Minnesota Pollution Control Agency Voluntary Investigation and Cleanup

Guidance Document #11

Phase II Investigation Work Plan

1.0 Purpose

This document provides guidance on preparing a Phase II Investigation Work Plan. The focus of the Phase II Investigation is to determine if potential sources of contamination identified during the Phase I Investigation (also known as Site History, Environmental Profile, Environmental Assessment, etc.) are causing a release or threatened release of hazardous substances, contaminants or pollutants to the soil, and surface water and ground water on the property (see Guidance Document #8). The Phase II Investigation primarily entails gathering site specific data on soils, surface water and ground water.

The Phase II Investigation Work Plan is typically prepared after completion of the Phase I Investigation. It is recommended that the Phase I Investigation Report and Phase II Investigation Work Plan be submitted to the Minnesota Pollution Control Agency (MPCA) staff for review and approval before the voluntary party proceeds with the Phase II Investigation field work. Failure to do so may result in the need to conduct additional field work and may limit the extent to which the MPCA Commissioner can grant Land Recycling Act liability protections or other written assurances. Please see VIC Guidance Document #13, "Guidelines for Phase II Investigation Reports" for additional information.

2.0 Objectives

The objectives of the Phase II Investigation Work Plan are to:

- describe how the potential sources of contamination identified in the Phase I Investigation will be investigated to determine if there has been a release of hazardous substances;
- determine the magnitude of the sources and determine the magnitude, extent and receptors of any releases or threatened releases;
- gather site information so MPCA staff can evaluate cleanup levels and determine whether a cleanup is necessary;
- gather site information to select a remedial technology, if cleanup is necessary;

- provide the MPCA staff an opportunity to comment on the planned field work in order to reduce the possibility that additional investigative work will be required by the MPCA staff; and

- establish a minimum level of inquiry for a Phase II Investigation.

3.0 Retain Consultant

The voluntary party conducting the Phase II Investigation Work Plan shall retain a consultant who is qualified to undertake and complete the Phase II Investigation Work Plan and who is familiar with this guidance document.

4.0 Phase II Investigation Work Plan

The critical components of the Phase II Investigation Work Plan are:

- an accurate and legible site map clearly showing locations of prominent and relevant site features — both past and present, such as buildings, retaining walls, fences, tanks, pipelines, waste piles, storage areas, utilities, ponds or lagoons [***NOTE:*** *All site maps shall include property boundaries, a north arrow and a bar scale.*];

- an accurate and legible site map depicting locations of proposed borings, monitoring wells, sampling locations, test pits or any other areas of investigation;

- a discussion of the rationale behind sampling locations, termination depths and vertical sampling or screening intervals;

- a sampling and analysis plan which includes a list of parameters to be investigated, a detailed description of the sampling protocol and analytical methods to be used, a rationale for the selection of the specified methods and a description of quality assurance and quality control (QA/QC) measures to be used to ensure that data obtained by analytical techniques is reliable, repeatable and representative of conditions at the site; and

- a proposed schedule of the field work for various stages of the project and the estimated date that the results of the Phase II Investigation would be available if timelines were followed.

Additionally, a Site Safety and Contingency Plan (see Guidance Document #10) shall be submitted with all Phase II Investigation Work Plans.

4.1 Site Investigation and Parameters

To conduct a complete Phase II Investigation, sampling and chemical and physical analyses of the site soil and ground water is required. These data aid in characterizing a site, and developing and implementing a Response Action Plan. The purpose of this section is to guide voluntary parties in

determining which parameters to include in a site specific investigation of soil, sediments, ground water, surface water soil gas and air. Typically, more than one ground water sampling event is necessary to determine the hydrogeologic character of a site. Additional parameters may be added based on the initial results.

Certain types of facilities are known to use, generate or contain specific chemicals or wastes. There may be several potential sources for environmental media contamination at a site. Table 1, attached to this guidance document, lists some types of sites common in Minnesota. Each Site Type is referenced with general pollutant categories that are required to be investigated at the site. The general pollutant categories selected for each Site Type are based on information about chemical or compound use and what specific byproducts or waste streams are commonly associated with that Site Type. Additional parameters may be required based on the available historical information on chemicals and waste streams for a given site.

A site may have been used for different purposes over time and all past and present uses of the site need to be considered when assembling the contaminant parameter list (e.g., a site may have been home to a dry cleaner with a small incinerator for general rubbish; both the dry cleaning category and the incinerator category would apply to the site). It is recommended the voluntary party work with their qualified environmental consultant to develop an appropriate contaminant parameter list. The consultant can help in identifying chemicals or compounds, byproducts or waste streams that may be necessary to investigate as potential contaminants at the site. MPCA staff in the Voluntary Investigation and Cleanup (VIC) Unit can be contacted for additional assistance. Table 1 lists chemical parameters commonly tested at given site types.

If it is known or anticipated that a remedial action will need to be conducted at the site, it may be cost effective to include additional parameters during the initial site investigation. The technology parameters portion of Table 1 is completed by referring to the Remedy Selection Treatment Technology (see Guidance Document #15) to assist in determining which parameters may be useful in selection and implementation of specific remediation technologies. The remediation technology for a site can often be considered or selected during the early phases of site investigation. When early technology identification is possible, the Phase II Investigation Work Plan shall include the sampling of soil, sediments, ground water, surface water and soil gas for the technology parameters in addition to the contaminant parameters.

4.2 Sampling and Analysis Description

Samples are collected and analyzed to:

- obtain data for assessing human exposure risks and protection measures;

- obtain data for assessing aquatic and terrestrial species, communities or ecosystem impacts and protection;
- determine the magnitude and extent of contamination;
- obtain site specific data for contaminant migration pathways between soil, ground water, surface water, soil gas and air; and
- determine which technology may be appropriate for sites requiring remediation.

With the investigation parameter list in mind, the voluntary party will need to provide a description of the planned sampling and analysis of the various environmental media to be sampled and a description of any materials stored on the site. These descriptions shall include:

- how decisions will be made on what and where to sample ;
- methods to be used to collect the samples;
- equipment and containers used to collect the samples;
- any filters used;
- sample preservation;
- number of samples to be collected;
- number of samples to be analyzed;
- planned laboratory methods of analysis; and
- when standard methods are not being used, a list of parameters and their detection limits.

The planned methods of analysis for samples shall follow the Master Template for Sample Analysis shown in Table 2 attached to this guidance document.

4.3 Storage Container, Conduit or Disposal System Description

Provide descriptions for all storage containers, above and below ground, conduit or disposal systems, including:

- location, number, type, size, age and condition;
- information provided on container labels;

- contents, past or current, of containers, conduit or disposal systems (material type and amount); and

- whether conduit or disposal systems are currently in use.

Notes on Investigation Techniques

As part of the Phase II Investigation, many storage containers, conduit or disposal systems are tested for integrity. The Phase II Investigation Work Plan shall include descriptions of equipment and methods used during integrity tests. Please consult the appropriate MPCA Tanks and Emergency Response Program Fact Sheets "Leak Detection for Pressurized Underground Piping," "Leak Detection for Underground Suction Piping," "Tank Tightness Testing and Inventory Control" and other information available from the MPCA by calling Joann Henry at (651) 297-8664.

If tracer tests are conducted for a conduit, submit the type of dye or other tracer to be used and methods used to collect and analyze the samples.

The use of geophysical techniques, such as infrared photography, seismic refraction, ground penetrating radar and magnetometer/gradiometer surveys, can be valuable as a supplement to the investigation of disposal sites, tanks, drums and other underground structures. It is recommended that the voluntary party discuss the use of these techniques with MPCA staff in the VIC Program before proposing their use in the Phase II Investigation Work Plan.

Above-Ground Storage Investigations

Above-ground storage containers (storage tanks, drums, etc.) that contain hazardous substances or substances of unknown composition shall be evaluated for their integrity and to determine if they are the source of any potential releases at the site. The contents of such containers must be managed or disposed of in accordance with federal, state and local statutes, regulations and policies.

Soil, ground water or surface water that may be contaminated by a release from storage containers shall also be investigated (see the Soil and Sediment Investigations, Ground Water Investigations and Surface Water Investigations sections 4.6, 4.7 and 4.8 respectively, in this document).

Underground Storage, Disposal System or Conduit Investigations

Underground storage tanks, drums, other storage containers, disposal systems or conduits (such as underground pipes, drainfields, seepage pits, oil and grease traps, septic tanks, etc.), which may have been or are being used for hazardous substance disposal, storage or transport, shall be investigated to determine if they are the source of any potential releases at the site. Methods of testing and investigating the integrity of tanks, conduits and disposal systems are available through the MPCA Tanks and Emergency Response Program.

4.4 Debris and Building Materials Investigations

Building materials and debris, such as asbestos, are generally not addressed by the VIC Program unless the materials are stored or disposed such that they may release hazardous substances into the soil, ground water or surface water. Abandoned dumps or stored creosote-treated materials are examples of potential contamination sources addressed by the VIC Program.

4.5 Air Quality and Soil Gas Investigations

Air quality and soil gas investigations that are reviewed under the VIC Program include explosive or toxic gases released from hazardous substances, contaminated soil or contaminated water. These investigations may also include measurements of contaminant-laden dust and airborne particulates carrying metals or other non-volatile pollutants. Air quality investigations of buildings (indoor air) located off-site are not generally reviewed under the VIC Program. Such investigations require the involvement of the Occupational Safety and Health Administration (OSHA), the Minnesota Department of Health (MDH) and local governmental representatives.

In order to characterize site conditions and to determine relative concentrations of airborne contaminants at a site, air monitoring using meters or detector tubes or sampling for analysis shall be planned. A variety of devices are available for monitoring vapors from drum contents, soil borings, soil or building gas surveys, and excavations. The Phase II Investigation Work Plan shall then include:

- a description of the planned monitoring locations (drums, stained soils, soil borings, buildings, utility lines, etc.) and criteria for their selection (visual, odor, depth, historical site use, etc.);

- the number of monitoring locations chosen;

- polyethylene bag headspace analysis technique shall be done according to MPCA Tanks and Emergency Response Program Fact Sheet "Soil Sample Collection and Analysis Procedures;"

- the type of air monitoring equipment to be employed including model number, and where appropriate, frequency of calibration, calibration gas and lamp size [***NOTE:*** *The ionization potential of the contaminants being investigated must be checked against the ionizing energy of the lamp. Generally, compounds must have a lower ionization potential than the ionizing energy of the lamp employed in order to adequately detect their presence. Many non-petroleum, chlorinated solvents have ionization potentials greater than 10.2 eV, a common lamp size used during field screening of soils at petroleum contamination sites.* ***As a result, a 11.7 eV or higher lamp must be used to adequately screen for the presence of most solvents included in the MDH laboratory list for volatile organic compounds (Method 465 D) and will be required for virtually all sites in the VIC Program.*** *The MPCA will only accept air sampling and soil*

screening data obtained using an appropriate lamp size for the known or suspected contaminants at a given site.

Moreover, if a site was initially investigated as a petroleum site using a 10.2 eV lamp and enters the VIC Program for non-petroleum contamination, the absence of vapor monitor response for soils screened with the lower lamp size may not be accepted as evidence of absence of solvent-related compounds.];

- detection limits of the air monitoring equipment;
- parameters the equipment is able to detect; and
- how the monitoring will be accomplished (polyethylene bag headspace analysis, ambient air, air immediately above a potential source, high volume air sampler, etc.).

4.6 Soil Investigations

Soil investigations shall be completed for all known or potential sources of soil contamination at the site. Investigations of general soil conditions are necessary at sites with few or no known or suspected sources.

Soil investigations are conducted for the reasons outlined in section 4.2, and may include:

- a soil gas survey (see 4.5 above);
- a soils metals survey;
- soil chemical characteristics (general and parameter specific); and
- soil physical characteristics.

The number of soil samples appropriate for a given site will vary. For certain sites, few samples can easily define the extent of soil contamination (for example, for isolated spill incidents or known releases) regardless of site size. By employing logic, Phase I Investigation information, knowledge of site conditions (e.g., data from field analytical screening equipment, discussed below), and theoretical considerations, judicious planning can result in a minimum of samples being submitted for laboratory analysis.

For sites with general, area-wide contamination due to diffuse manufacturing, storage or disposal practices, a sampling grid shall be developed to address the entire site and to determine which area(s) of the site merit further investigation and, if necessary, remediation. The size of the sampling grid established must be small enough to address the known or suspected variability of contaminant distribution at the site. ***Averaging the contamination levels across the site by compositing samples before analysis is not acceptable. Similarly, compositing samples from within a single boring is not acceptable when the contamination may be concentrated in a***

single horizon (for example, where heavy metals in soil may be the result of surface spillage). Composite soil samples are not acceptable for Toxic Characteristic Leaching Procedure analysis.

For sites with specific areas of contamination, soil samples shall be taken from the center of the known or suspected contamination zone, with additional samples taken at progressively larger distances from the center, to determine the radial extent of the contamination zone. The depth of individual samples may be limited by bedrock or excessively large distances to the water table; most sampling is continued until the water table aquifer is encountered.

For additional guidance on soil sampling, please refer to the MPCA Risk-Based Site Characterization and Sampling Guidance at www.pca.state.mn.us/cleanup/riskbasedoc.html

Soil investigation is important to determine the types of contaminants, soils, and geologic constituents present at a site, the interaction between particular contaminants and these constituents, and how these constituents and contaminants will react during specific kinds of remediation. A number of soil parameters must be determined during soil investigations to evaluate the soil leaching pathway (see the Risk Based Guidance for Evaluating the Soil Leaching Pathway.)

Soil samples can be obtained using:

- drill rigs fitted with hollow stem augers and split spoon sampling devices;
- drive point devices such as Geoprobe™ (see below);
- hand augers or other hand sampling devices; and
- bucket or power augers.

Specific drilling or sampling methods may be required or recommended on a site specific basis in order to provide the most reliable information, and to ensure that existing contamination is not spread during the Phase II Investigation. Drilling methods need to be tailored to the site soil conditions and contamination.

During drilling or sampling, many parameters are collected on-site and recorded in boring logs. A required Boring Log Format shall be used to assist consultants and MPCA staff in developing a three-dimensional picture of the site. The required format simplifies interpretation of the data and accelerates MPCA staff review time.

It is also important for consultants to maintain adequate field notes during soil sampling, including but not limited to:

- weather conditions;

- odors;
- visual observations;
- organic vapor analyzer readings;
- drilling or sampling anomalies; and
- other facts that may assist MPCA staff in the ultimate review of reports.

The MPCA staff may request copies of field notes if they are not provided in submitted reports. Proper decontamination of field instruments such as drills, soil probes, and other tools is important to secure quality data and ensure safety of personnel participating in field investigations. Proper disposal of drill cuttings and investigation derived wastes is required. Decontamination plans and waste management plans shall be submitted to MPCA staff for review as part of a complete Phase II Investigation Work Plan.

In many cases, borings are used solely to obtain soil and geologic parameters, and must be sealed properly by "backfilling" with materials that seal the boring from potential surface contamination, or from transmitting below surface contamination to uncontaminated regions of the soil or geologic profile. Proper sealing techniques shall be described in Phase II Investigation Work Plans, and shall adhere to the MDH Rules Relating to Wells and Borings, Minnesota Rules, Chapter 4725.

In addition to general soil and geologic parameters, borings provide an opportunity to obtain semi-quantitative information about contaminants associated with the mineral and organic particles in soils, as well as the air space between soil particles. This information is obtained from soil or soil gas samples taken from specialized tools attached to drill rigs, hand tools or other specialized equipment.

Utilization of protocols developed by the MPCA Tanks and Emergency Response Program, as described in the Fact Sheet "Field Screening Procedure," may be required as part of an approvable field screening program for volatile contaminants.

A soil metals survey can be accomplished for some metals by using an X-ray fluorimeter (XRF). Calibration, sampling, and data interpretation methods shall be included in the Phase II Investigation Work Plan when a soil metals survey is conducted.

Soil Analysis

The planned methods of analysis for samples shall follow the Master Template for Sample Analysis shown in Table 2. Variations or adaptations of these or other methods shall be described in the Phase II Investigation Work Plan.

Mobile Field Analytical Screening Equipment for Soils

Drive Point Devices and Screened Augers, such as Geoprobe™ and Hydropunch™ etc., have been used successfully in Minnesota as methods to investigate soil or soil gas. Phase II Investigation Work Plans proposing the use of such devices must adequately describe how the devices are to be employed. When soil investigations are done correctly, valuable borehole data is collected and may serve as the basis for issuing No Action letters and other types of written assurances under the VIC Program. The MPCA staff cautions that under certain circumstances these holes may be considered environmental boreholes or monitoring wells which are subject to regulations under the MDH well code. Please contact the MDH at (651) 215-0811 for further guidance on this matter.

Establishing Soil Cleanup Levels

Data obtained from soils investigations shall be used to generate cleanup levels for soil contamination. Soil cleanup levels for contaminated sites in Minnesota will be based on the assumption that the future use of the site will reflect the most stringent human health or ecological exposure scenario. All routes of human and ecological exposure shall be evaluated, with one resulting in the most stringent cleanup level used in site cleanup.

Soil cleanup levels can be calculated for various human health routes of exposure at the site and the soil-to-ground water pathway. The more stringent of the various exposure pathways will dictate the site cleanup level. Routes of exposure may include ingestion and dermal contact, inhalation of vapors and particulates, ingestion of contaminated crops, fish, wildlife, surface water and ground water. For all routes of exposure, the Risk Based Guidance for the Soil-Human Health Pathway shall be used to determine cleanup level requirements unless the voluntary party proposes background or non-detectable soil cleanup levels. The ground water route of exposure is assessed using site specific soils data collected during site investigation and is developed in conjunction with the Approach to Ground Water Cleanup (see Guidance Document #14).

4.7 Ground Water Investigations

The MPCA requires that ground water be investigated at those sites where ground water impacts are likely (i.e., due to mobility or volume of the contaminant release, or due to the depth to ground water) and at sites where written assurances relative to ground water are requested. If ground water is not investigated, any written assurances stating that the MPCA is not currently requiring further remedial action at a site will contain disclaimers stating that ground water at the property was not addressed during site investigation.

An investigation of ground water includes an assessment of:

- ground water levels, flow direction and flow paths such as course backfill in utility trenches or vertical migration paths;

- chemistry (see Section 4.2 of this document, Sampling and Analysis Description); and
- physical properties that may be useful in selecting and implementing a remedy.

The identification of ground water flow paths is an important first step in determining several aspects concerning the extent, magnitude and source of ground water contamination. Ground water elevation (levels) and flow direction are best determined by judicious placement of three or more piezometers or monitoring wells located to bracket the site or contaminant release in question.

Often, more than one aquifer is impacted or must be surveyed to define the extent of contaminant migration. These cases require additional wells placed at appropriate depths.

Monitoring well and piezometer placement shall be coordinated to obtain background, upgradient, downgradient and site specific information. The exact number and placement of wells is site specific. Submittal of a Phase II Investigation Work Plan, including anticipated geological information for the area or site is recommended to prevent inappropriate well placement. As is the case with soils investigation, knowledge of site conditions coupled with theoretical considerations combine to limit the number of wells or piezometers needed at a site.

Certain aspects of well design and construction are governed by the MDH Rules Relating to Wells and Borings, Minnesota Rules, Chapter 4725. It is recommended that the voluntary party contact the MDH staff directly at (651) 215-0811 to obtain additional information on this subject. Although certain design and construction elements are governed by law, the MPCA staff maintains information on filter packs, screen types, casing materials, sealing and grouting materials and other pertinent information specific to the investigation of contaminated sites. In addition, certain kinds of wells at contaminated sites are constructed for purposes of extracting or injecting air in the course of remediation, and may have different installation and maintenance requirements than monitoring wells. Documentation is required during well drilling, installation, and maintenance and should be provided as submittals to MPCA staff for review and approval. Please see VIC Guidance Document #13, “Guidelines for Phase II Investigation Reports.”

Once the wells are installed, certain procedures are required to obtain reliable information on ground water quality from well samples. Ground water sampling data obtained by methods other than those prescribed in MPCA guidance documents may not be considered acceptable by MPCA staff. Ground water sampling guidance and an example sampling protocol are described in the “Part 1 – 1995 MPCA (agency-wide) Ground-Water Sampling Guidance” located at http://www.pca.state.mn.us/water/groundwater/sampleguide.html#part1.

After wells are installed and properly developed, a waiting period of at least one to two weeks is required before the well can be stabilized and sampled. Various well development methods and grouting materials can affect the quality of ground water samples collected from recently installed wells. Grout and filter pack materials used in well construction can directly affect pH, temperature and conductivity. Well development can aerate ground water and affect dissolved oxygen and redox potential. As a result, time for the well to equilibrate is necessary. Certain

geologic formations (e.g., clay deposits) may require a relatively longer period of time between installation/development and the first sampling event.

Additionally, a minimum of two sampling events separated by a minimum of two weeks is required to confirm sampling results and to obtain enough data on which to base decisions regarding ground water quality. Longer ground water monitoring periods may be required depending on the nature of the site, the contaminants present and the assurances sought by the voluntary party.

Ground water levels or piezometric surfaces shall be plotted for all Phase II Investigations that involve the installation or use of monitoring wells. The method used to plot lines of equal water level or piezometric head shall be stated in the Phase II Report. Specifically, both the method of interpolation, and the water levels or piezometric heads at the monitoring wells shall be reported in appropriate figures and tables.

The same methodology applies to contaminant concentrations in ground water or soil. Both the monitoring point concentrations and the interpolation method for plotting lines of equal concentration shall be provided if such figures are used to define a plume.

Eventually, maintenance of monitoring wells or wells used for remediation will become unnecessary and wells must be permanently sealed. All wells shall be sealed according to MDH Rules Relating to Wells and Borings, Minnesota Rules, Chapter 4725. It is recommended that the voluntary party contact the MDH directly at (651) 215-0811 to obtain additional information for well sealing procedures.

Ground Water Analysis

The planned methods of analysis for samples shall follow the Master Template for Sample Analysis located under Appendix B at http://www.pca.state.mn.us/water/groundwater/sampleguide.html#part1. Variations or adaptations of these or other methods shall be fully described in the Phase II Investigation Work Plan.

Mobile Field Analytical Screening Equipment for Ground Water

Drive Point Devices and Screened Augers such as Geoprobe™ and Hydropunch™ have been used successfully in Minnesota as methods to screen ground water for contamination. When combined with stratigraphic logging of the soils in the vicinity of the holes, such direct push devices can be used successfully as aids in determining the appropriate locations for screened intervals and permanent ground water monitoring wells.

These techniques, when coupled with gas chromatography mobile laboratory services, have proven to be fast, cost effective methods to obtain qualitative type ground water data. While these techniques have an application as screening tools, it is important to exercise care in interpreting the ground water data generated.

A preliminary ground water investigation does not necessarily require permanent monitoring wells. A ground water investigation targeted for issuances of a No Association Determination, Off-site Source Determination or No Action Letter, may be accomplished with direct push technology as long as the data quality objectives are met. However, actual ground water monitoring well data shall be provided before the MPCA Commissioner will issue a full or partial Certificate of Completion. Additional information is provided in the MPCA Risk-Based Site Characterization and Sampling Guidance.

Monitoring Well Construction Materials

As a cost savings measure, consultants and voluntary parties occasionally propose the installation of poly-vinyl chloride (PVC) casing for site monitoring wells rather than stainless steel casing and screen. According to the Minnesota Department of Health well code, installation of PVC wells is limited to water table aquifers, cannot be installed in bedrock and must not be installed at depths greater than 50 feet. PVC casing and screens can be joined either by glue or flush threads. Use of solvent-based glue may contribute to confusion regarding the source of ground water contaminants. Furthermore, vinyl chloride may be released from PVC well material, as well as other organic (impurities or constituents of the particular polymer employed in the casing manufacturing) compounds. Other contaminants, including perchloroethylene and trichloroethylene, may be adsorbed by PVC materials, disguising the true analytical concentrations in the ground water. This is of special importance when contaminant levels are low or near the cleanup goals. In cases where metals are the only contaminants of concern, the use of PVC wells raises fewer questions, and may actually be the preferred well material. PVC may also be preferred in highly acidic ground water conditions. However, low pH ground water conditions and investigations limited to metals are extremely rare. PVC wells may be more vulnerable to frost heave, brittleness resulting in cracking or breaking, and joint failure.

Historically, the VIC Program assurances issued for sites with PVC-installed monitoring wells have included comments or disclaimers regarding the quality of the analytical investigation. The use of PVC well materials may preclude the MPCA staff from making any statement about the absence or presence of organic contaminants in the ground water. Especially if organic contaminants likely associated with PVC well materials are reported, a stainless steel well may be required to determine the source of contamination. This is particularly true if assurances regarding organic contaminants are desired.

The objectives in obtaining the VIC Program written assurance may determine the well materials employed. The installation of PVC monitoring wells may introduce the risk of contributing low-level or confusing analytical results, which may cause buyers or lenders to be hesitant about the property. The risk of confusing analytical results is greater with PVC than stainless steel well materials, and this may lead to the installation of stainless steel wells to “arbitrate” the issue. For either short term sites where reliable data must be obtained rapidly or for sites where long term ground water monitoring is anticipated, the MPCA staff recommends installation of stainless steel wells.

Establishing Ground Water Cleanup Levels

Calculation of ground water cleanup levels is determined by various criteria established in the Approach to Ground Water Cleanup (see Guidance Document #14). If ingestion of ground water is the appropriate criterion, then a non-degradation standard or National Interim Primary Drinking Water Standards, Maximum Contaminant Levels (MCLs) or MDH Health Risk Levels (HRLs) are considered applicable criteria for ground water ingestion. Until promulgated, the MDH Recommended Allowable Limits shall be used in the absence of MCLs or HRLs. Other ground water criteria may include non-consumption uses which may be more or less stringent than a drinking water criteria.

If the ground water discharges to surface water, the appropriate surface water criteria may be applicable depending on whether the ground water is also protected for consumption and whether the surface water criteria are more or less stringent than drinking water criteria.

Please consult the Approach to Ground Water Cleanup (see Guidance Document #14) for more information regarding ground water cleanup levels.

Ground Water Flow Models

The MPCA staff has selected one analytic and one numerical ground water flow modeling approach that may be submitted for review where the use of a model is desired.

The analytic modeling software to be used are the Single Layer Analytic Element Model (SLAEM), the Single Layer Analytic Element Model – Strata version (SLAEMS) and the Multi-Layer Analytic Element Model (MLAEM). For purposes of this guidance, these codes are collectively referred to as SLAEM. SLAEM was chosen because it is very flexible and powerful, and is being used by an increasing number of consultants.

The numerical modeling software to be used is MODFLOW, which was developed by the U.S. Geological Survey, and is regarded as an industry standard. MODFLOW was chosen because it is a public domain numerical model that is widely accepted by both government and the private sector, and also because it can be supplied with commercially available processors to make it user-friendly at a modest cost.

Voluntary parties are advised that ground water flow modeling work submitted to the MPCA staff shall be conducted using one of these approaches. However, the voluntary party may propose the use of other ground water flow modeling software, provided they justify its use. The MPCA staff will evaluate whether the use of the proposed ground water flow model is acceptable. Building this flexibility into the process has two advantages. The first is that the environmental consultant may actually have a better tool for a particular application then either of our two software packages. The second advantage is that this may provide a mechanism for environmental consultants to share the benefit of their experience with MPCA staff.

An important part of any submittal of ground water flow modeling results is a description of the hydrogeologic conceptual model and how it is integrated into the computer flow simulation. Therefore, this information shall be included with any modeling results submitted to the MPCA staff. Additionally, the MPCA staff may require that submittals of ground water flow modeling results include hard copy and computer files of the model inputs and results.

4.8 Surface Water Investigations

Surface waters (lakes, rivers, drainage ditches, lagoons, wetlands, etc.) shall be investigated if there is possible contamination due to hazardous substance disposal, surface run-off or discharge of ground water. A surface water investigation may include physical and analytical testing. A Phase II Investigation Work Plan, with respect to a surface water quality investigation, shall include a description of planned physical testing methods such as flow velocity measurements, flow pattern testing, and methods and equipment used to collect the data. Analytical testing requirements are described in Section 4.2 and in Table 2.

Surface water investigation shall follow guidance available from the MPCA Environmental Outcomes Division staff. Contact the MPCA Environmental Outcomes Division at (651) 296-7237 for further information.

Additional guidance on surface water sampling is available through the U.S. EPA (Environmental Response Team, Response Engineering and Analytical Contract Standard Operating Procedures, Standard Operating Procedure 2013).

5.0 Management of Investigation Derived Wastes

Byproducts of site investigation activities are derived during soil and geologic investigations, and during well and piezometer installation. These byproducts are wastes that are often hazardous due to the fact that they are comprised of the contaminated ground water or source material being investigated. Such wastes are often stockpiled or barreled according to specific guidelines and tested at a later date or compared to analytical results of the soil or ground water samples taken during drilling or well development.

A plan for the management of investigation derived wastes is an integral part of the Phase II Investigation Work Plan, and their appropriate storage and management is a required part of final reports submitted to MPCA staff.

6.0 Site Safety and Contingency Plans

A Site Safety and Contingency Plan shall be prepared for all site activities (see Guidance Document #10). The MPCA staff recommends a copy of the plan be submitted for review. If a Site Safety and Contingency Plan is submitted, the MPCA staff may provide comments but will not “approve” the Plan.

The Site Safety and Contingency Plan is expected to cover safety considerations for field work planned, and shall include information needed in a health emergency situation, such as the location of the nearest medical facility. The consultant may have a generic safety plan, which they are required by company policy to follow at all work sites. When a generic plan is used, it shall be tailored to the investigation being conducted, and the nature of the potential hazards presented at the site. Safety considerations included in a Site Safety and Contingency Plan shall comply with applicable Federal and State OSHA regulations.

7.0 Duty to Notify

If investigation activities cause a release of a hazardous substance or a release is identified that has not been previously reported, that release must be reported to the MPCA through the Minnesota Duty Officer, Division of Emergency Management. The notification must be made within 24 hours. Contacting the Duty Officer will fulfill obligations for the notification requirements under Minn. Stat. § 115.061. The number for the Duty Officer is **(651) 649-5451** (Metro) and **1-800-422-0798** (Greater Minnesota). TDD numbers are (651) 297-5353 and 1-800-627-3529.

8.0 Schedule

The MPCA staff in the VIC Program assigned to the site shall be notified at least five working days prior to the start of any field work in order for the MPCA staff to visit the property during the completion of on-site activities and split samples if necessary. As part of the Phase II Investigation Work Plan, a schedule shall be submitted. This schedule shall include, but is not limited to, dates or times expected for the following items:

- Field Work Schedule – specify the estimated start and completion of field work for the various stages of the investigation; and

- Investigation Results Schedule – specify the estimated dates that the results of the Phase II Investigation will be available, including field observations, analytical results and submittal of reports or other documents to the MPCA.

9.0 Remedial Options

After the development of the Phase II Investigation Work Plan the MPCA staff recommends the voluntary party and the consultant consider meeting with the MPCA to begin discussions of remedial options. The MPCA staff believes the Phase II Investigation be developed to answer two principal questions: 1) If contamination is present that requires remediation, what is the proper remedy? and 2) Will implementation of the anticipated remedy achieve the applicable cleanup levels? Traditionally, a Focused Feasibility Study (FFS) (see Guidance Document #16) is developed after the Phase II Investigation to select one or several remedial options based on the need or desire for bench-scale studies, treatability studies, or pilot studies. **However, voluntary**

parties are encouraged to study remedial options as part of the Phase II Investigation, and include a description of the remedial option in the Phase II Investigation Report (see Guidance Document #12). This "fast track" approach eliminates the need for submittal of a separate FFS, and is often employed due to:

- the voluntary party's desire to expedite site cleanup; and
- the consultant's knowledge of limited remedial options given the nature of the site and its contaminants.

Remedy Selection Framework

Remedy selection for all sites in the VIC Program shall take place within the following framework. The framework shall be consulted once results of the Phase II Investigation have been compiled and evaluated. Voluntary parties are encouraged to contact the MPCA staff in the VIC Program for discussions regarding which elements of the framework may apply to a given set of investigation results. For all potential remedies, the following VIC Program Guidance Documents will need to be consulted:

- Risk Based Site Evaluation Manual;
- Approach to Ground Water Cleanup (Guidance Document #14);
- Remedy Selection Treatment Technology (Guidance Document #15); and
- Design and Reporting Requirements – Vapor Extraction, Air Sparging (Guidance Document #17).

Soil Contamination

When site contamination (i.e., contaminated source material) is limited to the shallow soil (soil extending from the surface to a depth which is easily excavated by conventional heavy construction equipment), a remedy may include excavation and treatment of the contaminated soil or source material. Technologies such as vapor extraction, soil venting or bioventing are alternatives to, or can be used in combination with excavation and treatment. Site soil conditions may limit the type and applicability of such technologies. MPCA staff recommends that the Remedy Selection Treatment Technology (see Guidance Document #15) be consulted for additional proven remediation technologies. If ground water is affected by contaminated source material, cleanup of ground water to applicable requirements may be required.

Limited Yield Ground Water Aquifers

If the ground water is affected by contaminated source material, but the aquifer yields little usable ground water for human consumption, is not connected to surface waters or wetlands, and is not connected to aquifers of higher yield or aquifers used for human consumption, then excavation and remediation of the source may need to be combined with ground water containment. Ground

water containment shall achieve the non-degradation standard for surrounding uncontaminated ground water and may include, but is not limited to, drainage, creation of a holding pond, pumping or pumping with treatment, depending on the level of contamination as defined by the applicable criteria (see Guidance Document #14) for ground and surface waters. A No Action determination or a requirement for monitoring of ground water may also be considered depending on applicable criteria.

Moderate to High Yield Ground Water Aquifers

Moderate to high yield ground water aquifers affected by contaminated source material may require a separate set of considerations depending on the applicable criteria for ground and surface waters. Such aquifers may need to be protected or remediated for current or potential future use. Additionally, these aquifers may be connected to protected surface waters or below or above ground ecosystems, necessitating additional review for associated ecological risks.

Ground Water Contamination Less Than Applicable Criteria

When ground water contamination is less than applicable criteria for a given contaminant or set of contaminants, then source removal combined with ground water containment may be necessary to achieve non-degradation for surrounding ground waters and surface waters. Since contaminant concentrations will be low relative to the applicable criteria, the effects of attenuation may be considered when calculating how to achieve the non-degradation standard.

Presence of Dense, Non-Aqueous Phase Liquids

When ground water is contaminated with a special class of contaminants known as Dense, Non-Aqueous Phase Liquids (DNAPLs), any remaining contaminated source material shall be removed or treated in place with consideration given to DNAPL mobilization to deeper soils, and containment and treatment of the ground water plume contaminated with dissolved DNAPLs must be implemented. In addition, DNAPLs may be treated or contained to limit the amount of ground water pumped and treated for dissolved contaminants. DNAPL source treatment or containment reduces the need for long-term pumping and the wasteful discharge of a valuable natural resource.

Aquifers Affected by Off-Site Sources

When ground water beneath a site impacts the site from an already contaminated aquifer (i.e., ground water upgradient of the site is contaminated), the efficacy of addressing ground water impacts from site releases may be considered and evaluated within the context of nearby monitoring or remediations, aquifer use and potential attenuation effects. The removal of source contamination on the site will be evaluated regardless of decisions made concerning ground water.

9.0 The Next Step

After completion of the Phase II Investigation field work any accompanying analyses, interpretation and remedy selection, a Phase II Investigation Report shall be submitted. Please see Guidance Document #12 for assistance with the drafting of the Phase II Investigation Report.

Table 1 - Site Types and Investigation Parameters

		Contaminant Parameters																				***Technology Parameters***															
		Organic												Inorganic						Misc.				Technology Needs															
	SITE TYPE	Halogenated Volatiles	Halogenated Semivolatiles	Nonhalogenated Volatiles	Nonhalogenated Semivolatiles	Organic Herbicides & Pesticides	Dioxins/Furans	PCBs	PAHs	Solvents	BTEX	Organic Cyanides	Organic Corrosives	Heavy Metals	Radioactive Metals	Asbestos	Inorganic Cyanides	Inorganic Corrosives	pH	Explosives/Propellants	Organometallic Herbicides/Pesticides	Selenium/Molybdenum	Fuel Oil	Dissolved Oxygen	Soluble Iron	Total Iron	Temperature	Conductivity	pH	Total Organic Carbon	Chemical Oxygen Demand	Biochemical Oxygen Demand	Nitrogen	Phosphorus	Sulfate	Carbonates, Alkalinity, Hardness	
1	Adhesives	X	X	X	X				X	X	X			X																							
2	Asphalt Plant, disposal							X	X																												
3	Autobody Shop	X	X							X				X									X														
4	Battery Recycling, Disposal													X				X																		
5	Ceramics Works													X	X	X																				
6	Chemical Manufacturing/Recycling							X		X	X			X																						
7	Chloro-Alkali Manufacturer												X					X																		
8	Coal Burning								X													X														
9	Coal Gasification	X	X		X				X		X	X		X									X														
10	Demolition Debris							X	X	X	X					X							X														
11	Dry Cleaners	X								X																											
12	Electronics (semiconductors, printed circuits)	X		X						X																											
13	Electroplating									X		X	X	X			X	X					X														
14	Food Processing									X													X														
15	Foundry													X																							
16	Grain Storage					X				X																											
17	Incinerator								X					X																							
18	Inorganic Chemical Manufacturer													X			X	X																		
19	Inorganic, Organic Pigments							X		X				X																							
20	Machine Shop									X	X			X									X														
21	Metal Ore, Mining, and Smelting										X			X				X																			
22	Ordnance	X								X				X	X					X																	
23	Paint, Ink Formulation	X						X		X	X			X																							
24	Pesticide Manufacturer, User		X		X	X															X															
25	Petroleum Refining, Reuse	X	X	X	X				X	X	X			X									X														
26	Photographic Products												X	X																							
27	Pipe Yard									X				X									X														
28	Plastics Manufacturer	X	X							X																											
29	Printers	X		X						X																											
30	Pulp and Paper Manufacturer	X					X						X																							
31	Railroad		X		X				X		X												X														
32	Rubber Manufacturer								X	X	X			X																							
33	Scrap Yard/Metal Recycling							X	X	X	X			X									X														
34	Storage Tank									X	X																										
35	Tannery	X		X										X																							
36	Tar Disposal							X	X							X							X														
37	Uncontrolled Dump (Industrial, Municipal)	X	X	X	X	X		X	X	X	X			X		X							X														
38	Waste Oil				X			X	X	X	X			X									X														
39	Wood Treating		X				X		X					X									X														
40	Woodproducts Manufacturing	X		X					X	X																											