Tributary One south of Pearson/Stone Roads. Historical businesses located adjacent to Tributary One included a coal storage yard and lumberyard, Loud-Wendell, Inc. plant (manufacturer of saw blades), flour and paper mills, stave

mill, and boat dry docks. In addition, many former orchards and agricultural fields have been historically cultivated adjacent to Tributary One and/or drained into Tributary One. In the late 1800s and early 1900s, several mill ponds existed as part of the stream at the following locations:

- Between Church Street and the Erie Canal
- South of Sherman Road
- Between Sherman Road and Chase Road
- Between Chase Road and North Hartland Road
- Northeast of Chase Road

Some forested/shrub areas along Tributary One north of the Erie Canal support wetland habitats and serve as a flood control/plain for Tributary One. The National Wetlands Inventory identifies four wetland areas (approximately 5 acres total) located along Tributary One in OU6. These areas include the former mill ponds located between Sherman and Chase Roads, between Chase Road and North Hartland Road, and northeast of Chase Road; and an area along Pearson Road, downstream of the Village of Middleport Wastewater Treatment Plant (WWTP).

FMC's existing State Pollutant Discharge Elimination System (SPDES)-permitted Outfall (Outfall 001) discharges into Tributary One north of the Francis Street bridge and south of the railroad tracks via a 30-inch corrugated metal pipe that runs from Outfall 001, along South Street and into Tributary One. The Outfall 001 discharge consists of treated water from the Facility's on-site water treatment plant (WTP) (surface water runoff from the northern portion of the Facility and extracted groundwater), and untreated surface water runoff from the southern portion of the Facility. Stormwater from a portion of the Northwest Conrail Area (also referred to as the "Phase 2 Interim Corrective Measure (ICM) Area of the North Railroad Property") and stormwater runoff from the back yards of several abutting residential properties, which were remediated by FMC in 2003 as part of an ICM, drain to a catch basin located in the Phase 2 ICM area. The catch basin is downstream of FMC's SPDES Outfall 001 and connects to the pipe that conveys water from the FMC Facility to Tributary One.

Stormwater from village and town streets, residential properties, commercial and business properties, and existing and former farm fields and orchards currently discharges into Tributary One South at various locations. The Village of Middleport WWTP also discharges to Tributary One near Pearson Road. North of the Erie Canal, flow in Tributary One is supplemented with water discharged from the canal during the summer and fall seasons (when the canal is full).

Prior to 1977, FMC's discharge point to Tributary One was located beneath the Francis Street Bridge. FMC and other industries (i.e., located in Middleport, including the Village of Middleport WWTP) have historically discharged stormwater or wastewater to Tributary One. Based on review of historical Sanborn maps, former industries located along Tributary One in OU6 that may have contributed to discharges to Tributary One include a dry dock, stave/saw mills, paper mills, flour mills, fruit and vegetable canning/packaging operations, copper shop, lumber and coal yards, food/feed/cider mills, and machine shops.

Between 1976 and 1978, FMC completed improvements for the handling of process wastewater and surface water at the Facility. The upgrades included, but were not limited to: construction of the Facility's on-site WTP to treat surface water runoff from the northern portion of the Facility; decommissioning (by plugging with grout) the Facility's buried sewer pipe (Outfall 001) and installed a new 30-inch buried sewer pipe approximately 100 feet north of the newly-plugged pipe, along South Street; and discharging treated water through the new pipe to Tributary One pursuant to the terms and conditions of the Facility's National Pollutant Discharge Elimination System (NPDES) permit, which later became a SPDES permit. Other upgrades and remediation activities related to FMC's past discharges to Tributary One are described in Section 2.5 of RFI Report Volume V.

Currently, stormwater in the northern portion of the Facility (south of the mainline railroad track, except the western portion of the Northwest Conrail Area) is directed primarily to asphalt-lined or grass-covered swales that drain into the Western Surface Impoundment (WSI). Water collected in the WSI is pumped to and treated at the Facility's WTP and then discharged to a downstream outfall at Tributary One in accordance with the Facility's SPDES permit. Stormwater runoff from the western portion of the Northwest Conrail Area drains to the aforementioned catch basin downstream of FMC's SPDES Outfall 001 (located in the Phase 2 ICM area). Stormwater runoff from the eastern portion of the Northwest Conrail Area drains to an asphalt-lined swale and is collected in the WSI.

The reconstructed north ditch on the North Railroad Property discharges into the Village of Middleport's Culvert 105 storm sewer. The reconstructed north ditch located along the north side of the active mainline railroad tracks receives stormwater runoff from the remediated Phase 1 ICM Area of the North Railroad Property, the properties (i.e., Falls Road Railroad tracks, the Royalton-Hartland Central School District property, Alfred Street, farm fields and commercial, industrial and residential properties) abutting the northern and eastern boundaries of the North Railroad Property, and a farm field that abuts FMC's eastern fence line. A new inlet to Culvert 105 was constructed in 2007 as part of the 2007 Early Actions performed on a parcel (referred to as the "Formerly Wooded Parcel") within the North Commercial/Industrial Area. Culvert 105 discharges to Tributary One at a location approximately 1.5 miles downstream of the FMC Outfall 001, immediately downstream of the Village WWTP.

3.3 Constituents of Concern

As described in RFI Volume V, soil and sediment in OU6 have been previously evaluated for constituents historically manufactured, formulated, handled, and/or used at the Facility. To supplement soil arsenic analytical data collected between 1993 and 2005 during the RFI and further delineate the horizontal and vertical extent of arsenic in the stream banks and flood plain, additional soil samples were collected in 2016. These supplemental activities are summarized in the Pre-Design Report and Data Summary Report concerning the upstream and downstream portions of the CMS Study Area, respectively.

The OU6 data set includes over 3,800 soil and sediment samples collected from approximately 850 locations. Arsenic was the constituent most frequently detected in the OU6 stream sediment and flood plain soil above background concentrations. Accordingly, arsenic defines the extent of potential Site-related impacts to soil and sediment in the CMS Study Area.

3.4 Land Usages within the CMS Study Area

Within the CMS Study Area, currently existing agricultural fields, wooded and residential properties are located along and drain to Tributary One. Maps identifying current land usages within the CMS Study Area are provided as Figures 2a and 2b. Table 1 identifies the current land use for each property in the OU6 CMS Study Area. As shown on Figures 2a and 2b, some "residential" properties (or a portion thereof) in OU6 are not currently developed or occupied by a residence, and/or are overgrown, wooded and/or contain wetland-like areas. It should be noted that development of many of these wooded and wetland-like areas would likely be limited based on existing codes, rules, and regulations applicable to the stream, flood plain and wetlands.

3.5 Tributary One Reach T1 ICM Scope

On November 24, 2015, representatives from FMC, the Agencies, and the NYSDOH met to discuss the Agencies' October 21, 2015 letter inviting FMC to discuss implementation of an ICM, under Section VI.6(e) of the above-referenced AOC, for OU6. During the November 24th meeting, it was agreed that FMC would submit a proposed approach for an ICM of Reach T1, the upstream portion of OU6 between Francis Street and the Erie Canal (Figure 1). FMC's proposed approach for an ICM was submitted on January 22, 2016 and accepted by the Agencies on February 3, 2016. Additional site-specific information and data needed to evaluate possible ICMs for Reach T1 were collected in 2016 and summarized in the Pre-Design Report, which included a proposed ICM Scope of Work for Reach T1.

By letter dated April 19, 2017, the Agencies conditionally accepted the Pre-Design Report and proposed ICM Scope of Work, and requested preparation and submission of an ICM Work Plan (including a detailed design to implement the ICM). Following discussion between FMC and the Agencies, the Pre-Design Report was revised by FMC and accepted by the Agencies by email dated May 24, 2017. The detailed design to implement the ICM, including a proposed schedule to initiate the ICM in 2018, is presented in the *Operable Unit 6 (OU6) Reach T1 Interim Corrective Measure (ICM) Work Plan* (ICM Work Plan; Draft August 2017).

As detailed in the ICM Work Plan, the proposed Reach T1 ICM Scope of Work requires excavation and removal of approximately 13,450 cubic yards of soil/sediment from the green-shaded area shown on Figure 3. The basis for this area was developed by considering stream morphology, site features (i.e., existing permanent structures), and areas needed to support construction activities and facilitate restoration of the stream banks, with adjustments for protection of adjoining structures and features. Restoration will be to approximate existing conditions regarding topography and surface cover type, including retaining walls, rip rap, and vegetation. Excavation and restoration will be conducted in sections and will begin in the upstream section (Francis Street to railroad overpass) and proceed downstream (north) to the canal overflow. Because of the potential for re-contamination and given the property line configurations, access to all properties in a section will be required to complete work in that section and any downstream section.

By letter dated September 22, 2017, the Agencies provided FMC with comments to the ICM Work Plan. In accordance with Section XI, Item 1 of the AOC, FMC requested a meeting to discuss the comments, by letter dated October 6, 2017.

4 IDENTIFICATION, DESCRIPTION, AND SCREENING OF CORRECTIVE MEASURES TECHNOLOGIES

This section identifies, describes, and provides a screening evaluation of corrective measure technologies and discusses several other topics relevant to the identification and development of site-specific CMAs.

4.1 Identification of Potentially Applicable Corrective Measures Technologies

As presented in the CMS Work Plan, potentially viable technologies appropriate for the CMS Study Area and the CAOs were identified based on the following primary considerations:

- Arsenic in soil/sediment is the primary constituent of concern that has/will influence the scope of remedial efforts in the CMS Study Area. Accordingly, corrective measures technologies that can effectively remove or isolate arsenic-containing soil/sediment or effectively reduce the soil arsenic concentrations were identified and used in the development of the CMAs.
- Arsenic is a naturally occurring element present in soil as a result of both geological background and use of man-made products. In western New York, there is evidence that suggests that arsenical pesticides were used in some fruit orchards. Therefore, the local background concentration of arsenic in soil is a key consideration in delineation of arsenic concentrations which could potentially be attributable to releases from the FMC Facility.
- Current land usages (Figures 2a and 2b) and environmental settings within the CMS Study Area.
- Minimization of potential disruption of the community and residents.
- Identification of “green” technologies and evaluation of technologies consistent with USEPA’s and NYSDEC’s “Green Remediation” practices.
- Identification and evaluation of both on-site and off-site options for the permanent disposal of non-hazardous remediation soil/sediment and debris (collectively “remediation wastes”).
- The off-site disposal option includes direct disposal or reuse as soil cover material at a commercial landfill(s) suitable for disposal of remediation wastes.
- The on-site disposal option consists of the use of an engineered, on-site consolidation area (Corrective Action Management Unit or “CAMU”) constructed, in accordance with RCRA regulations, in the eastern portion of the FMC Facility (“Facility” or “Site”). The CAMU would be used for the placement and permanent management of non-hazardous soil and other remediation waste at the eastern portion of the FMC Facility where there are existing engineering and administrative controls to prevent exposure to or migration of remediation waste. The proposed location for the CAMU includes the Eastern Surface Impoundment (ESI) Fill Area that has been used in the past for the temporary on-site placement and management of remedial soils generated in conjunction with Agencies’ approval of ICMs or interim remedial measures (IRMs), with final disposition to be determined during the CMS process.

The following technologies were identified for consideration in the development of CMAs:

1. No Further Action involves no further remedial activities. This technology does not include the implementation of additional soil/sediment excavation or remedial activities beyond those detailed in the ICM Work Plan for the Tributary One Reach T1 ICM (described in Section 3.5).
2. Institutional Controls (nonresidential properties only) involve the use of administrative measures to prevent or reduce the potential for human exposure to impacted soil/sediment. Institutional controls may include: use of deed restrictions (would require property owner consent); private property agreements/easements (would require property owner consent and would not require intervention of government authority); and environmental easements (would require property owner consent and intervention of NYSDEC). Institutional controls also include governmental controls such as zoning classifications that specify allowed land use.
3. Engineering Controls involves the use of physical controls that may be used (for example) to limit contact, restrict access, or support remediation. Engineering controls consist of physical measures to restrict access and/or maintain the integrity of another technology. Engineering Controls may include one or more of the following: 1) warning signs; 2) fences; and 3) engineered covers (to physically isolate soil/sediment and prevent the transport of and/or exposure to contaminants).
4. Soil Tilling/Blending involves the tilling or blending of soil in-place to reduce the concentrations of arsenic in soil and to recycle land/soil. Soil tilling/blending may be appropriate for upland soils on properties that are non-residential (e.g., agricultural).
5. Bank Stabilization includes engineered means to stabilize the bank and mitigate bank erosion and channel widening. Bank stabilization would limit the amount of impacted soil that may erode from the banks into the stream (where it could be transported further downstream).
6. Maintenance consists of activities required to maintain the effectiveness of an implemented remedial measure.
7. Removal and On-Site (CAMU) Disposal involves physical removal of soil/sediment containing arsenic and placement of that soil in a CAMU at the FMC Facility. A CAMU is defined as “an area within a facility that is used only for managing remediation wastes and for implementing corrective action or cleanup at the facility” (6NYCRR 370.2(b)(37) and 40 CFR 260.10). The placement and management of soils in the CAMU would be performed in accordance with design plans and procedures approved by the Agencies. Prior to approval by the Agencies, the design plans and associated procedures and support documents will be subjected to public comment and review. Details regarding the proposed CAMU are provided in the *Corrective Measures Study (CMS) Report – Suspected Air Deposition and Culvert 105 Study Areas* (Arcadis 2011). The CAMU, if approved, could also be used for the disposal of remediation wastes associated with other FMC study areas located south of Pearson/Stone Roads. Excerpts from the report that identify conceptual design level detail and show the proposed layout and cross-sections of the CAMU, are provided in Appendix C.
8. Removal and Off-Site Disposal/Reuse involves the removal of soil/sediment containing arsenic and disposal or beneficial reuse as daily cover at permitted commercial landfill. Off-site disposal evaluations presented in this CMS are based on truck transport of remediation waste to a commercial facility for purposes of making detailed comparisons between CMAs. Consistent with the reasons detailed in the *Corrective Measures Study (CMS) Report – Suspected Air Deposition and Culvert 105*

Study Areas, including Appendix D to that report, rail transport offers no advantages over truck transport at this time.

9. Sediment Collection Features would be designed to intercept and capture sediment at strategic locations intended to minimize downstream deposition, to separate clean material if possible, and to facilitate straightforward maintenance, as needed. The capacity of the sediment collection features would be optimized to minimize construction costs and to maximize the length of time required between maintenance cleanout events.

4.2 Evaluation of Sediment Collection Features

As listed in Section 4.1, sediment collection features are considered potential technologies for this CMS. Sediment collection features are structures that intercept and capture sediment by manipulating stream morphology. In general, sediment collection features slow down the flow of water to encourage the deposition of sediment. Over time this allows for the collection of sediment transported from upstream portions of the stream. Sediment collection features are well documented at being effective for capturing sediment. The collected sediment would be periodically removed and transported for disposal.

Field conditions, ease of construction, and trapping efficiency would be considered in choosing the type and configuration of sediment collection features. In general, the greater the surface area and volume, the more effective the sediment collection feature. Common types of features considered for the CMS include:

- **Existing Sediment Feature** - The use of existing features to intercept sediments from downstream transport. The former mill ponds may be useful as a sediment collection feature, but would likely require enhancement. This alternative would be minimally disruptive of the surrounding wetland areas, but may not be as effective as more engineered systems.

- **Sediment Basin** - A basin constructed across a drainage way, within the floodplain area, or at other suitable locations to slow and collect sediment laden water for deposition before downstream transport. Sediment basins are more effective as they increase in surface area and volume, but larger sediment basins would be more disruptive of the surrounding habitats. The former mill pond area between Sherman Street and Chase Road or the area north of the Village of Middleport WWTP would be suitable for a sediment basin.

- **Sediment Dike** - An earthen dike and trench along the bank to intercept sediment from upland erosion before entering waterway. Dikes could be used parallel to drainage areas where upland/bank transport might occur, but dikes would be hard to maintain. Bank stabilization is considered more effective because it would prevent erosion rather than capture it.

- **Sediment Channel** - Create a new channel or deepen an existing channel to act as a sediment sink that intercepts sediment from downstream transport. Shallow bedrock would limit channel deepening and deepening the channel could affect local habitats. Additionally, deepening a sediment channel would be less effective in maintaining accumulated sediment than basins because the deposition would not be in a controlled area and could be subject to downstream transport.

- **Sediment Rock Dam or Riffle Ramp Structure** - A rock embankment followed by a pool located to intercept sediment from downstream transport. A series of riffles and pools may also be installed. However, this sediment collection method is less effective in maintaining accumulated sediment because the deposition would not be in a controlled basin and could be subject to subsequent downstream transport.
- **Earthen Sediment Trap** - Controls consisting of excavation and/or embankment to intercept sediment from downstream transport. Sediment traps have a small footprint and therefore, are more feasible for streams with limited access or limited work space. Sediment traps can also be used to intercept/divert clean sediments from entering other sediment collection features. However, excavation may be limited by shallow bedrock and the deposition area would not be in a controlled basin.
- **Commercial Sediment Trap** - A passive sediment collector that captures targeted sizes of sediment in engineered storage chambers. The captured sediment can be pumped out by a vacuum truck. Similar to earthen sediment traps, commercial sediment traps have small footprints, are feasible for a wide range of site conditions, and have a variety of applicable uses.

For the purposes of this CMS and the reasons highlighted above, sediment traps and basins are considered the most effective sediment collection features for this project and are collectively referred to as “sediment traps” in the subsequent sections of this report.

5 DETAILED DESCRIPTIONS OF CORRECTIVE MEASURES ALTERNATIVES

This section identifies and describes the CMAs that are evaluated in this CMS Report.

5.1 Identification of Alternatives

CMAs were developed incorporating the following corrective measures technologies identified and discussed in Section 4 of this report: no further action; institutional controls (nonresidential properties only); engineering controls; bank stabilization; maintenance; sediment collection; and soil/sediment removal and disposal.

CMAs Developed

The CMAs listed below have been identified and developed to address the presence of potentially FMC-related arsenic in OU6 (Table 2; Figures 3 through 6).

- Alternative 1 (also referred to as CMA 1) – Complete Reach T1 ICM Soil/Sediment Removal as proposed in the ICM Work Plan
- Alternative 2 (also referred to as CMA 2) – CMA 1, plus institutional controls for management of Property BH3 future land use
- Alternative 3 (also referred to as CMA 3) – CMA 1, plus soil/sediment removal (24-inches deep) in designated areas north of the Erie Canal, and construct sediment traps
- Alternative 4 (also referred to as CMA 4) – Same as CMA 3, plus soil/sediment removal (24-inches deep) in stream bed and banks in designated areas upstream of the sediment traps

During the RFI, a soil arsenic concentration of 20 milligrams per kilogram (mg/kg) was used for delineation purposes. The Agencies have asserted that a soil arsenic concentration of 20 mg/kg generally represents the upper limit of local background for residential properties. The 20 mg/kg concentration is not necessarily a “remediation” criterion or standard, as stated in RFI Report Volume V, approved by the Agencies. CMAs adopting a universal 20 mg/kg soil arsenic concentration goal or a 20 mg/kg soil arsenic concentration goal with “flexibility” (NYSDEC 2013) do not produce any measurable or meaningful difference in human health or environmental risk when compared to CMAs identified herein and are not necessary to achieve the CAOs established by the Agencies pursuant to the AOC. Consequently, those CMAs were not evaluated further in the CMS.

5.2 Description of Alternatives

Descriptions of the CMAs are presented by first discussing common elements of the CMAs, and then identifying the specific, distinguishing features for each CMA. The CMAs include the following common elements:

- **Reach T1 ICM** – As discussed in Section 3.5, each of the CMAs include implementation of the proposed Reach T1 ICM. The proposed Reach T1 ICM, detailed in the ICM Work Plan, requires excavation and removal of approximately 13,450 cubic yards (including staging/access areas) of

soil/sediment from the green-shaded area shown on Figure 3. Restoration will be to approximate existing conditions regarding topography and surface cover type, including retaining walls, rip rap, and vegetation. Excavation and restoration will be conducted in sections and will begin in the upstream section (Francis Street to railroad overpass) and proceed downstream (north) to the canal overflow.

- **Section 404 of the Federal Clean Water Act Permitting** – Remediation within the stream (i.e., below the ordinary high-water mark) requires prior review and approval by the United States Army Corps of Engineers (USACE) and NYSDEC under Section 404 of the Federal Clean Water Act. Approval is through the USACE Nationwide Permit (NWP) program; specifically, *NWP 38 – Cleanup of Toxic and Hazardous Waste*, which allows for streamlined review and approval of remediation projects ordered by a government agency (i.e., NYSDEC/USEPA). The permit is obtained through submittal of a joint permit application and supporting detailed project information prescribed by USACE NWP regulations. NYSDEC is delegated authority to review and approve projects, through issuance of a Clean Water Act Section 401 Water Quality Certification permit.

- **Flood Plain and Local Permitting** – The estimated 100-year flood zone, identified by the Federal Emergency Management Agency (FEMA), is shown on Figures 2A and 2B. Activities within the flood plain are subject to NYSDEC requirements for flood plain disturbance and sedimentation and erosion control, requiring development and implementation of a storm water pollution prevention plan (SWPPP). Local permits will also be required for trucking on village roads and protection of village infrastructure.

- **Access Agreements** – FMC owns three properties (BD3, BG1 and BH2) in the CMS Study Area (Figures 2A and 2B). FMC will not perform any work on a property without receipt of written access permission from the property owner. FMC will contact each property owner and review the planned corrective measures implementation (CMI) activities for the subject property with the owner. If written access permission to perform the construction activities is granted, FMC will inform the property owner of the anticipated construction schedule. Permission to access all properties within a section of the stream is required for the CMI activities to proceed in that section of the stream and any downstream sections, as work will proceed from upstream sections to downstream sections Access permission to all affected properties in a stream section is critical to the remediation continuing to proceed further downstream.

- **Remediation Waste Disposal Options** – As discussed in Section 4.1, on-site and off-site waste disposal options are included in the CMAs. Excavated soil would be loaded into trucks and transported to and placed in the CAMU (proposed to be located at the eastern portion of the FMC Facility and designed as conceptually described in Appendix C), or transported by truck to appropriate commercial landfills for disposal or beneficial reuse. For the purposes of the detailed evaluation of the CMAs in this CMS, including development of cost estimates, remediation waste is assumed to be transported by truck to a local commercial landfill for disposal as non-hazardous solid waste. The appropriate disposal option will be determined during the CMI phase.

- **Property Restoration** – Excavated areas will be backfilled (clean fill soil and topsoil, as appropriate) to approximate original surface grade, except for locations proposed for a sediment trap. Imported fill

used to restore excavated areas will meet chemical and geotechnical criteria to be specified in the remedial design. Lawns would be restored by seeding or placement of sod.

- **Property-Specific Features within the Remediation Area** – Landscaping features, sidewalks, driveways, and other property-specific features (e.g., sheds, fences, etc.), will be replaced in-kind where removal is necessary. The need for removal of property-specific features will be determined during the design of the CMI phase, in consultation with the affected property owners and the Agencies.
- **Bank Stabilization** – Stream banks will be stabilized at locations disturbed by CMI activities. Stabilization will be accomplished using a range of applicable technologies including, but not limited to, placement of rip rap, geoweb, and gabion walls. Retaining walls in good condition, or needing limited repair, will be kept in place and protected during CMI activities. Retaining walls in poor condition or constructed of loose stone/block will be removed along with the adjoining bank soil and replaced with similar material.
- **Railroad Embankments and Bridge Abutments** – Excavation, survey, backfill, and compaction at locations adjacent to these structures will be conducted in an incremental and sequenced manner to minimize the time that "open" excavations are present, and may be backfilled to design elevations at the end of each work day should conditions warrant. Excavation offset distances and/or limited depths may be established, in concert with the structure owner, to be protective of structure stability. One or more optical survey points will be positioned on the top of the abutment wing wall for monitoring during excavation and backfilling activities.
- **Stream Diversion and Bypass System** – Methods to divert or bypass the stream around the work area will be employed, such that excavation in the stream bed and banks can be performed "in the dry," with minimal diversion/bypass duration. Possible approaches include gravity flow around a water-tight barrier diversion installed longitudinally within the stream and bypass piping pumping around the work area from an upstream temporary dam. Both general approaches, or an alternative approach, may be suitable for different sections of the stream and depending on the flow conditions during that time of the year.
- **Dewatering and Water Management** – Steps will be taken to minimize the amount of water to be handled during the remedial activities. Since the only contaminant associated with the water is arsenic adsorbed to soil/sediment (not dissolved in the water), the above waters may be managed by removing turbidity and then returning to the ground or stream, with no off-site treatment or disposal needed. Surface water diversion methods will be used to minimize the amount of runoff that enters an excavation or material staging area. Surface water diversion methods may include, but are not limited to, channeling surface water flow around an area using a temporary ditch or berm. Soil berms, silt fence and hay bales, silt logs/socks, or other similar measures will be used, as needed, to minimize the discharge of silt-laden water to the stream. If dewatering of an excavation is needed, pumped water will be directly pumped through a sediment trap or bag filter (depending on the volume of water pumped) prior to allowing it to drain into the stream. If needed based on site logistics, the water could also be temporarily staged in a dewatering box or frac tank before passing through a sediment trap or bag filter.

- **Environmental Monitoring and Mitigation** – Community air monitoring, dust suppression, noise suppression, and stream turbidity monitoring will be deployed, as appropriate for each alternative.
- **Institutional Controls** – Use of institutional controls to: 1) require deed restriction and implementation of a Site or Soil Management Plan for Property BH3; and/or 2) address maintenance activities that may be conducted on a property using a Site Management Plan. Institutional controls would be implemented for the properties within the CMS Study Area where the sediment traps are constructed to ensure their continuation as intended and provide access for maintenance (i.e., periodic clean-out of accumulated sediment, as needed).

The following subsections 5.3 through 5.6 further discuss Alternatives 1 through 4, respectively, including the following distinguishing features of each alternative:

a. Number of properties to be remediated.

b. Estimated volume of soil/sediment to be removed, based on existing, available information (e.g., sediment thickness, topographic survey data). The actual design limits and volumes of soil/sediment expected to be removed will be determined during the CMI phase, which will occur after selection of the final corrective measures by the Agencies.

c. Long-term maintenance activities (as needed).

d. Design and implementation activities.

e. Estimated costs for implementation, including capital costs (e.g., soil/sediment removal), engineering/administrative costs (e.g., preparation of design plans, construction management, public communication activities), and maintenance costs (e.g., verify institutional controls, maintain sediment traps as needed).

f. Estimated time (number of construction seasons) to complete remediation. The estimated construction duration is primarily based on past experience conducting remediation in Middleport. The estimated number of construction seasons (May to November) will be re-evaluated during the CMI planning stage and may be more or less than the estimated duration presented herein.

Figures 3 through 6 depict the estimated extent of remediation for Alternatives 1 through 4, respectively.

5.3 Alternative 1

5.3.1 Description of Alternative 1

Alternative 1 (or CMA 1) does not include implementation of additional soil/sediment excavation or remedial activities beyond those detailed in the ICM Work Plan for the Tributary One Reach T1 ICM. The ICM Work Plan presents the detailed design to implement the ICM. As detailed therein, the proposed Reach T1 ICM Scope of Work requires excavation and removal of approximately 13,450 cubic yards of soil/sediment from the green-shaded area shown on Figure 3 (17 properties; 1.9 acres). The basis for this area was developed by considering stream morphology, site features (i.e., existing permanent structures), and areas needed to support construction activities and facilitate restoration of the stream banks, with adjustments for protection of adjoining structures and features. Restoration will be to approximate existing conditions regarding topography and surface cover type, including retaining walls, rip rap, and vegetation.

Excavation and restoration will be conducted in sections and will begin in the upstream section (Francis Street to railroad overpass) and proceed downstream (north) to the canal overflow. Access agreements would be required to conduct the remediation work.

5.3.2 Cost and Timing of Alternative 1

The total estimated cost for implementation of Alternative 1 is approximately $5.5 million. The estimated costs for Alternative 1 are detailed in Table F-1 of Appendix F.

For CMA 1, two full construction seasons (typically a construction season is from May to November) are estimated to be required to complete the CMI field activities. The estimated construction duration is primarily based on the number of properties to be remediated (17) and the estimated amount of soil/sediment to be removed (13,450 cubic yards). The actual number of construction seasons for the selected CMA or CMAs would be determined during the CMI planning stage through an Agencies' approved schedule.

5.4 Alternative 2

5.4.1 Description of Alternative 2

Alternative 2 (or CMA 2) is the same as CMA 1 (as described above), with the addition of institutional controls (e.g., deed restriction and implementation of a Site or Soil Management Plan) for Property BH3 to control future access to arsenic-impacted soil on the lower portion of the property. As shown on Figure 2B, Property BH3 is unimproved land located north of the canal and is owned by the Village. No other property would merit institutional controls for this purpose. Accordingly, CMA 2 requires excavation and removal of approximately 13,450 cubic yards of soil/sediment from the green-shaded area shown on Figure 4 (17 properties; 1.9 acres), and institutional controls at Property BH3, also shown on Figure 4.

5.4.2 Cost and Timing of Alternative 2

The total estimated cost for implementation of Alternative 2 is approximately $5.6 million. The estimated costs for Alternative 2 are detailed in Table F-2 of Appendix F.

The remedial construction for CMA 2 is the same as CMA 1, and therefore two full construction seasons (typically a construction season is from May to November) are estimated to be required to complete the CMI field activities. The estimated construction duration is primarily based on the number of properties to be remediated (18) and the estimated amount of soil/sediment to be removed (13,450 cubic yards). The actual number of construction seasons for the selected CMA or CMAs would be determined during the CMI planning stage through an Agencies' approved schedule.

5.5 Alternative 3

5.5.1 Description of Alternative 3

Alternative 3 includes CMA 1 (as described above), plus soil/sediment removal 24-inches deep in designated areas north of the Erie Canal (including Property BH3), and constructed sediment traps. The designated areas are strategic locations to intercept and capture sediment. The former mill pond area between Sherman Street and Chase Road, the areas upstream of the Pearson and North Hartland Roads crossings, and the area north of the Village of Middleport WWTP are suitable areas (Figure 5) that naturally slow and collect sediment laden water for deposition prior to downstream transport. To enhance sediment collection, these areas would be excavated to an average depth of 24 inches.

A total of approximately 58,200 cubic yards of soil/sediment would be removed from the green-shaded area shown on Figure 5 (36 properties; 15.8 acres). The basis for this area was developed by considering stream morphology, site features, and areas needed to support construction and maintenance activities and facilitate restoration of the stream banks, with adjustments for protection of adjoining structures and features.

After excavation, the area would be restored in accordance with the remedial design documents and sediment traps would be constructed in the designated areas (Figure 5) to collect sediment. Specific details for the sediment traps (e.g., actual location and extent of structures) would be determined during the CMI phase and would be based, in part, on the results of a bedload monitoring pilot study. ICs would be required for those properties identified during the CMI phase for location of and access to the sediment traps.

The CMI phase consists of the design and implementation of the selected CMA. During the remedial design, FMC representatives would visit the affected property owners to discuss the nature of the project and project schedule, to provide contact information and information on the associated activities, and seek and execute necessary access agreements. Pre-design activities would be necessary to support the preparation of remedial design documents and permit applications.

As noted above, pre-design activities necessary to support the remedial design for the sediment traps include a bedload monitoring pilot study. Potential additional examples of required pre-design information include soil/sediment sampling and analysis, stream characterization information, property boundary and surface topographic survey, and an inventory/documentation of non-permanent features on each property (e.g., sheds, fences, utilities, etc.). The remedial design documents required as part of the CMI phase include technical drawings, plans and specifications, as well as other project specific plans (e.g., Community Participation Plan, Health and Safety Plan, remedial construction implementation schedule, traffic control plan, air monitoring and dust control plan, erosion and sedimentation control plan, stream section specific remediation work scopes, etc.) necessary to implement the CMI construction activities.

The detailed design to implement the CMI activities south of the canal are provided in the ICM Work Plan. For CMI activities to be conducted north of the canal, the detailed design drawings would be prepared and submitted to the Agencies for review and approval. Using the remedial design, qualified contractor(s) would be secured to implement the remedial activities. Remedial construction start-up activities would begin after receipt of the Agencies' approval of the remedial design documents.

The construction start-up activities would include (but would not be limited to):

- Revision of the construction schedule
- Submittal of contract-required plans and information
- Mobilization of equipment, materials, and personnel necessary to complete the remediation
- Identify and pre-qualify potential sources of imported backfill materials to verify that the materials meet chemical and geotechnical criteria to be specified in the remedial design
- Establish project field offices and equipment/material storage areas
- Locate and mark underground and overhead utilities and other relevant site features scheduled to remain within or adjacent to the works areas
- Conduct a walk-through of each property to be remediated to inspect and document existing conditions
- Obtain stream characterization information and bathymetry data
- Conduct a survey (using a New York State-licensed surveyor) to document pre-remediation elevations, establish survey control, and mark the remediation limits and property boundaries
- Construct a temporary staging area(s) for remediation wastes to facilitate off-Site disposal at a commercial landfill
- Upgrade or construct haul roads (as necessary) at the remedial work areas
- Install erosion and sedimentation controls
- Conduct baseline air monitoring
- Establish site security

After completing the remedial construction activities, a Site Management Plan would be prepared to provide details (e.g., methods, procedures, schedule) for periodic removal of and disposal of accumulated sediment from the sediment traps, as needed. The plan would also address the associated ICs and periodic verification reporting to NYSDEC.

5.5.2 Cost and Timing of Alternative 3

The total estimated cost for implementation of Alternative 3 is approximately $28.6 million. The estimated costs for Alternative 3 are detailed in Table F-3 of Appendix F. For cost estimating purposes, some periodic removal of accumulated sediment has been included, but the need for and frequency would be determined after construction.

For CMA 3, six full construction seasons (typically a construction season is from May to November) are estimated to be required to complete the CMI field activities. The estimated construction duration is primarily based on the number of properties to be remediated (36) and the estimated amount of soil/sediment to be removed (58,200 cubic yards). The actual number of construction seasons for the

selected CMA or CMAs would be determined during the CMI planning stage through an Agencies' approved schedule.

5.6 Alternative 4

5.6.1 Description of Alternative 4

Alternative 4 has the same remedial components as Alternative 3 (as described above), plus soil/sediment removal in stream bed and banks in designated areas upstream of the sediment traps. This results in the removal of approximately 14,000 cy of soil/sediment more than CMA 3. The additional removal would be along Tributary One from Mill Street to Sherman Street and north of Chase Road to the northern boundary of Property BJ2. This additional soil/sediment removal for CMA 4 eliminates the need for the upstream sediment trap identified in CMA 3.

A total of approximately 72,200 cubic yards of soil/sediment would be removed from the green-shaded area shown on Figure 6 (50 properties; 20.1 acres). Consistent with CMA 3, the basis for this area was developed by considering stream morphology, site features, and areas needed to support construction and maintenance activities and facilitate restoration of the stream banks, with adjustments for protection of adjoining structures and features.

Because CMA 4 includes the same remedial components as CMA 3, see Section 5.5 for additional details associated with the CMI phase.

5.6.2 Cost and Timing of Alternative 4

The total estimated cost for implementation of Alternative 4 is approximately $31.3 million. The estimated costs for Alternative 4 are detailed in Table F-4 of Appendix F.

For CMA 4, eight full construction seasons (typically a construction season is from May to November) are estimated to be required to complete the CMI field activities. The estimated construction duration is primarily based on the number of properties to be remediated (50) and the estimated amount of soil/sediment to be removed (72,200 cubic yards). The actual number of construction seasons for the selected CMA or CMAs would be determined during the CMI planning stage through an Agencies' approved schedule.

6 RISK ASSESSMENT

As indicated in Section 1.3, potential human health and environmental risks are two of the seven criteria to be used in the evaluation of CMAs. In addition, the CAOs require corrective action decision-making to be based on site-specific data. Accordingly, site-specific human health and ecological risk assessments are used to evaluate the degree to which a corrective measure would protect human health and the environment and achieve target risks. A Human Health Risk Assessment (HHRA) and a Fish and Wildlife Resource Impact Analysis (FWRIA) have been prepared by Ramboll and Arcadis, respectively. These documents are provided in Appendix D and Appendix E, respectively, and are summarized in Sections 6.1 and 6.2, respectively.

6.1 Human Health Risk Assessment Summary

The Tributary One South Study Area (OU6) HHRA assesses the CMAs proposed in the CMS. The HHRA was conducted according to the March 26, 2009 CAOs for public health issued by the NYSDEC. The CAOs specify that potential human health risks associated with FMC-related contaminants in soil and sediment should be reduced and managed according to the following guidelines:

- Excess human health carcinogenic risks are reduced such that the lifetime excess cancer risks fall within the range appropriate for residential communities (i.e., 10^{-4} to 10^{-6});
- Human health non-carcinogenic risks are reduced such that non-cancer risks do not exceed the level appropriate for residential communities (i.e., Hazard Index ≤ 1.0); and
- The "point of departure", or starting point for corrective action risk-management decisions pertaining to arsenic in soil, is the site-specific residential background considering site-specific histories of use for current and reasonably anticipated future residential properties within the study area.

The HHRA consists of four stages: Problem Formulation, Exposure Assessment, Toxicity Assessment, and Risk Characterization. The complete HHRA is provided in Appendix D.

6.1.1 Problem Formulation

The problem formulation identifies potentially exposed groups of people (termed “receptor groups”), and the pathways by which these groups may be exposed to constituents of concern. The primary outcome is development of a conceptual site model (CSM) that characterizes the ways people might be exposed to contaminants identified as being of potential concern. Contaminant screening procedures were employed to identify contaminant-specific exposure scenarios for focused consideration in the analysis phase of the HHRA.

The extent of the CMS Study Area was delineated based on the soil and sediment arsenic data distribution, surface topography, stream and surface water drainage hydrology, and historical land use. Among the 62 properties included in the CMS, the portion of an individual property that is within the CMS Study Area varies greatly, ranging from less than 1 percent to 100 percent. Due to the great variation in the fraction that falls within the study area, as well as variation in land use and applicable receptors, this HHRA takes a property-specific approach for most receptors, with risks calculated separately for each property. Table 1 lists the OU6 properties north of the canal and those south of the canal, each property’s

current land use(s), the fraction of the property that falls within the CMS Study Area, and the receptors evaluated for each property. There are three sets of properties that are effectively used as one property, and those properties are shown as combined areas in Table 1.

6.1.2 Conceptual Site Model

The CSM includes sources of potential exposure, mechanisms of chemical transport in various media, exposure points of contact, and exposure routes at the points of contact for all receptor groups. Receptors considered for OU6 include residents, recreational users, trespassers, and agricultural and commercial/industrial workers. The primary source media are surface soil (0-6 inches deep) and sediment. As shown in Table 1, the majority of properties are evaluated assuming current residential use. If the property does not have current residential use, possible future residential use is considered unless the property clearly could not have a residential use (e.g., the canal and railroad properties and the sewage treatment plant). Trespassers are not evaluated on a property-specific basis, but consider potential exposure to all properties south of the canal or north of the canal.

The primary intake route for constituents of interest (COIs) is from incidental ingestion of soil or sediment particles adhered to skin via hand-to-mouth activities. Dermal absorption of COIs in soil particles adhered to skin, and inhalation of COIs in resuspended surface soil particles may also occur, but the contribution to total intake from these pathways is smaller. Soil/sediment exposure via ingestion, dermal contact and inhalation of resuspended particles is quantified in the HHRA. Pathways that are not evaluated quantitatively, but are evaluated qualitatively include house dust, surface water, fish consumption, and homegrown produce consumption.

6.1.3 Screening

Soil, sediment, surface water and fish samples collected in the CMS Study Area are evaluated for constituents that were historically manufactured, formulated, handled, or used at the Facility. All samples are analyzed for arsenic, and a subset of samples are analyzed for other metals, pesticides, herbicides, and phenolic compounds. USEPA Regional Screening Levels and NYSDEC Soil Cleanup Objective (SCOs) are compared to constituent concentrations measured in OU6 environmental media. A pathway screening is performed following the constituent screening to further evaluate the significance of any elevated constituent concentrations, and the potential for human exposure. Following the screening process, arsenic was determined to be the only constituent of concern. Arsenic in surface soil and sediment are evaluated quantitatively in the HHRA. Arsenic in fish is evaluated qualitatively.

6.1.4 Exposure Assessment

The Exposure Assessment quantifies the amount of arsenic individuals in the Study Area may be exposed to assuming a reasonable maximum exposure (RME) scenario through incidental ingestion, dermal absorption, and inhalation of soil particles resuspended in air under each of the proposed CMAs. Exposure assumptions used in the risk assessment are conservative exposure estimates, based primarily on values presented in NYSDEC/NYSDOH guidance for SCOs developed for the New York State brownfield cleanup program (as presented in NYSDEC and NYSDOH 2006, NYSDEC 2010). Data from site-specific studies, USEPA guidance, and professional judgment are also applied as needed.

6.1.5 Exposure Point Concentrations

For each CMA, exposure point concentrations (EPCs) are calculated based on data obtained from sample locations at each property that are within the CMS Study Area. EPCs are calculated according to USEPA guidance (1992), as the 95 percent upper confidence limit of the arithmetic mean or the maximum concentration, whichever is lower. For each CMA, the arsenic concentration at each area to be excavated is replaced with 5 mg/kg, which was selected (based on prior remedial activities for the FMC Middleport Project) as an average concentration representative of the concentration of arsenic in imported backfill to be used for property restoration, prior to EPC calculation. When sediment is present, it is combined with soil to generate a combined surface soil/sediment EPC. For trespassers, separate EPCs are calculated for the CMS Study Area north of the canal and south of the canal.

6.1.6 Exposure Parameters

NYSDEC/NYSDOH (2006) default exposure parameters are used for the majority of the exposure inputs in the HHRA. NYSDEC/NYSDOH exposure parameters are modified when appropriate to modify receptors not specified in SCO Technical Guidance (i.e., agricultural worker), and to better approximate site-specific conditions. For example, the exposure frequency is modified using site-specific climate data for Niagara County. This reduces the exposure period from the NYSDEC default of 31 weeks to 24.7 weeks. The exposure frequency is incorporated into the soil ingestion rate as specified in NYSDEC/NYSDOH guidance.

Exposure parameters specific to Middleport are used in the HHRA when available and appropriate. The biomonitoring study conducted in Middleport in 2004 (Exponent 2004; Tsuji 2005), oral bioavailability study conducted in 2007 (Roberts et al.), and dermal absorption study conducted in 2007 (Lowney et al.) are used to guide recommendations for site-specific exposure. Roberts et al.'s in vivo oral bioavailability study using Middleport soils fed to cynomolgus monkeys found the relative bioavailability of arsenic in soil ranges from 19 to 28 percent (n=3). The mean value of 22 percent (i.e., a fraction of 0.22) is used in the HHRA instead of the 0.6 default USEPA assumption. The 0.005 site-specific dermal absorption fraction for arsenic calculated by Lowney et al. is also used instead of the 0.03 USEPA default. USEPA default exposure parameters are used when site-specific or NYSDEC/NYSDOH values are not available.

This risk assessment focuses on incremental risks to people from contact with soil and sediment within the CMS study area. USEPA risk assessment guidance (1989) allows for inclusion of a fractional intake term in the intake equation that accounts for the fraction of soil or sediment contacted that is presumed to be contaminated. Contact with contaminated soil within the CMS Study Area is assumed to be proportional to the fraction of each property that is located within the CMS Study Area. Therefore, the fraction of the property in the CMS Study Area is applied to each dose equation.

6.1.7 Toxicity Assessment

The toxicity assessment provides an overview of toxicity values selected for estimating the risk of adverse health effects from chemical exposures and summarizes toxicity information from governmental health authorities and in peer-reviewed publications. Toxicity values are numerical expressions of chemical dose and response, and vary based on factors such as route of exposure (e.g., oral, inhalation, or dermal) and duration of exposure. Arsenic is the only chemical of concern in this HHRA. The scientific literature on

arsenic toxicity is voluminous and constantly expanding. However, the USEPA arsenic toxicity values have not changed since prior Middleport HHRAs were conducted. USEPA is in the process of conducting an updated toxicity assessment for arsenic, but revised toxicity values are not anticipated to be released in the near future.

6.1.8 Cancer Effects

Inorganic arsenic is a known human carcinogen when ingested. The oral cancer slope factor (CSF) for arsenic is 1.5 (mg/kg-day)-1 based on skin cancer. ATSDR (2016) reports that chronic exposure to arsenic in drinking water is associated with squamous cell carcinomas of the skin and cancer of the bladder and urothelium, gastrointestinal tract, kidney, liver, lung, pancreas, and skin; as well as with associations between in utero exposure and cancers of the bladder and kidney. The majority of data on the carcinogenic effects of ingested inorganic arsenic come from populations chronically exposed to high levels of arsenic naturally present in drinking water sources. These studies contain numerous limitations and uncertainties when applied to ingestion of soil, but are recommended as the most appropriate datasets for dose response assessment.

Inorganic arsenic is also considered a human carcinogen when inhaled. Epidemiological studies have reported increased risk of lung cancer in workers at smelters (ATSDR 2007, Erraguntla et al. 2012, WHO 2000). The USEPA inhalation unit risk factor (URF) of 0.0043 per µg/m3 was derived in 1984. Since then, multiple worker studies have been published, including updates to the cohort studies used in the 1984 URF derivation. A more recent URF of 1.5E-04 per µg/m3 was proposed by the Texas Commission on Environmental Quality (TCEQ) in 2012. Although we use the USEPA URF in this HHRA, the more recent analysis by TCEQ suggests it overestimates cancer risks from inhaled arsenic by a factor of 30-fold.

6.1.9 Non-cancer effects

The non-cancer oral reference dose for arsenic is 0.0003 mg/kg-day. This value was derived from a critical effect based on human chronic oral exposure resulting in hyperpigmentation and keratosis (Tseng et al. 1968, Tseng 1977). Hyperkeratinization of the skin, formation of multiple hyperkeratinized corns or warts, and hyperpigmentation of the skin with interspersed spots of hypopigmentation are the most common types of lesions associated with oral arsenic exposure. Other non-cancer outcomes associated with increased arsenic in drinking water include cardiovascular effects, diabetes, ocular effects, disturbance in immune response, impairment of neurological function, and developmental effects.

USEPA does not provide an inhalation reference concentration (RfC) for arsenic. However, California EPA has derived a reference exposure level of 0.015 µg/m^3 based on a critical effect of decreased intellectual function in children (Tsai et al. 2003, Wasserman et al. 2004).

6.1.10 Risk Characterization

To characterize risks related to arsenic exposure, estimated intakes calculated in the exposure assessment and the toxicity values are combined to yield numerical estimates of potential health risk for carcinogenic and non-carcinogenic endpoints. A cancer risk estimate derived using standard risk assessment methods is characterized as the incremental probability that an individual will develop cancer during his or her lifetime due to exposure to site-related chemicals in the specific exposure scenario

evaluated. Non-carcinogenic health risks are the simple ratio of the intake from site exposures to the non-cancer toxicity value, called the hazard quotient. The sum of the hazard quotients across the exposure pathways is called the hazard index.

Risk estimates for receptors at properties in the CMS are driven by the soil ingestion pathway. The dermal pathway generally contributes less than 10 percent to the total risk, while the inhalation pathway contributes a negligible amount to total risk.

6.1.11 Cancer Effects

All properties in the CMS evaluated for current or future land use are within or below the risk range specified in the CAOs (1E-04 to 1E-06).

South of the canal, incremental lifetime cancer risk estimates for properties with primary residential use (combined child and adult exposures) are identical for all the CMAs, and range from 2E-07 to 1E-05. Future cancer risks for two properties that could possibly have future residential use (BC6 and BD3) were also within or below the risk range specified in the CAOs. Cancer risk estimates for the three properties with primary recreational use (combined child and adult exposures) are identical for all CMAs, and range from 2E-08 to 9E-07. Risks for the two commercial/industrial properties south of the canal are 7E-08 (BC6) and 4E-07 (BD3) for all CMAs. For trespassers exposed to property within the CMS Study Area south of the canal, the risk for all CMAs was 4E-08.

North of the canal, total incremental lifetime cancer risk estimates for properties with current residential use (combined child and adult exposures) are estimated to range from 3E-08 to 3E-05 for all CMAs. Future cancer risks for ten of eleven properties that could possibly have future residential use are also below or within the risk range specified in the CAOs. One property (BH3) evaluated for future residential use has a risk estimate for CMA 1 of 1E-04, at the top end of the risk range. CMA 2 restricts BH3 from future residential use through the use of institutional controls, and the soil/sediment on this property is removed under CMAs 3 and 4, reducing the risk to 6E-06. Cancer risk estimates for the two properties evaluated for primary recreational use (BG1 and BH3) range from 1E-06 to 3E-05. For the two commercial/industrial properties north of the canal (AJ1 and BE4) the highest risk for any CMA is 8E-07. For the two properties north of the canal with agricultural use (BH1 and BO2) the highest risk for any CMA is 4E-09. For trespassers exposed to property within the CMS Study Area north of the canal, risks for all CMAs range from 5E-08 to 2E-07.

6.1.12 Non-cancer effects

All properties in the CMS evaluated for current residential land use are equal to or below a hazard index of one (1). South of the canal, the highest hazard index is 0.2 for a child resident (BC9). North of the canal, the highest hazard index for a property evaluated for current land use is 0.6 for a child resident (BL3). Hazard indices were well below 1 for all other current land uses south and north of the canal.

One property evaluated for future residential land use (BH3) has a hazard index of three (3) in CMA 1, but this property is restricted from future residential use under CMA 2 and soil/sediment (24-inches deep) from this property within the CMS Study Area will be removed under CMAs 3 and 4. All other properties evaluated for future residential use have a hazard index equal to or below 1 for all CMAs.

6.1.13 Conclusions

All properties, both south and north of the canal, have current and potential future cancer risks below or within the range of risks specified by the CAOs for all receptors and all properties. South of the canal, hazard indices are below 1 for all receptors for all properties. North of the canal the hazard index for one property is 3 under CMA 1, but is below 1 for all other CMAs and equal to or below 1 for all other properties for all CMAs. Thus, health risks are not a concern for CMAs 2, 3, and 4.

6.2 FWRIA Summary

6.2.1 Study and Results

Ecological protectiveness is a criterion used to evaluate each CMA. Specifically, one of the CAOs is to "eliminate, reduce or control existing or potential adverse ecological impacts due to elevated concentrations of FMC-related contaminants in soil and/or sediments, while balancing adverse ecological impacts that may result from the remediation activities themselves." The evaluation of ecological protectiveness is based on the results of the FWRIA provided in Appendix E. The FWRIA identified arsenic as the primary constituent of potential ecological concern (COPEC) (along with other select metals and chlorinated pesticides) in soil and/or sediment; no COPECs were identified for surface water. The FWRIA evaluates potential impacts to aquatic benthic invertebrates, fish, plants, and wildlife receptors from these COPECs.

The FWRIA results indicate that under current conditions potential impacts to aquatic receptors (benthic invertebrates, fish) are minimal. For aquatic invertebrates, the results indicate that concentrations of select metals (especially arsenic) are elevated in Tributary One sediment. However, these metals are predicted to have limited bioavailability. The results of site-specific sediment toxicity tests and benthic macroinvertebrate community surveys indicate that Tributary One sediment is not toxic, and the benthic macroinvertebrate community is unaffected compared to background conditions. Collectively, the measurement endpoints indicate there are no site-related impacts to aquatic benthic invertebrates. Therefore, each CMA is predicted to be equally protective of benthic invertebrates. The variance is the degree of ecological perturbation from habitat disruption under each CMA.

For fish, the FWRIA results indicate that site COPECs are not elevated in surface water, and therefore potential exposure for fish is limited. The tissue data indicate limited COPEC accumulation in fish tissue, and confirm the lack of COPEC exposure for fish. Fish community results indicate similar abundance and diversity of fish in Tributary One compared to background locations, and a lack of anomalies. Collectively, the measurement endpoints indicate there are no site-related impacts to fish, and therefore each CMA is predicted to be equally protective of fish. Again, the variance between CMAs is the degree of habitat disruption.

For plants, the FWRIA results indicate that although soil COPEC concentrations exceed screening benchmarks, actual site-specific observations of the plant community do not identify differences in species abundance and diversity in plant covertypes or the presence of COPEC-related stressed vegetation. Collectively, these measurement endpoints indicate there are no site-related impacts to plants, and therefore each CMA is predicted to be equally protective of plants. The difference between

the ecological protectiveness to plants for each CMA is the degree of habitat disruption to the riparian plant community.

For wildlife, the FWRIA evaluates potential impacts to several types of birds and mammals, including piscivorous, insectivorous, carnivorous, and vermivorous species. The evaluation is based on a comparison of dose estimates to conservative No Observed Adverse Effect Levels (NOAELs) and Lowest Observed Adverse Effect Levels (LOAELs) to calculate hazard quotients (HQs). The foodweb model indicates no impacts to wildlife that may consume fish, aquatic invertebrates, or small mammals from the site. HQ values are less than 1 for most COPECs and most species, and reflect the overall lack of significant levels of COPEC uptake in food items. Although HQ values above 1 are estimated for some wildlife species (specifically worm-eating birds and mammals), HQs greater than 1 do not necessarily indicate that an effect will occur. In fact, the focus of protecting ecological resources typically focuses on a population or community level, and higher HQ values (e.g., HQ values above 10 to 20) are likely required to potentially elicit population-level effects.

The results of the wildlife foodweb modelling indicate that the primary ecological risks (e.g., site-related HQs greater than 10) are associated with potential effects from arsenic to short-tailed shrews foraging on earthworms from OU6. Therefore, the protectiveness for each CMA to this receptor and exposure pathway is evaluated below.

- CMA1 (Complete Reach T1 ICM Soil/Sediment Removal; No Action North of the Canal): CMA 1 offers ecological protectiveness to wildlife because it reduces soil arsenic concentrations in Reach T1 (also known as Reach A in the FWRIA study). Reach T1 was the only reach with an arsenic LOAEL-based HQ value greater than 10 (for shrews). The CMA includes the least amount of ecological disturbance (1.9 acres).
- CMA 2 (Complete Reach T1 ICM Soil/Sediment Removal; North of the Canal Institutional Controls at Property BH3): CMA 2 offers ecological protectiveness to wildlife because it reduces soil arsenic concentrations in Reach T1. Reach T1 was the only reach with an arsenic LOAEL-based HQ value greater than 10 (for shrews). This CMA also includes the least amount of ecological disturbance (1.9 acres).
- CMA 3 (Complete Reach T1 ICM Soil/Sediment Removal; North of the Canal Soil/Sediment Removal [24-inches deep] in Designated Areas and Construct Sediment Traps: CMA 3 offers ecological protectiveness because it also reduces soil arsenic concentrations in Reach T1, as well as downstream reaches. However, the CMA includes a higher level of ecological disturbance (15.8 acres).
- CMA 4 (Complete Reach T1 ICM Soil/Sediment Removal; North of the Canal same as CMA 3, plus Soil/Sediment Removal in Stream Bed and Banks in Designated Areas Upstream of the Sediment Traps): CMA 4 offers ecological protectiveness because it also reduces soil arsenic concentrations in Reach T1, as well as downstream reaches. However, the CMA includes a higher level of ecological disturbance (20.1 acres).

6.2.2 Conclusions

Based on this information, each CMA is protective for wildlife by reducing concentrations of arsenic (and other COPECs) in flood plain soil in Reach T1 (the only reach with an arsenic HQ value greater than 10 [for shrews]). These reductions would reduce the potential for exposure to wildlife that may forage on earthworms and other prey items. Because widespread elevated ecological risk is not predicted in the FWRIA, large-scale remediation of the flood plain is not warranted to protect ecological receptors. Conversely, wide-spread remedial efforts would lead to increased habitat destruction and disruption of ecological resources.

7 EVALUATION OF CORRECTIVE MEASURES ALTERNATIVES

This section presents the detailed evaluation of the CMAs identified and described in Section 5.

7.1 CMA Evaluation Criteria

The CMAs were evaluated based on the ability to meet the project-specific CAOs issued by the Agencies (provided in Appendix A) using the following criteria specified in the CMS Work Plan:

1. Community/Property Owner Acceptance
2. Technical
3. Environmental
4. Human Health
5. Institutional
6. Green Remediation Practices
7. Cost

The factors considered for each of these evaluation criteria, as presented in the CMS Work Plan, are summarized in Table 3 and described in the subsections below.

7.1.1 Community/Property Owner Acceptance

CMAs are to be evaluated based on the degree to which they are acceptable to the community and affected property owners consistent with CAOs 2 and 3. Except for three properties, the properties within OU6 are not owned by FMC. Understandably, the community has potential sensitivities and concerns associated with implementing corrective measures within their yards and neighborhood. Further, corrective measures cannot be performed on private properties without permission of the property owner(s).

The potential concerns include disruptions to residents and the community; public safety; overall effectiveness of the remedy; maintaining the character of the Village and neighborhoods (e.g., mature trees); human health concerns over exposure to soil contaminants; minimizing any restrictions on properties that may limit property usage, redevelopment or reuse; and the need for the Agencies to provide documentation that properties are acceptable for unrestricted use.

Community acceptance will continue to be evaluated throughout the CMS process and community concerns will be considered as the CMS process continues through selection and implementation of the corrective measures.

7.1.2 Technical

Consistent with Attachment II of the AOC and the CAOs, the technical criterion requires each CMA to be evaluated with respect to performance, reliability, implementability, and safety. The performance and

reliability evaluation examines the effectiveness of the CMA in reducing unacceptable risks and its demonstrated ability to maintain that effectiveness over time. The implementability evaluation examines the engineering and construction related tasks necessary to carry out the corrective measure. The implementability evaluation typically covers permit requirements and other necessary approvals, equipment requirements, space and logistics considerations, and maintenance requirements. The safety evaluation examines potential safety risks to workers and community members during and after implementation of the CMA.

7.1.3 Environmental

Consistent with Attachment II of the AOC and CAOs 1.D and 1.E, the environmental criterion requires each CMA to be evaluated with respect to: 1) short-term adverse environmental impacts during construction; and 2) short-term and long-term beneficial and adverse impacts of the CMA on the environment, particularly in any environmentally sensitive areas.

7.1.4 Human Health

Consistent with Attachment II of the AOC and CAOs 1.A, 1.B and 1.C, the human health criterion requires each CMA to be evaluated on the extent to which short- and long-term exposures to contaminants of concern are mitigated. The assessment includes an examination of how each CMA protects human health during corrective action implementation.

7.1.5 Institutional

Consistent with Attachment II of the AOC, the institutional criterion requires each CMA to be evaluated with respect to Federal, State and local standards, criteria or guidance relative to the design, operation and timing of each alternative.

7.1.6 Green Remediation Practices

Consistent with CAO 4, the green remediation practices criterion requires each CMA to be evaluated for consistency with USEPA's and NYSDEC's Green Remediation concepts and strategies which consider the environmental consequences of remedial actions, including energy requirements, air emissions, material consumption, resource consumption and waste generation.

7.1.7 Cost

Consistent with Attachment II of the AOC, the cost criterion requires each CMA to be evaluated with respect to the capital, engineering, and long-term costs (e.g., inspection and maintenance as needed) associated with each CMA. These costs are detailed in Appendix F. The capital costs consist of two components: 1) direct cost expenditures for construction equipment, labor and materials to perform the remedial construction; and 2) indirect cost expenditures for engineering, financial, and other services that are not part of the actual construction but required to implement the corrective measure.

7.2 Summary of Differences between the CMAs

As described in Section 5, the OU6 CMAs have many similar elements. The major differences between the CMAs are:

- Number of properties to be remediated
- Volume and extent of soil/sediment to be removed
- Estimated duration of remediation construction
- Length of stream disturbed

The comparative evaluations presented in the following sections involve assessment of the extent to which these differences have beneficial or adverse effects on the CMA evaluation criteria. For example, a CMA which would remediate a greater number of properties and a higher volume of soil/sediment may require a longer time to implement and may cause more community disruption, greenhouse gas emissions, and adverse ecological impacts than a CMA which would remediate fewer properties and less soil/sediment volume.

7.2.1 Number of Properties to be Remediated

The numbers of properties which would be remediated for each CMA are summarized as follows:

Alternative	1	2	3	4
Number of Properties to be Remediated	17	18	36	50

Note: The number of properties to be remediated includes properties where soil/sediment removal will occur, and those where ICs will be required (Property BH3 under CMA 2, as well as properties where sediment traps will be located, and access provided for periodic removal of accumulated sediment under CMAs 3 and 4, as needed).

7.2.2 Volume and Extent of Soil/Sediment Removal

The estimated volume and total area of soil/sediment which would be removed for each CMA are summarized as follows:

Alternative	1	2	3	4
Volume of Soil/Sediment (cy)	13,450	13,450	58,200	72,200
Total Area of Soil/Sediment (acres)	1.9	1.9	15.8	20.1

7.2.3 Estimated Duration of Remediation

The estimated duration of the remediation for each CMA is summarized as follows:

Alternative	1	2	3	4
Estimated Number of Construction Seasons (May to November) to Complete	2	2	6	8

7.2.4 Length of Stream Disturbed

The estimated length of stream disturbed for each CMA is as follows:

Alternative	1	2	3	4
Estimated Length of Stream Disturbed (linear feet)	1,600	1,600	4,800	7,400

7.3 Community/Property Owner Acceptance

This criterion compares the alternatives based on the degree to which the CMAs are anticipated to address the community and property owners' concerns. The Agencies' CAO 3 is to "minimize disturbance and disruption of the community so that the character of the neighborhoods can be maintained." Since formal public comments on this draft CMS Report have not yet been received, the evaluation presented herein is necessarily subjective based on general community input received to date during and before the CMS.

CMA 1 (Complete Reach T1 ICM Soil/Sediment Removal; no remediation north of the Erie Canal) and CMA 2 (Complete Reach T1 ICM Soil/Sediment Removal; Institutional Controls at Property BH3 north of the Erie Canal) may be acceptable to portions of the community based on the following:

- Risk assessment results (post-remediation risks are within acceptable range, except Property BH3 in consideration of potential future residential use) and

- No disruption of the community north of the Erie Canal, and property use restrictions only at Property BH3, which is Village-owned.

As described in Section 6.1, the site-specific human health risk assessment estimated post-remediation conditions south of the Erie Canal and current conditions north of the Erie Canal to be below or within the acceptable cancer risk range of $1x10^{-6}$ to $1x10^{-4}$ and below a non-cancer Hazard Index of 1. CMAs 1 and 2 offer ecological protectiveness to wildlife because they reduce soil/sediment arsenic concentrations south of the canal (Reach T1). Reach T1 was the only reach under pre-remediation conditions with an arsenic LOAEL-based HQ value greater than 10 (short-tailed shrew). CMAs 1 and 2 also include the least amount of ecological disturbance (1.9 acres) but do not address the potential for downstream migration of

sediment (CAO 1.E). Therefore, pending additional input, Community/Property Owner Acceptance for CMA 1 is considered not favorable because it does not address Property BH3 and CMA 2 is considered moderate.

CMA 3 (CMA 1, plus soil/sediment removal in designated areas north of the Erie Canal, and construct sediment traps) may be acceptable to the community because CMA 3 will result in acceptable risks and offers less disruption to the community compared to CMA 4. CMA 3 includes sediment traps, which address the requirement of CAO 1.E to "eliminate, reduce or control the potential for migration of FMC-related contaminants in soil and/or sediment."

CMA 4 (Same as CMA 3, plus soil/sediment removal in stream bed and banks in designated areas upstream of the sediment traps) may also be acceptable to the community. CMA 4 is similar to CMA 3 but includes removal of an additional 14,000 cy of soil/sediment upstream of the proposed sediment collection areas. This additional soil/sediment removal for CMA 4 eliminates the need for the upstream sediment trap identified in CMA 3. CMA 4 requires an estimated two additional construction seasons for remediation, compared to CMA 3.

Both CMAs 3 and 4 offer potential flexibility for the CMI phase that could be viewed favorably by the community. The downstream sediment traps included in these CMAs offer a potential remedial option that could be implemented in the event that an upstream property owner(s) does not provide access to perform soil/sediment removal on their property during the CMI phase.

Overall, given the similarities between CMAs 3 and 4 and the potential flexibility for installation of the sediment traps and basins, Community/Property Owner Acceptance for CMAs 3 and 4 is considered to be favorable.

7.4 Technical

The technical criterion requires an evaluation of performance, reliability, implementability, and safety. The performance and reliability of each CMA is essentially the same, as all of the CMAs employ construction technologies that have been well demonstrated to be effective and reliable.

Consequently, the primary consideration that differentiates the alternatives under this criterion is relative ease of implementation and potential short-term public and worker risks during construction (e.g., potential for injury due to operation of heavy equipment and trucks, increased traffic, and traffic disruption). These considerations and risks are proportional to the soil/sediment volumes to be addressed under each CMA.

CMAs 1 and 2 are considered favorable for ease of implementation because no additional remedial activities are required beyond the Reach T1 ICM. For the same reason, these CMAs are also considered favorable with respect to the technical criterion, including safety considerations during construction (i.e., short-term).

For CMAs 3 and 4, construction implementation considerations are proportionate to the number of properties and soil volumes to be remediated and would be greater than CMAs 1 and 2. Likewise, CMAs 3 and 4 would result in increased short-term risks associated with potential construction and traffic accidents compared to CMAs 1 and 2. The potential for accidents would be higher as remediation construction seasons are increased (i.e., CMAs 1 and 2 would be associated with the lowest short-term

risk and CMA 4 the highest). CMA 3 would have short-term risks similar to those posed by CMA 4. CMAs 3 and 4 include maintenance activities associated with periodic cleanout of the sediment traps, as needed. Such short-term risks would be minimized by adherence to applicable rules and regulations and best management practices during construction and maintenance. Therefore, on balance, CMAs 3 and 4 are considered moderate with respect to the technical criterion, including short-term safety considerations.

7.5 Environmental

This criterion requires an assessment of short and long-term beneficial and adverse impacts of each CMA and in particular adverse effects on environmentally sensitive areas. As documented in the FWRIA (see Appendix E and Section 6.2), each CMA is protective for wildlife by reducing concentrations of arsenic (and other COPECs) in flood plain soil in Reach T1 (the only reach with an arsenic HQ value greater than 10 [shrews]). The remedial actions would reduce the potential for exposure to wildlife that may forage on earthworms and other prey items. Because widespread elevated ecological risk is not predicted in the FWRIA, large-scale remediation of the flood plain is not warranted to protect ecological receptors. Conversely, wide-spread remedial efforts would lead to increased habitat destruction and disruption of ecological resources

Additional considerations for this criterion are short- and long-term environmental impacts associated with implementing a CMA. The potential for short- and long-term impacts of the CMA is proportionate to the extent and amount of soil/sediment to be addressed and corresponding ability of mitigative measures or engineering controls to be implemented during remedial construction (e.g., sedimentation and erosion controls) to remain effective. While mitigative measures during soil/sediment removal and during construction/maintenance of sediment traps are well demonstrated to be effective if properly installed and maintained, the potential for adverse impacts remains proportional to the volume of soil/sediment addressed.

CMAs 1 and 2 offer ecological protectiveness to wildlife because they reduce soil arsenic concentrations in Reach T1, the only reach with an arsenic LOAEL-based HQ value greater than 10 (shrew). These CMAs also include the least amount of ecological disturbance (1.9 acres). These CMAs, however, do not include any remedial action north of the canal and therefore do not meet CAO 1.E. Therefore, CMAs 1 and 2 are considered not favorable with respect to this criterion.

CMAs 3 are 4 offer ecological protectiveness by reducing soil/sediment arsenic concentrations in Reach T1, as well as downstream reaches, and also address CAO 1.E. However, these CMAs include a higher level of ecological disturbance relative to CMAs 1 and 2. CMAs 3 and 4 are considered moderate with respect to this criterion.

7.6 Human Health

This criterion, similar to the environmental criterion, includes an evaluation of both potential short- and long-term exposures both during and after CMA implementation.

Short-term human health impacts of the CMAs are primarily related to potential wind and water dispersion of soil/sediment from excavation sites and stockpiles. These potential releases can be minimized using

standard engineering controls and monitoring. Short term safety considerations associated with construction and traffic are discussed in Section 7.4, above.

With respect to the long-term health risks, based on the results of the site-specific risk assessments (see Section 6.1 and Appendix D), each of the CMAs, except for potential future use at Property BH3 under CMA 1, is associated with a level of risk that is within or below the acceptable risk range as defined by the Agencies' CAOs. Moreover, the differences among CMAs 2 through 4 in terms of reducing human health risks are very small based on the risk assessment.

All of the alternatives, except CMA 1 when future residential use is conservatively considered, are therefore considered comparable with respect to potential long-term exposure and are rated as favorable with respect to the human health criterion. CMA 1 is considered not favorable with respect to this criterion.

7.7 Institutional

The institutional criterion considers the effects of relevant federal, state, and local standards, criteria, or guidance on the design, operation, and timing of each CMA. The standards, criteria, and guidelines relevant to setting corrective action goals have been considered in developing, and are synthesized in, the CAOs issued by the Agencies. Therefore, this criterion also considers how each CMA fares in meeting the Agencies' CAOs (see Appendix A).

The Agencies' CAOs for the CMS Study Area and relevant NYSDEC and USEPA regulations and guidance allow for the use of site-specific human health and environmental risk assessments. The CAOs expressly call for the reduction of human health lifetime excess cancer risks to within the range acceptable for residential communities (i.e., 10^{-4} to 10^{-6}) and non-cancer risks to a level also acceptable for residential communities (i.e., Hazard Index ≤ 1). Based on the results of the human health and ecological risk assessments, each of the alternatives, except CMA 1 when future residential use is conservatively considered, results in conditions within or below an acceptable level of long-term human health and environmental risks determined in accordance with the Agencies' CAOs. Therefore, all CMAs, except CMA 1, are comparable with respect to institutional concerns associated with long-term health risks.

CMAs 1 and 2 fare less favorably in meeting CAO 1.E because no remedial action is implemented north of the Erie Canal to address "the potential for migration of FMC-related contaminants in soil and/or sediment downstream."

The Agencies' CAOs include the following goal:

- "The Point of Departure", or starting point for corrective action risk-management decisions pertaining to arsenic in soil, is the site-specific residential background considering site-specific histories of use for current and reasonably anticipated future residential properties within these study areas."

Action-specific standards, criteria, and guidance would be identified, integrated into the design and met during implementation of each CMA (e.g., Village ordinances/requirements related to work hours and use of public roads). All CMAs are comparable with respect to compliance with such action-specific standards, criteria and guidance.

Overall, CMA 4 provides the maximum reduction in exposure with time and minimum level of exposure to contaminants, meeting the preference for CMAs identified in the AOC (Attachment II [Scope of Work for Corrective Measures Study], page 12).

Therefore, CMA 1 is considered not favorable, CMAs 2 and 3 are considered moderate, and CMA 4 is considered favorable for the institutional criterion.

7.8 Green Remediation Practices

This criterion considers the environmental effects of the remedial actions and consistency with the NYSDEC's and USEPA's green remediation practices. The primary considerations for this criterion are: 1) consumption of natural resources (soil and fuel), 2) extent of demolition and earth moving activities, 3) waste generation, and 4) greenhouse gas and other air emissions.

The following is the assessment and rating of each CMA's green remediation practices criterion.

CMAs 1 and 2 are considered favorable with respect to this criterion because no further remedial action beyond the Reach T1 ICM would be required for the CMS Study Area and therefore no additional wastes would be generated and no additional natural resources would be consumed.

For CMAs 3 and 4, these considerations are proportionate to the soil/sediment volumes to be remediated. These CMAs would be associated with similar resource utilization and air emissions and are considered moderate with respect to the green remediation practices criterion.

7.9 Cost

The CMAs represent a range of costs, consistent with the estimated soil/sediment volumes to be remediated. A detailed cost estimate for each alternative has been developed and is presented in Appendix F and summarized in Table 4.

8 JUSTIFICATION AND RECOMMENDATION OF THE CORRECTIVE MEASURES ALTERNATIVE

This section presents the recommended CMA for the Tributary One South Study Area and justification for the recommended CMA. Table 4 summarizes the comparative evaluation of alternatives presented in detail in Section 7.

The recommended CMA for the CMS Study Area and justification for the recommended CMA are based on the detailed evaluation of alternatives using the CAOs and the applicable evaluation criteria.

All of the CMAs, except CMA 1, protect human health by achieving acceptable long-term human health risks (i.e., estimated excess lifetime cancer risks are within or below the range of 10^{-4} and 10^{-6}, and the non-cancer hazard indices are below the target value of 1). CMA 1 protects human health by achieving acceptable long-term human health risks, except with respect to the hypothetical future residential use of a single undeveloped property (BH3) owned by the Village. While all of the CMAs protect the environment by achieving acceptable ecological risks, CMA 1 and CMA 2 do not address potential downstream migration and, therefore, do not satisfy CAO 1.E. Since all of the corrective measures alternatives retained for analysis in this CMS satisfactorily protect human health and the environment, the remaining evaluation criteria take on added significance.

All of the CMAs, except CMA 1, protect human health and the environment with respect to FMC-related contamination, in accordance with, and/or consideration of applicable, or relevant and appropriate laws, rules and guidance, using site-specific data and information, supported by multiple lines of evidence, including site-specific risk assessment, and based on current and reasonably anticipated future land use. The remedial-decision making process embodied in the CMS is consistent with the AOC, the CAOs, and federal law, and does not default to New York State's rules and guidance concerning the remediation of historical contamination that presumptively require the excavation and removal of all soil with arsenic concentrations above background levels. For the FMC Middleport Project, the Agencies have asserted that a soil arsenic concentration of 20 mg/kg generally represents the upper limit of local background for residential properties. CMAs based on that site-specific residential background value of 20 mg/kg have been screened out of the final CMS analysis because: (i) they are not necessary to achieve the CAOs established by the Agencies pursuant to the AOC; and (ii) those types of alternatives necessarily compare unfavorably to CMAs 1 through 4 on every other substantive evaluation criteria. Consequently, those CMAs were not evaluated further in this CMS.

CMAs 3 and 4 satisfy more evaluation criteria than the other CMAs. CMA 1 satisfies the least number of evaluation criteria. CMAs 1 and 2 provide no remediation in the CMS Study Area north of the Erie Canal and therefore compare less favorably to CMAs 3 and 4 in meeting CAO 1E ("…eliminate, reduce, or control the potential for migration FMC-related contaminants in soil and/or sediment"). The downstream sediment traps included in CMAs 3 and 4 offer a potential remedial option that could be implemented in the event that an upstream property owner(s) does not provide access required for the CMI phase.

CMA 4 removes approximately 25% greater volume of soil/sediment than CMA 3, resulting in proportionately greater ecological and short-term public and worker safety risks, although such risks would be minimized by adherence to applicable rules and regulations and best management practices during construction. CMA 4 provides the maximum reduction in exposure with time and minimum

exposure to contaminants, meeting the preference for CMAs identified in the AOC (Attachment II [Scope of Work for Corrective Measures Study], page 12).

CMAs 3 and 4 were assessed as moderate for the green remediation practices criterion, primarily due to the amount of soil/sediment to be remediated and transported. Likewise, CMAs 3 and 4 were assessed as moderate for the technical criterion for short-term safety criteria.

The soil/sediment which would be generated by implementation of the CMA is well-suited to disposal in a commercial landfill or placement in an on-site CAMU. Final decisions regarding management of remediation wastes will be determined during the corrective measures implementation (CMI) phase. This phase includes activities associated with planning, designing, constructing and maintaining the selected remedy, and associated community participation and outreach activities.

On the basis of the detailed evaluation and critical comparison of alternatives, FMC recommends CMA 4 as the preferred final corrective measure for OU6.

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TABLES

ARCADIS Design & Consultancy for natural and built assets

TABLE 1
PROPERTIES EVALUATED IN HUMAN HEALTH RISK ASSESSMENT
(with current land use, fraction in CMS Study Area, and receptor(s) evaluated)
0U6 CMS REPORT
FMC CORPORATION – MIDDLEPORT, NEW YORK

Property	Current Land Use	Fraction in Study Area	Receptor
North of Canal			
AJ1	Village wastewater treatment plant	3%	Commercial/Industrial Worker
AK1+AK2	wetland, road right of way	20%	Resident
BE1	residential	70%	Resident
BE2	residential	39%	Resident
BE3	residential	100%	Resident
BE4	commercial	18%	Commercial/Industrial Worker, Future Resident
BF1	residential	17%	Resident
BF2	residential-wooded	81%	Resident
BG1	unimproved (former trailer park) - FMC owned	71%	Recreational, Future Resident
BH1	agricultural	0.5%	Agricultural Worker, Future Resident
BH2	wetland - FMC owned	100%	Future Resident
BH3	unimproved - Village owned	90%	Recreational, Future Resident[1]
BH4	residential	28%	Resident
BH5	residential	73%	Resident
BH6	residential	15%	Resident
BH7+BH9+BH12	residential	58%	Resident
BH8	residential	33%	Resident
BH10+BH11	residential	15%	Resident
BH14	residential	93%	Resident
BI1	residential	4%	Resident
BI2	residential	54%	Resident
BJ1	residential-wooded	87%	Future Resident
BJ2	residential-wooded	4%	Resident
BJ3	residential	66%	Resident
BJ4	residential	40%	Resident
BJ7	residential-wooded	71%	Resident
BK1	residential-wooded	58%	Future Resident
BL1	residential	22%	Resident
BL2	residential-wooded	40%	Resident
BL3	residential	60%	Resident
BL4	residential-wooded	48%	Resident
BL6	residential-wooded	60%	Future Resident
BL7	residential-wooded	95%	Future Resident
BN1	residential-wooded	40%	Resident
BN2	residential-wooded	51%	Future Resident
BO1	residential	13%	Resident
BO2	agricultural	1%	Agricultural Worker, Future Resident
South of Canal			
BB1	residential	71%	Resident
BB2	residential	100%	Resident
BB3	residential	100%	Resident
BB4	residential	100%	Resident
BB5	unimproved - National Grid land	24%	Resident

TABLE 1
PROPERTIES EVALUATED IN HUMAN HEALTH RISK ASSESSMENT
(with current land use, fraction in CMS Study Area, and receptor(s) evaluated)
0U6 CMS REPORT
FMC CORPORATION – MIDDLEPORT, NEW YORK

Property	Current Land Use	Fraction in Study Area	Receptor
South of Canal			
BB6	residential	92%	Resident
BB7	railroad tracks	16%	Recreational
BC1	residential	78%	Resident
BC2	residential	70%	Resident
BC3	residential	79%	Resident
BC4	residential	58%	Resident
BC6	commercial	35%	Commercial/Industrial Worker, Future Resident
BC9	residential	31%	Resident
BC11	residential	37%	Resident
BC12	residential	71%	Resident
BC13	residential	63%	Resident
BD1	unimproved-canal	9%	Recreational
BD2	residential	66%	Resident
BD3	gauging station - FMC owned	81%	Commercial/Industrial Worker, Recreational, Future Resident
BD4	canal structure and path	25%	Recreational
BD5	residential	4%	Resident

Note:
1. Future resident not evaluated under CMA 2 for property BH3.

TABLE 2
IDENTIFICATION OF CORRECTIVE MEASURES ALTERNATIVES
OU6 CMS REPORT
FMC CORPORATION – MIDDLEPORT, NEW YORK

Alternative	Figure	Action to be Conducted South of the Erie Canal	Action to be Conducted North of the Erie Canal	Estimate of Total Area and In-Place Volume of Soil/Sediment to be Remediated
1	3	Complete Reach T1 ICM Soil/Sediment Removal	No action	1.9 acres / 13,450 cubic yards
2	4	Complete Reach T1 ICM Soil/Sediment Removal	Institutional controls for management of property BH3	1.9 acres / 13,450 cubic yards
3	5	Complete Reach T1 ICM Soil/Sediment Removal	Soil/sediment removal (24-inches deep) in designated areas and construct sediment traps	15.8 acres / 58,200 cubic yards
4	6	Complete Reach T1 ICM Soil/Sediment Removal	Same as CMA 3, plus soil/sediment removal (24-inches deep) in designated areas and construct sediment traps	20.1 acres / 72,200 cubic yards

Note:

1. Reach T1 ICM as described in the Draft August 2017 *Operable Unit 6 (OU6) Reach T1 Interim Corrective Measure (ICM) Work Plan*.

TABLE 3
CORRECTIVE MEASURES ALTERNATIVES EVALUATION CRITERIA
OU6 CMS REPORT
FMC CORPORATION – MIDDLEPORT, NEW YORK

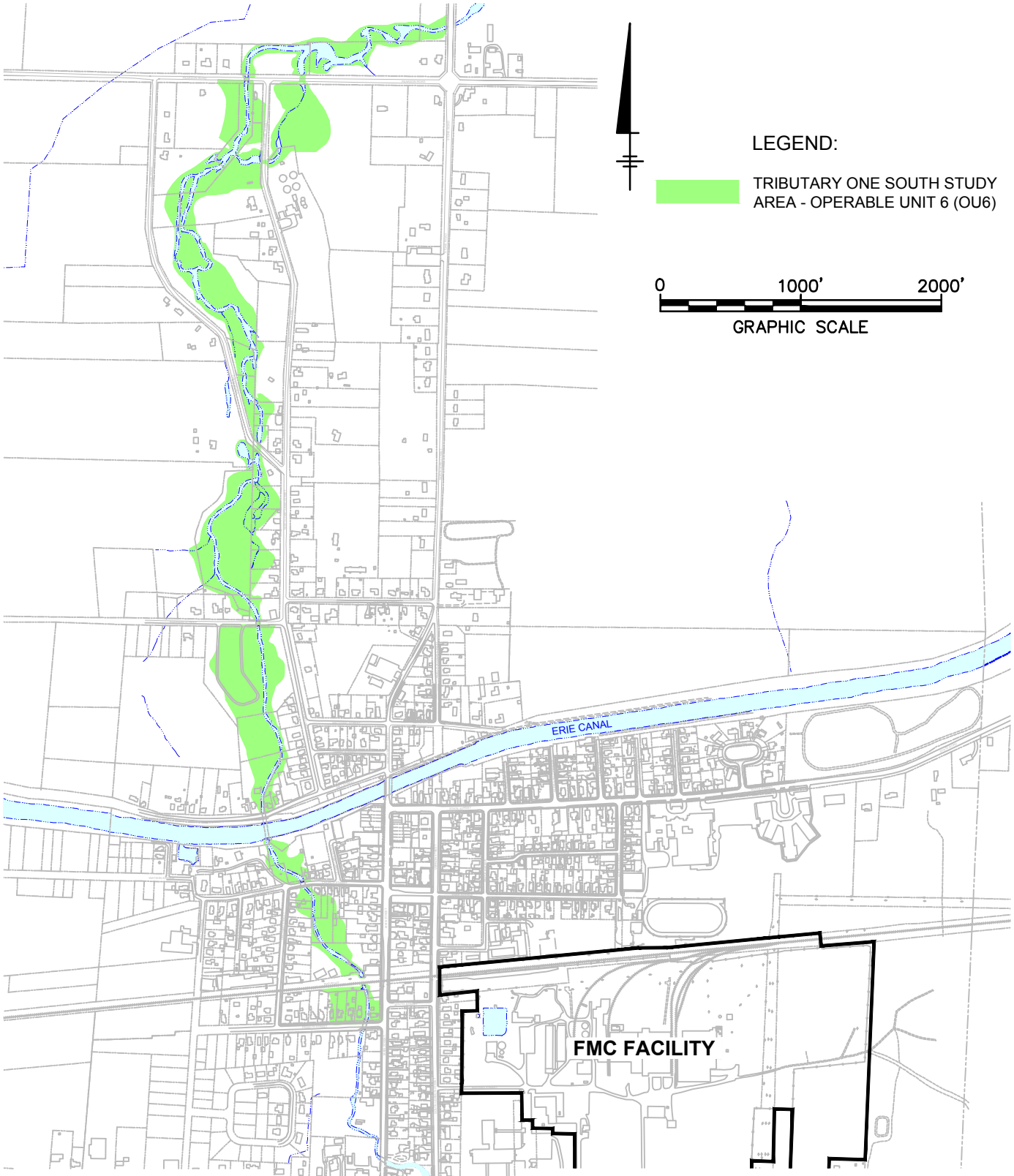
Community/ Property Owner Acceptance	Technical	Environmental	Human Health	Institutional	Green Remediation Practices	Cost
• Public Safety • Health of Residents and Town/Village Workers • Noise, Traffic, and Disruption of Neighborhood • Preservation of Neighborhood Character/Setting (Impact due to Loss of Trees) • Tree Preservation • Public Image of Village • Institutional Controls • Impact on Future Land Uses • Impact to Village Roads and Infrastructure • Property Values • Potential for Development or Reuse of Property and Adjacent Property • Remediation Schedule	• Effectiveness at Reducing Unacceptable Human Health Risk Levels (site-specific) • Ability to Maintain Effectiveness Over Time (Useful Life) • Demonstrated Effectiveness • Relative Ease of Implementation/ Construction • Short-Term Worker and Community Safety Risks During Implementation • Permits or Agreements Required • Equipment and Disposal Availability • Frequency and Complexity of Any Needed Post-Remediation Inspection, Monitoring and/or Maintenance	• Identify Pathways of Contamination Addressed (groundwater, surface water, ecological) • Short-Term Impacts to Environmentally Sensitive Areas (Erosion and Sedimentation Controls) • Long-Term Environmental Benefits (potential migration controlled)	• Mitigation of Potential Human Exposures for Current and Reasonably Anticipated Future Land Uses • Reduce and Manage Potential Human Health Risks Associated with FMC-related Contamination • Short-Term Health Risks During Implementation	• Federal, State, Local Standards, Criteria, and Guidance • Ordinances	• Increase Energy Efficiency • Reduce Greenhouse Gas and other Air Emissions • Minimize Demolition and Earth Moving Activities • Reduce Consumption of Natural Resources • Ecological and Soil Preservation • Conservation/ Efficient Use of Available Space at Offsite Commercial Disposal Facilities • Reduce Material Consumption and Waste Generation • Increase Reuse and Recycling of Materials • Minimize Effects to Land and Ecosystem • Foster Long-Term Environmental Stewardship	• Capital Costs of Construction • Costs of Engineering, Permitting, Reporting • Present Worth of Future Expenses (Post-Construction EC/IC Verification and Maintenance, if needed)

TABLE 4
RESULTS OF CORRECTIVE MEASURE ALTERNATIVES COMPARISON ANALYSIS
OU6 CMS REPORT
FMC CORPORATION - MIDDLEPORT, NEW YORK

		Alternatives			
	Evaluation Criteria	**CMA 1**	**CMA 2**	**CMA 3**	**CMA 4**
1	Community/Property Owner Acceptance	○	◎	●	●
2	Technical	●	●	◎	◎
3	Environmental	○	○	◎	◎
4	Human Health	○	●	●	●
5	Institutional	○	◎	◎	●
6	Green Remediation Practices	●	●	◎	◎
7	Cost	$5.5 M	$5.6 M	$28.6 M	$31.3 M
	Estimated Remediation to be Completed				
8	Number of Properties	17	18	36	50
9	Volume of Soil/ Sediment (cubic yards)	13,450	13,450	58,200	72,200
10	Total Area of Soil/ Sediment (acres)	1.9	1.9	15.8	20.1
11	Number of Construction Seasons (May to November)	2	2	6	8
12	Wetland Area Disturbed (acres)	0	0	6.4	6.4
13	Length of Stream Disturbed (linear feet)	1,600	1,600	4,800	7,400

● = favorable
◎ = moderate
○ = not favorable

FIGURES



FMC CORPORATION - MIDDLEPORT, NEW YORK
OU6 CMS REPORT

LOCATION MAP

ARCADIS Design & Consultancy for natural and built assets

FIGURE
1

CITY: SYRACUSE, NY DIV/GROUP: EBC-IM/DV DB/LD: L.POSENAUER PM/TM: D.WRIGHT
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SHERMAN STREET
NORTH HARTLAND STREET
MILL STREET
ERIE CANAL
CHURCH STREET
FALLS ROAD RAIL ROAD
FRANCIS STREET
TRIBUTARY ONE
FMC
85-16-1-8
(N. HARTLAND ST.)

BG1
BG2
BF1
BF2
BE1
BE2
BE3
BE4
BE5
BD1
BD2
BD3
BD4
BD5
BC1
BC2
BC3
BC4
BC5
BC6
BC7
BC8
BC9
BC10
BB1
BB2
BB3
BB4
BB5
BB6
BB7
BB8

LEGEND:

- APPROXIMATE PROPERTY LINE
- EXISTING RAILROAD
- EDGE OF WATER
- EXISTING CULVERT 105 (BURIED)
- CULVERT 105 (OPEN DITCH PORTION)
- FEMA 100-YEAR FLOODPLAIN BOUNDARY (APPROXIMATE)
- BB4 PROPERTY ID
- SAMPLING LOCATION
- BUILDINGS
- CMS AREA

CURRENT LAND USE (SEE NOTE 4):

- RESIDENTIAL MAINTAINED
- RESIDENTIAL OVERGROWN
- AGRICULTURAL
- COMMERCIAL/INDUSTRIAL
- CANAL, RAILROAD

NOTES:

1. ALL LOCATIONS AND PROPERTY BOUNDARIES SHOWN ARE APPROXIMATE AND SUBJECT TO VERIFICATION.
2. PROPERTY ID NUMBERS SHOWN ARE NOT RELATED TO STREET ADDRESS OR TAX PARCEL NUMBERS.
3. FLOODPLAIN BOUNDARIES APPROXIMATED USING FEMA FLOOD INSURANCE RATE MAPS 36063C0276E AND 36063C0278E (EFFECTIVE DATE: SEPTEMBER 17, 2010.
4. CURRENT LAND USE ONLY SHOWN FOR PROPERTIES WITHIN OR PARTLY WITHIN OU6 STUDY AREA.
5. APPROXIMATE WETLAND BOUNDARIES AND IDENTIFICATION BASED ON U.S. FISH AND WILDLIFE SERVICE'S WETLAND ONLINE MAPPER.

0 140' 280'
GRAPHIC SCALE

FMC CORPORATION - MIDDLEPORT, NEW YORK
OU6 CMS REPORT

CURRENT LAND USE - FRANCIS STREET TO SHERMAN STREET

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FIGURE
2A

CITY: SYRACUSE, NY DIV/GROUP: EBC-IM/DV DB/LD: L.POSENAUER PM/TM: D.WRIGHT
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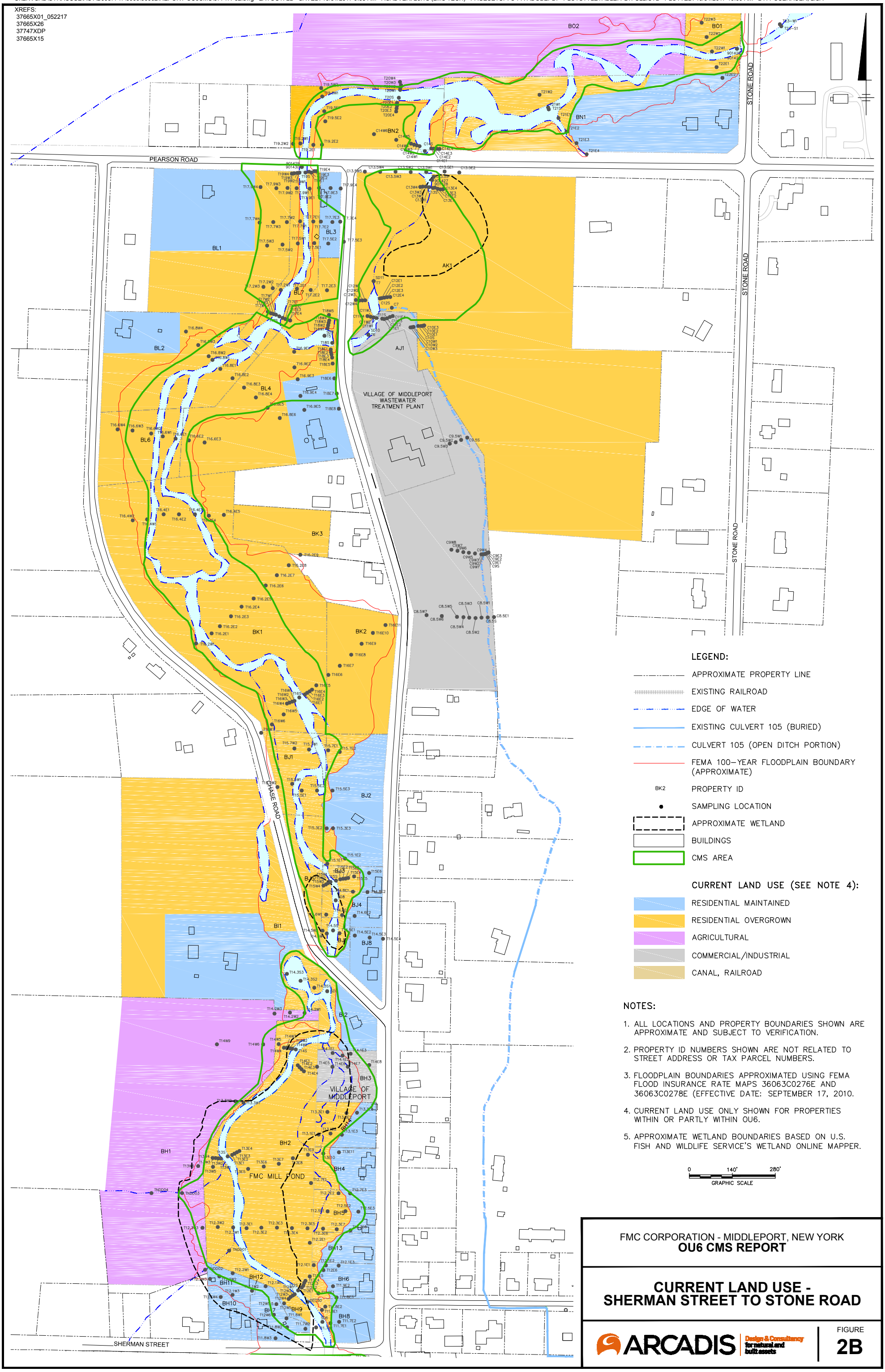

LEGEND:

- APPROXIMATE PROPERTY LINE
- EXISTING RAILROAD
- EDGE OF WATER
- EXISTING CULVERT 105 (BURIED)
- CULVERT 105 (OPEN DITCH PORTION)
- FEMA 100–YEAR FLOODPLAIN BOUNDARY (APPROXIMATE)
- BK2 PROPERTY ID
- SAMPLING LOCATION
- APPROXIMATE WETLAND
- BUILDINGS
- CMS AREA

CURRENT LAND USE (SEE NOTE 4):

- RESIDENTIAL MAINTAINED
- RESIDENTIAL OVERGROWN
- AGRICULTURAL
- COMMERCIAL/INDUSTRIAL
- CANAL, RAILROAD

NOTES:

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4. CURRENT LAND USE ONLY SHOWN FOR PROPERTIES WITHIN OR PARTLY WITHIN OU6.
5. APPROXIMATE WETLAND BOUNDARIES BASED ON U.S. FISH AND WILDLIFE SERVICE'S WETLAND ONLINE MAPPER.

0 140' 280'
GRAPHIC SCALE

FMC CORPORATION - MIDDLEPORT, NEW YORK
OU6 CMS REPORT

CURRENT LAND USE - SHERMAN STREET TO STONE ROAD

ARCADIS Design & Consultancy for natural and built assets

FIGURE
2B

CITY: SYRACUSE, NY DIV/GROUP: EBC-IM/DV DB/LD: L.POSENAUER PM/TM: D.WRIGHT
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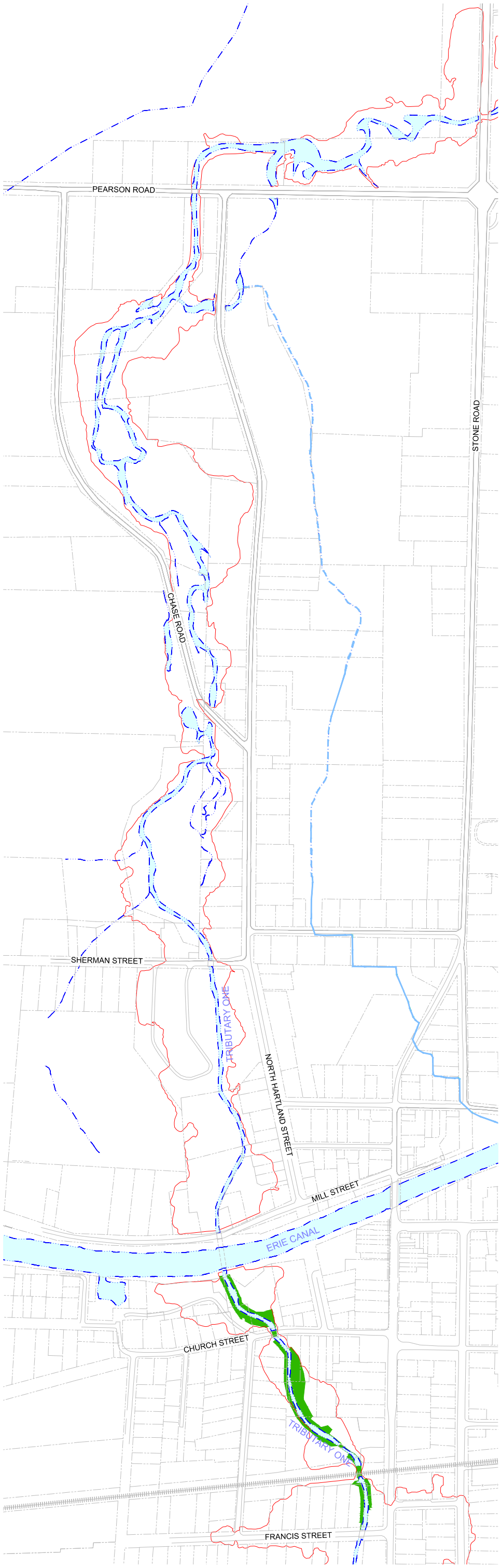

LEGEND:

- APPROXIMATE PROPERTY LINE
- EXISTING RAILROAD
- EDGE OF WATER
- EXISTING CULVERT 105 (BURIED)
- CULVERT 105 (OPEN DITCH PORTION)
- FEMA 100–YEAR FLOODPLAIN BOUNDARY (APPROXIMATE)
- APPROXIMATE EXTENT OF REMEDIATION

NOTES:

1. ALL LOCATIONS AND PROPERTY BOUNDARIES SHOWN ARE APPROXIMATE AND SUBJECT TO VERIFICATION.
2. FLOODPLAIN BOUNDARIES APPROXIMATED USING FEMA FLOOD INSURANCE RATE MAPS 36063C0276E AND 36063C0278E (EFFECTIVE DATE: SEPTEMBER 17, 2010.

0 250' 500'
GRAPHIC SCALE

FMC CORPORATION - MIDDLEPORT, NEW YORK
OU6 CMS REPORT

PROPOSED REMEDIATION AREA - CORRECTIVE MEASURES ALTERNATIVE 1

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FIGURE
3

CITY: SYRACUSE, NY DIV/GROUP: EBC-IM/DV DB/LD: L.POSENAUER PM/TM: D.WRIGHT
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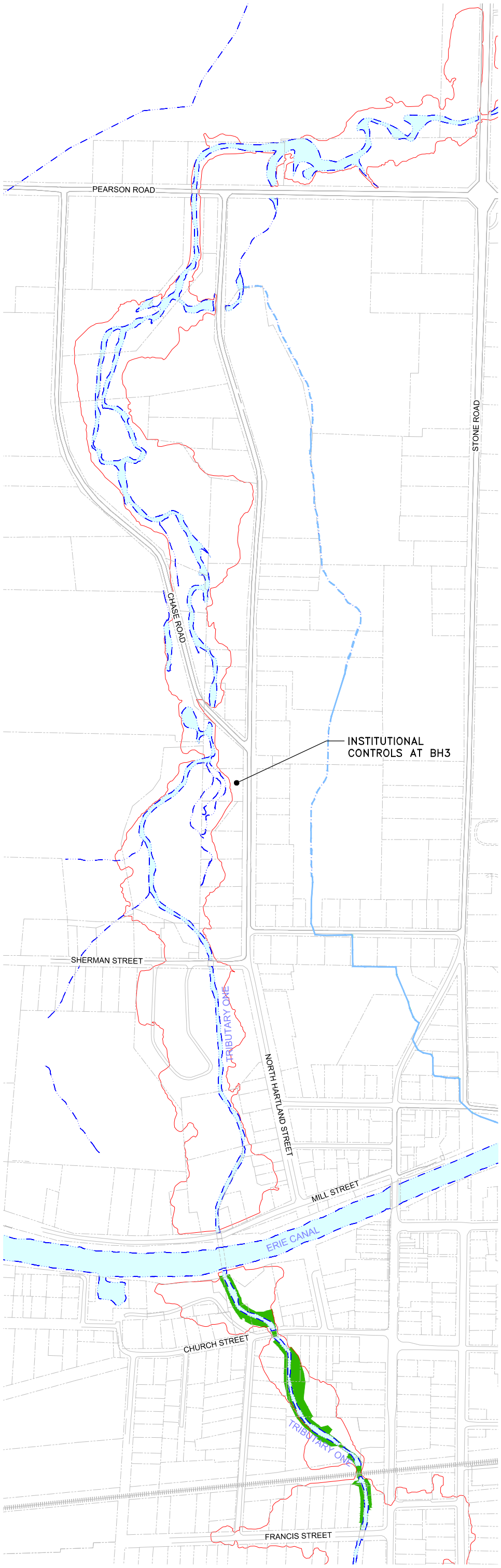

LEGEND:

- APPROXIMATE PROPERTY LINE
- EXISTING RAILROAD
- EDGE OF WATER
- EXISTING CULVERT 105 (BURIED)
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- FEMA 100–YEAR FLOODPLAIN BOUNDARY (APPROXIMATE)
- APPROXIMATE EXTENT OF REMEDIATION

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0 250' 500'
GRAPHIC SCALE

FMC CORPORATION - MIDDLEPORT, NEW YORK
OU6 CMS REPORT

PROPOSED REMEDIATION AREA - CORRECTIVE MEASURES ALTERNATIVE 2

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FIGURE
4

CITY: SYRACUSE, NY DIV/GROUP: EBC-IM/DV DB/LD: L.POSENAUER PM/TM: D.WRIGHT
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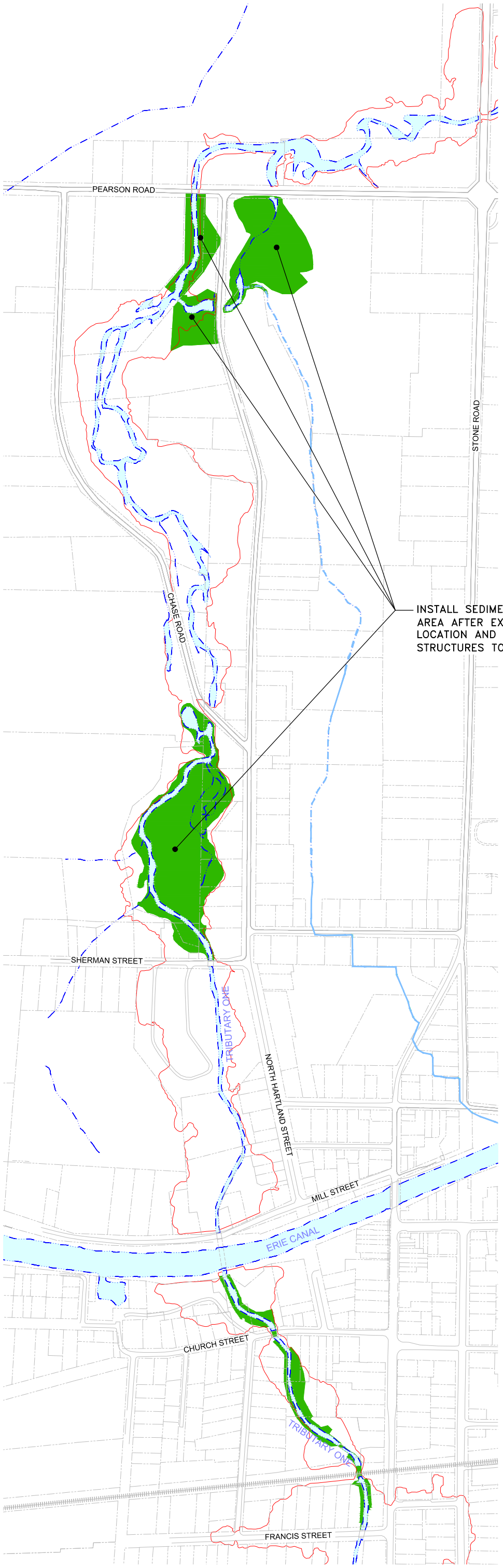

LEGEND:

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- EXISTING RAILROAD
- EDGE OF WATER
- EXISTING CULVERT 105 (BURIED)
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- FEMA 100–YEAR FLOODPLAIN BOUNDARY (APPROXIMATE)
- APPROXIMATE EXTENT OF REMEDIATION

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0 250' 500'
GRAPHIC SCALE

FMC CORPORATION - MIDDLEPORT, NEW YORK
OU6 CMS REPORT

PROPOSED REMEDIATION AREA - CORRECTIVE MEASURES ALTERNATIVE 3

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FIGURE
5

CITY: SYRACUSE, NY DIV/GROUP: EBC-IM/DV DB/LD: L.POSENAUER PM/TM: D.WRIGHT
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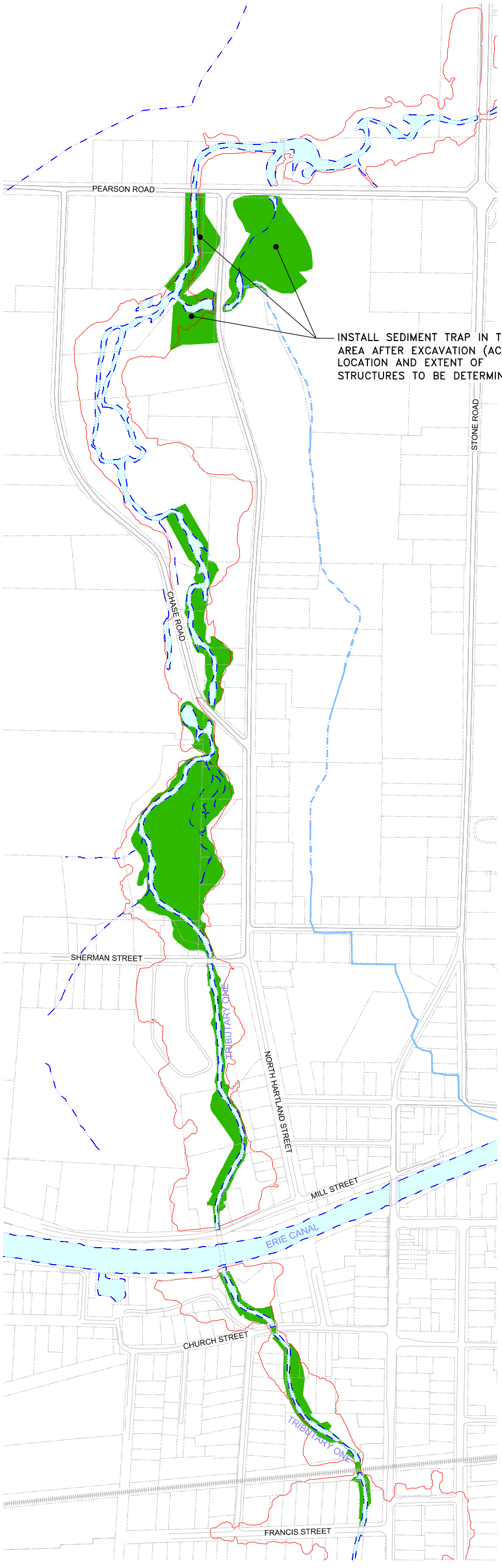

LEGEND:

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- EXISTING RAILROAD
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0 250' 500'
GRAPHIC SCALE

FMC CORPORATION - MIDDLEPORT, NEW YORK
OU6 CMS REPORT

PROPOSED REMEDIATION AREA - CORRECTIVE MEASURES ALTERNATIVE 4

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FIGURE
6

APPENDICES

Appear on CD

A Agencies' Corrective Action Objectives for Off-Site Soils and Sediment

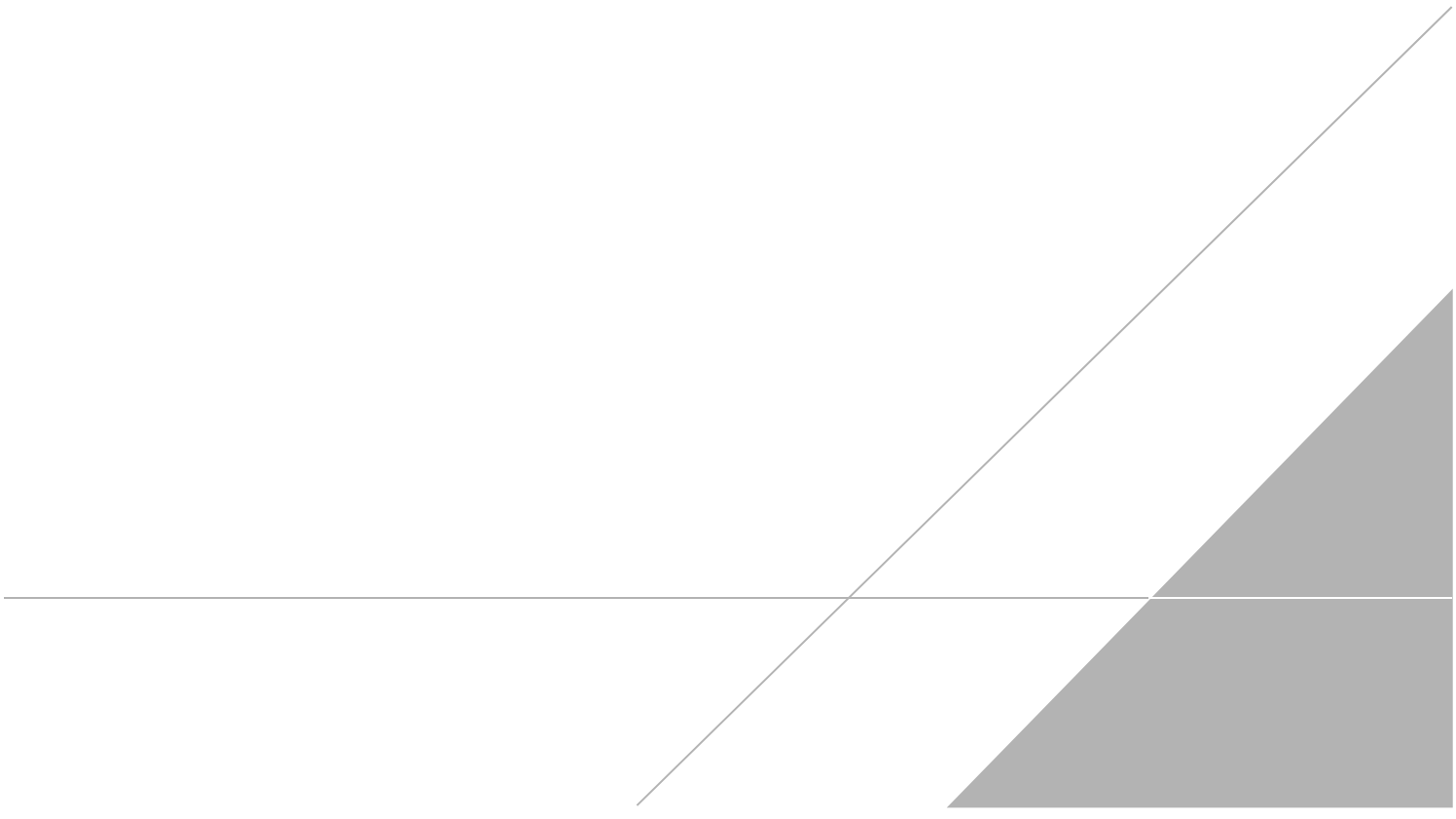
B 2016 North of Canal Data Summary Report

C CAMU Background Information (Excerpt from Attachment D-1 to May 2011 Draft CMS Report for OUs 2/4/5)

D Human Health Risk Assessment, FMC Corporation, Middleport NY, Tributary One South Study Area (OU6)

E Fish and Wildlife Resource Impact Analysis (FWRIA) Report, FMC Corporation, Middleport, New York, Tributary One South Study Area (OU6)

F Detailed Cost Estimates for Each Corrective Measures Alternative



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