MINNESOTA POLLUTION
CONTROL AGENCY

520 Lafayette Road North
St. Paul, MN 55155-4194

Attachment A

Example Workplan

Project Title: Remedial Design/Remedial Action (RD/RA) Workplan
Former Ag-Chem Plant, MPCA Site ID SA0002018

1. Project Summary

Background Information

The site is a former agricultural chemical (ag-chem) plant that operated from 1960 to 1991 and has been purchased for redevelopment into a golf course. The site is being investigated under the MPCA Site Assessment (SA) program because the property owner is no longer working cooperatively with the MPCA, and several neighborhood communities have expressed concerns about their health risk.

Ag-chem contamination has been documented in soil and groundwater collected at the site. In 1997, a groundwater sample collected from the shallow (30-foot) on-site well by the MDA documented concentrations of nitrate (116 mg/L), metolachlor (424 µg/L), and dicamba (283 µg/L) at levels above Minnesota Department of Health (MDH) Health Risk Limits (HRLs). A previous limited push probe investigation identified nitrogen, dicamba, metolachlor, metribuzin, pendimethalin and triclopyr in soil and groundwater above agency-regulated cleanup goals. Evidence (discolored soil and site records) suggest that discharge has occurred to the north of the fertilizer building. The fertilizer building burned in 1999, firefighting foam was applied.

In addition to ag-chem impacts to the environment, extensive degreasing of parts occurred at the maintenance garage. Discharge of parts degreaser directly to ground north of the maintenance garage has resulted in trichloroethylene (TCE) impacts to soil and groundwater. TCE has been detected above the HRL in three domestic wells located downgradient of the presumed groundwater flow direction (west) from the site. TCE vapors were detected above commercial intrusion screening values (ISV) in sub-slab samples collected from beneath two additions of the maintenance garage, and TCE was above residential ISV in soil gas and sub-slab samples in the neighborhood downgradient of the site. Potential impacts to the on-site well by volatile organic compounds (VOCs) have not been evaluated.

Potential impacts to the environment from a heating oil aboveground storage tank (AST) at the maintenance garage and a gasoline underground storage tank (UST) near the former fertilizer plant have not been evaluated.

Information provided in the RFP suggests potential for human or ecological exposure at the stream; direct soil exposure north of the fertilizer building, maintenance garage and in ag-chem handling areas; exposure to soil vapors; and exposure to contaminated groundwater and drinking water. The magnitude, lateral and vertical extents of soil, groundwater, and vapor contamination were undefined. The stream had not been evaluated.

Remedial Investigation Sampling

WCEC performed remedial investigation (RI) sampling activities under the guidance of the Minnesota Pollution Control Agency (MPCA) and the Minnesota Department of Agriculture (MDA), as outlined in the *Remedial Investigation (RI) Sampling Plan*. Investigation activities evaluated exposure to the environment of:

- Agricultural chemicals (ag-chem) associated with historic agricultural chemical operations at the site,
- TCE as a result degreasing activities and discharge near the maintenance shop,
- Petroleum impacts associated with the gasoline heating oil aboveground storage tank (AST),
- Petroleum impacts associated with the gasoline underground storage tank (UST), and
- Perfluorochemicals (PFCs) impacts to groundwater that may be associated with the firefighting foam applied to the former dry fertilizer building

An exposure pathway assessment and Contamination Impact Survey were completed to assess associated risks. Existing information indicates potential for human or ecological exposure risk at the stream; direct soil exposure in former degreaser handling/dumping areas garage and former ag-chem handling areas; exposure risk to chemical vapors, and exposure risk to contaminated groundwater and drinking water. It is assumed that there are no physical public access restrictions to the site. The property will be developed into a golf course and potential exposure to the general public will be high.

2. Statement of Problems, Opportunities, and Existing Conditions

Problems

Prior to the WCEC-proposed remedial investigation, several problems were evident. The *Remedial Investigation (RI) Sampling Plan* proposed investigation activities to understand these problems, which included:

- The extent of TCE vapors and impacts to soil and groundwater is unknown
- The extent of ag-chem impacts to soil and groundwater is unknown
- Potential impacts to the stream are unknown
- Potential petroleum impacts to the environment associated with the 1,000-gallon UST have not been evaluated
- Potential petroleum impacts to the environment associated with the 500-gallon fuel oil AST have not been evaluated stained soils were noted beneath the AST
- Potential Perfluorochemical (PFC) impacts associated with the firefighting foam applied to the dry fertilizer building have not been evaluated
- The concrete floor of the fertilizer building is in poor condition and has been exposed to environmental conditions for nearly 20 years. Based on the inferred high permeability of the subsurface unit, underlying ag-chem contamination has likely been dispersed/mobilized by surface water infiltration
- The UST beneath the maintenance garage is likely discharging contamination (ag-chem, TCE and petroleum) to the subsurface
- There are four at-risk shallow wells located immediately downgradient of groundwater flow from the site that are screened at the same depth as the on-site supply well, in which ag-chem impacts above MDH Health Risk Limits HRLs have been documented; TCE impacts have been documented in three of these wells
- The presence and location of any community and non-community public water supply wells is unknown
- Site geology is indicative of high hydraulic conductivity and transmissivity; the potential for contaminant migration is high
- Laminations of silt in more granular soils beneath the garage where TCE has been identified raises potential for DNAPL "pools" to exist, and increased contaminant migration pathway complexity
- Contiguous/competent confining layer may not be present to limit deep migration of DNAPL
- Potential for heaving sands may require adding water or other alternative soil sampling or drilling technique

The proposed RI sampling work is assumed to have helped quantify and delineate the extent of impacts to the soil, groundwater, soil gas and surface water. Rather than fabricate specific RI findings, our discussion will be focused on the MPCA-identified site conditions found in the RFP. These identify several additional problems, including the following:

Vapor intrusion risks are not defined:

- Land use, individual property uses and building construction in neighborhoods is unknown
- Validity of vapor attenuation factor is unknown
- Known vapor impacts at building where pregnant person is present may require emergency actions

Groundwater/drinking water impacts are not defined:

- Impacts to stream from runoff and/or contaminated groundwater is unknown
- The site well has been impacted by ag-chem at levels above MDH HRLs and is screened at the same depth as the downgradient domestic wells
- Number of residents/volume of domestic well water usage is unknown
- Location (and type) of municipal water supply is unknown
- Presence of deeper aquifers is unknown
- Condition of domestic wells is unknown
- Number of homes with sumps is unknown

Soil impacts will require corrective actions:

- Soil is known to be impacted with ag-chem at levels above clean-up goals established for the site (high-risk to groundwater cleanup goals.
- Soil near the in the reported degreaser dumping area may require corrective actions.

Opportunities

WCEC observed several opportunities in the RFP conditions. This includes the following:

- A municipal potable water system extends adjacent to blocks 5 and 7, the more western portions of the current study area. This suggests the source water used for municipal supply is located farther west, or at least some distance from the site in the newer part of town. This also provides a potential opportunity to extend this municipal service to the (generally shallow) private supply wells in areas closer to the site.
- Point-of-Use (100-gallon capacity) carbon filters are readily available from MPCA-Emergency Management Unit (EMU)
- No limitation to excavation of ag-chem and TCE impacted surface soils other than the maintenance building that remains in good condition for future use
- Excavation of shallow ag-chemicals may be combined with excavation of TCE-impacted soils (if necessary) to reduce mobilization/equipment expenses.
- Remedial system at the maintenance garage could mitigate vapors
- Concrete floor of maintenance garage is intact and may aid in exposure risk reduction and vapor mitigation
- The maintenance garage is currently unoccupied; no receptors of potential fugitive vapors generated by remediation are present in/near the maintenance garage, and there would be no conflicts in site use during remediation activities
- Assuming the golf course development remains the projected future land use, this information can be used to guide receptor risk assessments and the applicable response actions
- Where possible, WCEC will combine on-site activities to reduce associated mobilization and personnel expenses. This includes on-site tasks such as residential well sampling, as well as office-related tasks such as reporting
- WCEC will combine required closure activities for both the gasoline UST and the drain UST

Assumptions

The RFP provides information concerning the site and surroundings, including analytical results for certain compounds that previous investigation had provided. These data point to several problems as outlined above, and WCEC does not have the results of our proposed investigation to guide response actions. Therefore, WCEC had to make several assumptions to develop our response actions and mitigation decisions.

- Although stained soils were apparent beneath the 500-gallon fuel oil AST, we assume the staining is due to routine filling. A boring will be completed at the AST to evaluate impacts but we assume the AST will not have to be removed, and impacted soil removal.
- WCEC assumes that a release has occurred from the gasoline UST. The system was installed decades before current release prevention technologies, and the system's age suggests that corrosion-related component failure would likely have occurred.
- Although no work has been done to evaluate the floor drain UST system, WCEC assumes it must be removed due to its use for underground storage of liquid containing hazardous agricultural chemicals. We have assumed that a release has occurred from this system, because corrosion-related component failure is likely on a system of this age. We further assume that the severity of TCE released is minor compared to other source areas.
- It is assumed that the extent of soil contamination at the site has been adequately delineated.
- It is assumed that the maintenance shop will not be removed in the near future.
- We assume that MPCA/MDA will have property owner consent for access that allows WCEC to perform all work required.
- It is assumed that subcontracted services associated with MDA project tasks will be contracted directly by the MDA.
- WCEC interpreted the two Scenario A maps in the RFP as follows. The scale of Scenario A, Figure 1, is approximately 400 feet per inch, indicating the maintenance garage is approximately 300 feet long and 240 wide, or approximately 72,000 square feet (SF) in area. A scale is not provided in Scenario A, Figure 2, which is referred to as a "Generalized Diagram" and appears to distort the building lengthwise. Assuming the garage is approximately 300 feet long and 240 wide, and correcting for distortion in Figure 2, the foundation sizes of the original building, and additions 1, 2, and 3, are approximately 23,000 SF, 15,000 SF, 19,000 SF, and 12,000 SF, respectively.
- Based on these assumed building foundation sizes, the number of sub-slab samples collected per building foundation size are less than suggested in MPCA Guidance Document c-rem3-06h Appendix C by 2 to 4 samples in each foundation. Using the entire building foundation size, the number of sub-slab samples collected (13) are less than suggested in this guidance by 3 samples, if no larger than 70,000 SF, or by 5 samples, if no larger than 80,000 SF. However, we assume that MPCA believes a sufficient number of sub-slab samples were collected to determine if mitigation is necessary. WCEC has numbered the three building areas shown in the RFP, assuming they represent separate foundation areas due to a sequence of building additions.

- TCE sub-slab concentrations exceed EISV below addition 3 and exceed ISV below addition 1. TCE sub-slab concentrations do not exceed ISV below the original building foundation. Although "the concrete floor in this building is intact", we assume the trench floor drain and associated 500-gallon UST invalidate the assumption of 33 times attenuation for the building addition 2 concrete slab. The assumption indicates expedited action may be needed for addition 2, as at addition 3. However, corrective actions proposed herein by WCEC include sealing of the trench floor drain and associated UST, so that the 33 times attenuation factor assumption will eventually apply. Given that the building is not currently occupied, expedited actions may not be necessary.

Existing Conditions (Preliminary Conceptual Site Model)

WCEC reviewed the RFP-provided information about this scenario, which provided location-specific prior investigation data. WCEC has used this to prepare the various figures attached to this section, which illustrate the known existing conditions. A preliminary Conceptual Site Model was developed from this information, as follows.

Contaminant Sources

TCE Sources
Degreasing solvents that contained TCE were used extensively at the former maintenance garage and likely entered the trench floor drain that discharged to the 500-gallon UST. Although no evidence of DNAPL has been found at the site, investigative sampling has not been completed where used parts degreaser was reported by a former employee to be regularly poured onto the ground near the stream.

The property owner conducted a limited investigation consisting of several push probes throughout the facility and adjacent property. This investigation identified TCE in soils and groundwater above agency-regulated cleanup goals.

A TCE-contaminated groundwater plume (ag-chemicals not evaluated in groundwater except for the on-site well) appears to extend west from the source area (former maintenance garage) into the adjacent neighborhood south of the stream. This shallow plume of TCE-contaminated groundwater appears to be the source of TCE vapors detected in soil gas and sub-slab samples.

Ag-Chem Sources
The site has not operated since 1991. It is assumed that ag-chem products have not been handled at the site since this time. During its operational period of 31 years, the primary source of ag-chem was the dry fertilizer building, used to store fertilizer and pesticide products. Pesticide products stored and handled at the site include both neutral-base (MDA List 1) and acid-base (MDA List 2) pesticides. Blending/mixing of pesticides occurred in the western portion of the building. Fertilizer and pesticide products were also likely handled in the water fill area, at the scale, in two equipment parking areas (north and south of the fertilizer building) and the maintenance garage, used to wash and maintain equipment. It is likely that fertilizer and pesticide products were discharged from the trench floor drain in the maintenance shop to the 500-gallon UST. Additional areas of concern include surficial runoff from the site, the stream to the north, and north of the fertilizer building and garage where discolored soil and records of a discharge have been noted. A total of nine High Risk Areas (HRAs) were identified and investigated during the remedial investigation.

Other Sources
Firefighting foam applied to a fire at the fertilizer building in 1999 may be a source of PFCs. The 1,000-gallon gasoline UST at the fertilizer building may be a source of VOC, including fuel additives (Tetraethyl lead, EDB, 1,2-DCA, MTBE); the 500-gallon fuel oil AST at the maintenance garage may be a source of petroleum-based VOCs.

Geology and Hydrogeology

General geology was noted to generally consist of coarse grained sands with thin lenses of silt and clay, as shown on geological cross-sections of the area beneath the former maintenance garage. The geology has been evaluated to approximately 28 feet below ground at the former maintenance garage. Geology between the source area and the adjacent neighborhood to the west is assumed to be the same, but geology below 30 feet is unknown.

The limited push-probe investigation completed by the property owner encountered shallow groundwater approximately 6 to 10 feet below ground with an assumed flow direction heading west into town. The horizontal hydraulic gradient is unknown, but site topography is mostly flat; vertical hydraulic gradients are unknown.

The site elevation dips downward toward a small stream running through the northern portion of the property. This stream continues into the town and it is assumed shallow groundwater discharges to the stream. Older portions of the town (situated closer to the former ag-chem plant) are on private well drinking water (blocks 3, 5, and 7) with wells reported to be approximately 30 feet deep. Newer portions of the town (farther from the former plant) are on community water from the local municipality (blocks 1, 2, 4, and 6). The number, location, depth, construction, and quality/nature of community and/or non-community public supply wells is unknown.

Spatial Distribution of Contaminants

TCE Sources

Based on the limited push-probe investigation, TCE is present in soil and groundwater beneath the former maintenance garage. TCE concentrations in soil and groundwater decrease with depth. Soil concentrations of approximately 100-125 mg/kg at the water table decrease to approximately 5 mg/kg at 25-30 feet below ground; groundwater concentrations of 500 µg/L at the water table decrease to 10 µg/L or less at approximately 25-30 feet below ground.

TCE concentrations in shallow groundwater (15 feet at borings, 30 feet at domestic wells) decrease to the west, in the assumed direction of groundwater flow. TCE concentrations east of the maintenance garage are unknown but assumed to decrease to non-detectable levels. TCE concentrations in soil and groundwater north of the stream are unknown (with the exception of no detection in shallow [15 feet] groundwater at the southeast corner of block 3).

TCE vapor concentrations in soil gas decrease significantly to the west of the former fertilizer building (200 ug/m^3) but persist at similar concentrations (100-115 ug/m^3) downgradient in blocks 5 and 7. TCE vapors were not detected in soil gas samples collected at two locations northwest of the former fertilizer building and to the west in block 3.

Ag-Chem

The previous limited push probe investigation identified nitrogen, dicamba, metolachlor, metribuzin, pendimethalin and triclopyr in soil and groundwater above agency-regulated cleanup goals. Discolored soil was noted at the surface to the north of the fertilizer building and garage. The UST beneath the maintenance garage has likely discharged contamination beneath the surface. In 1997, a sample collected from the shallow (30-foot) on-site well contained concentrations of nitrate (116 mg/L), metolachlor (424 µg/L), and dicamba (283 µg/L).

A total of nine High Risk Areas (HRAs) were investigated during the remedial investigation. Remedial investigation soil data was compared to the MDA's high risk to cleanup goals (clean-up goals). Based on information provided for the site in the RFP, it is assumed that soil impacts were documented above the cleanup goals in one or more HRAs at the site.

During the remedial investigation, groundwater samples were collected from a temporary monitoring well in the footprint of the former fertilizer building and adjacent to the trench drain UST beneath the maintenance garage. Monitoring wells were installed near these likely source areas, outside of anticipated corrective action boundaries. It is assumed that groundwater impacts were documented in these areas. Monitoring wells were installed downgradient of groundwater flow from the source areas to assess risks to downgradient domestic supply wells. It is unknown if the domestic supply wells are impacted by ag-chem. Because they are completed at the same depth as the (ag-chem-impacted) site well, samples were collected from the residential wells during the remedial investigation.

Contaminant Migration Pathways and Potential Receptors

Contaminants have migrated from ground (and the trench drain UST) to the shallow water table and with groundwater flow to the west. The plume of VOC contaminated groundwater is generating vapors that have migrated into buildings.

Potential receptors of soil contamination include direct human contact and groundwater. The risk of direct human exposure to soil contamination will be high in the future because the site is being redeveloped into a golf course. Potential receptors of contaminated groundwater include the stream, buildings (sumps), underground utilities, the on-site well and downgradient domestic supply wells. The municipal water supply may be at-risk; either by a migrating groundwater contaminant plume moving toward a municipal supply well, or via stream sediment impacts if the city utilizes this surface water as a supply source. Potential receptors of VOC vapors include the on-site and off-site buildings and underground utilities.

3. Goals, Objectives, Tasks, and Subtasks

The goal of the proposed RD/RA activities is to eliminate pathways of contaminant migration to potential receptors thereby reducing the potential for exposure to chemicals. This includes the following objectives:

1. **Evaluate and address vapor intrusion impact receptors**
2. **Evaluate and address impacted groundwater receptors**
3. **Remedial alternatives and pilot testing for the TCE source area**
4. **UST Closures**
5. **Corrective Actions to address ag-chem impacts**

Where complete source removal is not feasible, pathway interruption will be required. Building-specific soil vapor investigation will be used to identify where mitigation will be completed. Objectives include evaluation for expedited or interim corrective actions (as needed) and remedial actions.

As with the RI work plan and spreadsheet, the Primary Sub-tasks associated with the above goals and objectives are identified in this Work Plan and the corresponding spreadsheet. These are general in nature and do not describe every professional activity or use of equipment in great detail; the intention is to provide an outline of activities that follow the applicable MDA and MPCA program guidelines in response to the available information provided in the RFP.

As with the RI level of effort spreadsheet, only the general staff classifications appear on the estimate of hours provided. WCEC will seek to combine mobilizations and tasks between the MDA and MPCA program work and assign the lower applicable staff classification where appropriate to increase cost-effectiveness.

4. Scope of Work

Objective 1: Evaluate Off-Site Vapor Receptors/Expedited Vapor Action or Mitigation

Concurrent with the tasks below, a desktop review of parcel/property zoning and occupancy, and walking survey will be conducted to determine building use, construction, etc. Currently available information indicates no detections of TCE (no other VOC detections above residential ISV are assumed) in soil gas samples collected between neighborhood block 3 and the site, and between block 3 and known vapor impacts in block 5. The walking survey will include all of blocks 5 and 7 based on known vapor impacts to eastern halves of blocks 5 and 7. A walking survey of block 4 east of the stream (1 building) and of block 6 (5 to 6 buildings) will be completed if additional soil gas sampling (RI Sampling Work Plan) indicates the potential for vapor impacts to those blocks. The potential for vapor impacts to the maintenance garage is proposed to be evaluated under Objective 3.

Task A: Vapor Intrusion Assessment/Active Vapor Mitigation or Expedited Action of Off-Site Property
Work will be completed under the supervision of a WCEC project manager that has VIA expertise and a certification through National Radon Proficiency Program (NRPP) to follow the MPCA Best Management Practices. Currently this includes Paul Carter, Steve Carlson, and Greg Frank; additional staff are progressing through the applicable NRPP training and certification process.

For this task, WCEC will need to complete a vapor intrusion interior building survey of the property where pregnant person is present to determine property use and if 33xISV attenuation factor is valid. This will develop the mitigation decision.
If residential and 33xISV is valid, then confer with MPCA on temporary housing for pregnant person pending active mitigation. Complete active mitigation under Subtask 2.

If residential and 33xISV is not valid, then confer with MPCA on temporary housing for pregnant person and determine need for expedited action; either paired sub-slab and indoor/outdoor air sampling **OR** system installation work as soon as possible. Complete sampling work using standard practices following MPCA VI-BMP. Complete expedited action under Subtask 2.

If commercial and 33xISV is valid, then install a sufficient number of vapor points to comply with VI-BMP and collect sub-slab samples and pressure differential measurements; repeat seasonal sampling. Complete work using standard practices following MPCA VI-BMP.

If commercial and 33xISV is not valid, then complete active mitigation **OR** paired sub-slab and indoor/outdoor air sampling or address building conditions so 33xISV screening level is valid, then repeat seasonal sub-slab sampling to determine mitigation. Complete active mitigation under Subtask 2.

Task B: Active vapor mitigation or expedited action of off-site property
If active mitigation, then solicit price quotes from state contract SSDS vendors using MPCA-prescribed forms and attachments for pre-diagnostics, mitigation, and post-diagnostics; assume some joint/crack sealing, installing up to 10 suction pits (based on 9,600 ft2 building), and up to 3 medium duty electric fans/3 U-tube manometers. Collect post-diagnostics within 30 days of system installation including collection of sub-slab and indoor/outdoor air samples using standard practices following MPCA VI-BMP.

If expedited action other than mitigation, then as soon as possible install sufficient number of vapor points to comply with the current VI-BMP and collect paired sub-slab and indoor/outdoor air samples and pressure differential measurements at sub-slab points, request 3-day TAT, and report immediately to MPCA. Ongoing work will include post-installation monitoring and documentation submitted to the MPCA.

Objective 1 Timeline: Complete within 30 days of work order issuance.

Objective 1 Deliverables: VI-IBS Forms, Vapor Property Summary Reports, bidding records and contractor submittals.

Objective 2: Evaluate Potential Impacts to Groundwater-Drinking Water Receptors; Treat or Replace Contaminated Domestic Wells or Extend Potable Water from Existing System

Task A: **Evaluate potential impacts to stream, buildings, and underground utilities from contaminated groundwater**

Subtask 1: Potential impacts to the stream were evaluated as part of the RI sampling work plan. Impacts may be corrected in Objective 3, Task B.

Subtask 2: Building surveys will be completed as part of the VIA. Buildings with sumps that may be discharging contaminated groundwater to ground will be noted and corrective actions may include treatment of contaminated sump water discharge with carbon, or discharge to nearby sanitary sewer (if present) if allowable by law and under a permit issued by the local sewer/water authority.

Subtask 3: Underground utility maps will be evaluated. Potential actions include sewer vapor surveys and utility backfill investigation.

Task B: Evaluate potential impacts to domestic and public supply wells

Subtask 1: Discuss with MPCA (and MDA, if ag-chem impacts are documented) the need to provide bottled water to 3 residences where TCE concentrations exceeded HRL in first sampling event. Resample the 3 domestic wells (if not already completed under the RI work plan) under Subtask 2.

Subtask 2: Resample the 3 domestic wells (if not already completed under the RI work plan) to confirm impacts above HRL (include 1 duplicate and 1 trip blank per field day, analyze for VOC by EPA Method 524.2, total Pb, nitrate/nitrite as N, TKN, MDA List 1 Pesticides and MDA List 2 Pesticides). Samples should be collected prior to entry into the water heater, water softener, filter, etc.

Subtask 3: Complete a water well receptor survey and collect/analyze samples from other domestic wells, and public water supplies, as needed, in same fashion as Subtask 2. This will include all wells identified during the walking survey and desktop review, consistent with the *sensitive groundwater condition* that applies to this site.

Subtask 4: Evaluate the risk to community and non-community public water supplies using available publications related to Drinking Water Supply Management Areas (DWSMA), DWSMA vulnerability, Wellhead Protection Areas (WHPA), and Transient Non-Community Inner Wellhead Management Zones. In the absence of these publications, estimate risk to public supply wells by reviewing available well logs and other pertinent information including estimates of hydraulic conductivity, groundwater flow velocity, etc.

Task C: Treat impacted domestic wells with Granular Activated Carbon (GAC) systems

Subtask 1: Assuming re-sampling in Task B, Subtask 1 confirms impacts above HRL, then solicit price quotes from state contract carbon vendors. Issue SCOF to low price quote state contractor and implement mitigation actions. If ag-chem impacts are documented, contracting will be discussed with the MDA.

Subtask 2: Place affected properties on quarterly sampling schedule for first year. Collect pre-, mid-, post-GAC samples (include duplicate of post-GAC and 1 trip blank per sampling event) and, analyze for VOC by EPA Method 524.2 (and total Pb, nitrate/nitrite-N, TKN, MDA List 1 and MDA List 2 pesticides, if necessary). Provide affected residents with analytical results on timely basis with MPCA approval.

Subtask 3: Change out lead GAC vessel, rotate lag vessel to lead, add new GAC vessel to lag on annual basis.

Task D: Alternate Water Supply
If a significant number of domestic wells are impacted, then consideration should be given to eliminating the pathway by drilling deeper wells or extending municipal water to the neighborhood. Complete cost/benefit analysis of replacing impacted domestic wells with deeper wells versus extending potable water to blocks 5 and 7 from existing municipal system. Subtask 1 involves well replacement; subtask 2 involves water line extension.

Subtask 1: If sufficient data exist to show a confining unit is present, and appreciable safe groundwater is available below the confining unit, then prepare drilling/well specifications and submit for MPCA approval (approvals by other agencies as needed per MPCA input). [Data necessary to determine deeper, safe groundwater could be accomplished first in this subtask, if necessary, by a preliminary drilling/sampling assessment.] Solicit state contract price quotes for drilling, well replacement, and well sealing. Tabulate results, present to MPCA with recommendations, solicit SCOFs, and implement corrective actions.

Subtask 2: Develop engineering specifications/drawings and solicit bids following MPCA Contractor and Subcontractor

Purchasing Manual for construction projects greater than $50,000 to be administered by the Department of Administration.

Objective 2 Timeline: Complete Tasks A and B within 30-60 days of work order issuance. Complete Task C with 90-120 days. Complete Task D as soon as reasonably possible, preferably before the end of the fiscal year or early in next fiscal year depending on risk and budget availability.

Objective 2 Deliverables: Survey forms, lab results, bid documents, bid tabulations, implementation documents, purchasing records.

Objective 3: Evaluate Remedial Alternatives for the TCE Source Area, Select and Complete Remedial Pilot Testing

Remedial alternatives will be evaluated to address vapor, soil, and groundwater contamination at the TCE source area (maintenance garage). Remedial actions will be selected for implementation (soil and potential vapor) and pilot testing. Potential impacts to the stream would be addressed by soil corrective actions if in close proximity to the stream and by groundwater corrective actions. Underground utility locations at the maintenance garage are unknown. If contaminant migration along potential underground utilities is suspected based data that become available during investigation and/or correction actions, then surface geophysical methods, including GPR and EM surveys, may be completed to identify structures that may be conduits (or the backfill) for contaminant migration.

Work will be completed under the supervision of a WCEC project manager that has VIA expertise and a certification through National Radon Proficiency Program (NRPP) to follow the MPCA Best Management Practices. Currently this includes Paul Carter, Steve Carlson, and Greg Frank; additional staff are progressing through the applicable NRPP training and certification process. Formal plans and specifications will be completed under the direction/approval of a licensed Professional Engineer.

Task A: Potential Vapor Mitigation of Maintenance Garage
Active vapor mitigation of the garage may be necessary if it is to be occupied; the assumption is that it will remain intact for further use. Evaluation of the building indicates only partial mitigation of the building may be necessary. TCE sub-slab concentrations exceed EISV below addition 3 and exceed ISV below addition 1. TCE sub-slab concentrations do not exceed ISV below the original building foundation. Although "the concrete floor in this building is intact", we assume the trench floor drain and associated 500-gallon UST invalidate the assumption of 33 times attenuation for the building addition 2 concrete slab. The assumption indicates expedited action may be needed for addition 2, as at addition 3. However, corrective actions will likely include sealing of the trench floor drain and UST so that the 33 times attenuation factor assumption will eventually apply. We have assumed the garage is not currently used/occupied so that vapor mitigation can be postponed pending completion of remedial pilot testing. If Task A were to be necessary, the following subtasks would be completed.

Subtask 1: Contact MPCA to determine need for expedited action

Subtask 2: Solicit price quotes from state contract SSDS vendors using MPCA-prescribed forms and attachments for pre-diagnostics, mitigation, and post-diagnostics; assume some joint/crack sealing, installing up to 75 suction pits (based on 72,000 ft2 maintenance garage and MPCA's opinion that the entire building needs to be mitigated as opposed to partial mitigation) to address original building foundation plus 3 additions, and up to 10 medium duty electric fans/10 U-tube manometers.

Subtask 3: Issue SCOF to low price quote state contractor or MPCA issues purchase order. Implement mitigation actions.

Subtask 4: Collect post-diagnostics within 30 days of system installation including collection of sub-slab, indoor, and outdoor air samples

Task B: Excavation and On-Site Treatment or Disposal of TCE-Impacted Surface Soils
Excavation of shallow soils impacted by dumping of used parts degreaser onto the ground near the stream north of the former maintenance garage is a reasonable corrective action to reduce contaminant mass discharge to the stream and groundwater and to eliminate the direct contact threat. Highly impacted shallow soils will act as a direct contact threat in the short-term and will act as a long-term source of groundwater impacts. Shallow soil sampling in a grid pattern at and near discolored soil is proposed in the RI work plan. The sampling results would determine the approximate area of soil excavation down the water table at 6 to 10 feet below ground. If treating the soil above ground on-site to delist the waste is not allowed, then the soil would be direct loaded for transportation and disposal as an F001 hazardous waste by a state contractor.

Subtask 1: Upon definition of the area and depth of excavation, prepare specifications and solicit bids following MPCA Contractor and Subcontractor Purchasing Manual for construction projects greater than $50,000 to be administered by the State Department of Administration.

Subtask 2: Schedule and hold on-site, pre-bid meeting. Review and tabulate bids received from Admin. Present bid documents to MPCA with recommendations.

Subtask 3: Implement work. Prepare and submit excavation corrective action document to MPCA.

Task C: Evaluate and Implement Remedial Pilot Testing for TCE Impacts at the Source Area
WCEC will complete an assessment of remedial alternatives and develop the pilot test for a selected remediation option based on the cumulative information developed from all investigation and expedited actions completed at the time of remedy selection. The following provides a sequence for a long-term pilot test based on the information available in the RFP.

Because this remedial action pilot test is based on limited information, WCEC made some assumptions to develop the pilot test, including the assumption that MPCA has approved the selected remedial alternative. The following Pilot Test Workplan follows the first 15 sections found in MPCA Guidance Document c-prp7-05; with Section 16 information limited to the attached Figure 5 and Figure 6.

Assumptions

- MPCA has requested submission of a pilot test for remedy implementation at the garage. WCEC is proposing preparation and submittal of a Pilot Test Work Plan. Costs included on Attachment B to the RD/RA Work Plan are for preparation and submittal of a Pilot Test Work Plan only. Below is a conceptual plan to implement a long-term pilot test for a selected alternative (dynamic groundwater recirculation). Attachment B to the RD/RA Work Plan does not include an estimate of personnel hours, subcontractors, equipment, or other related expenses to implement a long-term pilot test for the selected alternative.
- Prior to pilot testing, monitoring well gauging confirmed groundwater gradients that indicate that flow is generally toward the west.
- Based on analytical data and observations collected prior to pilot testing (additional investigation data), the presence of DNAPL is not likely.
- The maintenance garage is assumed to be open and available for pilot testing and future remediation activities.

Subtask 1: Site Conceptual Model Update
Degreasing solvents that contained TCE were used extensively at the former maintenance garage and likely entered the trench floor drain that discharged to the 500-gallon UST. Although no evidence of DNAPL has been found at the site, investigative sampling has not been completed where used parts degreaser was reported by a former employee to be regularly poured onto the ground near the stream. Discolored soils were reported to the north of the fertilizer building and garage during the last facility inspection. These records suggest a discharge had occurred. Follow-up work was never conducted. Due diligence efforts conducted during property transfer indicated these discolored soils were still present.

The property owner conducted a limited investigation consisting of several push probes throughout the facility and adjacent property. This investigation identified TCE in soils and groundwater above agency-regulated cleanup goals.

The TCE-contaminated groundwater plume appears to extend west from the source area (former maintenance garage) into the adjacent mixed use (assumed) neighborhood south of the stream. This shallow plume of TCE-contaminated groundwater appears to be the source of TCE vapors detected in soil gas and sub-slab samples.

As part of pilot testing activities, eight (8) monitoring wells are proposed to be installed (see Figure 5) to evaluate localized groundwater gradients and groundwater chemistry including dissolved phase TCE impacts and standard field chemistry parameters (dissolved oxygen, pH, temperature, oxidation-reduction potential, and conductivity). Approximately one week after installation and development of monitoring wells, wells will be gauged and sampled to evaluate groundwater gradients and groundwater chemistry. These wells are in addition to monitoring wells proposed in the RI Work Plan.

Subtask 2: Pilot Test Overview
WCEC project manager and senior engineer will be responsible for conducting the dynamic groundwater recirculation (DGR) pilot test, which will consist of two nested pairs (total of 4) extraction wells and 4 nested pairs (a total of 8) injection wells. Two injection wells are designed for each recovery well to allow reducing the injection rate (of each well) to 50% of the extraction rate. It is assumed that prior to pilot testing, monitoring well gauging confirmed groundwater gradients generally toward the west. Aquifer re-injection will require a variance from the Minnesota Department of Health Rule 4725.2050. Based on investigation data collected (assuming this is consistent with RFP information), the presence of DNAPL is not likely beneath the building.

Subtask 3: Target Zone
The pilot test will target dissolved phase TCE, which is mobile within groundwater (relatively low retardation factor estimated to be 1.2 to 1.3, based on assumed values for organic carbon-water partitioning coefficient, fraction of organic carbon, bulk density, and total porosity) and degrades completely under anaerobic conditions into ethene; however, incomplete anaerobic degradation can result in production of toxic by-products including cis-DCE and vinyl chloride.

Dynamic groundwater recirculation (DGR) technology consists of recovering dissolved-phase impacted groundwater, removing dissolved-phase impacts with granular activated carbon (GAC), and then re-injecting treated groundwater into the aquifer. The remedial strategy of DGR is to overwhelm aquifer heterogeneities and overcome the impacts of matrix controlled back diffusion through enhanced flushing [Suthersan, S., P. Carroll, M. Schnobrich, J. Horst, S. Potter, L. Peters .2015. Cleaning Up a 3-Mile-Long Groundwater Plume: It Can Be Done. *Groundwater Monitoring and Remediation.* 35, no.

4: 27–35]. This approach has been demonstrated to remediate dissolved phase TCE much faster than traditional pump and treat by strategically moving more pore volumes of groundwater across targeted zones (e.g., flush out zones with higher concentrations, increase head gradients across lower permeable zones to increase flow).

Aside from pump and treat, other TCE remediation strategies typically attempt to modify the groundwater chemistry by either inducing anaerobic conditions to promote anaerobic degradation or by chemically oxidizing TCE. These remediation strategies can be limited by the ability to create interactions between the injected reagent and the target (especially over large areas), by inadequate characterization of groundwater chemistry, and by unsuitable groundwater chemistry (limited by natural oxidant demand, creation of aquifer biofouling, production of precipitates, inadequate degradation due to insufficient type of microcosm, etc.).

The proposed remediation approach focuses on advective transport mechanisms within the groundwater to remove TCE impacts and can be used to reverse the advective and diffusion processes in which the TCE plume was distributed. Upon removal of TCE impacts within the advective zones, back-diffusion out of the storage zones (silt and clay lenses) will begin to occur. The target zone is comprised primarily of coarse sands with thin lenses of silt and clay from the surface to the deepest investigated depth of approximately 30 feet below grade and beneath the maintenance garage. Groundwater was encountered from approximately 6 to 10 feet below grade.

The maintenance garage is assumed to be open and available for pilot testing and future remediation activities. The locations of utilities are not known, so a private utility locator will be contracted for services. Any utilities that may be damaged as part of remediation or monitoring well installation will be repaired. The pilot testing will be focused around the maintenance garage which is the suspected source of the TCE impacts based on reports of historical dumping.

Successful remediation of the TCE plume beneath and around the maintenance garage will also eliminate potential chemical vapor impacts into the maintenance garage. If the DGR technology successfully remediates the TCE plume beneath and around the maintenance garage, it can be employed in other areas of the site to target the TCE plume, as warranted.

Subtask 4: Remediation and Monitoring Points

The location of proposed pilot test remediation and monitoring points is shown on Figure 5. Remediation points will be installed beneath and around the maintenance garage, which is the reported source of the historical dumping activities and the location where the conceptual full-scale remediation will occur. Remediation points will be screened at nested depths spanning the top of the aquifer to the base of the (identified) zone of highest impacts which is identified from approximately 5 to 30 feet below grade. Installation of remediation points at multiple depths and locations provides the ability to target specific zones to overwhelm aquifer heterogeneities and maximize contaminant removal (e.g., manipulate head gradients to flush out zones with higher concentrations, increase head gradients across lower permeable zones to increase flow).

Injection wells will be constructed of two-inch diameter steel casing and screen and will be nested at each location with screens from 5 to 15 feet below grade and 15 to 25 feet below grade. Extraction wells will be constructed of four-inch diameter PVC screen and casing, and nested at each location with screens from 10 to 20 feet below grade and 20 to 30 feet below grade. Remediation and monitoring points will be installed using hollow stem auger drilling technology. During remediation and monitoring point installation, soils will be screened to record geology and monitored for the presence of contaminants (head space PID monitoring and visually examining for the presence of non-aqueous phase liquid). All remediation points will be installed to Minnesota Department of Health Well Code and will be installed by a state drilling contractor.

Historical soil characterization has not identified the presence of confining layers within the target zone, but if field staff suspect the presence of a confining layer during well installation, remediation well installation depths may have to be adjusted or the location may have to be moved. Remediation and monitoring points will be developed to ensure aquifer communication by an iterative process of surging and pumping, until sediment and turbidity is clear from the water. Remediation points will be incorporated into the full-scale remediation well field or abandoned following the pilot test if the technology is determined not to be feasible or suitable for full scale application. Monitoring points will be incorporated into the site wide monitoring well network or abandoned if determined unneeded for future use.

Subtask 5: System Equipment, Process Flow, and System Controls

A process and instrumentation diagram (P&ID) is provided as Figure 6. The proposed pilot test will require the following equipment:

Submersible well pumps - A four-inch diameter submersible well pump will be installed in each recovery well to the base of the well. Groundwater will be pumped into an aboveground storage tank for equalization and then will be pumped through granular activated carbon (GAC) treatment vessels using a centrifugal water pump (see next section). Each submersible pump must be capable of achieving 40 gallons per minute (gpm) discharge rate at a head pressure of 25 pounds per square inch (psi).

Impacted water aboveground storage tank (IWAST) - Groundwater recovered from the submersible pump will be discharged into an aboveground storage tank (frac tank), denoted as the *impacted water aboveground storage tank* (IWAST), for equalization prior to GAC treatment. One or more storage tank(s) must have a cumulative capacity of at least 5,000 gallons, constructed of steel or poly, and have an access port on the top or side of the tank for inspection and cleaning. Float controls will be installed within the tank to operate the transfer pump, using a standard high/low/high-level alarm logic controls.

Centrifugal water pumps - A centrifugal pump (*transfer pump*) will be used to transfer water from the IWAST through GAC treatment and into a clean water aboveground storage tank (CWAST). A second centrifugal pump (*injection pump*) will transfer water from the CWAST through injection wells into the aquifer. One or more centrifugal pumps can be used in each location but must be capable of achieving the following cumulative specifications: 200 gpm at a head pressure of 40 psi.

Granular Activated Carbon (GAC) Treatment - Recovered groundwater impacted with dissolved phase TCE will be treated with GAC prior to injection back into the aquifer. GAC treatment will include at least two vessels with a minimum total treatment flow rate of 200 gpm and capability to treat maximum anticipated TCE concentrations to <0.4 µg/L.

Clean water aboveground storage tank (CWAST) - Impacted water that is transferred through GAC treatment will be temporarily stored within a clean water aboveground storage tank (CWAST) prior to injection into the aquifer. The storage (frac) tank must have a capacity of at least 5,000 gallons, constructed of steel or poly, and have an access port on the top or side of the tank for inspection and cleaning. Float controls will be installed within the tank to operate the injection pump, using a standard high/low/high-level alarm logic controls. Injection into the aquifer will be continuous so floats will be positioned accordingly, to only cause the injection pump to turn off if the tank becomes empty or under a high tank overfill condition.

Conveyance lines - Conveyance lines connected to remediation wells will be constructed of 1-inch or 1.5-inch diameter high density polyethylene (HDPE) piping. Conveyance lines on the suction side of transfer pumps will be constructed of schedule 80 diameter polyvinyl chloride (PVC) piping and be sized by the equipment vendor to reduce friction loss based on maximum anticipated flow rates. Conveyance piping downstream of the transfer pump can be schedule 80 PVC piping or high pressure flexible hose and will be sized by the equipment vendor to reduce friction loss based on maximum anticipated flow rates.

Process flow, controls, measurements, and sampling - Groundwater will be pumped from recovery wells through a backflow prevention check valve into the IWAST. The groundwater recovery rate will be controlled by a variable speed pump controller to optimize the recovery rate and fine-tuned by manual control valves on the manifold inlets. Recovery well discharge conveyance piping will be manifolded together and discharged into the IWAST. Prior to manifold connection, each recovered water stream will be monitored for pressure, flow rate, and sample valve. The discharge pressures will be measured using a standard bourdon type pressure gauge to monitor pump performance. The flow rates will be monitored by a Blancett digital flow meter / totalizer. Samples will be collected from a ¼-inch sample valve and periodically analyzed for dissolved phase TCE to evaluate contaminant mass recovery.

Water accumulated within the IWAST is pumped through a backflow prevention check valve through a particulate filter and through GAC treatment and into the CWAST. Float controls will be installed within the IWAST to control transfer pump operation, using a standard high/low/high-level alarm logic controls. The transfer rate can be controlled manually via gate valve and will be monitored by a digital flow meter. Post-GAC treatment water will be periodically sampled from between the GAC vessels and downstream of the GAC vessels and analyzed for dissolved phase TCE to evaluate breakthrough and GAC performance, and ensure injected water meets regulatory criteria.

Clean water is pumped through a backflow prevention check valve, through a manifold of injection pipes and to individual injection wells. Downstream of the manifold, each injection conveyance line will be monitored for flow (using a Blancett digital flow meter) and pressure (using a bourdon style pressure gauge). The injection flow rate is controlled by a variable speed pump controller to optimize injection rates and can be fine-tuned using flow control valves on the manifold. Float controls will be installed within the tank to operate the injection pump, using a standard high/low/high-level alarm logic controls. Injection into the aquifer will be continuous so floats will be positioned accordingly, to only cause the injection pump to turn off if the tank becomes empty or under a high tank overfill condition. No control settings will be monitored during the pilot test, but resultant flow meter results will be monitored at each location (both the rate and total volume discharged). Control adjustments may periodically be made to achieve the targeted flow rate (recovery or injection rate); these minor adjustments will not be recorded. No other equipment recording, such as equipment run time, will be necessary, as the primary metrics are the extraction and injection flow rates.

Subtask 6: Process Material Chemistry
As outlined in the previous section, samples will be collected in the following locations:

Extraction well discharge - Water samples will be collected from the extraction well discharge (prior to GAC treatment) and analyzed for dissolved phase TCE to evaluate contaminant mass recovery (the flow rate is monitored in this location also using a Blancett flow meter).

In between GAC treatment vessels - Water samples will be periodically collected from a sample port located between GAC vessels to evaluate breakthrough and GAC treatment performance.

Downstream of GAC treatment vessels - Water samples will be periodically collected from a sample port located downstream of GAC vessels to evaluate GAC treatment performance and ensure injection meets regulatory requirements.

All sampling methods and procedures will follow MPCA guidance documents. Samples will be analyzed for TCE using EPA method 8260B. Duplicate samples will be collected at a frequency of one per ten samples collected. Samples will be submitted to an MPCA contractor laboratory for analyses.

Subtask 7: Waste Generation, Handling, and Disposal
The only anticipated waste to be generated during the pilot test is spent GAC media. Spent GAC media is analyzed for RCRA metals and TCLP, prior to disposal or re-activation and reuse. All recovered groundwater is intended to be treated with GAC and re-injected into the aquifer. Non-aqueous phase liquid is not anticipated to be encountered based on historical sampling data.

The maximum anticipated recovery rate is 40 gpm. Injection wells are designed for injecting half of the recovery rate (i.e. two injection wells are planned for each recovery well), so the maximum anticipated injection rate is 20 gpm. The highest historical detection of TCE in groundwater is 500 µg/L, which is the highest anticipated TCE concentration to be encountered. Based on available sampling data, the average TCE concentration within the target zone is approximately 70 to 80 µg/L.

Subtask 8: Installation Activities
The pilot testing will require a variance from the MDH Rule 4725.2050 to re-inject treated water into the aquifer. Installation of monitoring and remediation wells will require MDH permits

Prior to pilot testing, the following activities must be completed:

Installation and development of monitoring and remediation wells - Sample monitoring wells (2 to 3 months after Pilot Test Workplan approval). Design, bid, and procure pilot test equipment through the most recent version of the MPCA Contractor and Subcontracting Purchasing Manual (1 month after Pilot Test Workplan approval). Equipment setup, mobilizing, and conduct pilot testing (5 to 7 months after Pilot Test Workplan approval).

Samples of drilling cuttings will be analyzed for VOCs, RCRA metals, and TCLP - To determine the most cost-efficient disposal method. Drilling cuttings will be containerized within 55-gallon steel drums and later disposed based on analytical results of the soil samples at an MPCA approved disposal location following the most recent version of the MPCA Contractor and Subcontracting Purchasing Manual.

Wastewater generated from well development activities will be containerized - Within totes or drums and sampled for the presence of VOCs, metals, GRO, and DRO to determine the proper disposal location. Wastewater will be disposed at an MPCA approved disposal location following the most recent version of the MPCA Contractor and Subcontracting Purchasing Manual.

Subtask 9: Subsurface Response Monitoring
The following physical and chemical conditions of the target zone will be monitored in the field during the pilot test.

Fluid levels - Monitored in monitoring wells and recovery wells to evaluate changes in groundwater gradients. Fluid levels will be monitored using a standard conductive level indicator.

Dissolved oxygen, redox potential, temperature, conductivity, and pH - Monitored using a YSI-556 multiparameter probe in monitoring wells and compared to the values of injected and extracted groundwater to evaluate changing groundwater dynamics.

The following chemical conditions will be measured by laboratory analysis during the pilot test:

Dissolved phase TCE - Concentrations will be sampled from monitoring wells to document plume changes during pilot testing.

Monitoring procedures will follow manufacturer's operation and calibrations instructions, and sampling and monitoring will be conducted in accordance with MPCA Guidance Documents. Samples will be submitted for laboratory analyses at a State-contracted laboratory.

Subtask 10: Pilot Test Description
The pilot test will be separated into 5 periods of activity, as follows: baseline monitoring, 3 stages of pilot testing, and rebound monitoring. Pilot test stages will be used to evaluate contaminant mass recovery and aquifer response under different operational configurations. Each pilot test stage will include 1 to 3 step tests to evaluate contaminant mass recovery and aquifer response under different extraction and injection rates. Prior to pilot testing, each of the following baseline parameters will be collected once.

Fluid levels - Monitored in monitoring wells and remediations wells to provide a baseline for evaluating changes in groundwater gradients during pilot testing. Fluid levels will be monitored using a standard conductive level indicator.

Dissolved oxygen, redox potential, temperature, conductivity, and pH - Data will be collected in monitoring and remediation wells prior to pilot testing to provide a baseline for evaluating changes during pilot testing. These data will be collected using a YSI-556 multiparameter probe in monitoring wells and compared to the values of injected and extracted groundwater to evaluate changing groundwater dynamics.

The following chemical conditions will be measured by laboratory analysis to provide a baseline for pilot testing.

Dissolved phase TCE - Concentrations will be sampled from monitoring wells prior to pilot testing to document plume changes during pilot testing.

Monitoring procedures will follow manufacturer's operation and calibrations instructions, and sampling and monitoring will be conducted in accordance with MPCA Guidance Documents. Samples will be submitted for laboratory analyses at a State-contracted laboratory.

No remediation or monitoring point testing will be required prior to pilot testing. If short-circuiting occurs via the injection well annulus, for example, it will be indicated by a substantial decrease in injection pressure. No leak testing will be required for pilot test equipment prior to pilot testing activities. All PVC piping joints will be fused with PVC rated cement, all threaded connections will be completed with sealant, and all hose barb joints will be double-clamped. Other joints or connections will be gasketed as applicable.

Pilot testing will be completed in the following three stages of different operational configuration:

Stage 1: Recovery wells operating alone (no injection);

Stage 2: Recovery wells and injection wells installed at the same nested depth range will be operating simultaneously and continuously; and

Stage 3: Recovery wells and injection wells installed at opposite nested depth ranges will be operating simultaneously and continuously.

Data collected during the three different stages will help evaluate the influence on groundwater gradients for full scale application of target zone flushing, including capture zone extents and efficacy of cross-zone flushing. The first two stages will be completed with three different step tests, with each step conducted at different extraction rates (e.g. 15, 25, and 40 gpm) from lowest to highest value.

The total injection rate will be equivalent to the total extraction rate, but there will be twice as many injection wells, so each injection well rate will be half of an individual extraction well rate. Step testing will provide data to evaluate the maximum aquifer yield rates to most efficiently size the full-scale system based on capital cost, aquifer yield rates, and remediation timeframes. Very little downtime will be required during different stages or steps, as each recovery well will be equipped with an individual submersible well and recovery conveyance lines will be plumbed together and manifolded upstream of the IWAST. Each stage will operate for approximately 72 hours, or until hydraulic equilibrium conditions are achieved based on changes in groundwater elevations in monitoring wells. When step testing is completed, each step will last approximately 24 hours or until equilibrium conditions are achieved.

After pilot testing, each of the following rebound parameters will be collected approximately 1 to 3 days after pilot testing has ended. The timing will be based on aquifer response observed during pilot testing (fast aquifer response will allow rebound monitoring to be completed on a shorter schedule); if the parameters noted below have not rebounded to baseline conditions, a subsequent set of baseline monitoring data will be collected approximately 2 to 4 weeks following pilot testing.

Fluid levels - Will be monitored in monitoring wells and remediations wells to evaluate aquifer response time. Fluid levels will be monitored using a standard conductive level indicator.

Dissolved oxygen, redox potential, temperature, conductivity, and pH - Data will be collected in monitoring and remediation wells prior to evaluate aquifer chemistry dynamics after pilot testing. These data will be collected using a YSI-556 multiparameter probe in monitoring wells and compared to the values of injected and extracted groundwater to evaluate changing groundwater dynamics.

The following chemical conditions will be measured by laboratory analysis to evaluate rebound conditions following pilot testing.

Dissolved phase TCE - Concentrations will be sampled from monitoring wells prior to pilot testing to document plume changes during pilot testing.

Monitoring procedures will follow manufacturer's operation and calibrations instructions, and sampling and monitoring will be conducted in accordance with MPCA Guidance Documents. Samples will be submitted for laboratory analyses at a State-contracted laboratory.

Subtask 11: Operation Monitoring Plan

In situ subsurface response field monitoring data, including the depth to groundwater and the suite of parameters measured by the multiparameter probe (pH, conductivity, ORP, DO, temperature) will be measured in monitoring and remediation (if accessible) wells at a schedule that is more frequent at the beginning of a test when changes are expected to occur more rapidly, and less frequent toward the end of a test. Field monitoring data will be used to evaluate changes in groundwater flow direction (via elevation gradient contour mapping and changes in field chemistry data) as indicators of controlling advective transport and flux dynamics.

Subsurface response will also be evaluated by collected groundwater samples from monitoring wells and lab analyze for TCE concentrations, to provide insight into changing plume dynamics under different induced gradients. Groundwater recovery rates and injection rates will be recorded on an hourly basis or whenever changes occur, to compare to induced gradients and chemistry data, to determine full scale applicability (e.g., number of full scale remediation points, spacing and location of full scale remediation points, etc.).

Water samples will be collected from recovered groundwater and analyzed for TCE to calculate contaminant mass removal (using flow rates and totals noted in the previous paragraph). A recovered water sample will be collected at the beginning and end of each step, and if a step lasts longer than 24 hours, an additional sample will be collected for each additional 24 hours of operation. Contaminant mass removal calculations will help determine the anticipated full-scale remediation timeframe based on estimated total plume mass and flux modeling.

Subtask 12: Data Evaluation

Contaminant Mass Recovery Calculations

Laboratory analysis of TCE concentrations from recovered groundwater samples will be reported in units of µg/kg. Recovered groundwater is recorded in units of gallons and will be converted to mass, assuming a density of 1000 kg/m3, using the conversion ratio of one gallon equals 3.79 kg. The contaminant mass recovered during each step will be calculated as the average TCE concentration in recovered groundwater samples multiplied by the mass of recovered groundwater.

Groundwater Flow and Flux Evaluation

Groundwater gradients will be recorded frequently during pilot testing and will be plotted on hydrographs to evaluate changes over time. A representative data set collected of the end of each step will be incorporated into Visual Modflow, a three-dimensional groundwater modeling program, to provide a three-dimensional view of changes in gradients during pilot testing and estimate capture zones.

Full Scale Evaluation

The modeling data and contaminant mass recovery calculations will help determine the anticipated full-scale remediation timeframe based on estimated total plume mass and the ability to target specific zones (estimating the number of pore volume flushes based on size of the zone and proximity to recovery and injection wells). Full scale remediation wells will be spaced depending upon the modeled capture zones based on recovery and injection flow rates, and strategically positioned to induce advection across multiple discrete targeted zones. The number of pore volume flushes required to achieve the cleanup value can be calculated by the following equation: $N_{pv} = R_f \times \ln [C_o / C_f]$, where N_{pv} is the number of pore volume flushes, R_f is the retardation factor, C_o is the initial highest and average concentrations, and C_f is the final clean up concentration. Using a range of initial concentrations from the average concentration to the highest concentration, the number of pore flushes required to achieve the targeted cleanup goal can be calculated.

Subtask 13: Technical Feasibility

To achieve technical feasibility, the proposed pilot test remediation must be able to demonstrate the capability to control groundwater advection across targeted zones of highest TCE concentration. Groundwater gradients will be monitored in multiple wells at multiple depths, so this complex set of data will be evaluated using a three-dimensional groundwater modeling program. The modeling must also indicate dynamic subsurface response to various remediation configurations (increasing and decreasing recovery and injection rates) to promote advection in desired target zones without requiring an excessive number of remediation wells.

TCE mass recovery calculations will confirm recovery efforts are achieved across the targeted zones and confirm remediation technology efficacy.

Injection rates are conceptually designed to be 50% of extraction rates, therefore twice as many injection wells are anticipated than extraction wells. This is both a conceptual physical limitation of groundwater hydraulics but also provides increased flexibility in gradient control. The feasibility of long term aquifer injection at the site will be evaluated based on injection pressures and flow rates monitored during the pilot test.

Pilot test data will also evaluate GAC treatment sizing and configuration for full scale application.

Subtask 14: Economic Feasibility

Pilot test modeling data will be used to evaluate capture zone and gradient control during different remediation configurations and across a large network of monitoring wells. This data will be used with estimates of the required number of pore flushing volumes to achieve remediation end points, to design the remediation well network in relation to the targeted remediation timeframes.

Remediation timeframes can be reduced by increasing the capital cost (higher number of remediation wells, larger treatment system, etc.), and will be evaluated based on pilot test data and projected construction timeframes associated with future uses of the property.

The most significant design criteria to be determined during the pilot test is the extraction rate required to adequately induce groundwater flow across a target zone, to induce advective transport of dissolved phase TCE and capture with recovery wells. If the extraction rate is too large, the number of remediation points or size of the treatment system or length of remediation timeframes may indicate economic infeasibility.

Subtask 15: Pilot Test Schedule
Proposed schedule for completing all pilot test activities, including submittal of a *Pilot Test Report*.

Upon MPCA approval of the Pilot Test Workplan, WCEC will complete the following tasks within approximately one month:

- Obtain Well Code injection variance
- Design pilot test equipment and specifications for vendor solicitation
- Pilot test vendor solicitation will be completed through the MN Dept of Administration
- Solicit a state drilling contractor
- Prepare work plan and cost estimate to MPCA for the below-listed items for work order issuance

The following activities will be completed 2 to 3 months after MPCA approval of the Pilot Test Workplan:

- Installation and development of monitoring and remediation wells
- Sample and gauge monitoring wells
- Create initial groundwater gradient maps to evaluate groundwater flow direction

The following activities will be completed 5 to 7 months after MPCA approval of the Pilot Test Workplan:

- Pilot test equipment mobilization and setup
- Conduct pilot testing
- Pilot test equipment decommissioning

The following activities will be completed 7 to 9 months after MPCA approval of the Pilot Test Workplan:

- Submit Pilot Test Report

<u>Conceptual Full-scale Application</u>
The estimated pore volume of TCE-impacted groundwater beneath the building is between 4 and 5 million gallons, assuming 35% total porosity and a saturated thickness of 25 feet. The highest detected TCE concentration detected beneath the maintenance garage is 500 µg/L (Sample 7). The average TCE concentration from the 12 groundwater samples collected in the cross-section profile of C-C' (Sample borings 4, 16, and 11) is 74 µg/L. The targeted final TCE concentration is the MDH Health Risk Limit value of 0.4 µg/L. The number of pore volume flushes required to achieve the cleanup value can be calculated by the following equation:

$$N_{pv} = R_f \times \ln [C_o / C_f],$$

where N_{pv} is the number of pore volume flushes, R_f is the retardation factor, C_o is the initial highest and average concentrations, and C_f is the final clean up concentration. Using a range of initial concentrations from the average concentration to the highest concentration, the calculated number of pore flushes to achieve the cleanup goal is 6.5 to 8.5, or between 29 to 43 million gallons. The remediation system could conceivably operate concurrently during golf course operations, so the targeted cleanup timeframe is 5 years. Assuming a 20-gallon per minute recovery rate per extraction well (to be determined based on pilot testing), and assuming the system will operate at a 90% uptime efficiency, a single recovery well can remove an estimated 47 million gallons during the 5-year period. Conversely, if 5 recovery wells are operated simultaneously, the cleanup timeframe can be reduced to approximately one year.

Objective 3 Timeline: Remedial alternatives can be evaluated, and a Pilot Test Work Plan can be prepared and submitted, within 30 days.

Objective 3 Deliverables: Pilot Test Work Plan

<u>Objective 4: UST Closures</u>

Given the age (approximately 50 years) of the 1,000-gallon gasoline UST at the former fertilizer building, WCEC proposes removal of the tank. Given the age and assumed condition (leaking) of the floor drain UST and non-compliance with MDA regulation and hazardous waste storage practices, WCEC proposes that this tank be closed-in-place.

Task A: Solicit Bids, Remove Tank, Complete Sampling and Reporting – Gasoline UST

Subtask 1: Develop specifications/drawings for the gasoline UST removal, and solicit bids following MPCA Contractor and Subcontractor Purchasing Manual for construction projects less than $50,000. Tabulate results, present to MPCA with recommendations, and solicit purchase order after all MPCA contracting and subcontracting requirements have been verified.

For the gasoline UST removal, the bid documents will specify the Contractor's requirements to characterize and complete disposal of the wastes (fluids, sludge) removed from the tank, and the excavated petroleum-impacted soil. WCEC will review the Subcontractor submittals, including performance documentation, waste records, and prevailing wage/withholding requirements.

Subtask 2: Remove gasoline tank, screen soils, document work, collect post-excavation soil samples, and collect tank basin water sample for VOC/GRO/Pb. If the groundwater is encountered, a grab water sample will be collected for PFC if sample dilution will not raise report limits above applicable HRL/HBV. WCEC will be prepared to collect free-phase gasoline to the extent practicable.

Task B: Sampling and Closure-in-Place – Drain UST

Subtask 1: Contractor will remove a section of concrete flooring to access the underlying UST. Sediment and liquid from the UST and associated trench drain will be pumped out and containerized. The trench drain outlet will be disconnected and permanently sealed off. The UST will be filled with a cement slurry. WCEC will oversee and document closure of the tank. The contractor will be directly hired by the MDA for this task. The concrete will be replaced by the contractor following completion.

Subtask 2: A sample will be collected from the recovered material and analyzed for nitrate as nitrogen, TKN, MDA List 1 and 2 Pesticides and TCE. Additional analyses will be completed to meet landfill profiling requirements (TCLP Pesticides, TCLP VOCs, TCLP metals). The containerized material will be labeled and secured in the maintenance garage until the landfill approval process is complete, after which the material will be hauled to a landfill for disposal. Disposal will be coordinated by WCEC but contracted directly by the MDA. Waste disposal will likely be combined with investigation-derived wastes and/or the excavated soil, where appropriate.

Objective 4 Timeline: Anticipated to be completed within 90 days of Work Order issuance. WCEC will seek to combine the mobilization for the on-site work to be combined with other site visits to increase cost-effectiveness.

Objective 4 Deliverables: Gasoline UST excavation report, audit-compliant purchasing records, documentation (photo and description) of drain UST closure-in-place, copies of laboratory reports, shipping manifests and landfill disposal tickets.

Objective 5: Ag-Chem Corrective Actions

Task A: Soil

A remedial soil excavation will be completed to remove accessible soil with ag-chem impacts above MDA cleanup goals, as proposed in the *Remedial Investigation Report / Corrective Action Plan* (completed in the RI Sampling Plan scope).

Subtask 1: Soil Excavation

WCEC will coordinate on-site activities with the excavating contractor (to be hired directly by the MDA). Specifications from the *Remedial Investigation Report / Corrective Action Plan* will be provided to the subcontractor. Accessible soil with ag-chem impacts above soil cleanup goals will be excavated. Excavation sidewalls and bases will extend to sampling locations and depths at which soil impacts are below clean-up goals

Corrective actions will include the removal of the concrete floor of the fertilizer building in areas where underlying soil is contaminated above cleanup goals. Concrete removal is generally not required by the MDA in areas where underlying soil impacts are below cleanup goals. If concrete is to remain in place in areas not requiring corrective actions (not recommended) cracks will need to be repaired and maintained in accordance with MDA Fact Sheet *Concrete Containment - Crack Repair and Maintenance*. Removed concrete will be hauled to a landfill for disposal.

It is assumed that the maintenance garage will remain intact. If ag-chem contamination is documented beneath the building, the building will require a contingency closure. If soil corrective actions are necessary adjacent to the outside of the building, a 1:1 slope will be maintained beneath the foundation to avoid undermining the foundation integrity.

Excavated areas will be backfilled with clean material similar in texture to that which was removed.

Subtask 2: Soil Characterization and Disposal

Soil excavated from areas known or suspected to be impacted by TCE (around the shop, near dumping area at stream), PFCs (fertilizer building footprint) or petroleum impacts (gasoline UST and fuel oil AST) will be segregated and stockpiled separately. This soil will need to be profiled and disposed of separately. RI sampling data will be used to segregate soil. A photoionization detector (PID) equipped with a 11.7 eV lamp will also be used to screen soils (for petroleum and TCE impacts only). The recommended disposal method will depend on the soil volume and concentrations of various chemicals but may likely include landfilling. This soil will be placed on and covered with 10-mil plastic following collection of samples, as required for profiling purposes (if for landfill, likely TCLP pesticides, TCLP metals and TCLP VOCs). WCEC will identify and evaluate favorable disposal options as well as complete the necessary soil profiling/proposal requirements.

Remaining ag-chem-impacted soil will be stockpiled separately and covered with plastic. Contaminated sediment from the scale pit, if present, will be added to the stockpile. The appropriate number of stockpile samples will be collected and analyzed for nitrate-N, TKN, MDA List 1 and List 2 Pesticides. Analytical data of the stockpile samples will be used to calculate land application rates. WCEC will work with local land owners to identify suitable spreading ground, after which the *Proposal to Land Apply Soil from Agricultural Chemical Incidents* will be submitted. Upon MDA approval, the soil will be land applied at the approved rate.

WCEC will coordinate hauling and disposal activities, but subcontracted tasks such as the laboratory analyses, trucking, loading, spreading and landfill disposal will be hired directly by the MDA.

Subtask 3: Non-Soil Impacts
Potential impacts to the stream will be addressed by source removal of soil impacts which will reduce future risks associated with surficial runoff.

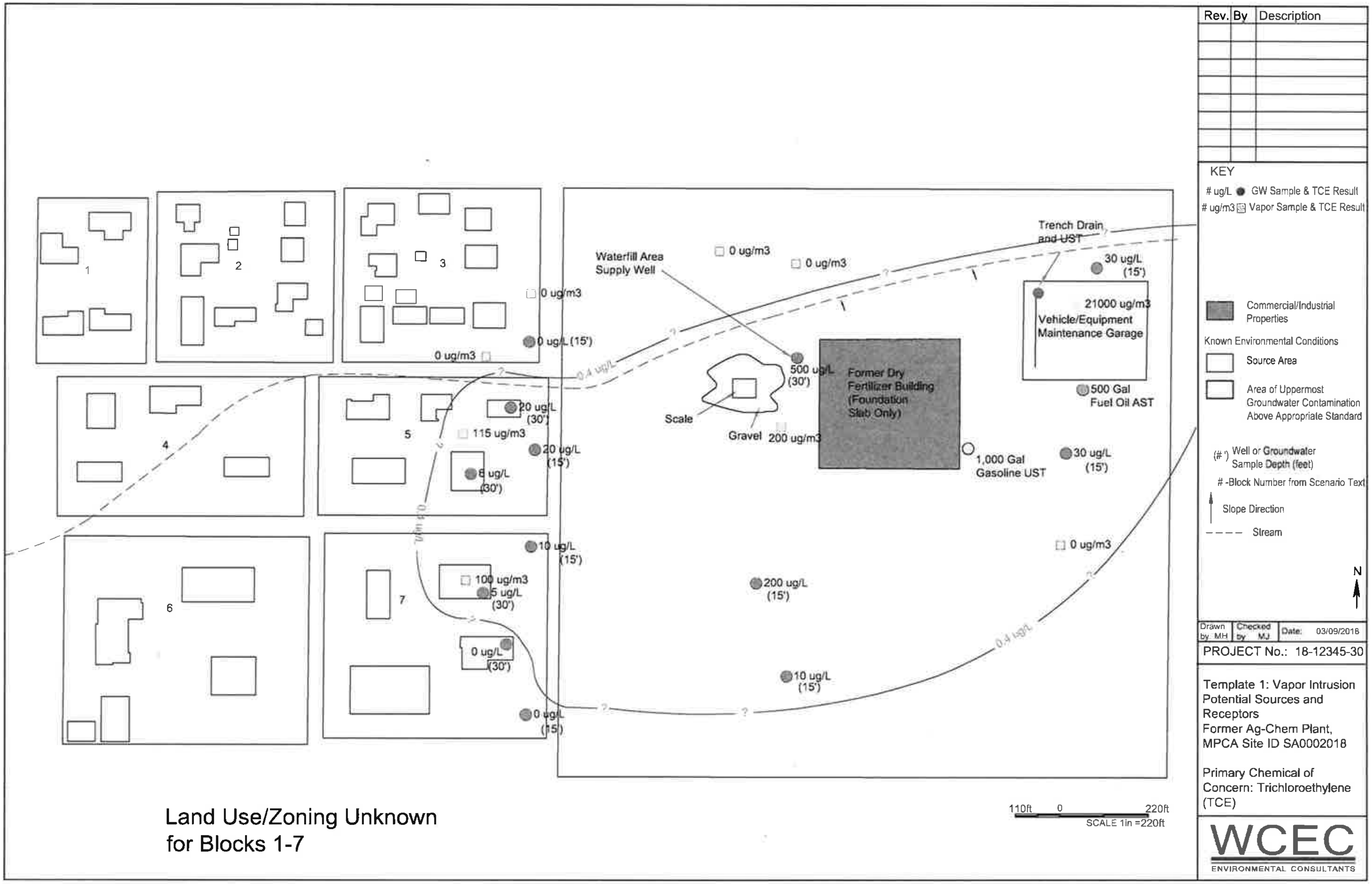
If contaminated water is present within the scale pit, it will be pumped out and containerized. WCEC will make recommendations to the MDA for disposal, which will likely include land application. The application rate will be based on analytical data collected during the RI.

Sampling recommendations relating to the downgradient domestic wells are discussed in Objective 2, Task B. If ag-chem impacts are identified in any of these wells, water supply provisions, corrective actions, and follow-up ag-chem sampling will be completed as described in Objective 2, Tasks B and C. Ag-chem sample analyses will be contracted directly by the MDA and will include applicable analytes.

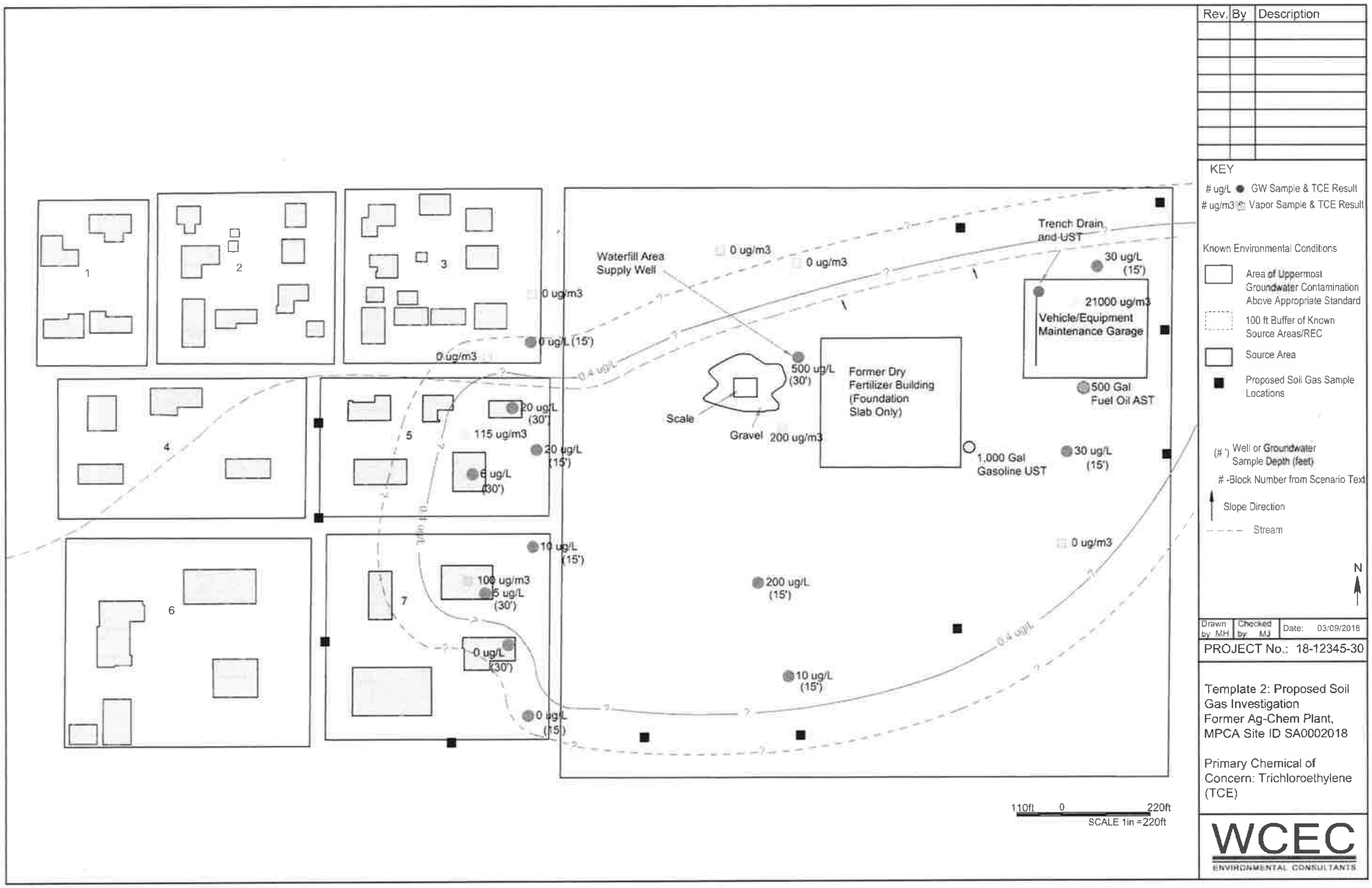
The impacted site well may be sampled as part of future groundwater monitoring activities. If the condition/construction of the well and/or soil contamination in this area suggest that the well is a contributing risk for groundwater contamination, the well should be sealed during a future scope of work.

Objective 1 Timeline: The soil excavation will be scheduled when suitable land application is identified. The anticipated acreage will be estimated based on the soil volume and analytical data. The excavation will not be completed when the ground is frozen. Timing of the land application (pre-emergent spring application or post-harvest) will be considered. Soil will not be land applied on ground that cannot be immediately tilled (i.e. frozen ground). Following receipt of stockpile analytical data, the *Proposal to Land Apply Soil from Agricultural Chemical Incidents* will be completed along with notifications to township and county officials. Additional soil profiling/proposals will be prepared for TCE/PFC/petroleum-impacted soil, if excavated. Following MDA approval of the land application proposal and additional disposal plan (if necessary), soil will be transported for disposal. Land applied soil will be incorporated immediately following application.

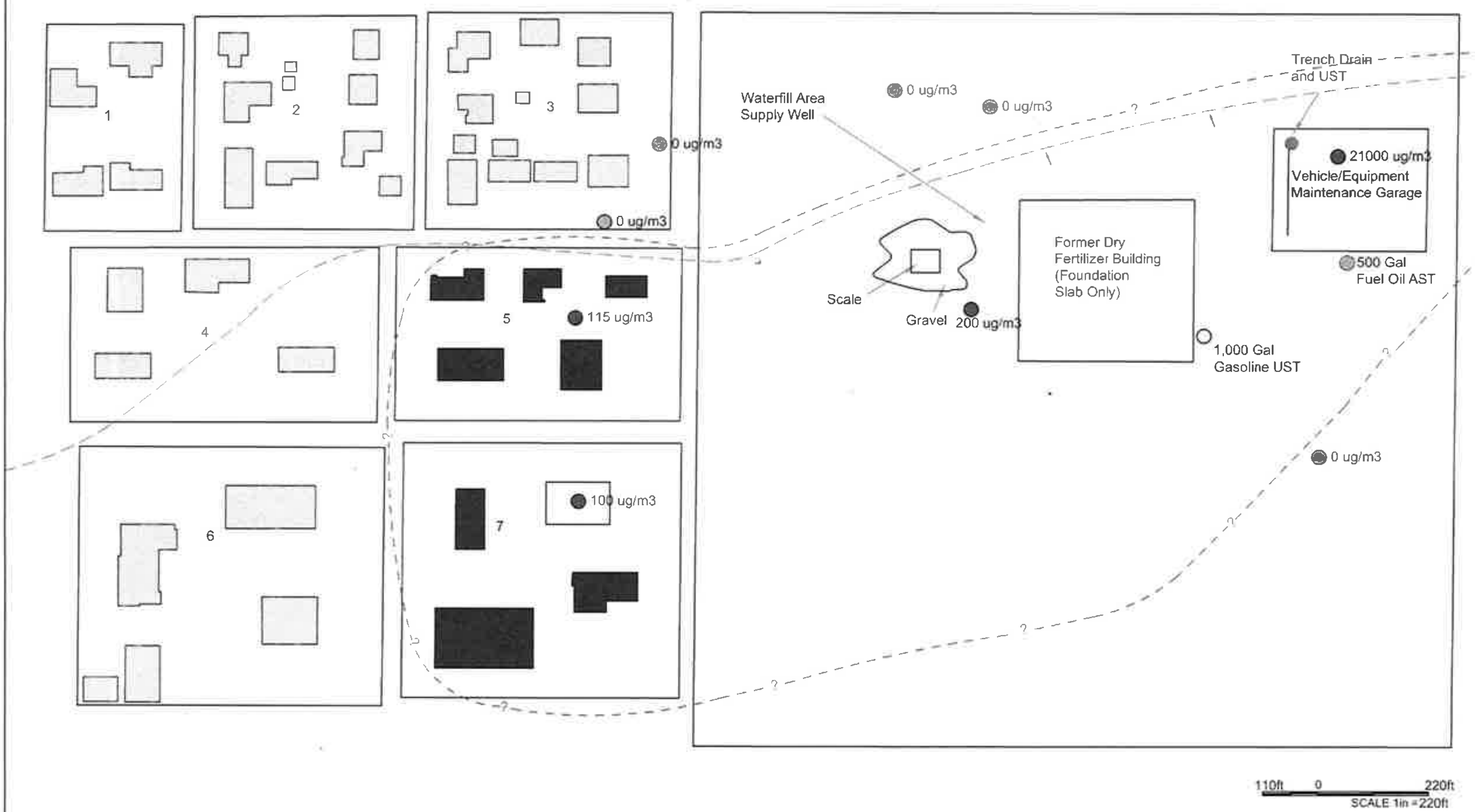
Objective 1 Deliverables: *Corrective Action Report* (including stockpile sampling data), *Proposal to Land Apply Soil from Agricultural Chemical Incidents* (with required signatures), shipping manifests and disposal tickets (if applicable)



Land Use/Zoning Unknown for Blocks 1-7



Rev. By Description
KEY
ug/L GW Sample & TCE Result
ug/m3 Vapor Sample & TCE Result
Known Environmental Conditions
Area of Uppermost Groundwater Contamination Above Appropriate Standard
100 ft Buffer of Known Source Areas/REC
Source Area
Proposed Soil Gas Sample Locations
(# ') Well or Groundwater Sample Depth (feet)
-Block Number from Scenario Text
Slope Direction
Stream
N
Drawn by MH
Checked by MJ
Date: 03/09/2018
PROJECT No.: 18-12345-30
Template 2: Proposed Soil Gas Investigation
Former Ag-Chem Plant, MPCA Site ID SA0002018
Primary Chemical of Concern: Trichloroethylene (TCE)
WCEC
ENVIRONMENTAL CONSULTANTS
1
2
3
4
5
6
7
Waterfill Area Supply Well
Trench Drain and UST
Vehicle/Equipment Maintenance Garage
21000 ug/m3
30 ug/L (15')
500 Gal Fuel Oil AST
30 ug/L (15')
1,000 Gal Gasoline UST
Former Dry Fertilizer Building (Foundation Slab Only)
500 ug/L (30')
Scale
Gravel
200 ug/m3
0 ug/m3
0 ug/m3
0 ug/m3
0 ug/L (15')
0 ug/m3
0.4 ug/L
20 ug/L (30')
115 ug/m3
20 ug/L (15')
5 ug/L (30')
10 ug/L (15')
100 ug/m3
5 ug/L (30')
0 ug/L (30')
0 ug/L (15')
200 ug/L (15')
10 ug/L (15')
0 ug/m3
110ft 0 220ft
SCALE 1in =220ft



Rev.	By	Description

KEY

- # ug/m3 ● Above Residential/ Commercial Screening Value
- # ug/m3 ● Below Residential/ Commercial Screening Value
- Vapor Intrusion Area of Concern
- Needs Sub Slab Sampling
- Source Area
- # -Block Number from Scenario Text
- Slope Direction
- Stream

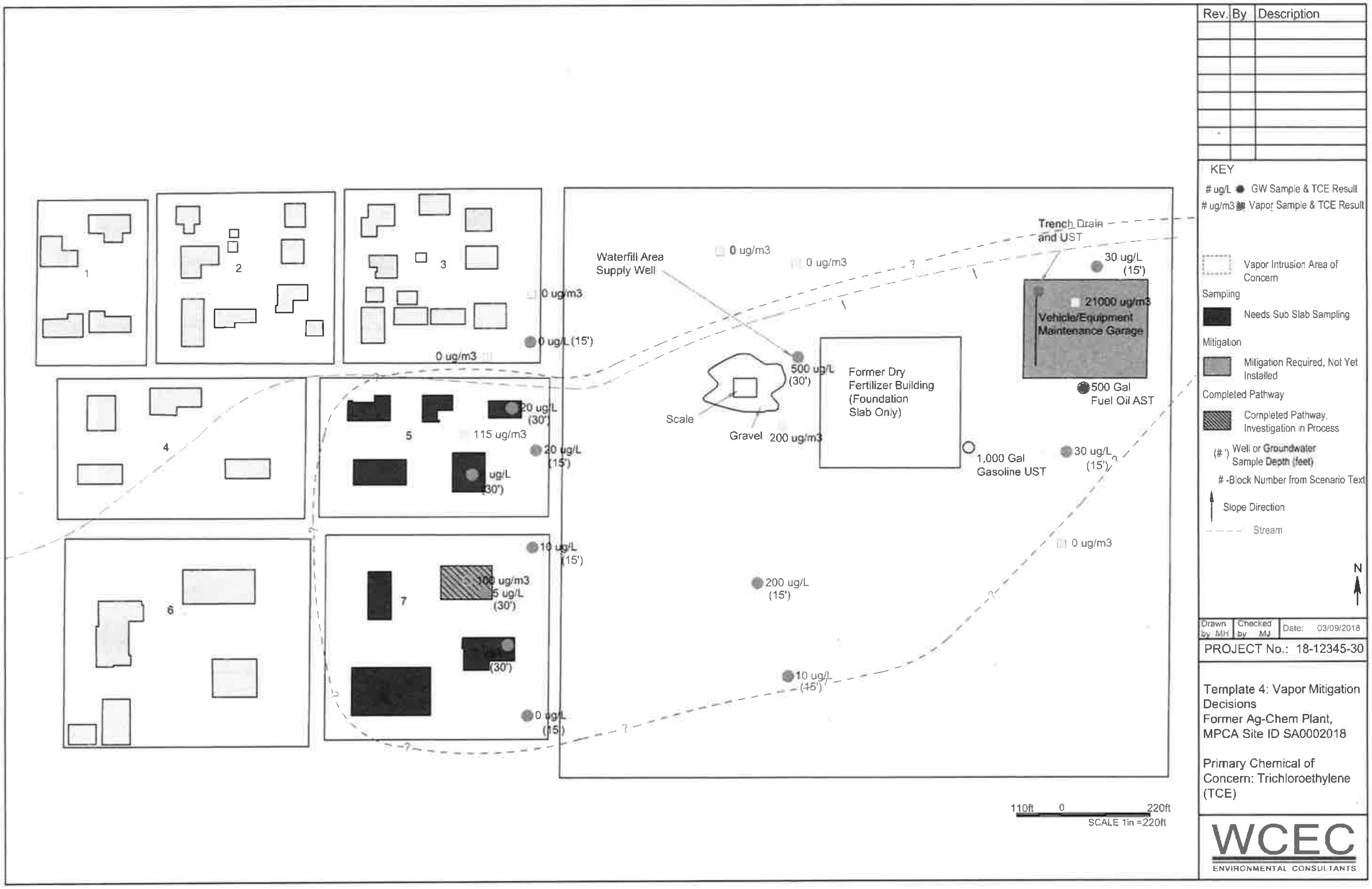
Drawn by MH | Checked by MJ | Date: 03/09/2018

PROJECT No.: 18-12345-30

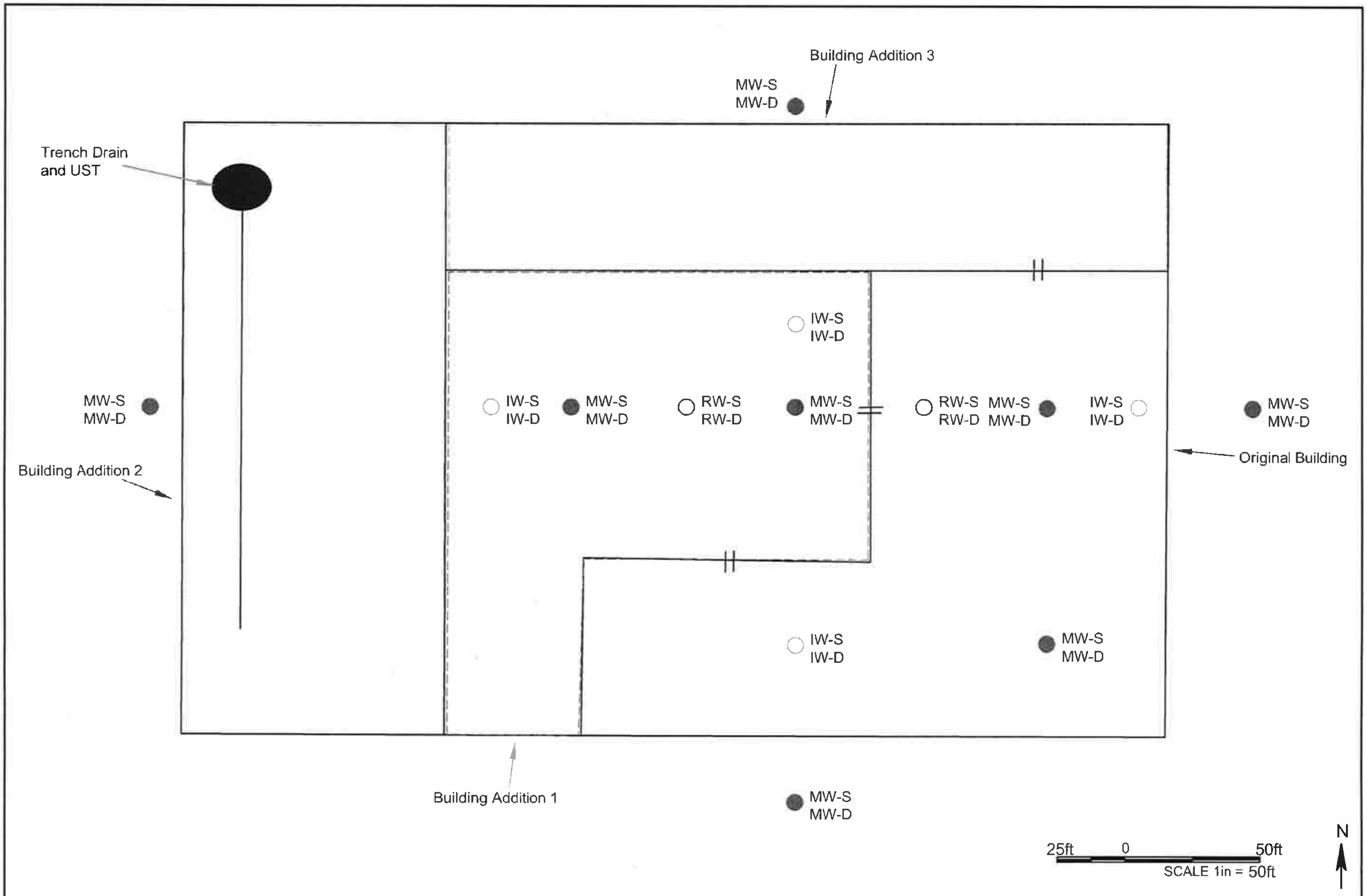
Template 3: Vapor Intrusion Area of Concern
Former Ag-Chem Plant,
MPCA Site ID SA0002018

Primary Chemical of Concern: Trichloroethylene (TCE)

WCEC
ENVIRONMENTAL CONSULTANTS



Rev. By Description
KEY
ug/L GW Sample & TCE Result
ug/m3 Vapor Sample & TCE Result
Vapor Intrusion Area of Concern
Sampling
Needs Sub Slab Sampling
Mitigation
Mitigation Required, Not Yet Installed
Completed Pathway
Completed Pathway, Investigation in Process
(# ') Well or Groundwater Sample Depth (feet)
-Block Number from Scenario Text
Slope Direction
Stream
N
Drawn by MH
Checked by MJ
Date: 03/09/2018
PROJECT No.: 18-12345-30
Template 4: Vapor Mitigation Decisions
Former Ag-Chem Plant, MPCA Site ID SA0002018
Primary Chemical of Concern: Trichloroethylene (TCE)
WCEC
ENVIRONMENTAL CONSULTANTS
Trench Drain and UST
30 ug/L (15')
21000 ug/m3
Vehicle/Equipment Maintenance Garage
500 Gal Fuel Oil AST
30 ug/L (15')
0 ug/m3
1,000 Gal Gasoline UST
Former Dry Fertilizer Building (Foundation Slab Only)
Waterfill Area Supply Well
0 ug/m3
0 ug/m3
500 ug/L (30')
200 ug/m3
Gravel
Scale
200 ug/L (15')
10 ug/L (45')
0 ug/m3
0 ug/L (15')
0 ug/m3
20 ug/L (30')
115 ug/m3
20 ug/L (15')
ug/L (30')
10 ug/L (15')
100 ug/m3
5 ug/L (30')
(30')
0 ug/L (15')
1
2
3
4
5
6
7
110ft 0 220ft
SCALE 1in =220ft



KEY
MW-S Monitoring Well- Shallow
MW-D Monitoring Well- Deep
IW-S Injection Well- Shallow
IW-D Injection Well- Deep
RW-S Recovery Well- Shallow
RW-D Recovery Well- Deep

PROJECT No.: 18-12345-30, Former Ag-Chem Plant, MPCA Site ID SA0002018

FIGURE 5: Conceptual Pilot Test Layout

WCEC
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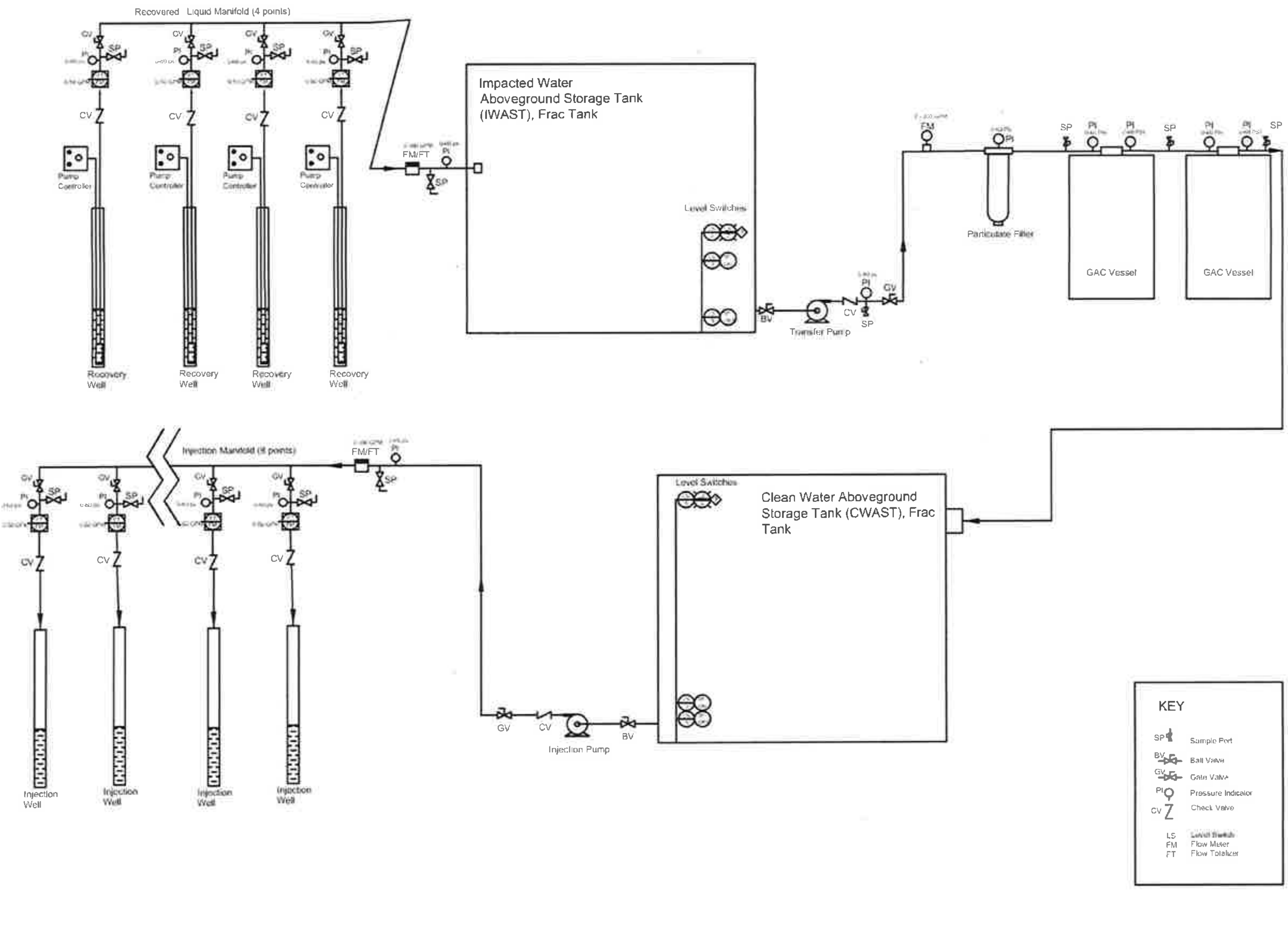


KEY

PROJECT No.: 18-12345-30, Former Ag-Chem Plant, MPCA Site D SA0002018

FIGURE 6: Process & Instrument Diagram (P&ID) for the Conceptual Pilot Test

WCEC ENVIRONMENTAL CONSULTANTS

MINNESOTA POLLUTION CONTROL AGENCY
520 Lafayette Road North
St. Paul, MN 55155-4194

Attachment B
Example Scenario A Project Spreadsheet
REMEDIAL INVESTIGATION

Project title: Former Ag-Chem Plant, MPCA Site ID SA0002018, MDA Case File No. #####

	1. Personnel					2. Subcontracting	3. Equipment			4. Other Expenses				Totals (Extended)
Project Budget	Project Manager	Scientist II	Scientist I	Field Technician	CADD and/or GIS specialist		Field Screening & Sampling	Measure & Survey	Transport, sample shipping	State Contract Lab (MPCA Parameters)	State Contract Driller (MPCA work)	State Contract Waste Disposal	MDA Direct Contracted Lab (Ag lists) and Drilling	
Objectives and sub-tasks														
1) Ag Chem Investigation														0
Task A Soil Investigation - Drilling/Sampling in Nine High Risk Areas, Coordination/Scheduling	8		16				Sampling Equipment	GPS	Truck				Composite and discrete sampling in 32 sampling locations	24
Task A Process Laboratory Soil Samples, Shipping, QA-QC checklist, Interim Report with Recommendations (3 rounds)	6		9	3									Nitrate-N/TKN MDA List 1 & List 2 Pesticides	18
Task B: Surface Water Assessment - Water Sample Collection and Processing				2			Sampling Equipment	GPS				If necessary, combined with solvent/petroleum investigation cuttings	Nitrate/nitrite-N, TKN, MDA List 1 & List 2 Pesticides	2
Task C Groundwater Assessment - Temporary Well Installation/development	1		12	12			Sampling Equipment	GPS					Nitrate/nitrite-N, TKN, MDA List 1 & List 2 Pesticides	25
Task C - Site Well Sampling				1			Sampling Equipment	GPS					Nitrate/nitrite-N, TKN, MDA List 1 & List 2 Pesticides	1
Task C - Monitoring Well Installation & Development	2		8				Sampling Equipment, Pump	GPS	Truck (may not be necessary) if combined event			If necessary, combined with solvent/petroleum investigation cuttings	Four Monitoring Wells	10
Task C Monitoring Well Sampling & Slug Testing			8	8			Transducer, YSI, Sampling Equipment		Truck				Nitrate/nitrite-N, TKN, MDA List 1 & List 2 Pesticides	16
Task D Contamination Impact Survey	1		4		1									6
Task D Investigation Report/Corrective Action Plan & Groundwater Monitoring Report	16	12	20	8	6									62
Total for Objective 1 Hrs	34	12	77	34	7									164
2) Solvent & Petroleum Investigation														0
Task A: Surface Soil Investigation, Used Solvent Dumping Area	2	2	8			State contract push-probe and analytical	PID and sampling equipment	GPS	Truck & sample shipping	VOC, RCRA metals	12 shallow borings	Soil if excavated		12
Task B, Soil and Ground Water Investigation, Subtask 1 Maintenance Garage	4	4	16			State contract MIT, push-probe, and analytical	PID and sampling equipment	GPS	Truck & sample shipping	VOC, RCRA metals	4 MIT / 4 push probe / 4 vertical profile			24
Task B: Soil and Ground Water Investigation, Subtask 2 Petroleum Source Areas	2	2	8			State contract push-probe and analytical	PID and sampling equipment	GPS	Truck & sample shipping	VOC, GRO, DRO, RCRA metals	2 push-probe			12
Task B Soil and Ground Water Investigation, Subtask 3 Downgradient and Lateral of TCE/Petroleum Sources	8	8	40			State contract HPT/vertical profiling/push-probe and analytical	PID and sampling equipment	GPS	Truck & sample shipping	VOC, GRO, DRO, RCRA metals, PFC	10 HPT / 10 push-probe / 10 vertical profile			56
Task B, Soil and Ground Water Investigation, Subtask 4 Monitoring Well Installations / Development / Surveying / 1 Round of Sample Collection	4	4	24	12		State contract drilling and analytical	PID and sampling equipment	Survey and GPS	Truck & sample shipping	VOC, GRO, DRO, RCRA metals, PFC	6 Monitoring wells, likely screened 15-20', additional wells in subsequent phases not part of this proposal	Drilling cuttings, development & purge water		44
Task B: Soil and Ground Water Investigation, Subtask 5 Risk Surveys	1	4	8			None		GPS	Truck					13
Task C Stream and Sediment Investigation, Subtask 1	1	1	2			State contract analytical			Truck	VOC, RCRA metals, PFC				4
Task C Stream and Sediment Investigation, Subtask 2	1	1	2			State contract analytical			Truck	VOC, RCRA metals, PFC				4
Task C Stream and Sediment Investigation, Subtask 3	1	4												5
Remedial Investigation Report	4	12	40		12									68
Total for Objective 2 Hrs	28	42	148	12	12									242
Total Project Hours	**62**	**54**	**225**	**46**	**19**									**406**

MINNESOTA POLLUTION CONTROL AGENCY
520 Lafayette Road North
St. Paul, MN 55155-4194

Attachment B
Example Scenario A Project Spreadsheet
RESPONSE DESIGN and RESPONSE ACTIONS

Project title: Former Ag-Chem Plant, MPCA Site ID SA0002018, MDA Case File No. #####

	1. Personnel						2. Subcontracting	3. Equipment			4. Other Expenses								Totals (Extended)
Project Budget	Project Manager	Engineer II	Scientist II	Scientist I	Field Technician	CADD and/or GIS specialist	Per MPCA Purchasing Manual	Field Screening & Sampling	Measure & Survey	Transport, sample shipping	State Contract Lab (MPCA Parameters)	State Contract Driller (MPCA work)	State Contract Hazardous Waste Disposal	Other state contractor	MDA Contracted Lab (Ag lists) and Shipping - direct contract	MDA Contracted Tank Removal Contractor	MDA Contracted Contractor - Soil Disposal	MDA Contracted Contractor - excavation, hauling	
Objectives and sub-tasks																			
1) Vapor Intrusion Receptors																			
Task A - Receptor Risk and Mitigation Decision	6		12			2	Depends on need for expedited action		submeter GPS										20
Subtask 2 - Mitigation	4		8				Bidding SSD installation by state contractors		micro-manometer					MPCA to retain SSD installer					12
Post-Installation Monitoring	Depends on # installed	Depends on # installed	Depends on # installed	Depends on # installed	Depends on # installed	Depends on # installed		PID	micro-manometer										0
Total for Objective 1 Hrs	10	0	20	0	0	2													32
2) Groundwater Receptors																			
Task A - Surface Water, Buildings, & Utilities Risk Survey	2	2	4	12		2		PID	GPS	Truck									22
Task B - Water Well Risk Survey	2		2	8	8	2		Sampling supplies	GPS	Truck	Drinking water				Nitrate+nitrite-N, TKN, MDA List 1, MDA List 2				22
Task C - GAC System Installations	2				8			Sampling supplies		Truck	Drinking water			GAC vessel installer					10
Task D - Water Main Extension (Connections and well sealing)	4	8	4			2	Labor and contractor costs depend on alternatives chosen					For well sealing work		ADMIN-selected construction, possible subs bid					18
Total for Objective 2 Hrs	10	10	10	20	16	6													72
3) Response Actions - Garage																			
Task A - Vapor Mitigation (active SSD)	6		8	6		2	SSD installer, bid and state-contracted	PID and sampling equip.	micro-manometer	Truck	Sub-slab / indoor / outdoor air			SSD system installer(s)					22
Task B - Excavation of TCE-impacted soil	6	6		8	8	2	Bid per MPCA Purchasing Manual	PID and sampling equip.	Submeter GPS	Truck	Estimated 12-20 samples, VOCs		Likely disposal alternative						30
Task C - Remedial Alternatives and Pilot Test Work Plan submittal	18	60	26	2															106
Total for Objective 3 Hrs	30	66	34	16	8	4													158
4) UST Closure																			
Task A - Excavate gasoline UST	4		4		8		Purge and empty UST, remove and dispose of tank, excavate soil, install clean backfill	PID and sampling equip.	Submeter GPS	Mobilization, and sample shipping	4 sidewall, 1 base soil sample for MPCA-required analysis		Dispose of impacted soils						16
Task B - Floor drain UST Closed-in-place	2				6			PID and sampling equip.		Mobilization, and sample shipping	Fluid, sludge, soil analysis per MPCA requirements, Disposal profile requirements (TCLP-metals, TCLP-VOCs)	Investigation to include soil boring for UST closure soil sampling for MPCA required analytes	Dispose of solvent/petroleum impacted fluids, sludge, soil		Nitrate, as N, TKN, MDA List 1, MDA List 2, Ag-Chem related soil disposal profile requirements (TCLP-Pesticides)	Open floor slab to purge and empty UST, fill with inert structural fill, restore slab, recover sediment liquid from trench drain		Haul UST/drain waste	8
Excavation report (2 USTs)	1		2	6		2													11
Total for Objective 4 Hrs	7	0	6	6	14	2													35
5) Ag-Chem Correction Action																			
Task A - Soil excavation and concrete removal / scale sediment/water recovery, if necessary	8			Dependent on Soil Volume				PID to segregate petroleum/TCE impacted soil		Truck								Excavate soil, remove concrete in areas where underlying soil requires excavation, backfilling concrete, hauling	8
Task B - Soil Disposal Coordination, Land Application Proposal	6			16				PID							Ag-Chem Stockpile - Nitrate, as N, TKN, MDA List 1, MDA List 2, Multiple Source Stockpile - Disposal profile requirements (TCLP - pesticides, TCLP-VOCs, TCLP metals		Spreading contractor to land apply ag-chem stockpile and scale water, disposal facility for multiple source stockpile	Soil /water hauling to land application site, soil disposal at facility, if necessary	22
Reporting - Corrective Action Report	2		4	6															12
Total for Objective 5 Hrs	16	0	4	22	0	0													42
Total Project Hours	73	76	74	64	38	14													339

NOTES:
Hours totaled only, per RFP. Refer to Work Plan text for assumptions and work scope
Mitigation decisions must be made during performance of the work shown above; WCEC assumes that in-task rebudgeting can occur, to fund the combination of actual responses required in response to site conditions

MINNESOTA POLLUTION CONTROL AGENCY
520 Lafayette Road North
St. Paul, MN 55155-4194

Example Workplan

Project Title: Remedial Investigation (RI) Sampling Plan
Former Ag-Chem Plant, MPCA Site ID SA0002018

1. Project Summary

The site is a former agricultural chemical (ag-chem) plant that operated from 1960 to 1991 and has been purchased for redevelopment into a golf course. The site is being investigated under the MPCA Site Assessment (SA) program because the property owner is no longer working cooperatively with the MPCA, and several neighborhood communities have expressed concerns about their health risk.

Ag-chem contamination has been documented in soil and groundwater collected at the site. In 1997, a groundwater sample collected from the shallow (30-foot) on-site well by the MDA documented concentrations of nitrate (116 mg/L), metolachlor (424 µg/L), and dicamba (283 µg/L) at levels above Minnesota Department of Health (MDH) Health Risk Limits (HRLs). A previous limited push probe investigation identified nitrogen, dicamba, metolachlor, metribuzin, pendimethalin and triclopyr in soil and groundwater above agency-regulated cleanup goals. Evidence (discolored soil and site records) suggest that discharge has occurred to the north of the fertilizer building. The fertilizer building burned down in 1999. Firefighting foam was applied.

In addition to ag-chem impacts to the environment, extensive degreasing of parts occurred at the maintenance garage. Discharge of degreaser directly to ground north of the maintenance garage has resulted in trichloroethylene (TCE) impacts to soil and groundwater. TCE has been detected above the HRL in three domestic wells located downgradient of the presumed groundwater flow direction (west) from the site. TCE vapors were detected above commercial intrusion screening values (ISV) in sub-slab samples collected from beneath the maintenance garage and above residential ISV in soil gas and sub-slab samples in the neighborhood downgradient of the site. Potential impacts to the on-site well by volatile organic compounds (VOCs) have not been evaluated. Potential impacts to the environment from a heating oil aboveground storage tank (AST) at the maintenance garage and a gasoline underground storage tank (UST) near the former fertilizer plant have not been evaluated.

As part of the RI, an exposure pathway assessment and contamination impact survey will be completed. Existing information suggests potential for human or ecological exposure at the stream; direct soil exposure north of the fertilizer building, maintenance garage and in ag-chem handling areas; exposure to soil vapors; and exposure to contaminated groundwater and drinking water. It is assumed that there are no physical access restrictions to the site by the public. The magnitude, lateral and vertical extents of soil, groundwater, and vapor contamination are undefined. The stream has not been evaluated.

2. Statement of Problems, Opportunities, and Existing Conditions

Problems

- The extent of TCE vapors and impacts to soil and groundwater is unknown
- The extent of ag-chem impacts to soil and groundwater is unknown
- Potential impacts to the stream are unknown
- Potential petroleum impacts to the environment associated with the 1,000-gallon UST have not been evaluated
- Potential petroleum impacts to the environment associated with the 500-gallon fuel oil AST have not been evaluated; stained soils were noted beneath the AST
- Potential petroleum impacts to the environment have not been evaluated
- Potential Perfluorochemical (PFC) impacts associated with the firefighting foam applied to the dry fertilizer building have not been evaluated
- The concrete floor of the fertilizer building is in poor condition and has been exposed to environmental conditions for nearly 20 years. Based on the inferred high permeability of the subsurface unit, underlying ag-chem contamination has likely been dispersed/mobilized by surface water infiltration
- The UST beneath the maintenance garage is likely discharging contamination (ag-chem, TCE and petroleum) to the subsurface
- There are four at-risk shallow wells located immediately downgradient of groundwater flow from the site that are screened at the same depth as the on-site supply well, in which ag-chem impacts above MDH Health Risk Limits (HRLs) have been documented; TCE impacts have been documented in three of these wells
- The presence and location of any community and non-community public water supply wells is unknown

- Site geology is indicative of high hydraulic conductivity and transmissivity; the potential for contaminant migration is high
- Laminations of silt in more granular soils beneath the garage where TCE has been identified raises potential for DNAPL "pools" to exist, and increased contaminant migration pathway complexity
- Contiguous/competent confining layer may not be present to limit deep migration of DNAPL
- Potential for heaving sands may require adding water or other alternative soil sampling or drilling technique

Opportunities

- Where possible, WCEC will combine ag-chem and TCE/petroleum/PFC investigation activities to reduce associated personnel, mobilization and equipment expenses. This includes on-site tasks such as sampling and soil boring oversight, as well as office-related tasks such as project scheduling/coordination, well receptor surveys, etc.
- Monitoring well placements provide value for both the ag-chem investigation and the TCE/petroleum/PFC investigation; although monitoring well placements were determined based on risks and information associated with independent source area(s), monitoring wells proposed for one purpose can be used in the future to assess risks associated additional contaminants/source areas at the site.
- No limitation to excavation of ag-chem and TCE impacted surface soils outside the maintenance building
- Concrete floor of maintenance garage is intact and will remain for future use; this will reduce receptor exposure risks in the building, and may aid in effective vapor mitigation
- The maintenance garage has no occupants, which allows remedial activities to be completed without usage conflicts
- Future land use for the site is known (golf course), which will guide the risk evaluations completed during the investigations

Assumptions

Certain assumptions have been established in order to expand on the given scenario. These assumptions were used to create a logical sequence of events to direct site management decisions following established MPCA and MDA programs and Guidance Documents. These assumptions help to establish probable outcomes and include the following:

- WCEC assumes that property owners involved have granted consent for MDA/MPCA/WCEC access to the areas required.
- The vapor results provided by the RFP are assumed to be in the past two years, and valid for use in our planning.
- Previous soil sampling has documented nitrogen and pesticide impacts above agency-related cleanup goals. It is assumed that proposed soil investigation activities are to investigate identified ag-chem High Risk Areas (HRAs) at the site, rather than to delineate the lateral extent of previously-documented soil impacts.
- The scale provided on Scenario A, Figure 1 (p. 35, Request for Proposal for Remediation Master Contract) was applied when creating additional figures. The scale was directly applied when drawing site features such as buildings, doorways and HRAs.
- It is assumed that subcontracted services associated with ag-chem investigation tasks will be contracted directly by the MDA.
- A private utility locator can be directly contracted, so this need not be included in purchasing related to the TCE/petroleum and PFC investigation.
- The site topography is noted as mostly flat, with the elevation dipping downward toward a small stream. It is assumed that surficial runoff from the site flows to the north, along this slope; we also assume the slope is gradual enough to allow access by the push-probe rig.
- It is assumed that the inside of the shop/maintenance building is accessible by a truck-mounted push probe drill rig. If not, a track-mounted probe should be utilized.
- The vehicle/maintenance garage is noted as being intact and in good condition for future use. It is assumed that this building will remain intact throughout the investigation and subsequent corrective actions.
- There are four access doors to the fertilizer building; two large overhead doors, a small overhead door, and a small service door on the south side of the building. It is assumed that the service door on the south side of the building is used only for entry and egress of personnel and not for equipment or fertilizer/pesticide product.
- It is assumed that both impregnated and non-impregnated fertilizer was loaded on the west side of the fertilizer building.
- It is assumed that the equipment doorway of the vehicle/equipment maintenance garage is on the west side of the building, based on the orientation of the trench-style floor drain.
- It is noted that discolored soil was reported to the north of the fertilizer building and north of the maintenance garage. It is assumed that the discolored soil may be related to the discharge of ag-chem products/rinsate. These areas will be sampled for ag-chem impacts. If site observations suggest that discolored soil is due to TCE or other contaminant sources, appropriate samples will be collected from these areas.

- It is noted that parts degreaser was regularly poured onto the ground near the stream, presumably north of the maintenance garage. This area will be assessed for TCE impacts.

In addition, incidental assumptions may be cited throughout the work plans, as part of the discussion of site decisions and probable future stages of work.

Existing Conditions (Preliminary Conceptual Site Model)

The following outline for a preliminary Conceptual Site Model (CSM) is based on the RFP-provided information. The findings of this proposed investigation will be used to refine the CSM and identify critical risk pathways and receptor impacts in the response actions to follow this phase of work:

Contaminant Sources

TCE Sources - Degreasing solvents that contained TCE were used extensively at the former maintenance garage and likely entered the trench floor drain that discharged to the 500-gallon UST. Although no evidence of DNAPL has been found at the site, investigative sampling has not been completed where used parts degreaser was reportedly (former employee statement) regularly poured onto the ground near the stream.

The property owner conducted a limited investigation consisting of several push probes throughout the facility and adjacent property. This investigation identified TCE in soils and groundwater above agency-regulated cleanup goals.

A TCE-contaminated groundwater plume (ag-chemicals not evaluated in groundwater except for the on-site well) appears to extend west from the source area (former maintenance garage) into the adjacent mixed use (assumed) neighborhood south of the stream. This shallow plume of TCE-contaminated groundwater appears to be the source of TCE vapors detected in soil gas and sub-slab samples.

Ag-Chemical Sources
The site has not operated since 1991. It is assumed that ag-chem products have not been handled at the site since this time. During its operational period of 31 years, the primary source of ag-chem was the dry fertilizer building, used to store fertilizer and pesticide products. Based on previous sampling data, pesticide products stored and handled at the site included both neutral-base (MDA List 1) and acid-base (MDA List 2) pesticides. Blending/mixing of pesticides occurred in the western portion of the building. Fertilizer and pesticide products were also likely handled in the water fill area, at the scale, in two equipment parking areas (north and south of the fertilizer building) and the maintenance garage, used to wash and maintain equipment. It is likely that fertilizer and pesticide products were discharged from the trench floor drain in the maintenance shop to the 500-gallon UST. Additional areas of concern include surficial runoff from the site, the stream to the north, and north of the fertilizer building and garage where discolored soil and records of a discharge have been noted.

Other Sources
Firefighting foam applied to a fire at the fertilizer building in 1999 may be a source of PFC contamination. The 1,000-gallon gasoline UST at the fertilizer building may be a source of VOC contamination, including fuel additives (Pb, EDB, 1,2-DCA, MTBE). The 500-gallon fuel oil AST at the maintenance garage may be a source of VOC contamination.

Geology and Hydrogeology

General geology was noted to consist of coarse grained sands with thin lenses of silt and clay, as shown on geological cross-sections of the area beneath the former maintenance garage. The geology has been evaluated to approximately 28 feet below ground at the former maintenance garage. Geology between the source area and the adjacent neighborhood to the west is assumed to be the same, but geology below 30 feet is unknown.

The limited push-probe investigation completed by the property owner encountered shallow groundwater approximately 6 to 10 feet below the ground surface (bgs) with an assumed westerly flow direction into town. The horizontal hydraulic gradient is unknown, but site topography is mostly flat; vertical hydraulic gradients are also unknown.

The site elevation dips downward toward a small stream running through the northern portion of the property. This stream continues into the town and it is assumed shallow groundwater discharges to the stream. Older portions of the town (situated closer to the former ag-chem plant) are on private well drinking water (blocks 3, 5, and 7) with wells reported to be approximately 30 feet deep. Newer portions of the town (farther from the former plant) are on community water from the local municipality (blocks 1, 2, 4, and 6). The number, location, depth, construction, and quality/nature of community and/or non-community public supply wells is unknown.

Spatial Distribution of Contaminants

TCE

Based on the limited push-probe investigation, TCE is present in soil and groundwater beneath the former maintenance garage. TCE concentrations in soil and groundwater decrease with depth beneath the former maintenance garage. Soil concentrations of approximately 100-125 mg/kg at the water table decrease to approximately 5 mg/kg at 25-30 feet below ground; groundwater concentrations of 500 µg/L at the water table decrease to 10 µg/L or less at approximately 25-30 feet below ground.

TCE concentrations in shallow groundwater (15 feet at borings, 30 feet at domestic wells) decrease to the west, in the assumed direction of groundwater flow. TCE concentrations east of the maintenance garage are unknown but assumed to decrease to non-detectable levels. TCE concentrations in soil and groundwater north of the stream area unknown (with the exception of no detection in shallow (15 feet) groundwater at the southeast corner of block 3).

TCE vapor concentrations in soil gas decrease significantly to the west of the former fertilizer building (200 µg /m3) but persist at similar concentrations (100-115 µg/L /m3) downgradient in blocks 5 and 7. TCE vapors were not detected in soil gas samples collected at two locations NW of the former fertilizer building and to the west in block 3.

Agricultural Chemical

The previous limited push probe investigation identified nitrogen, dicamba, metolachlor, metribuzin, pendimethalin and triclopyr in soil and groundwater above agency-regulated cleanup goals. Information regarding contamination locations and depth was not provided. Discolored soil has been noted at the surface to the north of the fertilizer building and garage. The UST beneath the maintenance garage has likely discharged contamination beneath the surface.

In 1997, a sample collected from the shallow (30-foot) on-site well by the MDA contained concentrations of nitrate (116 mg/L), metolachlor (424 µg/L), and dicamba (283 µg/L). Impacts to the stream were not evaluated during the investigation.

Contaminant Migration Pathways and Potential Receptors

Contaminants have migrated from ground (and the trench drain UST) to the shallow water table and with groundwater flow to the west. The plume of contaminated groundwater is generating volatile vapors that have migrated into buildings.

Potential receptors of soil contamination include direct human contact and groundwater. Potential receptors of contaminated groundwater include the stream, buildings (sumps), underground utilities, and the on-site well and domestic and public supply wells. Potential receptors of VOC vapors include the on-site and off-site buildings and underground utilities.

3. Goals, Objectives, Tasks, and Subtasks

The goal of the remedial investigation is to collect data to characterize site conditions, determine the nature of wastes, and assess risk to human health and the environment. This information is required to develop site decisions and corrective actions.

During site characterization, objectives include defining the lateral and vertical extent of contamination in free-phase (LNAPL and DNAPL), dissolved phase, vapor phase, and the adsorbed or solid phase and to determine associated risks. Objectives are:

1. **Complete Ag-Chem Soil Investigation**
2. **Complete Solvent and Petroleum Investigation**

Section 4 provides a discussion of the tasks proposed for each objective, with subtasks to briefly describe the specific activities associated with each item. Risk assessments, unique to each investigation (per applicable regulatory requirements), are described within each objective.

As with the RI work plan and spreadsheet, the primary sub-tasks associated with the above goal and objectives are identified in this Work Plan and the corresponding spreadsheet. These are general in nature and do not describe every professional activity or use of equipment in great detail; the intention is to provide an outline of activities that follow the applicable MDA and MPCA program guidelines in response to the available information provided in the RFP.

As with the RI level of effort spreadsheet, only the general staff classifications appear on the estimate of hours provided. WCEC will seek to combine mobilizations and tasks between the MDA and MPCA program work and assign the lower applicable staff classification where appropriate to increase cost-effectiveness.

A formal feasibility study for the development, screening, and detailed evaluation of alternative remedial actions, has not been requested at this time but is a separate attachment per the RFP requirements. Data collected during the RI and during pilot testing in the RD/RA phase of work will be used to evaluate the potential performance and cost of the treatment technology selected for pilot testing. A phased RI approach is proposed to determine monitoring well locations and screen depths to limit unnecessary data collection and maximize data quality.

4. Scope of Work

Objective 1: Complete Agricultural Chemical Investigation

Based on the historical information available for the site, nine High Risk Areas (HRAs) have been identified. HRAs are highlighted on Figure 1. HRAs and associated chemicals of concern (COCs) are listed in Table 1. WCEC has identified additional risks associated with contamination at the site including four water supply wells located downgradient of groundwater flow from the site and the stream located immediately north of the site. Conditions at the site require that the MDA's high risk to groundwater cleanup goals (cleanup goals) be applied to evaluate site data and guide the investigation.

Task A: Soil Investigation
Collection of soil samples is recommended in each of the HRAs. A general discussion of recommended soil sampling parameters is provided below; specific soil sampling parameters are detailed in Table 2. Soil sampling depths will be completed to the depth of 5 feet, unless otherwise noted.

Former dry fertilizer building (SL1-SL13) – The remaining concrete slab is cracked. It is assumed that there is a fertilizer leg/loading area on the west side of the fertilizer building. Soil beneath the concrete foundation, all equipment doorways, the loading area, and the mixing/blending area should be assessed. Soil borings will be completed through cracks/fractures/joints in the floor. Soil borings through the concrete floor will be completed in a grid pattern. Deeper soil borings are recommended in this HRA based on the age of the building and the condition of the floor (10 feet below surface grade or the base of the concrete). Four of the borings through the concrete floor (SL2, SL4, SL6, SL8) should be extended to a depth of 15 feet. It is recommended that all soil collected within this area is analyzed for both nitrate as nitrogen (nitrate-N) and total Kjeldahl nitrogen (TKN).

Pesticide products were handled in the mixing/blending area on the west side of the building (SL4) and presumably loaded in and out on the west side of the building, at the west doorway (SL12) and loading area (SL13). In addition to nitrate- N and TKN analyses, samples collected from these pesticide handling areas should be analyzed for MDA List 1 Pesticides and MDA List 2 Pesticides. In sampling locations surrounding these areas, MDA List 1 and List 2 Pesticide samples should be collected and held in the freezer (for up to six months), in the case that lateral delineation of pesticide impacts is necessary around the pesticide handling areas.

Scale (SL14-SL17) – Soil samples should be collected on each side of the scale. Loose gravel surrounds the scale pad. Soil samples will be collected from a depth interval of 0-6 inches and 2-2.5 feet below the base of the gravel. Samples will then be collected at six-inch depth intervals every two feet to the base of the scale pit. Additional, deeper sampling is necessary in this area because of the presence of the scale pit. Soil samples will be collected from a depth interval of 0-6 inches beneath the base of the scale pit, 2-2.5 feet below the base of the scale pit and 4.5-5 feet beneath the base of the scale pit or the water table, whichever is encountered first. All sample depths will be referenced from the ground surface for identification purposes. Samples from this area should be analyzed for nitrate-N, TKN, MDA List 1 Pesticides and MDA List 2 Pesticides.

If there is water or sediment present within the scale pit, a sample will be collected. If there are detectable levels of nitrate-N, TKN, MDA List 1 Pesticides or MDA List 2 Pesticides, the water and/or sediment will be removed from the scale pit during corrective actions (Remedial Design/Remedial Action [RD/RA] Workplan).

Equipment parking – south (SL18-SL19) – Soil samples should be collected from this area and analyzed for nitrate-N, TKN, MDA List 1 Pesticides and MDA List 2 Pesticides.

Equipment parking – north (SL20-SL21) – Soil samples should be collected from this area analyzed for nitrate-N, TKN, MDA List 1 Pesticides and MDA List 2 Pesticides.

Vehicle/equipment maintenance garage (SL22-SL26) – The concrete floor of this building is in good condition and the building will presumably remain in use. Based on the trench drain configuration, it is assumed that the equipment doorway is on the west side of the building. Soil samples will be collected from outside of the equipment doorway (SL22). The trench floor drain within the building is connected to a UST that is assumed to have leaked. It is recommended that a boring be advanced through the concrete floor, adjacent to the UST (SL23), so that impacts within this source area can be quantified (note that a section of the concrete floor in this area will be removed and replaced as part of corrective actions to address the UST). This boring should extend to five feet below the base of the UST or the water table, whichever is deeper. Borings will be completed outside of the northwest corner of the building (SL24-SL26). These borings should extend to five feet below the base of the UST or the water table, whichever is encountered first. Samples collected within this HRA will be analyzed for nitrate-N, TKN, MDA List 1 Pesticides and MDA List 2 Pesticides. Additional sampling and corrective actions relating to the trench drain and UST are addressed in the separate RD/RA Workplan.

Stained soil – north of the vehicle/equipment maintenance garage (SL27) – Discolored soils were reported north of the vehicle/equipment maintenance garage and records suggest that a discharge, assumed to be ag-chem products/rinsate, has occurred in this area. Soil samples should be collected and analyzed for nitrate-N, TKN, MDA List 1 Pesticides and MDA List 2 Pesticides. If site observations suggest that discolored soil is due to TCE or other contaminant sources, appropriate additional samples will be collected from this area.

Stained soil – north of former fertilizer building (SL28) - Discolored soils were reported north of the former fertilizer building and records suggest that a discharge, assumed to be ag-chem products/rinsate, has occurred in this area. Soil samples should be collected and analyzed for nitrate-N, TKN, MDA List 1 Pesticides and MDA List 2 Pesticides. If site observations suggest that discolored soil is due to TCE or other contaminant sources, appropriate additional samples will be collected from this area.

Runoff (SL29-SL31) – Surficial runoff is to the north, along the downward slope towards the stream. Sampling in this area will be completed to assess whether ag-chem runoff has occurred. If staining or distressed vegetation is observed, sampling locations will be added and/or adjusted to include these areas (the MDA will be notified prior to the sampling modification). Soil samples should be analyzed for nitrate-N, TKN, MDA List 1 Pesticides and MDA List 2 Pesticides.

Waterfill (SL32) – Nitrate and pesticide (metolachlor and dicamba) impacts were documented at levels above MDH HRLs in the shallow well (30' deep); no additional construction information is known regarding this well; the presumed age of the well suggests that there is likely no well record. It should be considered that construction of this well (such as improper grouting) may potentially be contributing to groundwater contamination in this area. The well may have been a conduit for contamination. The boring in this area will be completed to the well depth (30') to assess the vertical contamination profile. Soil samples should be collected and analyzed for nitrate-N, TKN, MDA List 1 Pesticides and MDA List 2 Pesticides.

Subtask 1: Coordinate and schedule drilling event
A drilling contractor will be hired to install soil borings using push probe technology. The drilling contractor and any additional subcontracted services, such as a private utility locating, will be contracted directly by the MDA. WCEC will schedule and coordinate the on-site drilling activities with the drilling contractor. Drilling activities will be coordinated in conjunction with the MPCA investigation drilling activities, as practicable.

Subtask 2: Drilling Investigation
WCEC will be on-site to oversee boring installation, collect soil samples and record detailed stratigraphic information. Composite and discrete soil samples will be collected as indicated on Table 2 and described in WCEC's methodologies and procedures (Appendix A). Composite soil samples will be collected from all sampling locations not overlain by concrete at the surface (0-6 inches) and at the 2.5-foot (2-2.5 feet) depth below the surface or below the base of the loose gravel, where present. Composite samples will be collected from equal volume subsamples collected from a common vertical depth interval at three equally-spaced borings within a 15-foot diameter sampling area. In areas overlain by concrete, the 0-6-inch and 2-2.5-foot intervals will be collected as discrete, rather than composite, samples.

Discrete soil samples will be collected from a centrally-located boring within each sampling location at sampling depths of 4.5-5 feet and greater. A field duplicate will be collected for approximately 10% of the soil samples, as described in the Appendix A, along with procedures for decontamination, chain of custody, and quality control/quality assurance.

Drill cuttings will be thin spread on-site. Cuttings from areas known or suspected to be contaminated with TCE/PFC/petroleum impacts will be combined and disposed of with petroleum and solvent investigation cuttings.

Subtask 3: Process Laboratory Samples
Soil samples from the former fertilizer handling and storage areas will be analyzed for nitrate-N and TKN. Soil samples collected from areas where pesticides were stored or handled will be analyzed for MDA List I Pesticides and MDA List 2 Pesticides. The 2.5-foot samples from all sample locations will be submitted immediately for analytical analysis. In select areas, deeper samples will also be submitted for initial analyses, as indicated on Table 2.

Samples will be analyzed by an MDA-approved laboratory selected and contracted directly by the MDA. All retained soil samples, not immediately submitted, will be stored under frozen conditions and chain-of-custody until analysis of these samples is required (up to six months as per *MDA Guidance Document 11- Soil Sampling Guidance*).

Subtask 4: Sample Recommendations/Additional Analyses
Initial analytical soil data will be compared to MDA's high-risk to groundwater cleanup goals (cleanup goals). Recommendations for additional soil analyses will be submitted to the MDA for review along with the analytical report, tables summarizing analytical results, the MDA *Laboratory Data Review Checklist*, boring logs, and a map showing sampling locations. Additional samples will be submitted for analyses only after MDA approval.

Task B: Surface Water Assessment
Previous investigation activities did not evaluate potential impacts to the stream bordering the northern edge of the property. Water samples will be collected from the stream in the following areas:

- Northeast of the former fertilizer building/northwest of the vehicle/equipment maintenance building (Stream Sample East)

- Northwest of the former fertilizer building (Stream Sample West)
- Northeast/upstream of the vehicle/equipment maintenance garage (Stream Sample Upgradient)

Samples will be collected in conjunction with soil sampling activities. Samples will be submitted to the MDA-contracted laboratory for analyses of nitrate+nitrite as nitrogen (nitrate/nitrite-N), TKN, MDA List 1 Pesticides and MDA List 2 Pesticides.

The Minnesota Department of Natural Resources (DNR) requires a "General Permit" for transporting surface water quality samples (at no cost). The intent of the permit is to protect against the spread of aquatic invasive species (AIS). The permit applies to all surface waters. A permit will be obtained prior to collecting the stream sample. DNR procedures will be followed when collecting, handling, and disposing of the sample. Permitting and procedural information will be referenced from DNR website: https://www.dnr.state.mn.us/invasives/ais_watersampling.html

Task C: Groundwater Investigation
Groundwater at the site has been impacted by ag-chem, as documented by previous groundwater sampling data collected from the site well and from previous push probe borings. To determine the extent of groundwater impacts and to evaluate risks to receptors, groundwater samples will be collected from soil borings (temporary monitoring wells), from the site well and from monitoring wells.

Subtask 1: Temporary Monitoring Well Installation/Sampling
To quantify the magnitude of groundwater impacts within source areas, groundwater samples will be collected in two the highest risk areas of the site; the former fertilizer building (SL4) and next to the UST beneath the maintenance garage (SL23). A 5-foot long PVC screen will be installed in each of these borings to intercept the groundwater table. Following sample collection, the borings will be sealed in accordance with the MDH Well Code. Samples will be submitted to the MDA-contracted laboratory for analyses of nitrate/nitrite-N, TKN, MDA List 1 Pesticides and MDA List 2 Pesticides.

Subtask 2: Site Well
Nitrate and pesticide (metolachlor and dicamba) impacts were documented at levels above MDH HRLs in this well in 1997. A groundwater sample will be collected from this well during the boring investigation. The well will be purged prior to sample collection. The groundwater sample will be submitted to the MDA-contracted laboratory for analyses of nitrate/nitrite- N, TKN, MDA List 1 Pesticides and MDA List 2 Pesticides.

Specific construction details and grouting information for this well are unknown. It should be considered that, if improperly grouted/constructed, this well may have acted as a conduit for contamination. Deep soil sampling will be completed in this area to characterize the vertical contamination profile. If data suggest that this well has acted as a conduit for contamination, the well should be sealed by a drilling contractor during future phases of work. If the well does not appear to be a conduit, the well should be sampled as part of an on-going groundwater investigation.

Subtask 3: Monitoring Well Installation
A total of four monitoring wells are proposed to document impacts within source areas of the site (MW1, MW2) and downgradient of groundwater flow from the source areas (MW3, MW4). Proposed monitoring well locations are shown on Figure 3 and briefly described below. Monitoring wells in source areas are proposed outside of anticipated corrective action boundaries.

- Monitoring Well MW1 – This well is adjacent to the former fertilizer building, outside of the anticipated corrective action boundary. This monitoring well will assess impacts near one of the suspected worst-case areas.

- Monitoring Well MW2 – This well is on the west side of the maintenance garage and will assess groundwater impacts associated with the maintenance garage UST, assumed to have discharged contamination to the subsurface.

- Monitoring Well MW3 – This well is located downgradient of groundwater flow from HRAs at the site, between HRAs and two residential wells on block five.

- Monitoring Well MW4 – This well is located downgradient / side gradient of groundwater flow from HRAs at the site, between HRAs and two residential wells on block seven.

This monitoring well configuration allows for groundwater contouring, contaminant characterization at source areas and evaluation of risks to receptors downgradient of groundwater flow from the site. In the future, additional monitoring wells may be proposed based on RI sampling and monitoring well data. Additionally, monitoring wells installed as part of the MPCA investigation may be sampled for ag-chem impacts.

A 10-foot long PVC screen will be installed to intercept to the groundwater table and allow for seasonal fluctuations in water levels. Based on historical information provided for the site, it is anticipated that the wells will be screened from 5-15 feet, however, the screen depth may be adjusted in the field (the MDA will be notified of any adjustment/modifications). A monitoring well construction diagram is included in Appendix B.

The monitoring well installation will be coordinated in conjunction with the soil investigation. A state contract driller will be hired directly by the MDA. A WCEC scientist will be on-site to oversee the well installation and record detailed stratigraphic information. Monitoring wells will be completed in compliance with the MDH water well construction code. Monitoring wells will be developed following installation. Drilling methods and development procedures are included in Appendix A.

Subtask 4: Monitoring Well Sampling
An initial groundwater monitoring event will be completed one week after monitoring wells are installed. During the monitoring event, the well elevations and the ground surface will be surveyed, groundwater elevation data will be collected, the monitoring wells will be slug tested and groundwater samples will be collected (after stabilization parameters have been met) in accordance with the procedures outlined in Appendix A. Groundwater samples will be submitted to the MDA-contracted laboratory for analyses of nitrate/nitrite- N, TKN, MDA List 1 Pesticides and MDA List 2 Pesticides.

Subtask 5: Residential Wells
There are four residential wells located immediately downgradient of groundwater flow from the site (blocks five and seven). These wells are completed at the same depth as the site supply well (30 feet), in which nitrate, metolachlor and dicamba impacts have been documented at levels above MDH HRLs. It is recommended that groundwater samples be collected from the four residential wells. The residential wells will be sampled as part of (expedited) remedial design/remedial action (RD/RA) activities under the MPCA scope (Remedial Design/Remedial Action [RD/RA] Workplan, Objective 2, Task B). The wells will be sampled for nitrate/nitrite- N, TKN, MDA List 1 Pesticides and MDA List 2 Pesticides at that time. Sampling is further discussed in the RD/RA scope of work.

Task D: Contamination Impact Survey
A Contamination Impact Survey will be completed to assess exposure pathway risks to human health, groundwater, surface water, and other potential receptors.

Human Exposure – The site will be redeveloped into a golf course and will be accessed by the general public on a day-to-day basis, making risks associated with the shallow soil pathway high. Property re-use will be considered when completing the Contamination Impact Survey and designing corrective actions at the site.

Groundwater – Risks to groundwater will be assessed. If sampling data from the downgradient residential wells suggest that the regional aquifer has been impacted, well logs and locations will be provided for all wells that utilize the impacted aquifer within a two-mile radius. Local authorities, county water planning officials, local well drillers and adjacent property owners will be contacted for information regarding unregistered or abandoned wells within one mile of the site and future groundwater development plans within one mile to the west (downgradient) of the site. Information regarding the municipal water source will also be obtained.

Surface Water - The stream to the north is within 200 feet of the site. If analytical data gathered during the investigation suggest that the stream is receiving or likely will receive discharge as a result of groundwater seepage or surface runoff, the water use, and classification will be provided. If likely or actual discharge is from groundwater, mass loading calculations will be submitted.

Other Potential Receptors – Any additional potential receptor(s) identified during the investigation will be assessed as part of the Contamination Impact Survey.

Objective 1 Timeline: The drilling investigation will be completed when a state-contract drilling firm and laboratory have been contracted by the MDA. The soil borings will be installed in conjunction with the monitoring well installation and development event. During the investigation, the stream and site well will be sampled. If feasible, the drilling activities will be completed in conjunction with drilling activities associated with the MPCA investigation.

Water samples will be submitted immediately; soil samples will be submitted incrementally, in rounds. Following receipt, WCEC will provide soil analytical data and recommendations/interim reports to the MDA within five days (likely less). Residential well data will be supplied immediately (within one day) upon receipt. If data suggest that treatment of the residential wells is necessary, WCEC will prepare a plan for immediate water supply provisions and corrective actions. The monitoring wells will be sampled, surveyed and slug tested one week after installation.

Objective 1 Deliverables: Interim analytical data reports and recommendations; *Remedial Investigation Report/Corrective Action Plan* and the Contamination Impact Survey; *Groundwater Monitoring Report* (to include groundwater data, installation information, survey information and slug testing data)

Objective 2: Complete Solvent and Petroleum Investigation

Receptor surveys will be conducted concurrent with investigation activities to determine risk to domestic and public water wells, and risk associated with chemical vapors. Risk associated with contaminated surface soils may be addressed by interim actions including restricting site access.

Currently available information indicates the on-site well and off-site domestic wells are shallow (~30 feet); no information is available regarding community or non-community public supply wells. A preliminary evaluation of extending potable water to blocks

3, 5, and 7 may be completed, or distribution of point-of-use filters, as part of the RD/RA work order. A walking survey related to vapors will include all of blocks 5 and 7 based on known vapor impacts to the approximate eastern halves of blocks 5 and 7. A walking survey of block 4 east of the stream (1 building) and of block 6 (5 to 6 buildings) will be completed if additional sampling indicates the potential for vapor impacts to those blocks.

Receptor surveys and preliminary risk evaluations may be used to prioritize potential interim corrective actions that may be necessary as the remedial investigation is being completed.

Objectives for the site assume that property owner consent to access has been achieved by MPCA/MDA. Actions necessary to accomplish objectives include administrative tasks required by the State of Minnesota.

Task A: Surface Soil Investigation
Shallow soil borings will be completed in a grid pattern at the area of discolored soil north of the maintenance garage. In addition to evaluating risk from direct contact and to groundwater, the work will help evaluate if concentrations are high enough to result in runoff discharge to the stream above applicable surface water standards.

Soil samples will be collected continuously from ground surface to the water table using push-probe dual-tube methods. Soil samples will be containerized in polyethylene bags and screened in the field with a photoionization detector (PID) equipped with a 11.7 eV lamp. One surface (0-6 inches) soil sample, and one soil sample from the water table will be collected from each soil boring; one soil sample from an intermediate depth will be collected from the depth of highest PID meter reading (if any) or a depth of one-half the distance from surface to the water table. Soil samples will be analyzed for VOC and RCRA metals.

Task B: Soil and Groundwater Investigation
If surface soil sampling north of the maintenance garage in Task B indicates DNAPL is present, then drilling will begin away from the known source area before drilling at the source area to form a reliable conceptual model of site hydrogeology, stratigraphy, and potential DNAPL pathways. Selected soil borings will be converted to monitoring wells for continued monitoring in later phases of work. During the monitoring well installation portion of investigation, special precautions will be taken at the source area to ensure that drilling does not create pathways for vertical migration of free-phase DNAPL.

The lateral extent of TCE impacts to groundwater are undefined, except at approximately 15 feet below ground in borings to the southwest in the southeast corner of block 7 and to the west in the southeast corner of block 3. The lateral extent in deeper groundwater is undefined.

The vertical extent of TCE concentrations was defined to below the HRL at approximately 25 to 27 feet below ground at SB-11 at the NE corner of the building. The deepest groundwater samples (same depth range of 25 to 27 feet) from all other borings exceeded the TCE HRL. Other than shallow groundwater samples at SB-7, where TCE concentrations were detected at 500 µg /L at approximately 5 and 10 feet below ground, the highest concentrations of TCE were detected at approximately 17 to 19 feet below ground at SB-3, SB-4, SB-7, and SB-16 (and approximately 10 feet at SB-16). Groundwater concentrations of TCE decreased to 10 µg /L or less at approximately 25 to 27 feet.

Subtask 1: Maintenance Garage (Solvent Source Area)
A significant number of soil and groundwater samples were collected from 10 borings completed through the maintenance garage slab. Although the vertical extent of impacts was not defined at depth, concentrations decreased to low levels at 25 to 30 feet below ground indicating additional drilling can be completed outside the building.

The source-area investigation will be completed using membrane interface probe / hydraulic profiling tool (MiHpt) to evaluate the vertical distribution of TCE and transmissive zones in the shallow sand unit. The MiHpt is a combination probe that can perform MIP, HPT, and EC measurements in one push. The MiHpt probe detects volatile contaminants with the MIP, measures soil electrical conductivity with a standard dipole array, and measures HPT injection pressure using the same down-hole transducer as the stand-alone HPT system. In post-processing the log data, hydraulic conductivity (K) and water table elevation can be estimated.

Borings are proposed on all four sides of the maintenance garage and through the area of surface soil impact (Figure 4): adjacent the building to the south where the heating oil AST is present, adjacent the building to the north where the highest levels of TCE impacted groundwater was detected, adjacent the building to the west, through the solvent dumping area evaluated in Task 1, and to the east to define impacts in the upgradient direction.

Using the MiHpt data, soil and groundwater sampling will be completed at key locations and depths to collect discrete soil and groundwater samples for laboratory analysis for VOC by EPA Method 8260. Soil samples will be collected continuously using push-probe dual-tube methods from ground surface to approximately 30 feet below ground, or deeper depending on MIP results. Soil samples will be containerized in polyethylene bags and screened in the field with a photoionization detector (PID) equipped with a 11.7 eV lamp.

Groundwater samples will be collected using a 2-foot long stainless steel discrete groundwater sampler driven by push-probing in an adjacent hole. Groundwater samples will be collected starting from shallow to deep at depths of higher transmissivity based on HPT data. Groundwater will be purged from vertical profiling borings using clean disposable tubing and check valve.

Subtask 2: Petroleum Source Areas
A boring will be completed near the 1,000-gallon UST at the SE corner of the fertilizer building using push-probe dual-tube methods. The soil boring will be advanced to a depth at least 10 feet below the water table, and 5 feet beyond measurable contamination as indicated by the headspace PID field readings. Analysis will include GRO, VOC, and RCRA metals.

Subtask 3: Downgradient and Lateral of the TCE and Petroleum Source Areas
Borings will be completed downgradient of the source area, and lateral of source area and suspected extent of dissolved-phase groundwater contamination, to evaluate the extent of impacts and select locations and screen depths for monitoring wells.

Subtask 4: Monitoring Well Installations
Monitoring wells will be installed at locations and screened at depths based on review of previously collected data. It is anticipated that 6 monitoring wells will be installed with screens set at approximately 15 to 20 feet below ground based on limited site investigation data collected by the property owner that showed the highest TCE concentrations at approximately 17-19 feet below ground. The actual number, locations, and screened depths will be modified based on data collected in Task A, and Task B, Subtasks 1, 2, and 3. All monitoring wells associated with the solvent investigation will be constructed of 2-inch diameter steel casing with 5-foot long stainless-steel screens.

In addition to the 15 to 20-foot depth wells, one shallow well will be installed with a screen set from 5 to 15 feet below ground near the 1,000-gallon gasoline UST to monitor potential petroleum impacts and for the presence of LNAPL. Based on the nature of petroleum impacts, water table monitoring wells installed as part of the MDA investigation may be sampled for petroleum impacts. Monitoring wells associated with the ag-chem investigation will be installed at the (anticipated) depth of 5-15 feet. Three of the monitoring wells (MW1, MW3 and MW4, Figure 3) are located downgradient from the TCE source area.

Additional monitoring wells may be necessary in subsequent investigation phases to define the lateral extent of dissolved-phase petroleum and LNAPL impacts at the water table. Monitoring wells associated with the petroleum investigation will be constructed of 2-inch diameter steel casing with 10-foot long stainless-steel screens to be compatible with potential solvent impacts and to provide for a range of water table fluctuation and LNAPL monitoring.

Preliminary proposed well locations are shown in Figure 4. Deeper monitoring wells may be needed, based on HPT data/vertical groundwater profiling data, in subsequent phases of work. Deep wells are anticipated to be located at the solvent source and downgradient in the direction of groundwater receptors including community and non-community public water supply wells.

Drilling and sampling during monitoring well installations will be completed using standard methods, such as split-spoon sampling with a hollow stem auger rig. Shallow wells may be installed with push-probe rigs designed for well completion. Heaving sands or the need for more accurate geological evaluation may require the use of roto-sonic methods.

Subtask 5: Groundwater Receptor Survey
A walking survey will be conducted to include all properties within 500 feet of the source. WCEC will conduct a well record search using the Minnesota Well Index to identify wells within ½ mile of the site. WCEC will identify the locations, depths, static water levels and screen depths of wells in the search area and use this data to identify the locations of the nearest beneficial use receptors. There is an active well at the Site and there are nine other domestic wells are within 500 ft of the Site. This represents a *sensitive groundwater condition* with respect to petroleum impacts, and active water supply wells are impacted by TCE. Therefore, all wells identified within the 500-foot radius will be sampled, this is included in the RD/RA work scope as an expedited action. In addition to the VOCs of concern, PFCs will be sampled as shown on the attached Tables 3 and 4. WCEC will access the MPCA GIS tool and MDH source water assessment area (SWA) webpage to determine whether the Site is in a protected area. The "sensitive groundwater assessment" will be completed based on investigation findings and the above receptor survey.

Given this a high priority condition, WCEC would recommend collecting a water sample from the site water supply well, and private water supply wells accessible to WCEC will also be sampled during this work; this is included in the RD-RA Work Plan as an expedited action.

Subtask 6: Surface Water Risk Assessment
A surface water risk assessment will be conducted to identify all surface water receptors within ¼-mile of the Site. WCEC will inspect the site vicinity during the 500 ft walking survey, review USGS topographical maps, and local units of government will be contacted to determine location and class of the surface water bodies near the Site. If there is a risk to surface water quality, or verified impact based on the storm sewer screening survey, the MPCA Project Leader will be contacted and permanent sampling locations will be determined with potential corrective actions considered. Sampling techniques and depths will be based upon field observations and discussions with the MPCA project leader. A surface water risk evaluation request form can be completed, for further technical assistance within the agencies.

Subtask 7: Vapor Receptor Survey and Risk Evaluation
If WCEC and the MPCA concur that the vapor impacts pose an immediate risk to health or the environment, appropriate

interim remedial actions will be implemented to address the vapors and stabilize the site. These actions are discussed in the RD-RA Work Plan.

Task C: Stream and Sediment Investigation
Since used parts degreaser was regularly poured onto the ground near the stream, and firefighting foam was used to extinguish a fire at the fertilizer building in 1991, stream and sediment sampling is proposed as part of the first phase of the investigation. Field work will be combined with the sampling required in Objective 1 (MDA investigation) wherever practicable. WCEC will obtain a DNR General Permit for surface water sample transport prior to the collection of this sample.

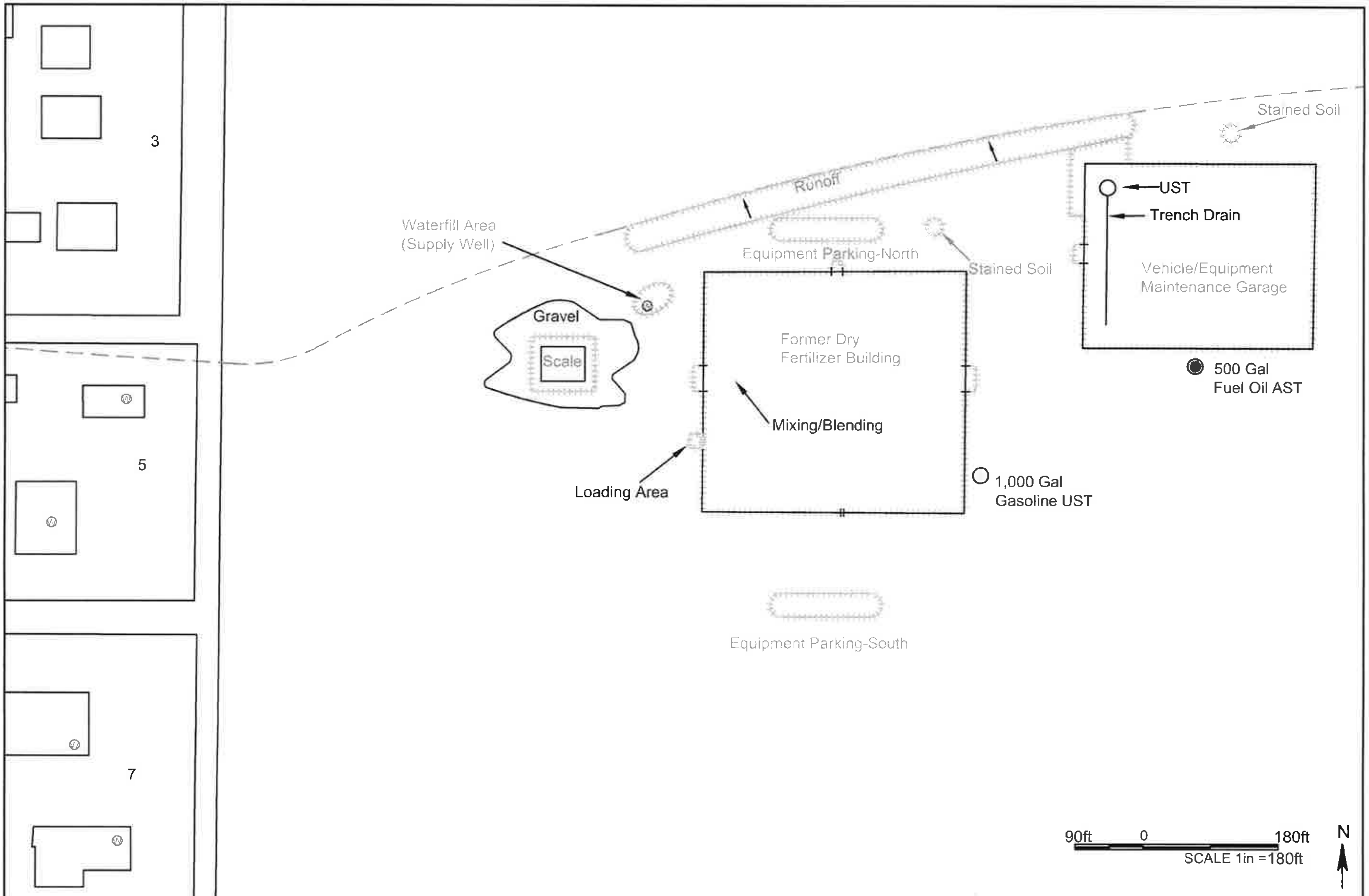
Subtask 1: Collect surface water samples upgradient of maintenance garage, between garage and former fertilizer building, and downstream of the fertilizer building. Analyze for VOC, PFC, and RCRA metals.

Subtask 2: Collect sediment samples from base of stream channel (0-6 inches) at same locations as Subtask 1. Analyze for PFC and RCRA metals.

Subtask 3: Receptor survey and receptor risk assessment, to include determining if the city uses surface water for a source of municipal water, coordination with MPCA regarding use of MR Chapt. 7050 use classes, standards, and defining assumptions.

Objective 2 Timeline: Work will be scheduled upon receiving authorization (Work Plan) from MPCA. Assuming good driller availability, site investigation can commence within 1-2 weeks, and be completed in one work week. Assuming approximately two-week service time from the State contract laboratory, soil and groundwater results will be available within one month from time of Work Order issuance. Monitoring well sampling results will be completed approximately one week later. The schedule may change if acceptable with MPCA and MDA, to allow well sampling for both tasks to be completed by one crew under a single mobilization.

Objective 2 Deliverables: Preliminary Site Assessment or Remedial Investigation/Feasibility Study Report, purchasing records for subcontractor/State Contractor use



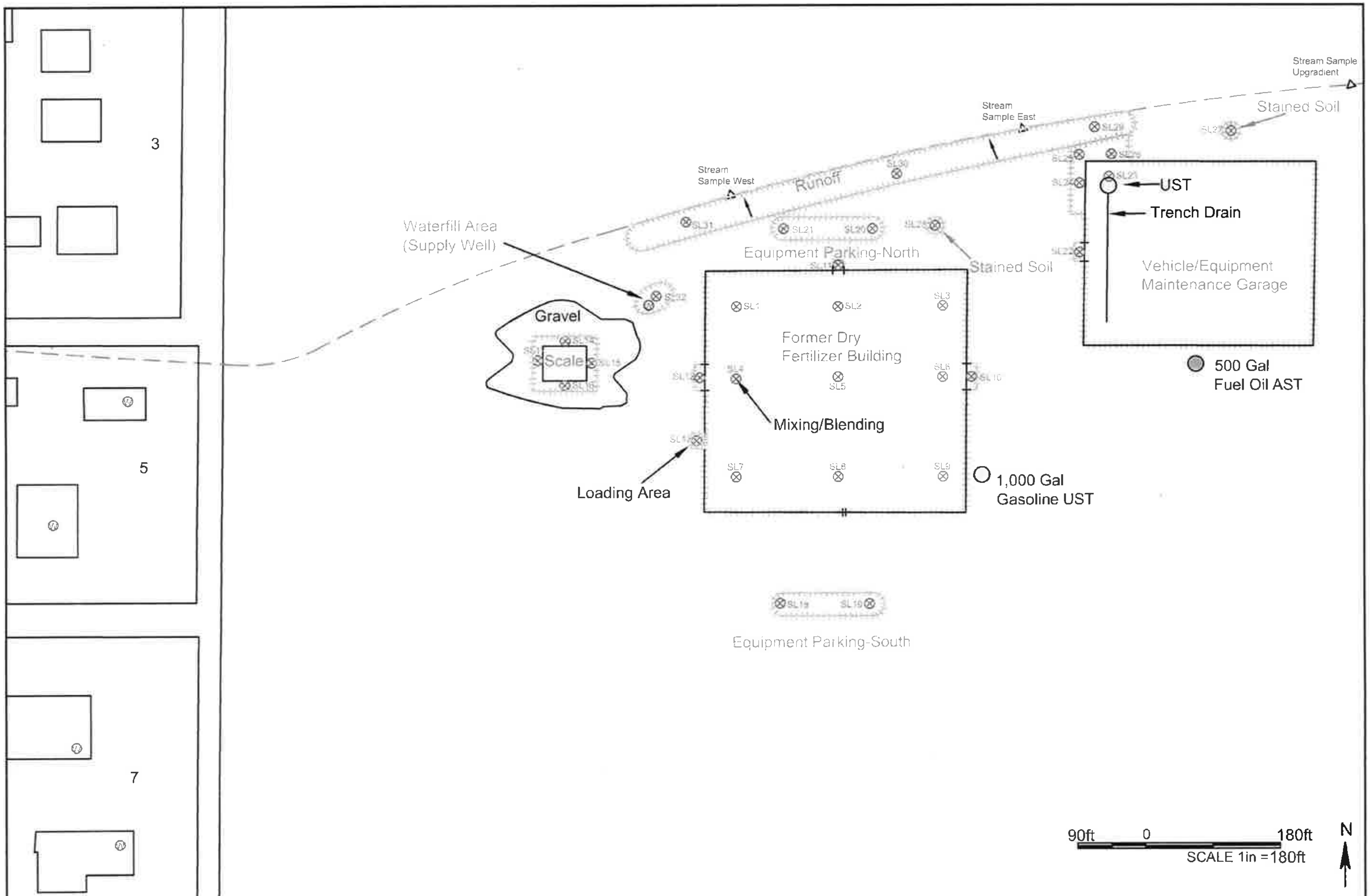
KEY

Well
----- Stream
-Block Number from Scenario Text
Ag-Chem High Risk Area (HRA)
Slope Direction

PROJECT No.: 18-12345-30, Former Ag-Chem Plant, MPCA Site ID SA0002018

FIGURE 1: Ag-Chem High Risk Areas

WCEC ENVIRONMENTAL CONSULTANTS



KEY

SL# ⊗ Ag-Chem Sample Locations (SL1-SL32)

△ Ag-Chem Stream Sample (East, West, Upgradient)

Ag-Chem High Risk Area (HRA)

Ⓦ Well

-Block Number from Scenario Text

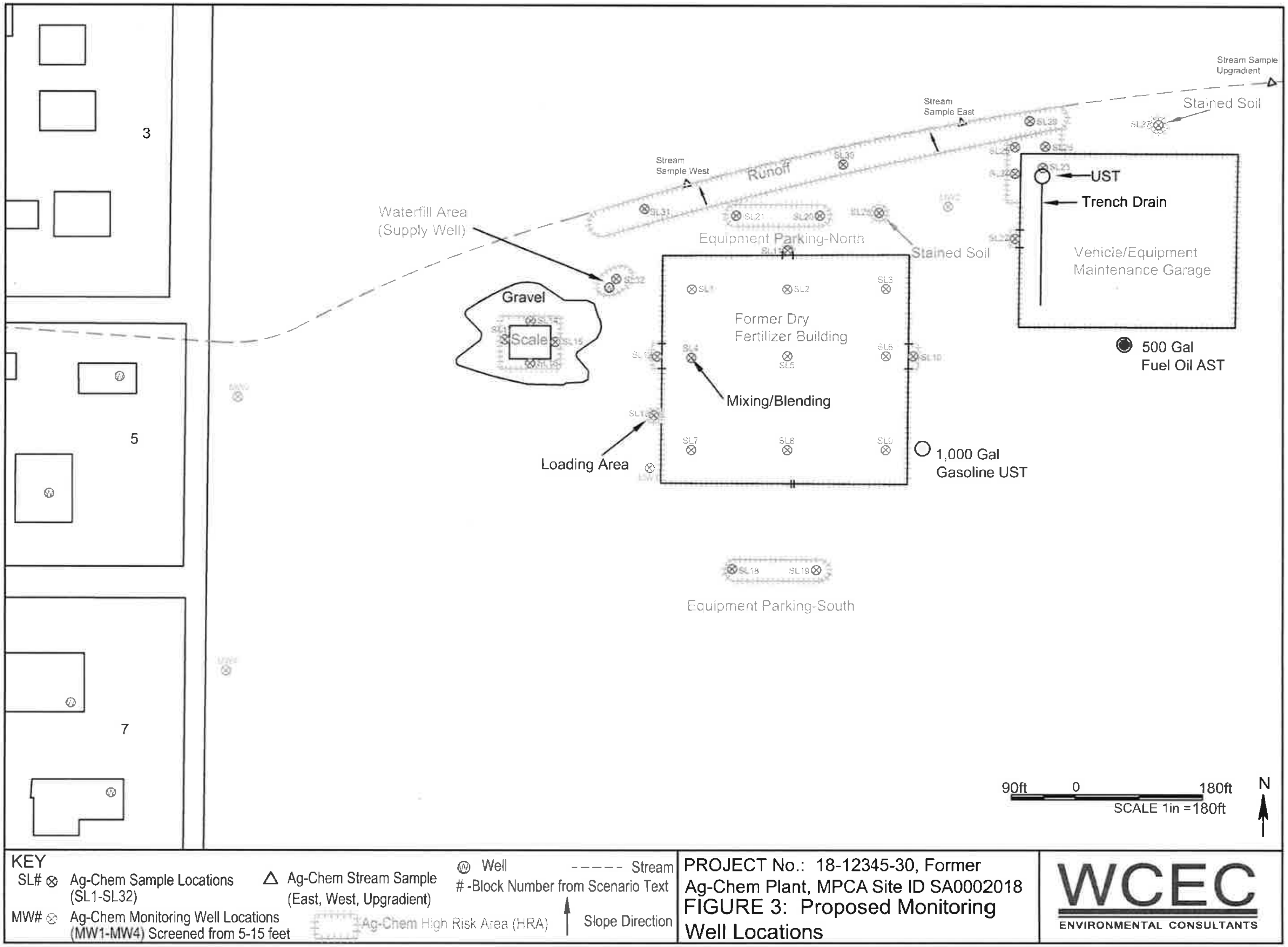
- - - - - Stream

↑ Slope Direction

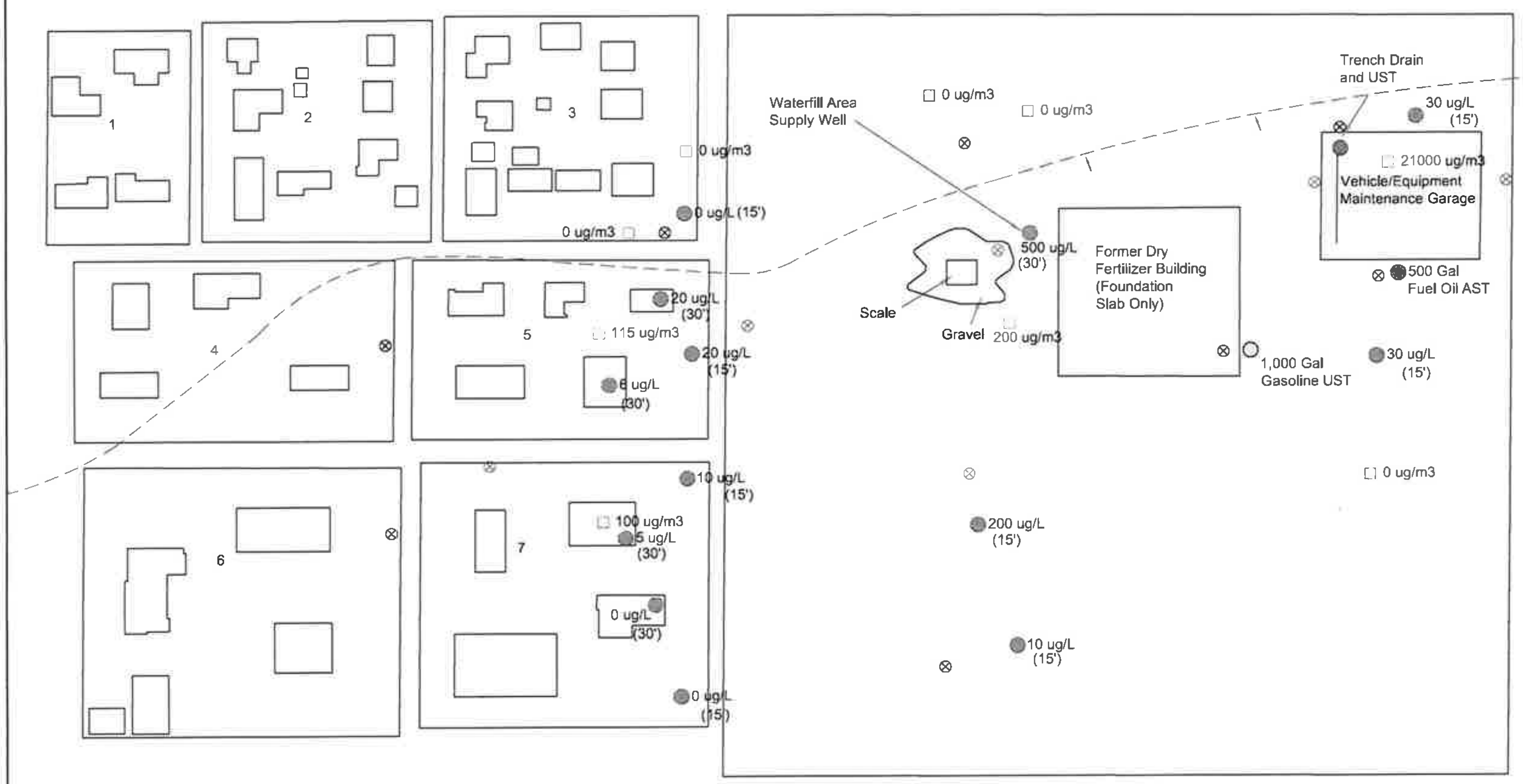
PROJECT No.: 18-12345-30, Former Ag-Chem Plant, MPCA Site ID SA0002018

FIGURE 2: Proposed Ag-Chem Sampling Locations

WCEC ENVIRONMENTAL CONSULTANTS



Stream Sample Upgradient
Stained Soil
Stream Sample East
Stream Sample West
Runoff
UST
Trench Drain
Vehicle/Equipment Maintenance Garage
500 Gal Fuel Oil AST
Waterfill Area (Supply Well)
Equipment Parking-North
Stained Soil
Gravel
Scale
Former Dry Fertilizer Building
Mixing/Blending
Loading Area
1,000 Gal Gasoline UST
Equipment Parking-South
3
5
7
90ft 0 180ft
SCALE 1in =180ft
N
KEY
SL# Ag-Chem Sample Locations (SL1-SL32)
MW# Ag-Chem Monitoring Well Locations (MW1-MW4) Screened from 5-15 feet
Ag-Chem Stream Sample (East, West, Upgradient)
Ag-Chem High Risk Area (HRA)
Well
-Block Number from Scenario Text
Stream
Slope Direction
PROJECT No.: 18-12345-30, Former Ag-Chem Plant, MPCA Site ID SA0002018
FIGURE 3: Proposed Monitoring Well Locations
WCEC
ENVIRONMENTAL CONSULTANTS



Rev.	By	Description

KEY

ug/L ● GW Sample & TCE Result
ug/m3 ☐ Vapor Sample & TCE Result

⊗ Proposed Soil and Groundwater Sample Location for Solvents and Petroleum (6 Converted to Monitoring Wells Shown in Green)

⊗ Proposed Monitoring Well Screened from 15-20' for Solvents and Petroleum

(# ') Well or Groundwater Sample Depth (feet)

-Block Number from Scenario Text

Slope Direction

Stream

N

Drawn by MH	Checked by MJ	Date: 03/09/2018

PROJECT No.: 18-12345-30
Former Ag-Chem Plant,
MPCA Site ID SA0002018

Figure 4: Proposed Petroleum and Solvents Remedial Investigation Sampling Locations

WCEC
ENVIRONMENTAL CONSULTANTS

Table 1: High Risk Areas and Chemicals of Concern – Ag-Chem
Agricultural Chemical Plant, MDA Case File No. ######, MPCA Site ID SA00002018
WCEC Project No.: 18.12345.30

High Risk Area	Target Areas	Chemicals of Concern
Former Dry Fertilizer Building	Specific areas within the HRA include the concrete floor, mixing/blending area, loading area, west doorway, east doorway and north doorwary)	Nitrate as Nitrogen (entire HRA), TKN (entire HRA), MDA List I Pesticides/MDA List II Pesticides (mixing/blending area, loading area and west doorway)
Water Fill	Source of site well impacts	Nitrate as Nitrogen, TKN, MDA List I Pesticides, MDA List II Pesticides
Scale	Below scale pit	Nitrate as Nitrogen, TKN, MDA List I Pesticides, MDA List II Pesticides
Equipment Parking Area- South		Nitrate as Nitrogen, TKN, MDA List I Pesticides, MDA List II Pesticides
Equipment Parking Area- North		Nitrate as Nitrogen, TKN, MDA List I Pesticides, MDA List II Pesticides
Vehicle/Equipment Maintenance Garage	Doorway (presumed to be on west side) and UST/Trench Drain	Nitrate as Nitrogen, TKN, MDA List I Pesticides, MDA List II Pesticides
Stained Soil, North of Vehicle/Equipment Mainentance Garage		Nitrate as Nitrogen, TKN, MDA List I Pesticides, MDA List II Pesticides
Stained Soil, North of Former Dry Fertilizer Building		Nitrate as Nitrogen, TKN, MDA List I Pesticides, MDA List II Pesticides
Runoff		Nitrate as Nitrogen, TKN, MDA List I Pesticides, MDA List II Pesticides

Table 2: Proposed Sampling Parameters - Ag-Chem
Agricultural Chemical Plant, MDA Case File No. #####, MPCA Site ID SA00002018
WCEC Project No.:18.12345.30

High Risk Area	Sampling Location Description	Sampling Location Name	Maximum Boring Depth	Sample Type	Sampling Depths	Chemicals of Concern	Initial Analytical Submittal (Round 1)	Analytical Parameters	Notes
Former Dry Fertilizer Building	Concrete Floor	SL1, SL3, SL5, SL7, SL9	10'	Soil	0-6"(d), 2-2.5'(d), 4.5-5 (d), 7-7.5 (d), 9.5-10'(d), water table/soil interface (d)	Nitrate as Nitrogen, TKN	2-2.5'(d)	Nitrate as Nitrogen, TKN	Borings will be advanced at concrete cracks, if present; additional samples will be collected at changes in lithology, if encountered; MDA List I Pesticides and MDA List II Pesticide samples will be collected and held in the case that lateral delineation of pesticide impacts is necessary around SL4
		SL2, SL6, SL8	15'	Soil	0-6"(d), 2-2.5'(d), 4.5-5 (d), 7-7.5 (d), 9.5-10 (d), 12-12.5'(d) 14.5-15'(d), water table/soil interface (d)	Nitrate as Nitrogen, TKN	2-2.5'(d)	Nitrate as Nitrogen, TKN	Borings will be advanced at concrete cracks, if present; additional samples will be collected at changes in lithology, if encountered; MDA List I Pesticides and MDA List II Pesticide samples will be collected and held in the case that lateral delineation of pesticide impacts is necessary around SL4
	Concrete Floor, Mixing/Blending	SL4	15'	Soil	0-6"(d), 2-2.5'(d), 4.5-5 (d), 7-7.5 (d) then 6" intervals every 2' to the water table/soil interface (d)	Nitrate as Nitrogen, TKN, MDA List I Pesticides, MDA List II Pesticides	2-2.5'(d), water table/soil interface (d)	Nitrate as Nitrogen, TKN, MDA List I Pesticides, MDA List II Pesticides	Boring will be advanced at concrete crack, if present, additional samples will be collected at changes in lithology, if encountered, a water sample will be collected from the boring
		SL4-Water Sample	15'	Groundwater	Water table/soil interface	Nitrate + Nitrite as Nitrogen, TKN, MDA List I Pesticides, MDA List II Pesticides	Water sample	Nitrate + Nitrite as Nitrogen, TKN, MDA List I Pesticides, MDA List II Pesticides	A screen will be installed to allow for collection of a groundwater sample
	East Doorway	SL10	10'	Soil	0-6"(c), 2-2.5'(c), 4.5-5'(d), 7-7.5 (d), 9.5-10 (d), water table/soil interface (d)	Nitrate as Nitrogen, TKN	2-2.5'(c)	Nitrate as Nitrogen, TKN	Additional samples will be collected at changes in lithology, if encountered; MDA List I Pesticides and MDA List II Pesticide samples will be collected and held in the case that lateral delineation of pesticide impacts is necessary
	North Doorway	SL11	10'	Soil	0-6"(c), 2-2.5'(c), 4.5-5 (d), 7-7.5'(d), 9.5-10 (d), water table/soil interface (d)	Nitrate as Nitrogen, TKN	2-2.5'(c)	Nitrate as Nitrogen, TKN	Additional samples will be collected at changes in lithology, if encountered; MDA List I Pesticides and MDA List II Pesticide samples will be collected and held in the case that lateral delineation of pesticide impacts is necessary
	West Doorway	SL12	10'	Soil	0-6"(c), 2-2.5'(c), 4.5-5'(d), 7-7.5'(d), 9.5-10 (d), water table/soil interface (d)	Nitrate as Nitrogen, TKN, MDA List I Pesticides, MDA List II Pesticides	2-2.5'(c)	Nitrate as Nitrogen, TKN, MDA List I Pesticides, MDA List II Pesticides	Additional samples will be collected at changes in lithology, if encountered
	Loading Area	SL13	10'	Soil	0-6"(c), 2-2.5'(c), 4.5-5'(d), 7-7.5'(d), 9.5-10'(d), water table/soil interface (d)	Nitrate as Nitrogen, TKN, MDA List I Pesticides, MDA List II Pesticides	2-2.5'(c)	Nitrate as Nitrogen, TKN, MDA List I Pesticides, MDA List II Pesticides	Assumed to be the loading area (fertilizer and pesticides associated with mixing/blending), Additional samples will be collected at changes in lithology, if encountered
Scale		SL14-SL17	5' Below scale base or the water table, whichever is encountered first	Soil	0-6" below gravel base (c), 2-2.5' below gravel base (c), 4.5-5'(d), then 6" intervals every 2' to the base of scale pit, 6" interval will be collected at the base of scale pit (base-6" below base) (d), 2-2.5' below scale base (d), and 4.5-5' below the scale base (d) or the water table/soil interface, whichever is encountered first	Nitrate as Nitrogen, TKN, MDA List I Pesticides, MDA List II Pesticides	2-2.5' below gravel base (c), 0-6" below scale base (d)	Nitrate as Nitrogen, TKN, MDA List I Pesticides, MDA List II Pesticides	0-6" and 2-2.5' samples will be collected from the base of the gravel; sampling depths will be referenced from the ground surface. Additional samples will be collected at changes in lithology, if encountered
		Water sample - Scale Pit	Not applicable		Water will be collected from the interior base of scale, if present and accessible from the surface	Nitrate + Nitrite as Nitrogen, TKN, MDA List I Pesticides, MDA List II Pesticides	Water sample - Scale Pit	Nitrate + Nitrite as Nitrogen, TKN, MDA List I Pesticides, MDA List II Pesticides	
		Sediment sample - Scale Pit	Not applicable		Sediment will be collected from the interior base of the scale, if present and accessible from the surface (f)	Nitrate as Nitrogen, TKN, MDA List I Pesticides, MDA List II Pesticides	Sediment sample - Scale Pit	Nitrate as Nitrogen, TKN, MDA List I Pesticides, MDA List II Pesticides	
Equipment Parking - South		SL18-SL19	5'	Soil	0-6"(c), 2-2.5'(c), 4.5-5 (d)	Nitrate as Nitrogen, TKN, MDA List I Pesticides, MDA List II Pesticides	2-2.5'(c)	Nitrate as Nitrogen, TKN, MDA List I Pesticides, MDA List II Pesticides	Additional samples will be collected at changes in lithology, if encountered
Equipment Parking Area - North		SL20-SL21	5'	Soil	0-6"(c), 2-2.5'(c), 4.5-5'(d)	Nitrate as Nitrogen, TKN, MDA List I Pesticides, MDA List II Pesticides	2-2.5'(c)	Nitrate as Nitrogen, TKN, MDA List I Pesticides, MDA List II Pesticides	Additional samples will be collected at changes in lithology, if encountered
Vehicle/Equipment Maintenance Garage	Doorway	SL22	5'	Soil	0-6"(c), 2-2.5'(c), 4.5-5 (d)	Nitrate as Nitrogen, TKN, MDA List I Pesticides, MDA List II Pesticides	2-2.5'(c)	Nitrate as Nitrogen, TKN, MDA List I Pesticides, MDA List II Pesticides	Additional samples will be collected at changes in lithology, if encountered
	Trench Drain and UST	SL23	Water table/soil interface or 5' below UST base, whichever is deeper	Soil	0-6"(d), 2-2.5'(d), 4.5-5 (d), then 6" intervals every 2' to the base of UST, 6" interval will be collected at UST base (base-6" below UST base) (d), 2-2.5' below UST base (d), and 4.5-5' below UST base (d), water table/soil interface (d)	Nitrate as Nitrogen, TKN, MDA List I Pesticides, MDA List II Pesticides	2-2.5'(c), 0-6" below base of UST (d), water table/soil interface (d)	Nitrate as Nitrogen, TKN, MDA List I Pesticides, MDA List II Pesticides	Additional samples will be collected at changes in lithology, if encountered
		SL23-Water Sample	Water table/soil interface or 5' below UST base, whichever is deeper	Groundwater	bottom 5' of boring (dependent on depth of water table and UST base)	Nitrate as Nitrogen, TKN, MDA List I Pesticides, MDA List II Pesticides	Water sample	Nitrate as Nitrogen, TKN, MDA List I Pesticides, MDA List II Pesticides	A screen will be installed to allow for collection of groundwater sample
		SL24-SL26	Water table or 5' below UST base, whichever is encountered first	Soil	0-6"(c), 2-2.5'(c), 4.5-5'(d), then 6" intervals every 2' to the depth of the UST base. 6" interval will be collected at depth of the UST base (base-6" below UST base) (d), 2-2.5' below UST base (d), and 4.5-5' below UST base (d) or water table/soil interface (d), whichever is encountered first	Nitrate as Nitrogen, TKN, MDA List I Pesticides, MDA List II Pesticides	2-2.5'(c), 0-6" below base of UST (d)	Nitrate as Nitrogen, TKN, MDA List I Pesticides, MDA List II Pesticides	Sampling locations will delineate impacts associated with the UST and potential runoff from the garage; additional samples will be collected at changes in lithology, if encountered
Stained Soil, North of Vehicle/Equipment Maintenance Garage		SL27	5'	Soil	0-6"(c), 2-2.5'(c), 4.5-5'(d)	Nitrate as Nitrogen, TKN, MDA List I Pesticides, MDA List II Pesticides	2-2.5'(c)	Nitrate as Nitrogen, TKN, MDA List I Pesticides, MDA List II Pesticides	Additional samples will be collected at changes in lithology, if encountered
Stained Soil, North of Former Dry Fertilizer Building		SL28	5'	Soil	0-6"(c), 2-2.5'(c), 4.5-5'(d)	Nitrate as Nitrogen, TKN, MDA List I Pesticides, MDA List II Pesticides	2-2.5'(c)	Nitrate as Nitrogen, TKN, MDA List I Pesticides, MDA List II Pesticides	Additional samples will be collected at changes in lithology, if encountered
Runoff		SL29-SL31	5'	Soil	0-6"(c), 2-2.5'(c), 4.5-5'(d)	Nitrate as Nitrogen, TKN, MDA List I Pesticides, MDA List II Pesticides	2-2.5'(c)	Nitrate as Nitrogen, TKN, MDA List I Pesticides, MDA List II Pesticides	Additional samples will be collected at changes in lithology, if encountered
Water Pit		SL32	30'	Soil	0-6"(c), 2-2.5'(d), 4.5-5'(d), 7-7.5'(d), 9.5-10'(d), 12-12.5'(d), 14.5-15'(d), 19.5-20'(d), 24.5-25'(d), 29.5-30 (d), water table/soil interface (d)	Nitrate as Nitrogen, TKN, MDA List I Pesticides, MDA List II Pesticides	2-2.5'(c), water table/soil interface(d), 29.5-30 (d)	Nitrate as Nitrogen, TKN, MDA List I Pesticides, MDA List II Pesticides	Deep sampling is recommended in this area to assess source of impacts to the well. Additional samples will be collected at changes in lithology, if encountered
		Water Supply Well - Water Sample	Not applicable	Groundwater	NP	Nitrate + Nitrite as Nitrogen, TKN, MDA List I Pesticides, MDA List II Pesticides	Water sample	Nitrate + Nitrite as Nitrogen, TKN, MDA List I Pesticides, MDA List II Pesticides	Well will be purged and allowed to recharge prior to sampling
Stream		Stream Sample East, Stream Sample West, Stream Sample Upgradient - Water Samples	Not applicable	Surface water	Stream Surface	Nitrate + Nitrite as Nitrogen, TKN, MDA List I Pesticides, MDA List II Pesticides	Stream Sample East, Stream Sample West, Stream Sample Upgradient	Nitrate as Nitrogen, TKN, MDA List I Pesticides, MDA List II Pesticides	A sample will be collected from the stream near the fertilizer building (west sample) and garage (east sample) and from up stream of the facility (upgradient sample) to evaluate background levels

A duplicate field sample will be collected for approximately 10% of the samples
(c) composite sample, (d) discrete sample
Sample types other than soil are highlighted as such:
Groundwater Sample
Surface Water
Sediment/liquid (non groundwater) sample

Table 3: High Risk Areas and Chemicals of Concern - Solvent and Petroleum
Ag-Chem Plant, MPCA Site ID SA0002018
WCEC Project No.: 18-12345-30

High Risk Areas	Target Areas	Chemicals of Concern
Former Dry Fertilizer Building	1,000-gallon gasoline UST	Petroleum, TCE, RCRA metals
	Water Supply Well	Petroleum, TCE, RCRA metals, PFCs
	Scale Area	Petroleum, TCE, RCRA metals, PFCs
	North Equipment Parking Area Down Gradient of TCE Source	Petroleum, TCE, RCRA metals, PFCs
	South Equipment Parking Area Down Gradient / Lateral to 1,000-gallon Gasoline UST	Petroleum, TCE, RCRA metals
Vehicle/Equipment Maintenance Garage	Used Solvent Dumping Area North of Garage	TCE, RCRA metals
	Trench Drain and 500-Gallon UST	TCE, RCRA metals
	Building and Surrounding Area including 500-Gallon Fuel Oil AST	Petroleum, TCE, RCRA metals
Stream	Surface Water and Sediments	PFCs
Down Gradient Receptors	Down gradient and lateral of source areas to evaluate lateral and vertical extent of impacts	Petroleum, TCE, RCRA metals, and PFC

Table 4: Proposed Sampling Parameters - Solvent and Petroleum
Ag-Chem Plant, MPCA Site ID SA0002018
WCEC Project No.: 18-12345-30

High Risk Area	Sampling Location Description	Sampling Depths	Chemicals of Concern	Analytical Parameters	Notes
Former Dry Fertilizer Building	Concrete Floor, Scale Area, Parking Areas	Continuous soil sampling for lithology and PID measurements; soil for analytical at 7', 22', 30', and 50'; actual depths will vary based on lithology/PID readings/information that becomes available	Petroleum, TCE	VOC (8260)/GRO/DRO	Push-probe dual-tube continuous soil sampling, add water or discrete soil sampling if heaving sands. Preliminary sampling depths match fine-grained soil depths shown on cross-sections (7' & 22'), shallow well depths (30'), and deep sample (50'); actual depths will vary based on lithology/PID readings/information that becomes available. Borings combined with ag-chem work where appropriate
		Water table (6-10'), 17-19' (highest TCE concentrations at garage), 30' (on-site and domestic well depths), and 50' (deep to evaluate TCE); actual depths dependent on HPT borings	Petroleum, TCE, RCRA metals, PFC	VOC (8260)/GRO/DRO/RCRA metals/PFC by PFAS in water	Discrete ground water profiling
	Water Supply Well	Well screen, approximately 30 feet	Petroleum, TCE, RCRA metals, PFC	VOC (8260)/GRO/DRO/RCRA metals/PFC by PFAS in water	
Vehicle/Equipment Maintenance Garage	Used Solvent Dumping Area North of Garage	Continuous push-probe soil sampling for lithology and PID measurements; soil for analytical at 0-6", 5', and 10'; actual depths will vary based on depth to water table/lithology/PID readings/information that becomes available	TCE, RCRA metals	VOC (8260)/RCRA metals	Push-probe borings to evaluate magnitude and extent of TCE impacts for potential interim corrective actions to remove risk of direct contact and runoff to stream.
		Water table (6-10'), 17-19' (highest TCE concentrations at garage), 30' (on-site and domestic well depths), and 50' (deep to evaluate TCE); actual depths dependent on HPT borings	TCE, RCRA metals	VOC (8260)//RCRA metals	Limited number of discrete ground water profiling borings through dumping area
	Trench Drain UST	Composite of base of trench drain and UST	Petroleum, TCE, RCRA metals	VOC (8260)/GRO/DRO/RCRA metals	
	Building and Surrounding Area including 500-Gallon Fuel Oil AST	Continuous MiHpt sampling; follow up continuous push-probe soil sampling for lithology and PID measurements; soil for analytical at 7', 22', 30', and 50'; actual depths will vary based on lithology/PID readings/information that becomes available	Petroleum, TCE, RCRA metals	VOC (8260)/GRO/DRO/RCRA metals	MiHpt borings to evaluate magnitude and lateral extent of TCE impacts and identify highly transmissive zones; follow up push-probe soil sampling. Borings combined with ag-chem work where appropriate
		Water table (6-10'), 17-19' (highest TCE concentrations at garage), 30' (on-site and domestic well depths), and 50' (deep to evaluate TCE); actual depths dependent on HPT borings	Petroleum, TCE, RCRA metals	VOC (8260)/GRO/DRO/RCRA metals	Multiple discrete ground water profiling borings down gradient, upgradient, lateral of sources to evaluate lateral and vertical extent of impacts
Down Gradient Receptors	Down gradient and lateral of source areas to evaluate lateral and vertical extent of impacts	Continuous soil sampling for lithology and PID measurements; soil for analytical at 7', 22', 30', and 50'; actual depths will vary based on lithology/PID readings/information that becomes available	Petroleum, TCE, RCRA metals	VOC (8260)/GRO/DRO/RCRA metals	Multiple push-probe borings down gradient, upgradient, lateral of sources to evaluate lateral and vertical extent of impacts. Borings combined with ag-chem work where appropriate.
		Water table (6-10'), 17-19' (highest TCE concentrations at garage), 30' (on-site and domestic well depths), and 50' (deep to evaluate TCE); actual depths dependent on HPT borings	Petroleum, TCE, RCRA metals, PFCs	VOC (8260)/GRO/DRO/RCRA metals/PFC by PFAS in water	Multiple discrete ground water profiling borings down gradient, upgradient, lateral of sources to evaluate lateral and vertical extent of impacts
Stream	Stream Bed	Sediment from base of stream - 3 locations	RCRA metals, PFCs	RCRA metals/PFAS in water	MDH Environmental Lab for PFCs
	Surface Water	Surface water from stream - 3 locations	TCE, RCRA metals, PFCs	VOC (8260)/RCRA metals/PFAS in water	MDH Environmental Lab for PFCs

Soil samples not highlighted
Sediment sample
Ground water sample
Surface water sample
Domestic well and vapor sampling is part of expedited action in RD/RA work plan
Duplicate samples will be collected each field day or for approximately 10% of the samples; trip blanks will be analyzed for appropriate parameters per guidance for each batch of samples

Appendix A: Methodologies and Procedures- Ag-Chem

Procedures for Soil Investigations

Geoprobe Systems™ Macro-Core Sampling Method

WCEC uses Geoprobe Systems® to advance borings for soil sample collection. A 2-inch outside diameter (OD) x 60-inch macro-core sampler is used to perform continuous soil sampling. The macro-core is driven by a hydraulic drive/push hammer. The sample is retained in a clear plastic disposable liner. Depth is obtained by threading hollow drive rods (3/4" OD x 5' long) on top of the macro-core sampler, until the bottom of the sampler reaches the next sampling interval. The plastic liners of the macro-core sampler are replaced after each sample to prevent cross contamination. After sampling, soil borings are immediately backfilled in accordance with state guidelines.

Geoprobe Systems™ DT21 Dual Tube Continuous Sampling Method

WCEC uses Geoprobe Systems® to advance borings for soil sample collection. Dual tube sampling enables the collection of representative soil samples through a cased probe hole preventing cross contamination and hole collapse. This system uses 2.125-inch OD probe rods as an outer casing and 1-inch OD rods for the inner rod string. The rod string is driven into the subsurface and a cutting shoe shears a 1.125-inch OD soil core which was collected inside the casing in a clear disposable plastic liner. The 1-inch inner rod string holds the liner in place while collecting the sample and also providing a means for retrieving the liner once the sample was collected. The plastic liners are replaced after each sample to prevent cross contamination. After sampling, soil borings are immediately backfilled in accordance with state guidelines.

Soil Sample Collection

All soil sample collection, handling, and storage procedures were developed to minimize the potential for contamination of the soil sample.

During the soil boring installation, detailed field notes are kept and any encountered problems or atypical circumstances are documented. Soil boring sampling details are recorded in WCEC's *Soil Boring Logs* and include the parameters outlined in MDA Guidance Document 10- Agricultural Chemical Incident Remedial Investigation Report and Corrective Action Plan. Soil samples are classified in accordance to ASTM methods D 2487/D 2488.

Composite Samples

Unless otherwise noted, all samples collected from depths less than 2.5 feet below surface grade are collected as composite samples. For each composite sample, subsamples of equal volume are collected from three to six equally spaced locations within a 15-foot diameter sampling area. Subsamples are collected from a common 6-inch vertical depth interval. Composite samples are collected from the surface to a depth of 6-inches below surface grade or below a loose gravel base (if present), and within the subsurface from an interval of 2-2.5 feet below ground surface or below a loose gravel base (if present). Soil from each subsample of the same vertical interval are thoroughly mixed and all large stones, sticks and vegetation are removed. Soil samples are transferred into the appropriate laboratory-supplied glass sample jar. The bottle threads are cleaned of any excess soil and the jar is sealed. All soil samples are labeled, logged on a chain-of-custody form, and shipped to a state-approved laboratory for the appropriate testing, or retained at WCEC under frozen condition as described in Guidance Document 11- Soil Sampling Guidance.

Discrete Samples

In areas overlain by concrete or asphalt, shallow soil samples are collected as discrete samples rather than composite samples. Samples collected from depths greater than 2.5 feet are collected as discrete samples. Discrete samples are collected from a centrally-located sub-boring. Deeper soil samples are collected according to the MDA approved *RI Work Plan* at the 4.5-5-foot interval and in six-inch intervals every two feet beyond the 5-foot depth, at changes in lithology and at the water table, when applicable. Borings will not penetrate through confining layers below saturated zones or connect aquifers and will be immediately grouted. Any large stones, sticks, and vegetation are removed from the sample and the soil is transferred into the appropriate laboratory-supplied glass sample jar. The bottle threads are cleaned of any excess soil and the jar is sealed. All soil samples are labeled, logged on a chain-of-custody form and shipped to a state-approved laboratory for the appropriate testing, or retained at WCEC under frozen condition as described in Guidance Document 11- Soil Sampling Guidance.

Soil Sample Analysis

Soil samples are submitted to an MDA approved commercial laboratory. If the contract laboratory does not have a current quality assurance/quality control plan on file with the MDA, the information required in Guidance Document 24- Fixed Base Laboratory Quality Assurance/Quality Control Plans will be provided to the MDA.

Soil samples will be analyzed at sampling intervals and for compounds as recommended in the MDA approved *RI Work Plan.* In general, the soil sample from the 2-2.5-foot interval is analyzed first. All other samples are held frozen under chain-of-custody for up to six months.

Upon receipt of the first-round analytical results, the MDA will be contacted to discuss the analyses of frozen samples as outlined in Guidance Document 9- Remedial Investigation Work Plan. The analytical report, the analytical results table, Guidance Document 29 Attachment- Laboratory Data Review Checklist, boring logs, a site map, and a proposal for additional analysis (if applicable) will be provided to the MDA. Typically, if the 2-2.5-foot sample is found to be impacted above the clean-up goal, deeper discrete samples (beginning with the 4.5-5-foot depth) will be submitted. If the 2-2.5-foot sample is not impacted above the clean-up goal, the surficial composite sample (0-6-inch depth) is submitted.

Sample Handling Procedures

Disposable nitrile gloves are used by field personnel at all times during sampling. Gloves are replaced when soiled and between each sampling point to minimize cross and background contamination. All sampling equipment and sampling jars are kept away from potential sources of cross or background contamination and replaced if deemed necessary. Sampling jars are supplied by the laboratory and are kept sealed until the time of sample collection. After collection, samples are kept cool. In the field, ice that has been double bagged in plastic is used to cool the samples. For short travel times in moderate temperatures, samples are kept off ice when there is no risk of overheating.

Equipment & Work Area Decontamination

Non-disposable sampling equipment is made of glass, stainless steel, Teflon, or other inert material. All non-disposable sampling equipment is scrubbed in a solution of biodegradable Alconox detergent and de-ionized water (if available), rinsed with de-ionized water (if available), rinsed with methanol and finally triple-rinsed with de-ionized water (if available). Sampling and equipment storage space is kept free of possible sources of cross contamination. Work space is cleaned using all, or a combination of Alconox, de-ionized water (if available) and methanol. The wash water is changed at regular intervals. Water disposal is in accordance with state guidelines. Disposable equipment is replaced between samples.

Chain-Of-Custody

Samples are logged onto a chain-of-custody form while on site. This record contains the following information: project number, sample description, number of containers, type of preservative, analyses requested, sampling date, sampler(s) name, sampler(s) signature(s), WCEC relinquishing signature(s), date and time.

The last page of the chain-of-custody form is retained by WCEC; the remainder of the form is shipped with the samples to the laboratory. At the laboratory, the chain-of-custody form is signed by the appropriate laboratory personnel at the time the samples are received. A copy of this chain-of-custody form is included in each laboratory report sent to WCEC. As few persons as possible handle the samples and chain-of-custody forms.

Quality Assurance / Quality Control

When applicable, temperature blanks accompany samples in each cooler to ensure that samples are kept at or below 4°C. Field duplicates are collected for approximately 10% of the samples. The duplicate samples are collected in the same manner as the investigative samples. The duplicate samples are submitted to the laboratory as “blind” duplicate samples. Field personnel recorded the origin (soil boring and depth) of the duplicate sample, but the origin is not identified on the chain-of-custody form. Comparison of the results of these two sets of analyses provides assurance that the laboratory quality standards are being maintained. MDA sampling protocol is followed for sample collection.

Procedures for Temporary Monitoring Well Installation and Sample Collection

Temporary Monitoring Well Installation

WCEC uses Geoprobe Systems™ to install temporary monitoring wells. A 2-inch outside diameter (OD) x 60-inch macro-core sampler is used to remove soil from the boring. The macro-core is driven by a hydraulic drive/push hammer. The soil is retained in a clear plastic disposable liner. Depth is obtained by threading hollow drive rods (3/4" OD x 5' long) on top of the macro-core sampler. Once the boring is completed, a 1-inch OD pvc screen is inserted into the hole creating a temporary monitoring well. The screen is installed to intersect the static water table. After sampling, soil borings are immediately backfilled in accordance with state guidelines.

Water Sample Collection

The static water level in each well was measured to the nearest 0.01 foot from the ground surface using a factory-calibrated electric water level probe. New 3/8-inch x 1/4-inch inner diameter (ID) disposable poly tubing with a 1/4-inch ID check valve is inserted into the screen to the static water level. Temporary monitoring wells are completely purged and allowed to recharge prior to sample collection. To minimize the possibility of cross-contamination, the wells are sampled from the expected least- to most-contaminated well. A sample is collected in a sterile, laboratory-supplied jar. Following Guidance Document 12- Groundwater Sampling Guidance, the cap of the sampling jar is not placed on the ground nor is the sampling device allowed to touch the sample bottle during sample collection. Prior to collecting a sample, unpreserved sampling jars and the jar caps are triple rinsed with water from the well before filling. Sampling jars are filled approximately one-third full, the cap is replaced, and the jar is shaken vigorously. The rinse water is discarded after each rinse cycle in accordance with state guidelines. Following rinsing, the water sample is collected. Immediately after collection, the water sample is labeled and logged on a chain-of-custody form. The sample is maintained at 4°C and shipped to a laboratory for the appropriate testing.

All water sample collection, handling, and storage procedures are conducted to minimize the potential for contamination of the water sample. Sampling details are recorded in WCEC's *Soil Boring Log* and on the chain-of-custody form.

Sample Handling Procedures

Disposable nitrile gloves are used by field personnel at all times during sampling. Gloves are replaced when soiled and between each sampling point to minimize cross and background contamination. All sampling equipment and sampling jars are kept away from potential sources of cross or background contamination and are replaced if deemed necessary. Sampling jars are supplied by the laboratory and are kept sealed until the time of sample collection. After collection, samples are stored at 4°C until analyzed. When applicable, ice is kept in Ziploc-type bags to contain ice and meltwater.

Equipment & Work Area Decontamination

Non-disposable sampling equipment is made of glass, stainless steel, Teflo, or other inert material. All non-disposable sampling equipment is scrubbed in a solution of biodegradable Alconox detergent and de-ionized water (if available), rinsed with de-ionized water (if available), rinsed with methanol, and finally triple-rinsed with de-ionized water (if available). If de-ionized water is not available, distilled water is used. Sampling and equipment storage space is kept free of possible sources of cross contamination. Work space is cleaned using all, or a combination of, Alconox, de-ionized water (if available) and methanol. The wash water is changed at regular intervals. Water disposal is in accordance with state guidelines. Disposable equipment is replaced between samples.

Chain-Of-Custody

Samples are logged on a chain-of-custody form while on site. This record contains the following information: project number, sample description, number of containers, type of preservative, analyses requested, sampling date, sampler(s) name, sampler(s) signature(s), WCEC relinquishing signature(s), date and time.

The last page of the chain-of-custody form is retained by WCEC; the remainder of the form is shipped with the samples to the laboratory. At the laboratory, the chain-of-custody form is signed by the appropriate laboratory personnel at the time the samples are received. A copy of this chain-of-custody form is included in each laboratory report sent to WCEC. As few persons .as possible handle the samples and chain-of-custody forms.

Quality Assurance / Quality Control

When applicable, temperature blanks accompany samples in each cooler to ensure that samples are kept at or below 4°C. If there is sufficient water volume, field duplicates are collected for approximately 10% of the samples. The duplicate samples are collected in the same manner as the investigative sample. Field personnel record the origin (soil boring and depth) of the duplicate sample, but the origin is not identified on the chain-of-custody form. Because the water sampling check valve is decontaminated and re-used, a field blank is collected. De-ionized water (if available) is run through the check valve after it has been decontaminated. If de-ionized water is not available distilled water is used. The field blank is handled and analyzed the same way as other field samples.

Methodologies and Procedures for Monitoring Well Installation, Development and Groundwater Monitoring

Monitoring Well Installation Oversight Procedures

WCEC provides professional oversight during the installation of monitoring wells. Oversight consists of implementing MDA guidance and completing thorough documentation of the well installation process to minimize problems in later phases of the project. To reduce confusion, oversight personnel act as the single contact for any on-site communication with property owners, city personnel, or other project related contacts. During the well installation, detailed field notes are kept, and any encountered problems or atypical circumstances are documented. When setting the well, detailed measurements of each well component are collected, allowing for variables in the length of the screen termination plugs, couplings, and length of each section of screen and casing. This process provides an accurate constructed well depth for use in calculation throughout the life of the well. Once the well is set, a total depth measurement is obtained by sounding the bottom of the well with a water level probe. All data and notes are documented on a task-specific field sheet for later reference.

Monitor Well Installation Procedures

Shallow depth (<50' below surface grade) monitoring wells are installed with a hollow-stem auger rig using 4.25" inside diameter hollow-stem augers. Monitoring wells are constructed with new PVC casing and a 10-foot long, 10-slot flush thread PVC screen. The screen is installed to intersect the static water table as well as accommodate for water table fluctuations as outlined in Guidance Document 9-Remedial Investigation Work Plan. The annular space around the screen is backfilled with flint sand from the bottom of the screen to one or two feet above the screen. The remaining annular space is grouted to the surface with Benseal® or liquid slurry in accordance with the MDH Well Code. For wells in which the annular space above the filter pack is greater than 10 feet, liquid slurry is used. When liquid slurry is used, hydrated Benseal® chips are placed over the filter pack to prevent infiltration into the sand pack.

Continuous soil samples are collected with a 5-foot macro-core sampler that is advanced ahead of the hollow-stem auger. The samples are retained in a clear disposable polyethylene liner. Soil from the liners is removed, classified, and logged. A detailed Monitor Well Construction Record and an MDH Well and Boring Record are completed for each well.

Monitoring Well Development and Purging

To ensure representative water samples and accurate water level measurements, new permanent wells are developed according to the ASTM *Standard Guide for Development of Groundwater Monitoring Wells in Granular Aquifers (D 5521-05)*. Prior to developing the wells, WCEC will complete the following tasks:

- Obtain information for the well being developed (i.e., drilling method, well diameter, well depth, screened interval, anticipated contaminants).
- Assemble necessary equipment on a plastic sheet surrounding the well.
- Record pertinent information in the Well Development Log (i.e., personnel, time, date, location, project manager, etc.).
- Measure depth to water and total depth of the monitoring well and calculate the water column volume of the well.
- Measure the initial temperature, pH and specific conductivity of the groundwater using a YSI multi-parameter meter (model number 556 MPS) and record data on the data form, along with the initial color, clarity, turbidity, and odor of the water.

Monitoring well development takes place in a series of steps:

- Initially, WCEC bails the well for a short time to ensure that the well will yield water (otherwise, the negative stroke of surging may cause the well to collapse). Then, the well is developed using the overpump method, which consists of using a submersible pump to purge the well at a higher rate than the well is purged at during sampling. During the purging, a process called *raw hiding* is used which involves starting and stopping a pump intermittently to produce rapid changes in the pressure head within the well. The alternate lifting and dropping of a column of water in the pump discharge pipe creates a surging action in the well.
- Water quality parameters are measured whenever possible throughout the development process to monitor water quality and well stabilization.
- Development continues until the water becomes clear and sediment-free.
- The final water quality parameters are noted in the site personnel logbook along with the following data:
  - Well designation (location ID).
  - Date(s) of well installation.
  - Date(s) and time of well development.
  - Static water level and well depth before and after development.
  - Quantity and description of water removed, initiation and completion time.
  - Quantity and description of sediment removed.
  - Type and capacity of pump or bailer or other equipment used.
  - Description of well development techniques.

Monitoring Well Water Level Measurement

The static water level in each well is measured to the nearest 0.01 foot from the surveyed reference point on the inner PVC well casing using a factory-calibrated electric water level probe. All water level measurements are collected from monitoring wells within the shortest time interval achievable and recorded on the *Monitoring Well Sampling Field Sheet*. Water levels are measured from the least contaminated wells (known or suspected) first, followed by increasingly contaminated wells. Water level measurements are converted to water level elevations using surveyed elevations of the reference points on the top of the inner well casings. The water level probe is decontaminated after each use according to WCEC's decontamination procedures.

Monitoring Well Water Sample Collection

Before the water sample is withdrawn from the well, the well is purged of the stagnant water until certain water quality parameters are stable following Guidance Document 12- Groundwater Sampling Guidance. The specific conductance, temperature, pH, and dissolved oxygen are measured with a multi-parameter YSI meter (YSI-556 MPS). The specific conductance, temperature, and pH are measured in intervals of one well volume until three successive readings yield measurements within the ranges listed below.

- specific conductance +/- 5% mS/cm
- temperature +/- 0.1 degrees Celsius
- pH +/- 0.04 units

The steady-state electrochemical sensors used to measure dissolved oxygen consume oxygen during measurement. Sensor movement is required to collect accurate dissolved oxygen readings. Without adequate sensor movement, dissolved oxygen readings may be artificially low. To collect the dissolved oxygen readings, the sensor is placed in the well. The flow requirement is met by moving the sensor within the well. Gradually the movement is increased until the dissolved oxygen reading stabilizes. Upon stabilization of the parameters, specific conductance, temperature, pH, and dissolved oxygen readings are recorded[1].

The stabilization test is completed on the well prior to sample collection. Parameter readings and the volume of water required to reach stabilization of these parameters is recorded. If the well is purged dry prior to stabilization, the well is allowed to recharge, and a sample is collected. In the case that the recharge rate in the monitoring well is not sufficient to allow for adequate sample volume, a groundwater sample is collected without purging.

Water samples are collected within the screened intervals via new disposable bailer and retrieval line. Water samples are collected from the least contaminated wells (known or suspected) first followed by increasingly contaminated wells. A sample is collected in a sterile, laboratory-supplied jar. Following Guidance Document 12- Groundwater Sampling Guidance, the cap of the sampling jar is not placed on the ground nor is the sampling device allowed to touch the sample bottle during sample collection. Prior to collecting a sample, unpreserved sampling jars and the jar caps are triple rinsed with water from the well before filling. Sampling jars are filled approximately one-third full, the cap is replaced, and the jar is shaken vigorously. The rinse water is discarded after each rinse cycle in accordance with state guidelines. Following rinsing, the water sample is collected. Immediately after collection the water sample is labeled and logged on a chain-of-custody form. The sample is maintained at 4°C and shipped to a laboratory for the appropriate testing.

All water sample collection, handling, and storage procedures are conducted to minimize the potential for contamination of the water sample. Monitoring well sampling details are recorded on the *Monitoring Well Sampling Field Sheet* and the chain-of-custody.

Sample Handling Procedures

Disposable nitrile gloves are used by field technicians at all times during sampling. Gloves are replaced when soiled and between each sampling point to minimize cross and background contamination. All sampling equipment and sampling jars are kept away from potential sources of cross or background contamination and are replaced if necessary. Sampling jars are supplied by the laboratory and are kept sealed until the time of sample collection. After collection, samples are stored at 4°C and shipped to a laboratory that is both certified by the Minnesota Department of Health and approved by the MDA for the required analytical methods. When applicable, ice is kept in Ziploc-type bags to contain ice and meltwater.

Equipment and Work Area Decontamination

All non-disposable or non-dedicated equipment introduced to the well is scrubbed in a solution of biodegradable Alconox detergent and de-ionized water (if available). The equipment is rinsed with de-ionized water (if available) to remove all soap, then rinsed with methanol. Finally, the equipment is triple rinsed with de-ionized water (if available). If de-ionized water is not available, distilled water is used. All sampling and equipment storage space is maintained free of possible sources of cross contamination. Work space is cleaned using all, or a combination of, Alconox, de-ionized water (if available) and methanol. The wash water is changed at regular intervals. Water disposal is in accordance with state guidelines. Disposable equipment is replaced between samples.

Chain-Of-Custody

Samples are logged on a chain-of-custody form while on site. The chain-of-custody contains the following information: project number, sample description, number of containers, type of preservative, analyses requested, sampling date, sampler(s), sampler's name(s) and signature(s), relinquisher's signature(s), date and time.

The last page of the chain-of-custody form is retained by WCEC; the remainder of the form is shipped with the samples to the appropriate laboratory. At the laboratory, the chain-of-custody form is signed by the appropriate laboratory personnel at the time the samples are received. A copy of this chain-of-custody form is included in each laboratory report sent to WCEC. As few persons as possible handle the samples and chain-of-custody forms.

Quality Assurance / Quality Control

When applicable, temperature blanks accompany samples in each cooler to ensure that samples are kept at or below 4°C. If there is sufficient water volume, field duplicates are collected for approximately 10% of the samples. The duplicate samples are collected in the same manner as the investigative sample. Field personnel record the origin (soil boring and depth) of the duplicate sample, but the origin is not identified on the chain-of-custody form. If non-disposable sampling equipment is decontaminated and re-used, a field blank is collected. Non-disposable sampling equipment is made of glass, stainless steel, Teflon, or other inert material. De-ionized water (if available) is run through the equipment after it has been decontaminated. If de-ionized water is not available distilled water is used. The field blank is handled and analyzed the same way as other field samples.

[1] References

YSI, *The Dissolved Oxygen Handbook A Practical Guide to Dissolved Oxygen Measurements*, (September 2009), 76.

Methodologies and Procedures for Surveying Monitoring Wells

Benchmarks

An automatic level and rod are used in conjunction with benchmarks in the field to provide elevations for monitoring wells. Benchmarks are solid, protected points that will not change in elevation. Benchmarks are easily accessible on the subject property or an adjacent public right-of-way and clear of overhead obstructions (e.g. buildings or trees). Examples of good benchmarks include: fire hydrant bolts, property pins, concrete foundations and right-of-way monuments. If there is no suitable location for a benchmark on a site, an 18-inch piece of rebar or a PK nail set is installed in concrete or asphalt. Benchmark locations are sketched and recorded. A temporary elevation of 100 feet is used for the benchmark elevation. If more than 100 feet of vertical relief exists across the site 500 feet or more will be used as necessary. The relative elevations between monitoring wells will be accurate to the fourth order, see the Vertical Accuracy section below for the definition of fourth order accuracy.

Vertical Accuracy

Vertical survey measurements for monitoring well casing elevations to be used for groundwater flow direction and gradient are accurate to the Fourth Order with a measurement precision of 0.01 feet.

<u>Fourth Order Accuracy Requirements</u>

$$\text{Closure Error (Feet)} < 0.10 \text{ feet} \times \sqrt{Total\ Distance\ in\ Miles}$$

$$\text{Closure Error (mm)} < 24 \text{ mm} \times \sqrt{Total\ Distance\ in\ Kilometers}$$

To put these requirements into an easily understandable distance to error tolerance format, the allowable error to total level loop distance is shown in Table 1.

Table 1: Total level loop allowable error

Error (feet)	Approximate Distance (feet)
0.01	50
0.03	470
0.06	1,900

As a general rule of thumb, a typical level loop should close with three hundredths (0.03) or less of error. The closing accuracy is assessed by comparing the summation of the foresights to the summation of the backsights. Any difference is the error in the loop. When using the radial method, no error greater than 0.01 feet is accepted. See the Leveling Methods section below for an explanation of the differences between the level loop and the radial method.

Leveling Methods

All monitoring well inner casing elevations will be surveyed using a level loop (preferred method) or radial method. When reading the rod, it is acceptable to round to the nearest 0.01 feet or use increments of 0.005 feet. The rounding error is balanced by rounding up approximately the same number of times as rounding down. The level operator will give hand signals to the rod personnel to balance the rod left to right as necessary. When shooting a high rod (anything over 7 feet), the rod personnel will rock the rod front to back (in line with the person reading the level) to ensure an accurate reading on the rod. The lowest measurement is recorded.

Turning points are selected prior to the field survey. Turning points are solid, defined locations (e.g. rocks, concrete corners, asphalt, or other points that remain intact until the survey is complete). Shorter shooting distances between the foresight and backsight are used to minimize error. The maximum site distance can vary depending on the quality of the level. A 100 to 120 foot maximum is recommended.

Note: Monitoring wells are marked on the north side (at-grade wells) or lock side (pro-top wells) during the survey for a common reference point when measuring depth to water.

Level Loop Method

A level loop turns through each monitoring well or measuring point, while beginning and ending at the same benchmark. With a level loop the error is easily calculated from the difference between the starting and ending elevation of the benchmark.

Radial Method

The radial method collects multiple measurements from one location without turning through each point of measurement. When using the radial method there is no check to confirm the correct measurement is collected. As a result, the entire process is repeated a second time using a different instrument height, so each location is measured twice. No error greater than 0.01 feet is acceptable when using the radial method because the distance of the shot will be the distance of the "loop" where an actual level loop will have a much larger total distance, allowing a greater error tolerance.

Field Documentation

Level Loop Method

A hypothetical level between two benchmarks is shown in Figure 1 with measurements to the half hundredth (0.005).

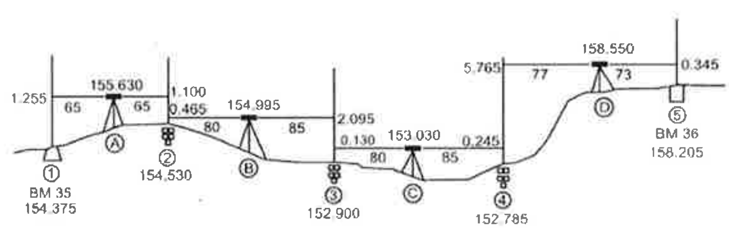


Figure 1: Notes for the segments depicted are presented in Table 2 below.

TABLE 2: Sample field notes using the level loop method

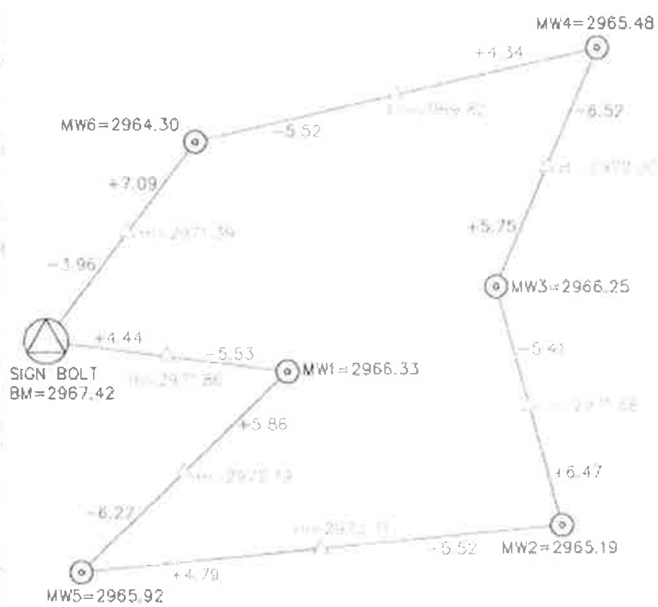
Station	Backsight (+)	Height of Inst. (HI)	Foresight (-)	Elevation
BM 35				154.375
	1.255	155.630		
2			1.100	154.530
	0.465	154.995		
3			2.095	152.900
	0.130	153.030		
4			0.245	152.785
	5.765	158.550		
BM 36			0.345	158.205

To close the level loop, the level team work back to BM 35 and calculate the closing error. An example of a level loop and associated field notes with closing error calculations are shown in Table 3 and Figure 2. A sketch of the traverse shown in Figure 2.

TABLE 3: Level loop closing error calculations

Sta	+	HI	-	2/3 EL
Sign bolt				2967.42
SW Cor	4.44	2971.86		
MW 1			5.53	2966.33
	5.86	2972.19		
MW 5			6.27	2965.92
	4.79	2970.71		
MW 2			5.52	2965.19
	6.47	2971.66		
MW 3			5.41	2966.25
	5.75	2972.00		
MW 4			6.52	2965.48
	4.34	2969.82		
MW6			5.52	2964.30
	7.09	2971.39		
bolt			3.96	2967.43
	Σ = 38.74		Σ = 38.73	

Figure 2: Level loop example field map



The level notes in Table 3 closed with an error of 0.01 feet. The sum of the (+) and (-) columns are calculated in the field to confirm the survey closes within the error tolerance.

Radial Method

Table 4 shows an example of field notes using the radial method to tie monitoring wells to a benchmark. The survey process is repeated a second time with a different instrument height to check the elevations as depicted in Table 4. When using the radial method, the benchmark and all monitoring wells need to be within approximately 100 feet of the instrument in order for all measurements to be collected from one location. It is acceptable to incorporate radial shots within a level loop. If radial shots are incorporated, the survey procedure must be repeated to check the radial elevation measurements.

Table 4: Sample field notes using the radial method

Station	Backsight (+)	Height of Inst. (HI)	Foresight (-)	Elevation
BM 2				100.00
	5.23	105.23		
MW 1			3.56	101.67
MW 2			2.31	102.92
MW 3			2.48	102.75
BM 2			5.23	100.00
2nd Survey – Elevation QAQC				
BM 2				100.00
	4.95	104.95		
MW 1			3.28	101.67 OK
MW 2			2.03	102.92 OK
MW 3			2.20	102.75 OK
BM 2			4.95	100.00 OK

If using half hundredth measurements, the elevations of some monitoring wells will be rounded to the nearest hundredth depending if the level loop closed low or high. In the case of zero closure error, all half hundredth (0.005) elevations will be rounded the same (up or down).

Monitoring Well Slug Testing Procedures

Slug testing in monitoring wells is used to estimate the horizontal hydraulic conductivity of the screened formation(s). Slug testing is performed in accordance with the ASTM D 4044 *Standard Test Method (Field Procedure) for Instantaneous Change in Head (Slug) Tests for Determining Hydraulic Properties of Aquifers* (ASTM International, 2002), the *Field Guide for Slug Testing and Data Analysis* (Midwest Geosciences Group, 2013)[1], and the product manual for In-Situ Inc. Rugged TROLL Data Loggers®. During slug testing, static water level measurements are collected after a mechanical slug is both injected into (falling head test) and withdrawn from (rising head test) the water column within the monitoring well.

Slug testing in 2-inch diameter monitoring wells is completed using a ¼-gallon displacement slug. An In-Situ Inc. Rugged TROLL 200 Data Logger® pressure transducer with data logging capabilities is used to measure water pressure in the water column of the monitoring well. The transducer consists of a pressure sensor, a temperature sensor, and memory for storing measurements. The Win-Situ 5® software package is used to download, process, and display the data. The transducer is factory calibrated and is operated according to the manufacturers' instructions.

In addition to the transducer Data Logger, an In-Situ Rugged BaroTROLL® is used. The BaroTROLL® acts as a barometer and records atmospheric pressure at each monitoring well. Atmospheric pressure data is used to compensate for atmospheric pressure variations in the pressure measurements recorded by the transducer Data Logger. The barometric compensations are applied using the Win-Situ Baro Merge® software package.

Slug testing is performed on selected monitoring wells, that are undisturbed, starting at the least contaminated wells (known or suspected) followed by well of increasing contamination. Slug testing is not performed on wells containing free product. Slug testing is conducted in accordance with the procedures outlined in the approved work plan. Slug testing takes place in the following steps:

Pre-Test Activities

- The pre-test static water level is measured to the nearest 0.01 foot from the reference point on the inner PVC well casing using a factory-calibrated electric water level probe. The volume of water in the well is calculated to ensure that there is enough water within the well to allow for full submersion of the transducer and the slug.
- If the volume of water within the well is sufficient for full submersion, the transducer is lowered to the appropriate position in the water column. To determine the depth of the transducer pressure sensor in the monitoring well, the precise length of the cable is measured and recorded. The transducer is always placed at a distance sufficiently above the bottom of the well to avoid settled fines. The transducer cable is secured to the well to prevent movement during the test.

- Prior to initiation of the test, 15-20 minutes are allowed to pass for the water level to stabilize to a near-static level, the transducer to thermally equilibrate with water, and the transducer cable to stretch.
- The transducer cables are connected to a laptop computer and known data is entered into the Diver-Office® software program.
- The slug is prepared, and the distance required to fully submerge and remove the slug is measured on the slug cable.

Test Initiation

- The transducer is started, and the slug is quickly and completely submerged to just below the surface of the water to initiate the Falling Head Test. The transducer records time and changes in water pressure at a frequent rate.
- Data is collected until the water level stabilizes to within 5% of the static water level.
- Once the water level stabilizes, the slug is completely removed from the water column as smoothly and instantaneously as possible to initiate the Rising Head Test. To minimize equipment interference with the transducer, the slug is not removed from the well at this point. The slug is only raised the minimum distance required to remove it from the water column. The transducer records time and changes in water pressure at a frequent rate.
- Data is collected until the water level stabilizes.
- A total of three Falling/Rising Head Tests are performed in each well.

Data Processing

- The test data is normalized and plotted (normalized head vs. test time). The test with the lowest data noise level is selected for analysis.
- For wells screened across the water table, a straight line(s) is fitted to the plotted data. When analyzing plotted data, drainage of the filter pack is considered. The portion of the plotted data that represents the response of the geologic formation (Figure 1) is used to calculate hydraulic conductivity using the Bouwer and Rice Model.

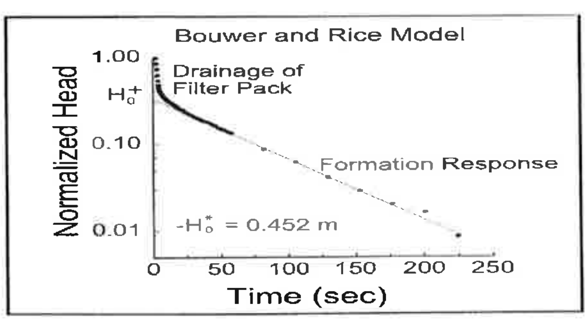


Figure 1. Plotted Slug Test Data Illustrating Filter Pack Drainage and Formation Response (*Field Guide for Slug Testing and Data Analysis,* Midwest Geosciences Group, 2013)

Disposable nitrile gloves are used by field personnel at all times during sampling. Gloves are replaced when soiled and between each sampling point to minimize cross and background contamination.

All non-disposable equipment is scrubbed in a solution of biodegradable Alconox detergent and de-ionized water (if available), rinsed with de-ionized water (if available), rinsed with methanol and finally triple-rinsed with de-ionized water (if available). If de-ionized water is not available, distilled water is used. Equipment storage space is kept free of possible sources of cross contamination. The wash water is changed at regular intervals. Work space is cleaned using all, or a combination of, Alconox, de-ionized water (if available) and methanol. Water disposal is in accordance with state guidelines. Disposable equipment is replaced between samples.

[1] References

Butler, 1998, *The Design, Performance and Analysis of Slug Tests*, Lewis Publishers, 252 pp.

Butler, Garnett and Healey, 2003, Analysis of slug tests in formations of high hydraulic conductivity, *Ground Water*, v. 41, no.5, 620-630 pp.

Sharpiro and Hsieh, 1998 How good are estimates of transmissivity from slug tests in fractured rock? *Ground Water*, v. 36, no. 1, 37-48 pp.

Procedures for Stockpile Soil Sampling

Excavation Procedures

WCEC provides professional oversight during the excavation. Oversight consists of implementing MDA guidance and completing thorough documentation of the excavation to minimize potential problems in later phases of the project. To reduce confusion, oversight personnel act as the single contact for any on-site communication with property owners, city personnel, or other project related contacts. During the excavation, detailed field notes are kept, and any encountered problems or atypical circumstances are documented. Prior to beginning the excavation, the excavation area is marked according to the specifications detailed in the MDA approved work plan. Detailed notes including, groundwater depth (if encountered); staining, free product or odors (if encountered); description of excavated soil type(s), and the source and type of backfill material used for site restoration are documented on a task-specific field sheet for later reference following Guidance Document 15- Corrective Action Report.

Stockpile Soil Sample Collection

Stockpile soil sample collection is completed according to Guidance Document 11- Soil Sampling Guidance. The number of composite soil samples is based on the volume of soil in each stockpile (Table 1)[1].

Table 1: Minimum number of composite samples required per volume soil in stockpile.

Volume of Soil in Stockpile (cubic yards)	Minimum Number of Composite Samples
<200	1
200-500	2
500-1,000	3
1,000-2,000	4
Each additional 2,000 cubic yards	1

Each stockpile is divided into approximate equal sections, with one section for each composite sample. Each composite sample is comprised of four to six borings, which are made up of one to three subsample locations. Equal volumes are collected from all subsamples from a depth of greater than one foot below the pile surface. Samples are collected from various depths throughout the stockpile. Soil from each subsample are thoroughly mixed and all large stones, sticks, and vegetation are removed. Soil samples are transferred into the appropriate laboratory-supplied glass sample jar. The bottle threads are cleaned of any excess soil and the jar is sealed. All soil samples are labeled, logged on a chain-of-custody form, and shipped to a state-approved laboratory for the appropriate testing, or retained at WCEC under frozen condition as described in Guidance Document 11- Soil Sampling Guidance. Example stockpile sampling points are included in *Figure 1: MDA Recommended Sampling Points for Stockpiles*[1].

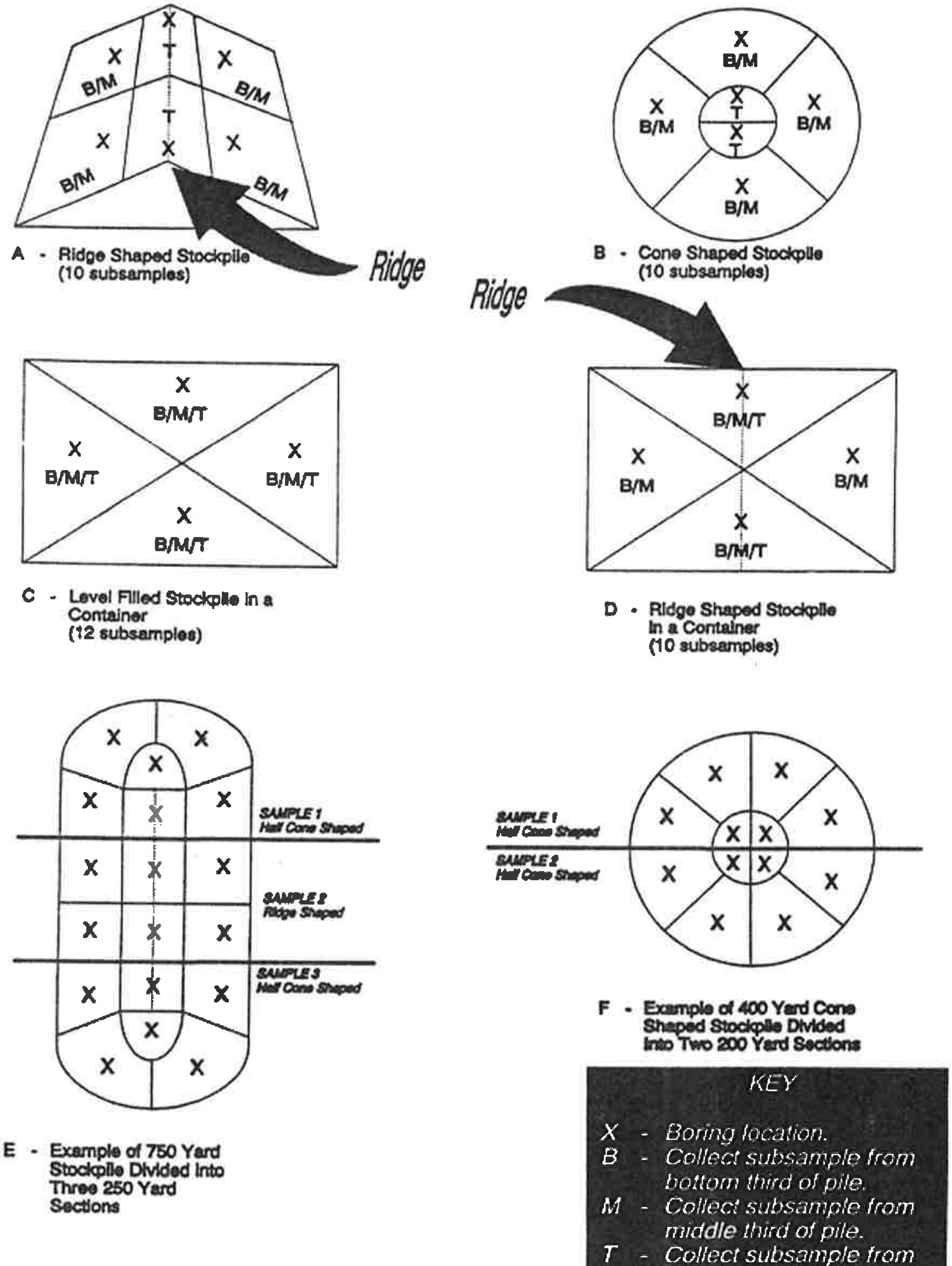


FIGURE 1. *MDA Recommended Sampling Points for Stockpiles*

Soil Sample Analysis

Soil samples are submitted to an MDA approved commercial laboratory. If the contract laboratory does not have a current quality assurance/quality control plan on file with the MDA, the information required in Guidance Document 24- Fixed Base Laboratory Quality Assurance/Quality Control Plans will be provided to the MDA. Soil samples will be analyzed for compounds as recommended in the MDA approved *Remedial Investigation Report and Corrective Action Plan.*

Chain-Of-Custody

Samples are logged on a chain-of-custody form while on site. This record contains the following information: project number, sample description, number of containers, type of preservative, analyses requested, sampling date, sampler(s) name, sampler(s) signature(s), WCEC relinquishing signature(s), date and time.

The last page of the chain-of-custody form is retained by WCEC; the remainder of the form is shipped with the samples to the laboratory. At the laboratory, the chain-of-custody form is signed by the appropriate laboratory personnel at the time the samples are received. A copy of this chain-of-custody form is included in each laboratory report sent to WCEC. As few persons as possible handle the samples and chain-of-custody forms.

Quality Assurance / Quality Control

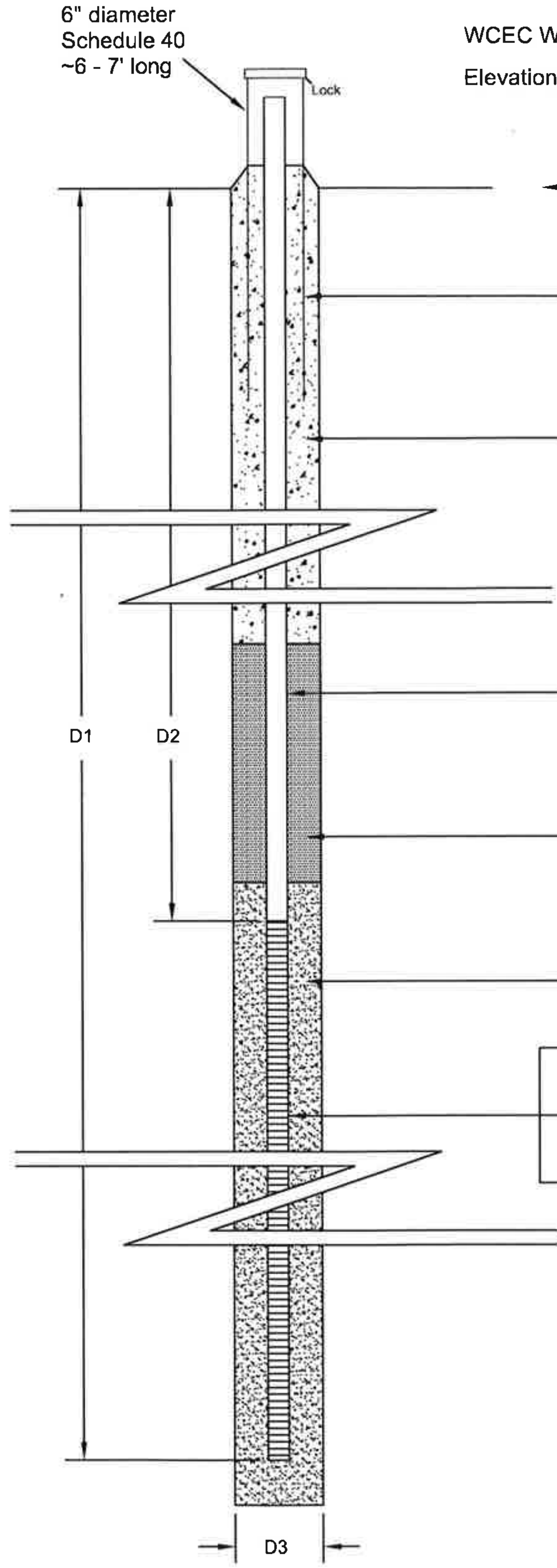
When applicable, temperature blanks accompany samples in each cooler to ensure that samples are kept at or below 4°C. Field duplicates are collected for approximately 10% of the samples. The duplicate samples are collected in the same manner as the investigative samples. The duplicate samples are submitted to the laboratory as "blind" duplicate samples. Field personnel recorded the origin (stockpile sample) of the duplicate sample, but the origin is not identified on the chain-of-custody form. Comparison of the results of these two sets of analyses provides assurance that the laboratory quality standards are being maintained. MDA sampling protocol is followed for sample collection.

[1]References

MDA (revised July 2011). Stockpile Samples. *Guidance Document 11- Soil Sampling Guidance*. Retrieved from http://www.mda.state.mn.us/chemicals/spills/incidentresponse/guidelist/gd11.aspx

MDA (revised July 2011). Figure 1: MDA Recommended sampling points for stockpiles. *Guidance Document 11- Soil Sampling Guidance*. Retrieved from http://www.mda.state.mn.us/chemicals/spills/incidentresponse/guidelist/gd11/gd11figure1.aspx

Appendix B: Monitoring Well Specifications- Ag-Chem



Minnesota Unique Well Number	Unknown
WCEC Well Number	MW1-MW4 for Ag Chem Investigation
Elevation-Ground surface	Unknown
Ground surface	
Depth of well protection below surface	4 ft.
Type of backfill around well casing	Bentonite or neat cement
Native soil description	Silts and clays
Diameter and material of well casing	2" PVC
Thickness and type of seal	1' or 2' bentonite chips
Type of filler around screen	15 slot flint sand
Screen material	PVC or steel
Screen gauge (slot size)	10 slot
Diameter and length of screen	2" x 10 ft.
D1 = Total well depth	15 ft.
D2 = Depth to screen	5 ft.
D3 = Borehole diameter	10" for 4.25" ID HSAS

PROJECT No. : 18-12345-30

Monitor Well Specifications - Pro-Top, Ag Chem Investigation

WCEC ENVIRONMENTAL CONSULTANTS

MINNESOTA POLLUTION CONTROL AGENCY
520 Lafayette Road North
St. Paul, MN 55155-4194

Remedial Design/Remedial Action (RD/RA) Work Plan Scenario A

Project Title: Former Fertilizer Plant and Maintenance Garage Site

1. Project Summary:

The Former Agricultural Chemical Plant site (the Site) was historically occupied by an agricultural chemical plant facility from 1960 to 1991, which included dry fertilizer storage, chemical storage, fertilizer blending/mixing, fuel storage, equipment/vehicle maintenance operations, and improper disposal of wastes. Since agricultural facility operations ceased, the Site has been partially investigated by the Site owner, which identified chlorinated ethenes (most notably trichloroethylene [TCE]) and agricultural chemicals (nitrogen, dicamba, metolachlor, metribuzin, pendimethalin, and triclopyr) in soil and groundwater above Minnesota Pollution Control Agency (MPCA) and Minnesota Department of Agriculture (MDA)-regulated cleanup goals. Results from this Site owner-initiated investigation also indicated that migration of TCE in soil vapor off-Site may have occurred, including potential exposure to a pregnant person. A subsequent MPCA investigation identified TCE in both on- and off-Site groundwater and soil vapor, including several potential source areas.

It is our understanding that there is currently no viable responsible party for the Site and therefore, the MPCA and the MDA is investigating various impacts at the Site in support of implementing appropriate response actions to address potential risks to human health and the environment. It is our understanding that the site is going to be redeveloped into a golf course. At this time, the Site has not been fully investigated, and the nature and extent of the impacts are not fully defined, however, based upon the initial site assessment performed at the Site, various remedial actions are needed to address impacted soil vapor and drinking water wells in buildings located adjacent to the Site, and to address potential exposure to soil, groundwater and soil vapor impacts at the Site. As additional information is acquired for the Site, additional remedial actions may be required. As requested by the MPCA, Braun Intertec has prepared this work plan to perform remedial actions to address known issues related to potential areas of concern (AOCs) identified as "high risk" in our separate proposal/work plan prepared for r the proposed remedial investigation of the Site.

2. Statement of Problems, Opportunities, and Existing Conditions

Braun Intertec has prepared this Work Plan in response to the February 28, 2018 Request for Proposal (RFP) for the MPCA and the MDA. As detailed it the RFP, Scenario A for Category A includes preparing a Work Plan that addresses Remedial Design/Remedial Action activities. Braun Intertec has included the number of hours needed to complete the Remedial Design/Remedial Action work and appropriate personnel classifications from the RFP in the attached Example Scenario Spreadsheet.

Based on the number of potential source areas and viable pathways, it is assumed a risk-based approach will be taken to minimize risk and prioritize remedial activities, from high risk areas to low risk areas. While every effort has been made to identify what may be perceived to be as high risk, the MPCA and MDA will ultimately decide which pathways will be considered high risk,
and therefore, funded for remediation. For the purpose of this scenario we have assumed the following:

- Remediation efforts will initially focus on addressing risks related to off-site residences with known identified impacts above the applicable action levels (i.e. TCE HRLs, TCE 33x ISVs etc.), based upon the information provided in the RFP.

- Additional occupied structures may also require remediation/mitigation once the full remedial investigation has been completed.

- The need for on-site soil, groundwater and soil vapor remediation of specific contamination source areas will be determined based on the risks identified during completion of the remedial investigation. It is not practical to provide a detailed remediation design for on-site contamination with the existing data.

- Although the maintenance garage is currently vacant, it is likely to be used after the Site is redeveloped. We have included design of a sub-slab vapor mitigation system within our scope of work, but we realize that the MPCA may prefer to have the property owner or future developer perform this work, if possible.

Site History
The Site operated as an agricultural chemical plant from 1960 to 1991. During agricultural operations, Site operations included dry fertilizer storage, chemical storage, fertilizer blending/mixing, fuel storage, equipment/vehicle maintenance operations, and improper disposal of wastes. Available information for these operational areas, as well as additional notable areas, include:

- Dry fertilizer building: The fertilizer building had four access doors: the east and west ends of the building had large overhead doors; a small overhead door was located in the middle of the building on the north side; and a small service door was located on the south side. A pesticide mixer/blender was located inside the former fertilizer building on the west end. In 1999, the former dry fertilizer building was destroyed in a fire. During the fire, foam fire suppressant was applied to the blaze as part of an act of vandalism. No sampling for potential contaminants of concern (CoC) has been conducted for the former dry fertilizer building.

- Maintenance garage: Historical documentation indicates that the maintenance garage was used extensively for degreasing operations as part of washing and maintaining equipment and vehicles. Building records note that there were three additions to the building over the years, however these records, do not denote utility locations. Previous investigation results include collection of several samples for soil gas, groundwater, and soil. Soil gas results indicate TCE at concentrations greater than MPCA Commercial/Industrial 33x Intrusion Screening Value (ISV) of 230 micrograms per cubic meter (µg/m3) in building additions 1, 2, and 3, indicating a need for response actions. Groundwater results were also identified above Minnesota Department of Health (MDH) Health Risk Limit (HRL) for TCE (0.4 micrograms per liter [µg/L]), in numerous samples, ranging up to 500 µg/L. Previous investigation data for soil also shows soil concentrations greater than the MPCA Commercial/Industrial and Short-Term Construction Worker Soil Reference Value (SRV) for TCE (46 milligrams per kilogram [mg/kg]). Soil concentrations of TCE beneath the maintenance garage have ranged up to 120 mg/kg. No sampling results were available for additional CoCs, including petroleum constituents, pesticides (List 1 and List 2), fertilizers (nitrates, ammonia, and total Kjeldahl nitrogen [TKN]), metals, polychlorinated biphenyls, or additional volatile organic compounds (VOCs).

- Parking areas: Agricultural chemical equipment storage/parking areas were located on the north and south sides of the former dry fertilizer building. Limited sampling has been conducted in the former parking areas; however, previous results from the southern parking area had TCE results in groundwater ranging from 10 µg/L to 200 µg/L, well above the MDH HRL for TCE. In addition, the extent of TCE contamination was not fully defined. No sampling results were available for additional CoCs, including petroleum constituents, pesticides (List 1 and List 2), fertilizers (nitrates and TKN), or additional VOCs.

- Water supply areas: A water fill area was located outside the former fertilizer building at the west end. In 1997, a sample collected from the well by the MDA contained concentrations of nitrate (116 milligrams per liter [mg/L]), metolachlor (424 µg/L), and dicamba (283 µg/L), all of which are greater than applicable MDH HRLs. A groundwater sample collected from the well was also reported to have TCE at a concentration of 500 µg/L, which is well above the MDH HRL for TCE.

- Truck scale: The scale is located outside the west end of the dry fertilizer building and is surrounded on all sides by gravel. No sampling for potential CoCs has been conducted for the truck scale; however, one soil vapor sample was collected, with a reported TCE concentration of 200 µg/m3.

- Fuel storage areas: Records note the presence of a 500-gallon fuel oil aboveground storage tank (AST) used to heat the garage (diesel range organics [DRO]), and a 1,000-gallon gasoline UST (gasoline range organics [GRO]) used to fill large trucks, both installed in the 1960's. No soil, groundwater, or soil vapor sampling for potential CoCs has been conducted in the fuel storage areas and surrounding area.

- Stained/dumping areas: According to an interview of a former employee, a used parts degreasing agent was regularly poured onto the ground near the stream on Site. Discolored soils were reported to the north of the fertilizer building and garage during the last facility inspection. Due diligence efforts conducted during property transfer indicated these discolored soils were still present. No sampling for potential CoCs has been conducted for the reported dumping area; however, one groundwater sample appears to have been collected on the north side of the former maintenance garage, with a reported TCE concentration in groundwater above the HRL. Additional results or sampling locations for potential CoCs has not been conducted or provided.

- Off-Site Areas: Previous investigation for off-Site areas to the north and west of the Site has been completed for soil vapor and groundwater. Based on available information, sub-slab and soil vapor probe results have identified TCE on blocks 5 and 7. A sub-slab sample in a residence occupied by a pregnant woman is above the 33x Residential ISV for TCE; therefore, in accordance with the MPCA's Interim ISV Short Guidance dated February 13, 2017, expedited mitigation is necessary. The soil vapor probe result is indicative of potential vapor intrusion risk to neighboring structures. Groundwater sampling results indicate TCE concentrations greater than the HRL for several private wells, ranging from 5 µg/L to 20 µg/L. It should be noted that off-Site samples north of the stream were non-detect for TCE in both soil vapor and groundwater; however, additional compound results were not provided.

Since ceasing operations in 1991, the Site was purchased for redevelopment into a golf course.

Site Setting
The Site is situated east of and adjacent to a residential area, and a stream is located to the north of the Site (Figure 1). The Site topography has generally been noted as being mostly flat; however, the elevation dips downward toward the stream which runs east to west into the residential areas. Based on available information, the stream may be acting as a hydraulic barrier; however, additional sampling must be completed to confirm this observation.

Based on previous investigations, the Site geology was noted to generally consist of coarse grained sands to at least 30 feet below ground surface (bgs) with thin lenses of silt and clay. Shallow groundwater on Site was encountered at depths between 6 and 10 feet bgs during previous investigations, with groundwater samples collected at 15 feet bgs from investigation borings. Groundwater samples retrieved from off-Site domestic wells were collected at 30 feet bgs. The assumed groundwater flow direction is to the west. It should be noted that older portions of the town (situated closer to the Site) are on private well drinking water (blocks 3, 5, and 7), while newer portions of the town (farther west of the Site) are on community water from the local municipality (blocks 1, 2, 4, and 6).

Current Site Conditions
Current information on the Site suggest that existing conditions pose known and potential threats to human health and the environment. Based on available information, the current conditions for the Site, including notable existing conditions which affect contaminant migration and exposure pathways for current and future use, include:

- Dry fertilizer building: As a result of a fire, only the building slab remains, which has been observed as being cracked. During the fire, fire suppressant foam was applied, followed by building material removal shortly thereafter.

- Maintenance garage: A trench drain was observed within the maintenance garage leading to a 500-gallon UST of unknown age. There are no records of the tank having ever been removed or cleaned out, and it is assumed the tank leaked. The remainder of utility locations remain unknown. The concrete floor in this building is intact, and the building remains in good condition for future use.

- Parking areas: No additional information regarding the current condition of the parking areas has been provided or observed.

- Water supply areas: The shallow water supply well is still located in the water fill area and reported to be functional.

- Truck scale: The scale remains located outside the west end of the dry fertilizer building.

- Fuel storage areas: Both the gasoline UST and diesel AST remain on-site. Stained soils were apparent beneath the AST.

- Stained/dumping areas: No additional information regarding the former dumping and stained areas has been provided or observed.

Based on the reviewed/available information, multiple source areas and potential exposure pathways exist as a result of the Site use. Each of these pathways, some of which have yet to be investigated, may have multiple receptors as a result of contaminant migration. It has been reported that the surrounding community has expressed concern about risk to their health. To minimize on-going risk and perform response actions for completed exposure pathways, data gaps must be filled in order to holistically evaluate the Site and prioritize response actions.

While there are data gaps that exist that will need to be addressed in order to design a holistic approach to remedial actions for the Site and affected adjacent areas, there are exposure risks that have been identified that require immediate response. The first priority is to address the identified exposure pathways to the residential homes located to the west of the Site.

Additional remedial activities will most likely been needed in order to fully address the impacts at the site, however additional remedial investigations are required in order to define the extent of these additional remedial activities (i.e. soils removal, groundwater containment, additional sub-slab depressurization systems).

The following is a list of the opportunities for initial remedial actions at the Site to mitigate the identified risks from various exposure scenarios for the identified high rick receptors:

- Alternate water supply for three residences with detected TCE exceedances in private drinking water wells located in Blocks 7 and 5.
- Sealing of drinking water wells once alternative water has been provided.
- Sub-slab depressurization system in the residence with impacted sub-slab soil vapor.
- Sub-slab depressurization in portions of the existing maintenance garage, which is targeted for re-use.

In addition, we have included removal of stained soil around the 500-gallon AST and preparation of a Focused Feasibility Study to evaluate approaches for addressing VOC impacted soil and groundwater associated with the maintenance garage.

3. Goals, Objectives, Tasks, and Subtasks

Objective 1: Address Elevated TCE in Drinking Water
The three residences in Blocks 5 and 7 where elevated concentrations of TCE have been detected in drinking water wells should be supplied with an alternative water source as soon as practical. Bottled water should be supplied as soon as practical as a temporary measure; the most effective long-term alternative water supply would be to connect these residences to the existing municipal system. If extending the municipal system is not viable, or would take a significant amount of time to implement, then on-site water treatment should be provided for each affected residence.

Task A: Bottled Water Scenario
If the MPCA elects to provide affected residences with bottled water until the residences can be added to the municipal water supply, the tasks completed by Braun Intertec would be minimal as we assume that MPCA staff would coordinate this activity with the City and the property owner.

Subtask 1: Well Abandonment
After the residences are connected to the municipal supply, the existing drinking water wells at these residences should be abandoned in accordance with Minnesota Department of Health (MDH) requirements. The well abandonment work would be completed by a State contract driller. As part of this task, Braun Intertec will provide well abandonment specifications and bidding documents for the well abandonment work per the MPCA subcontractor manual. The specifications will be submitted to the MPCA for approval prior to bidding.

Once a State contract driller has been selected, Braun Intertec will coordinate mobilization with the well driller and the property owners, provide field oversight during well abandonment, and document that the three wells were properly abandoned and the site was restored appropriately. We assume that three private wells will be abandoned during one field mobilization under this scope of work.

Subtask 2: Reporting
Braun Intertec will provide a letter report that includes a summary of the well abandonment and copies of the well abandonment records.

Task B: Residential Water Treatment System Design and Installation (if municipal supply connection is not immediately feasible).

Subtask 1: Residential Water Treatment System Design and Contracting.
Braun Intertec will prepare specifications for furnishing and installing residential water treatment systems per the MPCA Contracting Manual. There are several technologies available for water treatment but the most cost-effective technology is using granular activated carbon for removal of TCE. The specifications will be submitted to the MPCA for approval prior to bidding. The MPCA could contract for the system installation directly or Braun Intertec could subcontract with a water treatment system installer under our work order. For the purpose of this work plan, we assume that Braun Intertec will retain a subcontractor to install the residential treatment systems and that the total installation cost of the three residential water treatment systems will cost between $5,000 and $10,000. Based on these assumptions, our budget for this subtask assumes that Braun Intertec will request bids from a minimum of two bidders. If possible, at least one bidder will be a Targeted Group/Economically Disadvantaged/Veteran-Owned (TG/ED/VO) Small Business. Once the bids have been received, Braun Intertec will review contractor bids with the MPCA to select the responsive low cost subcontractor before proceeding with the work.

Subtask 2: Residential Water Treatment System Installation Oversight and Confirmation Sampling
This subtask includes scheduling water treatment system installation with the residents and providing oversight during system installation. Our oversight will include one site visit per residence during system installation (for total of three site visits). Once the treatment systems have been installed and are operational, Braun Intertec will collect one water sample from each residence to confirm that the system is reducing contaminant concentrations below drinking water standards.

- For purposes of this Work Plan, it is assumed that MPCA will obtain access to the private residential properties for sampling.

- Upon approval of sampling, the homeowners will be contacted by Braun Intertec to schedule a sampling time and determine the best water sampling location. Since the purpose of this sample is to verify that the selected treatment system is reducing.

- TCE concentrations to meet drinking water standards, confirmation water samples will be collected downstream of the installed.

- Water Treatment System and upstream of any other water-altering device (i.e. water softener, pressure tank, or filtration system).

Once a suitable sample location is chosen, a purge of the water line will be performed by calculating the volume of water in the line and determining the water volume within the well (3 casing volumes). If well construction specifications are unknown, water quality stabilization parameters will be monitored until stabilized or 10 minutes of continuous purge has elapsed. Low-flow sampling will then be employed to fill sampling containers. For purposes of this Work Plan it is assumed that a 10-minute purge will be used for wells with no readily available construction information. The samples will be submitted to State Contract Laboratory for analysis of VOCs.

As part of this sub-task, Braun Intertec will prepare a letter report for each residence documenting the water treatment system design, installation and post-installation confirmation sampling results. Note that additional sampling and maintenance of the water treatment systems beyond installation and the initial post-installation confirmation sampling is beyond this scope of work.

Subtask 3: Well Abandonment
After water treatment systems are provided for the residences, the existing drinking water wells at these residences should be abandoned in accordance with Minnesota Department of Health (MDH) requirements. The well abandonment work would be completed by a State contract driller. As part of this task, Braun Intertec will provide well abandonment specifications and bidding documents for the well abandonment work per the MPCA subcontractor manual. The specifications will be submitted to the MPCA for approval prior to bidding.

Once a State contract driller has been selected, Braun Intertec will coordinate mobilization with the well driller and the property owners, provide field oversight during well abandonment, and document that the three wells were properly abandoned and the site was restored appropriately. We assume that three private wells will be abandoned during one field mobilization under this scope of work.

Objective 1 Timeline
If the MPCA elects to install residential water treatment systems (Task B), preparation of specifications will take approximately 2 weeks to complete. The bidding process will take 2-3 weeks, and system installation will take 1-2 weeks to coordinate and implement pending access to the residences.

Well abandonment can occur within 1-2 weeks after installation of the treatment system/access to bottled water or after connection to the municipal supply and selection of a State-approved drilling firm. The documentation reports will be prepared within 1-2 weeks after receiving the post-installation system installation confirmation sampling results from the laboratory, and after the well abandonment.

Objective 1 Deliverables
The deliverables for Task A include specifications for residential well abandonment and providing the MPCA with well abandonment records. The deliverables for Task B include specifications for the installation of treatment systems and well abandonment, bidding documents, three residential water treatment systems, a three residential treatment system installation reports that include descriptions the systems, installation and post-installation confirmation sampling results, well abandonment specifications and well abandonment records.

Objective 2: Mitigate Vapor Intrusion Risk to Home with Elevated Concentrations of TCE Detected in Soil Vapor

Task A: Sub-slab Depressurization System (SSDS) Design and Installation

Subtask 1: SSDS Design and Installation
As part of this task, Braun Intertec will prepare specifications to be used for bidding purposes under SSD State Contract S-1050. The technical specifications prepared for installation of the SSDS will meet the design criteria required in MPCA document c-rem3-06, "Diagnostic testing, installation and confirmation sampling for active vapor mitigation systems in single-family residential buildings".

It is our understanding that quote solicitation and SSDS installation contractor selection will be made by MPCA staff. In addition, we understand the MPCA will retain and pay the installation contractor directly. As part of this task, Braun Intertec will review contractor bids with the MPCA and provide recommendations for contractor selection.

Subtask 2: Installation Documentation, Confirmation Sampling and Reporting
Braun Intertec will conduct one site visit to oversee and document system installation at the property with elevated TCE concentrations in sub-slab soil vapor. Observations by Braun Intertec staff will be documented in field notes and photographs.
The MPCA selected SSDS installation contractor will follow the technical specifications prepared by Braun Intertec. All activities will be conducted in general accordance with the guidelines specified in MPCA document c-rem3-06, "Diagnostic testing, installation and confirmation sampling for active vapor mitigation systems in single-family residential buildings". Specifically, the selected contractor will perform pre-mitigation diagnostics, SSDS installation, and post-mitigation diagnostic testing at each targeted property, and will provide a property data submittal for each property.

Approximately 15 days following SSDS installation and diagnostic testing, Braun Intertec will return to the Site and conduct post-mitigation confirmation sampling at the property. Post-mitigation confirmation sampling will include collecting concurrent sub-slab, indoor air and ambient outside samples, and conducting follow-up pressure field extension (PFE) diagnostic testing. The post-mitigation confirmation sampling will be conducted after a one week (seven calendar days) equilibration period and completed within 30 days after active system installation. This proposal assumes 2 sub-slab samples, 1 indoor air sample, and 1 outdoor air sample will be collected and analyzed for VOCs using the TO-15 Method.

Confirmation Sub-slab Vapor Sample Collection Methods
The sub-slab vapor sampling pins will be installed in the basements of each of the residential houses targeted for sampling using hand equipment. Following installation, the newly installed sub-slab vapor points will be sampled.

The sub-slab vapor samples will be collected in accordance with MPCA Guidance Document 4-01a Vapor Intrusion Assessments Performed During Site Investigations and Guidance document Best Management Practices for Vapor Investigation and Building Mitigation Decisions dated October 2017 (October 2017 VI Guidance).

The vapor samples will be collected using a brass sub-slab vapor monitoring point from Vapor Pin™. A rotary hammer drill equipped with a 5/8-inch diameter hole will be used to drill through the slab and approximately 1-inch into the underlying soil. If permanent sub-slab vapor sampling pins are feasible, the hammer drill will be utilized to drill a 1½-inch diameter hole at least 1¾-inches into the slab to allow for flush installation of the vapor pins. The Vapor Pin™ will be driven into place in the slab using the vapor pin tools and a mallet. The installed vapor pin will then be allowed to equilibrate for at least 20 minutes after installation prior to sampling. After the pin has been allowed to equilibrate for at least 20 minutes, the Teflon cap will be removed for sample collection. Prior to collecting the soil vapor sample, Braun Intertec will complete a leak test and shut in test in accordance with Appendix B of the October 2017 VI Guidance. Once the leak test (water dam), and shut in test are completed successfully.

After the shut in test is completed successfully and prior to collecting the soil vapor sample, a minimum of three air volumes (the volume of the sample pin, pilot hole in the concrete and sample tubing) will be purged with a pump or graduated syringe. After purging an in-line particulate filter were be installed to prevent particulates and moisture from entering the evacuated sampling canister. The soil vapor sample will be collected by attaching the top end of the tubing to a sampling canister (summa canister under vacuum) instrumented with a vacuum gauge and a 200 ml/min flow regulator. After an adequate volume of air had been filled, the sampling canister valve will closed and final canister pressure and time required for sampling will be recorded on the chain-of-custody form and sample sheets.

Ambient Air Sampling Sample Collection Methods
One outdoor ambient air sample will be collected concurrently with the sub-slab soil vapor samples at each of the residential houses targeted for sampling. The ambient air samples will be placed in exterior areas on either side of the Site. The ambient air samples will be collected using laboratory-supplied negative pressure 6-liter summa canisters with 24-hour flow controllers. In addition, organic vapor readings will be measured with a PID in the vicinity of the sample locations.

The ambient air samples will be submitted analyzed for VOCs using United States Environmental Protection Agency (EPA) Method TO 15.

Indoor Air Sampling Sample Collection Methods
One indoor air sample will be collected at each of the residential houses targeted for sampling, concurrently with the sub-slab soil vapor samples. The indoor air samples will be collected from the basement of the property. The indoor air samples will be collected using laboratory-supplied negative pressure 6-liter summa canisters with 24-hour flow controllers. In addition, organic vapor readings will be measured with a PID in the vicinity of the sample locations.

The indoor air samples will be submitted and analyzed for VOCs using United States Environmental Protection Agency (EPA) Method TO 15.

After the results of the post-mitigation confirmation sampling are received from the analytical laboratory, Braun Intertec will preparation a Property Summary Report (MPCA document c-rem3-07) for the property. The Property Summary Report will follow the prescribed MPCA format and include all appropriate tables, figures (including the GIS templates figures), and appendices.

Objective 2 Timeline
Preparation of technical specifications will take approximately 1-2 weeks to complete. The bidding process will take 1-2 weeks, and system installation will take 1-2 weeks to coordinate and implement pending access to the residential home. Post-installation confirmation sampling will occur within 30 days of SSDS installation, with the final report completed 1-2 weeks after receiving analytical data from the post-construction confirmation sampling

Objective 2 Deliverables
The deliverables include technical specifications for installation of the SSDS, bidding documents, and one property summary report that includes description the SSDS, installation documentation, and the post-installation confirmation sampling results.

Objective 3: Mitigate Vapor Risk to the Future Occupants of the Existing Maintenance Garage (Optional)
We assume that since the maintenance garage is in good condition, this structure will remain on site for future re-use by the golf course. This objective includes design, installation oversight, and confirmation sampling for a sub-slab vapor mitigation system within our scope of work. However, we realize that the MPCA may prefer to have the property owner or future developer perform this work, if possible.

Based upon the figure provided, the Maintenance Garage is approximately 75,000 square feet in size.

Task A: Additional Sub-Slab Vapor Sampling to Define the Area Needing Mitigation
This task will be completed as part of the RI Work Plan included with this RFP.

Task B: Pre-diagnostic testing and vapor system specifications preparation
We assume that this task will be completed as part of the RI Work Plan included with this RFP.

Task C: System Installation Bid Preparation and selection
As part of this task, Braun Intertec will prepare specifications to be used for bidding purposes under the SSD State Contract S-1050. The technical specifications prepared for installation of the SSDS will meet the design criteria required in MPCA document c-rem3-06, "Diagnostic testing, installation and confirmation sampling for active vapor mitigation systems in single-family residential buildings".

Additional sub-slab vapor sampling proposed under Objective 3 of the *Remedial Investigation Work Plan (Scenario A)* included as Attachment A of this RFP, will define which portion of the building will require partial mitigation per MPCA guidance.

It is our understanding that quote solicitation and SSDS installation contractor selection will be made by MPCA staff. In addition, we understand the MPCA will be retaining the installation contractor directly. Braun Intertec will review the quotes obtained by the MPCA and provide recommendations for contractor selection.

Task D: Installation Documentation, Confirmation Sampling and Reporting
Installation of a sub-slab depressurization system will reduce the risk of vapor intrusion to future occupants by mitigating migration of impacted soil vapor into the building. Braun Intertec will coordinate with the selected SSDS installation contractor to schedule mitigation system installation.

Braun Intertec will conduct up to four site visits to oversee and document system installation at the Site with each visit consisting of two hour site visits during installation of the sub-slab depressurization system (SSDS). Observations by Braun Intertec staff will be documented in field notes and photographs.

The MPCA selected SSDS installation contractor will follow the technical specifications prepared by Braun Intertec. All activities will be conducted in general accordance with the guidelines specified in MPCA document c-rem3-06, "Diagnostic testing, installation and confirmation sampling for active vapor mitigation systems in single-family residential buildings". Specifically, the selected contractor will perform pre-mitigation diagnostics, SSDS installation, and post-mitigation diagnostic testing at each targeted property, and will provide a property data submittal for each property.

Following SSDS installation and diagnostic testing, Braun Intertec will conduct post-mitigation confirmation sampling at the property. Post-mitigation confirmation sampling will include collecting concurrent sub-slab, indoor air and ambient outside samples, and conducting follow-up pressure field extension (PFE) diagnostic testing. The post-mitigation confirmation sampling will be conducted after a one week (seven calendar days) equilibration period and completed within 30 days after active system installation.

It is assumed for this proposal that the post-mitigation confirmation sampling will be conducted in the first winter season after SSDS start-up. This proposal assumes three sub-slab samples, three indoor air samples, and one outdoor air sample analyzed for VOCs by Method TO-15.

Braun Intertec will prepare a field sketch map, a summary table of the sampling results, and a brief summary about the PFE measurements testing.

After the results of the post-mitigation confirmation sampling are received from the analytical laboratory, Braun Intertec will preparation a Property Summary Report (MPCA document c-rem3-07) for the property. The Property Summary Report will follow the prescribed MPCA format and include all appropriate tables, figures (including the GIS templates figures), and appendices.

Objective 3 Timeline
Preparation of bids and specifications will take approximately 1 week to complete. The bidding process will take 1-2 weeks, and then system installation will take 2-3 weeks pending access to maintenance building. The post confirmation sampling will occur within 30 days of system installation, with the final report completed 1-2 weeks after receiving the analytical data from the post confirmation sampling. The second round of seasonal sampling require 1-2 days of field work, and then 1-2 weeks to complete the final report once the data is received from the laboratory.

Objective 3 Deliverables
The deliverables include specifications for the installation of sub-slab depressurization system, bidding documents, sub-slab vapor system(s) installation, one property summary report that includes description of the system(s), installation and the post confirmation sampling results.

Objective 4: Focused Feasibility Study and Bench Scale Studies - Maintenance Garage.

Task A: Focused Feasibility Study
Objectives 1 through 3 address the known impacts at high risk AOCs, however, additional response actions may be required to address impacted environmental media associated with other AOCs. For example, existing soil and groundwater collected near the maintenance garage and the existence of impacted groundwater down-gradient from the Site are indications that there are soil source areas present that pose a continued risk to drinking water receptors as well as surface water and sediments associated with the stream that flows through the Site.

Although not proposed in the scope of the initial RI Work Plan, it is recognized that additional depth-stratified sampling for TCE in soil and groundwater below the Maintenance Garage will likely be needed as part of subsequent phases of the remedial investigation to confirm the lateral and vertical extent of impacts and total mass of TCE present. This work is not proposed at this time due to a lack of existing data related to the nature and extent of potential impacts related to PFCs and agricultural chemicals. Waiting until completion of the work proposed in the RI Work Plan will allow us to efficiently incorporate all potential COCs into the additional remedial investigation work that is needed in this area.

Following completion of additional remedial investigation activities below the Maintenance Garage, a focused feasibility study (FFS) will be performed to develop a cost-effective approach for addressing impacted soil and groundwater associated with the former Maintenance Garage. The FFS will identify, evaluate, and recommend selection of appropriate and cost effective remedial actions. The FFS will evaluate remedial approaches on the basis of effectiveness, implementability, and cost.

Based on existing available data and identified impacts, remedial actions that will be evaluated in the FFS include the following:

- Excavation and off-site disposal of shallow source soils.
- In-situ bioremediation.
- In-situ chemical oxidation.
- In-well air stripping.
- Zero valence iron (micro-particle injection).
- Groundwater extraction and treatment to provide hydraulic containment and to reduce the size of the groundwater plume.
- Construction of clean soil buffers to protect future users of the golf course.
- Administrative controls such as an environmental covenant for the Site and MDH well Advisory for the vicinity of the Site.

Bench scale studies may be appropriate for understanding the effectiveness, implementability, and cost of one or more potential remedial actions as discussed below.

Task B: Bench Scale Study (not included in scope)
Additional field studies and bench scale studies may be performed to determine cost effective methods for reducing contamination at the Site. Full evaluation of in-situ bioremediation, chemical oxidation, and micro-particle zero valance iron injections may require additional field studies and bench test studies to determine if the technologies will be capable of degrading the CoCs below the Maintenance Garage to acceptable levels. Goals of a bench-scale study are described below for each of these three technologies.

- Anaerobic dechlorination occurs by sequential removal of chloride ions. For example, the chlorinated ethenes are transformed sequentially from PCE to TCE to the dichloroethene (DCE) isomers (cis-DCE or *trans-DCE)* to vinyl chloride (VC) to ethene. In this reaction, hydrogen serves as an electron donor and the chlorinated ethene molecule is the electron acceptor. Anaerobic reductive dechlorination of chlorinated hydrocarbons is dependent on many environmental factors (e.g., anaerobic conditions, presence of fermentable substrates, and appropriate microbial populations). In-situ anaerobic dechlorination requires that specific subsurface geochemistry conditions and microbial conditions exists. Field studies will need to determine if the appropriate strains of bacteria are present, evaluate the substrate geochemistry including laboratory and field analysis of volatile organic compounds, sulfate, ferrous iron, methane/ethane/ethene, manganese, nitrate, specific conductance, total organic carbon (TOC), oxidation reduction potential (ORP), temperature, pH, and dissolved oxygen (DO). Reductive dechlorination degradation can be enhanced by introducing various fermentable compounds. The hydrogen needed to initiate the reaction is generated by fermentation of non-chlorinated organic substrates including naturally occurring organic carbon, accidental releases of anthropogenic carbon (fuel), or introduced substrates such as carbohydrates (sugars), alcohols, and low-molecular-weight fatty acids. Potential compounds include cheese whey, emulsified vegetable oil, molasses or others. A bench scale study for reductive dechlorination could provide information regarding the type of substrate that is most effective at enhancing biodegradation of CoCs, nutrient requirements (e.g., including carbon source, nitrogen, and phosphorous), determine if bioaugmentation is required, estimates of biodegradation rates and the types of daughter products generated by differing bioremediation approaches, and establish design parameters for full-scale bioremediation remedy.

- In situ chemical oxidation includes injecting chemical oxidants into the subsurface to reduce concentrations of COCs by destroying the chemicals in place via chemical oxidation reactions. Common oxidants that are utilized for this technology include Fenton's reagent, sodium permanganate, sodium persulfate, and ozone. Bench-scale treatability studies are useful for this technology to determine the most effective treatment chemistry for destruction of COCs and to estimate the dose of chemical required to achieve success.

- Zero valance iron additional studies are completed to determine whether the zero valance iron is capable of degrading the COCs, and whether a catalyst or other additives are required to increase effectiveness. Additional laboratory and field analysis should include chemical oxidation demand (COD), biological oxygen demand (BOD), soil oxidant demand (SOD), metals, major anions and cations, and total inorganic carbon (TIC).

The need for bench scale studies and scope of bench-scale studies cannot be defined based on existing information, so **Bench Scale Studies are not included in the scope of this Work Plan.** If performed in the future, results of bench scale studies will be combined with the results of the RI and used to refine the evaluation in the FFS.

Objective 4 Timeline
4-6 weeks will be needed to perform the evaluation and prepare a FFS report.

Objective 4 Deliverables
The deliverable includes a FFS report with recommendations for additional remedial actions to be completed at the Site.

Objective 5: Source Soil Removal
Potential source soils have been observed around the 500-gallon fuel oil AST (petroleum) and north of the fertilizer building and garage (unknown source). Potential source soil removal from these areas is described below.

Task A: Petroleum Stained Soils around the 500-Gallon Fuel oil AST
Petroleum saturated soils observed around the fuel oil tank (up to 200 cubic yards) will be removed in accordance with MPCA guidance document *Excavation of Petroleum-Contaminated Soil and Tank Removal Sampling c-prp3-01* dated March 2017 (March 2017 Petroleum Excavation Guidance).

Subtask 1: Plans and Specifications/Bidding Documents
Braun Intertec will prepare specifications for excavation and stockpiling of the petroleum impacted soils per the MPCA Contracting Manual. The specifications will be submitted to the MPCA for approval prior to bidding. We assume that Braun Intertec will retain a subcontractor to perform the excavation work and that the total installation cost of the work will cost between $5,000 and $10,000. Based on these assumptions, our budget for this subtask assumes that Braun Intertec will request bids from a minimum of two bidders. If possible, at least one bidder will be a Targeted Group/Economically Disadvantaged/Veteran-Owned (TG/ED/VO) Small Business. Once the bids have been received, Braun Intertec will review contractor bids with the MPCA to select the responsive low cost subcontractor before proceeding with the work.

Braun Intertec will prepare specifications and bidding documents for the soil boring in the petroleum stained soil area per the MPCA subcontractor manual. The specifications will be submitted to the MPCA and MDA for approval prior to bidding, as appropriate.

Subtask 2: Petroleum Impacted Soil Excavation and Stockpiling for Characterization
Braun Intertec will oversee the excavation of the petroleum impacted soils around the exiting fuel oil AST. Petroleum contaminated soils around the AST that meet the following criteria will be excavated:

- Soil headspace readings greater than 10 parts per million (ppm).
- Visual evidence of staining.
- Positive sheen test results.

If all of the soils that exceed the field screening criteria cannot be removed within 200 cubic yards, then a limited site investigation (LSI) will be performed in the vicinity of the AST under a separate scope of work.

If all impacted soils are removed by excavating no more than 200 cubic yards, sidewall and bottom excavation confirmation samples will be collected in accordance with the March 2017 Petroleum Excavation Guidance.

The excavated impacted soils will be stockpiled onsite and stockpile soil samples will be collected in accordance with the March 2017 Petroleum Excavation Guidance. The stockpiled petroleum-impacted soils may be land treated, composted, thermally treated, or disposed at a sanitary landfill in accordance with MPCA guidance. As the size of the stockpile is not know at this time, costs for sampling the stockpile for characterization are not included under this scope of work, however the number of stockpile samples for characterization will be in accordance with MPCA guidance as follows:

Cubic Yards of Soil in Stockpile	Number of Grab Samples
Less than 50	1
51-500	2
501-1,000	3
1,001-2,000	4
2,001-4,000	5
each additional 2,000	one additional sample

Soil samples will be submitted for the analysis as outlined in the MPCA Guidance documents *Soil Sample Collection and Analysis procedures c-prp4-04* dated March 2017, following the applicable analysis as listed for the gasoline UST, the fuel oil AST and for the "used oil" tank beneath the maintenance garage.

Subtask 3: Post-Excavation Boring
Since the site is primarily sandy, with a groundwater table less than 25 feet bgs, a post-excavation soil boring will be performed and soil and groundwater samples will be collected to evaluate if an LSI is necessary. Braun Intertec will contract a State Contract drilling firm to advance one boring to determine if a LSI is necessary. Soil and groundwater samples from the post-excavation soil boring will be collected in accordance with MPCA Guidance documents *Soil Sample Collection and Analysis procedures c-prp4-04* dated March 2017 and *Groundwater Sample Collection and Analysis Procedures | c-prp4-05* dated March 2017. Based on the results of the post-excavation soil boring sample analysis and the post excavation soil boring, the need for an LSI will be evaluated. An LSI is not included in this scope of work.

Task B: Discolored Soils to the North of the Fertilizer Building and Garage (not included in scope)
There are discolored soils located north of the former fertilizer building and the existing maintenance garage building. The exact cause of the discoloration is not known, however agricultural chemicals and PFC were used on-site and a former employee stated that used parts degreaser was regularly poured onto the ground near the stream (which is located north of the former fertilizer building and the existing maintenance garage). Additional investigation of this area will occur during the proposed RI, once the extent and magnitude of the impacts to the discolored soil are defined then an appropriate soil excavation and treatment can be implemented to address these soils in accordance with applicable MDA and MPCA guidance. **Removal of the discolored soils is not included in the scope of this Work Plan.**

Objective 5 Timeline
Bid specifications will be prepared in 2-3 week and the stained soils around the AST will be excavated for removal approximately 2-3 weeks following bid specification preparation pending excavator availability. The post-excavation boring will be completed within 1-2 days after completing the excavation. The confirmation sample and boring sampling results will require 1-2 weeks to receive from the analytical laboratory, and a final report can be created within 1-2 weeks of receiving the laboratory data.

Objective 5 Deliverables
The deliverables include bid specifications and is a report documenting the soil excavation (including the general excavation form), post-excavation soil boring advancement and sampling, stockpile soil sampling results.

Objective 6: Tank Removal/Abandonment
There are three unused petroleum storage tanks at the Site and we assume that these tanks will not be used by the potential future golf course. The unused tanks include a 500 gallon Fuel Oil AST, a 1,000 gallon gasoline UST, and a 500 gallon UST connected to the floor drain in the maintenance garage (suspected of having leaked). For the purposes of this Work Plan, Braun Intertec assumes that the 1,000 gallon gasoline tank and the AST will be removed and disposed off-site, and the 500 gallon UST beneath the maintenance garage floor will be abandoned in place.

Task A: Prepare Bid Specifications
Braun Intertec will prepare bid specifications for tank removal and disposal or abandonment in place (as appropriate) per the MPCA Contracting Manual. The specifications will be submitted to the MPCA for approval prior to bidding. For the purpose of this work plan, we assume that Braun Intertec will retain a subcontractor to remove the tanks and that the total construction costs for abandonment of all three tanks will cost between $10,001 and $50,000. Based on these assumptions, this budget for this subtask assumes that Braun Intertec will compete and submit the forms required per the purchasing manual, that the work will be advertised on the Department of Administration website, and that the solicitation will be sent to a minimum of three vendors. A minimum of one bidder will be a Targeted Group/Economically Disadvantaged/Veteran-Owned (TG/ED/VO) Small Business. We assume that no site walk will be required as part of the bidding process. Once the bids and required documents per the purchase manual have been received, Braun Intertec will review contractor bids with the MPCA to select the winning subcontractor before proceeding with the work.

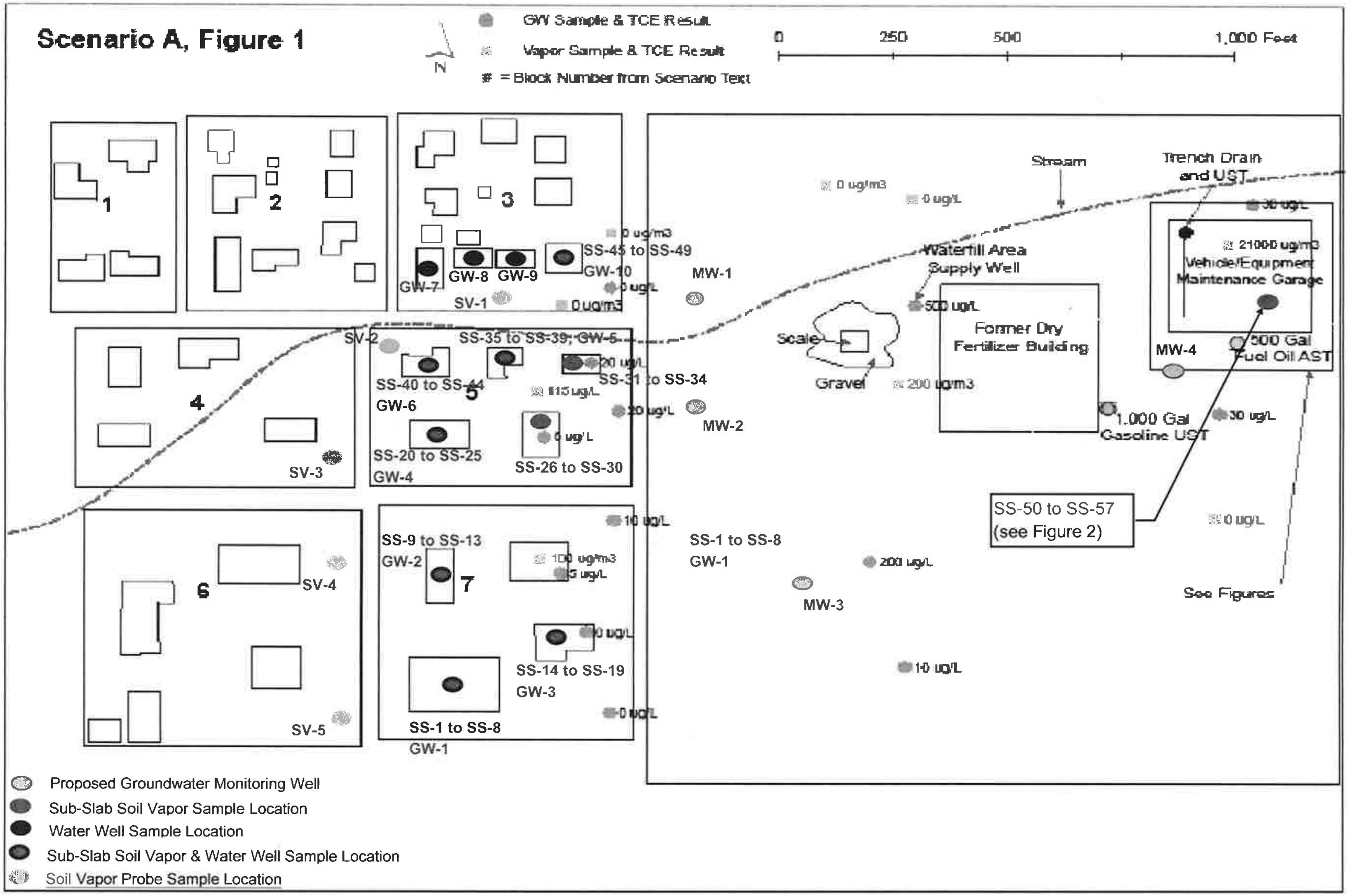
Task B: Tank Removal/Abandonment and Post-Excavation Sampling
Two tank removals and a tank abandonment will be performed by a MPCA certified contractor with oversight performed by Braun Intertec. After the tanks are removed, Braun Intertec will observe the tank basins for field indications of a release, if there are no field indications of a leak, and the tank appear to be in good condition, then Braun Intertec will collect soil samples from beneath the removed tank in accordance with MPCA guidance document *Site Assessment for Underground Storage Tanks with No Apparent Contamination* t-u2-11 Dated April 2012. For the 1,000 gallon gasoline UST, the two samples collect from beneath the tank. For the AST, one sample will be collected from 2 feet below the center of the removed AST. For the UST beneath the maintenance floor that is suspected of leaking, the contractor will cut two holes in the tank (after it is emptied and cleaned), and two soil samples will be collected from beneath each end of the UST.

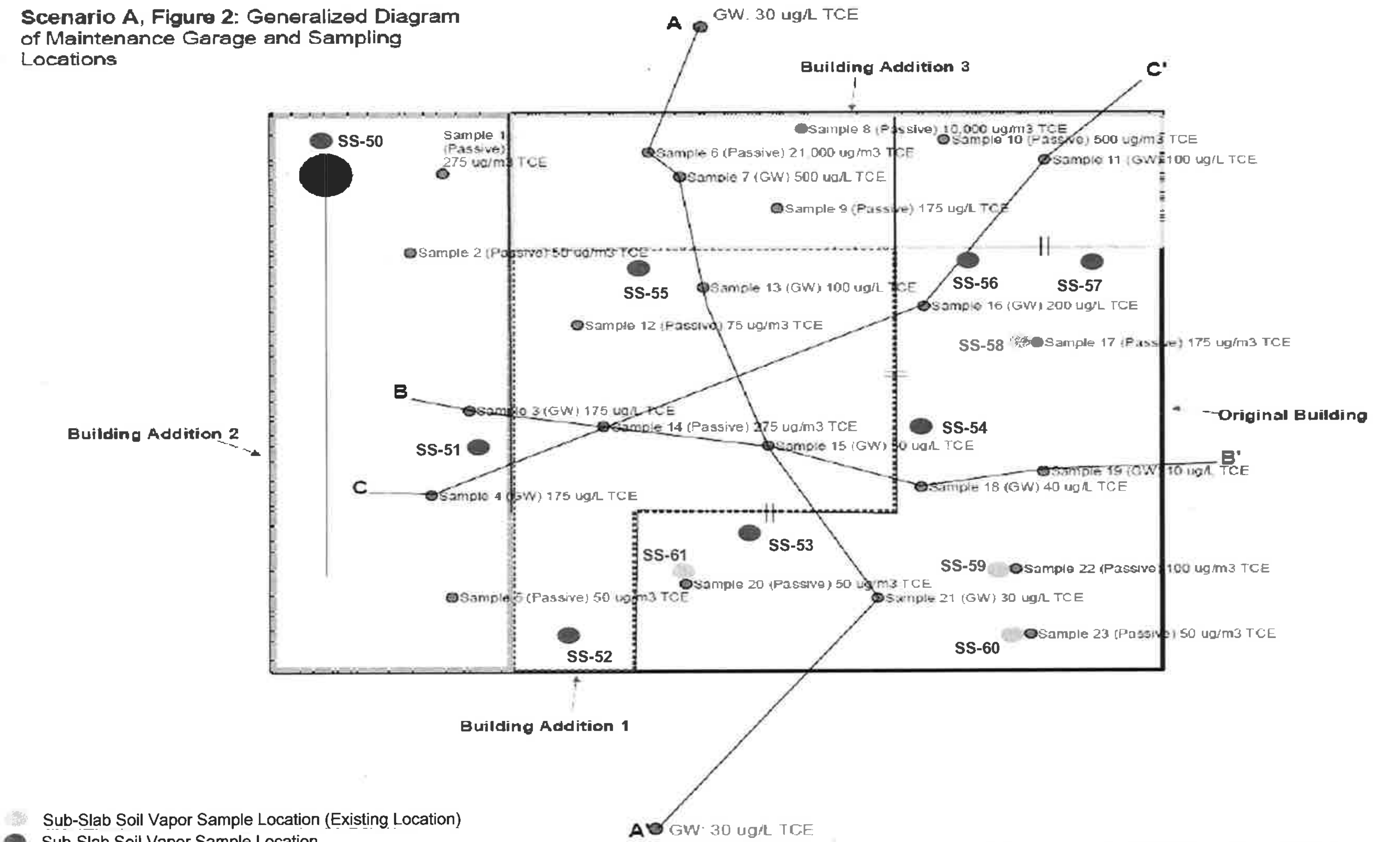
For all tank locations, if there are system components present, samples will be collected from all transfer areas, beneath any leaking pipes or in areas of visible contamination. Samples will be collected from 2 feet below the loading rack, 2 feet below the leaking pipe sampling location, and/or in the most heavily stained area. If field indications are present that a leak from the tank has occurred, then the MPCA project manager will be called, and we assume that an LSI will be required. An LSI would be outside the scope of this Work Plan.

Soil samples will be submitted for the analysis as outlined in the MPCA Guidance documents *Soil Sample Collection and Analysis procedures c-prp4-04* dated March 2017, following the applicable analysis as listed for the gasoline UST, the fuel oil AST and for the "used oil" tank beneath the maintenance garage.

Objective 6 Timeline
The plans and specifications/Bidding documents can be prepared within 1-2 weeks for submittal to the MPCA Core Response Team to review. Work can begin within 2-3 weeks of the contractor being selected. Tank removal/abandonment is estimated to take 2-3 days to complete. Soil sample analysis will require 2 weeks. Tank abandonment reports will be completed 1-2 weeks after receiving laboratory data.

Objective 6 Deliverables
The deliverables include a report documenting tank removal/abandonment.


Scenario A, Figure 1
N
GW Sample & TCE Result
Vapor Sample & TCE Result
= Block Number from Scenario Text
0
250
500
1,000 Feet
1
2
3
4
5
6
7
GW-7
GW-8
GW-9
SS-45 to SS-49
GW-10
SV-1
0 ug/m3
0 ug/L
0 ug/m3
MW-1
SV-2
SS-35 to SS-39, GW-5
SS-40 to SS-44
GW-6
20 ug/L
SS-31 to SS-34
115 ug/L
20 ug/L
MW-2
0 ug/L
SS-20 to SS-25
GW-4
SS-26 to SS-30
SV-3
SV-4
SV-5
SS-9 to SS-13
GW-2
100 ug/m3
5 ug/L
10 ug/L
0 ug/L
SS-14 to SS-19
GW-3
SS-1 to SS-8
GW-1
0 ug/L
SS-1 to SS-8
GW-1
MW-3
200 ug/L
10 ug/L
0 ug/m3
0 ug/L
Stream
Waterfill Area
Supply Well
500 ug/L
Scale
Gravel
200 ug/m3
Former Dry
Fertilizer Building
1,000 Gal
Gasoline UST
Trench Drain
and UST
30 ug/L
21000 ug/m3
Vehicle/Equipment
Maintenance Garage
500 Gal
Fuel Oil AST
MW-4
30 ug/L
SS-50 to SS-57
(see Figure 2)
0 ug/L
See Figures
Proposed Groundwater Monitoring Well
Sub-Slab Soil Vapor Sample Location
Water Well Sample Location
Sub-Slab Soil Vapor & Water Well Sample Location
Soil Vapor Probe Sample Location



Scenario A, Figure 2: Generalized Diagram of Maintenance Garage and Sampling Locations

MINNESOTA POLLUTION CONTROL AGENCY
520 Lafayette Road North
St. Paul, MN 55155-4194

Remedial Design/Remedial Action Scenario Spreadsheet

Project title: Former Agricultural Chemical Plant

	1. Personnel						2. Subcontracting		3. Equipment						Totals (Extended) (Personnel Hours Only)
Project Budget	Project Manager	Field Technician	GIS/CADD Specialist	QA/QC Officer	Scientist 1 or Engineer 1	Scientist 2 or Engineer 2	Laboratory	Drilling/ Other Contractor	Mileage	Sub-Slab Sampling Kit	PID (10.6 eV)	Micro Manometer	Water quality meter	GPS (sub-meter)	
Objective 1: Address Elevated TCE in Drinking Water															
Task A: Bottled Water Scenario															
Subtask 1: Well Abandonment (three wells)	4	10						Abandon 3 wells	60						14
Subtask 2: Reporting	4		1		4										9
Task B: Residential Water Treatment System Design and Installation (if municipal supply connection is not immediately feasible).															
Subtask 1: Residential Water Treatment System Design and Contracting	4				2	4		System Install							10
Subtask 2: Residential Water Treatment System Installation Oversight and Confirmation Sampling	4	16		3	8		3 water samples for VOCs		180				1		31
Subtask 3: Well Abandonment	4	10													14
Total for Objective 1 Hrs/Qty	**20**	**36**	**1**	**3**	**14**	**4**			**240**	**0**	**0**	**0**	**1**	**0**	**78**
Objective 2: Mitigate Vapor Intrusion Risk to Home with Elevated Concentrations of TCE Detected in Soil Vapor															
Task A: Sub-slab Depressurization System (SSDS) Design and Installation															
Subtask 1: SSDS Design and Installation.	3		2		4										9
Subtask 2: Installation Documentation, Confirmation Sampling and Reporting	4	8	1		8		TO-15, assumes 2 sub-slab, one indoor air, and one outdoor air	System Install	60	1	1	1			21
Total for Objective 2 Hrs/Qty	**7**	**8**	**3**	**0**	**12**	**0**			**60**	**1**	**1**	**1**	**0**	**0**	**30**
Objective 3: Mitigate Vapor Risk to the Future Occupants of the Existing Maintenance Equipment Garage															
Task A: Additional Sub-Slab Vapor Sampling to Define the Area Needing Mitigation. **(Included in RI Costs)**															
Task B: Pre-diagnostic testing and vapor system specifications preparation. **(Included in RI Costs)**															
Task C: System Installation Bid Preparation and Selection.	4		3		8										15
Task D: Installation Documentation, Confirmation Sampling and Reporting	5	20	3		16		Assumes 3 sets of paired sub-slab, indoor air and ambient air.	System Install	60		1				44
Total for Objective 3 Hrs/Qty	**9**	**20**	**6**	**0**	**24**	**0**			**60**	**0**	**1**	**0**	**0**	**0**	**59**
Objective 4: Focused Feasibility Study and Bench Scale Studies - Maintenance Garage															
Task A: Focused Feasibility Study	20		6		20	50									96
Task B: Bench Scale Study **(Future task, costs not included)**															
Total for Objective 4 Hrs/Qty	**20**	**0**	**6**	**0**	**20**	**50**			**0**	**0**	**0**	**0**	**0**	**0**	**96**
Objective 5: Source Soil Removal															
Task A: Petroleum Stained Soils around the 500-Gallon Fuel Oil AST															
Subtask 1: Plans and Specifications/Bidding Documents	3				8										11
Subtask 2: Petroleum Impacted Soil Excavation and Stockpiling for Characterization	3	12							60		1			1	15
Subtask 3: Post Excavation Boring (includes reporting for Objective 5)	2	8	2		12				60		1			1	24
Task B: Discolored Soils to the North of the Fertilizer Building and Garage **(Future task, costs not included)**															
Total for Objective 5 Hrs/Qty	**8**	**20**	**2**	**0**	**20**	**0**			**120**	**0**	**2**	**0**	**0**	**2**	**50**
Objective 6: Tank Removal/Abandonment															
Task A: Prepare Bid Specifications	3		1		6										10
Task B: Tank Removal/Abandonment and Post-Excavation Sampling	3	12							60		1			1	15
Total for Objective 6 Hrs/Qty	**6**	**12**	**1**	**0**	**6**	**0**			**60**	**0**	**1**	**0**	**0**	**1**	**25**
Total Project Hours/Quantities	**70**	**86**	**19**	**3**	**96**	**54**			**540**	**1**	**5**	**1**	**1**	**3**	**338**

Assumptions:
Site is assumed to be in rural Minnesota 30 miles one way from our closest office.

Attachment A

MINNESOTA POLLUTION CONTROL AGENCY
520 Lafayette Road North
St. Paul, MN 55155-4194

Remedial Investigation Work Plan (Scenario A)

Project Title: Former Agricultural Chemical Plant

1. Project Summary

The Former Agricultural Chemical Plant site (the Site) was historically occupied by an agricultural chemical plant facility from 1960 to 1991, which included dry fertilizer storage, chemical storage, fertilizer blending/mixing, fuel storage, equipment/vehicle maintenance operations, and improper disposal of wastes. Since agricultural facility operations ceased, the Site has been partially investigated by the Site owner, which identified chlorinated ethenes (most notably trichloroethylene [TCE]) and agricultural chemicals (nitrogen, dicamba, metolachlor, metribuzin, pendimethalin, and triclopyr) in soil and groundwater above Minnesota Pollution Control Agency (MPCA) and Minnesota Department of Agriculture (MDA)-regulated cleanup goals. Results from the Site owner-initiated investigation also indicate that migration of TCE in soil vapor off-Site may have occurred, including potential exposure to a pregnant person. A subsequent MPCA investigation identified TCE in both on- and off-Site groundwater and soil vapor, including several potential source areas. Based on these investigation findings and lack of cooperation by the current Site owner, this Remedial Investigation (RI) Work Plan has been prepared to further investigate known and potential risks to human health and the environment as a result of historical Site use and releases, which in turn will be used for Remedial Design/Remedial Action (RD/RA) planning.

2. Statement of Problems, Opportunities, and Existing Conditions

Braun Intertec has prepared this RI Work Plan in response to the Request for Proposal (RFP) from the MPCA and MDA. As detailed in the RFP, Scenario A for Category A includes preparing a Work Plan for a Remedial Investigation to address known and potential contamination identified at the Site. As part of the RI Work Plan, contaminant pathways will be investigated to identify and evaluate those representing a high risk and support preparation of a RD/RA work plan to address complete high-risk exposure pathways. We have also included work to characterize and delineate suspected on-site source areas and to begin characterization of groundwater flow characteristics at the Site.

For the purposes of this RI Work Plan, Braun Intertec has made the following assumptions:

- Tasks that would typically be completed prior to preparing a RI Work Plan would include:
- Review of all available data to appropriately scope RI Work Plan activities. As this data has not been provided, based on available information a data gap analysis has been proposed to be completed along with receptor surveys.
- A Site walk with Braun Intertec, the MDA/MPCA, and person's familiar with the Site history and facility operations, to review the site use history to identify sampling areas including potential source areas and potential receptors.
- Based on the number of potential source areas and viable pathways, it is assumed a risk-based approach will be taken to minimize risk and prioritize investigation activities, from high risk areas to low risk areas. While every effort has been made to identify what may be perceived to be as high risk, the MPCA and MDA will ultimately decide which pathways will be considered high risk, and therefore, funded for investigation.
- Although the maintenance garage is currently vacant, it is likely to be used after the Site is redeveloped. We have included characterization of sub-slab soil vapor within our scope of work, but we realize that the MPCA may prefer to have the property owner or future developer perform this work, if possible.

- Although not proposed in the scope of this work plan, it is recognized that additional depth-stratified sampling for TCE in soil and groundwater below the Maintenance Garage will likely be needed to delineate the lateral and vertical extent of impacts and total mass of TCE present. This work is not proposed at this time due to a lack of existing data related to the nature and extent of potential impacts related to PFCs and agricultural chemicals. Waiting until completion of the work proposed in this Work Plan will allow us to efficiently incorporate all potential COCs into the additional remedial investigation work that is needed near the Maintenance Garage.

Site History
The Site operated as an agricultural chemical plant from 1960 to 1991. During agricultural operations, Site operations included dry fertilizer storage, chemical storage, fertilizer blending/mixing, fuel storage, equipment/vehicle maintenance operations, and improper disposal of wastes. Available information for these operational areas, as well as additional notable areas, include:

- Dry fertilizer building: The fertilizer building had four access doors: the east and west ends of the building had large overhead doors; a small overhead door was located in the middle of the building on the north side; and a small service door was located on the south side. A pesticide mixer/blender was located inside the former fertilizer building on the west end. In 1999, the former dry fertilizer building was destroyed in a fire. During the fire, foam fire suppressant was applied to the blaze as part of an act of vandalism. No sampling for potential contaminants of concern (CoC) has been conducted for the former dry fertilizer building.

- Maintenance garage: Historical documentation indicates that the maintenance garage was used extensively for degreasing operations as part of washing and maintaining equipment and vehicles. Building records note that there were three additions to the building over the years, however these records, do not denote utility locations. Previous investigation results include collection of several samples for soil gas, groundwater, and soil. Soil gas results indicate TCE at concentrations greater than MPCA Commercial/Industrial 33x Intrusion Screening Value (ISV) of 230 micrograms per cubic meter (µg/m3) in building additions 1, 2, and 3, indicating a need for response actions. Groundwater results were also identified above Minnesota Department of Health (MDH) Health Risk Limit (HRL) for TCE (0.4 micrograms per liter [µg/L]), in numerous samples, ranging up to 500 µg/L. Previous investigation data for soil also shows soil concentrations greater than the MPCA Commercial/Industrial and Short-Term Construction Worker Soil Reference Value (SRV) for TCE (46 milligrams per kilogram [mg/kg]). Soil concentrations of TCE beneath the maintenance garage have ranged up to 120 mg/kg. No sampling results were available for additional COCs, including petroleum constituents, pesticides (List 1 and List 2), fertilizers (nitrates, ammonia, and total Kjeldahl nitrogen [TKN]), metals, polychlorinated biphenyls, or additional volatile organic compounds (VOCs).

- Parking areas: Agricultural chemical equipment storage/parking areas were located on the north and south sides of the former dry fertilizer building. Limited sampling has been conducted in the former parking areas; however, previous results from the southern parking area had TCE results in groundwater ranging from 10 µg/L to 200 µg/L, well above the MDH HRL for TCE. In addition, the extent of TCE contamination was not fully defined. No sampling results were available for additional COCs, including petroleum constituents, pesticides (List 1 and List 2), fertilizers (nitrates and TKN), or additional VOCs.

- Water supply areas: A water fill area was located outside the former fertilizer building at the west end. In 1997, a sample collected from the well by the MDA contained concentrations of nitrate (116 milligrams per liter [mg/L]), metolachlor (424 µg/L), and dicamba (283 µg/L), all of which are greater than applicable MDH HRLs. A groundwater sample collected from the well was also reported to have TCE at a concentration of 500 µg/L, which is well above the MDH HRL for TCE.

- Truck scale: The scale is located outside the west end of the dry fertilizer building and is surrounded on all sides by gravel. No sampling for potential COCs has been conducted for the truck scale; however, one soil vapor sample was collected, with a reported TCE concentration of 200 µg/m3.

- Fuel storage areas: Records note the presence of a 500-gallon fuel oil aboveground storage tank (AST) used to heat the garage (diesel range organics [DRO]), and a 1,000-gallon gasoline UST (gasoline range organics [GRO]) used to fill large trucks, both installed in the 1960's. No soil, groundwater, or soil vapor sampling for potential COCs has been conducted for the fuel storage area and surrounding area.

- Stained/dumping areas: According to an interview of a former employee, a used parts degreasing agent was regularly poured onto the ground near the stream on Site. Discolored soils were reported to the north of the fertilizer building and garage during the last facility inspection. Due diligence efforts conducted during property transfer indicated these discolored soils were still present. No sampling for potential COCs has been conducted for the reported dumping area; however, one groundwater sample appears to have been collected on the north side of the former maintenance garage, with a reported TCE concentration in groundwater above the HRL. Additional results or sampling locations for potential COCs has not been conducted or provided.

- Off-Site Areas: Previous investigation for off-Site areas to the north and west of the Site has been completed for soil vapor and groundwater. Based on available information, sub-slab and soil vapor probe results have identified TCE on blocks 5 and 7. A sub-slab sample in a residence occupied by a pregnant woman is above the 33x Residential ISV for TCE; therefore, in accordance with the MPCA's Interim ISV Short Guidance dated February 13, 2017, expedited mitigation is necessary The soil vapor probe result is also indicative of potential vapor intrusion risk to neighboring structures. Groundwater sampling results indicate TCE concentrations greater than the HRL for several private wells, ranging from 5 µg/L to 20 µg/L, including the home where a pregnant woman is known to reside. It should be noted that off-Site samples north of the stream were non-detect for TCE in both soil vapor and groundwater; however, additional compound results were not provided.

Since ceasing operations in 1991, the Site was purchased for redevelopment into a golf course.

Site Setting
The Site is situated east of and adjacent to a residential area, and a stream is located to the north of the Site (Figure 1). The Site topography has generally been noted as being mostly flat; however, the elevation dips downward toward the stream which runs east to west into the residential areas. Based on available information, the stream may be acting as a hydraulic barrier; however, additional sampling must be completed to confirm this observation.

Based on previous investigations, the Site geology was noted to generally consist of coarse grained sands to at least 30 feet below ground surface (bgs) with thin lenses of silt and clay. Shallow groundwater on Site was encountered at depths between 6 and 10 feet bgs during previous investigations, with groundwater samples collected at 15 feet bgs from investigation borings. Groundwater samples retrieved from off-Site domestic wells were collected at 30 feet bgs. The assumed groundwater flow direction is to the west. It should be noted that older portions of the town (situated closer to the Site) are on private well drinking water (blocks 3, 5, and 7), while newer portions of the town (farther west of the Site) are on community water from the local municipality (blocks 1, 2, 4, and 6).

Current Site Conditions
Current information on the Site suggest that existing conditions pose known and potential threats to human health and the environment. Based on available information, the current conditions for the Site, including notable existing conditions which affect contaminant migration and exposure pathways for current and future use, include:

- Dry fertilizer building: As a result of a fire, only the building slab remains, which has been observed as being cracked. During the fire, fire suppressant foam was applied, followed by building material removal shortly thereafter.

- Maintenance garage: A trench drain was observed within the maintenance garage leading to a 500-gallon UST of unknown age. There are no records of the tank having ever been removed or cleaned out, and it is assumed the tank leaked. The remainder of utility locations remain unknown. The concrete floor in this building is intact, and the building remains in good condition for future use.

- Parking areas: No additional information regarding the current condition of the parking areas has been provided or observed.

- Water supply areas: The shallow water supply well is still located in the water fill area and reported to be functional.

- Truck scale: The scale remains located outside the west end of the dry fertilizer building.

- Fuel storage areas: Both the gasoline UST and diesel AST remain on-site. Stained soils were apparent beneath the AST.

- Stained/dumping areas: No additional information regarding the former dumping and stained areas has been provided or observed.

Based on the reviewed/available information, multiple source areas and potential exposure pathways exist as a result of the Site use. Each of these pathways, some of which have yet to be investigated, may have multiple receptors as a result of contaminant migration. It has been reported that the surrounding community has expressed concern about risk to their health. To minimize on-going risk and perform response actions for completed exposure pathways, data gaps must be filled in order to holistically evaluate the Site and prioritize response actions.

The following table summarizes potential areas of concern (AOCs) identified at the Site. Each source area was ranked based on potential risk to receptors based on available information. The rankings (low, medium, and high) are intended to prioritize investigation in a phased approach based on identified exposure pathways and receptors, as well as take into account the potential for limited funding to be available. The COCs at the Site have been selected based on our review of the available information and the MDA/MPCA guidance documents.

The table also incorporates the rationale for investigating each AOC and applicable contaminant migration pathways.

Table A
AOCs, Associated COCs, Pathways, Risk Ranking and Rationale

AOC	COCs	Potential Media	Risk Level	Rationale
Northern Dumping & Staining Areas	VOCs GRO/DRO Pesticides	Soil	Medium	Potential source area(s) based on previous results and/or historical Site information; ability to leach to groundwater, migrate to stream via runoff/infiltration
		Groundwater	Medium	Potential source area(s) based on previous results and/or historical Site information; ability to migrate through groundwater and/or interact with surface water
Northern & Southern Parking Area	VOCs Pesticides/Herbicides Ammonia/Nitrates/TKN	Soil	Medium	Potential source area(s) based on previous results and/or historical Site information; ability to leach to groundwater or migrate through soil vapor
		Groundwater	Low	Potential source area(s) based on previous results and/or historical Site information; ability to impact off-Site receptors through groundwater and soil vapor
Former Dry Fertilizer Building	PAHs Pesticides/Herbicides Ammonia/Nitrates/TKN PFCs Metals	Soil	Medium	Potential source area(s) based on previous results and/or historical Site information; ability to have leached COCs to groundwater and be present in soil based on Site use
		Groundwater	Medium	Potential source area(s) based on previous results and/or historical Site information; ability to impact off-Site receptors through groundwater and/or soil vapor
Maintenance Garage	GRO/DRO VOCs Ammonia/Nitrates/TKN Metals Pesticides/Herbicides	Soil	Low	Potential source area(s) based on previous results and/or historical Site information; ability to have leached COCs to groundwater and be present in soil based on Site use
		Groundwater	Medium	Potential source area(s) based on previous results and/or historical Site information; ability to impact off-Site receptors through groundwater
		Soil Vapor	Medium	Potential source area(s) based on previous results and/or historical Site information; ability to impact off-Site receptors through soil vapor and/or utility corridors
500-gallon AST & 1,000-gallon UST	Petroleum	Soil	Low	Potential source area(s) based on previous results and/or historical Site information; ability to leach to groundwater or migrate through soil vapor
		Groundwater	Low	Potential source area(s) based on previous results and/or historical Site information; ability to impact off-Site receptors through groundwater
		Soil Vapor	Low	Potential source area(s) based on previous results and/or historical Site information; ability to impact off-Site receptors through soil vapor and/or utility corridors
Water Fill/Scale/Water Supply Well Areas	GRO/DRO PFCs VOCs Ammonia/Nitrates/TKN Pesticides/Herbicides	Soil	Medium	Potential preferential pathway based on previous results and/or historical Site information; ability to impact off-Site receptors through migration to groundwater and/or soil vapor
		Groundwater	Medium	Potential preferential pathway based on previous results and/or historical Site information; ability to impact off-Site receptors through groundwater and/or soil vapor migration
Nearby Stream Channel	VOCs GRO/DRO PFCs	Sediment	Medium	Potential receptor based on previous results and/or historical Site information; ability to impact natural resources, impact stream users, and/or water intakes due to uptake and/or leaching
		Surface Water	Medium	Potential receptor based on previous results and/or historical Site information; ability to impact natural resources, impact stream users, and/or water intakes due to ingestion or contact
Residential Neighborhood	VOCs PFCs Pesticides/Herbicides Ammonia/Nitrates/TKN Petroleum	Soil Vapor	High	Potential receptors based on previous results and/or historical Site information; ability to be present within indoor spaces (inhalation)
		Groundwater	High	Potential receptors based on previous results and/or historical Site information; ability to be ingested or off-gas into soil vapor (inhalation)

Based on the reviewed/available information, opportunities for efficiency may exist across the MDA and MPCA Site Assessment Programs, as well as the MPCA Petroleum Remediation Program. Potential synergies may involve locating borings within preferential zones to allow for sample collection according to the individual program requirements. In addition, stratified samples may also be collected as required by the MDA and MPCA Petroleum Remediation programs. The ranking of AOCs also presents an opportunity to investigate highest priority pathways and potential receptors first (i.e. vapor intrusion and/or impacted domestic wells).

3. Goals, Objectives, Tasks, and Subtasks

Goal: To conduct a Remedial Investigation based on a tiered approach to evaluate Site conditions and assess risk to identified receptors, as well as collect additional information to resolve data gaps and evaluate and implement response actions.

Objective 1: Complete a data gap analysis, receptor survey, and pre-investigation plans

Task A: Data Gap Analysis
Due to the numerous potential exposure pathways and COCs, a data gap analysis is proposed to identify missing or inadequate information that would be required to more accurately characterize the Site as it relates to impacts on human health and the environment. During the data gap analysis, all previous reports will be reviewed, pertinent data obtained from available resources, and summarized to identify shortfalls. Ideally, the data gap analysis will allow for more focused and efficient data collection during the RI. For the purposes of this RI Work Plan, potential data gaps may include but are not limited to:

- Receptor-specific items (e.g. is the municipal water source from the stream and determining what stream classification/uses are applicable?).
- Besides TCE, are other COCs present in previous samples (i.e. petroleum).
- Available utility information, which may be obtained from municipal departments.
- A review of all COCs which may have been stored/used on Site and the disposition of the COCs (e.g. were COCs present on Site during the fire).
- The potential for byproducts/emerging contaminants to be present as a result of Site history (e.g. dioxins due to burned pesticides and perfluorinated chemicals (PFCs) due to fire foam suppressant).
- The status of Site redevelopment and planned use (e.g. has potentially contaminated soil been removed and utility corridor locations which may expose workers).
- Evaluating which pathways have not been evaluated to date (e.g. surface water).
- What additional information is required to evaluate remedial actions (e.g. soil porosity for soil vapor extraction).

As data gaps are identified or resolved, the preliminary risk rankings may be adjusted to account for information identified during the data gap analysis.

Task B: Receptor Survey
A receptor survey will be completed to identify potential receptors which may be exposed as a result of releases on Site. The receptor survey is generally a preliminary component completed for both the MPCA and MDA Site Assessment programs, as well as being required for petroleum tank Limited Site Investigations under the Petroleum Remediation Program. As part of this task, a receptor survey will be completed by identifying all pertinent receptors with potential or completed exposure pathways for soil, groundwater, soil vapor, surface water, sediment, and/or food chain. The survey will incorporate requirements from the individual programs as specified in MDA Guidance Document GD-9 (Attachment 2) and MPCA Guidance Document 4-02 (petroleum) and Risk-Based Site Evaluation Manual (non-petroleum). The receptor survey will be used to support creation of a Conceptual Site Model, which will be updated as additional information becomes available. The receptor survey may also be used to revise AOC priority ranking as necessary.

Braun Intertec will conduct a receptor survey in accordance with MPCA Guidance Document 4-02 Potential Receptor Survey and Risk Evaluation Procedures at Petroleum Release Sites. The receptor survey will identify water wells, potential vapor receptors and surface water bodies that may be at risk from the potential petroleum release related to the Site history. Results of the survey will be included in the investigation report.

Specifically, Braun Intertec will identify and map potential receptors starting with areas with known contamination. For the receptor survey, Braun Intertec will perform the following activities:

- Vapor Receptors: Potential receptors will be mapped within a 100-foot radius of the Site and/or known off-Site impacts.
- Water Well Survey: For potential water wells, Braun Intertec will conduct a walking survey of all properties within a 500-foot radius of the Site and known off-Site contamination areas, and contact the property owners regarding the presence of water wells, basements or sumps on their property. Braun Intertec will contact the City utility billing department to confirm which properties within the 500-ft radius are connected to the municipal water supply. Braun Intertec will search the Minnesota Geological Survey database for registered water wells within the one-mile radius and tabulate any well construction details for identified wells. Braun Intertec will contact City officials regarding any future water development plans in the area. The information obtained from the water well receptor survey along with the groundwater data from previous investigations will be used to evaluate the risk to potential water well receptors.
- Surface Water Receptor Survey: Braun Intertec will identify and map the potential surface water receptors within a 1/4-mile radius of the Site. In addition, the stream classification and user characteristics. If necessary, the Minnesota Department of Natural Resources and/or U.S. Fish & Wildlife Service will be contact to determine whether any threatened or endangered species are present which require special protections, or are known to be for consumption by humans.

Task C: Pre-Investigation Plans
Prepare a Sampling and Analysis Plan (SAP) incorporating results of the data gaps analysis and receptor survey, as well as a project-specific Quality Assurance Project Plan (QAPP) and Health and Safety Plan (HASP).

Subtask 1: RI SAP Preparation
The RI SAP will detail the proposed sampling approach for the RI, including methods and procedures for soil, soil vapor, and/or groundwater sampling, as well as outline the project objectives, proposed sampling locations and rationale, data requirements, and schedule. The RI SAP will incorporate requirements from the individual programs as specified in MDA Guidance Document GD-9 and MPCA Guidance Document 4-01 (petroleum) and Risk-Based Site Evaluation Manual, including pathway-specific guidance documents (non-petroleum).

Subtask 2: QAPP Preparation
As is typically required for Site Assessment projects, a project QAPP will be prepared to identify data quality objectives and ensure data is usable in support of the project objectives.

Subtask 3: HASP Preparation
A Site-specific HASP will be prepared to identify potential Site hazards as they relate to the proposed RI. The HASP may be used to assist subcontractors with subcontractor-specific HASP generation for their associated tasks.

Objective 1 Timeline: 3-4 weeks

Objective 1 Deliverables: RI SAP with supporting QAPP and HASP

Objective 2: Complete a RI to Evaluate Receptor Risk

Task A: Evaluate Identified Receptors (High Risk Areas)
Task A will focus on evaluating potential exposure to identified receptors as summarized in the RI SAP. As included above in Table A, numerous potential source areas and/or migration pathways exist which may expose potential receptors to COCs. For the purposes of this Work Plan and as specified in the RFP, details regarding investigation of "high risk" AOCs are provided below and in Table B. Recommended investigation activities for the currently classified medium- and low-risk areas are provided under separate subtasks in order to confirm that the respective areas do not represent a higher risk than anticipated and to determine if corrective measures/response actions are warranted.

The AOCs identified in Task A as "high risk" have been assigned the highest priority based on the available information, which suggests that exposure via the identified pathways is already occurring or is imminent. Table B summarizes the pathways considered to be high risk, additional details on potential COCs associated with the AOC, and the proposed number of borings and sample locations to evaluate the pathway.

Table B
High Risk AOCs, Potential COCs, Pathways, and Investigation Information

AOC	Potential COCs	Potential Media	# Borings / Sample Locations	Sampling Intervals
Residential Occupants	VOCs PFCs Pesticides/Herbicides Ammonia/Nitrates/TKN Petroleum	Soil Vapor	5 probes 49 sub-slab locations during the first seasonal event and 20 locations (assumed) during the second seasonal event.	5 feet bgs (soil gas probe) Based on square footage (see Table 1)
		Groundwater	10 locations (existing private wells)	Not Applicable

Subtask 1: Soil Vapor Sampling
Soil vapor sampling will consist of both sub-slab soil vapor sampling using Vapor Pins™ and soil vapor sampling in exterior spaces using soil vapor probes. Forty-nine sub-slab (SS-1 through SS-49) and five soil vapor probe (SV-1 through SV-5) sample locations are proposed to investigate the extent of soil vapor contamination in the adjacent neighborhood, which is known to be at least partially residential. However, based on results from the sampling proposed herein, subsequent additional sub-slab or soil vapor probes sample locations may be necessary to fully define the vapor intrusion AOC. Sub-slab sampling locations are being proposed for structures adjacent to previous sample locations with detections above applicable ISVs or contaminated groundwater, while soil vapor probes are proposed as step out locations from sub-slab sample locations.

Prior to performing any ground intrusive sampling, a utility locate request will be filed with the Minnesota Gopher State One Call system to mark and clear public underground utilities. In addition, due to the need to sample on private property, a private locate will be performed to minimize the potential for utility strikes outside of public right-of-way.

For sub-slab sampling, it is assumed that sub-slab samples will be collected from the lowest level of nine structures to complete definition of the vapor intrusion AOC. This RI Work Plan assumes that the installation and sampling activities will require up to three separate mobilizations due to potential access and coordination difficulties. The sub-slab vapor samples will be collected in general accordance with MPCA Guidance Document 4-01a *Vapor Intrusion Assessments Performed During Site Investigations.* The soil vapor samples will be collected using a brass sub-slab vapor monitoring point (Vapor Pin™). Prior to installing the Vapor Pin™, the work area will be observed for evidence of sub-slab utilities and/or obstructions. A rotary hammer drill equipped with a 5/8-inch diameter hole will be used to drill through the slab and approximately 1-inch into the underlying soil in the lowest level of the structure. The hammer drill will be utilized to drill a 1½-inch diameter hole at least 1¾-inches into the slab to allow for flush installation of the vapor pins for completion of subsequent sampling events (i.e. heating/non-heating events). The Vapor Pin™ will be driven into place in the slab using the vapor pin tools and a mallet. A Teflon cap will be placed onto the sample barb at the top of the vapor pin to prevent interaction of the sub-slab air with air from the interior of the building. The installed Vapor Pin™ will then be allowed to equilibrate for at least 20 minutes after installation prior to sampling. During this time, sample location and building-specific information, including any potential vapor sources, will be recorded on a *Vapor Intrusion Building Survey Form* (MPCA document 3-01a).

After the pin has been allowed to equilibrate for at least 20 minutes, the Teflon cap will be removed for sample collection. A photoionization detector (PID) reading will be obtained prior to installing the sampling train and performing a water dam leak test and sampling train shut-in test. Upon completion of the leak tests, a minimum of three purge volumes (the volume of the sample pin, pilot hole in the concrete and sampling train) will be purged with a pump or graduated syringe. The soil vapor sample will then be collected by opening the sampling canister (summa canister under vacuum) affixed with a vacuum gauge and a 200 milliliter per minute (ml/m) flow regulator. After an adequate volume of air has been obtained, the sampling canister valve will be closed and final canister pressure and time required for sampling will be recorded on the chain-of-custody form and sample sheets. After sample collection, the Teflon cap will be replaced and a stainless-steel cover will be placed over the Vapor Pin™.

Three outdoor air samples (for each day of sampling) will also be collected concurrently with the sub-slab vapor sampling as quality assurance samples. The outdoor air samples will be obtained as time-weighted samples over a 24-hour period using certified-clean canisters provided by the laboratory. A flow controller will be affixed to the canister prior to sampling to ensure proper sample collection.

The following additional information regarding the sampling conditions and methodologies will be documented and reported along with the sampling results during indoor air sampling:

- A sketch of the lowest level floor of the structure showing the sampling location and noteworthy features observed especially potential vapor entry locations.
- Pertinent observations during sampling such as odors or field instrument readings, and ventilation conditions (e.g., heating system active and windows closed).
- The following actions will be taken to document conditions during the planned outdoor air sampling:
  - An outdoor plot sketch will be drawn that includes the building site, area streets, outdoor air sample location, location of potential interferences (e.g., gasoline stations, factories, lawn movers, etc.), and compass orientation (north).
  - Weather conditions (e.g., precipitation, indoor and outdoor temperature, and barometric pressure) and ventilation conditions (e.g., heating system active and windows closed) will be recorded.
  - Any pertinent observations such as odors, field instrument readings, and significant activities in the vicinity (e.g., operation of heavy equipment or dry cleaners) will be recorded.

Should results indicate vapor concentrations below applicable 33x ISVs, follow-up sampling will be performed in the subsequent season. For the purposes of this proposal, it is assumed that 20 second sampling event samples will be required.

For results greater than applicable 33x ISVs, an evaluation will be made on whether to perform a pre-mitigation diagnostic test on the entire structure, or perform additional focused sampling for partial mitigation. In these instances, the MPCA Project Manager will be contacted regarding a recommended approach. After a decision has been made, a Change Order for the selected approach will be submitted.

A State Drilling Contractor will install up to five temporary soil vapor probes to an approximate depth of 5 feet bgs (assuming no basements in nearby structures with groundwater at 6 feet bgs) using direct-push drilling technologies. Soil vapor probe locations have been pre-selected based on historical information; however, modifications may be made dependent upon field observations and utility locate information (see Figure 1).
The proposed soil vapor probe locations are intended to fully define the vapor intrusion AOC.

Soil vapor probes will be installed by pushing a disposable sampling point to the desired depth with minimal soil disturbance and sealing the annular space with hydrated bentonite. Prior to sample collection, a Braun Intertec field technician will screen soil vapor samples with a PID. The field technician will then collect a soil vapor sample from each sampling point with a summa canister affixed with a 200 ml/m flow controller and dedicated tubing.
The probes will then be sealed/abandoned in accordance with MDH regulations. All soil vapor probe locations will then be recorded using a portable GPS unit.

All samples will be submitted under chain-of-custody and analyzed for VOCs by a State Contract Laboratory using U.S. Environmental Protection Agency (EPA) Method TO-15 on a standard turnaround time (Table 2).

Our cost estimate assumes that vapor investigation will be completed over a five-day period, with drilling activities being completion in one mobilization however, due to the difficulties in coordinating with 12 different property owners' schedules, additional time and/or mobilizations may be required. In the event additional time/mobilizations are required, the MPCA Project Manager will be notified regarding a change order. A 2-person crew will perform all Task A activities within the allotted timeframe with one 150-mile mobilization.

Subtask 2: Domestic Well Water Sampling
Sampling of domestic wells will occur for 10 existing well locations on Blocks 3, 5, and 7 to assess groundwater quality (see Figure 1 and Table 1). Results from the domestic well sampling will be used to eliminate the contaminated groundwater pathway or be used for determining appropriate remedial actions. Depending on the results of the water well receptor survey, additional samples may be necessary should potential receptors be identified outside those outlined in Table 1.
To initiate domestic well sampling, Braun Intertec will assist the MPCA/MDA with creating a letter that MPCA will mail or leave during neighborhood canvassing. The letter will include information for scheduling sampling of the well, as well as asking for well construction information, if known. For purposes of this RI Work Plan, it is assumed that MPCA

will obtain access to the private residential properties for sampling. Upon approval of sampling, the homeowners will be contacted by Braun Intertec to schedule a sampling time and determine the best water sampling location. Braun Intertec will collect a sample from an exterior faucet, if possible. If there is no exterior faucet located outside a specific home, Braun Intertec will coordinate entry to the home with the homeowner and will collect a sample from an interior faucet upstream of any water-altering device (i.e. water softener, pressure tank, or filtration system).

Once a suitable sample location is chosen, a purge of the water line will be performed by calculating the volume of water in the line and determining the water volume within the well (3 casing volumes). If well construction specifications are unknown, water quality stabilization parameters will be monitored until stabilized or 10 minutes of continuous purge has elapsed. Low-flow sampling will then be employed to fill sampling containers. For purposes of this RI Work Plan it is assumed that a 10-minute purge will be used for wells with no readily available construction information.

To more efficiently characterize the off-Site boundaries of COCs, domestic wells will be sampled for analytes which are overseen by all three regulatory programs. Domestic wells will be sampled and analyzed by a subcontracted State Contract Laboratory with MDA approval to perform the selected agricultural chemical analyses for contaminants specific to each regulatory agency as follows:

MPCA Site Assessment Program:
VOCs by EPA Method 8260
PFCs by EPA Method 537

MDA Site Assessment Program:
MDA List 1 & List 2 Pesticides by EPA Method 8270
Nitrates as nitrogen by EPA Method 300
TKN by EPA Method 351.2,

MPCA Petroleum Remediation Program:
GRO & DRO by modified Wisconsin method

Quality control/quality assurance (QA/QC) samples, including a trip blank, duplicate sample, and extra-volume laboratory spike sample, will also be collected as part of sampling activities and submitted for analytical testing as specified in Table 2. Samples submitted for laboratory analysis (including QA/QC samples) will be transported from the Site to the laboratory in a cooler on ice and delivered under chain-of-custody protocol. All sampling containers, preservation methods, hold times and QA/QC samples will follow requirements outlined in the approved Site-specific QAPP prepared for the RI. All sampling containers will be supplied by the subcontracted laboratory. Samples will be submitted on a standard turn around and laboratory results will be available within 2 weeks of sample submittal.

Our cost estimate assumes that water sample collection will be completed in a 1-day timeframe during other investigation activities; however, due to the difficulties in coordinating with 10 different property owners' schedules, additional time and/or mobilizations may be required. In the event additional time/mobilizations are required, the MPCA Project Manager will be notified. Upon sample completion, Braun Intertec will deliver the samples under chain-of-custody to the subcontracted laboratory for analysis.

Task B: Investigation of Medium and Low Risk AOCs
Medium risk AOCs are considered viable exposure pathways; however, based on limitations for imminent/substantial risk to receptors, are not considered high-risk, while low risk AOCs are viable pathways, but CoC toxicity or pathways may not be as toxic. A list of potential COCs for each AOC is presented in Table A. It should be noted that response actions taken on Site will be largely dependent upon data collected as part of investigation for medium and low risk AOCs.

Subtask 1: Soil/Groundwater Investigations
Additional sampling to investigate medium and low risk AOCs may involve several types of sampling, including: surface and subsurface soil collection, additional groundwater delineation on-Site and off-Site, and stream and sediment sampling adjacent and downgradient of the Site. Based on MDA and Petroleum Remediation Program requirements, in addition to grab samples obtained from borings exhibiting visual or olfactory indications of contamination, strategic interval sampling will be required for select areas (notably tank locations and pesticide/fertilizer use areas).

Based on the Site layout, several opportunities for sampling efficiency/consolidation are available. For instance, Limited Site Investigation of the gasoline UST may be combined with investigation of the eastern access door for the former dry fertilizer building. In addition, sampling the existing water supply well for additional parameters, such as PFCs or dioxins, may be useful in determining whether these COCs are present on Site and whether additional investigation is warranted.

It should be noted that investigation of medium and low risk AOCs will be required to redevelop the Site into a golf course. Considerations with respect to the proposed redevelopment are likely to include potential leaching ability of existing soils, determining an appropriate engineered cap over soils, identifying potential utility corridors, and delineation of any hazardous waste.

As discussed above, there are efficiencies that can be gained by taken a holistic approach to the investigation of the low and medium risk AOCs. There are several AOCs that will require additional investigations based upon contaminant type. Below is a table which identifies onsite AOCs that will require initial assessment to determine if a release has occurred. These areas may require an iterative investigation approach to fully delineate the impacts.

Table C below identifies the AOC, the rationale for sampling in that area, the assumed media that will be sampled and the assumed COCs.

Note: the exact number of borings required and the boring locations for each risk area will be determined after an initial site visit has been performed. For the purpose of this initial work plan, Braun Intertec is assuming that one soil boring will be advanced in each AOC identified below, except for the former fertilizer building and agricultural equipment parking and storage areas where two borings (or boring clusters when composite samples are collected) will be advanced. Additional assessment work will most likely be needed to fully delineate the extent of impacts identified during implementation of this initial work plan. This additional assessment work is outside of the scope of this initial work plan.

Table C
On-Site AOC Investigation Information

AOC	Feature	Rationale	Media	Depths sampled	COCs
Former Dry Fertilizer Building	Cracked Pad	Fertilizers and other ag chemical storage and mixing activities and cracked floor	Soil/ Groundwater	0-0.5 C 2-2.5 C 4.5-5 D Plus Every two ft. until the Water table D*.	Pesticides/Herbicides (MDA Lists 1 & 2) Ammonia/Nitrate-Nitrogen/TKN
Former Dry Fertilizer Building	Cracked Pad	Fire suppression and fire suppression chemicals could have penetrated through cracks to underlying soils.	Soil/ Groundwater	0-0.5 4.5-5 Water table	PAHs PFCs Metals

Former Dry Fertilizer Building	Load in/Load out areas	Two large overhead doors, one small overhead, and one service door (4 sample areas total)	Soil	0-0.5 C 2-2.5 C 4.5-5 D	Pesticides/Herbicides (MDA Lists 1 & 2) Ammonia/Nitrate-Nitrogen/TKN
Northern & Southern Parking Area	Agricultural equipment parking and storage	Potential track off or spills from equipment	Soil	0-0.5 C 2-2.5 C 4.5-5 D	Pesticides/Herbicides (MDA Lists 1 & 2) Ammonia/Nitrate-Nitrogen/TKN
Water Fill/Scale/Water Supply Well Areas	Water Fill area	Chemical mixing, filling of chemical dispersion equipment	Soil/ Groundwater	0-0.5 C 2-2.5 C 4.5-5 D Plus Every two feet until the Water table D*	Pesticides/Herbicides (MDA Lists 1 & 2) Ammonia/Nitrate-Nitrogen/TKN
Water Fill/Scale/Water Supply Well Areas	Scale pits	Track off, spills	Soil/ Groundwater	0-0.5 C 2-2.5 C 4.5-5 D Plus Every two feet until the Water table D*	Pesticides/Herbicides (MDA Lists 1 & 2) Ammonia/Nitrate-Nitrogen/TKN
Former Dry Fertilizer Building	Run off from fire	Fire extinguish run off from the Ag chemical building, plus PFCs form fire suppression chemicals	Soil	Ag Chemicals : 0-0.5 C 2-2.5 C 4.5-5 D Non –Ag Chemicals: 0-0.5 and Indications of impacts	Pesticides/Herbicides (MDA Lists 1 & 2) Ammonia/Nitrate-Nitrogen/TKN PAHs PFCs Metals
Northern Dumping & Staining Areas	Discolored Soils	Discolored soils, potentially related to dumping of spent solvents, however the source of the staining is unknown	Soil	0-0.5 and Indications of impacts	VOCs Metals PAHs DRO GRO TCLP for disposal characterization

Maintenance Garage	500 Gallon Trench Waste UST	Waste tank connect to floor drain, reported to have leaked	Soil/ Groundwater	Base of tank, Water Table And/or Indications of impacts	PAHs VOCs Metals DRO GRO Pesticides/Herbicides (MDA Lists 1 & 2) Ammonia/Nitrate-Nitrogen/TKN
500-gallon AST & 1,000-gallon UST	1,000 Gallon UST, 500 Gallon AST**	---	---	---	---

C = Composite Samples
D = Discrete Sample
D* = Per MDA guidance, these samples will be held under chain of custody procedures and analyzed per MDA staff approval.
** = The existing 500 gallon fuel oil AST and 1,000 gallon gasoline UST will be abandoned under the Remedial Design/Remedial Action Activities Work Plan included as Attachment A of this RFP. The investigation required for these tanks will be evaluated after the tanks are removed.

All samples collected for non- agricultural analyses (VOCS, metals, PFCs, and PAHs) will be discreet samples. Additional analyses (PCBs, SVOCs, zinc, copper), etc. may be recommended as additional information concerning site activities and chemical products stored on site becomes available. These analyses are not included in the scope of work for this subtask. QA/QC samples will be collected in accordance with the project QAPP.

Sampling for Agricultural COCs
Prior to investigation in areas sampled for agricultural COCs, Braun Intertec will perform a preliminary Site visit with MDA staff to confirm proposed sampling area/boring locations and related sample collection and laboratory analysis requirements.

For soil borings advanced in agricultural chemical AOCs, sampling will consists of at least one surface composite sample, one subsurface composite sample and one subsurface discrete sample. Composite samples will consist of 4 evenly-spaced sub-samples from an area roughly 15 feet in diameter. Surface composite samples will be taken from 0 to 6 inches below any surficial gravel. Subsurface composites will be collected from a depth of 2 to 2.5 feet below ground surface (bgs).

One discrete "grab" sample will be collected from a depth of 4.5 to 5 feet bgs, and will be collected from the boring near the center of the risk area or close to the probable source in each surface composite area.

Borings completed through concrete will be through cracks whenever possible and will be patched and sealed upon completion of sampling.

Dedicated sampling equipment will be used for each sample to reduce the risk of cross-contamination. All drilling and hand auger equipment will be decontaminated between sampling in accordance with MDA Soil Sampling Guidance (Guidance Document 11). All agricultural chemical samples collected during the field investigation which were not initially submitted for analysis will be held frozen for future possible analysis based on review of the initial results and discussions with MDA staff.

Given the shallow groundwater conditions at the Site (less than 10 feet bgs), at least one of the borings in each risk area will be advanced to the water table to collect a groundwater sample for agricultural chemical analysis.

Groundwater sampling in agricultural risk areas will include the collection of water from a temporary screened PVC well using a check valve and dedicated polyethylene tubing. All water sampling will be completed in a manner consistent with MDA Ground Water Sampling Guidance (Guidance Document 12).

Task C: Permanent Groundwater Monitoring Wells
To define groundwater flow direction at the Site, four permanent groundwater wells will be installed. These monitoring wells will be screened to intersect the shallow water table to evaluate groundwater flow direction in the surficial acquirer. The results of the RI described in this work plan may identify additional impacts to groundwater in the surficial aquifer and, therefore, additional permanent monitoring wells in the surficial aquifer may be necessary in the future. In addition, deeper monitoring wells will be needed in the future to assess the nature and extent of TCE migration in deeper aquifers.

Subtask 1: Well Installation Plans and Specifications/Bidding Documents
As part of this task, Braun Intertec will provide monitoring well installing specifications and bidding documents for the well installation work per the MPCA subcontractor manual. The specifications will be submitted to the MPCA and MDA for approval prior to bidding, as appropriate.

Subtask 2: Well Installation
The permanent monitoring wells will be placed with one well located along the eastern (assumed upgradient) portion of Site, and two wells placed on the western portion of the Site, down-gradient of the suspected onsite source areas. Additionally one well will be placed on the north of the stream east of the fertilizer building in order to evaluate whether the onsite stream is acting as a hydrogeological barrier. The locations of the proposed monitoring wells are shown on Figure 1.

Water level gauges (staff head gauge or similar) will be installed in two locations within the stream (upgradient and downgradient of the former fertilizer building) to evaluate groundwater and surface water interactions at the site.

Braun Intertec will provide oversight during well construction. After the permanent monitoring well have been installed Braun Intertec will properly develop the wells. After the wells are properly developed and have been allowed to equilibrate completely, Braun Intertec will collect one round of groundwater elevation data.
Sampling of the newly installed wells will occur under a separate work plan once the shallow groundwater COCs have been determined through sampling and analysis of groundwater samples from the planned temporary wells.

Task D: Geophysical Survey
In addition to a private utility locate, a geophysical survey of the Site is proposed to identify underground utilities which may act as preferential pathways or sources of releases of COCs (e.g. sewers). Ground-penetrating radar (GPR) or electromagnetic (EM) methods would be applied in all areas. For the purposes of this RI Work Plan, it is assumed that GPR will achieve the stated objective. GPR will also be used to determine the presence/absence of additional underground features, such as buried materials or tanks. To complete the geophysical survey, bids will be solicited by potential subcontractors in accordance with the State of Minnesota Purchasing Manual. Upon receipt of the required number of bids, the MPCA Project Manager will be sent a bid tabulation sheet for selection of the contractor.

Task E: Domestic and Supply Well Information
As impacts to domestic wells and the Site supply well have already been identified, additional information regarding well construction is necessary to appropriately scope potential response actions (i.e. well abandonment). A well survey will be completed concurrently with domestic well sampling (Task A, Subtask 1), which will identify well specifications such as depth, diameter, casing material, pump status, and disconnects that may be required. Should information not be easily attainable, well sounding or logging may be employed.
Well sounding or logging is not included in this proposal.

Task F: RI Report
Braun Intertec will complete a comprehensive report of RI assessment activities. The report will include a description of field methods and procedures, discussion of RI results, and include information applicable to completing a RD/RA and/or feasibility study. Supporting data to be included within the RI Report will include a site location map on a USGS topographic map, a site map showing pertinent features including utilities, well and vapor receptor survey maps (including MPCA vapor intrusion templates), groundwater elevation contour maps, sample location maps, at least two geologic cross sections, a table of sample location geographic coordinates, tables with PID results and soil and groundwater analytical results, tables of groundwater elevation data, a table of water supply wells, a photographic log, copies of all laboratory reports, soil boring and monitoring well logs,
and water supply well logs.

Objective 2 Timeline: Based on the tasks as part of Objective 2, it is anticipated that RI activities will be completed within 6 to 8 weeks of authorization to proceed, with the timeline highly dependent upon Site and individual property access or time of year (for existing soil vapor sample second round sampling only). A draft RI Report submitted approximately 10 to 12 weeks after authorization to proceed.

Objective 2 Deliverables: RI Report including supporting documentation. Raw data will also be submitted in MPCAs/MDAs requested format for database format.

Objective 3 - RD/RA Data Collection
Additional sampling and data collection activities for use in a RD/RA for the Site are summarized below

Task A: Sub-Slab Vapor Evaluation in Support of Mitigation
This Task includes additional sub-slab vapor sampling and completing pre-diagnostic testing to support design of a vapor mitigation approach for the Maintenance Garage. As noted above, as the building is currently vacant, this work may be completed at a later date, or may be completed by the golf course owner. For the purpose of this proposal we have assumed that the MPCA will request that Braun Intertec perform this work under this Work Plan.

Sub Task 1: Additional Sub-Slab Soil Vapor Sampling
Additional sub-slab sampling will be completed within the maintenance garage to fully define the vapor intrusion AOC. For the purposes of this RI Work Plan, it is assumed that Vapor Pins™ installed during the previous round of sampling are still present and in usable condition and that additional sub-slab sampling will occur during completion of Task A.

Ten sub-slab samples were previously collected within the structure; however, based on the square footage of the building (estimated to be 75,000 square feet), 8 additional sub-slab samples are required to fully define and identify partial mitigation areas (SS-50 to SS-57). Two additional Vapor Pins™ will be installed in both building addition 1 and 2, while four additional sample locations will be placed within the original building (see Figure 2 and Table 2). All Vapor Pins™ will be installed and sampled in a similar manner as off-Site sub-slab sampling (Task A, Subtask 1). In addition, one outdoor air sample will be collected as previously described.

Based on the results from the previous investigation, mitigation of the original building may not be required; therefore, a second round of sampling is proposed to verify COCs are not greater than 33x Commercial/Industrial ISVs. For the second seasonal event (heating or non-heating), the four previously existing sub-slab monitoring points (SS-58 to SS-61), as well as the four additional sample locations (SS-53, SS-54, SS-56 and SS-57) will be resampled (minimum 30 days between events). For the purposes of this RI Work Plan, it is assumed that the second sampling event will not be conducted in the same heating/non-heating season as the original round.
All Vapor Pins™ will be sampled in a similar manner as off-Site sub-slab sampling (Task A, Subtask 1).

Subtask 2: Follow up Seasonal Sampling to Confirm the VI AOC Boundaries
This subtask includes performing a second round of sub-slab sampling in the portions of the building outside the VI AOC to confirm the VI AOC boundaries. As the exact size of the VI AOC is not know at this time, the exact number of samples required cannot be defined in this scope of work. However, once the additional sampling in Task A above is competed and the VI AOC is defined, a work plan for the second round of sampling (performed in the opposite season as the entail round of sub-slab data) will be prepared and submitted to the MPCA for approval.

Subtask 3: Pre-mitigation Diagnostic Testing
Concurrently with soil vapor sampling activities described in Subtask 1, pre-mitigation diagnostic assessments will be performed for two structures: building additions 1, 2, and 3 of the maintenance garage, and the northeastern structure of Block 7 (previous sub-slab result greater than 33x Residential ISVs.

Braun Intertec will perform diagnostic testing at both structures to evaluate sub-slab pressure fields and identify vapor mitigation system design criteria. As part of diagnostic testing, the following activities will be completed:

- A private locate and Site walk will be performed prior to selecting appropriate testing locations and identify any subgrade features which may affect testing and/or future system installation.

- It is assumed at least four suction pit test locations will be needed to complete the diagnostic testing within each of the four identified areas. At each test location, approximately 4-inch diameter holes will be cored through the concrete floor slab to monitor vacuum at various locations and distances within the building (approximately 1 per 250 square feet). Different fans sizes will then be used to generate vacuum beneath the floor slab, and several ¼-inch-diamater holes will be drilled into the floor slab around each test location to measure the sub slab vacuum at different distances from the test locations. The results will then be used to determine system design and select an adequately sized fan(s) to maintain vacuum under the building.

- Results will be compiled on a Pre-Mitigation Diagnostic Checklist for each area (MPCA Guidance Document 3-06a).

- Pressure differentials will be monitored throughout the testing, with a goal of maintaining 3 to 5 pascals, depending on the season.

Objective 3 Timeline: It is anticipated that RD/RA data collection activities will be completed within 2 to 4 weeks of authorization to proceed.

Objective 3 Deliverables: A letter report that defines the AOC for vapor mitigation in the Maintenance Garage, which includes soil vapor sampling and vacuum field extension data.

Objective 4: Assist MPCA and MDA with Public Outreach Support

Task A: Assist with public outreach
Based on concerns previously expressed by area residents, a provisional task has been included within this RI Work Plan to assist MPCA and MDA perform public outreach. While the needs of outreach are generally unknown, it is assumed that public outreach assistance may be required with respect to converting individual property owners to other potable water sources, as well as entering residences for sub-slab vapor sampling and/or providing additional support for conveying risks should results indicate a potential risk.

Objective 4 Timeline: As needed

Objective 4 Deliverables: Property summary reports or other deliverables, as requested.

Table 1
Sample Locations, Matrices and Rationale - Off Site Receptors
Scenario A

Sample ID		Sample Matrix	Location	Rationale
SV-1		Soil Vapor	ROW, Block 3	Screen/evaluate soil vapor beyond known area 100' buffer
SV-2		Soil Vapor	ROW, Block 5	Screen/evaluate soil vapor beyond known area 100' buffer
SV-3		Soil Vapor	ROW, Block 4	Screen/evaluate soil vapor beyond known area 100' buffer
SV-4		Soil Vapor	ROW, Block 6	Screen/evaluate soil vapor beyond known area 100' buffer
SV-5		Soil Vapor	ROW, Block 6	Screen/evaluate soil vapor beyond known area 100' buffer
SS-1 to SS-8		Soil Vapor	Block 7, SW structure	Assess sub-slab conditions for structure adjacent to known plume
SS-9 to SS-13		Soil Vapor	Block 7, NW structure	Assess sub-slab conditions for structure adjacent to known plume
SS-14 to SS-19		Soil Vapor	Block 7, SE structure	Assess sub-slab conditions for structure adjacent to known plume
SS-20 to SS-25		Soil Vapor	Block 5, SW structure	Assess sub-slab conditions for structure adjacent to known plume
SS-26 to SS-30		Soil Vapor	Block 5, SE structure	Assess sub-slab conditions for structure with known impacted well
SS-31 to SS-34		Soil Vapor	Block 5, NE structure	Assess sub-slab conditions for structure with known impacted well
SS-35 to SS-39		Soil Vapor	Block 5, middle structure	Assess sub-slab conditions for structure adjacent to known plume
SS-40 to SS-44		Soil Vapor	Block 5, NW structure	Assess sub-slab conditions for structure adjacent to known plume
SS-45 to SS-49		Soil Vapor	Block 3, SE structure	Verify no vapor risk is present across from known plume area
SS-50 to SS-57		Soil Vapor	Maintenance Garage	Complete density sampling within building additions for targeted partial mitigation of sub-slab vapors
SS-58 to SS-61		Soil Vapor	Maintenance Garage	Complete density sampling and 2nd round for original building clearance (samples 17, 20, 22, and 23)
GW-1		Groundwater	Block 7, SW structure	Assess groundwater conditions adjacent to known plume
GW-2		Groundwater	Block 7, NW structure	Assess groundwater conditions adjacent to known plume
GW-3		Groundwater	Block 7, SE structure	Verify no impacts to well, including additional analyses
GW-4		Groundwater	Block 5, SW structure	Assess groundwater conditions adjacent to known plume
GW-5		Groundwater	Block 5, middle structure	Assess groundwater conditions adjacent to known plume
GW-6		Groundwater	Block 5, NW structure	Assess groundwater conditions adjacent to known plume
GW-7		Groundwater	Block 3, SW structure	Verify no impacts to well, including additional analyses
GW-8		Groundwater	Block 3, left-mid structure	Verify no impacts to well, including additional analyses
GW-9		Groundwater	Block 3, right-mid structure	Verify no impacts to well, including additional analyses
GW-10		Groundwater	Block 3, SE structure	Verify no impacts to well, including additional analyses
QA/QC*	TB-X	Trip Blank (GW)	Not Applicable	QA/QC, 1 per cooler (trip blank)
	GW-X	Field Duplicate	Same as original/native sample	QA/QC, 1 per 20 samples per matrix (field duplicate)
	Same as Original	MS/MSD	Same as original/native sample	QA/QC, 1 per 20 samples per matrix (MS/MSD extra volume)

Notes: *Locations not shown on Figure 1
QA/QC = Quality Assurance/Quality Control
X = Sequential number
ROW = right-of-way

Table 2
Proposed Analyses – Off-site Receptors
Scenario A

Sample ID	Laboratory Analysis									Quality Control Samples		
	TO-15	VOCs	PFCs	List 1 Ag Chem	List 2 Ag Chem	Nitrates	TKN	GRO	DRO	Duplicate/ Replicate	Trip Blank	MS/MSD
SV-1	X	-	-	-	-	-	-	-	-	-	-	-
SV-2	X	-	-	-	-	-	-	-	-	-	-	-
SV-3	X	-	-	-	-	-	-	-	-	-	-	-
SV-4	X	-	-	-	-	-	-	-	-	-	-	-
SV-5	X	-	-	-	-	-	-	-	-	-	-	-
SS-1 to SS-8	X	-	-	-	-	-	-	-	-	-	-	-
SS-9 to SS-13	X	-	-	-	-	-	-	-	-	-	-	-
SS-14 to SS-19	X	-	-	-	-	-	-	-	-	-	-	-
SS-20 to SS-25	X	-	-	-	-	-	-	-	-	-	-	-
SS-26 to SS-30	X	-	-	-	-	-	-	-	-	-	-	-
SS-31 to SS-34	X	-	-	-	-	-	-	-	-	-	-	-
SS-35 to SS-39	X	-	-	-	-	-	-	-	-	-	-	-
SS-40 to SS-44	X	-	-	-	-	-	-	-	-	-	-	-
SS-45 to SS-49	X	-	-	-	-	-	-	-	-	-	-	-
SS-50 to SS-57	X	-	-	-	-	-	-	-	-	-	-	-
SS-58 to SS-61	X	-	-	-	-	-	-	-	-	-	-	-
GW-1	-	X	-	-	-	-	-	-	-	-	X	-
GW-2	-	X	X	X	X	X	X	X	X	X	-	-
GW-3	-	X	X	X	X	X	X	X	X	-	-	-
GW-4	-	X	X	X	X	X	X	X	X	-	-	-
GW-5	-	X	X	X	X	X	X	X	X	-	-	X
GW-6	-	X	-	-	-	-	-	-	-	-	-	-
GW-7	-	X	-	-	-	-	-	-	-	-	-	-
GW-8	-	X	-	-	-	-	-	-	-	-	-	-
GW-9	-	X	-	-	-	-	-	-	-	-	-	-
GW-10	-	X	X	X	X	X	X	X	X	-	-	-

Notes:
VOCs Volatile Organic Compounds by EPA Method 8260
PFCs Perfluorinated Chemicals by EPA Method 537
List 1 & 2 MDA agricultural compounds by modified EPA Method 8270
Nitrates Nitrate as nitrogen by EPA Method 300 or similar
TKN Total Kjeldahl Nitrogen by EPA Method 351.2
GRO Gasoline range organics by modified Wisconsin method
DRO Diesel range organics by modified Wisconsin method

Figure 1
Proposed Sample Locations – Adjacent Neighborhood
High Risk Areas of Concern Only
Scenario A

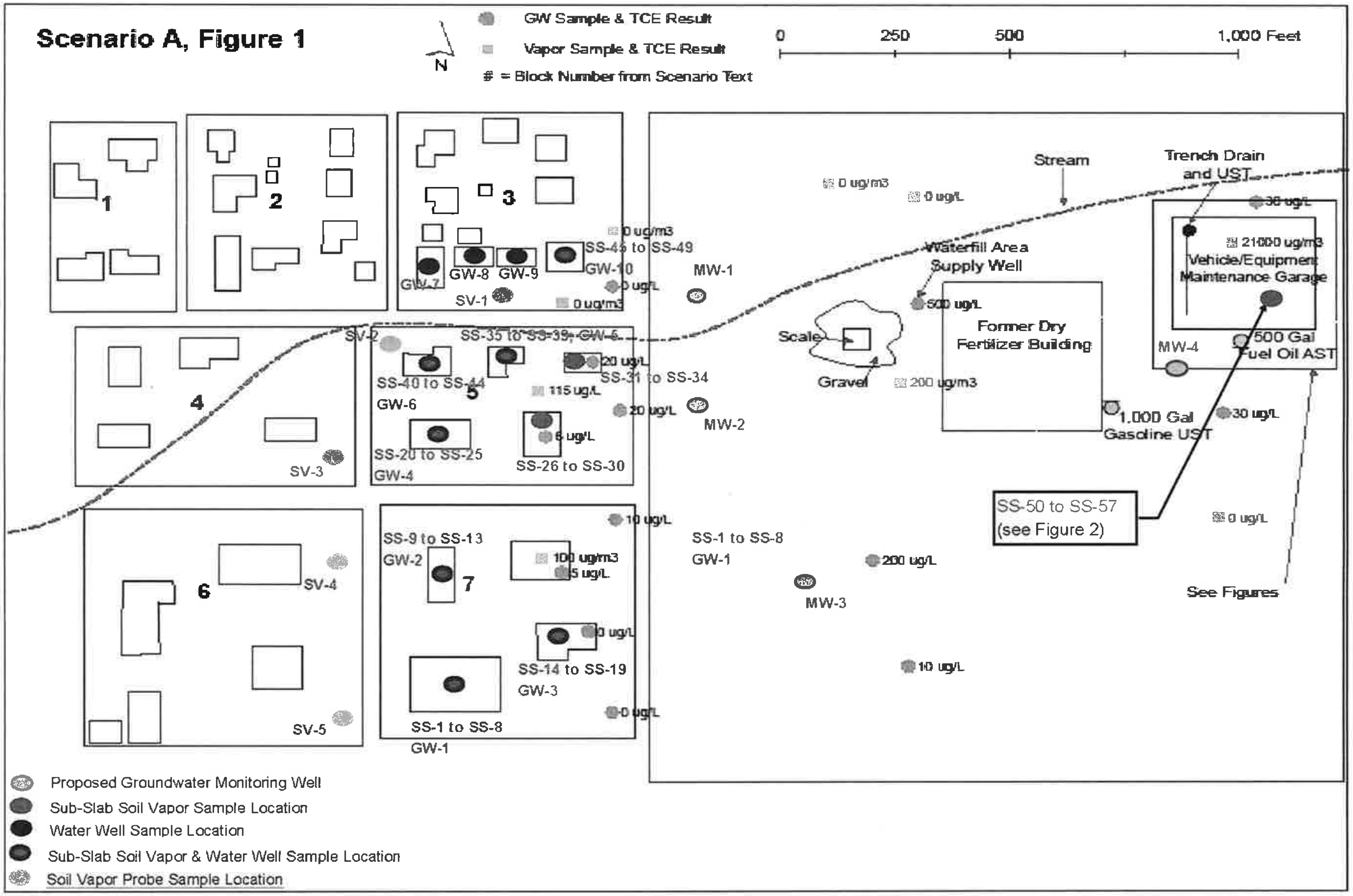
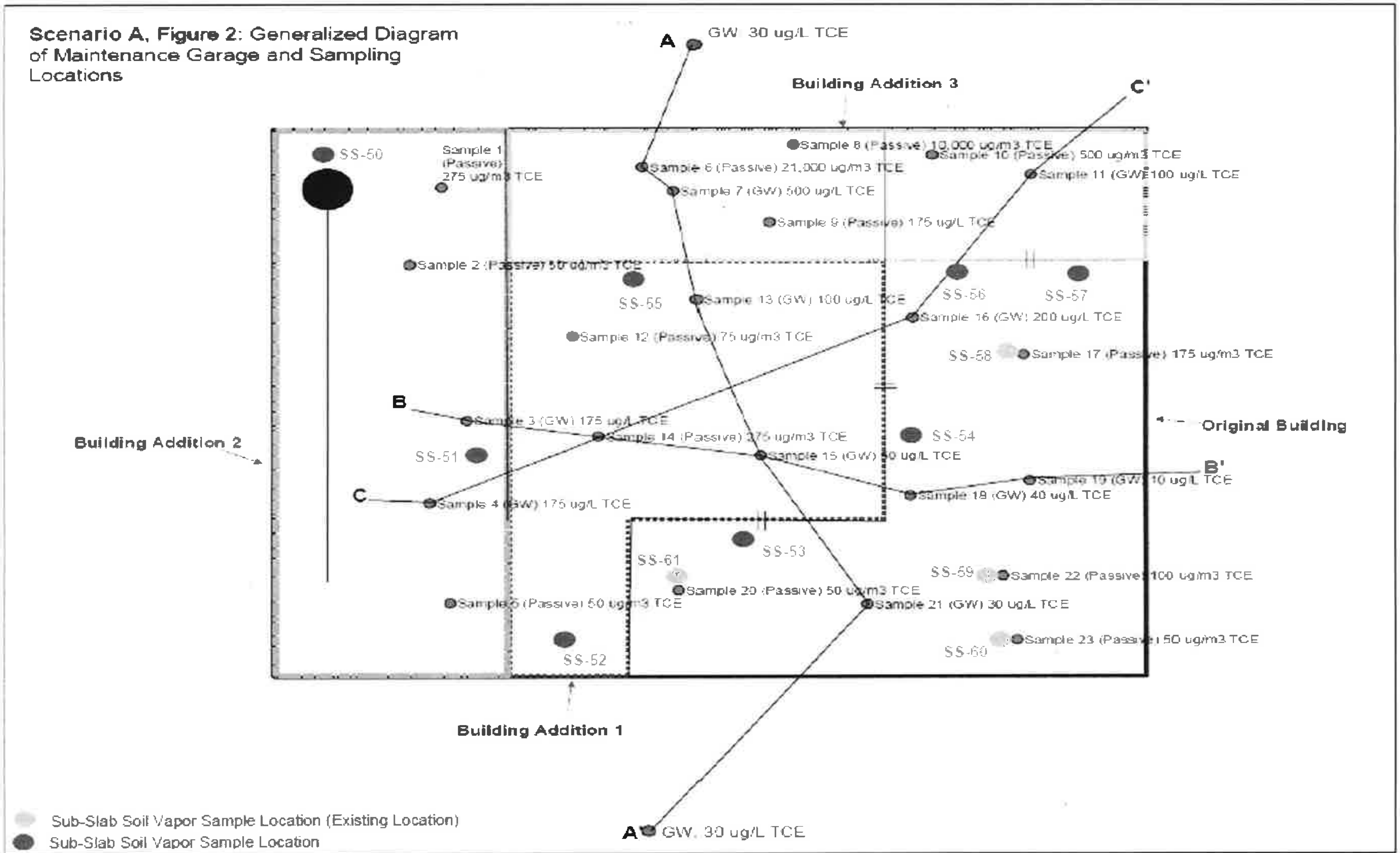


Figure 2
Proposed Sample Locations – Maintenance Garage
High Risk Areas of Concern Only
Scenario A



MINNESOTA POLLUTION CONTROL AGENCY
520 Lafayette Road North
St. Paul, MN 55155-4194

Remedial Investigation Scenario Spreadsheet (Scenario A)

Project title: Former Agricultural Chemical Plant

	1. Personnel						2. Subcontracting		3. Equipment											Totals (Extended) (Personnel Hours Only)
Project Budget	Project Manager	Field Technician	GIS/CADD Specialist	QA/QC Officer	Scientist 1 or Engineer 1	Scientist 2 or Engineer 2	Laboratory	Drilling	Mileage	Sub-Slab Sampling Point	Sub-Slab Sampling Kit	PID (10.6 eV)	Micro Manometer	Submersible pump	Water quality meter	Water Level indicator	GPR	GPS (sub-meter)	Coring Machine	
Objective 1: Complete a data gap analysis, receptor survey, and pre-investigation plans																				
Task A: Data Gap Analysis	3			2	10	10														25
Task B: Receptor Survey	3		2			16			60											21
Task C: Pre-Investigation Plans																				0
Subtask 1: SAP	2		2	2	10	20														36
Subtask 2: QAPP	2			4		4														10
Subtask 3: HASP					1	1														2
Total for Objective 1 Hrs/Qty	10	0	4	8	21	51			60	0	0	0	0	0	0	0	0	0	0	94
Objective 2: Complete a RI to Evaluate Receptor Risk and in Support of a RD/RA																				
Task A: Evaluate Identified Receptors - High-Risk AOCs																				
Subtask 1: Soil Vapor Sampling - Including acquiring drilling quotes	10	62			55		77 TO-15 (69 Sub-Slab & 5 subsurface soil vapor, 3 ambient); 3 certified cans (ambient air);	5 Vapor Probes + Private Locate	300	49	49	5						1		127
Subtask 2: Domestic Well Water Sampling (10 wells)	5	20			5		12 VOCs (GW); 6 PFCs, List 1, List 2, Nitrates, TKN, GRO, DRO (GW)		60						2					30
Task B: Investigation of Medium and Low Risk AOCs																				
Subtask 1: Soil/Groundwater Investigations (Assumes 13 sampling locations, 11 of which will consist of multiple borings in a 15 foot radius to create composite samples), includes 5 temp wells, one initial site walk to select boring locations, and acquiring drilling quotes.	8	30			2			46 total borings, 5 temp wells + Private Locate	120			3		3	3	3		1	1	40
Task C: Permanent Groundwater wells																				
Subtask 1: Well Installation Plans and Specifications/Bidding Documents					6															6
Subtask 2: Well installation (Assumes 4 permanent wells and two surface water gauges will be installed and developed, one round of ground water elevation data)	4	30			4			4 permanent wells, 2 stream gauges	60			2		1	1	2				38
Task D: Geophysical Survey	2	20	2						60								2	2		24
Task E: Domestic and Supply Well Information		5							20											5
Task F: RI Report	16		8	4	8	24														60
Total for Objective 2 Hrs/Qty	45	167	10	4	80	24			620	49	49	10	0	4	6	5	2	4	1	330
Objective 3: RD/RA Data Collection																				
Task A: Sub-Slab Vapor Evaluation in Support of Mitigation																				
Subtask 1: Additional Sub-Slab Soil Vapor Sampling (initial round plus workplan for second round)	3	18			6		18 TO-15 (16 Sub-Slab & 2 outdoor)		20	8	16	2								27
Subtask 2: Follow up Seasonal Sampling To confirm the VI AOC Boundaries (cost no included as dependent on result of subtask 1)																				
Subtask 3: Pre-mitigation Diagnostic Testing	4	40			40				20			4	4						4	84
Total for Objective 3 Hrs/Qty	7	58	0	0	46	0			40	8	16	6	4	0	0	0	0	0	4	111
Objective 4: Assist MPCA and MDA with Public Outreach Support																				
Task A: Assist with public outreach	10		2						80											12
Total for Objective 4 Hrs/Qty	10	0	2	0	0	0			60	0	0	0	0	0	0	0	0	0	0	12
Total Project Hours/Quantities	72	225	16	12	147	75			780	57	65	16	4	4	6	5	2	4	5	547

Assumptions:
Site is assumed to be in rural Minnesota 30 miles one way from our closest office.