3. The arsenic distribution in soil within each property, the entire Study Area and historic regional wind patterns and/or proximity to the FMC Facility will be evaluated to evaluate the likelihood of historic air deposition at a given location.

At the completion of this task a CMS Task 2 Data Evaluation Technical Memorandum will be prepared to present the data evaluation results and will include:

- a description of the methods used;
- a list of properties that are consistent with local soil arsenic background levels and/or consistent with the soil arsenic data for the 46 NFA properties identified by the Agencies;
- a list of properties and/or sample locations with potential outliers or anomalies that are not consistent with air deposition from the Facility and thus attributed to non-FMC related, anthropogenic background;
- a list of properties and/or sample locations where non-FMC derived arsenic likely predominates.

The above mentioned lists will be used in the development of the corrective measures alternatives.

5.0 CMS TASK 3: RISK ASSESSMENTS

5.1 RISK-BASED CORRECTIVE MEASURE APPROACH

Risk Assessment will be used in the CMS to delineate areas that may warrant remediation. As discussed in Section 1.0, arsenic is expected to be present in all soils. Therefore, there is a theoretical risk associated with exposure to arsenic in soil at any location. It is the difference in the risk between the Study Area and the background conditions (e.g., areas that could not have been impacted by past operations at the FMC Facility) that will be evaluated in the CMS risk assessments.

Risk assessments will be conducted separately for the Study Area and for the background data sets. The results of the two risk assessments will be compared to estimate the increased risk above background associated with the Study Area (if any). This "incremental increase" in risk compared to background will be the basis for identifying properties warranting remediation and in development of several corrective action scenarios and corrective measures alternatives (see Section 7.0). Scenarios will be developed that involve remediation of selected properties in order to reduce the incremental increase in risk associated with the post-remediation conditions in the Study Area compared to background.

The estimated risks associated with exposure to background soil arsenic will be based on the 2001-2003 Gasport Background Study dataset discussed in Section 4.0.

5.2 HUMAN HEALTH RISK ASSESSMENT APPROACH

The health risk characterization will estimate the health risks potentially posed by the presence of arsenic in soil. This will include an exposure assessment (characterization of route of exposure and estimation of its magnitude) and a toxicity assessment (identification and evaluation of hazards posed by arsenic).

Risk assessment typically involves the use of a number of variables, assumptions or factors in the assessment of exposure and toxicity. This inherently results in both variability and uncertainty. For example, exposure factors such as the daily rate of soil ingestion are expected to vary widely from individual to individual. Measuring soil ingestion is technically challenging and poses the potential for measurement errors or uncertainties. For many exposure factors, there is no consensus in the professional community as to a specific value that best represents a given population.

In a deterministic risk assessment, exposure is expressed as a single value generally based on a single set of exposure assumptions. The variability and uncertainty associated with exposure assumptions are not quantitatively considered in a deterministic risk assessment. This is a significant limitation in the ability to apply deterministic risk assessment results to a broad population.

According to USEPA (1997a, 2001), if a deterministic risk assessment, based on conservative exposure assumptions, leads to risk estimates that are below "levels of concern", then there is no need for a more complex probabilistic risk assessment. However, if a conservative deterministic assessment leads to estimates above levels of concern, a more sophisticated probabilistic risk assessment may be warranted. This illustrates a problem with use of deterministic assessment in this CMS to identify areas warranting remediation--the USEPA recommended toxicity values for arsenic are such that even background levels of arsenic would represent a "risk concern" using deterministic risk assessment methods. Therefore, the deterministic risk assessment approach would not be useful as a screening tool and has little applicability for use in this CMS.

However, the applicability of probabilistic assessment methods is constrained by the adequacy of the data set being analyzed. In particular, the sampling strategy and number of sample points must be sufficient to produce a meaningful representation of the distribution of the data points (in this case arsenic concentration in soil). Based on preliminary review, the residential sampling datasets appear to be adequate for probabilistic analysis. Because there are fewer non-residential sample locations, it is not clear whether the datasets will be sufficient to use probabilistic risk assessment methods for evaluation of non-residential exposures. If this is determined to the case, deterministic assessment methods may be relied upon or, if appropriate, some nonresidential use areas may be incorporated into the residential risk assessment.

It is planned that this CMS will use probabilistic risk assessment methods for evaluation of residential exposures (though this will be subject to a review of data adequacy as indicated above). Unlike deterministic risk assessment, probabilistic risk assessment considers ranges of values for exposure factors and weight possible values by the estimated probability of occurrence. "Monte Carlo" or similar computer simulations are used to select individual values from the probability-weighted distribution of exposure factors to generate a range and frequency of potential exposures. The probabilistic risk assessment results are presented as probability distributions, which quantitatively characterize variability and uncertainty.

5.3 HUMAN HEALTH RISK ASSESSMENT

5.3.1 General

Human health risk assessments will be conducted for the Study Area and for background conditions. The objectives of the risk assessments will be to:

1. Estimate potential "baseline" human health risks associated with arsenic in soil within the Study Area in the absence of any further remedial action;

2. Estimate potential "background" human health risks associated with arsenic in soil that has not been impacted by historic operations at the FMC Facility;

3. Estimate the incremental increase, if any, in risk associated with the Study Area above risk associated with background conditions.

The activities involved in the human health risk assessment are summarized in the subsections below.

5.3.2 Elements of the Human Health Risk Assessment

The human health risk assessment will include the following elements:

1. Problem formulation

2. Exposure assessment, including the identification of exposure pathways and the calculation of exposure point concentrations,

3. Toxicity assessment,

4. Risk characterization, and

5. Description of uncertainties and limitations.

The human health risk assessment will be performed in accordance with relevant USEPA guidance, including but not necessarily limited to, the following documents (as appropriate):

- Risk Assessment Guidance for Superfund (RAGS): Human Health Evaluation Manual, Part A (USEPA, 1989);

- Risk Assessment Guidance for Superfund: Human Health Evaluation Manual, Part E – Dermal Risk Assessment (USEPA, 2002);

- Risk Assessment Guidance for Superfund: Volume III – Part A, Process for Conducting Probabilistic Risk Assessment, OSWER 9285.7-45 (USEPA, 2001);

- Exposure Factors Handbook (USEPA, 1997);

- Guidance for Data Usability in Risk Assessment (USEPA, 1992a);

- USEPA Risk Characterization Program Memorandum (USEPA, 1995);

- Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites (USEPA, December 2002. OSWER 9355.4-24); and

- Integrated Risk Information System (IRIS), which contains USEPA's on-line database of toxicity factors (http://www.epa.gov/ngispgm3/iris/index.html).

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5.3.3 Problem Formulation

As described in Section 1.2.2, arsenic will dictate the scope of the remediation efforts in the Study Area and is the only potential FMC-related chemical of potential concern for the Suspected Air Deposition Study Area CMS.

All arsenic soil data collected during the Study Area and background investigations will be considered in the evaluation of potential health threats to current and future receptors. Data evaluation will include, but will not necessarily be limited to, examination of site topography, land use, sampling locations, arsenic concentrations, and the potential for exposure.

5.3.4 Exposure Assessment

Exposure assessment involves identification of the potential human exposure pathways at the site, and quantification of those exposures. Site data and conditions will be reviewed consistent with USEPA (2001) to confirm the applicability and methodology of the probabilistic approach to be used.

The exposure assessment will begin with refinement of the site conceptual model presented in FMC's draft RFI Report (CRA 1999). Potential release and airborne transport mechanisms will be identified. Exposure pathways have been initially identified in FMC's draft RFI Report (CRA 1999). The exposure pathway links the sources, locations, types of environmental releases, and environmental fate with receptor locations and activity patterns. Generally, an exposure pathway is considered complete if it consists of the following four elements:

- A source and mechanism of release;
- A transport medium;
- An exposure point (i.e., point of potential contact with a contaminated medium); and
- An exposure route (e.g., ingestion) at the exposure point.

Soil arsenic concentrations in the Middleport Study Area and at background conditions will be represented by probability density functions (PDFs). A PDF is a statistical representation of the range of possible values for a variable and the probability that the variable will assume each of the values within the range. In the case of soil concentrations, the PDFs will represent the ranges of soil concentrations detected in Middleport and Gasport, with greater emphasis on concentrations detected more frequently.

Daily intakes will be calculated for chronic exposures. Exposure factor assumptions used in daily intake calculations will be based on information contained in USEPA guidance, site-specific information, published scientific literature, and professional judgment. Critical exposure factors include: soil ingestion rates, relative oral bioavailability of arsenic in soil, exposure frequency, exposure duration, and body weight,. Exposure factors will be in the form of either PDFs or point estimates depending on the parameter and the information available.

FMC has sponsored a study to determine the oral bioavailability of arsenic in soil from Middleport (Roberts et al. 2007). This study will provide the basis for assessing the relative oral bioavailability of arsenic in soil. In addition, FMC has sponsored a study to evaluate the dermal absorption of arsenic in soil from the Middleport area (Lowney et al. 2007). This study found that dermal absorption of arsenic from Middleport soil derived was negligible, so this exposure route will not be quantified in the risk assessment.

Whenever possible, these assumptions will be site-specific and will include average values that represent the central tendency (CT) or average exposure and upper-bound values that may be used in estimating the reasonable maximum exposure (RME). The RME is the highest exposure that is reasonably expected to occur at a site, and is derived by using a combination of average and upper-bound values that yields an estimate approximating a 95th percentile exposure. For the probabilistic approach to be used, an upper-bound value representing an exposure at approximately the 95th percentile of the distribution will be selected to represent the RME.

An Exposure Assessment Technical Memorandum that will be submitted to the Agencies and community stakeholders will be prepared to:

1. Evaluate the adequacy of the arsenic soil data sets for probabilistic risk assessment approach for evaluation of residential, industrial/commercial and other applicable exposures;

2. Describe the exposure pathways and the refined conceptual site model;

3. Describe the methodology or methodologies (e.g., deterministic or probabilistic) to be used in the risk assessments; and

4. Identify the proposed exposure factor assumptions and describe the rationale for use of the proposed factors.

5.3.5 Toxicity Assessment

The toxicity assessment will review the general toxicological properties and dose response characteristics of arsenic using the most current toxicological human health effects data.

In risk assessment, a cancer slope factor is used to estimate an upper-bound probability of an individual developing cancer as a result of a lifetime of exposure to a particular level of a potential carcinogen. Specifically, a cancer slope factor is a plausible upper-bound estimate of the probability of a response per unit intake of a chemical over a lifetime and is usually the upper 95th percent confidence limit of the slope of the dose-response curve expressed in $(mg/kg\text{-}day)^{-1}$.

For the evaluation of noncarcinogenic effects of arsenic in the risk assessment, chronic reference dose (RfD) for the ingestion route and reference concentrations (RfC) for the inhalation route (if evaluated) are used. A chronic RfD is an estimate of a daily exposure level for the human population, including sensitive subpopulations, that is likely to be without appreciable risk of deleterious effects during a lifetime. The RfC is expressed in units of milligrams of chemical per cubic meter of air (mg/m^3) and is an estimate of the maximum air concentration that can be present over a specified time period without an appreciable risk of deleterious effects.

5.3.6 Risk Characterization

Toxicity and exposure assessments will be integrated into expressions of carcinogenic risk and noncarcinogenic hazards. Carcinogenic risks are estimated as the incremental probability of an individual developing cancer over a lifetime as a result of exposure to a potential carcinogen. The cancer slope factor multiplied by the estimated daily intake of a chemical averaged over a lifetime of exposure yields an estimate of incremental risk of an individual developing cancer. A range of lifetime risk values from $1x10^{-6}$ to $1x10^{-4}$ is considered by USEPA (USEPA 1990) to represent an acceptable lifetime incremental increased cancer risk range.

The potential for noncarcinogenic effects will be evaluated by comparing exposure over a specified time period with a reference dose derived for a similar exposure period. This ratio of exposure to toxicity is referred to as a hazard quotient. This hazard quotient assumes that there is a level of exposure below which it is unlikely even for sensitive populations to experience adverse health effects. If the hazard quotient exceeds one, there may be concern for potential noncancer effects; generally, the greater the hazard quotient above unity, the greater the level of concern.

Cancer risk and noncancer hazard results will be presented in the form of PDFs. The PDFs for the Study Area and for background conditions will be compared in terms of measures of central tendency exposure risks (e.g., average and/or median of each distribution) and reasonable maximum exposure risks (e.g., 95th percentile of each distribution) to identify whether there is an incremental increase in risk for Middleport over background.

The risk results will be used to:

- Provide a basis for determining residual arsenic levels that do not pose unacceptable incremental risk compared to background levels;

- Assist in determining whether additional response action is necessary in the Study Area; and

- Provide a basis for comparing potential health impacts (relative to background) of various corrective measure alternatives (including no action).

5.3.7 Uncertainties and Limitations in Risk Assessment

In any risk assessment, estimates of potential carcinogenic risk and non-carcinogenic health effects have uncertainties. Uncertainties associated with some of the variables/assumptions used in the risk calculations will be quantitatively characterized in the probabilistic risk assessment and will be identified and discussed in the risk assessment report. Any other significant areas of uncertainty and limitations will be discussed qualitatively, and the potential magnitude and impact of each source of uncertainty will be summarized. The overall impact of uncertainty on the confidence of the risk estimates will be described.

A sensitivity analysis may also be conducted to further assess the impacts of various sources of uncertainty.

5.3.8 2003 Middleport Environmental Exposure Investigation

The risk assessment process described above incorporates health protective assumptions to avoid underestimation of soil exposure. Biomonitoring studies, if available for the potentially exposed population, may provide a useful comparison to the theoretical exposures estimated in the risk assessment.

A comprehensive arsenic exposure and biomonitoring study was conducted during 2003 in Middleport (Exponent 2004). An independent panel of scientific experts from health institutes, universities, and the Centers for Disease Control and Prevention (CDC) provided oversight for this voluntary study and the findings were peer reviewed and published in the scientific literature (Tsuji et al. 2004). Because absorbed arsenic is rapidly excreted in the urine, arsenic exposure was assessed by measuring arsenic concentrations in urine. The researchers targeted young children whose exposure to soil is expected to be highest and conducted the study during the summer months when outdoor activities involving soil contact occur most frequently. Arsenic was also measured in yard soil, house dust, and garden produce for participating residents who elected to have such sampling.

Key findings of the Middleport biomonitoring study included the following:

- Speciated and inorganic urinary arsenic levels (i.e., the forms relevant to assessing exposures to arsenic in soil) in Middleport residents were low.
- Urinary arsenic levels were generally not correlated with soil or house dust.
- House dust concentrations were not correlated with soil concentrations.

Specifically, all urinary arsenic levels for Middleport were below reference levels for speciated and inorganic arsenic in urine of 40 and 20 µg/L, respectively. The range in speciated arsenic concentrations was from 0.89 to 20 µg/L, with the highest concentration approximately half the reference level of 40 µg/L. The maximum inorganic arsenic level found in Middleport, 2.7 µg/L, was approximately one-quarter of the lowest reference level of 10 µg/L. There were no significant relationships between urinary arsenic and arsenic in soil. The only significant relationship between urinary arsenic and environmental media occurred between levels of speciated arsenic in creatinine-adjusted urine samples and house dust in young children. However, there was no significant relationship found between house dust concentrations and soil concentrations.

The Middleport biomonitoring study was designed to have the greatest chance of detecting any increased arsenic exposures associated with Middleport soil. Despite this design, no such association was detected, and urinary arsenic concentrations were found to be below reference levels and comparable to those of other populations without elevated soil arsenic concentrations.

The lack of increased exposure associated with arsenic in soil can to be attributed to three primary factors: 1) concentrations of arsenic in Middleport soils are low, 2) little soil is ingested by residents, and 3) arsenic in soil has low bioavailability. Furthermore, exposures to arsenic naturally present in drinking water and food are much higher than those from soil with concentrations of arsenic at Middleport levels.

The results and conclusions of the biomonitoring study will be considered in the CMS process and will be used in communicating and explaining risks to the community.

5.3.9 Human Health Risk Assessment Deliverables

The following risk assessment deliverables will be prepared and submitted to the Agencies:

- Exposure Assessment Technical Memorandum (see Section 5.3.4); and

- Background and Study Area Human Health Risk Assessment Report.

The Exposure Assessment Technical Memorandum will identify the information and assumptions that will be used in the risk assessments. The Background and Study Area Human Health Risk Assessment Report will present the results of the probabilistic human health risk assessments for the Study Area (in the absence of any further remedial action) and for the background conditions and the differences between the two. Both documents will be provided for review and comment to the Agencies, Stakeholders and the Community.

5.4 USE OF RISK ASSESSMENTS FOR DEVELOPMENT AND COMPARISON OF ALTERNATIVES

If the comparison of risk PDFs for the Study Area and for background conditions, discussed in Section 5.3.6, shows no difference between the two study areas, remediation will not be warranted. On the other hand, if the comparison of risk PDFs shows an increased risk for the Study Area above background conditions, remediation may be warranted. As discussed in Section 7.0, possible corrective action scenarios that will represent various incremental risk levels between the two risk PDFs (Study Area and background conditions) will be developed. The goal in evaluating these scenarios will be to identify a scenario that alters the risk PDF for the Study Area until it is within an acceptable increment of the risk PDF for background conditions.

Human health risks associated with arsenic in soil after the corrective measures have been implemented will be characterized for the corrective measures alternatives developed for detailed evaluation (see Section 8.0). The risk assessment for evaluation of alternatives will be performed as described above in Section 5.3.

5.5 ECOLOGICAL RISK ASSESSMENT

An ecological risk assessment will not be included in the CMS. Given the predominant land uses within the Study Areas, human exposures will be of greater importance than ecological exposures in selecting the corrective measures. Potential ecological impacts will be considered, however, during corrective measure alternatives development, screening and selection to ensure that the selected remedy does not adversely affect wildlife, mature trees and plantings in the village.

6.0 CMS TASK 4: TECHNOLOGY SCREENING AND PILOT STUDIES

The purpose of CMS Task 4 is to identify and screen corrective measure technologies that can be used to remediate soil in the Study Area. The sections below describe the considerations and specific activities that will be used to identify and screen technologies and associated activities.

Activities included in CMS Task 4 include identification of viable technologies appropriate to the Study Area land use types; screening of the technologies to identify a list of technologies for the development of corrective measure alternatives; identification and evaluation of various methods for removal of soil within the protected root zone of a mature tree; and performance of ongoing and proposed pilot studies to obtained additional data required to better assess and screen certain proposed technologies.

6.1 GENERAL CONSIDERATIONS

The following have been and will be considered during identification and screening of technologies:

1. As required by the AOC, FMC performed a preliminary evaluation of corrective measures technologies in 1991, prior to starting the RFI. The results of that evaluation are presented in the report entitled "Pre-investigation Evaluation of Corrective Measures Technologies" (dated August 1991) (referred to as "1991 Technologies Evaluation Report"). Potential corrective measures preliminarily identified to address impacted soils will be reviewed and considered along with other appropriate supplemental technologies.

2. Since arsenic in soils is expected to dictate the scope of remedial efforts in the Study Area, only corrective measure technologies that can remove or isolate arsenic-containing soils or reduce the arsenic levels in the soil will be identified. Technologies which are clearly inappropriate for the relatively low arsenic levels and nature of arsenic in the soil (e.g., arsenic can not be destroyed) will not be considered. Excluded technologies previously identified in the 1991 Technologies Evaluation Report include soil washing, solidification/stabilization, vitrification, incineration, chemical extraction, chemical reduction/oxidation, biological degradation, vapor extraction, soil flushing);

3. As indicated in Section 1.0, the Suspected Air Deposition Study Area consists of properties within the community that are not owned by FMC. Potential disruption of

the community will be an important consideration in the selection of potentially feasible technologies.

4. The current land usages of these properties include residential, commercial/business, industrial, agricultural, public land and school property. Technologies specific to the land uses and physical characteristics of the Study Area, and the environmental settings within the Study Area will be identified. Technologies that are clearly inappropriate because of the land uses and physical characteristics will not be considered further.

5. Some technologies to be evaluated will be consistent with USEPA's "Green Remediation " strategies, including conservation and efficient use of natural resources and energy, reduction of negative impacts (e.g., generation of greenhouse gas) on the environment, minimization of pollution at its source, and reduction of waste to the extent possible.

6. Innovative technologies have been identified below, if practicable;

7. FMC has requested that a Corrective Action Management Unit (CAMU) be designated at eastern portion of the FMC Plant Facility for the permanent management of any excavated contaminated soil or materials determined to be a non-hazardous waste. For the purposes of this CMS, it is assumed that any excavated soil will be a non hazardous waste. Soil disposal options/technologies will include the use of a CAMU at the FMC Facility.

6.2 IDENTIFICATION & SCREENING OF TECHNOLOGIES

Based on the above considerations and review of the contaminated soil remedial technologies identified in 1991 Technologies Evaluation Report, the following response actions and/or technologies have been identified for further screening and/or evaluation:

1. <u>No Action or No Further Action</u>;

2. <u>Administrative Controls</u> to prevent or reduce potential for human exposure to contaminated soil. Administrative controls include use of deed restrictions (non-enforceable and requires property owner consent), private property agreements/easements (requires property owner consent and does not require

intervention of government authority), and/or environmental easements (requires property owner consent and intervention of by NYSDEC);

3. Access Restrictions consist of physical mechanisms that can restrict access and or maintain the integrity of another technology. Access restrictions include posting of signage and/or fencing to restrict access;

4. Monitoring and Maintenance consists of activities required to verify and maintain the effectiveness of a remedial measure;

5. Engineered Cover involves the construction of an engineered cover to limit contact with contaminated soil;

6. Soil Excavation/CAMU involves the removal of contaminated soil and the disposal of the excavated soil in a CAMU at the FMC Facility;

7. Phytoremediation involves the use of certain plants to reduce arsenic levels in soil. Plant materials accumulate arsenic and will require periodic harvesting/removal and off-site disposal. Phytoremediation is an in situ treatment technology and is considered to be a "Green" technology;

8. Soil Tilling/Blending involves the tilling, mixing and blending (with topsoil or compost that contain low levels of arsenic) of soil to reduce arsenic levels and to recycle land/soil. Soil Tilling/Blending is considered to be an in situ technology and a "Green" technology since it conserves a significant natural resource--soil.

Additional information is required to evaluate the site-specific effectiveness of phytoremediation and soil tilling/blending. FMC began implementation of an arsenic phytoremediation pilot study in early 2008 and intends to perform a soil tilling/blending pilot study. These pilot studies are discussed in Section 6.3.

The above listed technologies will be considered as appropriate in the development of corrective measures alternatives.

6.3 PILOT STUDIES

6.3.1 ARSENIC PHYTOREMEDIATION PILOT STUDY

The overall objective of the phytoremediation pilot study is to evaluate the effectiveness and feasibility of phytoremediation to reduce the arsenic levels in the soil in the test areas. The work plan for the phytoremediation pilot study was submitted to the Agencies in December 2007. The Agencies approved the laboratory testing task of the work plan and provided comments on the remaining portion of the plan in January 2008. FMC began implementation of the approved the laboratory testing task in January 2008 and is revising the work plan to address the Agencies' comments and to incorporate the preliminary laboratory testing results.

6.3.2 SOIL TILLING/ BLENDING PILOT STUDY

In general, arsenic concentrations in the Study Area are higher at the surface and decrease at depth. In addition, arsenic concentrations can vary significantly within the boundaries of each property. Tilling or blending of the surface soils (upper 12 inches) of soil may adequately reduce the more elevated arsenic concentrations.

The soil tilling/blending pilot study will be performed at selected FMC-owned residential properties and/or on agricultural properties where the magnitude and distribution of arsenic concentrations offer a suitable test area. These properties will be identified in the pilot study work plan. Information and data (e.g., depth of mixing, level of effort required, maximum and average resulting arsenic concentrations, and associated costs) obtained during these studies will be incorporated into the CMS.

In order to evaluate the effectiveness and feasibility of soil tilling/blending, the pilot study will focus on the following study questions:

1. What pre-existing distributions and concentrations of arsenic in the soil are appropriate for use of tilling or blending?
2. What level of mechanical effort is required to effectively till or blend the soil?
3. What mechanical equipment is most suitable for tilling or blending the soil?
4. What depths can the mechanical equipment effectively till/blend soil?
5. What are the effects of tilling or blending on the distributions of arsenic in the soil in the test areas?

6. Will the addition of soil amendments (i.e., compost, topsoil) that contain low levels of arsenic facilitate the reduction of soil arsenic levels?

7. What conditions (e.g., land use, property configuration, soil type) are appropriate for use of tilling or blending?

A Soil Tilling/Blending Pilot Study Work Plan will be submitted to the Agencies in June 2008 for review and comment.

6.4 EVALUATION OF SOIL REMOVAL METHODS BENEATH MATURE TREES

Potential methods for removal of soil within the protected root zones of mature trees will be identified and evaluated. The evaluation will include, but may not be limited to, the following considerations:

1. Ability to perform the work without causing permanent damage to the tree.

2. The level of effort and type of equipment required.

3. The safety of workers, residents and neighbors during implementation.

4. The potential for the tree to fall down or die during or after completion of the work.

5. Costs for performance of the work and potential future costs/liabilities.

A CMS Task 4 Technical Memorandum will be prepared to present the results of this evaluation and will include description of the methods identified and the evaluation results.

6.5 CMS TASK 4 DELIVERABLES

CMS Task 4 deliverables will be as follows:

1. Phytoremediation Pilot Study Work Plan (Geomatrix 2007) *(draft work plan already submitted December 5, 2007)* and progress and pilot study reports described in the Phytoremediation Pilot Study Work Plan;

2. Soil Tilling/Blending Pilot Study Work Plan;

3. Soil Tilling/Blending Pilot Study Report, as specified in the Soil Tilling/Blending Pilot Study Work Plan;

4. CMS Task 4 Technical Memorandum: Feasibility Assessment for Soil Removal Under Trees

7.0 CMS TASK 5: DEVELOPMENT OF CORRECTIVE MEASURES ALTERNATIVES

7.1 OBJECTIVE AND GENERAL APPROACH

Corrective measure alternatives will be developed with the objective of reducing the Community-wide risk distribution within the Suspected Air Deposition Study Area and/or to manage unacceptable human health risks on certain properties based on current and reasonable future land uses (as appropriate). The approach to development of corrective measure alternatives will be as follows:

1. Exclude areas where the weight of evidence suggests arsenic presence is not derived from airborne transport from the Facility (if this distinction proves to be feasible)

2. Identify Study Area properties and/or portions of Study Area properties which contribute to the elevated risk distribution when compared to the background risk distribution *(note: this is predicated on the assumption that the probabilistic risk assessments will in fact show a significantly increased risk distribution in the Study Area compared to the background community).*

3. Identify those properties or portions of properties where the property specific concentration data contributes to the elevated (with respect to background) risk distribution developed from the probabilistic risk assessments.

4. Develop corrective action scenarios based on a range of potentially acceptable community-wide risk distributions.

5. Incorporate applicable technologies for the various corrective action scenarios into corrective measures alternatives for detailed evaluation.

7.2 APPROACH FOR DEVELOPMENT OF COMMUNITY-WIDE RISK-BASED CORRECTIVE ACTION SCENARIOS

As discussed in Section 5.4, possible corrective measure alternative scenarios will be developed to represent various incremental risk levels between the Study Area and background conditions. The post-remediation risk levels or risk distribution (expressed as a PDF as described in Section 5.3.4) will be compared to the background risk levels or PDF to evaluate the

effectiveness of the corrective measure in reducing risks. At least one alternative scenario will be targeted toward achieving a risk level/PDF equivalent to the background risk level/PDF.

7.3 COMPONENTS OF THE CORRECTIVE MEASURE ALTERNATIVES

One of the corrective measure alternatives will be a "No Action/No Further Action Alternative". The remaining corrective measure alternatives to be evaluated will be a series of actions involving remediation of selected risk-contributing properties to achieve a desired outcome within the range of potentially acceptable risk distributions. The remaining corrective measure alternatives will consist of remediation scenarios developed as described in Section 7.2 and a series of corrective action technologies identified in Section 6.2. The corrective measure alternatives will consist of remediation of some properties and/or portions of properties.

Corrective measures technologies that will be included in each alternative will be property-specific and will be selected based on the property characteristics/setting, current and potential future (as appropriate)land use, and arsenic distribution in the soil on the property. It may be that the results of the pilot studies (in particular the phytoremediation study) will not be available at the time of the CMS completion. If this is the case, the corrective measure alternatives may be generic, simply referring to remediation of the selected properties. The actual technologies used may be determined as part of the corrective measures design program (to be implemented following completion of the CMS).

7.4 TASK 5 DELIVERABLE

A Technical Memorandum for CMS Task 5 will be prepared to describe the alternative corrective action scenarios and supporting risk analysis. It will also identify the list of corrective measures alternatives that will be evaluated in CMS Task 6.

8.0 CMS TASK 6: EVALUATION OF CORRECTIVE MEASURES ALTERNATIVES

Once the list of corrective measures alternatives has been developed, the detailed evaluation will follow the process specified in the AOC, the "Interim Guidance for Conducting RI/FS under CERCLA" (USEPA 1988), USEPA Fact Sheet #3, Final Remedy Selection for Results-Based RCRA Corrective Action (March 2000), and other applicable documents.

8.1 BALANCING/EVALUATION CRITERIA

The evaluation criteria to be used to evaluate each alternative and recommend the most appropriate alternative are described below:

Community/Property Owner Acceptance

This criterion evaluates remedies based on the degree to which they are acceptable to the community and property owner and incorporates public concerns into the evaluation of the remedial alternatives.

Based on surrounding land use and the community, it is anticipated that the focus of community concerns will be on possible short-term and long-term impacts during remediation, overall effectiveness of the remedy, socioeconomic concerns such as the environmental setting and character of the Study Area neighborhoods, and potential for development or beneficial reuse of the property and/or adjacent land. Tree destruction is a key socioeconomic impact which will be considered.

Community acceptance will be evaluated throughout the CMS process and community concerns will be considered during the process. Section 2.0 describes the public participation process.

Short-Term Effectiveness

This criterion evaluates the effects of the alternative during the construction and implementation phase until the corrective measures have been completed and the selected level of protection has been achieved. Each alternative is evaluated with respect to its effects on the community (e.g., safety, health, and quality of life) and on-site workers during the remedial action, the environmental impacts resulting from implementation, and the amount of time it will take for design, construction and implementation of the remedy.

Long-Term Effectiveness

This criterion evaluates the alternatives based on long-term reliability and effectiveness of the controls in reducing or managing unacceptable human health risks in the remediation areas. The factors to be evaluated include the magnitude of incremental difference between the background community and the Study Area post-remediation risk distributions, and the adequacy, suitability and long-term reliability of the technical components (e.g., phytoremediation, excavation, tilling, and institutional controls).

Reduction of Toxicity, Mobility, or Volume

This criterion addresses the preference for selecting remedial actions that employ treatment technologies that permanently and significantly reduce toxicity, mobility or volume of the contaminants. As discussed elsewhere, arsenic cannot be destroyed, nor can arsenic be isolated from human exposure pathways (as it will be present in any replacement soils or cover materials). Compliance with this criterion therefore depends in part on the degree to which soil containing unacceptable arsenic concentrations can be isolated from the public and/or replaced with soil containing lower arsenic concentrations.

Implementability

This criterion evaluates the alternatives based on the technical and administrative ease or difficulty implementing an alternative and the availability of various services and materials required during its implementation.

Technical feasibility considers construction and operational difficulties, reliability, ease of undertaking additional remedial action (if required), and the ability to monitor or document its effectiveness.

Administrative feasibility considers activities needed to coordinate with other agencies (e.g., state and local), the community and affected property owners in regard to obtaining permits or approvals for implementing remedial actions. Availability of services and materials, including capacity of proposed CAMU at the Facility.

Cost

This criterion addresses the capital costs, annual operation and maintenance costs (if any), and present worth analysis (if any).

Capital costs consist of direct (construction) and indirect (non-construction and overhead) costs. Direct costs include expenditures for the equipment, labor and material necessary to perform remedial actions. Indirect costs include expenditures for engineering, financial and other services that are not part of actual construction activities but are required to implement the corrective measure.

Agency Acceptance

This criterion evaluates the technical and administrative issues and concerns the State of New York and the USEPA may have regarding each of the alternatives. Evaluation of the Agency acceptance criterion will consider comparison of the corrective measure alternative with USEPA approved cleanups of arsenic in soil which have been successfully conducted elsewhere.

Green Remediation Practices

The corrective measure alternatives will be evaluated for consistency with USEPA's Green Remediation objectives at the request of the MCIG. USEPA is encouraging "green remediation" practices that consider all of the environmental effects of remedial actions, including energy requirements, air emissions, effects to land and ecosystems, material consumption and waste generation, and impacts on long-term environmental stewardship. The corrective measures will be evaluated to determine which alternatives offer the maximum net environmental benefit.

8.2 ALTERNATIVES COMPARATIVE ANALYSIS

After each of the corrective measure alternatives has been assessed versus the evaluation criteria, a comparative analysis will be performed. This analysis will compare all of the corrective measure alternatives with one another with respect to achievement of the evaluation criteria.

8.3 TASK 6 DELIVERABLE: CMS REPORT-PART A

A CMS Report-Part A will be issued which includes the results of Tasks 1 through 6, culminating with the Evaluation of Corrective Measures Alternatives. The CMS Report-Part A will not include a Recommended Corrective Measure Alternative. The CMS Report-Part A will be available for affected property owners and community review and comment. It is expected that one public meeting and one or more availability/information sessions will be held to discuss the report and obtain community input with respect to its contents and the development of the Recommended Alternative.

9.0 CMS TASK 7: DEVELOPMENT OF RECOMMENDED ALTERNATIVE

As indicated above, the CMS Report-Part A will not identify the Recommended Alternative. The reason for this omission is that community input will be considered in determining which corrective measure alternative is most appropriate. Community input will help determine how to qualitatively weight certain attributes of the comparative evaluation (for examples, tree destruction versus post-remediation risk distribution).

Comments and concerns from affected property owners and community review of CMS Report–Part A and the corrective measures alternatives presented will be documented and summarized. Responses to owner/community comments and concerns will be prepared. If appropriate, the corrective measures alternatives evaluation and comparative evaluation will be revised. The revised evaluation will lead to development of the Recommended Alternative which will be described in a CMS Report Part B-Recommended Alternative.

10.0 REPORTS AND OTHER DELIVERABLES

As described in the prior Task descriptions, the following deliverables will be provided to the NYSDEC, EPA, and other stakeholders:

1. CMS Task 2 Arsenic Soil Data Evaluation Technical Memorandum, as described in Section 4.4.

2. CMS Task 3 Exposure Assessment Technical Memorandum, as described in Section 5.3.9.

3. CMS Task 3 Background and Study Area Human Health Risk Assessment Report, as described in Section 5.3.9.

4. The following documents will be prepared as part of CMS Task 4 for corrective measures technology screening and pilot studies (described in Section 6.0):

    - Phytoremediation Pilot Study Work Plan *(draft work plan already submitted December 5, 2007)*, and progress and completion reports specified in the Phytoremediation Pilot Study Work Plan.

    - Soil Tilling/Blending Pilot Study Work Plan, and reports that will be specified in the Soil Tilling/Blending Pilot Study Work Plan.

    - CMS Task 4 Technical Memorandum: Feasibility Assessment for Soil Removal Under Trees.

5. CMS Task 5 Technical Memorandum: Alternative Corrective Action Scenarios, Supporting Risk Analysis and List of Alternatives.

6. CMS Report Part A (without a recommended alternative section).

7. CMS Report Part B-Recommended Alternative. This report will include an addendum to the CMS Report Part A (if necessary to address review comments), a community/property owner input summary, a description of the recommended alternative and the rationale for selection of the recommended alternative.

11.0 PROJECT SCHEDULE

The preliminary project schedule for performance of the CMS is presented in Figure 5. The project schedule will be revised during the implementation of the project to reflect any changes and actual completion dates.

12.0 REFERENCES

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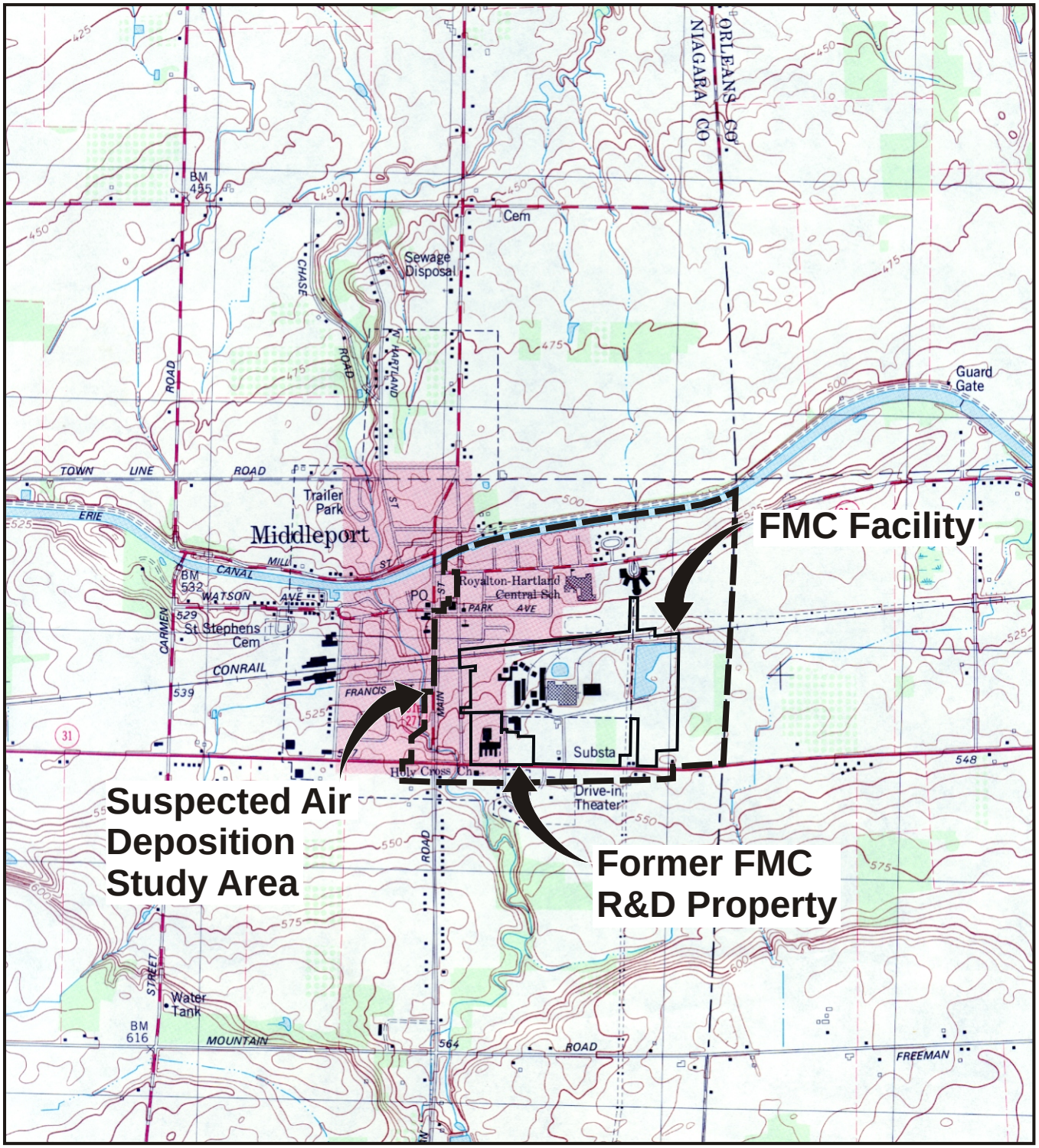
USEPA 1997a: Guiding Principles for Monte Carlo Analysis. EPA/630/R-97/001. Risk Assessment Forum, U. S. Environmental Protection Agency, Washington, DC.

USEPA 2001: Risk Assessment Guidance for Superfund; Volume III – Part A, Process for Conducting Probabilistic Risk Assessment. OSWER 9 285.7-45.

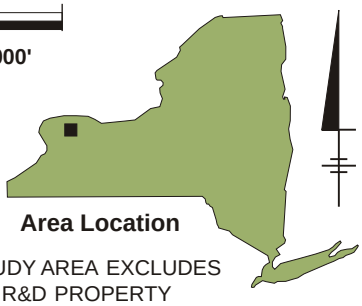
FIGURES



REFERENCE: BASE MAP USGS 7.5 MIN. QUAD., MEDINA, NY, 1980.

2000' 0 2000'

Approximate Scale: 1" = 2000'



Area Location

SUSPECTED AIR DEPOSITION STUDY AREA EXCLUDES FMC FACILITY AND FORMER FMC R&D PROPERTY

FMC CORPORATION - MIDDLEPORT, NEW YORK

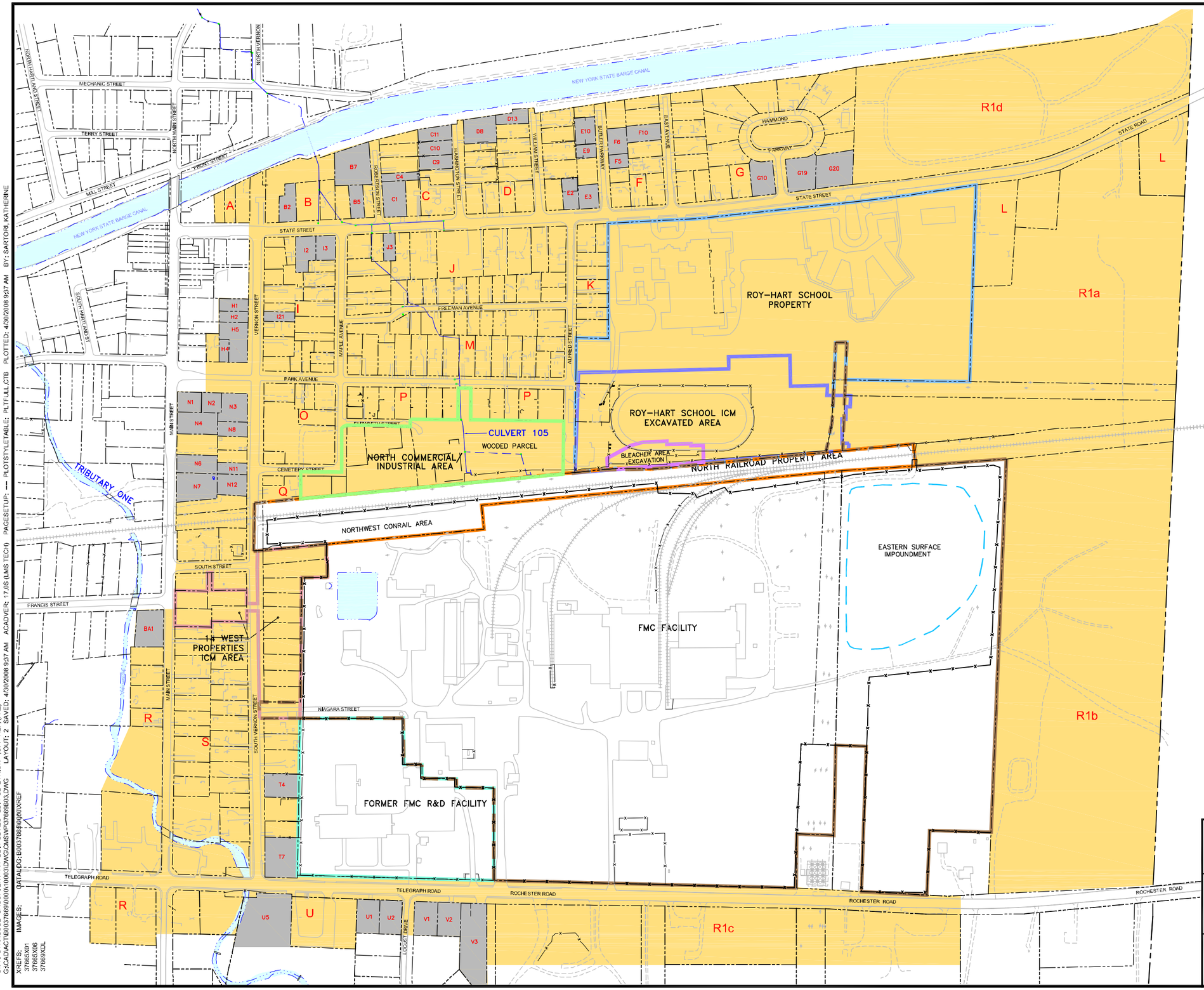
CORRECTIVE MEASURES STUDY WORK PLAN
SUSPECTED AIR DEPOSITION STUDY AREA

SITE LOCATION MAP

ARCADIS

FIGURE
1

04/30/08 SYR-141ENV-KLS, DJH
B0037668/0000/03003/CDR/37668N01.CDR



LEGEND:

- APPROXIMATE PROPERTY BOUNDARY
- EXISTING BUILDING
- EXISTING FENCELINE
- EXISTING RAILROAD
- EXISTING CULVERT
- EDGE OF WATER
- FMC FACILITY PROPERTY BOUNDARY
- LIMITS OF ESI FILL AREA
- ROY-HART SCHOOL PROPERTY BOUNDARY
- ROY-HART SCHOOL ICM EXCAVATED AREA
- NORTH COMMERCIAL/ INDUSTRIAL AREA
- NORTHWEST CONRAIL AREA
- 14 WEST PROPERTIES ICM AREA
- FORMER FMC R&D FACILITY
- PLANT FENCELINE
- CULVERT 105
- 73 BUILDING NUMBER
- LIMITS OF STUDY AREA
- A GROUP STUDY AREA
- PROPERTIES RECEIVING AGENCIES' 2/22/07 NO FURTHER ACTION LETTER
- B2 FIGURE INDEX NUMBER

NOTES:

1. BASEMAP OBTAINED FROM A FIGURE BY CONESTOGA-ROVERS AND ASSOCIATES TITLED "HISTORIC ARSENIC SOIL/SEDIMENT DATA – NORTH RAILROAD PROPERTY" DATED OCTOBER 2003 AT A SCALE OF 1"=120'.
2. ALL LOCATIONS ARE APPROXIMATE.

0 400' 800'

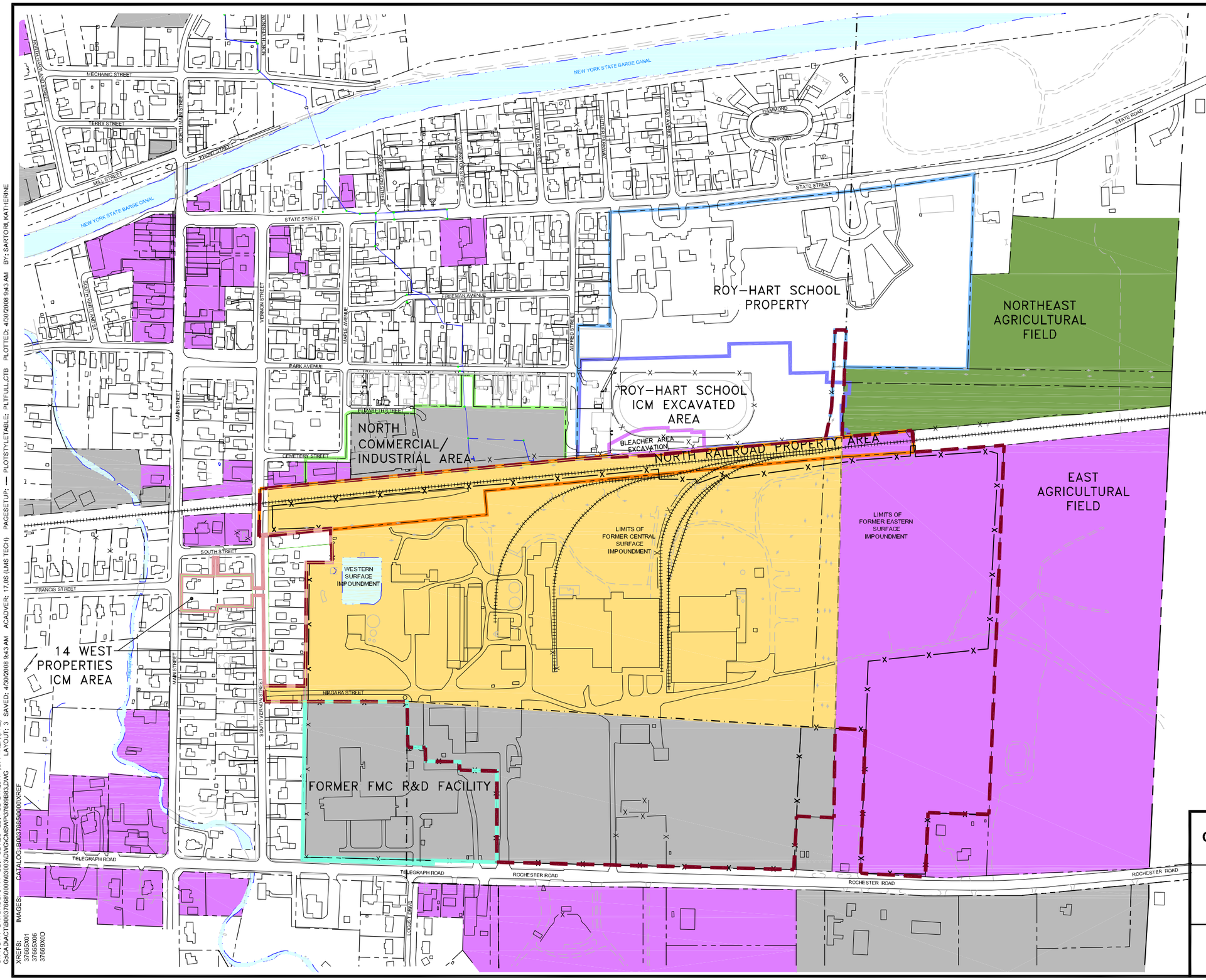
GRAPHIC SCALE

FMC CORPORATION - MIDDLEPORT, NEW YORK
CORRECTIVE MEASURES STUDY WORK PLAN
SUSPECTED AIR DEPOSITION STUDY AREA

SUSPECTED AIR DEPOSITION STUDY AREA

ARCADIS

FIGURE 2



LEGEND:

- APPROXIMATE PROPERTY BOUNDARY
- FENCELINE
- RAILROAD
- SHORELINE
- BUILDING
- APPROXIMATE FMC FACILITY PROPERTY BOUNDARY
- ROY–HART SCHOOL PROPERTY BOUNDARY
- ROY–HART SCHOOL ICM EXCAVATED AREA
- NORTH COMMERCIAL/ INDUSTRIAL AREA
- 14 WEST PROPERTIES ICM AREA
- FORMER FMC R&D FACILITY
- VILLAGE OF MIDDLEPORT MUNICIPAL BOUNDARY (APPROXIMATE)
- PROPERTIES ZONED BUSINESS (B–1)
- PROPERTIES ZONED LIGHT INDUSTRIAL (L–1)
- PROPERTIES ZONED INDUSTRIAL (F–1)
- PROPERTIES ZONED AGRICULTURAL

NOTE:

ZONING INFORMATION WAS OBTAINED FROM VILLAGE OF MIDDLEPORT ZONING MAP UPDATED JANUARY 2002, TOWN OF ROYALTON ZONING MAP UPDATED IN 1999, TOWN OF HARTLAND ZONING MAP UPDATED IN 1993, TOWN OF YATES ZONING MAP UPDATED IN 2003, VILLAGE OF LYNDONVILLE ZONING MAP UPDATED IN 2003, AND TOWN OF RIDGEWAY ZONING MAP UPDATED IN AUGUST 2003.

0 200' 400'
GRAPHIC SCALE

FMC CORPORATION - MIDDLEPORT, NEW YORK

CORRECTIVE MEASURES STUDY WORK PLAN
SUSPECTED AIR DEPOSITION STUDY AREA

CURRENT ZONING

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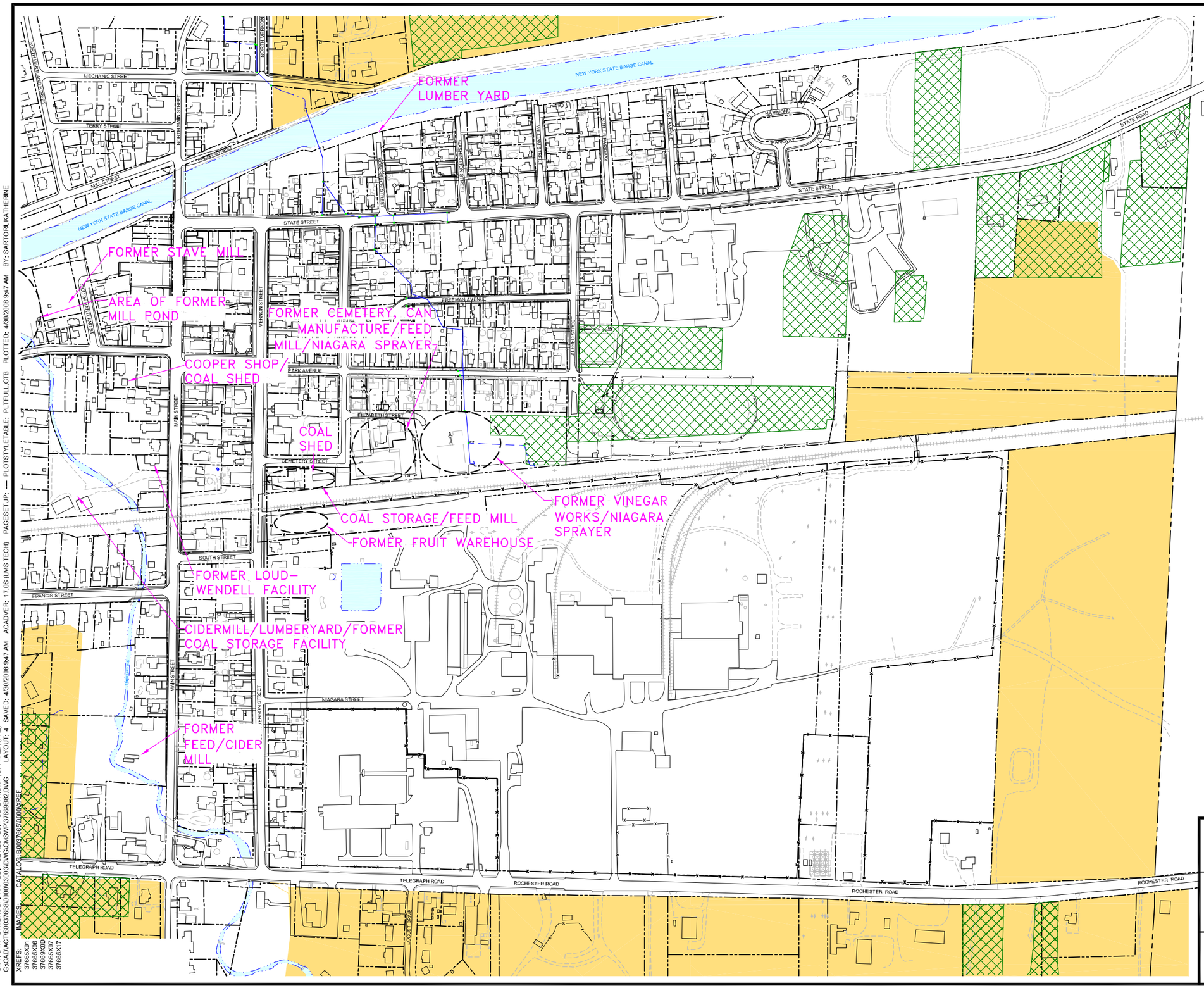
FIGURE
3



LEGEND:

- APPROXIMATE PROPERTY BOUNDARY
- FENCELINE
- RAILROAD
- SHORELINE
- BUILDING
- VILLAGE OF MIDDLEPORT MUNICIPAL BOUNDARY
- HISTORIC ORCHARDS
- HISTORIC FARM FIELDS

NOTE:

HISTORICAL ORCHARD AND FARM FIELD LOCATIONS WERE IDENTIFIED BASED ON REVIEW OF AERIAL PHOTOGRAPHS DATED 1931, 1938, 1951, 1958, 1966, 1968, 1971, 1973, 1977, 1978 AND SANBORN MAPS DATED 1889, 1894, 1900, 1905, 1911, 1920, 1931, 1945, AND 1968.

0 200' 400'
GRAPHIC SCALE

FMC CORPORATION - MIDDLEPORT, NEW YORK

CORRECTIVE MEASURES STUDY WORK PLAN
SUSPECTED AIR DEPOSITION STUDY AREA

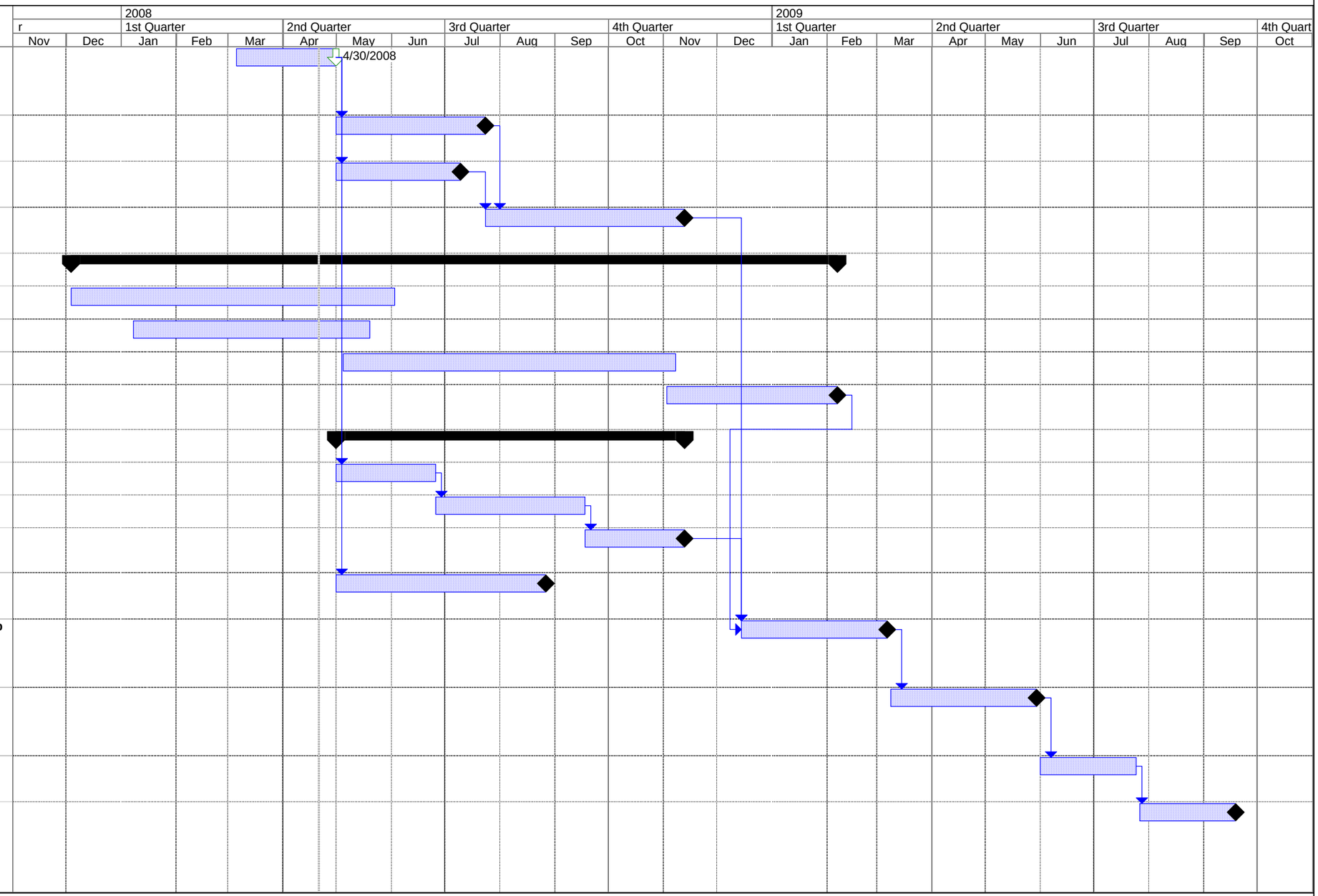
HISTORIC LAND USES

ARCADIS

FIGURE
4

Figure 5
PRELIMINARY PROJECT SCHEDULE
CORRECTIVE MEASURES STUDY (CMS) FOR SUSPECTED AIR DEPOSITION AREA SOUTH OF THE CANAL AND WEST OF THE COUNTY LINE
FMC CORPORATION, MIDDLEPORT, NY

ID	Task Name
1	**Prepare & Submit CMS Work Plan for Suspected Air Deposition Area South of the Canal and West of the County Line**
2	**Preparation of CMS Task 2 Arsenic Soil Data Evaluation Technical Memorandum**
3	**Preparation of CMS Task 3 Exposure Assessment Technical Memorandum**
4	**Preparation of CMS Task 3 Background and Study Area Human Health Risk Assessment Report**
5	**Phytoremediation Pilot Study**
6	Work Plan Preparation & Approval
7	Bench-Scale
8	Year 1 Field Study
9	Year 1 Study Evaluation & Findings Report
10	**Soil Tilling/Blending Pilot Study**
11	Work Plan Preparation & Approval
12	Soil Tilling/Blending Pilot Study Implementation
13	Pilot Study Report
14	**Preparation of CMS Task 4 Technical Memorandum: Feasibility Assessment for Soil Removal Under Trees**
15	**CMS Task 5 Technical Memorandum: Alternative Cleanup Scenarios, Supporting Risk Analysis, and List of Alternatives**
16	**CMS Report Part A - Alternatives Evaluation and Comparative Analysis (without a recommended alternative section)**
17	**Public, Community, Property Owner Review and Comment on CMS Report Part A**
18	**CMS Report Part B-Recommended Alternative, including an addendum, if necessary, summary of community/property owner comments, and rationale for selection of the recommended alternative**



Date: Mon 4/21/0
2008.04_CMS.WP_Schedul

Task | Split | Progress | Milestone | Summary | Project Summary | External Tasks | External Milestone | Deadline