Arsenic Phytoremediation Pilot Study Work Plan

FMC Corporation, Middleport, New York

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TABLE OF CONTENTS

Page

FIGURES

APPENDICES

ARSENIC PHYTOREMEDIATION
PILOT STUDY WORK PLAN
FMC Corporation, Middleport, New York

1.0 INTRODUCTION

Geomatrix Consultants, Inc. has prepared this pilot study work plan (plan) on behalf of FMC Corporation (FMC) to evaluate the effectiveness and feasibility of phytoremediation to address soil with elevated arsenic levels in various FMC study areas in Middleport, New York. Figure 1 illustrates the location of the FMC Plant Site (Site or Facility). This pilot study will be performed under the under the terms and conditions of the 1991 Administrative Order of Consent, 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 (EPA) (collectively, “Agencies”).

This plan includes background information on arsenic in soils and plant species used for phytoremediation of arsenic in soil, a description of the goals of the study, and a detailed scope of work for the pilot study. Appendix A includes several reprints of professional papers that provide detailed information on arsenic in soil and vegetation. These papers are available to provide the reader with additional information on the complex nature of arsenic geochemistry in the environment and potential arsenic uptake by plants.

2.0 BACKGROUND

Phytoremediation of arsenic compounds in soils has been documented by a number of researchers throughout the United States. The chemistry of arsenic is very complex and is present in the environment in many forms; however, the main forms are arsenate and arsenite. Arsenic is also present as organo-arsenicals in soil. Arsenate is the primary form of arsenic in oxygenated environments, such as well drained upper soil layers. It is soluble in water and will adsorb to reactive clay particles and oxides of aluminum and iron. Arsenate that becomes adsorbed in soils is relatively immobile in a soil environment. Any arsenate that remains in soil solution (soil pore water) is available for uptake by plants. Under reducing conditions, arsenite is generally the predominant species formed. At near neutral pH (i.e., less than 9), arsenite is less mobile in the soil (and less available to plants) than arsenate.

Researchers at the Argonne National Laboratory have shown uptake and partitioning of arsenic in willows and poplars trees grown on contaminated soil and the same species grown in quartz sand irrigated with water containing sodium arsenite. Analysis of plant material after the study showed that arsenic accumulated in both the leaves and roots of the plants with considerably more arsenic sequestered in the roots (Hinchman et al., 1998). Other work on arsenic phytoremediation focused on developing genetically engineered plants that can uptake plant available arsenate from the soil and then reduce it to (the less-mobile) arsenite in aboveground tissue. This is accomplished via inserting an arsenate reductase gene into the plant, which ultimately facilitates trapping arsenite in the aboveground biomass. The objective of this approach is to facilitate transport of arsenic within the plant and reducing the arsenate to arsenite once the chemical has moved to the above ground biomass in the plant (ENS, 2002).

Research on other arsenic accumulator plants has resulted in a widely marketed plant species, Brake Fern (*Pteris ensiformis*), for cleanup of soils contaminated with arsenic. The Brake Fern (*Pteris ensiformis*) is a perennial and is native to southern latitudes (Ma et al., 2001) of the United States. The plant is marketed by Edenspace Systems Corporation as the Edenfern™. The Edenspace website contains detailed information on the Brake Fern and its application as an arsenic hyperaccumulator (http://www.edenspace.com/edenfern.html). The Brake Fern may lack the hardiness and frost tolerance to survive as a perennial plant in the northern latitudes; however, it may be an effective plant for arsenic soil remediation in the northeastern United States if it is replanted each year. In addition to the Brake Fern, other herbaceous plant species have been demonstrated to take up high levels of arsenic, but accumulation is largely within the roots. Some of these are well adapted to the Middleport, New York climate and persist over the winter. Because the plants will persist over the winter, the biomass in year 2 will be significantly greater than with an annual plant.

In discussions with researchers, other practical approaches to phytoremediation of arsenic have been identified. In particular, discussions with Dr. Gary Banuelos of the United States Department of Agriculture, Agricultural Research Service in Parlier, California, indicated that since arsenic uptake by plants is analogous to phosphorus uptake, then phosphorus accumulator plants might be potential species to evaluate for arsenic phytoremediation (personal communication, 2006). Many of these types of plants and forbs are fast growing (typically one growing season) and can be easily harvested and removed from the site. In addition to the Brake Fern, other herbaceous species that will be considered as having potential to be successful soil arsenic accumulators and candidates for a pilot study include: Sudan grass, Sunflower, and Canola. Because of the relatively slow growing nature of poplars and willow trees, as compared to the above herbaceous species, they have not been included in this initial pilot study but may be evaluated at a later time.

Soil amendments may also increase the availability of arsenic to plants. Certain ionic species exists in the soil with properties similar to that of arsenate, which is the most common form of arsenic in soil. These ionic species will compete with binding sites of arsenate in soil and thereby make the arsenate more bioavailable to the plant. Some of these may also limit toxicity of arsenic to plants by competing for binding sites within the plants. In addition, chelation of heavy metals with ethylenediaminetetraacetic acid or the like may also improve the ability of arsenic to be accumulated within the plant. The specific arsenic species that may accumulate within the plants is unknown at this time; however, research has shown that inorganic forms of arsenic predominate in plants grown on soils with elevated arsenic concentrations.

3.0 PILOT STUDY OBJECTIVE

The overall objective of this phytoremediation pilot study is to evaluate the effectiveness and feasibility of phytoremediation to reduce the arsenic levels in the soil in the study areas. Information and data (e.g., time required to reduce soil arsenic levels, reduction levels, and associated costs) obtained during these studies will be incorporated into the corrective measures study for the site. In order to evaluate the effectiveness and feasibility of phytoremediation, the pilot study will focus on the following study questions:

1. What plants can reduce soil arsenic levels in the study area?
    - Will the Edenfern™ effectively grow in the cooler Middleport climate?
    - What other plant species can be used?

2. For the plants being evaluated, what, if any, soil amendments will help increase plant uptake of soil arsenic?

3. How much arsenic is removed from the soil by plants?
    - How will the harvested plant material be handled?
    - What are the disposal options for the harvested plants?

4. What area and depth can the plants reduce the soil arsenic levels?
    - What is the most effective plant spacing for maximum arsenic uptake from surrounding soils for each individual non broadcast species?

5. What will be the requirements (i.e., watering, weeding, fertilizing, pest control, etc.) for maintaining the plants?

6. Will the phytoremediation activities adversely affect the health of tree when using the technology to reduce arsenic levels in soil within the protected root zone of a tree?

4.0 SCOPE OF WORK

The scope of work includes seven tasks. The effectiveness of the remediation will be evaluated based on the ability of the various plantings to accumulate arsenic from the soil as measured by the sampling task described below. The feasibility will be evaluated based on a qualitative assessment of the growth and hardiness of the various plant species and any agronomic factors that might limit the applicability of phytoremediation to the FMC study areas.

A second study intended to evaluate uptake of arsenic in a riparian environment is currently being considered and may be included as part of this pilot study. At this point we anticipate that this additional work would be to evaluate arsenic uptake by existing vegetation in an impacted riparian area and would not require additional plantings. Prior to implementing this work, a work plan addendum will be submitted to the Agencies for review and approval.

4.1 TASK 1 – EVALUATING EXISTING SITE SOIL DATA

Based on a review of the existing soil sampling data for the study areas and on discussions with affected property owners and the Agencies, the proposed pilot study sites ("Study Sites") that have been identified include the following:

- The primary pilot study site will be located within an agricultural field (shown on Figures 1 and 2) to the northeast of the FMC Middleport Plant site and adjacent to the southeastern portion of the Royalton-Hartland School property. The planting test plots ill be approximately 60 feet by 40 feet in area.

- The protected root zone (PRZ) of an approximately 15-inch diameter breast height crimson maple tree on a residential property (Property AB4) north of the Erie Barge Canal. Soil containing elevated arsenic levels was removed from Property AB4, except from within the PRZ of the tree, as part of the 2007 Early Actions (completed in November 2007). In order to save the crimson maple tree, soil was not excavated within the PRZ, which is an area approximately 20 feet (critical root radius) around the trunk to prevent damage to the root zone.

- A portion of the front yard of a State Street residential property (Property F2) that contains a maple tree (approximately 15-inch diameter breast height).

Written access permission from the owners of the above Study Sites must be obtained prior to performing any field activities.

Existing soil data from the above Study Sites are presented in Appendix B. The soil from these Study Sites will be evaluated for suitability for plant growth. Both physical and chemical characteristics will be evaluated. Physical characteristics that will be evaluated include soil texture, drainage characteristics, depth to water, and existing vegetative cover. These data will be determined from review of existing soil survey data obtained from previous environmental studies conducted by FMC and site reconnaissance. Chemical characteristics to be evaluated include soil pH, soil oxidation/reduction status, and total and soluble arsenic concentrations in soil. In the event that certain data are not available, additional soil samples and field measurements may be necessary and will be collected during the pilot study soil sampling task (Task 3).

An arborist will assess the health and condition of the trees on Study Sites AB4 and F2 before preparation and planting of the phytoremediation vegetation and again at the end of the growing season.

4.2 TASK 2 – LABORATORY STUDY

A pre-field laboratory study will be conducted by Cornell University to look at various combinations of plants, competitive ions, chelating agents, and root colonizing microorganisms to determine the most effective combinations for the demonstration study to be implemented in the spring of 2008. After completion of the laboratory study, a letter-report will be prepared to summarize the laboratory study results from Cornell University. It is anticipated that the laboratory study report will be completed in June or July 2008.

4.3 TASK 3 – SOIL SAMPLING AND EVALUATION FOR DESIGN

Prior to planting, soil samples will be collected from each study plot to evaluate the fertility of the soil and to establish the baseline concentration of arsenic in the soil. Soils from each Study Site will be sampled for standard soil fertility analyses prior to preparation for planting. Based on the results of the fertility analysis, the types and amounts of fertilizers (plant nutrients) required will be determined and applied to the plots. The fertility analysis will be conducted by a qualified agricultural laboratory that will also provide recommendations with respect to fertilization.

After preparation of the soil in the plots (e.g., tilling) and addition of any fertilizers and any other soil amendments (as recommended by Cornell University), composite soil samples will be collected for analysis of arsenic in accordance with the procedures specified in the approved Appendix D - Sampling and Analysis Plan of the “Soil Sampling Work Plan, Areas Potentially

Affected by Historic Air Deposition, FMC Corporation, Middleport New York" (prepared by Blasland, Bouck & Lee, Inc. and dated July 2004) (referred to herein as "2004 SAP"), except as described below:

1. The test plots for the agricultural field, Property AB4 and Property F2 are shown on Figures 3, 4, and 5, respectively. Composite soil samples will be collected from the sampling grids depicted on Figures 3, 4, and 5.
2. At each sampling grid, a composite soil sample will be collected at 0 to 6 inches, 6 to 12 inches, and 12 to 18 inches. Samples may be collected from greater depths for the end of the growing season sampling event, depending upon the observed root zone depth.
3. Agricultural Field (see Figure 3) – For each sampling depth interval, one composite soil sample will be collected from each of the eight 5-foot by 10-foot planting plots and from each of the twenty 10-foot by 10-foot planting plots. The 5-foot by 10-foot planting plots will be divided into six sectors (all approximately equal in area) and a soil aliquot will be collected from the approximate center of each sector (and at the approximate midpoint between plants for the end of the growing season sampling event) and composited into one sample per specified sampling depth interval. The 10-foot by 10-foot planting plots will be divided into nine sectors (all approximately equal in area) and a soil aliquot will be collected from the approximate center of each sector (and at the approximate midpoint between plants for the end of the growing season sampling event) and composited into one sample per specified sampling depth interval.
4. Property AB4 (see Figure 4) – For each sampling depth interval, one composite soil sample will be collected from each 9-foot by 9-foot planting plots. The 9-foot by 9-foot planting plot will be divided into nine sectors (all approximately equal in area) and a soil aliquot will be collected from the approximate center of each sector (and at the approximate midpoint between plants for the end of the growing season sampling event) and composited into one sample per specified sampling depth interval.
5. Property F2 (see Figure 5) – The test plot for Property F2 will contain six sampling grids comprised of a) two 4-foot by 5-foot grid (with the 1-foot spacing of artichokes and the 6-inch spacing of ferns); b) two 4-foot by 10-foot grid (with the 2-foot spacing of artichokes and the 1-foot spacing of ferns; and c) two 4-foot by 15-foot sampling grids with the rapeseed and turnip plants. One composite soil sample per sampling depth interval will be collected from each sampling grid. The 4-foot by 5-foot grid, the 4-foot by 10-foot grid and the 4-foot by 15-foot grid will be divided into four, six and eight sectors, respectively, (all approximately equal in area). At each sampling grid, soil aliquots will be collected from the approximate center of the sector (and at the approximate midpoint between plants for the end of the growing season sampling event) and composited into one sample per sampling depth interval.
6. A dedicated/disposable precleaned sampling tool (e.g., trowel, spoon or scoop) will be used to remove a soil aliquot from the designated sample depth at each location. The soil aliquots will be collected from an area (e.g., 3-inch by 3-inch) or hole similar in size. The soil aliquots from the sampling grid will be placed into a clean, dedicated container (e.g., aluminum pan or plastic container) for compositing and

homogenization. The homogenized soil will be transferred from the sample jars provided by the laboratory.

7. Any portion of the collected soil sample not required for analysis will be placed back into the hole. Any remaining voids in the soil created from the sampling will be allowed to collapse naturally. No imported soils will be used to fill the voids nor will soil be moved from one location to another within the test plots.
8. The requirements and/or protocols for the sampling supplies , field quality control (QC) sampling, equipment decontamination, sample containers and handling, and sample delivery will be as specified in Sections 3.1 (Sampling Supplies), 3.2 (Field QC Samples), 3.3 (Equipment Decontamination Protocols), 3.5 (Sample Containers and Handling) and 3.6 (Chain-of-Custody Forms/Sample Delivery) of the 2004 SAP.
9. Soil samples will be analyzed for total arsenic in accordance with the analytical procedures specified in Section 4 (Analytical Procedures and Laboratory Qualifications) and 5 (Laboratory QA/QC Requirements) of 2004 SAP. The arsenic soil data will be reported by the laboratory with NYSDEC Analytical Services Protocol Category A deliverables.

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4.4 TASK 4 – FIELD PILOT STUDY DESIGN

The pilot study test plots on the agricultural field, Property AB4 and Property F2 are shown on Figures 3, 4, and 5, respectively. The agricultural field plots are located within a portion of the field that is not subject to periodic flooding.

Four annual plants have been identified for inclusion in the field pilot study: Sudan grass, Sunflower, Rapeseed (Canola), and Edenfern™. The Cornell Cooperative Extension Service reports Sudan grass and Sunflower can uptake phosphorus at rates of about 0.36 and 1.02 percent of dry matter produced. Specific yields for these crops are based on specific management practices and climatic conditions but can be as high as 3 tons per acre for Sudan grass and about 8 tons per acre for Sunflowers. Assuming, for example, that the plants remove arsenic at ¼ the removal rate reported for phosphorus, the amount of arsenic that could be potentially removed from the system would be about 1,500 pounds per acre for Sudan grass and about 4,000 pounds per acre for Sunflower (assuming arsenic is present in these quantities). Rapeseed (or Canola) has a much lower phosphorus requirement and will uptake about 100 to 150 pounds of phosphorus per acre. It should be noted that information to directly compare the uptake rate of arsenic with phosphorus for these species is not available so the actual rate may be higher or lower than these estimates. The fourth plant that will be evaluated is the Edenfern™. These ferns are capable of accumulating high levels of arsenic. Edenspace Systems Corporation reports that the Edenfern™ has the capability of removing arsenic concentrations at rates 200 times that of other ferns grown in the same environment. Other researchers have reported arsenic concentrations in excess of 7,500 parts per million in aboveground portions of the Edenfern™. The actual amount of arsenic that can be removed by the Edenfern™ will be dependent upon the aboveground biomass produced by each plant and the availability of arsenic in site soils for plant uptake.

In addition to the above species, Dr. Harman at Cornell University recommended inclusion of novel plants with specialized storage organs that will accumulate arsenic. These plants are Appian Turnip and Jerusalem Artichoke and were included in Cornell University's laboratory study. In addition, a portion of this pilot study will focus on using the combination of test plants together with appropriate addition of phosphorus based on the preliminary recommendations of the Dr. Harman. The pilot study test plot designs shown on Figures 3, 4, and 5, respectively have been developed with consultation from Dr. Harman.

4.5 TASK 5 – PILOT STUDY IMPLEMENTATION

Prior to planting, a qualified arborist will be consulted for any residential plot preparation including tilling/planting precautions that should be utilized to minimize any detrimental effects to existing trees on Property AB4 and F2. In addition, the arborist will assess the health and condition of the trees prior to planting and at the end of the growing season. The results of the tree evaluation by the arborist will be reviewed with the property owner.

The agricultural field site will be disked (cultivated) to a maximum depth of 6-inches, fertilized and select plots will be amended prior to planting. The amount of fertilizers that will be applied will be based on the results of the soil fertility analysis and recommendations from an appropriate agricultural laboratory. The purpose of the fertilizer is to supply the soil with appropriate nutrients for optimum plant growth. Portions of the agricultural field plots will be amended with phosphorus (as shown on Figure 3) based on the results of lab study performed at Cornell University during the winter of 2007/2008.

The planting plots on Property AB4 and F2 will be prepared by removal of the sod and manual preparation of soil to incorporate any fertilizers prior to planting (to minimize disturbance of the tree roots).

The soil in the plots will be wetted down during dry conditions to minimize fugitive dust during the soil preparation and planting activities.

After adding fertilizers and amendments and tilling/preparing the planting plots, the composite soil samples will be collected for analysis of total arsenic, as described in Section 4.3.

Planting of the annual vegetation will be conducted using standard agricultural equipment. All planting procedures will be in accordance with any instructions that may be provided from the specific suppliers or with standard practice for the specific plant types. Detailed written planting procedures are not necessary for the purposes of this study. Broadcast seeding rates will be based on rates (pounds per acre of pure live seed) recommended by the Cornell Agricultural Extension Service (or similar information source) for similar crops and adjusted for the square footage of each plot. Rates of application for the broadcast species proposed in the work plan are as follows:

- Sudan Grass at a rate of 50 pounds per acre;
- Rapeseed at a rate of 12 pounds per acre; and
- Appian Turnip at a rate of 12 pounds per acre.

All non broadcast species (Sunflower, Bake Fern and the Jerusalem Artichoke) will be planted in rows with the following spacings between the individual plants:

- Sunflowers will be planted at a 1-foot and 2-foot spacing as shown on Figure3.
- The Edenfern™ will be transplanted from potted plants into individually dug holes at a 0.5-foot and 1-foot spacing, as shown on Figures 3, 4 and 5.
- Jerusalem artichoke (which is a tuber at planting) will be planted at a 1-foot and a 2-foot in the rows, as shown on Figures 3, 4 and 5.

One composite sample of the Edenfern™ plants and one composite sample of the Artichoke tubers will be collected prior to planting for analysis of total arsenic by a qualified laboratory. Each composite sample will be comprised of three plants/tubers. The fern plant and tuber will be thoroughly cleaned prior to analysis by the laboratory. The plant biomass analysis will be performed by using typical agricultural plant analysis procedures (e.g., as presented in the "Handbook of Reference Methods for Plant Analysis", prepared for the Soil and Plant Analysis Council, Inc., 1997). These data will be used to determine "background" or baseline biomass concentrations for the various plant species used in the study.

To facilitate germination of seeds, the planted plots will be watered by hand or via a temporary irrigation system to keep the soil surface moist until the seeds have germinated and are actively growing. Watering will be performed throughout the growing season, as described in Section 4.6.

The three test plots will be enclosed by a fence (e.g., chicken wire or similar) to eliminate the possible damage to the plantings from wildlife and vandals. Each test plot within the residential properties will have a temporary four foot high wire mesh fence (metal or plastic) installed around its perimeter. For the agricultural plot, a three foot or higher fence will suffice. In addition, "No Trespassing" signs will be posted on or next to the fences.

Concerns about the concentration of arsenic in the study plants was addressed by Michael Blaylock, director of technology at Edenspace, in a 2004 Genome News Network article where he stated that the ferns "pose an overall low risk and could be dangerous to children or animals only if consumed in large quantities", [reference http://www.genomenewsnetwork.org/articles/2004/08/06/fern.php]. The Edenspace website also states that "Touching or handling the ferns is not hazardous to people or animals. Because arsenic is a poison (it had widespread use in pesticides), ferns that have accumulated arsenic should not be eaten."

The planting procedures may be modified in the field based on the physical characteristics of the Study Sites (e.g., presence of tree roots) and on discussions with the owners of the Study Sites.

4.6 TASK 6 – MONITORING AND REPORTING

Once the field study has been implemented, weekly monitoring will be conducted to evaluate the performance of the vegetation and the general conditions of the plots. It is anticipated that weekly monitoring will be conducted from the end of planting until the first killing frost. Monitoring will consist of recording visual observation on the health and vigor of the plants including insect or other pest problems and documenting those observations on inspection forms. Stakes with markings will be placed beside the plants and used as datum from which to measure growth. Photographs will be taken of each of the planted plots during the growing season. In addition, the general shaded areas of each study site will be recorded.

The fencing will be inspected and repaired, if necessary, at the time of the inspection when possible. In addition, the area outside the fenced plots will be inspected for any wind-blown plant parts or growth through the fence. Any parts of the study plants found outside of the fenced area will be removed at the time of the inspection. If needed, additional methods will be employed to contain the study plants within the fencing. Any addition of soil amendments and/or fertilizers during the study will be documented as to date applied, type, amount and the plot to which it was applied.

The moisture content of the soil within each plot will also be visually monitored during the weekly inspections, or more frequently in consideration of weather conditions. Irrigation water will be added as needed to maintain soil moisture. Soil moisture content will be evaluated consistent with the United States Department of Agriculture (USDA) guidelines for "Estimating Soil Moisture by Feel and Appearance" (see Appendix C). Precipitation amounts and other weather data will be obtained from local weather stations (e.g., at the Plant Site). When practicable, watering events will be recording.

The weekly field inspection results will be documented in a log book. A copy of the logs will be provided to the Agencies on a monthly basis. In addition, photographs of the study plants will be taken monthly and will be provided to the Agencies.

After the first growing season (fall 2008), samples of the vegetation will be collected and submitted to a laboratory for analysis of arsenic to determine the amount of arsenic accumulating in the plant biomass. The plant biomass analysis will be performed by using typical agricultural plant analysis procedures (e.g., as presented in the "Handbook of Reference Methods for Plant Analysis", prepared for the Soil and Plant Analysis Council, Inc., 1997). The detailed procedures for the plant uptake sampling and analysis will be developed prior to sampling and after receipt of the final results from Cornell University's bench scale testing. These procedures will be submitted to the Agencies under separate cover. The procedures will include a description of plant sampling procedures (e.g., number of plants per species), plant cleaning procedure (for removal of any soil adhering to the plant), identification of which parts of the plants will be analyzed, plant sample preparation procedures, and analytical methods.

Any harvested plant species will be placed in a plastic bag in the field and transferred to a drum at the FMC Plant. One composite biomass sample per plant species (six waste characterization biomass samples) will be collected for waste characterization analysis by the Toxicity Characteristics Leaching Procedure (TCLP) for arsenic. The detailed procedures for the waste characterization sampling and analysis will be provided to the Agencies along with the plant uptake sampling and analysis procedures. Based on the results of the waste characterization samples, harvested plant materials will be disposed at a permitted, commercial disposal facility. Harvested plant biomass that exhibits the hazardous waste characteristics will be disposed at an appropriate hazardous waste disposal facility. Non-hazardous harvested plant materials will be disposed at a permitted sanitary landfill facility.

In addition, after the final harvest or at the end of the first growing season, soil samples will be collected for analysis, as described in Task 3. Where practicable, soil aliquots will be collected from locations next to the plants that are collected for biomass analysis.

4.7 TASK 7 – PLANT UPTAKE EVALUATION REPORT

Upon completion of the first growing season sampling and analysis, a report will be prepared to document the pilot study activities, present the sampling results, evaluate the performance of the various plant species, present conclusions and recommendations (if any) with respect to the study objectives and questions. Since there is little information on arsenic uptake potential or the pilot study plants (except for the Edenfern™), the results of the plant uptake evaluation will be used to determine appropriate handling precautions and proper transport/disposal needs, and the plants will be managed accordingly. Information provided by Edenspace Systems Corporation on the Edenfern™ indicates that touching or handling the ferns is not hazardous to people or animals; however, because arsenic accumulation in the plant, ferns (or other plants) that have accumulated arsenic should not be ingested (http://www.edenspace.com/edenfern.html).

5.0 SCHEDULE

The arsenic phytoremediation study work plan will be implemented upon approval of the regulatory Agencies. The following summarizes the schedule for the pilot study tasks:

- Order Edenfern™ for spring 2008 planting – completed in late 2007/early 2008.

- Submit draft work plan for review and approval by Agencies – completed in December 2007. Revised work plan submitted in May/June 2008.

- Collect bulk soil samples from the primary pilot study site (i.e, the agricultural field site) for Cornell University laboratory study – completed in January 2008.

- Conduct Cornell University laboratory study and submit Cornell University's study report - January 2008 through June/July 2008.

- Inspection of test properties and obtain written access permission – completed April-May 2008.

- Pilot study plot layout, cultivation, and soil sampling for fertility analysis, addition of fertilizers and amendments – late May – early June 2008.

- Planting and baseline soil and biomass sampling – early June – early July 2008 (the turnips will need to be planted around July 1).

- Weekly Monitoring – daily for the first week after planting; thereafter, weekly though fall 2008 (end of growing season).

- Submittal of biomass sampling and analysis procedures for arsenic uptake evaluation and waste characterization – August 2008.

- End of first year growing season harvest of plant material, biomass sampling and soil sampling – fall 2008 (end of growing season).

- Biomass and soil sample analysis – approximately 6 weeks after sample collection.

- Prepare report of findings – December 2008 or approximately 6-weeks after receipt of end of first year growing season biomass and soil sample data.

6.0 REFERENCES

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