Remedial Investigation Work Plan

Former Hillcrest Golf Course
St. Paul, Minnesota
MPCA Brownfields Site ID: BR1281
MDA Project No.: JAL101091523

Prepared for

Saint Paul Port Authority

March 27, 2020
Project B1903316.00

Braun Intertec Corporation

105694008.1 0049912-00041

BRAUN INTERTEC
The Science You Build On.

Table of Contents

Description **Page**

Tables

Figures

Appendix

Remedial Investigation Work Plan

Former Hillcrest Golf Course

St. Paul, Minnesota

A. Introduction

The Saint Paul Port Authority (SPPA) owns the Former Hillcrest Golf Course located at 2200 Larpenteur Avenue East in Saint Paul, Minnesota (Site) and is in the early stages of planning for redevelopment. Currently the Site is a vacant former golf course. The purpose of the Remedial Investigation (RI) is to evaluate the potential presence of impacts in soil and shallow perched groundwater related to areas of concern previously identified at the Site. The location of the Site is shown on Figure 1.

This Remedial Investigation Work Plan (RI Work Plan) presents the protocols and procedures to be followed by Braun Intertec Corporation while implementing field activities for the Additional Site Investigation. This RI Work Plan was prepared for Minnesota Department of Agriculture (MDA) Agricultural Voluntary Investigation and Cleanup (AgVIC) Program and Minnesota Pollution Control Agency (MPCA) Voluntary Investigation and Cleanup (VIC) Program review.

The investigation activities outlined in this document will be completed in accordance with our professional services agreement with the Saint Paul Port Authority dated March 6, 2020.
The investigation will be funded from 128(a) assessment money through U.S. Environmental Protection Agency (EPA) Grant Number BF00E02723. As such, all field work and sampling procedures will be conducted in accordance with the Quality Assurance Project Plan (QAPP), Revision 0, dated September 26, 2019, that was previously submitted to and approved by EPA Region 5. As required under the QAPP, a sampling and analysis plan (SAP) document containing the same elements of this
RI Work Plan will be submitted to the U.S. EPA Region 5 separately.

B. Background

Braun Intertec conducted a Phase I Environmental Site Assessment of the Site in 2019 the results of which are presented in the report entitled: *Phase I Environmental Site Assessment, Former Hillcrest Golf Course, McKnight Road and Larpenteur Avenue East, St. Paul, Minnesota*, dated June 10, 2019 (2019 Phase I ESA).

Information reviewed for the 2019 Phase I ESA indicated that the Site was used for cultivated agricultural land or grazing land prior to the 1920s. The Site was developed and used as a golf course from the early 1920s until it was closed in 2017. The Site has been vacant since 2017.

At the time of this Phase I ESA, the Site consisted of a vacant 18-hole golf course that included club facilities, a driving range, practice putting greens, and support buildings. A vacant clubhouse with associated paved parking lot, swimming pool, vacant pool building, vacant golf cart sheds, and vacant garages were located in the northwest corner of the Site. The former fairways extended south of the clubhouse. A vacant maintenance area is located in the southeastern area of the Site that includes a former maintenance shop building, former maintenance storage building, and former agricultural chemical storage and mixing buildings (Ag chemical buildings). Earthen berms were located along the southeastern Site boundary next to and south of the former maintenance area. Two unsealed water wells and two small petroleum above ground storage tanks (ASTs) were also identified at the Site. A diagram of site features observed at the time of the 2019 Phase I ESA is included as Figure 2. The layout of the Former golf course is displayed on Figure 3.

The 2019 Phase I ESA identified the following recognized environmental conditions (RECs) at the Site:

- Petroleum products, including heating oil, gasoline, and diesel, were stored in aboveground and underground tanks as well as lubricant, hydraulic, and various other oils that were stored in containers ranging in size from one pint to 55-gallons. Government database records and previous investigation reports indicate the likely presence of remaining contamination from past petroleum tank leaks. There is a potential to encounter identified and unidentified petroleum contamination at the Site during redevelopment.

- The use of the Site included storage, mixing, and application of various agricultural chemicals on the Site. Small quantities of chemicals were still stored on the Site at the time of reconnaissance for the Phase I Environmental Site Assessment. There is potential for agricultural chemical impacts to the soil and groundwater at the Site from spills during mixing, transport, or storage, which is considered a recognized environmental condition.

- The agricultural chemicals used and stored on the Site historically included mercury-based fungicide products. Repeated historical application of the fungicide results in an accumulation of mercury in the soils overtime. The resulting accumulation of mercury in the soils is considered a recognized environmental condition.

- Materials observed protruding from earthen berms next to and south of the maintenance area appeared to indicate a potential for the presence of buried trash, pavements, landscaping spoils, construction and demolition debris in the berms. Based on observations, there is potential for encountering contaminated soils and buried regulated waste in the berms, which is considered a recognized environmental condition.

A regulatory file review was conducted for the 2019 Phase I ESA. Three petroleum tank leak files were identified for the Site (Leak ID# 5050; Leak ID# 6222; and Leak ID# 18327). The following summarizes the MPCA file information for the three leak sites.

Leak ID# 5050

The file information obtained consists of an MPCA Closure Confirmation Letter dated May 17, 2011. The letter states that the petroleum storage tank release was reported March 24, 1992 and assigned a closed status on June 1, 1992. The letter stated that it should be assumed that petroleum contamination is present during the planning stage of any future development.

Leak ID# 6222

The file information obtained includes the following:

- Remedial Investigation (RI) Report, Leak ID# 6222, Hillcrest Country Club, prepared by Applied Engineering, Inc., dated February 16, 1994.

- MPCA Closure Confirmation Letter dated May 17, 2011.

The RI report indicates that soil was excavated from two tank locations (Tank 1 and Tank 2), both in the vicinity of the maintenance building. The RI report indicates that 193 tons of soil were thermally treated and disposed off-site. The RI report indicates that contaminated soils exhibiting photoionization detector (PID) readings of 0 to 200 parts per million (ppm) remained in the ground.

The Closure Confirmation Letter states that the petroleum storage tank release was reported April 22, 1993 and assigned a closed status on September 26, 1994. The letter stated that it should be assumed that petroleum contamination is present during the planning stage of any future development.

Leak ID# 18327

The file information included the following:

- Remedial Investigation (RI) Report, Leak ID# 18327, Hillcrest Country Club, prepared by Landmark Environmental, LLC; dated January 8, 2011 (2011 RI).
- Phase I Environmental Site Assessment, 2200 East Larpenteuer Avenue and 1475 McKnight Road, St. Paul, Minnesota, prepared by Landmark Environmental, LLC; dated February 9, 2011 (2011 Phase I).
- Phase II Environmental Investigation Report, Hillcrest Golf Course, St. Paul, Minnesota, prepared by Landmark Environmental, LLC; dated February 9, 2011 (2011 Phase II).
- MPCA Closure Letter dated June 15, 2011.

The documents listed above are summarized individually in the paragraphs below.

2011 RI:

The 2011 RI indicates that eighteen borings were completed on January 5 and 7, 2011 to collect samples of soil, soil vapors, and perched groundwater near a diesel AST. The samples were analyzed for various volatile organic compounds (VOCs) and other petroleum related compounds and fuel additives. Petroleum compounds were detected in soil and perched groundwater in samples collected during the 2011 RI. The 2011 RI report concluded that petroleum contaminated soils were encountered but it could not be ascertained with certainty if the petroleum contamination was associated with Leak ID # 5050, Leak ID # 6222, or Leak ID # 18327.

2011 Phase I:

The 2011 Phase I was completed for the entire Hillcrest Golf Course. The significant findings of the 2011 Phase I included the use and storage of petroleum products on the Site; the previously identified petroleum tank releases; and the potential for unidentified past releases of agricultural chemicals.

2011 Phase II:

The 2011 Phase II was completed to further evaluate for non-petroleum releases. The 2011 Phase II ESA indicates that polycyclic aromatic hydrocarbons (PAHs) and mercury were identified in soil and cis 1, 2-dichloroethylene was identified in perched groundwater.

MPCA Closure Letter:

It appears that Leak ID# 18327 was a release opened by the MPCA in response to data submitted in the 2011 Phase II indicating petroleum impacts were present in the general area of the former release areas. The MPCA closed this Leak number after reviewing the 2011 Phase II and upon review of data for soil samples collected after the last remaining UST at the Site was removed.

The closure letter stated that the MPCA staff concluded that any remaining contamination, if present, does not appear to pose a threat to public health or the environment. The letter adds that it should be assumed that petroleum contamination is present during the planning stages of any future development.

2019 Phase I Addendum

Braun Intertec amended the 2019 Phase I ESA in response to the MDA's letter to the SPPA dated July 19, 2019. The amended Phase I ESA is presented in the letter entitled: *Phase I Environmental Site Assessment Addendum, Agricultural Chemical Incident Investigation, Former Hillcrest Golf Course, St. Paul, Minnesota*, prepared by Braun Intertec and dated August 15, 2109 (2019 Phase I Addendum).

The 2019 Phase I Addendum identified eight high risk areas (HRAs) at the Site consisting of the following:

- Agricultural chemical storage buildings loading areas.
- Damaged floors in the agricultural chemical storage buildings (3 buildings).
- Agricultural chemical mixing/washout area.
- Drainage area adjacent to mixing/wash area.
- Berms on eastern portion of Property.
- Golf greens and practice greens constructed before 1994.
- Tee boxes.
- Fairways.

As requested by the MDA during an October 29, 2019 Site walk, Braun Intertec added (a) the primary pesticide/fertilizer storage building, and (b) the associated loading area as HRAs. The ten identified high risk areas are shown on Figures 4A-4F.

2019 Phase I Addendum included review of available MDA files for the Site. These files included documents indicating that the facility was cited for not having proper backflow prevention and for applying an aquatic pesticide without the proper use categories.

In addition, as part of the 2019 Phase I Addendum, Braun Intertec reviewed the historical agricultural pesticide and fertilizer use at the former golf course. The facility primarily used granular and soluble fertilizers consisting of various brands and formulations of nitrogen, potassium and phosphorus-based fertilizers. The available records indicate the fertilizers used in the largest quantities were granular fertilizers. According to Tom Schmidt, former Hillcrest golf course superintendent, the majority of these fertilizers were applied to greens, tee boxes, and fairways with occasional applications to roughs and around the club house area.

The facility used a variety of pesticides including fungicides, herbicides, insecticides, and algicides for various applications across the golf course. Based upon available usage records it appears that these were used in smaller quantities primarily on the greens, but occasionally on the fairways, approaches, and tees and sporadically around the club house. Common pesticides used included 2, 4-D, imidacloprid, Dicamba, chlorothalonil, iprodione.

2019 Phase II ESA

In 2019, Braun Intertec conducted a Phase II Environmental Site Assessment, in support of the SPPA acquiring the Site, the results of which are presented in the report entitled: *Preliminary Phase II Environmental Site Assessment, Former Hillcrest Golf Course, St. Paul, Minnesota*, dated June 10, 2019 (2019 Phase II ESA).

The 2019 Phase II ESA consisted of twelve geotechnical soil borings (ST-1 through ST-12), nine environmental soil borings (GP 1 through GP 9), four temporary perched groundwater monitoring wells (ST-3, ST-8, ST-12, and GP 8), two soil vapor probes (SV-1 and SV-2), and one sub-slab vapor point (SSV-1). In addition, one soil sample was collected from the maintenance berm and 25 surficial soil samples were collected throughout the former golf course. Select soil and perched groundwater samples were collected and submitted for laboratory analysis of various analytes including, volatile organic compounds (VOCs), polycyclic aromatic hydrocarbons (PAHs), Resource Conservation and Recovery Act (RCRA) metals, diesel range organics (DRO), gasoline range organics (GRO), organochlorine pesticides, and toxicity characteristic leaching procedure (TCLP) mercury.

The following provides a summary of analytical results from the 2019 Phase II ESA:

Soil

- Mercury was detected at elevated concentrations in soil at numerous locations at the Site. Mercury concentrations in the samples ranged from not detected (<0.020 mg/kg) to 144 mg/kg. For comparison purposes, the Minnesota Pollution Control Agency (MPCA) Residential and Industrial Soil Reference Values (SRVs) are 0.5 milligrams per kilogram (mg/kg) and 1.5 mg/kg, respectively.

- The highest concentrations of mercury were detected in soil samples collected from the former greens and related fringe/apron areas. Mercury concentrations exceeding SRVs were also detected consistently on tee boxes, sampled fairways and in soil near the “mixing area” where fungicides are known to have been mixed with water and loaded into the turf management equipment for use on the golf course. The location of the mixing area is known based on an interview with a former Superintendent of the Hillcrest Golf Course, who has knowledge of golf course maintenance activities dating back to the 1990’s.

- The two soil samples with the highest mercury concentrations from the 2019 Phase II ESA were also analyzed for mercury using the Toxicity Characteristic Leaching Procedure (TCLP). The TCLP mercury concentrations for these sample were less than the TCLP hazardous waste criterion of 0.2 mg/L.

- Total arsenic was detected at a concentration of 15.7 milligrams per kilogram (mg/kg) in soil sample ST-3 (0-2), which exceeds the MPCA residential soil reference value of 9 mg/kg. This sample was collected from a former putting green that also had elevated mercury. Elevated concentrations of arsenic in soil were not detected in any other soil sample during the past or current Phase II ESAs at the property.

- Several soil berms with intermixed debris and solid waste are present in the wooded area south of the maintenance shop on the east side of the property and adjacent to McKnight Road. Debris types observed in the soil include brick, asphalt, concrete, carpet, drain tile, conduit, plastic, etc. A composite soil sample consisting of several discrete soil samples collected from different areas of the soil berms with observed debris detected mercury at a concentration exceeding the Industrial SRV, and low concentrations (less than SRVs) of DRO and PAHs.

Groundwater

- No VOCs, PAHs, GRO or pesticides were detected above the laboratory reporting limits in the samples analyzed during the 2019 Phase II ESA investigation.

- Dissolved Barium was the only metal detected in the water samples; however, the detected concentrations were well below the drinking water standard for barium.

- DRO was detected at 540 microgram per liter (ug/l) in perched groundwater at boring locating ST-8, in the former washout/tank area of the site. DRO was not detected above the laboratory reporting limits in the other samples analyzed during this investigation.

Vapor

- Various VOCs were detected in the soil vapor samples collected during this investigation at low concentrations; however, no VOCs were detected at concentrations above the MPCA 33 times (33x) Residential ISV criteria for assessing the vapor intrusion pathway.

The following provides a summary of the conclusions of the 2019 Phase II ESA:

- Past and current Phase II ESAs have detected both non-petroleum and petroleum compounds in soil at various locations and depths across the Site. The non-petroleum impacts include widespread mercury contamination from the historical use of specialty fungicides and other turf management agricultural products associated with golf courses dating back to the 1930's and into the 1990's. Additional non-petroleum impacts to soil from PAHs and arsenic have also been detected at a few locations at the Site, but these impacts are relatively minor in extent and magnitude. Petroleum impacts detected at the Site are primarily associated with the past use and storage of diesel fuel and gasoline products in the former maintenance shop area located on the east side of the Site adjacent to McKnight Road. Specifically, there were three separate petroleum leak site numbers opened by the MPCA for the releases reported in the vicinity of the former maintenance shop area at the property. The MPCA closed these leak site numbers following review of the previously completed petroleum release investigations and/or soil corrective actions.

- Groundwater samples collected during the recent 2019 Phase II ESA completed by Braun Intertec did not detect evidence of significant or widespread contamination by petroleum compounds or hazardous substances. The presence of residual petroleum-related perched groundwater contamination that was previously investigated, is a known condition, and would only be a concern for redevelopment if dewatering for construction was required and/or if a storm water infiltration feature was planned for this particular area of the property.

- Low concentrations of VOCs were detected in soil vapor samples collected during this investigation. However, none of the detected concentrations of VOCs in soil vapor were above the MPCA's action level of 33X the residential ISVS in any of the sample locations.

C. Site Description

C.1. Geologic Setting

The unconsolidated sediment in the Site vicinity are Pleistocene age till deposits that consist of sandy loam, clay loam, and silty clay loam. The till deposit is generally reddish brown in color and is locally compact (2019 Phase I ESA).

The depth to bedrock in the Site vicinity is 100 to 150 feet below land surface (2019 Phase I ESA). The uppermost bedrock units in the Site vicinity include the Middle Ordovician, Decorah Shale on the western portions of the Site, the Platteville and Glenwood Formations on most of the central and northern portions of the Site, and the St. Peter Sandstone on the southern portions of the Site (2019 Phase I ESA). The Decorah Shale is described as a green, calcareous shale with thin limestone interbeds. The Platteville Formation is described as fine-grained dolostone and limestone underlain by thin, green, sandy shale (3-5.5 feet thick) of the Glenwood Formation. The upper portions of the St. Peter Sandstone are described as fine- to medium-grained, quartz sandstone which is generally massive to thick-bedded while the lower portion of the unit contains multicolored beds of mudstone, siltstone and shale, with interbeds of very coarse sandstone.

Soil encountered during the 2019 Phase II ESA included a layer of dark brown to black topsoil in all of the soil borings from the surface to approximately one foot below ground surface (bgs). Beneath the topsoil there was a layer of tan to brown sandy fill that ranged in depth from three to seven feet bgs. Clayey sand or organic clayey sand was encountered beneath the fill. Fragments of concrete and asphalt were encountered in boring GP-2 at a depth ranging from one to 5.5 feet bgs.

Soil borings in the northwest corner of the golf course contained interbedded layers of glacial till and fluvium. The till was composed of a reddish-brown clayey sand with trace gravel.

C.2. Hydrogeologic Conditions

The reported depth to groundwater in the Site vicinity is 100 to 200 feet below land surface. Perched groundwater may occur at shallower depths above clay layers. According to published geologic information, the regional groundwater flow direction in the Site vicinity is generally westerly (2019 Phase I ESA). However, the local direction of groundwater flow may be affected by nearby streams, lakes, wells, and/or wetlands and may vary seasonally.

Groundwater, suspected to be perched, was encountered in some of the borings advanced during the 2019 Phase II ESA at depths ranging from approximately 5 to 13 feet bgs. Groundwater was not encountered in soil borings advanced during the 2019 Phase II ESA.

D. Site Remedial Investigation

The remedial investigation is designed to collect data that will further characterize the high risk areas and other areas of concern identified at the Site. The locations of the planned soil borings and test pits were selected based upon known Site impacts, site use history, and discussions during the October 29, 2019 Site walk with representatives of the SPPA the MDA.
The remedial investigation will consist of following:

- Advancing direct push soil borings in the agricultural chemical investigation areas.
- Advancing direct push soil borings in the former leak tank basins and recently removed ASTs.
- Advancing a direct push soil boring on the northern boundary of the Site.
- Converting one of the soil borings to a temporary well to facilitate perched groundwater sample collection.
- Convert two of the soil borings to a permanent wells to facilitate perched groundwater sample collection.
- Install one additional permanent groundwater well to facilitate perched groundwater sample collection.
- Excavating test trenches in area of buried and suspected buried debris.
- Advancing hand augers to further delineate mercury impacts related the past use of mercury-based fungicides.
- Sampling groundwater from the two existing water supply wells located at the Site.

The planned soil borings, test pits, hand augers and water supply well locations are shown on Figures 5a-5e. All of the identified HRAs will be investigated during the RI, with the exception of some of the individual fairways, greens and tee boxes. For golf courses with mercury impacts, the historic chemical applications are usually consistent across the golf course as a whole, and the investigation data obtained from a subset of representative fairways, greens, and tee boxes can be applied to the other similar locations provided that the data sets overall are consistent.

At this time, no additional soil vapor investigation is planned. The only vapor area of concern identified to date at the Site is the former petroleum leaks located near the former maintenance sheds. The need for additional soil vapor investigation and the scope of such investigation will be evaluated once the development plans, grades and future building locations for the property are further defined.

D.1. Preparation

D.1.a. Health and Safety Plan

A Site-specific Health, Safety and Accident Prevention Plan (HASP) will be prepared. The HASP provides guidelines and procedures to protect the health and safety of personnel conducting field activities. The Site-specific HSAPP will be developed for Braun Intertec personnel based on the requirements contained in 29 CFR 1910.120. The HASP will be based on information available at the time of development of this Work Plan SAP and will be subject to revision as new data and information on potential health and safety hazards at the Site becomes available.

D.1.b. Utilities

The drilling subcontractors, or Braun Intertec (if they perform any drilling), will arrange for a public utility meet at the Site prior to conducting any subsurface investigation. In addition, the Braun Intertec or other drilling subcontractors, will contract with a private utility locator to attempt to locate all private utilities (if any) near planned soil borings and test trenches.

D.2. Soil Borings and Test Trenches

The following soil borings and test pits will be advanced during the remedial investigation:

- Thirteen soil borings for investigating agricultural chemical releases will be advanced to 5 feet bgs.

- Five soil borings for investigating historical petroleum releases and the recently remove ASTs will be advanced to 15 feet bgs or an estimated five feet below the water table in the locations with planned temporary wells.

- Six test trenches will be excavated through the fill soils to observe the underlying native soils or a maximum depth of 15 feet bgs.

- A minimum of 130 hand auger borings will be advanced to a depth of 1.5 feet bgs.

Soil borings will be drilled using direct-push drilling techniques to collect samples for physical description and chemical analysis. Direct push borings (SBs) will be collected continuously using a macrocore sampler (or similar). Following completion of soil/groundwater sampling, the soil borings will be abandoned in accordance with Minnesota Department of Health (MDH) regulations.

Hand auger borings and test trenches will be backfilled with excavated soils. Care will be taken to replace the soils to their original locations.

Observations made by the field personnel will be recorded on a boring log at the time of drilling or a test pit log. Lithological descriptions of soil encountered during drilling will also be recorded on the logs. Samples of soil collected for logging purposes will be described using visual-manual techniques. Soils will be classified in the field in accordance with ASTM D 2487 "Unified Soils Classification System" and ASTM D 2488 "Recommended Practice for Visual and Manual Description of Soils." Soil discoloration and odors will be documented if detected.

Soil samples will be screened for the presence of organic vapors with a photoionization detector (PID) using both direct readings from each sample and the headspace method of analysis recommended in "Soil Sample Collection and Analysis Procedures, Minnesota Pollution Control Agency (MPCA) Petroleum Remediation Program Fact Sheet #4-04 (April 2005). Samples used for bag headspace measurements will not be used for chemical analysis. The PID will be equipped with a 10.6-electron-volt lamp and calibrated to an isobutylene standard on a daily basis at a minimum. The results of these calibrations will be documented.

PID operation will be in accordance with Braun Intertec SOP No. 202 Organic Vapor Soil Screening.

D.3. Soil Sampling

The sample collection depths, the rationale for sample collection, and analytes for soil sampling are detailed in Table 1. All soil samples collected for laboratory analysis will be immediately placed into laboratory supplied appropriate sample containers for the analytical method. All soil samples will be placed into clean coolers on ice. The ice in the cooler, or the sample container themselves, will be double bagged to prevent water from the ice contacting the sample containers.

D.3.a. Agricultural Chemical Storage/Use Areas

Soil borings for the agriculture chemical investigations will either be discrete borings or composite borings. Per MDA *Guidance Document 9 – Remedial Investigation Work Plan*, soil sampling in agricultural chemical storage/use areas should consist of at least one surface composite sample, one subsurface composite sample and one subsurface discrete sample from each HRA or other potential contamination source areas.

Per the October 29, 2019 Site walk with the MDA, HRA soil borings advanced through cracks in existing floor slabs or bituminous asphalt will be discrete samples collected from one boring and HRA soil borings advanced in non-paved exterior HRAs will consist of composite borings per *MDA Guidance Document 11*. The composite samples in non-paved exterior HRAs will be created from equal volume subsamples collected from the following:

- Three to six equally spaced sub-boring locations within a 15-foot diameter sampling area.
- Common 6-inch thick vertical depth intervals.

Composite samples from borings in non-paved exterior HRAs will be collected from the following intervals:

- 0-0.5 ft. bgs (surficial composite sample).*
- 2-2.5 ft. bgs or below base of gravel (Intermediate Composite Sample).
- 4-4.5 ft. bgs (Discreet Sample).

  ** Surficial composite samples in non-graveled HRAs will be collected from the surface to a depth of 6 inches, and in loose gravel areas from a depth interval of 0 to 6 inches below the base of the gravel.*

All samples collected from soil borings/hand augers will be removed from the acetate liner/auger barrel starting at the bottom and continuing upward only until the required volume of soil is obtained. Care will be taken to prevent slough from coming in contact with or becoming part of the soil sample.

Composite samples from the 2 to 2.5-foot interval will be analyzed immediately, unless otherwise requested by MDA. The surface composite samples and 4.5 to 5-foot discrete samples will be held frozen under proper chain of custody for long-term storage. Soil samples, for investigating agricultural chemical releases, which are not analyzed immediately, (i.e., within a few days), will stored frozen for up to six months under proper chain of custody.

D.3.a.1. Composite Samples

Composite sample from the subsamples will be created using the following procedure from MDA *Guidance Document 11*:

- Combine all of the sub-boring subsamples in a large clean stainless-steel mixing bowl or disposable aluminum pan.
- Decant or drain away any liquids.
- Remove large stones, sticks and vegetation.
- Thoroughly mix the subsamples together with a clean stainless steel or disposable spoon.
- Transfer an adequate volume of the composite sample to a lab supplied clean amber glass jar with a Teflon lined lid.
- Wipe the threads, then cover, label and seal the container.

D.3.a.2. Discrete Samples

Discrete samples will be collected from one specific horizontal location and vertical interval. A 6-inch vertical sampling interval will be sampled. If there is free liquid, large stones, sticks or vegetation in the sample, the sample will be placed in a clean stainless-steel mixing bowl or disposable aluminum pan and the foreign material will be removed. Otherwise, discrete samples will be transferred directly from the sampler to the sample container using a clean stainless steel or disposable implement. After filling the sample jar, the threads of the sample container will be wiped and the container will be covered, labeled, and sealed.

As discussed in MDA guidance document *GD9 Remedial Investigation and Work Plan*, discrete samples will be collected from the 4.5 to 5-foot depth interval, near the center of composite sampling areas, to provide vertical delineation of contamination, if necessary.

D.3.b. Non- Agriculture Chemical Investigation Areas

For the planned soil borings/test pit locations, that are not associated with agricultural chemical storage, up to two discreet soil samples will be collected from each soil boring/test pit and containerized pending submission to the laboratory. Soil samples for chemical analysis from the soil borings will be preferentially collected from intervals that exhibit indications of debris, soil staining, odors or elevated PID readings. At locations with no observed field indications of potential impacts, soil samples will be preferentially collected from the surficial fill soils where present.

Sample collection from soil borings for laboratory analysis will be performed in accordance with the protocols described in the SOPs prepared by Braun Intertec (Appendix A, specifically SOPs 208, Soil Grab Sample, and 209, Soil Composite Sample).

Additional soil samples maybe collected if field personnel encounter indications of potential impacts in the borings that are distinctly different from that observed in previous borings. Indications of potential impacts may include:

- Obvious discoloration, odor, or other visible signs of contamination.
- Elevated organic vapor readings as measured with a PID.
- The presence of suspected asbestos-containing materials (ACM) or soil.

Field personnel will consult with the Braun Intertec Project Manager or the Field Team Leader if they encounter indications of potential impacts and/or unexpected soil conditions.

D.4. Soil Sample Analysis

Per the email dated December 26, 2019 from Mr. Josh Leable, P.G. MDA Project Manager, Incident Response Unit Pesticide & Fertilizer Management Division, the MDA is requesting the following analytes near pesticide handling areas at the Hillcrest Golf Course:

- MDA List 2 Pesticides
- Chlorothalonil
- Propiconazole
- Iprodione

Per the email dated December 26, 2019 from Mr. Leable, the cleanup goals for the specialty pesticides are as follows:

- Chlorothalonil: 0.6 mg/kg
- Propiconazole: 0.06 mg/kg
- Iprodione: 0.75 mg/kg

Braun Intertec will collect soil samples in accordance with the specified method, using laboratory provided jars and bottles. Soil samples will be sent to the Pace Analytical Services (Pace Analytical) in Minneapolis, an MDH and MDA certified analytical laboratory, for analysis. Pace Analytical is not currently certified by the MDA for Chlorothalonil, Propiconazole, and Iprodione, therefore Pace Analytical will subcontract those analysis to Synergistic Pesticide Laboratory in Portland Oregon, which is a MDA certified analytical laboratory.

Methods of analysis are as follows:

Analyte*	Analytical Method
VOCs	EPA 8260
TKN	EPA 351.2
PAHs	EPA 8270C
Nitrate-Nitrite	EPA 353.2
Chlorothalonil	EPA 8270
GRO	WI MOD GRO
DRO	WI MOD DRO
Chlorothalonil	EPA 8270
Propiconazole	EPA 8321
Iprodione	EPA 8270
MDA list 2	EPA 8321
RCRA Metals/mercury	EPA 6020/7471

***Not all analytes will be analyzed at every sample location; the planned analytes for each sample are presented on Table 1.**

If suspected ACM are encountered while advancing soil borings, a sample of the suspected ACM will be collected and analyzed by polarizing light microscopy. If paint chips or materials that are suspected to contain lead paint are encountered, a sample of the paint chips or material will be collected and analyzed by EPA Method 6010.

D.5. Groundwater Sampling

Groundwater samples will be collected from either permanent or temporary wells placed into three of the planned direct-push borings and from the two existing groundwater wells at the site.

D.5.a. Temporary Monitoring Well

A temporary monitoring well will be installed in soil boring SB-1. Temporary monitoring wells will be constructed with 1-inch polyvinyl-chloride (PVC) screen and riser pipe. The temporary wells will be permitted in accordance with MDH guidelines. One groundwater sample will be collected from each of the temporary wells advanced at the Site.

D.5.b. Permanent Monitoring Wells

Three permanent monitoring wells will be installed during this investigation as part of a comprehensive Site wide evaluation of shallow groundwater at the Site.

Soil borings SB-2 and SB-5 will be converted into permanent monitoring wells, in addition a monitoring well (MW-3), not associate with any planned environmental borings, will be installed in the southern portion of the Site to provide groundwater elevation data for the planned future development.

D.5.b.1. Monitoring Well Construction

Construction of monitoring wells will be in accordance with the MDH well code. Monitoring wells installed in both the unconsolidated and bedrock aquifers will be of similar construction, except for the length of the well screens. Screens that are 10 feet in length will be used for monitoring wells installed in the unconsolidated materials.

A written record of daily field activities while constructing monitoring wells will be kept in accordance with Braun Intertec SOP 101 (Appendix A). Monitoring well construction details will be recorded on a monitoring well/piezometer data sheet (SOP 310; Appendix A). A water level will be measured once the monitoring well is constructed following the procedures in Braun Intertec SOP 301 (Appendix A). The measured water level will be recorded on the monitoring well/piezometer data sheet.

Well construction materials will consist of 2-inch diameter, carbon steel well casing or schedule 40-PVC and 2-inch diameter, wire-wrapped, stainless steel or factory slotted schedule 40-PVC well screens. Well screen slot size will be 0.010 inches (10-slot).

Filter pack material will be well-graded, clean sand and will be a standard sand gradation compatible with the slot size of the well screen (e.g., Red Flint #40). The filter pack sand will be placed after the well assembly has been lowered to the borehole. Drill casing will incrementally be raised as the filter sand is emplaced. The depth of the top of the filter pack will be measured after each increment to detect possible bridging. If bridging occurs, the filter pack materials will be washed into proper place with potable water or by repeatedly raising and lowering the drill casing slightly. A tremie pipe may be used to facilitate emplacement of the filter pack for deep wells. The amount of water added to the borehole during well construction, if any, will be noted on the boring log or monitoring well/piezometer data sheet.

The filter sand will be placed in a quantity sufficient to fill the annular space to a level of about two feet above the top of the well screen. A 6-inch thick fine sand seal will then be emplaced above the filter pack. The type of filter pack and fine sand material and amount of material used will be recorded on the monitoring well/piezometer data sheet. The depth of the top of the filter pack and fine sand seal will be verified by measuring using a weighted tape and recorded on the monitoring well/piezometer data sheet.

A bentonite seal will be emplaced above the filter pack sand. A sufficient quantity of bentonite will be added to fill the annular space to a level of at least two feet above the top of filter pack. The bentonite seal will be composed of bentonite chips poured through the annulus, which will be hydrated if emplaced above the water table. The type and amount of material used for the bentonite seal will be recorded on the monitoring well/piezometer data sheet. The depth to the top of the bentonite seal will be verified by measuring using a weighted-tape and recorded on the monitoring well/piezometer data sheet. Neat cement grout will be placed from the top of the bentonite seal to near the ground surface using a tremie pipe. Only potable water will be used to prepare the grout.

The type of grout and grout interval will be recorded on the monitoring well/piezometer data sheet. The grout will allowed to set for a minimum of 48 hours prior to well development.

Upon completion of the well, a suitable cap will be fitted on top of the well casing to reduce the potential for entry of surface runoff or foreign matter. Surface completion in green space areas and paved locations outside of main traffic areas will consist of a nominal 6-inch diameter, 6- to 7-foot long, lockable, protective casing placed over the well casing and set to a depth of at least three feet below ground surface (i.e., stick-up). The protective cover will be set securely in concrete. Bumper posts or bollards may be installed around the protective casing for additional well protection.

D.5.b.2. Monitoring Well Development

Monitoring wells will be developed to improve the hydraulic connection with the surrounding aquifer and remove fine-grained sediments that may have accumulated in the well and filter pack during well installation. Monitoring well development procedures will follow Braun Intertec SOP 303 (Appendix A).

Well development will be documented on a well development record (SOP 303; Appendix A). A written record of daily field activities during well development will be kept in accordance with Braun Intertec SOP 101 (Appendix A).

Monitoring wells will be initially developed by the either the well installation contractor or a Braun Intertec field technician using a bailer. In most instances, a bailer will be used within the entire screened interval to flush the filter pack of fine sediment. Surging will be conducted slowly with the bailer to reduce disruption of the filter pack and screen. The well will be bailed to remove sediment drawn in the by surging process until suspended sediment is visibly reduced.

Following initial well development efforts, the well will be further developed using a submersible pump. If possible, the well will be developed at a higher rate than the anticipated rate of future purging and sampling.

During well development, turbidity and field water quality parameters will be monitored periodically by obtaining aliquots of water from the discharge end of the pump for measurement. The turbidity of the water will be measured using a turbidity meter operated by Braun Intertec. The turbidity meter will be verified daily using procedures in Braun Intertec SOP 317 (Appendix A). Field water quality parameters, such as pH, temperature, and specific conductance, will be measured using a water quality meter following procedures in Braun Intertec SOP 303 (Appendix A). The water quality meter will be calibrated using procedures in Braun Intertec SOP 316 (Appendix A).

Well development will proceed until 10 well casing volumes (volume of water in well casing, well screen and filter pack) or until development water is free of suspended sediment, turbidity values are less than10 nephelometric turbidity units (NTUs), and field parameters have stabilized in accordance with criteria in Braun Intertec SOP 303 (Appendix A).

At a minimum, water levels will be measured at the beginning and at the end of the development process with a water level indicator following the procedures in Braun Intertec SOP 301 (Appendix A).

D.5.b.3. Well Sampling

Prior to purging and sampling, well water levels in the temporary/permanent monitoring wells will be measured to the nearest 0.1 foot from the top of well casing. The wells located furthest from the Site operations and product storage (SB-5) will be sampled first and those wells located nearest to the facility operations and product storage areas (SB-1 and SB-2) will be sampled last.

After the initial water levels are measured, each temporary/permanent monitoring well will be purged of stagnant water and select field water quality parameters will be monitored until stabilized. Specific conductance, temperature, dissolved oxygen (DO) and pH will be monitored during purging until three successive readings are within the specified criteria using a multi-probe meter (YSI or similar) equipped with a flow through cell. The following groundwater parameter criteria, based upon MDA *Guidance Document 12 – Groundwater Sampling Guidance*, Revised 2/2017 (MDA Guidance Document 12), will be followed during purging:

1. Specific Conductance +/- 5%
2. Temperature +/- 0.1 degrees Celsius
3. pH +/- 0.01 units
4. Dissolved Oxygen (DO) +/- 0.3 mg/L

Per MDA Guidance Document 12, prior to sampling, a minimum of 3 to 5 well volumes will be removed from each monitoring well. For temporary monitoring wells that bail dry, the wells will be purged until at least one full well volume has been removed, the well will then be allowed to recover, a groundwater sample will be collected, and if sufficient water remains, stabilization parameters will be measured.

The water quality meter will be calibrated prior to use as described in Braun Intertec SOP 316 (Appendix A).

The anticipated method of well purging and sampling will be using either a suction or inertia pump with new dedicated tubing for each well.

Groundwater samples will be collected directly into laboratory supplied appropriate sample containers with appropriate preservatives. Groundwater samples will be collected in accordance with Braun Intertec SOP 311, Groundwater Sample Collection. Samples will be labeled and placed in double bagged ice for transport using chain-of-custody procedures. Braun Intertec SOPs are included in Appendix A.

The groundwater samples will be submitted to Pace Analytical services in Minneapolis, Minnesota, a pre-approved MDA fixed based laboratory.

Methods of analysis are as follows:

Analyte*	Analytical Method
VOCs	EPA 8260
PAHs	EPA 8270C
GRO	WI MOD GRO
DRO	WI MOD DRO
RCRA Metals/mercury	EPA 6020/7471

***Not all analytes will be analyzed at every sample location; the planned analytes for each sample are presented on Table 1.**

D.6. Spatial Data Collection

Spatial data such as sampling locations will be collected using a global positioning system (GPS) device and recorded for Site features in accordance with MPCA Guidance Document 1-03 *Spatial Data Collection at Petroleum Remediation Sites*.

D.7. Investigation Derived Waste

Waste generated during the investigation will be handled and disposed in accordance with the procedures described in SOP 702, Investigative Derived Waste.

This SAP includes investigation activities that will generate waste that will require management. Investigation-derived waste generated as a result of the activities within this SAP will be managed as follows:

- Personal protective equipment, disposable sampling equipment, and paper products (e.g., paper towels): will be bagged and disposed of as solid waste.
- Soil cuttings from drilling: will be placed back into the borehole.
- Decontamination fluids: will be containerized and temporarily stored on-site until its ultimate disposition is determined. Upon completion of the investigation, the containerized waste will be sampled for waste characterization purposes and disposed off-site. Specific analytical parameters will be determined by the disposal facility. Once disposal arrangements are made, fluids may be transferred to a vacuum truck for transport to disposal, or fluids may be solidified prior to transport for disposal.

D.8. Sample Handling and Custody

Soil samples selected for laboratory analysis will be placed in containers supplied by the analytical laboratory and labeled with a unique identification number keyed to the sample location and depth, the date and time the sample was collected, and the initials of the sample collector. The sample containers will be suitable for the intended analysis and contain preservative as required by the method. This information will be recorded on a sample control log. The samples will be placed on ice in a cooler pending shipment to the laboratory.

Sample labels will be used to identify and prevent misidentification of the samples. The labels will be affixed to the sample containers prior to or at the time of sampling. The labels will be filled out in permanent ink at the time of collection and will include the following information:

- Sample number
- Initials of collector
- Date and time of collection
- Client and geographic location
- Company name
- Project number

A written record (i.e., chain-of-custody) will be created to document the transportation and possession of each sample from the moment of collection through analysis. The resulting information will aid in data interpretation and serve as legal evidence of sample handling. The sample custody procedures are designed to comply with United States Environmental Protection Agency (U.S. EPA) requirements for sample control and to ensure that the samples arrive at the laboratory with the chain of custody record intact.

The field sampler will be personally responsible for the care and custody of the samples until they are transferred or properly dispatched.
The samples will be hand-delivered to the analytical laboratory. During transfer of custody, samples will be accompanied by a properly completed chain-of-custody form. The chain-of-custody form will include the following information:

- Project number
- Sample number
- Sample location
- Date collected
- Type of sample
- Analyses to be performed

When transferring the possession of samples, the individuals relinquishing and receiving the samples will sign, date, and note the time on the chain-of-custody form. This record documents transfer of custody of samples from the sampler to the laboratory.

Upon receipt of the samples at the selected laboratory, the sample custodian will note the condition of the shipping containers and each sample, will note the presence/absence of ice or obtain cooler temperature, and will log in the samples. The accompanying original chain-of-custody record will be signed and dated and returned to Braun Intertec.

The laboratory will use serially numbered lab-tracking report sheets or similar method to document sample custody. The laboratory will follow their Laboratory Quality Assurance Manual (on file at the MDA) for sample handling, storage, and dispersal for analysis.

Additional information in regard to sample handing, preservation, and chain of custody protocols is included in SOP 602, Chain of Custody.

D.9. Chain of Custody

Chain-of-custody will be initiated at the time of sampling and be conducted in accordance with SOP 602 included in Appendix A.

E. Quality Control Quality Assurance

Data quality objectives were determined for each data set that will be generated during the investigation. The following data will be generated:

- Sample locations and depths.
- Observations of subsurface conditions such as the presence of debris, staining and presence of waste materials.
- PAH, VOC, DRO, GRO, RCRA Metal, Pesticide, and Fertilizer concentrations.
- PID readings.

The sample locations and depths will need to be documented with sufficient accuracy, so they can be located for potential response action or further investigative purposes. The planned sample locations and depths are sufficient to represent the local conditions of interest for the purposes of this SAP. Observations of subsurface conditions need to be accurate and complete so that the sampling plan, which targets potentially impacted areas and depths, can be successfully implemented.

The chemical concentration data need to be precise, accurate, representative and complete to allow a meaningful comparison to applicable standards. Acceptable criteria for precision and accuracy are provided by the analytical laboratory and will include acceptable ranges for matrix spike recovery limit, matrix spike relative percent difference, laboratory control sample recovery, and surrogate recovery.

Representativeness will be evaluated in relation to equipment blanks. Comparability will be addressed by utilizing procedures and methods described in this plan, which incorporates standard sampling and analytical methods.

E.1. Quality Control – Field Methods

Care will be exercised to avoid the following common ways in which cross contamination or background contamination may compromise samples:

- Improper storage or transportation of equipment.
- Contaminating the equipment or sample bottles on Site by setting them on or near potential contamination sources such as uncovered ground, a contaminated vehicle.
- Or vehicle exhaust.
- Handling bottles or equipment with dirty hands or gloves

Care will be exercised to prevent cross-contamination of sampling equipment, sampling bottles, or anything else that could potentially compromise the integrity of samples. Field personnel will work under the assumption that contamination exists in land, surface soils and vegetation near sampling points, wash water, etc. Therefore, taking at least the following precautions will minimize exposure to these media:

- Minimizing the amount of rinse water left on washed materials.

- Minimizing the time sampling containers are exposed to airborne dust or volatile contaminants in ambient air.

- Placing equipment on clean, ground covering materials instead of on the land surface.

All field personnel will wear clean gloves made of appropriately inert material. Gloves will be kept clean while handling sampling-related materials. The gloves will be replaced by a new pair whenever soiled and between each sample.

E.2. Decontamination

Dedicated sampling equipment will be utilized on site whenever feasible to prevent cross-contamination and biased results in samples. Re-usable sampling equipment will be made of glass, stainless steel, Teflon, or other inert material. Shovels, picks, hand augers, split tube samplers, stainless steel bowls or spoons and any other equipment that comes in direct contact with the sample will be decontaminated prior to first use and between each collected sample.

Per MDA *Guidance Document 11- Soil Sampling Guidance,* sampling equipment will be cleaned using the following procedures:

- Vigorous wash in an Alconox solution, followed by a potable water rinse, followed by an acetone or methanol rinse or wipe, followed by a triple rinse with deionized water (distilled water can be used if deionized is not available), air dry.

- After air dry the reusable sample equipment will be wrapped in aluminum foil or other suitable material or stored on a clean surface in a protected area until used. Alternatively, disposable plastic and PVC materials may be used. Replace disposable equipment between samples.

- Decontamination water will be sourced from potable water or preferable distilled water from an off-site source.

- Wash basin/buckets will be made of steel or other inert materials, not plastic.

All drilling equipment and tooling that may come into contact with site soils will be decontaminated with a steam cleaner before initial use. Enough pre-steam cleaned auger will be brought to the Site, so that augers are not re-used in between samples.

Any non-dedicated sampling equipment, such as the drilling core tube samplers, will be steam cleaned before initial use, unbeaten samples this equipment will be washed with non-phosphate biodegradable soap, rinsed with water and then acetone, and triple rinsed with clean water between samples.

All subsamples collected for a single composite sample are considered one sample unless the subsamples are used for both discrete and composite samples.

E.3. Quality Control Sample Collection

Quality assurance/quality control (QA/QC) samples will be used during this investigation at the rate described below.
The laboratory will provide QC in accordance with their laboratory quality assurance manuals and the analytical methods in use.
In addition to the investigative samples, the following QA/QC samples will be collected:

- A laboratory supplied trip blanks will accompany each cooler containing samples for VOC analyses. The trip blanks will be analyzed for VOCs.

- Two equipment blanks will be collected and analyzed for VOCs, PAHs, RCRA metals Chlorothalonil/Propiconazole/Iprodione, List 2 Pesticides, and NN. The Equipment blanks will be created by passing laboratory supplied deionized water over the decontaminated field equipment to access the adequacy of the decontamination process.

- A minimum of 10% blind duplicate samples will be collected and analyzed for VOCs, PAHs, RCRA metals and/or mercury, Chlorothalonil/Propiconazole/Iprodione, List 2 Pesticides, and NN. Blind Duplicates will be labeled as “DUP”, followed by sequential number of the duplicates (i.e. 1, 2, 3) followed by the-date of collection, (i.e. Dup -1- 04202020, Dup-2-04202020).

A duplicate soil sample may be created by creating Field Duplicates. Field duplicate soil samples are created from soil that has been thoroughly mixed (granular soils) similar to creating a composite sample, or for fine grain soils (i.e. clay) cutting the clay cores down the vertical axis into halves for separate analysis.

F. Assessment, Oversight, and Data Usability

A Braun Intertec licensed professional geologist or professional engineer will direct the fieldwork, review the field records and laboratory reports and will assess the data.

Data review is the process of reviewing the QA/QC documentation provided by field sampling teams and by the analytical laboratories to determine if QA/QC requirements are satisfied.
The objective of data review is to determine the quality and usability of the data, and to classify the data into one of three general categories: usable and quantitative data, usable but qualitative data, and unusable data.

The field data package includes all of the field records and the measurements developed by the field sampling team. The field data package will be reviewed by designated personnel. Review of the field data package will include the following:

- Review of field data contained in sampling logs.
- Verification that QC samples were properly prepared, identified, and analyzed.
- Review of field record documentation including equipment calibration, instrument condition, and decontamination procedures.
- Review of the chain-of-custody form to assure proper completion.

The laboratory will submit analytical results that are supported by sufficient QC data to enable the data reviewers to conclusively assess the validity of the data. The data provided by the laboratory will be validated prior to data interpretation. Data will be reviewed using the USEPA Functional Guidelines for Data Review. Unusable data (if any) will not be used in the data interpretation.

In addition, per MDA *Guidance Document 9 – Remedial Investigation Work Plan*, the Laboratory Data Review Checklist will be completed for the analytical data.

G. Data Generation/Acquisition and Quality Assurance/ Quality Control

The plan for data generation and acquisition is described in the following sections, including sample handling and custody, analytical methods, quality control and data management.

Field data sheets and logs will be maintained in accordance with SOP 101. In addition to the information required by the SOP, the following will be noted:

- All deviations from the protocols referenced or described in this document.
- Record of decisions or directions made by MPCA staff, Site manager, Braun Intertec project manager, client or other authorized person.

If exceptions to this protocol occur, documentation will include the following details for each exception:

- The reason for the exception.
- The identification of all samples and individual parameters that may have been impacted either in terms of the quantitative or legal integrity of their reported values.

If there has been any potentially significant impact on sample integrity, the potential impact for each parameter for each sample affected will be footnoted whenever the results are reported or referred to.

H. Report

Braun Intertec will prepare a report, including the following:

- Text describing the site conditions, methods, deviations, and results of the work.
- Laboratory reports.
- Chemical concentration data both in a table and plotted on the Site map.
- Boring logs, sketches, and photographs.
- A map based on the data that displays the detected impacts.

Table

Table 1
Sampling Plan
Former Hillcrest Golf Course
2200 Larpenteur Ave E
St. Paul, Minnesota

Sample Location ID	Location with Respect to Existing Building / Proposed or Existing Site Features	Boring Depth (feet bgs)	Number of Samples[1]	Sample Matrix	Composite or Discrete	Sample Depth[3]	Analytes										
							Mercury	Arsenic	RCRA Metals	PAHs	VOCs	GRO	DRO	Nitrate-Nitrite	TKN	Chlorothalonil/Propiconazole/Iprodione	List 2 Pesticides
ASB-1	Large crack in floor of agricultural chemical storage building (west bay)	5	3	Soil	Discreet	0-0.5, 2-2.5, 4-4.5	X		X					X	X		
ASB-2	Large crack in floor of agricultural chemical storage building (east bay)	5	3	Soil	Discreet	0-0.5, 2-2.5, 4-4.5	X							X	X		
ASB-3	Large crack in exterior asphalt loading area for agricultural chemical storage building	5	3	Soil	Discreet	0-0.5, 2-2.5, 4-4.5	X							X	X		
ASB-4	Exterior chemical loading area (cracked asphalt)	5	3	Soil	Discreet	0-0.5, 2-2.5, 4-4.5	X									X	X
ASB-5 - C	Outlet for drain in concrete loading pad for agricultural chemical storage shed	5	3	Soil	Composite	0-0.5, 2-2.5, 4-4.5	X									X	X
ASB-6 - C	Grass area immediately adjacent to concrete loading pad for agricultural chemical storage shed	5	3	Soil	Composite	0-0.5, 2-2.5, 4-4.5	X									X	X
ASB-7	Inlet to drainage swale adjacent to agricultural chemical mixing area	5	3	Soil	Discreet	0-0.5, 2-2.5, 4-4.5	X							X	X	X	X
ASB-8 -C	Agricultural chemical mixing area	5	3	Soil	Composite	0-0.5, 2-2.5, 4-4.5	X							X	X	X	X
ASB-9 - C	Drainage area from agricultural chemical mixing area	5	3	Soil	Composite	0-0.5, 2-2.5, 4-4.5	X							X	X	X	X
ASB-10	Interior crack in slab maintenance building where agricultural chemical storage occurred	5	3	Soil	Discreet	0-0.5, 2-2.5, 4-4.5			X		X					X	X
ASB-11	Loading door on west side of the southern most maintenance and storage building	5	3	Soil	Composite	0-0.5, 2-2.5, 4-4.5								X	X	X	X
ASB-12	Loading door on south side of the southern most maintenance and storage building	5	3	Soil	Composite	0-0.5, 2-2.5, 4-4.5								X	X	X	X
ASB-13	Water Filll Area	5	3	Soil	Composite	0-0.5, 2-2.5, 4-4.5	X									X	X
SW-1	Drainage swale adjacent to agricultural chemical mixing area - Surface ater	WT	1	Water	Discreet	Surface								X	X	X	X
SB-1	Former UST basin - Leak Site #5050	WT	1-2	Soil	Discreet	TBD[2]			X		X	X	X	X	X	X	X
SB-1 (TW)	Former UST basin - Leak Site #5050 - Temporary well	WT	1	Water	Discreet	TBD[2]					X	X	X	X	X	X	X
SB-2	Former UST basin - Leak Site #18327	WT	1-2	Soil	Discreet	TBD[2]			X		X	X	X				
SB-2/MW-2	Former UST basin - Leak Site #18327-Temporary well	WT	1	Water	Discreet	TBD[2]					X	X	X	X	X	X	X
SB-3	Former Diesel AST	WT	1-2	Soil	Discreet	TBD[2]				X	X	X	X				
SB-4	Former Gasoline AST	WT	1-2	Soil	Discreet	TBD[2]					X	X	X				
SB-5/MW-1	Upgradient boring	WT	1-2	Soil	Discreet	TBD[2]			X	X	X						
SB-5	Upgradient boring -Temporary well	WT	1	Water	Discreet	TBD[2]			X	X	X						
TT-1	Former pool house (potential buried debris)	10	1-2	Soil	NA	TBD[2]			X	X	X						
TT-2	Former pool house (potential buried debris)	10	1-2	Soil	NA	TBD[2]			X	X	X						
TT-3	Former tennis courts (potential buried debris)	10	1-2	Soil	NA	TBD[2]			X	X	X						
TT-4	Raised berm (potential buried debris)	10	1-2	Soil	NA	TBD[2]			X	X	X			*	*	*	*
TT-5	Raised berm (potential buried debris)	10	1-2	Soil	NA	TBD[2]			X	X	X			*	*	*	*
TT-6	Raised berm (potential buried debris)	10	1-2	Soil	NA	TBD[2]			X	X	X			*	*	*	*
SS-1B	Delineation of mercury impacts associated with golf course fungicide use.	1.5	2	Soil	NA	0-0.5, 1-1.5	X	X									
SS-1C	Delineation of mercury impacts associated with golf course fungicide use.	1.5	2	Soil	NA	0-0.5, 1-1.5	X	X									
SS-1D	Delineation of mercury impacts associated with golf course fungicide use.	1.5	2	Soil	NA	0-0.5, 1-1.5	X										
SS-1E	Delineation of mercury impacts associated with golf course fungicide use.	1.5	2	Soil	NA	0-0.5, 1-1.5	X										
SS-1F	Delineation of mercury impacts associated with golf course fungicide use.	1.5	2	Soil	NA	0-0.5, 1-1.5	X	X									
SS-1G	Delineation of mercury impacts associated with golf course fungicide use.	1.5	2	Soil	NA	0-0.5, 1-1.5	X										
SS-1H	Delineation of mercury impacts associated with golf course fungicide use.	1.5	2	Soil	NA	0-0.5, 1-1.5	X										
SS-1I	Delineation of mercury impacts associated with golf course fungicide use.	1.5	2	Soil	NA	0-0.5, 1-1.5	X										
SS-1J	Delineation of mercury impacts associated with golf course fungicide use.	1.5	2	Soil	NA	0-0.5, 1-1.5	X										
SS-1K	Delineation of mercury impacts associated with golf course fungicide use.	1.5	2	Soil	NA	0-0.5, 1-1.5	X										
SS-3G	Delineation of mercury impacts associated with golf course fungicide use.	1.5	2	Soil	NA	0-0.5, 1-1.5	X										
SS-3H	Delineation of mercury impacts associated with golf course fungicide use.	1.5	2	Soil	NA	0-0.5, 1-1.5	X										
SS-3I	Delineation of mercury impacts associated with golf course fungicide use.	1.5	2	Soil	NA	0-0.5, 1-1.5	X										
SS-3J	Delineation of mercury impacts associated with golf course fungicide use.	1.5	2	Soil	NA	0-0.5, 1-1.5	X										
SS-3K	Delineation of mercury impacts associated with golf course fungicide use.	1.5	2	Soil	NA	0-0.5, 1-1.5	X										
SS-3L	Delineation of mercury impacts associated with golf course fungicide use.	1.5	2	Soil	NA	0-0.5, 1-1.5	X										
SS-3M	Delineation of mercury impacts associated with golf course fungicide use.	1.5	2	Soil	NA	0-0.5, 1-1.5	X										

BRAUN INTERTEC

Table 1
Sampling Plan
Former Hillcrest Golf Course
2200 Larpenteur Ave E
St. Paul, Minnesota

Sample Location ID	Location with Respect to Existing Building / Proposed or Existing Site Features	Boring Depth (feet bgs)	Number of Samples[1]	Sample Matrix	Composite or Discrete	Sample Depth [3]	Analytes										
							Mercury	Arsenic	RCRA Metals	PAHs	VOCs	GRO	DRO	Nitrate-Nitrite	TKN	Chlorothalonil/Propiconazole/Iprodione	List 2 Pesticides
SS-4C	Delineation of mercury impacts associated with golf course fungicide use.	1.5	2	Soil	NA	0-0.5, 1-1.5	X										
SS-4D	Delineation of mercury impacts associated with golf course fungicide use.	1.5	2	Soil	NA	0-0.5, 1-1.5	X										
SS-4E	Delineation of mercury impacts associated with golf course fungicide use.	1.5	2	Soil	NA	0-0.5, 1-1.5	X										
SS-4F	Delineation of mercury impacts associated with golf course fungicide use.	1.5	2	Soil	NA	0-0.5, 1-1.5	X										
SS-5D	Delineation of mercury impacts associated with golf course fungicide use.	1.5	2	Soil	NA	0-0.5, 1-1.5	X										
SS-5E	Delineation of mercury impacts associated with golf course fungicide use.	1.5	2	Soil	NA	0-0.5, 1-1.5	X										
SS-5F	Delineation of mercury impacts associated with golf course fungicide use.	1.5	2	Soil	NA	0-0.5, 1-1.5	X										
SS-5G	Delineation of mercury impacts associated with golf course fungicide use.	1.5	2	Soil	NA	0-0.5, 1-1.5	X										
SS-5H	Delineation of mercury impacts associated with golf course fungicide use.	1.5	2	Soil	NA	0-0.5, 1-1.5	X										
SS-5I	Delineation of mercury impacts associated with golf course fungicide use.	1.5	2	Soil	NA	0-0.5, 1-1.5	X										
SS-5J	Delineation of mercury impacts associated with golf course fungicide use.	1.5	2	Soil	NA	0-0.5, 1-1.5	X										
SS-5K	Delineation of mercury impacts associated with golf course fungicide use.	1.5	2	Soil	NA	0-0.5, 1-1.5	X										
SS-5L	Delineation of mercury impacts associated with golf course fungicide use.	1.5	2	Soil	NA	0-0.5, 1-1.5	X										
SS-5M	Delineation of mercury impacts associated with golf course fungicide use.	1.5	2	Soil	NA	0-0.5, 1-1.5	X										
SS-10B	Delineation of mercury impacts associated with golf course fungicide use.	1.5	2	Soil	NA	0-0.5, 1-1.5	X										
SS-10C	Delineation of mercury impacts associated with golf course fungicide use.	1.5	2	Soil	NA	0-0.5, 1-1.5	X										
SS-10D	Delineation of mercury impacts associated with golf course fungicide use.	1.5	2	Soil	NA	0-0.5, 1-1.5	X										
SS-10E	Delineation of mercury impacts associated with golf course fungicide use.	1.5	2	Soil	NA	0-0.5, 1-1.5	X										
SS-10F	Delineation of mercury impacts associated with golf course fungicide use.	1.5	2	Soil	NA	0-0.5, 1-1.5	X										
SS-10G	Delineation of mercury impacts associated with golf course fungicide use.	1.5	2	Soil	NA	0-0.5, 1-1.5	X										
SS-10H	Delineation of mercury impacts associated with golf course fungicide use.	1.5	2	Soil	NA	0-0.5, 1-1.5	X										
SS-13B	Delineation of mercury impacts associated with golf course fungicide use.	1.5	2	Soil	NA	0-0.5, 1-1.5	X										
SS-13C	Delineation of mercury impacts associated with golf course fungicide use.	1.5	2	Soil	NA	0-0.5, 1-1.5	X										
SS-14B	Delineation of mercury impacts associated with golf course fungicide use.	1.5	2	Soil	NA	0-0.5, 1-1.5	X										
SS-14C	Delineation of mercury impacts associated with golf course fungicide use.	1.5	2	Soil	NA	0-0.5, 1-1.5	X										
SS-14D	Delineation of mercury impacts associated with golf course fungicide use.	1.5	2	Soil	NA	0-0.5, 1-1.5	X										
SS-16B	Delineation of mercury impacts associated with golf course fungicide use.	1.5	2	Soil	NA	0-0.5, 1-1.5	X										
SS-16C	Delineation of mercury impacts associated with golf course fungicide use.	1.5	2	Soil	NA	0-0.5, 1-1.5	X										
SS-16D	Delineation of mercury impacts associated with golf course fungicide use.	1.5	2	Soil	NA	0-0.5, 1-1.5	X										
SS-17	Delineation of mercury impacts associated with golf course fungicide use.	1.5	2	Soil	NA	0-0.5, 1-1.5	X										
SS-17B	Delineation of mercury impacts associated with golf course fungicide use.	1.5	2	Soil	NA	0-0.5, 1-1.5	X										
SS-17C	Delineation of mercury impacts associated with golf course fungicide use.	1.5	2	Soil	NA	0-0.5, 1-1.5	X										
SS-17D	Delineation of mercury impacts associated with golf course fungicide use.	1.5	2	Soil	NA	0-0.5, 1-1.5	X										
SS-17E	Delineation of mercury impacts associated with golf course fungicide use.	1.5	2	Soil	NA	0-0.5, 1-1.5	X										
SS-17F	Delineation of mercury impacts associated with golf course fungicide use.	1.5	2	Soil	NA	0-0.5, 1-1.5	X										
SS-17G	Delineation of mercury impacts associated with golf course fungicide use.	1.5	2	Soil	NA	0-0.5, 1-1.5	X										
SS-17H	Delineation of mercury impacts associated with golf course fungicide use.	1.5	2	Soil	NA	0-0.5, 1-1.5	X										
SS-17I	Delineation of mercury impacts associated with golf course fungicide use.	1.5	2	Soil	NA	0-0.5, 1-1.5	X										
SS-17j	Delineation of mercury impacts associated with golf course fungicide use.	1.5	2	Soil	NA	0-0.5, 1-1.5	X										
SS-18	Delineation of mercury impacts associated with golf course fungicide use.	1.5	2	Soil	NA	0-0.5, 1-1.5	X										
SS-18B	Delineation of mercury impacts associated with golf course fungicide use.	1.5	2	Soil	NA	0-0.5, 1-1.5	X										
SS-18C	Delineation of mercury impacts associated with golf course fungicide use.	1.5	2	Soil	NA	0-0.5, 1-1.5	X										
SS-18D	Delineation of mercury impacts associated with golf course fungicide use.	1.5	2	Soil	NA	0-0.5, 1-1.5	X										
SS-18E	Delineation of mercury impacts associated with golf course fungicide use.	1.5	2	Soil	NA	0-0.5, 1-1.5	X										
SS-19	Delineation of mercury impacts associated with golf course fungicide use.	1.5	2	Soil	NA	0-0.5, 1-1.5	X										
SS-19B	Delineation of mercury impacts associated with golf course fungicide use.	1.5	2	Soil	NA	0-0.5, 1-1.5	X										
SS-19C	Delineation of mercury impacts associated with golf course fungicide use.	1.5	2	Soil	NA	0-0.5, 1-1.5	X										
SS-19D	Delineation of mercury impacts associated with golf course fungicide use.	1.5	2	Soil	NA	0-0.5, 1-1.5	X										

BRAUN INTERTEC

Table 1
Sampling Plan
Former Hillcrest Golf Course
2200 Larpenteur Ave E
St. Paul, Minnesota

Sample Location ID	Location with Respect to Existing Building / Proposed or Existing Site Features	Boring Depth (feet bgs)	Number of Samples[1]	Sample Matrix	Composite or Discrete	Sample Depth[3]	Analytes										
							Mercury	Arsenic	RCRA Metals	PAHs	VOCs	GRO	DRO	Nitrate-Nitrite	TKN	Chlorothalonil/Propiconazole/Iprodione	List 2 Pesticides
SS-19E	Delineation of mercury impacts associated with golf course fungicide use.	1.5	2	Soil	NA	0-0.5, 1-1.5	X										
SS-19F	Delineation of mercury impacts associated with golf course fungicide use.	1.5	2	Soil	NA	0-0.5, 1-1.5	X										
SS-20	Delineation of mercury impacts associated with golf course fungicide use.	1.5	2	Soil	NA	0-0.5, 1-1.5	X										
SS-20B	Delineation of mercury impacts associated with golf course fungicide use.	1.5	2	Soil	NA	0-0.5, 1-1.5	X										
SS-20C	Delineation of mercury impacts associated with golf course fungicide use.	1.5	2	Soil	NA	0-0.5, 1-1.5	X										
SS-20D	Delineation of mercury impacts associated with golf course fungicide use.	1.5	2	Soil	NA	0-0.5, 1-1.5	X										
SS-21	Delineation of mercury impacts associated with golf course fungicide use.	1.5	2	Soil	NA	0-0.5, 1-1.5	X										
SS-21B	Delineation of mercury impacts associated with golf course fungicide use.	1.5	2	Soil	NA	0-0.5, 1-1.5	X										
SS-21C	Delineation of mercury impacts associated with golf course fungicide use.	1.5	2	Soil	NA	0-0.5, 1-1.5	X										
SS-21D	Delineation of mercury impacts associated with golf course fungicide use.	1.5	2	Soil	NA	0-0.5, 1-1.5	X										
SS-21E	Delineation of mercury impacts associated with golf course fungicide use.	1.5	2	Soil	NA	0-0.5, 1-1.5	X										
SS-21F	Delineation of mercury impacts associated with golf course fungicide use.	1.5	2	Soil	NA	0-0.5, 1-1.5	X										
SS-21G	Delineation of mercury impacts associated with golf course fungicide use.	1.5	2	Soil	NA	0-0.5, 1-1.5	X										
SS-22	Delineation of mercury impacts associated with golf course fungicide use.	1.5	2	Soil	NA	0-0.5, 1-1.5	X										
SS-22B	Delineation of mercury impacts associated with golf course fungicide use.	1.5	2	Soil	NA	0-0.5, 1-1.5	X										
SS-22C	Delineation of mercury impacts associated with golf course fungicide use.	1.5	2	Soil	NA	0-0.5, 1-1.5	X										
SS-22D	Delineation of mercury impacts associated with golf course fungicide use.	1.5	2	Soil	NA	0-0.5, 1-1.5	X										
SS-22E	Delineation of mercury impacts associated with golf course fungicide use.	1.5	2	Soil	NA	0-0.5, 1-1.5	X										
SS-22F	Delineation of mercury impacts associated with golf course fungicide use.	1.5	2	Soil	NA	0-0.5, 1-1.5	X										
SS-22G	Delineation of mercury impacts associated with golf course fungicide use.	1.5	2	Soil	NA	0-0.5, 1-1.5	X										
SS-22H	Delineation of mercury impacts associated with golf course fungicide use.	1.5	2	Soil	NA	0-0.5, 1-1.5	X										
SS-22I	Delineation of mercury impacts associated with golf course fungicide use.	1.5	2	Soil	NA	0-0.5, 1-1.5	X										
SS-23	Delineation of mercury impacts associated with golf course fungicide use.	1.5	2	Soil	NA	0-0.5, 1-1.5	X										
SS-23B	Delineation of mercury impacts associated with golf course fungicide use.	1.5	2	Soil	NA	0-0.5, 1-1.5	X										
SS-23C	Delineation of mercury impacts associated with golf course fungicide use.	1.5	2	Soil	NA	0-0.5, 1-1.5	X										
SS-23D	Delineation of mercury impacts associated with golf course fungicide use.	1.5	2	Soil	NA	0-0.5, 1-1.5	X										
SS-23E	Delineation of mercury impacts associated with golf course fungicide use.	1.5	2	Soil	NA	0-0.5, 1-1.5	X										
SS-23F	Delineation of mercury impacts associated with golf course fungicide use.	1.5	2	Soil	NA	0-0.5, 1-1.5	X										
SS-23G	Delineation of mercury impacts associated with golf course fungicide use.	1.5	2	Soil	NA	0-0.5, 1-1.5	X										
SS-23H	Delineation of mercury impacts associated with golf course fungicide use.	1.5	2	Soil	NA	0-0.5, 1-1.5	X										
SS-23I	Delineation of mercury impacts associated with golf course fungicide use.	1.5	2	Soil	NA	0-0.5, 1-1.5	X										
SS-23J	Delineation of mercury impacts associated with golf course fungicide use.	1.5	2	Soil	NA	0-0.5, 1-1.5	X										
SS-23K	Delineation of mercury impacts associated with golf course fungicide use.	1.5	2	Soil	NA	0-0.5, 1-1.5	X										
SS-23	Delineation of mercury impacts associated with golf course fungicide use.	1.5	2	Soil	NA	0-0.5, 1-1.5	X										
SS-23B	Delineation of mercury impacts associated with golf course fungicide use.	1.5	2	Soil	NA	0-0.5, 1-1.5	X										
SS-23C	Delineation of mercury impacts associated with golf course fungicide use.	1.5	2	Soil	NA	0-0.5, 1-1.5	X										
SS-23D	Delineation of mercury impacts associated with golf course fungicide use.	1.5	2	Soil	NA	0-0.5, 1-1.5	X										
SS-23E	Delineation of mercury impacts associated with golf course fungicide use.	1.5	2	Soil	NA	0-0.5, 1-1.5	X										
SS-23F	Delineation of mercury impacts associated with golf course fungicide use.	1.5	2	Soil	NA	0-0.5, 1-1.5	X										
SS-24	Delineation of mercury impacts associated with golf course fungicide use.	1.5	2	Soil	NA	0-0.5, 1-1.5	X										
SS-24B	Delineation of mercury impacts associated with golf course fungicide use.	1.5	2	Soil	NA	0-0.5, 1-1.5	X										
SS-24C	Delineation of mercury impacts associated with golf course fungicide use.	1.5	2	Soil	NA	0-0.5, 1-1.5	X										
SS-24C	Delineation of mercury impacts associated with golf course fungicide use.	1.5	2	Soil	NA	0-0.5, 1-1.5	X										
SS-24E	Delineation of mercury impacts associated with golf course fungicide use.	1.5	2	Soil	NA	0-0.5, 1-1.5	X										
SS-24F	Delineation of mercury impacts associated with golf course fungicide use.	1.5	2	Soil	NA	0-0.5, 1-1.5	X										
SS-25	Delineation of mercury impacts associated with golf course fungicide use.	1.5	2	Soil	NA	0-0.5, 1-1.5	X										

BRAUN INTERTEC

Table 1
Sampling Plan
Former Hillcrest Golf Course
2200 Larpenteur Ave E
St. Paul, Minnesota

Sample Location ID	Location with Respect to Existing Building / Proposed or Existing Site Features	Boring Depth (feet bgs)	Number of Samples[1]	Sample Matrix	Composite or Discrete	Sample Depth[3]	Analytes										
							Mercury	Arsenic	RCRA Metals	PAHs	VOCs	GRO	DRO	Nitrate-Nitrite	TKN	Chlorothalonil/Propiconazole/Iprodione	List 2 Pesticides
SS-26	Delineation of mercury impacts associated with golf course fungicide use.	1.5	2	Soil	NA	0-0.5, 1-1.5	X										
SS-27	Delineation of mercury impacts associated with golf course fungicide use.	1.5	2	Soil	NA	0-0.5, 1-1.5	X										
SS-28	Delineation of mercury impacts associated with golf course fungicide use.	1.5	2	Soil	NA	0-0.5, 1-1.5	X										
SS-29	Delineation of mercury impacts associated with golf course fungicide use.	1.5	2	Soil	NA	0-0.5, 1-1.5	X										
SS-30	Delineation of mercury impacts associated with golf course fungicide use.	1.5	2	Soil	NA	0-0.5, 1-1.5	X										
SS-31	Delineation of mercury impacts associated with golf course fungicide use.	1.5	2	Soil	NA	0-0.5, 1-1.5	X										
SS-32	Delineation of mercury impacts associated with golf course fungicide use.	1.5	2	Soil	NA	0-0.5, 1-1.5	X										
SS-33	Delineation of mercury impacts associated with golf course fungicide use.	1.5	2	Soil	NA	0-0.5, 1-1.5	X										
SS-34	Delineation of mercury impacts associated with golf course fungicide use.	1.5	2	Soil	NA	0-0.5, 1-1.5	X										
SS-35	Delineation of mercury impacts associated with golf course fungicide use.	1.5	2	Soil	NA	0-0.5, 1-1.5	X										
SS-36	Delineation of mercury impacts associated with golf course fungicide use.	1.5	2	Soil	NA	0-0.5, 1-1.5	X										
SS-37	Delineation of mercury impacts associated with golf course fungicide use.	1.5	2	Soil	NA	0-0.5, 1-1.5	X										
SS-38	Delineation of mercury impacts associated with golf course fungicide use.	1.5	2	Soil	NA	0-0.5, 1-1.5	X										
SS-39	Delineation of mercury impacts associated with golf course fungicide use.	1.5	2	Soil	NA	0-0.5, 1-1.5	X										
SS-40	Delineation of mercury impacts associated with golf course fungicide use.	1.5	2	Soil	NA	0-0.5, 1-1.5	X										
SS-41	Delineation of mercury impacts associated with golf course fungicide use.	1.5	2	Soil	NA	0-0.5, 1-1.5	X										
SS-42	Delineation of mercury impacts associated with golf course fungicide use.	1.5	2	Soil	NA	0-0.5, 1-1.5	X										
SS-43	Delineation of mercury impacts associated with golf course fungicide use.	1.5	2	Soil	NA	0-0.5, 1-1.5	X										
SS-44	Delineation of mercury impacts associated with golf course fungicide use.	1.5	2	Soil	NA	0-0.5, 1-1.5	X										
SS-45	Delineation of mercury impacts associated with golf course fungicide use.	1.5	2	Soil	NA	0-0.5, 1-1.5	X										
SS-46	Delineation of mercury impacts associated with golf course fungicide use.	1.5	2	Soil	NA	0-0.5, 1-1.5	X										
SS-47	Delineation of mercury impacts associated with golf course fungicide use.	1.5	2	Soil	NA	0-0.5, 1-1.5	X										
SS-48	Delineation of mercury impacts associated with golf course fungicide use.	1.5	2	Soil	NA	0-0.5, 1-1.5	X										
SS-49	Delineation of mercury impacts associated with golf course fungicide use.	1.5	2	Soil	NA	0-0.5, 1-1.5	X										
SS-50	Delineation of mercury impacts associated with golf course fungicide use.	1.5	2	Soil	NA	0-0.5, 1-1.5	X										
SS-51	Delineation of mercury impacts associated with golf course fungicide use.	1.5	2	Soil	NA	0-0.5, 1-1.5	X										
MW-3	New permanent well in south portion of Site for coverage	TBD	1	Water	Discrete	TBD2					X						
Maintenance Well	Well near maintenance/agricultural chemical storage building	NA	**1**	Water	NA	Static Water					X			X	X	X	X
Irrigation Well	Irrigation well at former golf course	NA	1	Water	NA	Static Water					X			X	X		
Additional Greens/Tee boxes/Fairways	Per MDA request	1.5	2	Soil	NA	0-0.5, 1-1.5	X										
Quality Control	Soil Blind Field Duplicates	NA	5	Soil	NA	TBD[2]	X		X					X	X	X	X
Quality Control	Soil Blind Field Duplicates	NA	15	Soil	NA	TBD[2]	X										
Quality Control	Trip Blanks	NA	3	Water	NA	TBD[2]					X						
Quality Control	Equipment Blank	NA	1	Water	NA	TBD[2]			X	X	X			X		X	X

Abbreviations:
NA - not applicable
TBD - to be determined
WT*- Water Table or 20 feet which ever is first
bgs - below ground surface

VOCs - volatile organic compounds
PAHs - polycyclic aromatic hydrocarbons
DRO = Diesel Range Organics
GRO = Gasoline Range organics
MDA = Minnesota department of Agriculture
TKN = Total Kjeldahl Nitrogen

Notes:

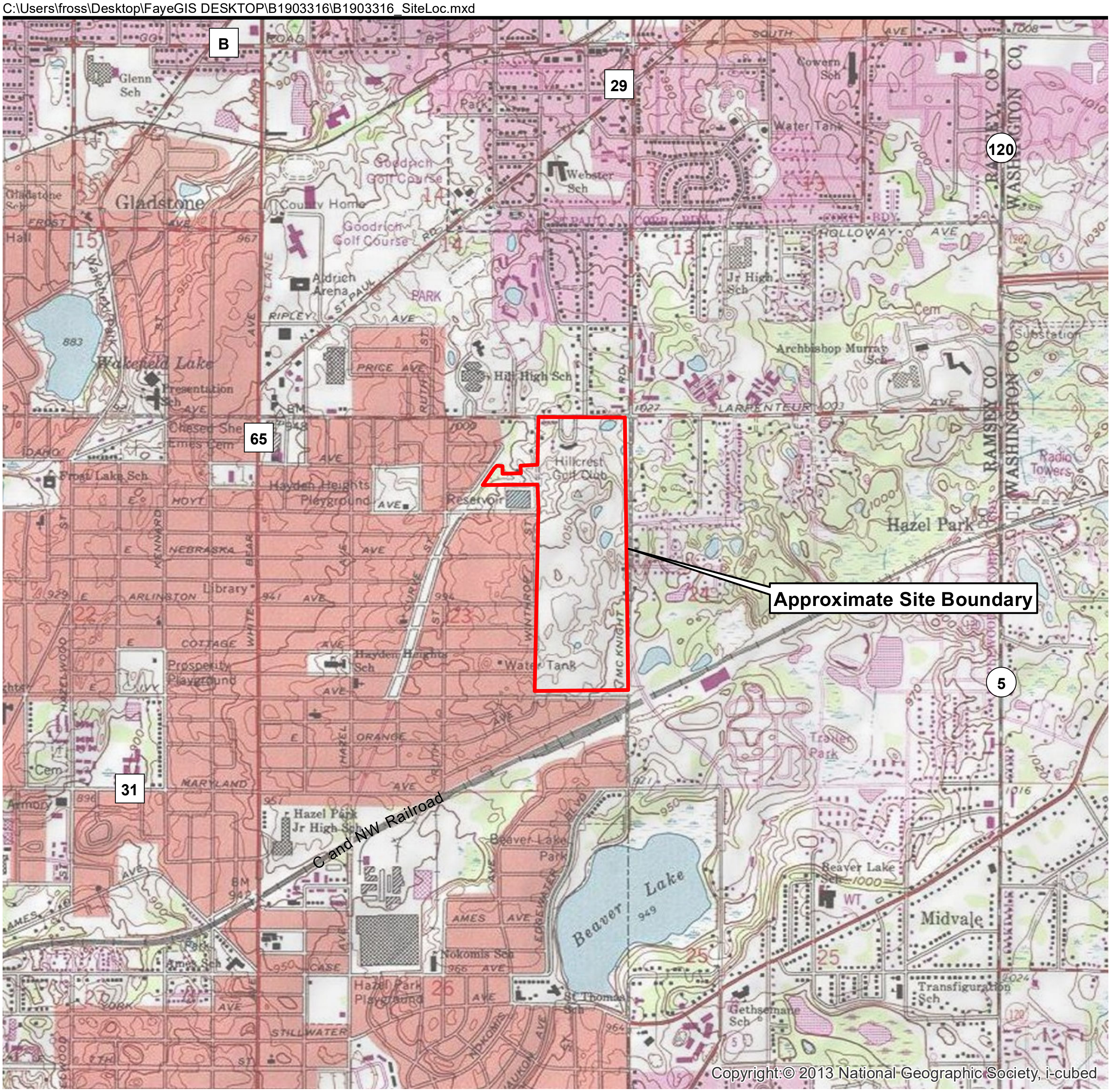
1. Up to 3 soil samples from each soil boring will be collected in the field. The total number of samples that will be analyzed will vary based upon field observations and/or discussion with the MDA project staff.
2. The depth of soil samples collected from borings will be determined in the field based upon field screening for indications of impacts and visual/olfactory observations of soil.

If no potential impacts are observed in soil collected from a soil boring , one sample will be collected from fill soils and one sample will be collected from native soils near the bottom of the boring.

BRAUN INTERTEC

Figures

C:\Users\fross\Desktop\FayeGIS DESKTOP\B1903316\B1903316_SiteLoc.mxd



Approximate Site Boundary

Data Source:
USGS Quadrangle

N

0 1,000 2,000 Feet

BRAUN INTERTEC

The Science You Build On.

11001 Hampshire Avenue S
Minneapolis, MN 55438
952.995.2000
braunintertec.com

Project No:
B1903316

Drawing No:
B1903316_SiteLoc

Drawn By:	FER
Date Drawn:	4/12/2019
Checked By:	MPE
Last Modified:	4/12/2019

Former Hillcrest Golf Course

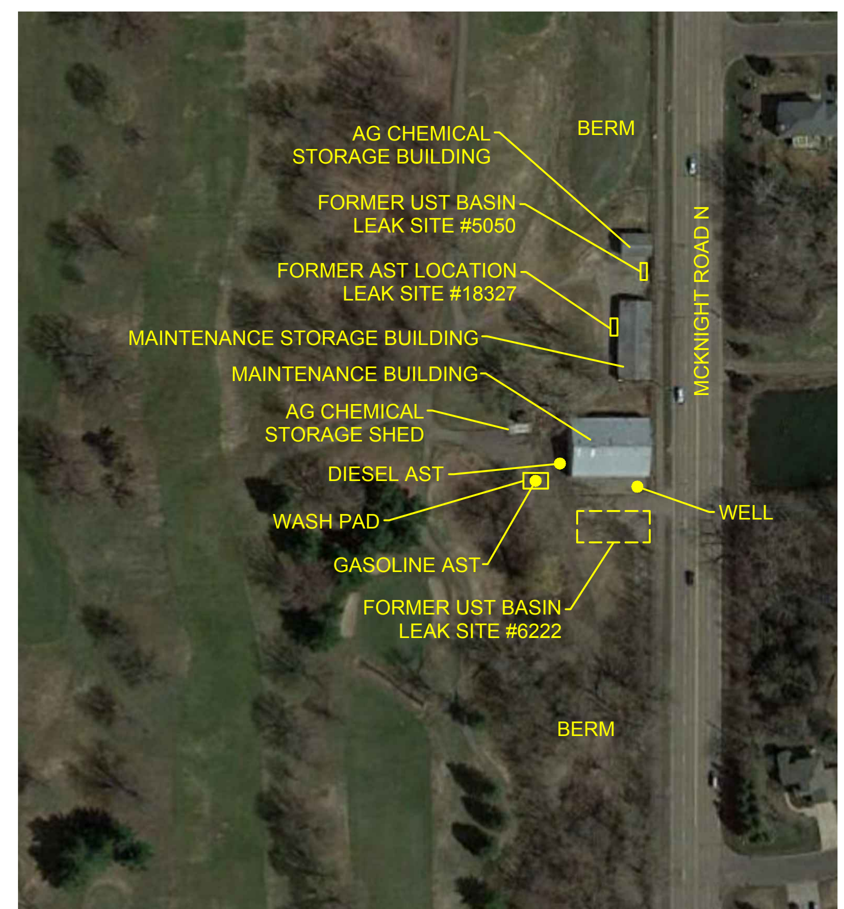
McKnight Road N and Larpenteur Avenue E

St. Paul, Minneosta

Site Location Map

Figure 1

INSET 1: CLUBHOUSE AREA
SCALE: 1" = 120'



INSET 2: MAINTENANCE FACILITY
SCALE: 1" = 200'

250' 0 500'
SCALE: 1"= 500'

BRAUN INTERTEC
The Science You Build On.
11001 Hampshire Avenue S
Minneapolis, MN 55438
952.995.2000
braunintertec.com

Drawing Information

Project No: B1903316

Drawing No: B1903316

Drawn By:	LAO
Date Drawn:	5/15/19
Checked By:	MPE
Last Modified:	6/10/19

Project Information

Former Hillcrest Golf Course

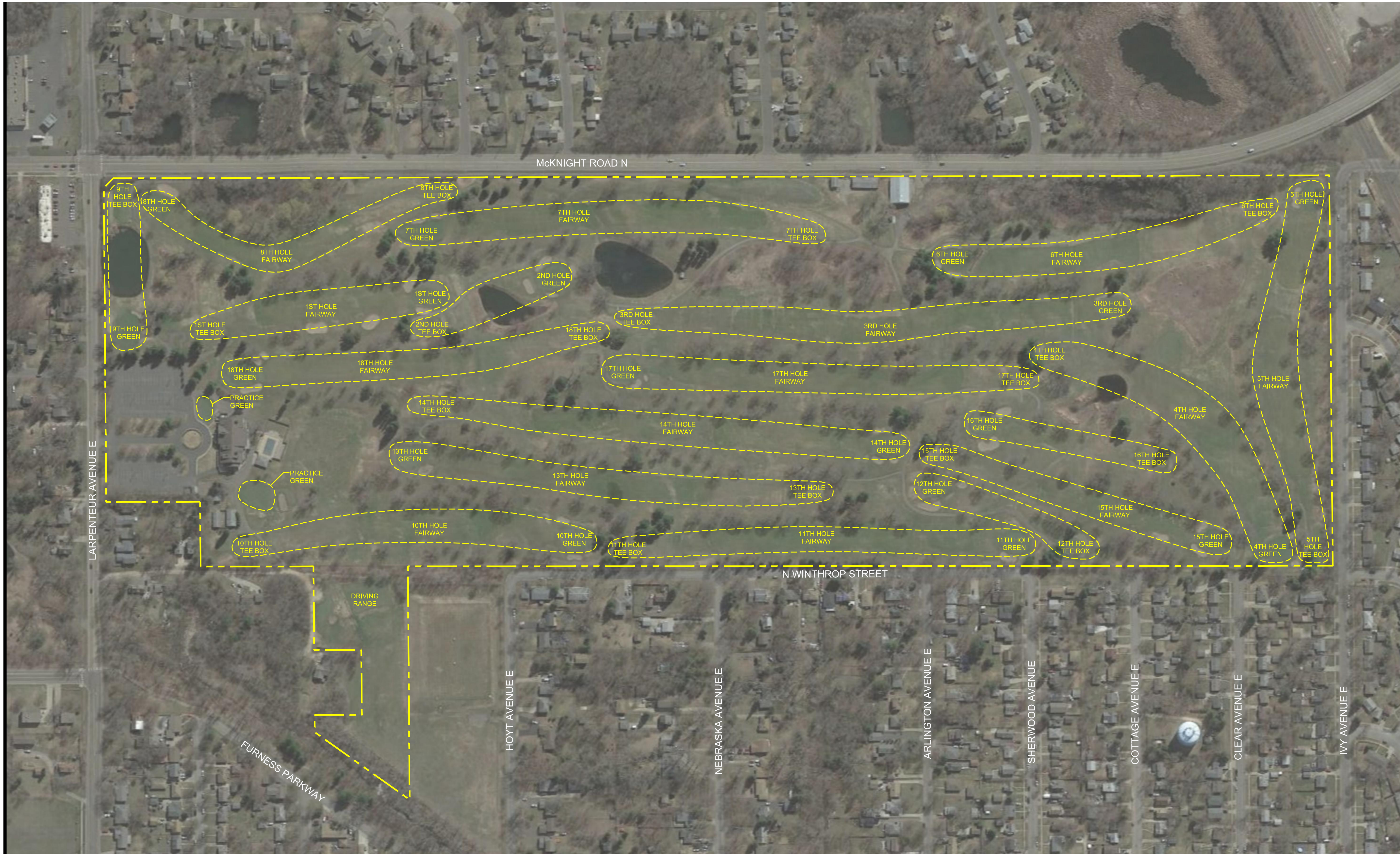
McKnight Road N and Larpenteur Avenue E

St. Paul, Minnesota

Site Diagram

Figure 2

F:\2019\B1903316.dwg,Phase I,6/10/2019 1:40:10 PM



150' 0 300'

SCALE: 1" = 300'

F:\2019\B1903316A.dwg,Overview,6/10/2019 4:13:20 PM

BRAUN INTERTEC
The Science You Build On.

11001 Hampshire Avenue S
Minneapolis, MN 55438
952.995.2000
braunintertec.com

Drawing Information

Project No:
B1903316

Drawing No:
B1903316A

Drawn By:	BJB
Date Drawn:	5/23/19
Checked By:	MK
Last Modified:	6/10/19

Project Information

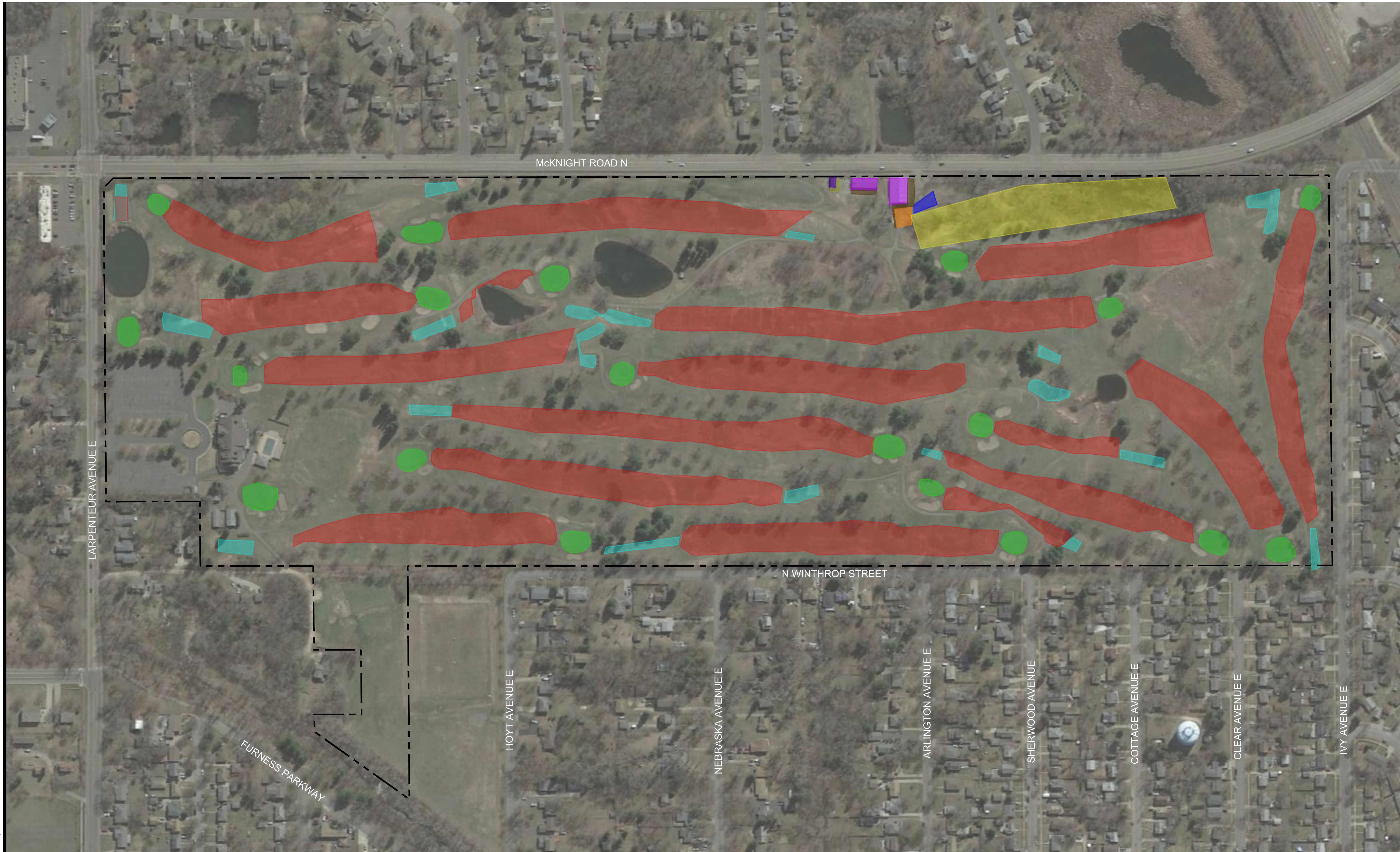
Former Hillcrest Golf Course

2200 Larpenteur Avenue E

Saint Paul, Minnesota

Golf Course Layout

Figure 3



- AGRICULTURAL CHEMICAL STORAGE BUILDINGS LOADING AREAS
- FLOORS IN THE AGRICULTURAL CHEMICAL STORAGE BUILDINGS (2 BUILDINGS)
- PESTICIDE / FERTILIZER STORAGE BUILDING LOADING AREA
- PESTICIDE / FERTILIZER STORAGE BUILDING
- AGRICULTURAL CHEMICAL MIXING / WASHOUT AREA
- DRAINAGE AREA ADJACENT TO MIXING / WASH AREA
- BERMS ON EASTERN PORTION OF PROPERTY
- GOLF GREENS / PRACTICE GREENS CONSTRUCTED BEFORE 1994*
- TEE BOXES
- FAIRWAYS

150' 0 300'

SCALE: 1" = 300'

BRAUN INTERTEC
The Science You Build On.
11001 Hampshire Avenue S
Minneapolis, MN 55438
952.995.2000
braunintertec.com

Drawing Information

Project No:	B1903316.00
Drawing No:	B1903316-00
Drawn By:	BJB
Date Drawn:	2/6/20
Checked By:	MK
Last Modified:	5/7/20

Project Information

Remedial Investigation

Former Hillcrest Golf Course

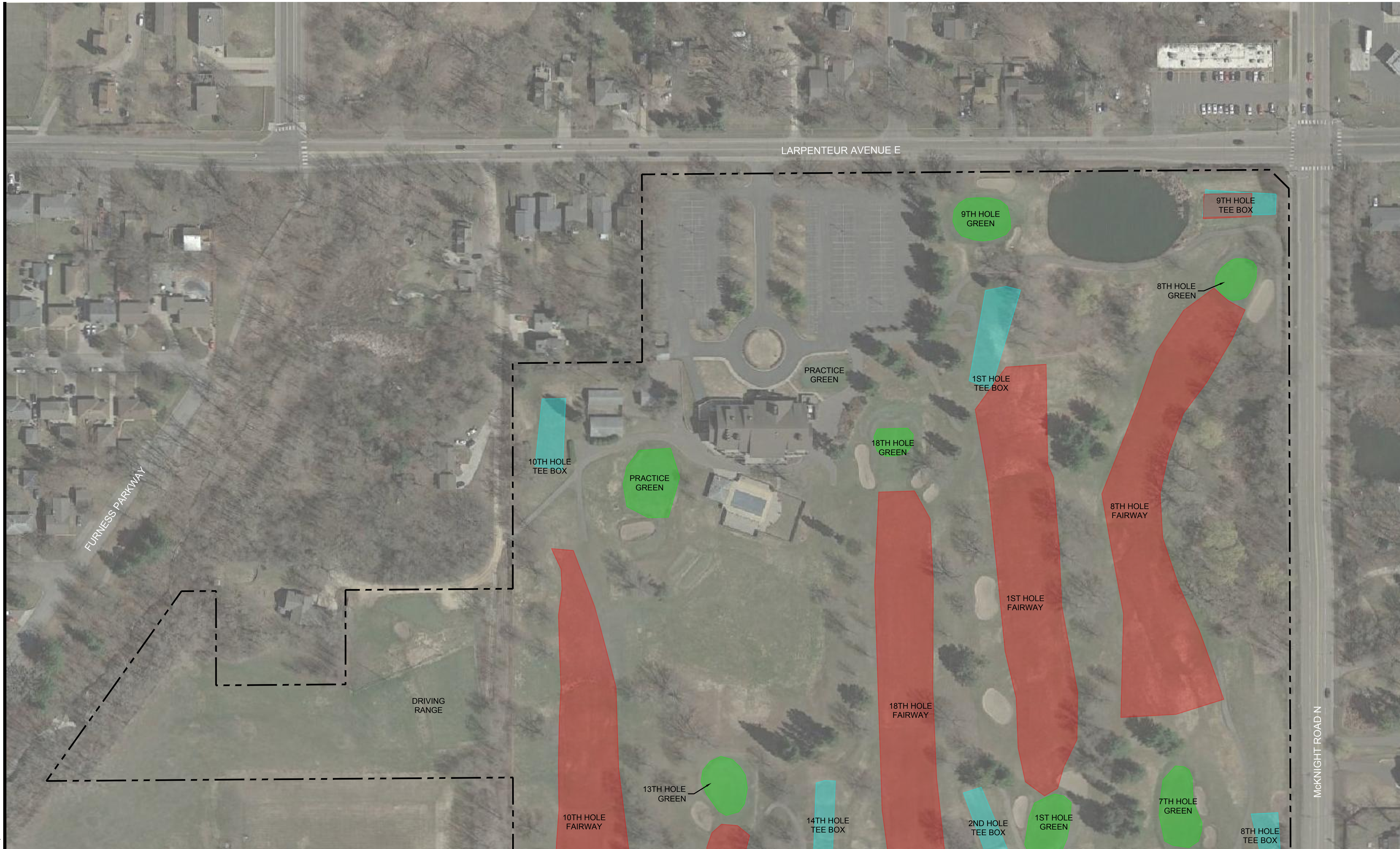
2200 Larpenteur Avenue E

Saint Paul, Minnesota

High Risk Areas - Overview

Figure 4A

F:\2019\B1903316-00.dwg,HRA Overview,5/7/2020 10:49:43 PM



AGRICULTURAL CHEMICAL STORAGE BUILDINGS LOADING AREAS
FLOORS IN THE AGRICULTURAL CHEMICAL STORAGE BUILDINGS (2 BUILDINGS)
PESTICIDE / FERTILIZER STORAGE BUILDING LOADING AREA
PESTICIDE / FERTILIZER STORAGE BUILDING
AGRICULTURAL CHEMICAL MIXING / WASHOUT AREA
DRAINAGE AREA ADJACENT TO MIXING / WASH AREA
BERMS ON EASTERN PORTION OF PROPERTY
GOLF GREENS / PRACTICE GREENS CONSTRUCTED BEFORE 1994*
TEE BOXES
FAIRWAYS

75' 0 150'
SCALE: 1" = 150'

F:\2019\B1903316-00.dwg,HRA Detail N,5/7/2020 10:49:44 PM

BRAUN INTERTEC
The Science You Build On.
11001 Hampshire Avenue S
Minneapolis, MN 55438
952.995.2000
braunintertec.com

Drawing Information

Project No: B1903316.00
Drawing No: B1903316-00
Drawn By: BJB
Date Drawn: 2/6/20
Checked By: MK
Last Modified: 5/7/20

Project Information

Remedial Investigation

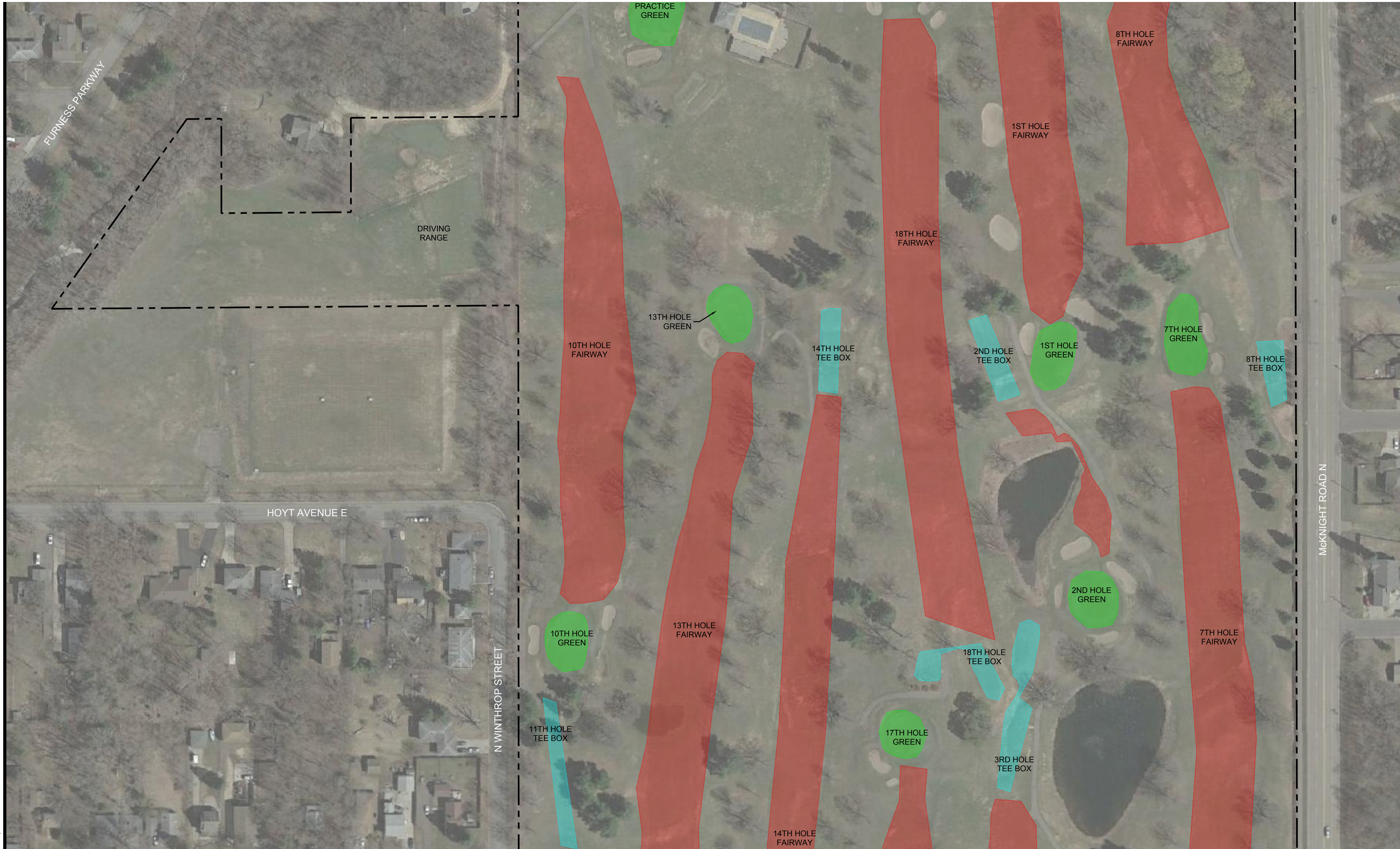
Former Hillcrest Golf Course

2200 Larpenteur Avenue E

Saint Paul, Minnesota

High Risk Areas - North

Figure 4B



AGRICULTURAL CHEMICAL STORAGE BUILDINGS LOADING AREAS
FLOORS IN THE AGRICULTURAL CHEMICAL STORAGE BUILDINGS (2 BUILDINGS)
PESTICIDE / FERTILIZER STORAGE BUILDING LOADING AREA
PESTICIDE / FERTILIZER STORAGE BUILDING
AGRICULTURAL CHEMICAL MIXING / WASHOUT AREA
DRAINAGE AREA ADJACENT TO MIXING / WASH AREA
BERMS ON EASTERN PORTION OF PROPERTY
GOLF GREENS / PRACTICE GREENS CONSTRUCTED BEFORE 1994*
TEE BOXES
FAIRWAYS

75' 0 150'

SCALE: 1" = 150'

BRAUN INTERTEC
The Science You Build On.
11001 Hampshire Avenue S
Minneapolis, MN 55438
952.995.2000
braunintertec.com

Drawing Information

Project No:	B1903316.00
Drawing No:	B1903316-00
Drawn By:	BJB
Date Drawn:	2/6/20
Checked By:	MK
Last Modified:	5/7/20

Project Information

Remedial Investigation

Former Hillcrest Golf Course

2200 Larpenteur Avenue E

Saint Paul, Minnesota

High Risk Areas - North Central

Figure 4C

F:\2019\B1903316-00.dwg,HRA Detail NC,5/7/2020 10:49:45 PM

- AGRICULTURAL CHEMICAL STORAGE BUILDINGS LOADING AREAS
- FLOORS IN THE AGRICULTURAL CHEMICAL STORAGE BUILDINGS (2 BUILDINGS)
- PESTICIDE / FERTILIZER STORAGE BUILDING LOADING AREA
- PESTICIDE / FERTILIZER STORAGE BUILDING
- AGRICULTURAL CHEMICAL MIXING / WASHOUT AREA
- DRAINAGE AREA ADJACENT TO MIXING / WASH AREA
- BERMS ON EASTERN PORTION OF PROPERTY
- GOLF GREENS / PRACTICE GREENS CONSTRUCTED BEFORE 1994*
- TEE BOXES
- FAIRWAYS

N

75' 0 150'

SCALE: 1" = 150'

BRAUN INTERTEC
The Science You Build On.
11001 Hampshire Avenue S
Minneapolis, MN 55438
952.995.2000
braunintertec.com

Drawing Information

Project No: B1903316.00

Drawing No: B1903316-00

Drawn By: BJB
Date Drawn: 2/6/20
Checked By: MK
Last Modified: 5/7/20

Project Information

Remedial Investigation

Former Hillcrest Golf Course

2200 Larpenteur Avenue E

Saint Paul, Minnesota

High Risk Areas - Central

Figure 4D

F:\2019\B1903316-00.dwg,HRA Detail C,5/7/2020 10:49:47 PM

AGRICULTURAL CHEMICAL STORAGE BUILDINGS LOADING AREAS
FLOORS IN THE AGRICULTURAL CHEMICAL STORAGE BUILDINGS (2 BUILDINGS)
PESTICIDE / FERTILIZER STORAGE BUILDING LOADING AREA
PESTICIDE / FERTILIZER STORAGE BUILDING
AGRICULTURAL CHEMICAL MIXING / WASHOUT AREA
DRAINAGE AREA ADJACENT TO MIXING / WASH AREA
BERMS ON EASTERN PORTION OF PROPERTY
GOLF GREENS / PRACTICE GREENS CONSTRUCTED BEFORE 1994*
TEE BOXES
FAIRWAYS

BRAUN INTERTEC
The Science You Build On.
11001 Hampshire Avenue S
Minneapolis, MN 55438
952.995.2000
braunintertec.com

Drawing Information

Project No: B1903316.00
Drawing No: B1903316-00
Drawn By: BJB
Date Drawn: 2/6/20
Checked By: MK
Last Modified: 5/7/20

Project Information

Remedial Investigation

Former Hillcrest Golf Course

2200 Larpenteur Avenue E

Saint Paul, Minnesota

High Risk Areas - South Central

Figure 4E

F:\2019\B1903316-00.dwg,HRA Detail SC,5/7/2020 10:49:48 PM

AGRICULTURAL CHEMICAL STORAGE BUILDINGS LOADING AREAS
FLOORS IN THE AGRICULTURAL CHEMICAL STORAGE BUILDINGS (2 BUILDINGS)
PESTICIDE / FERTILIZER STORAGE BUILDING LOADING AREA
PESTICIDE / FERTILIZER STORAGE BUILDING
AGRICULTURAL CHEMICAL MIXING / WASHOUT AREA
DRAINAGE AREA ADJACENT TO MIXING / WASH AREA
BERMS ON EASTERN PORTION OF PROPERTY
GOLF GREENS / PRACTICE GREENS CONSTRUCTED BEFORE 1994*
TEE BOXES
FAIRWAYS

75' 0 150'

SCALE: 1" = 150'

BRAUN INTERTEC
The Science You Build On.
11001 Hampshire Avenue S
Minneapolis, MN 55438
952.995.2000
braunintertec.com

Drawing Information

Project No: B1903316.00

Drawing No: B1903316-00

Drawn By: BJB
Date Drawn: 2/6/20
Checked By: MK
Last Modified: 5/7/20

Project Information

Remedial Investigation

Former Hillcrest Golf Course

2200 Larpenteur Avenue E

Saint Paul, Minnesota

High Risk Areas - South

Figure 4F

F:\2019\B1903316-00.dwg,HRA Detail S,5/7/2020 10:49:49 PM

- SOIL BORING LOCATION
- SOIL BORING / TEMPORARY WELL LOCATION
- SOIL BORING / PERMANENT WELL LOCATION
- MONITORING WELL LOCATION
- AGRICULTURAL CHEMICAL SOIL BORING LOCATION
- TEST TRENCH LOCATION
- SHALLOW HAND AUGER BORING LOCATION
- WELL LOCATION
- SURFACE WATER SAMPLE

BRAUN INTERTEC
The Science You Build On.
11001 Hampshire Avenue S
Minneapolis, MN 55438
952.995.2000
braunintertec.com

Drawing Information

Project No:	B1903316.00
Drawing No:	B1903316-00
Drawn By:	BJB
Date Drawn:	2/6/20
Checked By:	MK
Last Modified:	6/8/20

Project Information

Remedial Investigation

Former Hillcrest Golf Course

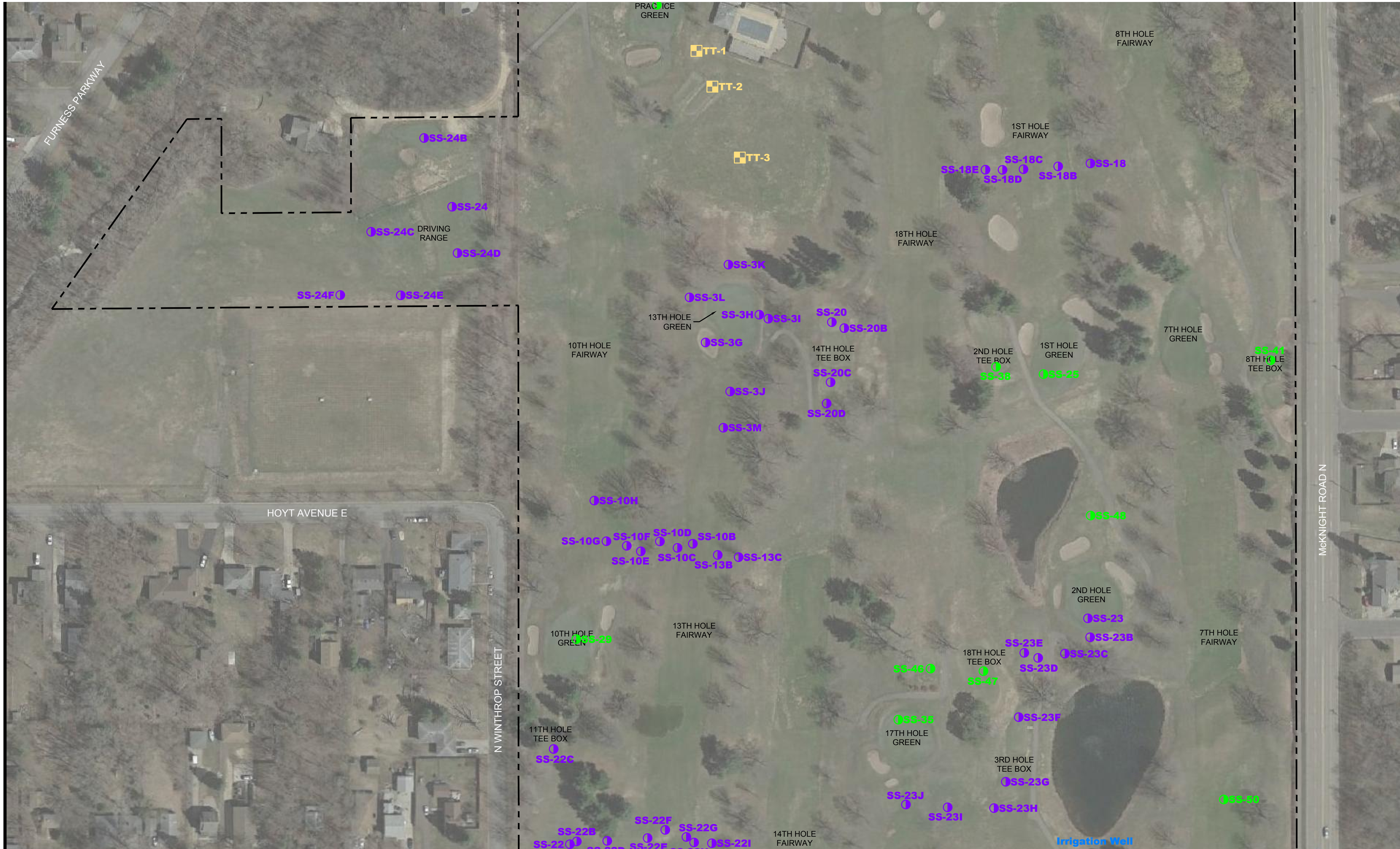
2200 Larpenteur Avenue E

Saint Paul, Minnesota

Sampling Locations - North

Figure 5A

F:\2019\B1903316-00.dwg,Detail N,6/8/2020 6:59:36 AM



SOIL BORING LOCATION
SOIL BORING / TEMPORARY WELL LOCATION
SOIL BORING / PERMANENT WELL LOCATION
MONITORING WELL LOCATION
AGRICULTURAL CHEMICAL SOIL BORING LOCATION
TEST TRENCH LOCATION
SHALLOW HAND AUGER BORING LOCATION
WELL LOCATION
SURFACE WATER SAMPLE

75' 0 150'
SCALE: 1" = 150'

F:\2019\B1903316-00.dwg,Detail NC,6/8/2020 7:00:03 AM

BRAUN INTERTEC
The Science You Build On.
11001 Hampshire Avenue S
Minneapolis, MN 55438
952.995.2000
braunintertec.com

Drawing Information

Project No:
B1903316.00

Drawing No:
B1903316-00

Drawn By:	BJB
Date Drawn:	2/6/20
Checked By:	MK
Last Modified:	6/8/20

Project Information

Remedial Investigation

Former Hillcrest Golf Course

2200 Larpenteur Avenue E

Saint Paul, Minnesota

Sampling Locations - North Central

Figure 5B

SOIL BORING LOCATION

SOIL BORING / TEMPORARY WELL LOCATION

SOIL BORING / PERMANENT WELL LOCATION

MONITORING WELL LOCATION

AGRICULTURAL CHEMICAL SOIL BORING LOCATION

TEST TRENCH LOCATION

SHALLOW HAND AUGER BORING LOCATION

WELL LOCATION

SURFACE WATER SAMPLE

N

75' 0 150'

SCALE: 1" = 150'

F:\2019\B1903316-00.dwg,Detail C,6/8/2020 7:00:35 AM

BRAUN INTERTEC
The Science You Build On.
11001 Hampshire Avenue S
Minneapolis, MN 55438
952.995.2000
braunintertec.com

Drawing Information

Project No:
B1903316.00

Drawing No:
B1903316-00

Drawn By:	BJB
Date Drawn:	2/6/20
Checked By:	MK
Last Modified:	6/8/20

Project Information

Remedial Investigation

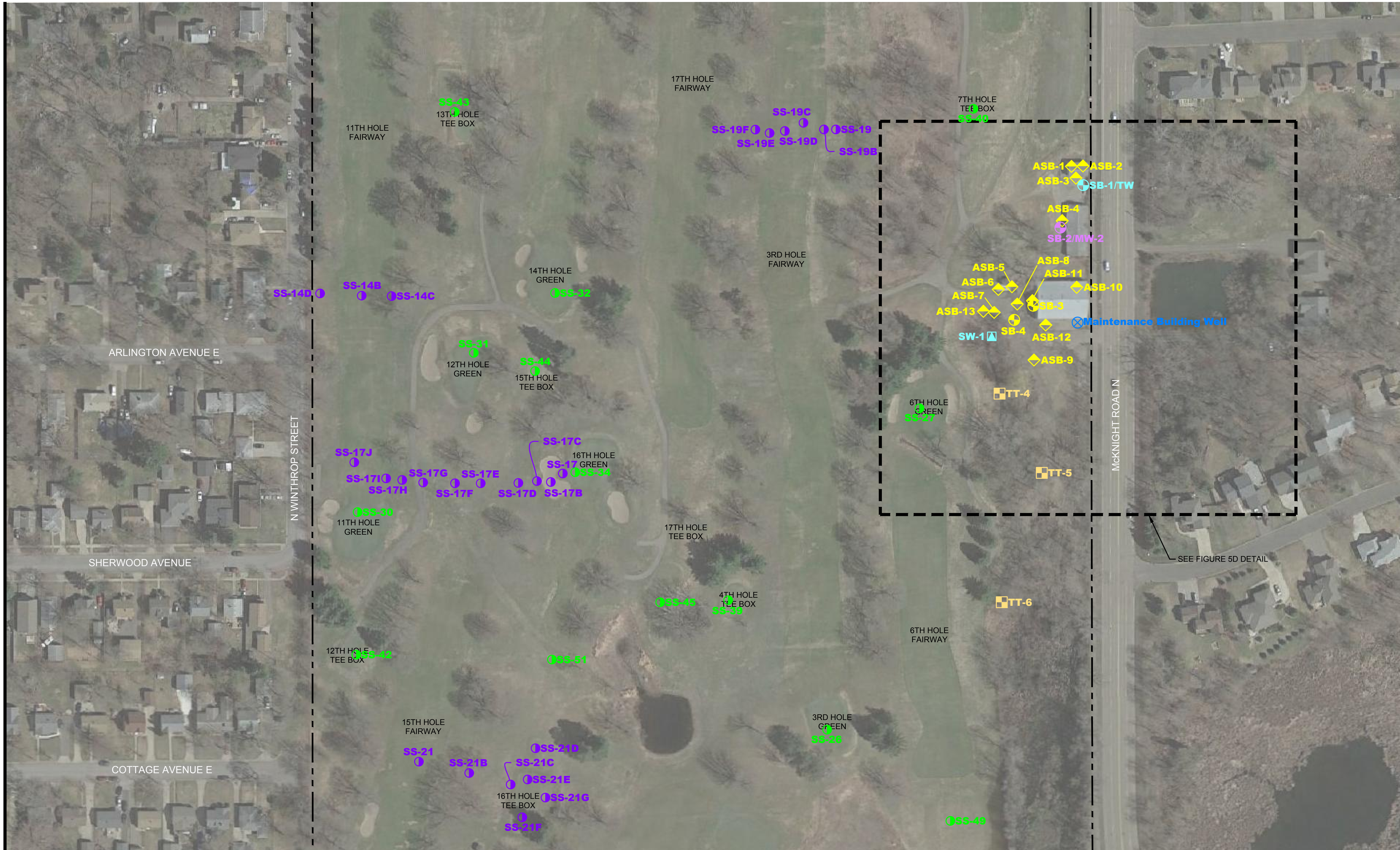
Former Hillcrest Golf Course

2200 Larpenteur Avenue E

Saint Paul, Minnesota

Sampling Locations - Central

Figure 5C



- SOIL BORING LOCATION
- SOIL BORING / TEMPORARY WELL LOCATION
- SOIL BORING / PERMANENT WELL LOCATION
- MONITORING WELL LOCATION
- AGRICULTURAL CHEMICAL SOIL BORING LOCATION
- TEST TRENCH LOCATION
- SHALLOW HAND AUGER BORING LOCATION
- WELL LOCATION
- SURFACE WATER SAMPLE

N

75' 0 150'

SCALE: 1" = 150'

F:\2019\B1903316-00.dwg,Detail SC,6/8/2020 7:01:14 AM

BRAUN INTERTEC
The Science You Build On.
11001 Hampshire Avenue S
Minneapolis, MN 55438
952.995.2000
braunintertec.com

Drawing Information

Project No:	B1903316.00
Drawing No:	B1903316-00
Drawn By:	BJB
Date Drawn:	2/6/20
Checked By:	MK
Last Modified:	6/8/20

Project Information

Remedial Investigation

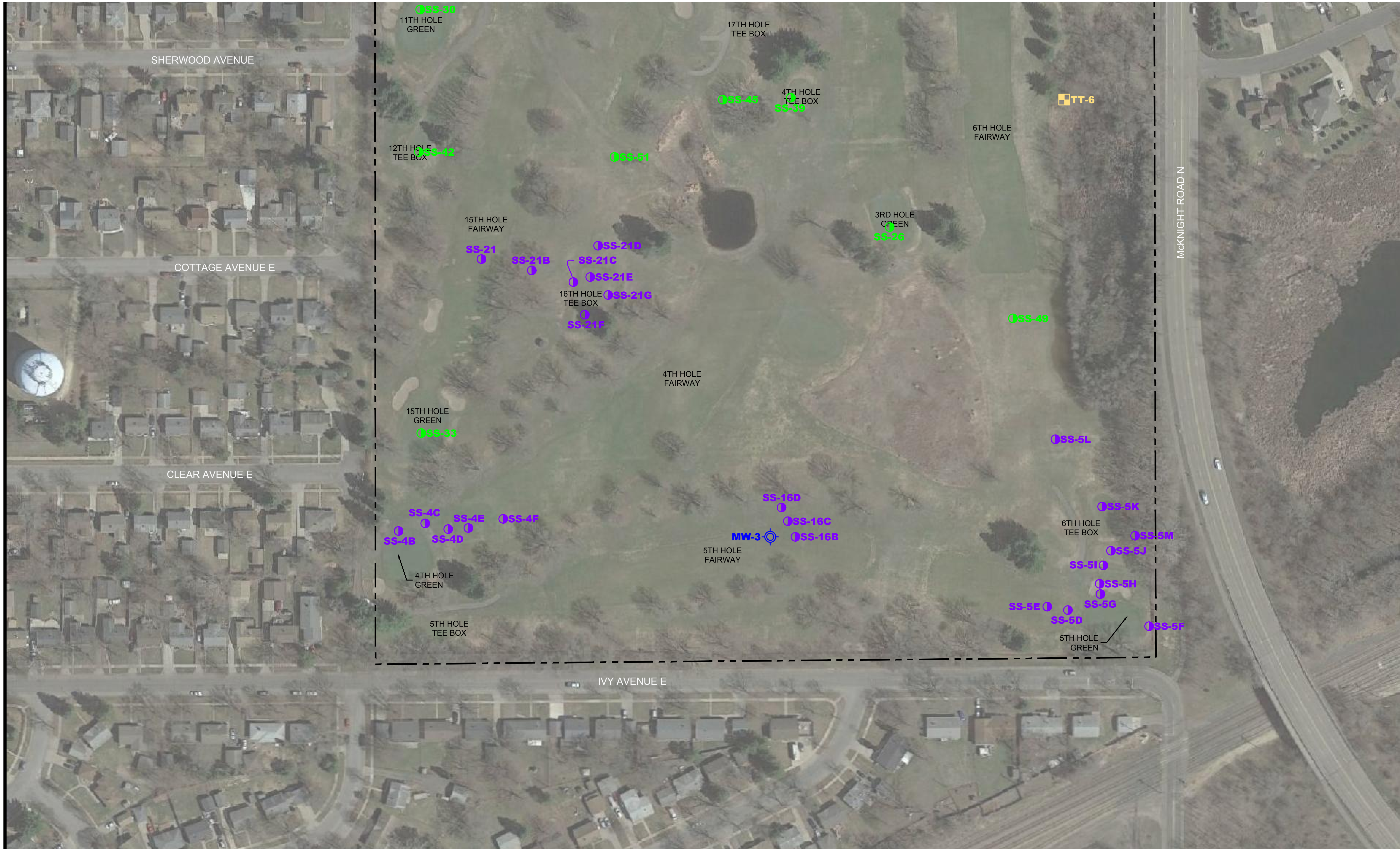
Former Hillcrest Golf Course

2200 Larpenteur Avenue E

Saint Paul, Minnesota

Sampling Locations - South Central

Figure 5D



- SOIL BORING LOCATION
- SOIL BORING / TEMPORARY WELL LOCATION
- SOIL BORING / PERMANENT WELL LOCATION
- MONITORING WELL LOCATION
- AGRICULTURAL CHEMICAL SOIL BORING LOCATION
- TEST TRENCH LOCATION
- SHALLOW HAND AUGER BORING LOCATION
- WELL LOCATION
- SURFACE WATER SAMPLE

N

75' 0 150'

SCALE: 1" = 150'

BRAUN INTERTEC
The Science You Build On.

11001 Hampshire Avenue S
Minneapolis, MN 55438
952.995.2000
braunintertec.com

Drawing Information

Project No:	B1903316.00
Drawing No:	B1903316-00
Drawn By:	BJB
Date Drawn:	2/6/20
Checked By:	MK
Last Modified:	6/8/20

Project Information

Remedial Investigation

Former Hillcrest Golf Course

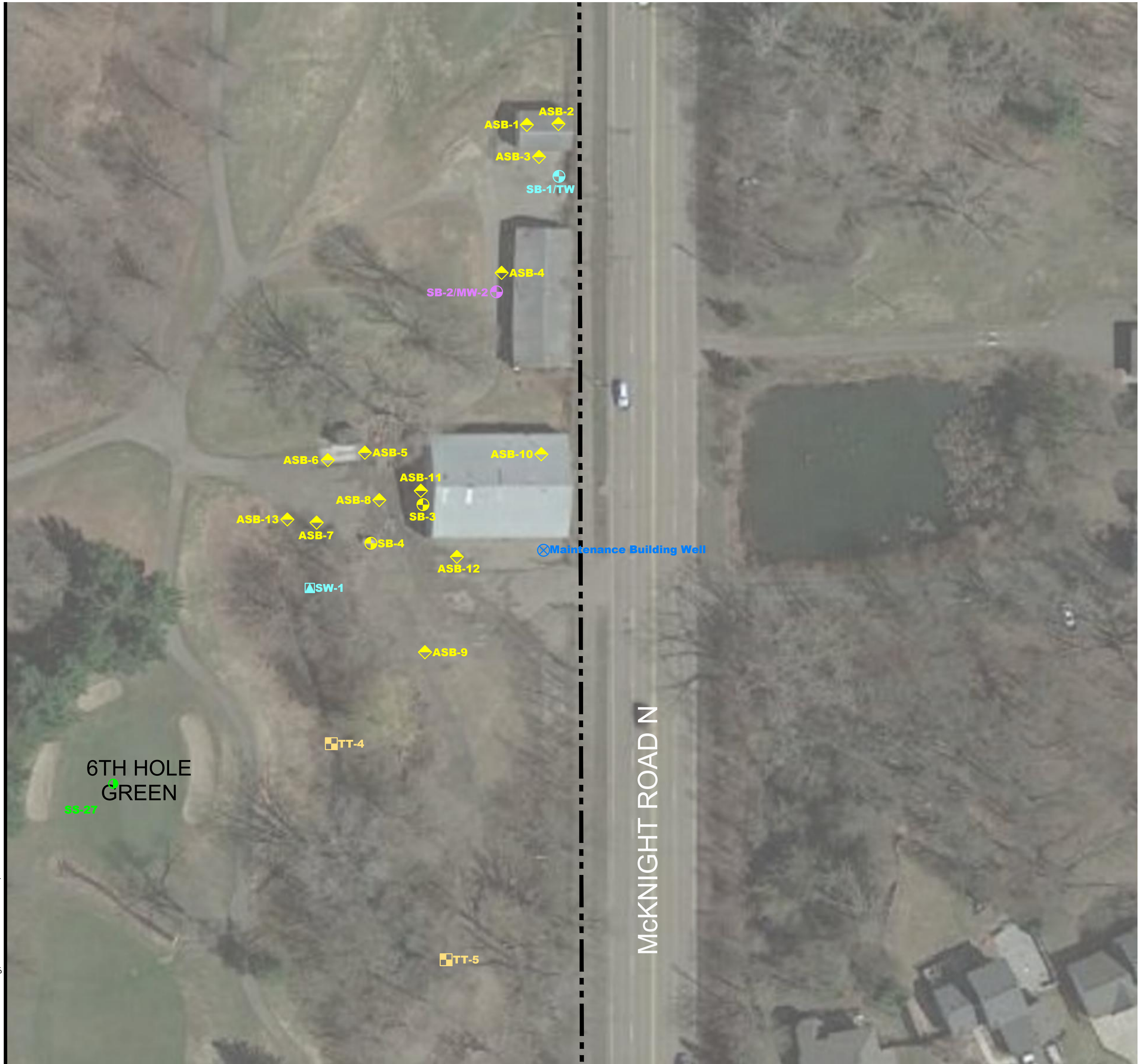
2200 Larpenteur Avenue E

Saint Paul, Minnesota

Sampling Locations - South

Figure 5E

F:\2019\B1903316-00.dwg,Detail S,6/8/2020 7:01:47 AM



SOIL BORING LOCATION
SOIL BORING / TEMPORARY WELL LOCATION
SOIL BORING / PERMANENT WELL LOCATION
AGRICULTURAL CHEMICAL SOIL BORING LOCATION
TEST TRENCH LOCATION
WELL LOCATION
SURFACE WATER SAMPLE

30' 0 60'
SCALE: 1" = 60'

BRAUN INTERTEC
The Science You Build On.
11001 Hampshire Avenue S
Minneapolis, MN 55438
952.995.2000
braunintertec.com

Drawing Information

Project No:	B1903316.00
Drawing No:	B1903316-00
Drawn By:	BJB
Date Drawn:	2/6/20
Checked By:	MK
Last Modified:	6/8/20

Project Information

Remedial Investigation

Former Hillcrest Golf Course

2200 Larpenteur Avenue E

Saint Paul, Minnesota

Sampling Locations - South Central Detail Area

Figure 5D Detail

F:\2019\B1903316-00.dwg,Detail SC - Detail Area,6/8/2020 7:19:55 AM

Appendix A

Standard Operating Procedures (SOPs)

A. Purpose

The objective of this Standard Operating Procedure (SOP) is to establish a consistent method and format for the use and control of documentation generated during field activities. Field notes, records, and photographs are intended to provide sufficient information that can be used to recreate the field activities and collection of environmental data. The information placed in these documents and/or records should be factual, detailed, and free of personal opinions.

A.1. Scope and Applicability

This SOP is applicable to Phase I Environmental Site Assessments (ESAs), Phase II ESAs, remedial investigations, and Response Action Plan (RAP) implementation. Documentation includes Field Report Form, additional field forms that are part of method SOPs, and photographs.

A.2. Personnel Responsibilities

The project manager (or designee) is responsible for properly preparing field personnel to perform the field work and to oversee that field documentation is collected in accordance with this SOP, site-specific or project-specific planning documents, and other applicable SOPs.

Field personnel are responsible for understanding and implementing this SOP during field activities, as well as completing appropriate Field Report Form to properly document the field activities. Field observations should be discussed with the project manager on a daily basis. If conditions change from initial expectations, a call should also be made to the project manager. Field personnel should document field activities and record field measurements as they occur and complete documentation prior to leaving the site. Field personnel are responsible for tracking the location of field documentation. Field personnel are responsible for preserving original documentation until it is provided to the project manager and placed into the permanent file or archived. Field personnel are responsible for distributing copies (or electronically preserving copies) of the documentation in a timely manner.

B. Health and Safety

Field work should be performed in accordance with the *Braun Intertec Corporate Health and Safety Manual Standard Operating Procedures* and the site-specific health and safety plan (HASP), if applicable.

C. Referenced SOPs

- None

D. Equipment and Supplies

- Field Report Form (see Attachment A) or field logbook
- Waterproof and/or indelible ink pens
- Cell phone camera or digital camera

E. Procedure

This SOP primarily addresses documentation using the Field Report Form (see Attachment A) or field logbook. However, procedures discussed in this SOP are applicable to other types of field documentation collected. Other field records and forms (e.g., soil boring logs, Chain-of-Custody records, water sample collection records, soil vapor monitoring forms) are discussed in the specific SOP associated with that particular activity and are not described in this SOP.

E.1. Field Report Form

Field personnel will keep accurate written records of their daily activities in chronological order on a Field Report Form that will be sufficient to recreate the project field activities without reliance on memory. Entries should be legible and written in black, waterproof or indelible ink. Each page should be numbered sequentially, dated, and signed by the field author. There should be no blank lines on a page. If only part of a page is used, the remainder of the page should have an "X" drawn over it. The completion of each day's work and the end of the field project should be clearly indicated with "END DAY" or "END FIELD INVESTIGATION."

If pre-printed adhesive labels or other added information are glued or taped onto a Field Report Form, the note taker should sign the addition. The signature should begin on the addition and extend onto the Field Report Form page so that the addition cannot be removed without detection.

At a minimum the following information should be recorded for each project:

- Site/project name
- Site location
- Site project number
- Name of project manager
- Full name of Field Report Form author
- Names of other Braun Intertec personnel on site and their role (full name and initials)
- Name of subcontractors performing work for Braun Intertec (or whose work Braun Intertec is monitoring) and the full name and phone number of their site superintendent

At a minimum, the following information should be recorded each day:

- Date
- Purpose of the day's activities
- Pertinent weather conditions (temperature, precipitation events, wind direction and speed, general air quality, particularly any ambient odors). Significant weather changes during the day should be noted
- Full name and initials of Field Report Form author, if different from previous day
- Full name and initials of other Braun Intertec personnel on site and their role, if different from previous day
- Documentation of exclusion zone setup and decontamination procedures, if applicable
- Record safety related monitoring information, including the time and location of the measurements or observations
- If not Level D, record the Personal Protective Equipment (PPE) level in which work is conducted and change in levels and the reason for the change

- Names, phone numbers, and affiliation of all site visitors and their reason for visiting, as well as their time of arrival(s) and departure(s). The project manager should be notified immediately if regulators (e.g., Minnesota Pollution Control Agency [MPCA], Environmental Protection Agency [EPA], Occupational Safety & Health Administration [OSHA]) visit the site. [Note: "all site visitors" means those who are inspecting or observing our work or the work we are overseeing. It is not intended to include unrelated site activities or personnel.]
- Persons contacted, name, and reason for contact, and decisions made. If the person contacted is not Braun Intertec personnel, also record the phone number.

E.2. Environmental Media Sampling Data

The information below should be recorded on specific forms if they are required by the data collection method SOP, but use of the form should be documented on the Field Report Form. The following information should be recorded:

- A chronological description of field observations and sampling events (i.e., date and time)
- Sampling locations (referenced/scaled drawings or global positioning system [GPS] coordinates, if not logged) should be identified. The project manager should provide the sample nomenclature system to the field personnel for consistency and continuity on sites with multiple rounds of data collection.
- Specific data associated with sample acquisition (e.g., field parameter measurements, field screening data, and HASP monitoring data)
- Source of samples, matrix, sample identification, sample container types and preservatives (including ice), field quality assurance/quality control sample collection, preparation, and origin
- Conditions that could adversely impact samples, such as smoke, wind, rain, or dust
- Make, model, and serial number of field instruments should be recorded in the Field Report Form or in a separate calibration log along with calibration data
- Deviations from the work plan and/or SOPs
- Sketches or scaled diagrams
- Process diagrams
- Waste generated and management methods (i.e., investigation derived waste [IDW]).

E.3. Sketches and Scaled Diagrams

Draw a site map using accurate measurements or make notes on a photocopy of an existing site map. The site map should include:

- Site boundaries (or features such as street curbs, fence lines, etc., that can later be related to site boundaries)
- Street names or other references that can be related to a site location map
- Investigation and well locations with dimensions to site landmarks
- Major structures with dimensions
- North arrow
- Scale
- Date
- Initials of field personnel

E.4. Photographs

Subject

Photographs should be taken to document existing conditions pertinent to the subject evaluation or remediation at a project site. Except when specifically required, it is unnecessary to photograph processes that are described by SOPs, but rather photograph the results of the process. **Note: Some restrictions may apply regarding Site photographic documentation.**

Composition

The three most common mistakes to avoid in providing photographic documentation are (1) too few photographs, (2) poor quality photographs, and (3) lack of subject identification in photographs. Photographic documentation should tell the story with as little need for narrative as possible.

When photographing several similar subjects or details that are not necessarily well identified in an establishing shot, such as a test excavations or test excavation spoil piles, it is recommended that you place a clip board with an identifying description in at least the first in the sequence of photographs of that subject or detail.

Scale

Where there are insufficient objects of widely known scale in a photograph, one should be placed in the photograph to provide scale. Some examples include a coin, ruler, clipboard, or cell phone.

Photographic Log

The following information should be recorded in the Field Report Form or field logbook:

- Site name, location, and field task
- Name of photographer
- Date and time the photograph was taken (verify the date/time stamp is correct if using a digital camera)
- Sequential number of the photograph
- Brief description of the subject of the photograph
- Site plan or site sketch showing the location from which the photograph was taken and the direction the photographer was facing.

E.5. Additional Field Forms/Records

Additional field records may be required for some field events. As an example, these may include soil boring logs during drilling, well construction and development records, groundwater purge and sample collection records, water level measurement records, instrument calibration records, sample container labels, sample container security tags and seals, Chain-of-Custody forms, field equipment calibration and maintenance logs and commercial shipping manifests. Use of these records described in the SOPs associated with the particular activity.

Prior to beginning field activities, field personnel will coordinate with the project manager, or designee, to determine which SOPs will be used and identify additional field forms that are required. These additional records will be maintained in a field file throughout the duration of the field activities. Copies of the records will be forwarded to the project manager (or designee) on a daily basis, if practical to do so.

E.6. Corrections

If an error is made in an entry in the field records, corrections will be made by drawing a SINGLE straight line through the error, entering the correct information, initialing, and dating the change. Materials that obliterate the original information, such as correction fluids, tapes or markers are prohibited. If the reason for the change is not obvious, provide a brief explanation.

E.7. Data and Records Management

Field records should be forwarded to the project manager or designated staff on a daily basis, if practical. The project manager should review progress and results in detail on a daily basis and evaluate the quality of the documentation. The field personnel should scan the field records and place them in the project folder in OnBase. This preserves documentation in the event that the Field Report Form is lost, stolen, or damaged. Copies of the field notes should be maintained in accordance with the Braun Intertec Records Retention Policy and Procedures. Photographs should be uploaded to the EnCon DRAFTS project folder as soon as possible.

Individual logbooks may be assigned to large projects. These logbooks will be returned to the project manager at the completion of field work and archived with the project file. Logbooks assigned to individual personnel for recording multiple project information from multiple projects should be provided to the designated EnCon project assistant for archiving when the logbooks are filled. Each logbook should have a table of contents (TOC) and be kept up to date by the personnel to which the book is assigned.

The TOC for each logbook should list the project names and locations, project numbers, inclusive dates and logbook page numbers.

E.8. Quality Assurance/Quality Control

All personnel that perform field work will be trained in the use of this SOP. Project managers or project staff who use the field notes for interpreting data and preparing reports should provide immediate feedback to those recording field information to reinforce conformance with the SOP and correct deficiencies. Periodic random audits of all field personnel documentation will be performed by the quality assurance (QA) manager or designees.

F. References

U.S. Environmental Protection Agency, Region 4, Science and Ecosystem Support Division, Athens, Georgia, Operating Procedure: Logbooks, SESDPROC-010-R3, October 31, 2007.

BRAUN INTERTEC

Field Report Form

Project No.:		Date:			
Project Name:		Personnel:			
Location:		Time On Site:		Time Off Site:	
☐ Photos taken and documented.		Project Manager:			

Other Braun Intertec Staff:

Weather (temperature, wind speed and direction, etc.):

Other Personnel (subcontractors, site superintendent, etc.; include time on site and time off site):

PPE and Field Equipment Used (e.g., PID; include ID numbers, calibration information, etc.):

Work Completed (include field scope, unexpected issues, action items, log of communication, and site sketch):

Signature:

BRAUN INTERTEC

Field Report Form

Project No.:		Date:	
Project Name:		Personnel:	
Location:		Project Manager:	

Work Completed (include field scope, unexpected issues, action items, log of communication, and site sketch):

Signature:

A. Purpose

The objective of this Standard Operating Procedure (SOP) is to establish a consistent method and format for visual identification and description of soil samples collected in the field. This SOP is applicable to soil samples collected during completion of soil borings (see SOP 203 – Soil Boring Observation and Sampling) and test trench excavations (see SOP 211 – Test Pit and Test Trench Observation and Sampling).

B. Health and Safety

Field work should be performed in accordance with the Braun Intertec Corporate Health and Safety Manual Standard Operating Procedures and the site-specific health and safety plan (HASP).

C. Referenced SOPs

- SOP 101 – Field Notes and Documentation
- SOP 203 – Soil Boring Observation and Sampling
- SOP 207 – Use of Hand Auger
- SOP 208 – Soil Grab Sample Collection
- SOP 209 – Soil Composite Sample Collection
- SOP 210 – Soil Stockpile Sampling
- SOP 211 – Test Pit and Test Trench Observation and Sampling
- SOP 301 – Water Level Measurement

D. Equipment and Supplies

- Soil boring or test trench log forms (see SOP 203 – Soil Boring Observation and Sampling, SOP 207 – Use of Hand Auger or SOP 211 – Test Pit and Test Trench Observation and Sampling)
- Field Report Form (see SOP 101 – Field Notes and Documentation) or field logbook
- Waterproof and/or indelible ink pens
- Field Guide for Soil and Stratigraphic Analysis, V. 2, Midwest Geosciences Group Press (Field Guide)
- (Optional, but preferred) Munsell® Soil Color Book or Munsell® Soil Color Pages (Soil Color Chart)

E. Procedure

As soil samples are collected in the field, a visual identification and description will be completed as described below. The Standard Practice for Description and Identification of Soils (American Society for Testing and Materials [ASTM] D2488-17) was used to prepare this SOP, and soil descriptions should follow that document as applicable.

When visually describing soils in the field, the following information should be provided at a minimum; however, more detailed descriptions are encouraged.

Prepare the soil description **in the order shown**, separated by commas. All field personnel should have a laminated copy of the Field Guide and use it for classification of soil.

E.1. Main Soil

A description of the main soil group name using the United Soil Classification System (USCS) nomenclature (e.g., gravel, sand, silt, clay, silty sand, clayey sand, organic soil, etc.).

E.2. Group Symbol

List the Group Symbol in parenthesis after the main soil group name. Group symbols include the following:

- SP = Well Graded Sand/Poorly Graded Sand
- SP-SM = Poorly Graded Sand with Silt
- SP-SC = Poorly Graded Sand with Clay
- SM = Silty Sand
- SC = Clayey Sand
- ML = Silt; Silt with Sand
- CL = Lean Clay; Lean Clay with Sand
- CH = Fat Clay
- GP = Well Graded Gravel/Poorly Graded Gravel
- GP-SM = Poorly Graded Gravel with Silt
- GP-SC = Poorly Graded Gravel with Clay
- GM= Silty Gravel
- GC = Clayey Gravel
- OL = Organic Clay
- OH = Organic Silt
- PT = Peat

E.3. Grain Size for Sand and Gravel

If the soil is coarse-grained (i.e., sand or gravel), include a brief description of the predominant particle grain size(s) (e.g., fine, medium, coarse) (see Field Guide).

E.4. Inclusions

Describe the percentage by volume of the soil type(s) present in the sample using ASTM adjectives based on the percentages present within the sample:

- Trace = < 5%
- Few = 5 to 10%
- Little = 10 to 25%
- Some = 30 to 45%
- Mostly = 50 to 100%

Note that whichever soil type is 50% or more of the sample will be the main soil type for Section E.1.

E.5. Unusual Materials or Debris

Note the presence of any unusual materials or debris (e.g., bricks, glass, wood). Include the specific depth interval of the occurrence of unique material in the description or in the Remarks. See SOP 203 – Soil Boring Observation and Sampling, SOP 207 – Use of Hand Auger, SOP 210 – Soil Stockpile Sampling, and SOP 211 – Test Pit and Test Trench Observation and Sampling for additional information.

Waste/debris terminology should be as specific and descriptive as possible (e.g., concrete and glass vs. demolition debris). Category names of waste/debris should not be used. Imprecise or incorrect terminology may cause undue concern among regulators. Several important distinctions should be drawn:

- **Wood:** The term wood should not be used alone. Differentiate between tree/brush waste and lumber. To the extent feasible, lumber should be further qualified as unadulterated or treated and the type of treatment described (e.g., painted, green treated, brown treated, creosote, etc.).
- **Debris:** The term debris should not be used alone. Most often, the term is used to refer to demolition debris; however, the distinction should be drawn between demolition debris consisting of road/paving demolition debris and building demolition debris.

    - Note and carefully describe the presence of concrete pieces or blocks, bricks, bituminous/ asphalt, recycled gravel, pipe, or tubing.
    - Asbestos is more frequently associated with building demolition debris; although, it can also be present with road/paving materials, particularly in cementitious utility conduits.
    - Household waste or garbage should be noted as such if present.

- **Sizes/Amounts:** Qualitative terms like small, medium, large, etc., should be avoided in favor of dimensions (i.e., inches, feet, etc.), unless they are defined by ASTM or other commonly understood conventions. When reasonable, descriptions of sizes and approximate volumes should be quantitative (e.g., “3 to 4 feet” or “less than 1 %”) rather than qualitative (e.g., “large”) or semi-quantitative (e.g., “several,” or “a few”).

E.6. Color

Describe the color of the main soil group (e.g., brown, gray, etc.). Preferably, the color should be identified using a Soil Color Chart. The Soil Color Chart is a good resource for characterization of color at sites with complicated geology. The soil color should be described for moist samples along with the color code from the Soil Color Chart in parentheses. If the soil sample contains layers or patches of varying colors (e.g., mottled), this should be noted and representative colors shall be described. If the color described is for dry soils, this must be noted on the log.

Mottling

Mottling is a patchwork of different colors in mineral soil (usually orange or rust against a background of grey or blue) which indicates periods of anaerobic (wet) conditions. If mottling is present, note the fraction of the sample that is mottled (e.g., 1/2 mottled and the color of the mottle).

E.7. Moisture

Describe the overall moisture of the soil sample using the terms dry, moist, or wet (do not use the term “saturated”):

- Dry = absence of moisture, dusty, dry
- Moist = damp, but no visible water
- Wet = visible water; usually soil is below the water table or perched water

E.8. Consistency

If the soil is fine-grained (i.e., clay or silt), describe the consistency based on finger pressure:

- Very soft = thumb will penetrate soil more than 1 inch
- Soft = thumb will penetrate soil about 1 inch
- Firm = thumb will penetrate soil about 1/4 inch
- Hard = thumb will not indent soil, but thumbnail will easily make a mark
- Very hard = thumbnail will not indent soil

E.9. Staining

Indicate if the soil appears to have staining, for example from petroleum or chemical contamination.

E.10. Odor

Indicate any odors that are present such as organic or unusual odors. Soils that have a significant amount of organic content usually have a distinct color and odor. If the odor is of decaying vegetation, state that there is an "organic odor" present. If the odor is unusual (petroleum, herbicides, chemicals) describe the odor intensity (strong, moderate, mild, no odor) and a general descriptor. However, do not use specific chemical names to describe the odor. For example, stating that "a strong petroleum-like odor is present from 2 to 3 feet bgs" is correct; however, stating that the soil "has a gasoline odor" is NOT correct.

Note: When smelling soil, do not inhale deeply or repeatedly; the chemicals present may represent a health risk.

E.11. Structure

Describe any structures present in the soil sample as follows:

- Stratified = alternating layer of varying materials or color layers at least 1/4 inch or greater, note thickness.
- Laminated = alternating layer of varying materials or color layers less than 1/4 inch thick, note thickness.
- Fissured = Breaks along definite planes of fracture with little resistant to fracturing.
- Slickensided = Fracture planes appear polished or glossy.
- Blocky = cohesive soil that can be broken down into angular lumps which resist further breakdown.
- Lensed = Inclusions of small pockets of different soils such as small lenses of sand scattered in a mass of clay, note thickness.
- Homogeneous = same color and appearance throughout.

E.12. Plasticity

Describe the plasticity of the soil sample as follows:

- Nonplastic = A 1/8-inch (3-mm) thread cannot be rolled at any water content.
- Low = The thread can barely be rolled, and the lump cannot be formed when drier than the plastic limit.
- Medium = The thread is easily rolled and not much time is required to reach the plastic limit. The thread cannot be rerolled after reaching the plastic limit. The lump crumbles when drier than the plastic limit.
- High = It takes considerable time rolling and kneading to reach the plastic limit. The thread can be rerolled several times after reaching the plastic limit. The lump can be formed without crumbling when drier than the plastic limit.

E.13. Cementation

Note if any cementation is present.

E.14. Fill

If the soil is fill or probable fill, note in brackets (e.g., [fill], [probable fill]).

E.15. Examples

The following are examples of correct visual soil classifications:

- Poorly graded sand with silt (SP-SM), fine- to medium-grained, light brown, moist.
- Silty sand (SM), mostly sand with some low plasticity fines and trace gravel, sand is fine- to medium-grained, dark brown (10YR 3/3), moist, firm, homogeneous.
- Clay (CL), mostly fines with trace sand, soft, gray (7.5YR 5/1), wet, laminated, moderate chemical odor(s), medium to high plasticity, [fill].
- Silty sand (SM), medium- to coarse-grained, 25-30% debris—concrete 4-6" pieces, glass <1" pieces, very dark brown, moist [fill].

E.16. Groundwater

If groundwater is encountered, note the depth to water in the log (refer to SOP 301 – Water Level Measurement).

E.17. Collecting Soil Samples

If soil samples are collected for laboratory analysis, refer to the appropriate SOPs including SOP 203 – Soil Boring Observation and Sampling, SOP 207 – Use of Hand Auger, SOP 208 – Soil Grab Sample Collection, SOP 209 – Soil Composite Sample Collection, SOP 210 – Soil Stockpile Sampling, and SOP 211 – Test Pit and Test Trench Observation and Sampling.

E.18. Geotechnical Logs

To ensure consistent logs across Braun Intertec disciplines, soil samples will be collected and classified by a Braun Intertec Geotechnical Engineer. The Geotechnical Engineer's log is a supplement to the field log and is not meant to be a replacement for the field log.

Place one or more representative portions of each two-foot interval into sealable moisture-proof containers (jars or quart-sized polyethylene sealable bags) without ramming or distorting any apparent stratification. Seal the containers to prevent evaporation of soil moisture.

Affix labels to the containers indicating job designation, boring number, and sample depth. If there is a soil change within the interval, collect a soil sample for each stratum and note its depth.

Deliver the samples to a Braun Intertec soil classification lab. Include a copy of the soil boring log form.

E.19. Data and Records Management

Observations should be documented in accordance with SOP 101 – Field Notes and Documentation.

E.20. Quality Assurance/Quality Control

Quality assurance/quality control (QA/QC) procedures described in the work plan should be followed.

A. Purpose

This Standard Operating Procedure (SOP) describes procedure for screening soil potentially contaminated with volatile organic chemicals, such as petroleum, and/or hazardous substances that can be ionized within the energy range of the photoionization detector (PID) lamp being used. The purpose of the bag headspace procedure is to assist with site soil characterization of organic chemical contamination, soil sample selection for laboratory analysis, and soil management during excavation.

A.1. Scope and Applicability

This procedure should be used during field activities where bag headspace procedures are required by regulatory guidance or site-specific work plans. This procedure is used for soil characterization and not for health and safety monitoring.

A.2. Summary of Method

A quart-size polyethylene bag with a tight sealing closure is filled with soil (approximately 1 cup) and immediately closed leaving air in the top portion of the bag (headspace). Organic vapors are allowed to accumulate in the headspace for approximately 10 minutes at room temperature. The bag is opened slightly and the tip of the PID probe is inserted to the middle of the headspace. The highest PID response observed is recorded in the field notes.

A.3. Definitions

Background Readings: The PID measurement of ambient air and bag headspace reading without soil in the bag.

Ionization energy (IE): The energy required to displace an electron and "ionize" a compound. Used more commonly than the old, but equivalent, term Ionization Potential (IP).

Photoionization Detector (PID): The PID is a portable, nonspecific, vapor/gas detector employing the principle of photoionization to detect and measure real-time concentrations of a variety of chemical compounds, both organic and inorganic, in air.

B. Health and Safety

Field work should be performed in accordance with the *Braun Intertec Corporate Health and Safety Manual Standard Operating Procedures* and the site-specific health and safety plan (HASP).

C. Referenced SOPs

- SOP 101 – Field Notes and Documentation
- SOP 201 – Classification of Soil
- SOP 205 – Calibration of MiniRAE PID

D. Equipment and Supplies

- Quart-size polyethylene sealable bags
- PID with appropriate lamp (10.6 or 11.7 electron volts [eV])
- Field Report Form (see SOP 101 – Field Notes and Documentation) or field logbook
- Waterproof and/or indelible ink pens
- Personal Protective Equipment (PPE)

E. Procedure

E.1. Preparation

PID lamps with two different light energy (in electron volts or eV) are available for use. The 11.7-eV lamp measures the broadest range of compounds at lower sensitivity; while the 10.6-eV lamp is responsive to most commonly-studied VOCs and has higher sensitivity. The standard lamp used is 10.6 eV unless otherwise specified by the technical project manager.

Calibrate the PID onsite at least daily to yield total organic vapors in parts per million (ppm) using an isobutylene standard. If field personnel are at multiple project locations in one day, calibrate the PID upon arrival to each project location. See SOP 205 – Calibration and Operation of MiniRAE PID for calibration procedures. Record the date and results of the daily calibration.

E.2. Collection

- Visually examine the soil for staining or sheens. Note observations in field logbook. Describe the type and general amount of debris, if present, in the field logbook (see SOP 201 – Classification of Soil).
- Do not intentionally smell the soil for odors, but note unintentional olfactory indication of contamination in the field logbook.
- Collect soil samples in increments according to instructions established by the project manager or the site-specific work plan.
- **Soil samples for laboratory analysis should not be collected from the sealable bag used for headspace analysis.**
- While wearing proper PPE (Nitrile gloves at a minimum), field personnel should fill approximately one-quarter of a quart-size polyethylene sealable bag with a tight sealing closure (about 1 cup of soil), leaving air in the upper portion of the sealable bag (the volume ratio of soil: headspace should be 1:3). Close the quart-size polyethylene sealable bag immediately, making sure all soil is clear from the path of the bag's seal. Break apart the soil while vigorously shaking the bag for 15 seconds, avoiding puncturing a hole in the bag or tearing apart the zipper.
- Allow the headspace to develop in the sealable bag at room temperature (e.g., approximately 50 °F or greater) for 10 to 20 minutes. If the temperature is below approximately 50 °F, allow the headspace to develop within a heated vehicle or building. Record the ambient temperature during headspace screening.
- Vigorously shake the sealable bag again for 15 seconds. Open the sealable bag slightly, enough for the end of the PID probe tip to enter the bag and insert the tip to the middle of the headspace, avoiding contact with the soil and/or potential moisture from condensation in the sealable bag. Watch the PID screen for the highest reading (ppm). The maximum reading should appear in less than 5 seconds. Record the maximum PID reading reached in the field notes. Record the actual PID reading, do not round the number.
- In addition to screening a soil sample, a background PID headspace reading should be established in the field. Under the same conditions as the screened soil sample (heated vehicle or building, etc.), take an empty quart-size polyethylene sealable bag, puff it up with air, and insert the probe of the PID in the same way as the soil sample. Watch the screen of the PID for the highest PID reading (ppm). Record the maximum PID reading reached in the field notes. Record the actual PID reading, do not round the number.

E.3. Cautions

PIDs provide non-specific measurement of the presence of organic compounds including the following: aromatics, ketones and aldehydes, amines and amides, chlorinated hydrocarbons, sulfur compounds, saturated and unsaturated hydrocarbons, and alcohols. The light energy in eV emitted by the PID lamp must be greater than the IE of the compound(s) of interest. However, 11.7-eV lamps should only be used when compounds with IEs over 10.6 eV are expected and are the primary contaminants. Examples include carbon tetrachloride, methylene chloride, chloroform, and 1,1,1-trichloroethane.

Consult the NIOSH Guide to Chemical Hazards for ionization energies for most common contaminants. The PID will not measure the following: radiation, air (N_2, O_2, CO_2, H_2O), natural gas (methane, ethane, propane), acid gases (HCl, HF, HNO_3), common toxics (CO, HCN, SO_2), freons, ozone, hydrogen peroxide, polychlorinated biphenyls (PCBs), or greases.

E.4. Interferences

Excessive moisture in the air or dust on the PID lamp and sensor housing can cause a false positive response on the PID. This problem can be demonstrated by a "drift" upward of the measurement or could be a sharp response to inserting the probe either into an empty sealable bag or into a sealable bag filled by blowing air into it. See SOP 205 – Calibration and Operation of MiniRAE PID for steps to take to resolve this.

E.5. Data and Records Management

Field data should be recorded and managed in accordance with SOP 101 – Field Notes and Documentation. Documentation should include the following:

- Calibration: date and result
- Maintenance performed, if any
- Background readings: ambient air and quart-size sealable bag
- Ambient air temperature at which headspace screened
- Sample identification information per sample method SOP
- General observations: condensed moisture in the bag, unusual odors associated with the soil sample and/or ambient air

E.6. Quality Assurance/Quality Control

Field personnel should check the PID maintenance log before beginning each new job to make sure that scheduled maintenance is current. Erratic PID responses in the field should be evaluated, and field maintenance performed or the PID should be replaced. The PID should be calibrated daily in the field.

Ambient air quality at the work site should be checked and recorded, as should a headspace sample of an empty sealable bag. All quality assurance (QA) checks should be documented in the field logbook.

Quality assurance/quality control (QA/QC) procedures described in the work plan should be followed.

F. References

Minnesota Pollution Control Agency, Soil Sample Collection and Analysis Procedures, Field Screening Procedures. Guidance Document 4-04, c-prp4-04. Petroleum Remediation Program, Minnesota Pollution Control Agency; St. Paul, MN, September 2008.

NIOSH, Pocket Guide to Chemical Hazards, NIOSH Publications; Cincinnati, OH, September 2007.

A. Purpose

The purpose of this Standard Operating Procedure (SOP) is to describe procedures to be used to conduct and document soil boring observations and sampling either from a direct-push probe or drill rig.

B. Health and Safety

Field work should be performed in accordance with the Braun Intertec Corporate Health and Safety Manual Standard Operating Procedures and the site-specific health and safety plan (HASP).

In addition to potential exposure to hazardous materials, observing drilling of soil borings presents safety risks due to working near drilling equipment.

One of the biggest risks during probe sampling is the use of utility knives to cut open the plastic sleeves that hold soil collected by the probe. Instruct the probe operator to cut the sleeves open. Do not cut the sleeves open yourself.

C. Referenced SOPs

- SOP 101 – Field Notes and Documentation
- SOP 201 – Classification of Soil
- SOP 202 – Organic Vapor Screening
- SOP 208 – Soil Grab Sample Collection
- SOP 209 – Soil Composite Sample Collection
- SOP 311 – Groundwater Sample Collection
- SOP 403 – Soil Vapor Sampling from a Borehole and with a Hand Probe
- SOP 702 – Management of Investigation Derived Waste

D. Equipment and Supplies

- Soil Boring Log form (see Attachment A)
- Global Positioning System (GPS) unit or measuring tape
- Photoionization detector (PID) with appropriate lamp (see SOP 202 – Organic Vapor Soil Screening)
- Soil sampling equipment (see SOP 208 – Soil Grab Sample Collection and SOP 209 – Soil Composite Sample Collection)
- Field Report Form (see SOP 101 – Field Notes and Documentation) or field logbook
- Groundwater sampling equipment (see SOP 311 – Groundwater Sample Collection)
- Soil vapor sampling equipment (see SOP 403 – Soil Vapor Sampling from a Borehole and with a Hand Probe)
- Waterproof and/or indelible ink pens
- Cell phone camera or digital camera
- Personal Protective Equipment (PPE)
- 55-gallon drum, if necessary

E. Procedure

E.1. Underground Utility Locates

Perform underground utility clearance in accordance with the Braun Intertec Corporate Utility Clearance Process.

Ensure that utilities are marked and the soil borings are located a safe distance from any buried utility.

E.2. Boring Location and Numbering

A day or two before the field work, review the written scope of work with the project manager. The scope should define the boring numbering scheme, boring locations, depths, sample intervals, and types of samples to be collected. Make sure that all required field equipment is prepared and in good working condition.

If required, determine the appropriate place to dispose of cuttings or provide an appropriate container per SOP 702 – Management of Investigation Derived Waste. If necessary, ensure that steel drums are provided to collect either the soil cuttings or excess removed groundwater.

During many projects, boring locations will be marked by Braun Intertec personnel, such as the CAD Staker, before the field event begins. In other cases, the responsibility to identify boring locations is left to field personnel on the day of the event. In either case once on site, identify the boring locations with the driller (or drilling subcontractor). Ensure that utilities are marked and that all proposed soil borings are located a safe distance from any buried utility. Review planned sampling procedures to ensure they meet the scope of work. In particular, review sample intervals and water sampling depths, if appropriate.

If the marked boring location must be changed, it is critical that the new location is clear of underground utilities. In some cases, utility marking does not apply to new locations and the work cannot proceed until new locations have been cleared. Use a measuring tape or GPS unit to document soil boring locations relative to the original marked location. This also may be necessary if a boring location must be modified due to refusal or if additional borings are advanced based on field observations (i.e., step out borings). If boring locations were not previously located with a GPS unit, make arrangements for proper location either on the day of the event or later.

E.3. Drilling

The driller or probe operator will collect soil samples from the sample intervals and provide the samples to the field personnel. It is the responsibility of the driller or probe operator to decontaminate the sampler and reusable sampling equipment to minimize cross-contamination using a brush in a detergent and water wash, followed by a clean water rinse between intervals.

Field personnel are responsible for making field observations of the soil, screening soil samples for volatile organic vapors, and collecting soil or water samples both for laboratory analysis and geotechnical classification by a Braun Intertec Geotechnical Engineer.

E.4. Soil Description

Note the surface composition (e.g., concrete, asphalt, grass, etc.). Indicate the material at the surface of the borehole (e.g., concrete, asphalt, grass, gravel) and the thickness of this material in inches in the top section of the soil boring log form.

The driller will bring the sampler to the surface and open it at the request of field personnel. Record the length of sample recovered in inches. Describe the soil type, color, stratification, and conditions of the soil samples recovered (see SOP 201 – Classification of Soil).

E.5. Soil Screening

Don new disposable gloves. Collect a small sample of the soil from each two-foot interval (or less) for organic vapor screening in the field using a photoionization detector (PID) (SOP 202 – Organic Vapor Soil Screening). Record the results of the vapor screening in the PID column of the soil boring log form.

E.6. Soil Sampling

Collect soil samples for chemical analysis in the field as soon as possible after retrieval. To collect soil samples for chemical analyses as specified in the project-specific work plan or Sampling and Analysis Plan, refer to SOP 208 – Soil Grab Sample Collection and SOP 209 – Soil Composite Sample Collection.

As samples are collected for laboratory analysis, note the sample name, sample depth, time collected, and analytical test(s) in the analytical samples column and the remarks column of the boring log form. For example:

- GP-1 (8-10') @ 10:15 – DRO, GRO and VOCs
- ST-3 (2-4') @ 10:45 – RCRA Metals

E.7. Groundwater Sampling

Groundwater Sampling from a Borehole Advanced by a Drill Rig

The drilling operator will advance the auger to the specified depth and prepare for groundwater collection. The operator may use one of the two following methods:

- In the case of shallow groundwater and a fairly competent soil formation, the operator advances the auger to the desired depth for groundwater sampling. All drilling equipment is removed from the borehole. Groundwater samples are collected from inside the open borehole.
- In the case of a less competent soil formation, the operator advances the auger to the desired depth for groundwater sampling. A length of PVC pipe with a five- or ten-foot screened portion on the bottom is extended down the open borehole. All drilling equipment is removed from the borehole. After an appropriate period of time, groundwater samples are collected from inside the screened portion of the PVC pipe.

Groundwater Sampling from a Probe Borehole

The sampling probe operator will advance the probe to the depth you specify and prepare the sampler for groundwater collection. The operator may use one of the two following methods:

- In the case of shallow groundwater and a fairly competent soil formation, the sampling probe is advanced to the desired depth for groundwater sampling. All sampling probe equipment is removed from the probe hole. A length of PVC pipe with a five- or ten-foot screened portion on the bottom is extended down the open hole. Groundwater samples are collected from the screened portion of the PVC pipe.
- In some cases the operator advances a special sampling probe to the desired depth for groundwater sampling. The tip of the probe will be an "expendable point" which is snugly attached to the probe. Inside the probe is a stainless steel screen section. The sampling probe is pulled up, releasing the expendable point and exposing the screen. Groundwater samples are collected from the screened portion of the stainless steel screen.

Groundwater Sample Collection

Refer to SOP 311 – Groundwater Sample Collection for procedures for collecting groundwater samples.

As samples are collected for laboratory analysis, note the boring identifier, time collected, and analytical test(s) in the analytical samples column and the remarks column of the boring log form.

E.8. Soil Vapor Sampling

Refer to SOP 403 – Soil Vapor Sampling from a Borehole and with a Hand Probe for details on collecting the soil vapor sample.

As samples are collected for laboratory analysis, note the boring identifier, time collected, and analytical test in the Remarks section of the Soil Boring Log.

E.9. Geotechnical Logs

To ensure consistent logs across Braun Intertec disciplines, samples of soil cores will be collected and classified by a Braun Intertec Geotechnical Engineer. The Geotechnical Engineer's log is a supplement to the field log and is not meant to be a replacement for the field log.

Place one or more representative portions of each interval into sealable moisture-proof containers (e.g., resealable bags) without ramming or distorting any apparent stratification. Seal the container to prevent evaporation of soil moisture.

Label the containers indicating job designation/project number, boring number, and sample depth. If there is a soil change within the interval, collect a soil sample for each stratum and note their depths.

Deliver the samples to a Braun Intertec soil classification lab. Include a copy of the soil boring log form.

E.10. Documentation

Logs of borings are required in investigation reports. Use the Soil Boring Log form (Attachment A). Descriptions of soil samples collected in the field are described in SOP 201 – Classification of Soil.

Photographs will be taken of the boring location in accordance with SOP 101 – Field Notes and Documentation. A photographic log should be included with the field notes. If there is something specific field personnel would like the viewer to note, be sure it is specified in the description.

E.11. Backfilling/Restoration

The boring will be backfilled with bentonite grout or reused soil cuttings, if appropriate, as allowed or required by the well code.

E.12. Data and Records Management

Observations should be documented in accordance with SOP 101 – Field Notes and Documentation.

E.13. Quality Assurance/Quality Control

Quality assurance/quality control (QA/QC) procedures described in the work plan should be followed.

BRAUN INTERTEC

Soil Boring Log

Project Number:		Latitude:	.	Boring ID:	☐
Project Name:		Longitude:	.	Personnel:	
Project Location:		Elevation:		Weather:	

Drill Company:		Sample Method:		Total Depth (ft):	
Drill Rig ID:		Surface Cover:		Refusal Depth (ft):	
Drill Method:		Surface Thickness:		☐ Permanent well installed.	

Drilling	Date & Time
Start:	
Finish:	
Backfill:	
☐ Cuttings ☐ Chips ☐ Grout	

Groundwater	Depth (ft)	Date & Time
While Drilling:		
End of Drilling:		
Temporary Well:		
Well Recheck:		

Temporary Well & GW Sampling	
Material & Size:	
Screen Top (ft):	
Screen Bottom (ft):	
☐ Check Ball ☐ Bailer ☐ Pump	

Depth (ft)	Recovery (in)	PID (ppm)	**Description** Soil group name, USCS symbol, grain size (f/m/c), amt. of gravel/sand/fines, inclusions, debris, color, moisture (d/m/w), consistency, staining, odor, structure, plasticity, geologic interpretation (fill/native/etc.)	Water & Well	Analytical Samples	**Remarks** Sample ID, times, analyses; odors, debris (%), staining; temp well details, etc.

BRAUN
INTERTEC

Soil Boring Log

Project Number: ______________________ Boring ID: ______________________

Depth (ft)	Recovery (in)	PID (ppm)	**Description** Soil group name, USCS symbol, grain size (f/m/c), amt. of gravel/sand/fines, inclusions, debris, color, moisture (d/m/w), consistency, staining, odor, structure, plasticity, geologic interpretation (fill/native/etc.)	Water & Well	Analytical Samples	**Remarks** Sample ID, times, analyses; odors, debris (%), staining; temp well details, etc.

A. Purpose

The purpose of this Stand Operating Procedure (SOP) is to provide the procedure to calibrate a Thermo Environmental 580B photoionization detector (PID). Proper calibration of the PID will help produce consistent and defensible field measurements.

B. Health and Safety

The use of the Thermo Environmental 580B PID should be in accordance with the *Braun Intertec Corporate Health and Safety Manual Standard Operating Procedures* and the site-specific health and safety plan (HASP).

C. Referenced SOPs

- SOP 101 – Field Notes and Documentation

D. Equipment and Supplies

- Thermo Environmental 580B PID with appropriate lamp
- Clean moisture filter
- Isobutylene span gas (100 parts per million [ppm])
- Regulator
- Polyethylene tubing with T-joint
- Bound Calibration Record (in PID case)
- Field Report Form (see SOP 101 – Field Notes and Documentation) or field logbook
- Waterproof and/or indelible ink pens

E. Procedure

E.1. Prior to Leaving Office

Prior to leaving the office, ensure that the PID has power and the span gas canister is full.

Attach the regulator to the 100 ppm isobutylene span gas. The regulator has a gauge on it to show how much span gas remains in the canister. The gauge should show more than 50 pounds per square inch (PSI) of gas. If not, replace the canister with a new one.

E.2. To Turn On

Inspect the moisture filter for dirt and replace it with a clean filter if necessary. Attach the probe with a clean filter to the PID.

Plug in the PID by inserting the metal connector (which should be hanging from the PID by an aluminum chain) into the outlet that is labeled RUN/CHG. Make sure that the raised tab on the metal connector lines up with the red mark at either the top or the bottom of the RUN/CHG outlet. The screen of the PID should read:

LAMP OUT
580 VER 3.1

Turn on the PID by pressing the ON/OFF button and holding it until there is a whirring sound or the screen reads:

MAX PPM = 0000
PPM = 000.0

Note: If this screen does not appear, the PID lamp has not lit. Turn off the PID by pressing the ON/OFF button until the whirring sound has resided. Remove the metal connector from the RUN/CHG outlet for several seconds. Repeat the process until the lamp lights or replace the PID.

E.3. To Calibrate

Press the MODE/STORE button until the screen reads:

LOG THIS VALUE?
MAX PPM = 0000

Press the -/CRSR button four times until the screen reads:

"RESET" TO
CALIBRATE

Press the RESET button. The screen will read:

RESTORE BACKUP
+ = YES

Press the -/CRSR button until the screen reads:

ZERO GAS
RESET WHEN READY

Press the RESET button. The screen will read:

MODEL 580 ZEROING

Wait for the PID to zero itself. It should take less than one minute. When the screen reads:

SPAN PPM = 0100
"+" TO CONTINUE

Press the +/INC button. The screen will read:

SPAN GAS
"RESET" WHEN READY

Attach the regulator to the 100 ppm isobutylene span gas. The regulator has a gauge on it to show how much span gas remains in the canister. The gauge should show more than 50 PSI gas. If not, do not use it because the calibration may not work, replace the canister with a new one. Attach one end of the polyethylene tubing to the top of the regulator. Tubing should have a T-joint on it to provide span gas at atmospheric pressure during calibration. Attach the other end of the tubing to the PID probe. Press and turn the "Control Button" of the regulator until the span gas can be heard being released from the canister. Press "RESET." The screen will read:

MODEL 580
CALIBRATING

Calibration should take approximately one minute. When the PID is calibrated, the screen will read:

"RESET"
TO CALIBRATE

Press the MODE/STORE button once. The screen will show the value at which the PID calibrated. The screen should read:

MAX PPM = 100.0
PPM = 100.0

Note: The MAX PPM is the maximum reading the PID reached while calibrating. Turn off the span gas by pressing and twisting the control button on the regulator until the gas does not escape from the canister any longer.

Wait for the reading to drop as fresh air enters the tubing. If the reading does not drop below 1.0 ppm, repeat the calibration. If it does drop below 1.0 ppm, record the lowest number displayed as the Ambient Air Reading in the Calibration Log. Turn the span gas back on and wait for the reading to stabilize. If the reading is not within ±5 ppm of 100 ppm, repeat the calibration. If the reading is within ±5 ppm of 100 ppm, turn off the gas and record the number displayed as the Span Gas Reading on the Calibration Log.

Turn off the span gas again. Release the tubing from the PID probe and regulator. Unscrew the regulator from span gas canister.

Complete the calibration information in the bound Calibration Record. Also note in field notes that the calibration was completed. If the calibration does not complete normally, or if the instrument will not produce the expected reading during the calibration, note the failure and attempted remedy in the Calibration Record. After attempting a remedy, repeat the calibration from the beginning. If the calibration does not produce the expected result contact the office to obtain instructions for other potential remedies or to obtain a replacement PID. Do not use a PID that does not calibrate properly.

E.4. To Turn Off

Turn off the PID by pressing the ON/OFF button and holding it until there is no whirring sound or the screen reads:

LAMP OUT
580 VER 3.1

Unplug the PID by removing the metal connector (which should be attached to the PID by an aluminum chain) out of the outlet that is labeled RUN/CHG.

E.5. Data and Records Management

Observations should be documented in accordance with SOP 101 – Field Notes and Documentation.

E.6. Quality Assurance/Quality Control

Quality assurance/quality control (QA/QC) procedures described in the work plan should be followed.

A. Purpose

The purpose of this Standard Operating Procedure (SOP) is to provide the procedure to calibrate a MiniRAE 3000 or MiniRAE Lite Photoionization Detector (PID). Proper calibration of the PID will help produce consistent and defensible field measurements. In addition, this SOP describes procedures to identify and address simple issues related to dust accumulation on the lamp and internal housing.

B. Health and Safety

The use of the MiniRAE 3000 or MiniRAE Lite PID should be in accordance with the *Braun Intertec Corporate Health and Safety Manual Standard Operating Procedures* and the site-specific health and safety plan (HASP).

C. Referenced SOPs

- SOP 101 – Field Notes and Documentation
- SOP 202 – Organic Vapor Soil Screening

D. Equipment and Supplies

- MiniRAE 3000 or MiniRAE Lite PID with appropriate lamp
- Clean moisture filter
- Isobutylene span gas (100 parts per million [ppm])
- Regulator
- Polyethylene tubing with T-connection
- Bound Calibration Record (in PID case)
- Isopropanol cleaner and Q-tips
- Field Report Form (see SOP 101 – Field Notes and Documentation) or field logbook
- Waterproof and/or indelible ink pens

E. Procedure

E.1. Prior to Leaving Office

Prior to leaving the office, ensure that the PID has power and the span gas canister is full.

Attach the regulator to the 100 ppm isobutylene span gas. The regulator has a gauge on it to show how much span gas remains in the canister. The gauge should show more than 100 pounds per square inch (PSI) of gas. If not, replace the canister with a new one.

E.2. To Turn On

Check the probe tip for dirt or other obstructions. Clean as necessary.

Check the moisture filter for visible dirt. Replace as necessary.

Screw the probe tip and filter assembly onto the PID.

There are three buttons on the screen face of the PID:

- MODE (Φ)
- **Y/+**
- **N/-**

There is one button on the body of the instrument:

- LIGHT

Press and hold the center MODE button for a few seconds, then release. The screen will flash through a series of screens. Screens will display:

RAE
SYSTEMS

PGM-7320
VOL 01.01

MINIRAE 3000
SN 952-001736

Self test….

Test Passed!

Ready…Start Sampling?

Press the **Y/+** key.

An audible whirring sound will begin, which is the air pump inside the PID.

Note: If the screen displays "Lamp" alarm, the internal lamp has failed to light. Wait for several minutes until it lights. If the "Lamp" display remains, turn off the PID, and retry turning on the instrument.

E.3. To Calibrate

Press and hold the MODE (Φ) and **N/-** buttons at the same time for approximately two (2) seconds. The screen will display:

ENTER PASSWORD ________

Do not enter a password. Press MODE (Φ), or enter, again. The screen will give the options of:

CALIBRATION
ZERO CALIB (highlighted)
SPAN CALIB

Press the **Y/+** key to select Zero Calibration. Be sure the PID is in "zero" (i.e., fresh) air.

Press the **Y/+** key again to start the zero air calibration. Zeroing starts a 30 second countdown. When complete the screen says:

Zeroing Is Done!
Reading = 0.0 PPM

Then the screen will give the options of:

Calibration
Zero Calib
Span Calib (highlighted)

Press **Y/+** to select Span Calibration. The screen will display:

C. Gas = Isobutylene
Span = 100 ppm
Please apply Gas 1

Attach the regulator to the 100 ppm isobutylene span gas. The regulator has gauge on it to show how much span gas remains in the canister. The gauge should show more than 50 PSI gas. If not, do not use it because the calibration may not work, replace the canister with a new one. Attach one end of the polyethylene tubing to the top of the regulator. Tubing should have a T-joint on it to provide span gas at atmospheric pressure during calibration. Attach the other end of the tubing to the PID probe. Push in and twist the control button on the regulator until the gas can be heard escaping the canister.

As soon as the tubing is in place, the PID may begin a 30 second countdown. Press "start" if the countdown does not begin automatically. After 30 seconds the screen will display:

Span 1 is done
Reading ___.___ppm.

Turn off the span gas by pressing and twisting the control button on the regulator until the gas does not escape from the canister any longer.

Wait for the reading to drop as fresh air enters the tubing. If the reading does not drop below 1.0 ppm, repeat the calibration. If it does drop below 1.0 ppm, record the lowest number displayed as the Ambient Air Reading in the Calibration Log. Turn the span gas back on and wait for the reading to stabilize. If the reading is not within ±5 ppm of 100 ppm, repeat the calibration. If the reading is within ±5 ppm of 100 ppm, turn off the gas and record the number displayed as the Span Gas Reading on the Calibration Log.

Release the tubing from the PID probe and regulator. Unscrew the regulator from span gas canister.

Complete the calibration information in the bound Calibration Record. Also note in field notes that the calibration was completed.

If the calibration does not complete normally, or if the instrument will not produce the expected readings during the calibration verification, note the failure and attempted remedy on the Calibration Record. After attempting a remedy, repeat the calibration. If the calibration does not produce the expected result contact the office to obtain instructions for other potential remedies or to obtain a replacement PID. Do not use a PID that does not calibrate properly.

E.4. To Turn Off

Press and hold the MODE (Φ) button. The instrument will count down for 5 seconds. The lights and/or alarm may flash and sound during the countdown. Release the MODE (Φ) button when the screen displays:

UNIT OFF!

E.5. Interference and Cleaning

Excessive moisture in the air can cause dust on the PID lamp and sensor housing to produce a false positive response on the PID due to current leakage across the electrodes. This problem can be demonstrated either by a "drift" upward of the measurement or a sharp response to inserting the probe either into an empty sealable bag or into a sealable bag filled by blowing air into it. Dust on the lamp and sensor is the primary reason for these responses. The sensor has two electrodes. With clean dry air and sensor components, no current can leak across the air space between the two electrodes. However, even microscopic dirt accumulations on the electrodes and Teflon parts can promote leakage. A sensor may appear to be clean, but may be dirty enough to cause current leakage.

If field personnel are observing false positive responses with the PID, they must perform a humidity response test. The humidity response test includes exhaling gently into an empty sealable bag and then inserting the probe tip into the bag. The PID should show little to no response from this test. If the PID reads more than 5 ppm, the lamp and sensor may need cleaning. Record the results of the humidity response test in the field logbook.

Take the following steps to attempt to resolve the high ambient PID readings. After each step, repeat the humidity response test. If the humidity response test passes (i.e., < 5 ppm reading), record the action in the field notes and proceed with using the PID. If the humidity response test does not pass, proceed to the next step:

- Replace or temporarily remove the moisture filter – The case should have a spare moisture filter. Discard the used filter and connect the new filter to the probe tip.

- Clean the PID lamp and sensor.

    1. Unscrew the large silver sensor cover from the front of the PID. Be careful, in some cases, the white-plastic sensor detector or lamp inside the cover may be loose. Take care not to drop them.

    2. Carefully remove the white plastic sensor detector from the PID housing. It may be necessary to hold the edges of the sensor detector and use a gentle rocking motion to remove it.

    Note: Never touch the lamp surface or the gold-colored sensors with your fingers.

    3. Dip a clean cotton swab into the isopropanol cleaner. Gently swab the flat surface of the lamp and the gold-colored electrodes on the back of the sensor detector.

    4. Let the cleaner evaporate from the components in the air for about five minutes.

5. Replace the sensor detector and screw the cover back onto the PID. Re-connect the probe.
6. Allow the PID to run several minutes until the ambient reading returns to 0.

- Stop using the PID and obtain a different PID to complete the work. The PID must be professionally serviced.

E.6. Data and Records Management

Observations should be documented in accordance with SOP 101 – Field Notes and Documentation.

E.7. Quality Assurance/Quality Control

Quality assurance/quality control (QA/QC) procedures described in the work plan should be followed.

F. References

Addressing PID Instruments Moisture Sensitivity: Humidity Effect on PID Instruments, Technical Note TN-163, RAE Systems by Honeywell; San Jose, CA, February 2014.

A. Purpose

This Standard Operating Procedure (SOP) is designed to provide guidelines for the collection of soil samples using a hand auger or soil core sampler. If soil samples are to be collected for laboratory analysis, the SOP for the selected sampling methods and parameters should be employed.

B. Health and Safety

Field work should be performed in accordance with the Braun Intertec Corporate Health and Safety Manual Standard Operating Procedures and the site-specific health and safety plan (HASP).

In addition to potential exposure to hazardous materials, buried utilities and heavy equipment present safety risks.

C. Referenced SOPs

- SOP 101 – Field Notes and Documentation
- SOP 201 – Classification of Soil
- SOP 202 – Organic Vapor Soil Screening
- SOP 203 – Soil Boring Observation and Sampling
- SOP 208 – Soil Grab Sample Collection
- SOP 209 – Soil Composite Sample Collection
- SOP 701 – Decontamination of Sampling Equipment
- SOP 702 – Management of Investigation Derived Waste

D. Equipment and Supplies

- Soil Boring Log Form (see Attachment A)
- Global Positioning System (GPS) unit or measuring tape
- Photoionization detector (PID) with appropriate lamp (see SOP 202 – Organic Vapor Soil Screening)
- Soil sampling equipment (see SOP 208 – Soil Grab Sample Collection and SOP 209 – Soil Composite Sample Collection)
- Field Report Form (see SOP 101 – Field Notes and Documentation) or field logbook
- Waterproof and/or indelible ink pens
- Cell phone camera or digital camera
- Personal Protective Equipment (PPE)
- Field test equipment per appropriate SOP (see SOP 202 – Organic Vapor Soil Screening)
- Appropriate sample containers and preservatives (see applicable Sampling and Analysis Plan)
- Decontamination products (see SOP 701 – Decontamination of Sampling Equipment)
- Steel bucket auger
- Extension shafts
- Cross handle
- Impermeable plastic liner for excavated soil

E. Procedure

E.1. Underground Utility Locates

Perform underground utility clearance in accordance with the Braun Intertec Corporate Utility Clearance Process.

Ensure that utilities are marked and the hand auger borings are located a safe distance from any buried utility.

E.2. Preparation for Field Work

Several days before field work is scheduled to begin, call or email the laboratory to order sample containers. It is a good idea to order extra bottles to allow for breakage, extra samples, etc. If you are unsure of the required sample volumes or proper laboratory sample containers for specific analytical parameters, ask that a written description be included with the bottle order clarifying sample container requirements.

A day or two before the field work begins, review the written scope of work with the technical project manager. The scope should define the boring numbering scheme, boring locations, depths, sample intervals, and types of samples to be collected. Make sure that all required field equipment is prepared and in good working condition.

If required, determine the appropriate place to dispose of cuttings or provide an appropriate container per SOP 702 – Management of Investigation Derived Waste.

Before you leave for the field, be sure that you have the appropriate sample containers (including appropriate preservatives) and that extra containers are included, if requested. **Be sure you are aware of sample volume and container requirements (discuss with analytical laboratory or project manager if unsure).**

Place ice into each sample cooler before collecting any samples. Double-bag the ice in sealable gallon bags or sealed garbage bags to avoid potential contact of water in the cooler with sample containers.

Place a temperature blank in each cooler and under the ice. If any samples will be analyzed for gasoline range organics (GRO), benzene, ethylbenzene, toluene and xylenes (BETX), or volatile organic compounds (VOCs), include a trip blank in each cooler.

Once on site, identify the boring locations. Review planned sampling procedures to ensure they meet the scope of work. In particular, review sample intervals and sampling depths, if appropriate. Use the GPS unit or measuring tape to determine the location of hand auger borings.

E.3. Procedures

Field personnel are responsible for making field observations of the soil, screening soil samples for volatile organic vapors, and collecting soil samples both for laboratory analysis and geotechnical classification by a Braun Intertec Geotechnical Engineer.

- Be aware of safety. Don appropriate PPE, as prescribed by the HASP.
- Decontaminate the auger bucket and soil core sampler prior to initial use (see SOP 701 – Decontamination of Sampling Equipment for decontamination procedures).
- If using a bucket auger, attach the auger bucket to one end of an extension shaft and attach a cross handle to the other end of the extension shaft.
- Turning the handle clockwise, auger down until the auger bucket or core sampler is full of soil.
- Lift the auger/sampler out of the bore hole and deposit the excavated soil on an impermeable plastic liner to prevent any leaching of possible contaminants.

- Soil from the hand auger borings should be described in accordance with SOP 201 – Classification of Soil and SOP 203 – Soil Boring Observation and Sampling. Record the soil descriptions on the Soil Boring Log (Attachment A).
- Soil from the hand auger boring should be screened in the field for indications of organic vapors in accordance with SOP 202 – Organic Vapor Soil Screening. Record the results of the vapor screening on the boring log.
- Attach additional extension shafts as needed.
- After auguring down to the desired sampling depth, decontaminate the auger/sampler bucket prior to advancing auger to next sampling interval.
- Place the auger back in the bore hole and advance it to the desired sampling depth.
- To collect soil samples for chemical analyses as specified in the project specific work plan, Sampling and Analysis Plan or QAPP, refer to SOP 203 – Soil Boring Observation and Sampling, SOP 208 – Soil Grab Sample Collection for collection of grab samples, and SOP 209 – Soil Composite Sample Collection for collection of composite samples.
- Label the sample container and place it on ice in a cooler until delivery to the laboratory.
- Repeat the above steps for the desired number of soil samples.
- Decontaminate all equipment prior to moving to next location (see SOP 701 – Decontamination of Sampling Equipment).
- Dispose of excess soil cuttings in accordance with SOP 702 – Management of investigation Derived Waste.

E.4. Documentation

Logs of borings are required in investigation reports. Use the Soil Boring Log form (Attachment A). Boring log preparation is described in SOP 201 – Classification of Soil and SOP 203 – Soil Boring Observation and Sampling.

Photographs should be taken of the boring location in accordance with SOP 101 – Field Notes and Documentation. A photographic log should be included with the field notes. If there is something specific personnel would like the viewer to note, be sure it is specified in the description.

E.5. Backfilling/Restoration

The boring should be backfilled with bentonite grout or excess soil cuttings, if appropriate, as allowed or required by the well code.

E.6. Data and Records Management

Observations should be documented in accordance with SOP 101 – Field Notes and Documentation.

E.7. Quality Assurance/Quality Control

Quality assurance/quality control (QA/QC) procedures described in the work plan should be followed.

BRAUN INTERTEC

Soil Boring Log

Project Number:		Latitude:	.	Boring ID:	☐
Project Name:		Longitude:	.	Personnel:	
Project Location:		Elevation:		Weather:	

Drill Company:		Sample Method:		Total Depth (ft):	
Drill Rig ID:		Surface Cover:		Refusal Depth (ft):	
Drill Method:		Surface Thickness:		☐ Permanent well installed.	

Drilling	Date & Time
Start:	
Finish:	
Backfill:	
☐ Cuttings ☐ Chips ☐ Grout	

Groundwater	Depth (ft)	Date & Time
While Drilling:		
End of Drilling:		
Temporary Well:		
Well Recheck:		

Temporary Well & GW Sampling	
Material & Size:	
Screen Top (ft):	
Screen Bottom (ft):	
☐ Check Ball ☐ Bailer ☐ Pump	

Depth (ft)	Recovery (in)	PID (ppm)	**Description** Soil group name, USCS symbol, grain size (f/m/c), amt. of gravel/sand/fines, inclusions, debris, color, moisture (d/m/w), consistency, staining, odor, structure, plasticity, geologic interpretation (fill/native/etc.)	Water & Well	Analytical Samples	**Remarks** Sample ID, times, analyses; odors, debris (%), staining; temp well details, etc.

BRAUN INTERTEC

Soil Boring Log

Project Number: ____________________ Boring ID: ____________________

Depth (ft)	Recovery (in)	PID (ppm)	**Description** Soil group name, USCS symbol, grain size (f/m/c), amt. of gravel/sand/fines, inclusions, debris, color, moisture (d/m/w), consistency, staining, odor, structure, plasticity, geologic interpretation (fill/native/etc.)	Water & Well	Analytical Samples	**Remarks** Sample ID, times, analyses; odors, debris (%), staining; temp well details, etc.

A. Purpose

The following Standard Operating Procedure (SOP) for the collection of grab soil samples is intended to be used by Braun Intertec field personnel for the purposes of soil sample collection. Grab sampling techniques should always be used to collect samples for volatile organic compounds (VOC), gasoline range organics (GRO), diesel range organics (DRO) or other analyses that require collection of a generally undisturbed portion of soil. Grab sampling techniques may also be used to collect other analytes such as semi-volatile organic compounds (SVOCs), polychlorinated biphenyls (PCBs), and metals. Grab samples should be collected prior to collection of other sample aliquots as soon as possible after the sampling interval is retrieved. Soil samples collected in the field during investigations for characterization and/or documentation of site conditions are integral to the services provided to clients and regulatory agencies.

This SOP is applicable for soil samples collected from soil borings (SOP 203 – Soil Boring Observation and Sampling), test pits and test trenches (SOP 211 – Test Pit and Test Trench Observation and Sampling), stockpiles (SOP 210 – Soil Stockpile Sampling), and/or excavations.

B. Health and Safety

Field work should be performed in accordance with the *Braun Intertec Corporate Health and Safety Manual Standard Operating Procedures* and the site-specific health and safety plan (HASP), if applicable.

C. Referenced SOPs

- SOP 101 – Field Notes and Documentation
- SOP 203 – Soil Boring Observation and Sampling
- SOP 210 – Soil Stockpile Sampling
- SOP 211 – Test Pit and Test Trench Observation and Sampling
- SOP 308 – Trip Blanks
- SOP 602 – Chain-of-Custody Procedures
- SOP 603 – Sample Shipping

D. Equipment and Supplies

- Coring device (one for each soil sample collected)
- Portable digital scale, if necessary
- Appropriate laboratory-supplied container and preservative (when applicable)
- Sample labels
- Sample coolers
- Ice
- Temperature blanks (one per sample cooler)
- Trip blanks, if necessary (see SOP 308 – Trip Blanks)
- Field Report Form (see SOP 101 – Field Notes and Documentation) or field logbook
- Chain-of-Custody (COC) forms (see SOP 602 – Chain-of-Custody Procedure)
- Custody seals
- Cell phone camera or digital camera
- Personal Protective Equipment (PPE)

The following table provides details regarding analytical parameters and the type of laboratory-supplied containers and applicable preservative.

Analytical Parameter (holding time)	Bottle Type and Preservation Type
DRO (10 days)*	4-oz. glass jar, pre-weighed and unpreserved
8 RCRA Metals or 13 Priority Pollutant Metals (6 Months, except mercury 28 days)	4-oz. glass jar, unpreserved
GRO (14 days)**	40-milliliter (mL) glass vial, with 10 mL methanol pre-weighed
PCBs (14 days)***	4-oz. glass jar unpreserved
SVOCs (14 days)****	4-oz. glass jar unpreserved
VOCs (14 days)**	40-mL glass vial, with 10 mL methanol, pre-weighed

*DRO soil samples collected in 60-mL pre-weighed containers must be filled with 25 to 35 grams or soil.
**VOC and GRO soil samples collected in 40-mL pre-weighed containers should contain between 8 to 11 grams of soil.
***PCBs – Polychlorinated Biphenyls
****SVOCs – Semi-volatile Organic Compounds

All soil samples must have a single unpreserved sample collected (5-10 gram minimum) for dry weight analysis (i.e., moisture sample).

E. Procedure

E.1. Bottle Order

Several days before field work is scheduled to begin contact the laboratory to order sample containers and soil coring devices by phone or email. It may be a good idea to order extra bottles to allow for breakage, extra samples, etc. If you are unsure of the required sample volumes or proper laboratory sample containers for specific analytical parameters, ask that a written description be included with the bottle order which clarifies sample requirements.

Upon receipt of the sample coolers and before you leave for the field, check the contents of the cooler to be sure that you have the appropriate sample containers and that extra containers are included, if requested. Be sure you are aware of sample volume and container requirements.

E.2. Cooler Preparation

Place ice or a frozen cold pack into each sample cooler before collecting any samples. Double-bag the ice in sealable gallon bags or sealed garbage bags to avoid potential contact of water in the cooler with sample containers.

Place a temperature blank into each cooler and under the sealed bags of ice. If the cooler will contain VOCs samples ensure that a trip blank is placed into the cooler with the samples.

E.3. Labeling Sample Containers

Prior to collecting soil grab samples, complete the sample label for the laboratory-supplied containers. The sample label must have the following information:

- Project Number (listed under "Client")
- Sample Name (listed under "Sample ID")
- Date Sample Collected (listed under "Collection Date")
- Sampler's Initials (listed under "Collected by")
- Time Sample Collected (listed under "Time")

Additionally, some laboratory-supplied sample containers (e.g., DRO, GRO, and VOCs) have been pre-weighed by the laboratory. It is important to make sure that the pre-weighed sample containers have their weight listed on the sample label and that the weight is visible.

E.4. Soil Sampling

Select sample location/interval per the Work/Sampling Plan. Don new disposable gloves and expose a fresh surface of soil, if necessary. Follow procedures listed below for each specific parameter. If VOCs and GRO samples are to be collected as part of the Work/Sampling Plan, these parameters are to be collected first from undisturbed soil or freshly exposed soil surfaces to minimize volatilization.

E.5. VOCs and GRO Soil Grab Sample Collection

- Place an electronic scale, which has been verified that day prior to use, on a flat surface and turn it on. A weighted standard shall be used to determine acceptable precision.
- Before filling the first jar, verify the accuracy of the scale. Place a pre-weighed sample container on the scale. Compare the reading to the weight on the container. If within 5 grams, the scale can be used for the rest of the day. If not within 5 grams, remove the container, turn the scale off, then on, and repeat the test. If still not within 5 grams, use a different scale.
- Remove cap from pre-weighed, pre-preserved 40-milliliter (mL) sample vial.
- Place 40-mL vial on electronic scale and press "tare" button to zero electronic scale.
- Electronic scale should read 0.0g – leave sample vial on electronic scale.
- Use the lab provided Terra Core® sampler (5- or 10-gram) or 10-mL syringe with the top cut off (approximately 10 grams when full) for collecting a sample. The laboratory may provide a different sampling device than described above; whichever device is provided, the goal is to have **8-11 grams** of soil in the sample jar for VOC/GRO analysis.
- Scrape off upper layer of soil to expose underlying soil. Remove the syringe cap and push the syringe into the freshly exposed soil until the soil column entering the syringe has forced the top of the plunger to the stopping point against the top of the syringe cradle.
- Wipe all debris from the outside of the syringe and remove any soil that extends outside the mouth of the syringe, so the soil sample is flush with the mouth of the syringe.
- Carefully place the mouth of the syringe against the top of the open 40-mL vial and gently extrude the sample into the vial. (Note: to prevent the methanol preservative from splashing out of the bottle, hold the syringe against the top of the vial until the sample has fallen into the preservative.) Try to avoid getting soil on the threads of the vial. Clean the threads if necessary and cap the vial immediately.

- Weigh the sample bottle. Tolerances and field actions required are presented in the table below:

Actual Sample Weight	Volume of Methanol	Field Action
< 8 grams	10 mL	Add soil to reach 10 grams
8-11 grams	10 mL	None required
> 11 to < 20 grams	10 mL	None required. Laboratory will add methanol to reach 1:1 ratio
20 or > grams	10 mL	Discard bottle and resample

- Cap the sample container. Gently swirl, do not shake, sample vial to fully immerse soil into methanol.
- Fill out the label on the vial completely, including project number, sample I.D., date, time and sampler's initials. Record the information on the Chain-of-Custody form and in the field notebook.
- Collect at least two vials of soil sample for each analysis (VOCs or GRO). Therefore, if the work plan requires only VOCs then you will fill two vials; if the work plan calls for VOCs and GRO you will fill four vials (two vials for each analyte).
- Manually fill a plastic snap-top tube (or similar unpreserved bottle) with soil from the same sampling interval/matrix as each sample. Remove soil particles from the rim of the snap tube so the cap will close securely and close the cap. This jar is for moisture calculation to be submitted with VOCs/GRO soil sample containers and should be labeled the same as the VOC/GRO sample jars. All soil samples for VOCs or GRO analysis require an accompanying moisture calculation jar. Only one moisture jar is required per soil sample (i.e., one moisture jar is sufficient for both VOCs and GRO analysis).
- Place a trip blank into the cooler with the VOCs/GRO samples; see SOP 308 – Trip Blanks.
- Store, transport, and maintain sample custody per SOP 602 – Chain-of-Custody Procedures.

E.6. DRO Soil Grab Sample Collection

- Place an electronic scale, which has been verified that day prior to use, on a flat surface and turn it on. A weighted standard shall be used to determine acceptable precision.
- Before filling the first jar, verify the accuracy of the scale. Place a pre-weighed sample container on the scale. Compare the reading to the weight on the container. If within 5 grams, the scale can be used for the rest of the day. If not within 5 grams, remove the container, turn the scale off, then on, and repeat the test. If still not within 5 grams, use a different scale.
- Remove cap from pre-weighed, unpreserved sample container.
- Place empty DRO bottle on electronic scale and press "tare" button to zero electronic scale.
- Electronic scale should read 0.0g – leave DRO bottle on electronic scale.
- Use the laboratory provided coring device such as a Terra Core® sampler (5- or 10-gram) or 10-mL syringe with the top cut off (approximately 10 grams when full) for collecting a sample. The laboratory may provide a different coring device than described above; whichever coring device is provided, the goal is to have **25 to 35 grams** of soil in a 4-oz. sample jar for the Wisconsin DRO method and Environmental Protection Agency (EPA) Method 8015, Total Petroleum Hydrocarbon (50 to 70 grams in an 8-oz. jar).
- Scrape off upper layer of soil to expose underlying soil. Push the coring device into the freshly exposed soil until the soil column entering the coring device has filled to the top of the plunger (Terra Core) or the 10-mL line (cut off Syringe).
- Wipe all debris from the outside of the coring device and remove any soil that extends outside the mouth of the coring device, so the soil sample is flush with the mouth of the coring device.
- Extrude soil sample from the coring device into the DRO bottle. Collected soil sample should have a cumulative weight between **25 and 35 grams (4-oz. jar)**. Repeat the steps above as necessary to achieve necessary soil sample weight. If more than 35 grams of soil are collected, discard all the soil

in sample jar and recollect the sample. Try to avoid getting soil on the threads of the sample jar. Clean the threads if necessary and cap the sample jar immediately after sample collection.

- Repeat the above steps to fill a second DRO sample container. Two soil sample jars may be required for this analytical method.
- Fill one unpreserved sample container (typically a small plastic jar provided by the lab) with soil from the same sampling interval/matrix as each sample. This jar is for moisture calculation to be submitted with DRO soil sample containers and should be labeled the same as the DRO sample jars. All soil samples for DRO analysis require an accompanying moisture calculation jar.

E.7. Metals Soil Grab Sample Collection

- One open-top, 4- or 8-oz. unpreserved jar.
- Using a clean stainless-steel spoon, scoopula, or gloved hand, thoroughly mix or homogenize the interval to be sampled, and fill the unpreserved sample containers with the collected soil sample. Avoid filling the sample containers with gravel or rocks.
- Wipe soil from the container threads. Close the flip-top of the unpreserved sample container.
- Note: if several analyses are being performed for a single soil sample, the collection and submission of one moisture calculation jar is sufficient for all of the analyses for that one soil sample.

E.8. PCBs/SVOCs Soil Grab Sample Collection

- Open 4-oz., unpreserved sample container.
- Using a clean stainless-steel spoon, scoopula, or gloved hand, thoroughly mix or homogenize the interval to be sampled, and fill the unpreserved sample containers with the collected soil sample. Try to fill the sample containers with soil and not gravel or rocks.
- Wipe soil from the container threads. Reseal the 4-oz. sample container with the lid.
- Note: if several analyses are being performed for a single soil sample, the collection and submission of one moisture calculation jar is sufficient for all of the analyses for that one soil sample.

E.9. Sample Delivery

Arrange for pick-up/drop-off of soil samples in laboratory-provided coolers to the analytical laboratory. If shipping of soil samples to the analytical laboratory is required, follow SOP 603 – Sample Shipping.

E.10. Data and Records Management

Soil samples collected in the field should be recorded in the Field Report Form or field logbook (see SOP 101 – Field Notes and Documentation), on the field log, soil boring log, test trench log, etc., and on the COC (see SOP 602 – Chain-of-Custody Procedures). Information recorded in the Field Report Form or field logbook and on the COC should be identical to the information listed on the sample container label(s). Additionally, it is useful to note how many soil sample containers were filled for each uniquely identified soil grab sample.

Note the presence of any pieces of bituminous in the samples, no matter how small, particularly in samples to be analyzed for DRO or SVOCs.

E.11. Quality Assurance/Quality Control

Quality assurance/quality control (QA/QC) procedures described in the work plan should be followed.

A. Purpose

The following Standard Operating Procedure (SOP) for the collection of composite soil samples is intended to be used by Braun Intertec field personnel for the purposes of composite soil sample collection. This SOP establishes a reproducible process for composite soil sample collection with the intent of maintaining integrity of the subsequent laboratory analytical procedures.

Compositing is the process of physically combining and homogenizing several individual soil aliquots of the same volume or weight.

This SOP is applicable to soil samples collected for the purposes of documenting the presence and/or concentration of regulated compounds in soil. Check the work plan or consult the project manager to determine if composite samples are required. This SOP is applicable for soil samples collected from soil borings (SOP 203 – Soil Boring Observation and Sampling), test pits and test trenches (SOP 211 – Test Pit and Test Trench Observation and Sampling), stockpiles (SOP 210 – Soil Stockpile Sampling), and/or excavations.

Specifically, this SOP is applicable for soil samples that might be analyzed for non-volatile parameters, including, but not limited to:

- Metals
- Semi-volatile organic compounds (SVOCs)
- Polychlorinated biphenyls (PCBs)
- Pesticides or herbicides

This SOP is not applicable to sampling volatile organic compounds (VOCs), gasoline range organics (GRO), diesel range organics (DRO), or other volatile analytes. VOCs, GRO, and DRO should be collected as grab samples, see SOP 208 – Soil Grab Sample Collection.

B. Health and Safety

Field work should be performed in accordance with the *Braun Intertec Corporate Health and Safety Manual Standard Operating Procedures* and the site-specific health and safety plan (HASP).

C. Referenced SOPs

- SOP 101 – Field Notes and Documentation
- SOP 203 – Soil Boring Observation and Sampling
- SOP 208 – Soil Grab Sample Collection
- SOP 210 – Soil Stockpile Sampling
- SOP 211 – Test Pit and Test Trench Observation and Sampling
- SOP 602 – Chain-of-Custody Procedures
- SOP 603 – Sample Shipping
- SOP 701 – Decontamination of Sampling Equipment

D. Equipment and Supplies

- Shovel, if necessary
- Gallon-size plastic bag or stainless-steel bowl
- Stainless-steel spoon or scoopula, if necessary
- Plastic cups or quart-sized plastic bags
- Appropriate laboratory-supplied containers
- Sample labels

- Sample coolers
- Ice
- Temperature blanks (one per sample cooler)
- Chain-of-Custody (COC) forms (see SOP 602 – Chain-of-Custody Procedure)
- Custody seals
- Field Report Form (see SOP 101 – Field Notes and Documentation) or field logbook
- Waterproof and/or indelible ink pens
- Decontamination equipment (see SOP 701 – Decontamination of Sampling Equipment)
- Cell phone camera or digital camera
- Personal Protective Equipment (PPE)

The following table provides details regarding analytical parameters and the type of laboratory-supplied containers.

Analytical Parameter (holding time)	Bottle Type and Preservation Type	Number of Containers
8 RCRA Metals or 13 Priority Pollutant Metals (6 Months)	40-mL Plastic Flip cap, unpreserved	1
PCBs (14 days)	4-oz. Glass jar, unpreserved	1
SVOCs (14 days)	4-oz. Glass jar, unpreserved	1
Pesticides (14 days)	4-oz. Glass jar, unpreserved	1
Herbicides (14 days)	4-oz. Glass jar, unpreserved	1

All soil samples must have an unpreserved sample collected in a separate unpreserved container for dry weight analysis.

E. Procedure

E.1. Bottle Order

Several days before field work is scheduled to begin contact the laboratory to order sample containers by phone or email. It is a good idea to order extra bottles to allow for breakage, extra samples, etc. If you are unsure of the required sample volumes or proper laboratory sample containers for specific analytical parameters, ask that a written description be included with the bottle order which clarifies sample requirements.

Upon receipt of the sample coolers and before you leave for the field, check the contents of the cooler to be sure that you have the appropriate sample containers and that extra containers are included, if requested. Be sure you are aware of sample volume and container requirements.

E.2. Cooler Preparation

Place ice or a frozen cold pack into each sample cooler before collecting any samples. Double-bag the ice in sealable gallon bags or sealed garbage bags to avoid potential contact of water in the cooler with sample containers.

Place a temperature blank into each cooler and under the sealed bags of ice.

E.3. Labeling Sample Containers

Prior to collecting soil composite samples, complete the sample label for the laboratory-supplied containers. The sample label must have the following information:

- Project Number (listed under “Client”)

- Sample Name (listed under "Sample ID")
- Date Sample Collected (listed under "Collection Date")
- Sampler's Initials (listed under "Collected by")
- Time Sample Collected (listed under "Time")

If not already present, affix the appropriate sample label to the laboratory-supplied sample container.

E.4. Soil Sampling

- Assess and approximate the size of soil from which the composite soil sample will be collected.
- Identify the number aliquots and splitting protocol using the work plan or consult the project manager.
- Prior to sampling, decontaminate the shovel, spoon or scoopula, and stainless-steel bowl or other appropriate container following SOP 701 – Decontamination of Sampling Equipment. In addition, decontaminate all sampling and compositing equipment before collecting each additional sample.
- Don new disposable gloves. Using a gloved hand or decontaminated shovel, spoon or scoopula, acquire the appropriate number of aliquots. The aliquots should be approximately the same size and weight. Place aliquots in the decontaminated stainless-steel bowl or appropriate container that will not introduce contaminants to the samples. Mix the aliquots until thoroughly homogenized, removing rocks or gravel.
- Using a gloved hand, spoon or scoopula, fill unpreserved sample containers with the collected soil sample.
- Fill one open flip-top (or similar), unpreserved jar with the remaining homogenized soil for the percent moisture calculation sample.
- Note: if several analyses are being performed for a single soil sample, the collection and submission of one moisture calculation jar is sufficient for all of the analyses for that one soil sample.
- Place the homogenized soil into the appropriate sample containers. Wipe the threads clean, close the jar, and place the sample on ice.

E.5. Sample Delivery

Arrange for pick-up/drop-off of soil samples in laboratory-provided coolers to the analytical laboratory. If shipping of soil samples to the analytical laboratory is required, follow SOP 603 – Sample Shipping.

E.6. Data and Records Management

Soil samples collected in the field should be recorded in the Field Report Form or field logbook (see SOP 101 – Field Notes and Documentation), on the field log, soil boring log, test trench log, etc., and on the COC (see SOP 602 – Chain-of-Custody Procedures). Information recorded in the Field Report Form or field logbook and on the COC should be identical to the information listed on the sample container label(s). Additionally, it is useful to note how many soil sample containers were filled for each uniquely identified soil composite sample.

Note the presence of any pieces of bituminous in the samples, no matter how small, particularly in samples to be analyzed for SVOCs.

E.7. Quality Assurance/Quality Control

Quality assurance/quality control (QA/QC) procedures described in the work plan should be followed.

A. Purpose

The purpose of this Standard Operating Procedure (SOP) is to describe procedures to be used to conduct and document test pit and test trench excavation observations. If samples are to be collected for laboratory analysis, the SOP for the selected sampling methods and parameters should be employed (i.e., soil grab or soil composite).

A.1. Scope and Applicability

Test excavations are the recommended procedure in most cases for environmental evaluation of subsurface conditions when fill containing waste is known or suspected to be present.

A.2. Summary of Method

Utilities are cleared by the excavation subcontractor, and test excavations are dug at selected locations. Safety is of paramount concern due to near constant motion of heavy equipment and potential of excavation collapse. Remove surface cover and set aside, as appropriate, for reuse in covering the fill when backfilling is complete. Excavate fill in thin lifts to limit the potential for damaging objects encountered such as containers. Create an excavation with the appropriate size and depth to obtain the desired information, and collect and document soil and/or groundwater samples. Document the final size and location of the excavation. Backfill and cover the excavation in a manner agreed upon with the property owner.

A.3. Definitions

Spoil: The soil, dirt, and rubble that results from an excavation.

Test Pit (TP): A hole-type excavation which has surface dimensions that are typically only large enough to allow the excavation to reach its intended depth and is generally as deep as or deeper than it is long. Test pits are typically used to evaluate subsurface conditions at the selected location.

Test Trench (TT): A ditch-type excavation that is typically longer than it is deep and usually used to evaluate the continuity of conditions observed at a beginning location. Trenches are sometimes used in lieu of a linear series of test pits.

Demolition debris: Demolition debris includes concrete, blacktop, bricks, stone facing, concrete block, stucco, glass, structural metal, and wood from demolished structures.

Hazardous materials: Hazardous materials are any refuse, sludge, or other waste material or combinations of refuse, sludge or other waste materials in solid, semisolid, liquid, or contained gaseous form which because of its quantity, concentration, or chemical, physical, or infectious characteristics may (a) cause, or significantly contribute to, an increase in mortality or an increase in serious irreversible, or incapacitating reversible illness; or (b) pose a substantial present or potential hazard to human health or the environment when improperly treated, stored, transported, disposed of, or otherwise managed. Categories of hazardous materials include, but are not limited to: explosives, flammables, oxidizers, poisons, irritants, and corrosives.

Scrap metal: Scrap metal means bits and pieces of metal parts (e.g., bars, turnings, rods, sheets, wire) or metal pieces that may be combined together with bolts or soldering (e.g., radiators, scrap automobiles, railroad box cars) which when worn or superfluous can be recycled.

Household waste: Household waste means any material including garbage, trash, and sanitary waste in septic tanks derived from households (including single and multiple residences, hotels and motels, bunkhouses, ranger stations, crew quarters, campgrounds, picnic grounds, and day-use recreation areas).

A.4. Personnel Qualifications and Responsibilities

Field personnel observing test excavations should be asbestos certified.

B. Health and Safety

Field work should be performed in accordance with the *Braun Intertec Corporate Health and Safety Manual Standard Operating Procedures* and the site-specific health and safety plan (HASP).

In addition to potential exposure to hazardous materials, conducting test excavations presents safety risks due to working near excavating equipment and due to potential excavation cave-in and engulfment.

Field personnel should stay out of equipment operator blind spots and be certain that the operator is aware of their presence. Equipment operation should be stopped when field personnel encroach on the swing area of the equipment to evaluate the excavation or adjacent spoil pile.

Entering an excavation deeper than 4 feet is highly discouraged, but if it is necessary, all Occupational Safety & Health Administration (OSHA) trench safety standards must be followed. In addition, field personnel should not stand immediately adjacent to a deep (greater than 4 feet) un-sloped, un-shored excavation for purposes of evaluating it or taking photographs due to the danger of soil collapse and engulfment. In addition, do not walk or stand between the spoil pile/windrow and the excavation unless they are far enough apart so that there is not a cave-in hazard.

If possible, the excavator and technician should work from the upwind or near upwind side of the excavation. If the soil is very dry and it is windy, fugitive dust may be a problem and should be controlled.

C. Referenced SOPs:

- SOP 101 – Field Notes and Documentation
- SOP 201 – Classification of Soil
- SOP 202 – Organic Vapor Soil Screening
- SOP 208 – Soil Grab Sample Collection
- SOP 209 – Soil Composite Sample Collection
- SOP 701 – Decontamination of Sampling Equipment

D. Equipment and Supplies

- Test Pit and Test Trench Log form (see Attachment A)
- Global Positioning System (GPS) unit and measuring tape
- Photoionization detector (PID) with appropriate lamp (see SOP 202 – Organic Vapor Soil Screening)
- Soil sampling equipment (see SOP 208 – Soil Grab Sample Collection and SOP 209 – Soil Composite Sample Collection)
- Field Report Form (see SOP 101 – Field Notes and Documentation) or field logbook
- Waterproof and/or indelible ink pens
- Cell phone camera or digital camera
- Decontamination equipment (see SOP 701 – Decontamination of Sampling Equipment)
- Personal Protective Equipment (PPE)

E. Procedure

E.1. Location, Measurements, Numbering, and Utility Locates

- Determine and document the location of the test excavations using an appropriate method determined by the project manager.
- Perform underground utility clearance in accordance with the Braun Intertec Corporate Utility Clearance Process.
- Ensure that utilities are marked and the excavations are located a safe distance from any buried utility.
- Measure and record the final length, width, depth, and orientation of the excavation.
- The location and dimensions of the excavations should be documented using a GPS unit, or if a GPS is not available, by measuring the distance from site landmarks.
- In the absence of instructions to the contrary, test pits should be numbered sequentially using "TP" as a prefix. Test trenches should be numbered sequentially using "TT" as a prefix.

E.2. Excavation

Make sure that the backhoe bucket is decontaminated at the beginning of the work day and between excavation locations per the decontamination requirements of the work plan.

- Carefully strip off the cover material (top soil or paving, if any) and set it aside so that it can be used to restore the surface to near its original condition or as agreed upon with the site owner. Do not leave debris or hazardous materials exposed.
- If the area will be difficult to clean up/decontaminate after backfilling, the cover and spoils should be placed on plastic sheeting.

E.2.a. General Excavation

The excavation should proceed cautiously, generally in thin lifts (no more than 1 to 2 feet at a time), to reduce the risk of puncturing containers if encountered.

E.2.b. Hazardous Materials

If hazardous materials are encountered that may require off-site management rather than replacement in the excavation, the hazardous materials should be separated so as not to cross-contaminate other soil from the excavation. The project manager should be notified immediately if the Contingency Plan (see work plan for the field work) requirements are triggered. Occurrences that may trigger the Contingency Plan include (but are not limited to) buried drums, tanks and other containers, unknown buried utility lines, unknown wells, suspect asbestos-containing material (ACM), solid waste, etc.

E.3. Fill Description

The material encountered should be thoroughly documented. Describe the type and approximate percentage of soil fill (matrix) and non-soil fill (waste/debris) present. Soil or soil matrix should be described using the Unified Soil Classification System (unless otherwise required) including notation of soil type, grain size, color, and moisture condition (see SOP 201 – Classification of Soil). Odor should be noted, if unusual. If there is no non-soil fill present, an opinion should be offered as to whether the soil is fill or native. Water present or accumulating in the excavation should be highlighted, and the depth to water or soil cave-in depth should be noted if occurring.

E.4. Soil Sampling

Soil samples for laboratory analysis should be collected per the work plan and its objectives and in discussion with the project manager as conditions warrant. Soil samples for laboratory analysis should be collected in accordance with SOP 208 – Soil Grab Sample Collection and/or SOP 209 – Soil Composite Sample Collection.

The location from which soil samples are collected should be described clearly, including the depth and a reference to a known location such as one end of the trench. Use the GPS unit or measuring tape to determine the location of each soil sample.

Entry into an excavation deeper than 4 feet for purposes of collecting soil samples is not allowed unless proper sloping and/or shoring is provided. Samples should be collected from the backhoe bucket, considering potential cross-contamination and how representative the actual sample is of the desired sample location.

E.5. Photoionization Detector Screening

Soil samples for photoionization detector (PID) screening should be taken approximately every 5 feet vertically in the test excavation or more frequently if odors and staining are observed, similar to soil borings. In long test trenches, soil samples should be taken approximately 30 feet apart laterally unless there is a compelling reason to do more or fewer (see SOP 202 – Organic Vapor Soil Screening).

When collecting analytical or headspace soil samples from trench excavations, always collect the sample from a freshly exposed surface. Soil that is in contact with the backhoe bucket sides or with soil from sidewall slumping should not be collected.

E.6. Geotechnical Logs

To ensure consistent logs across Braun Intertec disciplines, soil samples representing discreet soil types or layers observed during test trenching will be collected and classified by a Braun Intertec Geotechnical Engineer. Check the work plan or discuss with the project manager regarding representative soil sampling intervals. The Geotechnical Engineer’s log is a supplement to the field log and is not meant to be a replacement for the field log.

Place one or more representative portions of each discreet soil type or layer into sealable moisture-proof containers (jars or Ziploc bags) without ramming or distorting any apparent stratification. Seal the containers to prevent evaporation of soil moisture.

Affix labels to the containers indicating job designation, test trench number, and sample depth. If there is a soil change within the interval, collect a soil sample for each stratum and note its depth.

Deliver the samples to a Braun Intertec soil classification lab. Include a copy of the soil boring log form.

E.7. Documentation

Logs of test excavations are required in investigation reports. For test pits, logs may take a form similar to soil boring logs, but for test trenches the field personnel should sketch a longitudinal section for each trench to approximate scale and note dimensions of important features. Use the Test Pit and Test Trench Log form (Attachment A) or draw it into the field report form or field logbook including the information on the form. The amount of detail in the sketch should be sufficient to understand the significant conditions encountered. The location of each sample collected for field or laboratory analysis should be noted on the sketch, and the results or type of laboratory analysis to be performed should be noted (see SOP 201 – Classification of Soil).

Take photographs of the test excavation to document conditions in accordance with SOP 101 – Field Notes and Documentation. Taking photographs of narrow excavations in bright sunlight often results in a shadow that limits the visibility of the sidewall in the shadow. Photographing the sunlit side or use of a flash may help. An 8.5-inch by-11-inch sheet of paper on a clip board with the site name and photograph number in dark marker should be placed in the foreground for scale and location identification. A photographic log should be included with the field notes. If there is something specific field personnel would like the viewer to note, be sure it is specified in the description.

E.8. Backfilling/Restoration

The excavation should be backfilled following completion and not left open or unsecured. All materials should be returned to the excavation except hazardous materials or containers with solid or liquid waste (which will require separate disposal) and suspected ACM. Field personnel should discuss backfilling with fill containing suspected ACM with the project manager.

Backfill should be compacted with the backhoe bucket to reduce the risk of post-backfill settling. Cover material should be replaced at the surface so that no waste is exposed at the surface. If the surface was paved or otherwise landscaped it should be restored as previously agreed upon with the owner. If waste material was placed on a hard surface, it should be swept and the material disposed in the excavation prior to placement of the final cover.

E.9. Data and Records Management

Observations should be documented in accordance with SOP 101 – Field Notes and Documentation.

E.10. Quality Assurance/Quality Control

Quality assurance/quality control (QA/QC) procedures described in the work plan should be followed.

BRAUN INTERTEC

Test Pit and Test Trench Log

Project No.:		Contractor:		Pit/Trench ID:	
Project Name:		Excavator:		Date:	
Location:		Equipment:		Personnel:	

Depth (feet)	PID (ppm)	Visual Classification and/or Observations	Analytical Sample Interval
0			
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			

Dimensions: Length: Width: Depth:

Notes:

A. Purpose

The purpose of the water level measurements Standard Operating Procedure (SOP) is to provide a description of the methods used to measure water levels in piezometers, monitoring, and recovery wells.

A.1. Summary of Method

Collection of water level measurements consists of decontaminating the water level measuring equipment, testing the equipment, lowering the water level probe into the well until a response is noted, verifying results, and finally recording the results in a field logbook or field report form. See SOP 701 – Decontamination of Sampling Equipment for proper decontamination procedures.

B. Health and Safety

Field work should be performed in accordance with the *Braun Intertec Corporate Health and Safety Manual Standard Operating Procedures* and the site-specific health and safety plan (HASP).

The collection of water level measurements can pose a hazard to human health unless appropriate precautions are taken. Potential hazards include, but are not limited to:

- Exposure to contaminants present in the fluid being measured.
- Exposure to decontamination solutions.
- Exposure to hazardous substances being removed as part of the decontamination procedure.
- Hand injuries associated with sharp edges and pinch points on wells and associated well piping and covers.

Proper personal protective equipment (PPE) should be selected based on the physical and chemical characteristic of the contaminant and decontamination solutions used.

C. Referenced SOPs

- SOP 101 – Field Notes and Documentation
- SOP 302 – LNAPL Level Measurement
- SOP 701 – Decontamination of Sampling Equipment

D. Equipment and Supplies

- Hand tools (such as wrenches or sockets for at grade wells)
- Electronic water lever indicator
- Well keys, if necessary
- Water level monitoring record form (Attachment A)
- Field Report Form (see SOP 101 – Field Notes and Documentation) or field logbook
- Waterproof and/or indelible ink pens
- Cell phone camera or digital camera
- Decontamination equipment (see SOP 701 – Decontamination of Sampling Equipment)
- PPE

E. Procedure

The following procedures are to be used, in the order listed, when collecting water level measurements:

- Prior to mobilizing to the site, turn on water level indicator and immerse the end of the water level indicator (i.e., water level probe) in a glass of tap water to check probe batteries. Note the instrument response as the probe contacts the water. If no response occurs, replace the batteries and try again or use an alternate piece of equipment if available.
- Once on-site, don appropriate PPE as prescribed by the HASP.
- Decontaminate the probe and entire cable length in accordance with SOP 701 – Decontamination of Sampling Equipment. Unless stated otherwise in the work plan, proceed from the wells least likely to be contaminated to those closest to the source area. Do not use the water level indicator in wells that are suspected to have, or have documented, free product. Use a product probe if light non-aqueous phase liquid (LNAPL) or free product is known or suspect. See SOP 302 – LNAPL Level Measurement.
- Lower the probe into the well by pulling the cable from the hand-held reel until the light comes on or the buzzer sounds.
- Move the cable up and down fractionally while looking/listening for a response from the probe. Note the exact length of cable to the 100th of a foot extended from the tip of the probe to the notch or highest point (or north side) of the well casing when the probe begins to be audible or light is visible. Record the cable length, well number, and time and date of the measurement in the field notes or water level record. The water level measurement should be repeated a second time. If the two measurements are different, repeat as necessary until results are consistent.

E.1. Cautions

Failure to follow proper water level measurement and/or decontamination procedures may result in the following:

- Cross-contamination between sampling points and/or sites. Cross-contamination would invalidate results, introduce new contaminants to an environment, or impact a previously unaffected sampling location.
- Decreased equipment performance due to foreign objects or incompatible materials on equipment surfaces or corrosion due to acidic environments.

E.2. Interferences

Factors that may interfere with water level measurement procedures include:

- The formation of ice in cold temperatures will prevent proper operation of equipment and may damage internal components of equipment when expansion occurs.
- Obstructions in the well due to down-hole equipment, defects in well piping, or other foreign objects.
- Access to the well through the well-head or access ports may limit the size of the probe that may be used.

E.3. Data and Records Management

Water level measurements should be recorded in the field form included as Attachment A in accordance with SOP 101 – Field Notes and Documentation. If water level measurements are completed in accordance with a site-specific HASP, work plan, or other related document, reference to the appropriate document should be made in the field form. Any deviations from the procedures outlined in this document or in a site-specific document should be described in detail in a field form, otherwise referencing existing procedures is sufficient. The sampler should note if there is pumping from a nearby well, dewatering, or other activity that may influence the elevation of the groundwater at the site.

E.4. Quality Assurance/Quality Control

The probe should be tested to verify proper operation of the equipment prior to its first use of the day, per the procedures outlined above. Water level measurements should be repeated as a means of verifying results, per the procedures outlined above.

BRAUN INTERTEC

Water Level Monitoring Record

Project Name: ______________________________ Project Number: ______________________

Date: ____________ Field Personnel: ________________ Instrument Used: ______________________

Well No.	Time	MP Elevation (feet)	Water Level Below MP (feet)	Water Level Elevation (feet)	Previous Water Level Below MP	Remarks

Note: For your convenience, the following abbreviations may be used.

P = Pumping I = Inaccessible D = Dedicated Pump ST = Steel Tape ES = Electric Sounder MP = Measuring Point WL = Water Level

A. Purpose

This Standard Operating Procedure (SOP) describes requirements for monitoring well development. Well development is necessary to remove any foreign materials (water, grout, mud) introduced during the drilling process. In addition, monitoring well development is used to ensure removal of fine-grained sediments from the vicinity of the well screen. This allows free flow of water from the formation into the well and reduces the turbidity of water during sampling events that may affect the quality of subsequent groundwater samples.

Note: Wells with measurable levels of light non-aqueous phase liquid (LNAPL) should not be developed unless all of the development water is contained. If LNAPL is observed in the development water, check with the project manager prior to proceeding with well development.

B. Health and Safety

Field work should be performed in accordance with the *Braun Intertec Corporate Health and Safety Manual Standard Operating Procedures* and the site-specific health and safety plan (HASP).

C. Referenced SOPs

- SOP 101 – Field Notes and Documentation
- SOP 301 – Water Level Measurement
- SOP 316 – Calibration of Water Meters
- SOP 701 – Decontamination of Sampling Equipment
- SOP 702 – Management of Investigation Derived Waste

D. Equipment and Supplies

Development with a Pump

- Clean submersible pump, peristaltic pump, Waterra actuator or other inertial pump
- Appropriate new tubing or tubing dedicated to the well (do not use tubing provided by a subcontractor unless it can be confirmed to meet QC requirements of the Sampling and Analysis Plan)
- Surge block

Development with a Bailer

- Disposable bailer
- New polypropylene rope or cord

All Development

- Electronic water level indicator (see SOP 301 – Water Level Measurement)
- Multiple parameter or individual parameter water quality meters for temperature, pH, specific conductance, and/or turbidity (as required by Sampling and Analysis Plan). A YSI 556 meter is common, but other meters may be used. The YSI 556 does not measure turbidity.
- Spare batteries for pump equipment or stabilization instruments
- Decontamination products (see SOP 701 – Decontamination of Sampling Equipment)
- Hand tools (such as wrenches or sockets for at grade wells or knife for cutting tubing/rope)
- Well keys (if necessary)
- Purge bucket
- Graduated cylinder or bottle with a known volume
- 55-gallon drums, if necessary

- Well Development Record (Attachment A)
- Field Report Form (see SOP 101 – Field Notes and Documentation) or field logbook
- Cell phone camera or digital camera
- Waterproof and/or indelible ink pens
- Personal Protective Equipment (PPE)

E. Procedure

1. Discuss with the project manager the appropriate method for developing the well. The development method may be pumping, bailing, or some combination of both methods.

2. Determine the appropriate place to discharge the water or provide an appropriate container per SOP 702 – Management of Investigation Derived Waste.

3. Calibrate and verify the accuracy of the water quality meter(s) per SOP 316 – Calibration of Water Meters.

4. Don appropriate PPE, as prescribed by the HASP.

5. Locate the desired monitoring well using a current Site Map. Note the following information in the Well Development Record (Attachment A):

   - Date
   - Time
   - Project location
   - Well identification number (common and unique)
   - Well development sequence
   - Name of field personnel
   - Development method and equipment
   - Any other field observations such as damage or evidence of tampering with the well casing, standing water, etc.

6. Remove the lock, well cover and well cap.

7. Measure the depth to the water level (DTW) from the top of the well casing to the nearest 0.01 foot using a water level indicator in accordance with SOP 301 – Water Level Measurement. Record the measurement on the Well Development Record.

8. Measure the total well depth (WD) of the well from the top of the casing using the water level indicator. Record this measurement.

9. Calculate the length of the water column (WC) in the well using the following equation:

   WD − DTW = WC (feet)

10. Calculate the well volume using the following equation:

    WC × *X* = Well Volume (gallons)

    Where *X* is the conversion factor for the volume of water in a well casing of a certain diameter per linear foot (gallons per foot) as follows:

Casing Diameter (in)	*X* (gal/ft)
2	0.16
4	0.65
6	1.5

E.1. Well Development with a Pump

1. Lower a decontaminated pump and tubing into the well so that the pump or tubing intake is approximately two or three feet above the bottom of the well, within the screened portion. Operate the pump at a fairly high flow rate during development, even if it exceeds the recharge rate (i.e., overpumping). If the well runs dry, stop, allow the well to recharge, and begin pumping again. The pumping rate used during development is commonly greater than the pumping rate that will be used during purging prior to sampling. You may want to bail water out of well until it begins to be relatively sediment free before installing the pump for well development.

2. Begin purging the monitoring well. Once the water reaches the ground surface record the start time on the data sheet. Direct the discharge to a 5-gallon bucket.

3. Record the initial pH, temperature, specific conductivity, turbidity, color, clarity and odor of an aliquot of pumped water on the Well Development Record. If available, measure the turbidity with a meter.

4. Adjust the pumping rate to provide sufficient yield from the screened interval. As the 5-gallon bucket fills with water, discharge or containerize the water as appropriate.

5. Use a graduated cylinder or bottle with a known volume to calculate the discharge rate. This can be done by timing how long it takes to fill a 1,000-mL sample container in seconds. Calculate the discharge rate using the following equation:

$$\frac{1{,}000\text{ mL}}{\_\_\_\_\text{ s}} \times \frac{1\text{ L}}{1{,}000\text{ mL}} \times \frac{60\text{ s}}{1\text{ min}} = \_\_\_\_\text{ LPM (Liters per minute)}$$

The discharge rate in LPM can be converted to gallons per minute (GPM) using the following equation:

$$\_\_\_\_\text{ LPM} \times \frac{1\text{ gal}}{3.8\text{ L}} = \_\_\_\_\text{ GPM (gallons per minute)}$$

The discharge rate can be used to calculate the time required to remove one well volume from the well in minutes or second.

$$\frac{\_\_\_\_\text{ Well Volume (gallons)}}{\_\_\_\_\text{ GPM}} = \_\_\_\_\text{ min per well volume}$$

$$\_\_\_\_\text{ min per well volume} \times \frac{60\text{ s}}{1\text{ min}} = \_\_\_\_\text{ s per well volume}$$

6. If the well cannot be overpumped, development should include surging by raising and lowering the pump through the water column or by removing the pump and raising and lowering a surge block through the water column. Surging, which creates two directional flow in and out of the well, prevents sand bridging in the sand pack, which would allow finer particles to enter the well. Please note that wells installed in fine grain geologic units (clay, silt) should be minimally surged during development as vigorous well development in fine grain units can actually increase the turbidity of the well.

7. For fast recharging wells, 10 well volumes of water should be removed at a minimum from the well during development. For slow recharging wells, the well should be pumped dry at least 3 times. Remove water until a clear and sediment-free discharge is obtained and the measured turbidity is less than 10 NTUs.

   Note that in fine grain geologic units it may not be possible to get the discharge to have a turbidity lower than 10 NTUs.

8. Record the total volume of water removed from the well in the Well Development Record.

9. For slow recharging wells, remove water until the well is dry. Allow the well to recharge at least 30 minutes and then pump the well dry again. Record the total amount of water removed from the well in the Well Development Record.

10. Decontaminate all equipment before proceeding to the next well or at the end of the day in accordance with SOP 701 – Decontamination of Sampling Equipment.

11. Following development, allow the well to equilibrate for at least three days before sampling.

E.2. Well Development with a Bailer

1. Lower the bailer into the water column, allow it to fill, and then raise it out of the well. Raise the bailer out of the well by grasping a section of cord using each hand alternately. This bailer lift method is used so that bailer rope will not come into contact with the ground or other potentially contaminated surfaces.

2. Pour water from the bailer into a small water container and pour the remainder into a 5-gallon bucket. Measure the initial pH, temperature, and specific conductivity of the water in the small container and record this data in the Field Report Form, field logbook or Well Development Record. Also note the odor, color, and turbidity of the water. If available, measure the turbidity with a meter.

3. Periods of removing water from the well should be alternated with periods of gentle surging by allowing the bailer to fill and then lifting and lowering the bailer through the water column. Surging prevents sand bridging in the sand pack, which would allow finer particles to enter the well. Note that wells installed in fine grain geologic units (clay, silt) should be minimally surged during development as vigorous well development in fine grain units can actually increase the turbidity of the well.

4. Collect the development water in a 5-gallon bucket to measure the amount of water that has been removed from the well. When full or finished, development water will then be directed away from the well or it will be containerized.

   For fast recharging wells, 10 well volumes of water should be removed at a minimum from the well during development. For slow recharging wells, the well should be pumped dry at least 3 times. If a pump is going to be used after the surging with the bailer you can stop bailing after the water begins to be relatively sediment free and finish the development using the pump. Remove water until a clear and sediment-free discharge is obtained, the measured turbidity is less than 10 NTUs, and three consecutive rounds of field measurements stabilize or sufficient well volumes have been removed. Stabilized readings fall within the following ranges:

Parameter	Criteria
Conductance	± 5%
pH	± 0.1 pH unit
Temperature	± 0.1°C

   Note that in fine grain geologic units it may not be possible to get the discharge to have a turbidity lower than 10 NTUs. Record the amount of water removed from the well in the Well Development Record.

5. For slow recharging wells, remove water until the well is dry (i.e., a bailer returns less than 1/2 full). Allow the well to recharge at least 30 minutes and then bail the well dry again. Record the total amount of water removed from the well in the Field Report Form, field logbook or the Well Development Record.

6. Measure the final pH, temperature, and specific conductivity of the water and record in the Field Report Form, field logbook, or Well Development Record. Also note the odor, color, and turbidity of the water. If available, measure the turbidity with a meter.

7. Decontaminate all equipment before proceeding to the next well or at the end of the day in accordance with SOP 701 – Decontamination of Sampling Equipment.

8. Following development, allow the well to equilibrate for at least three days before sampling.

E.3. Data and Records Management

Observations should be documented in accordance with SOP 101 – Field Notes and Documentation.

E.4. Quality Assurance/Quality Control

Quality assurance/quality control (QA/QC) procedures described in the Sampling and Analysis Plan should be followed.

BRAUN INTERTEC

Well Development Record

Project Name/Location:	Date:	Well ID:
Project Number:	Field Personnel:	
Depth to Water, ft. (DTW):	Well Depth, ft. (WD):	Casing Diameter, in.:
Water Column (WC), ft (WD - DTW):	X (casing conversion), gal/ft: *2" = 0.16 4" = 0.65 6" = 1.5*	
Well Volume, gal: WC x X =		
Development Equipment Used:		Pump Intake, ft:
Start Time, hrs:	Water Quality Meter Used:	Calibrated Today? Y N

	Time	Depth to Water (ft)	Pump Rate* (gpm)	Volume Pumped (gal)	Temp (°C)	pH	Spec. Cond. ( )	Turbidity (NTU)	Other (color, odor, sheen)
0				0					
1									
2									
3									
4									
5									
6									
7									
8									
9									
10									
11									
12									
13									
14									
15									
16									

* Pump Rate (GPM) = Volume (ml) * 0.00026 / Time (minutes)

	Temp	pH	Spec. Cond.	Turbidity	Other
Stabilization Criteria	± 0.1° C	± 0.1 unit	± 5%	<10 NTU OR ±5%	
Calculated Criteria					

Stop Time:					
Duration, min:	Purged Dry?	Y N			
Total Volume Purged (gal):	No. of Well Volumes Purged = Total Volume Purged / Well Volume =				
Notes:					

Well development criteria: Continue development until a turbidity reading of 10 NTUs or less. If the turbidity reading cannot be reached the temperature, pH, specific conductance must meet the Stabilization Criteria, and, if available, the change in turbidity must be less than ±5%. Slow recharging wells should be purged dry 3 times.

A. Purpose

The purpose of this Standard Operating Procedure (SOP) is to detect contamination that may have been introduced in the field by the sampling equipment, sampling procedures, or inadequate decontamination of field equipment.

B. Health and Safety

Field work should be performed in accordance with the *Braun Intertec Corporate Health and Safety Manual Standard Operating Procedures* and the site-specific health and safety plan (HASP).

C. Referenced SOPs

- SOP 101 – Field Notes and Documentation
- SOP 602 – Chain-of-Custody Procedures
- SOP 701 – Decontamination of Sampling Equipment

D. Equipment and Supplies

- Deionized and filtered water. If not available, distilled water can be used. The water source must be noted in the field notes. Do not use tap water.
- Appropriate laboratory-supplied containers
- Chain-of-Custody (COC) forms (see SOP 602 – Chain-of-Custody Procedure)
- Field Report Form (see SOP 101 – Field Notes and Documentation) or field logbook
- Waterproof and/or indelible ink pens
- Decontamination equipment (see SOP 701 – Decontamination of Sampling Equipment)
- Personal Protective Equipment (PPE)

E. Procedure

- Prepare equipment blanks in the field by drawing deionized water into or through decontaminated sampling equipment such as a pump. Collection of equipment blanks should simulate actual field sampling methods in a manner that would detect the presence of contamination in sampling equipment. Record sample collection procedures, equipment, and sampling order in the field report form or field logbook.
- Collect the rinsate in appropriate laboratory-supplied sampling containers. Equipment blanks should be preserved and handled in the same manner as other investigative samples.
- Label the containers with the identifier “EB,” “EB-#,” or a blind identifier, as necessary. Include a sample called “EB,” “EB-#” or “Equipment Blank” on the COC Form (see SOP 602 – Chain-of-Custody Procedures).
- Analyze equipment blanks for the parameters specified in the site-specific work plan.

E.1. Data and Records Management

Observations should be documented in accordance with SOP 101 – Field Notes and Documentation.

E.2. Quality Assurance/Quality Control

Quality assurance/quality control (QA/QC) procedures described in the work plan should be followed.

A. Purpose

The purpose of this Standard Operating Procedure (SOP) is to detect cross-contamination that occurred during sample collection, preservation, and shipment, as well as in the laboratory. It can also help verify use of appropriate sample containers and preservatives.

B. Health and Safety

Field work should be performed in accordance with the *Braun Intertec Corporate Health and Safety Manual Standard Operating Procedures* and the site-specific health and safety plan (HASP).

C. Referenced SOPs

- SOP 101 – Field Notes and Documentation
- SOP 602 – Chain-of-Custody Procedures

D. Equipment and Supplies

The following materials are required:

- Deionized and filtered water. If not available, distilled water can be used. The water source must be noted in the field notes. Do not use tap water.
- Appropriate laboratory-supplied containers
- Chain-of-Custody (COC) forms (see SOP 602 – Chain-of-Custody Procedure)
- Field Report Form (see SOP 101 – Field Notes and Documentation) or field logbook
- Waterproof and/or indelible ink pens
- Personal Protective Equipment (PPE)

E. Procedure

- Collect field blanks by pouring deionized, filtered, or distilled water into appropriate sample containers at one of the site sampling locations. Record the sample location in the field report form or field logbook. The field blank water should be exposed to air on-site for an amount of time equal to the amount of time for filling and closing an investigative sample container. Preserve and handle field blanks in the same manner as investigative samples.
- Label sample containers using the identifier "FB," "FB-#," or a blind identifier, as necessary. Include a sample called "FB," "FB-#" or "Field Blank" on the COC Form (see SOP 602 – Chain-of Custody Procedures).
- Analyze field blanks for the parameters specified in the site-specific work plan.

E.1. Data and Records Management

Observations should be documented in accordance with SOP 101 – Field Notes and Documentation.

E.2. Quality Assurance/Quality Control

Quality assurance/quality control (QA/QC) procedures described in the work plan should be followed.

A. Purpose

The purpose of this Standard Operating Procedure is to check for contamination of gasoline range organics (GRO) and volatile organic compounds (VOCs) during handling, storage, and shipment from the laboratory to the field and back to the laboratory. If contaminants are reported in the trip blank it may indicate that the investigative samples from that sampling event have been contaminated during handling, transportation, or shipment.

B. Health and Safety

Field work should be performed in accordance with the *Braun Intertec Corporate Health and Safety Manual Standard Operating Procedures* and the site-specific health and safety plan (HASP).

C. Referenced SOPs

- SOP 101 – Field Notes and Documentation
- SOP 602 – Chain-of-Custody Procedures

D. Equipment and Supplies

- Field Report Form (see SOP 101 – Field Notes and Documentation) or field logbook
- Waterproof and/or indelible ink pens
- Chain-of-Custody (COC) Form (see SOP 602 – Chain-of-Custody Procedure)
- For Water Sampling:
  - Two laboratory-prepared 40-milliliter (mL) glass vials with organic-free water in hydrochloric (HCl) acid preservative. Commonly provided in a small bubble-wrap bag.
- For Soil Sampling:
  - One laboratory-prepared 40-mL glass container with methanol preservative. Commonly provided in a small bubble-wrap bag.

E. Procedure

- The laboratory should prepare and provide VOC trip blanks with every bottle order. If it is necessary to prepare a trip blank in the office or in the field, note the exception in the field report form or field logbook and the investigation report. **Note: New trip blanks must be provided along with the laboratory bottle order for a specific project. Trip blanks prepared for a prior sampling event cannot be used.**
- Label sample containers using the identifier "TB," "TB-#," or a blind identifier, as necessary.
- Ensure a trip blank is located in each cooler to be used to hold the investigative samples. Preserve and handle the trip blank(s) in the same manner as investigative samples.
- Include a sample called "TB," "TB-#," or "Trip Blank" on the COC Form. Do not include a date or time for the sample. Check the appropriate column to indicate that the trip blank should be analyzed for GRO and/or VOCs per the investigation work plan (see SOP 602 – Chain-of-Custody Procedures).

E.1. Data and Records Management

Observations should be documented in accordance with SOP 101 – Field Notes and Documentation.

E.2. Quality Assurance/Quality Control

Quality assurance/quality control (QA/QC) procedures described in the work plan should be followed.

A. Purpose

The following Standard Operating Procedure (SOP) for field filtration of water samples will be used to collect aqueous samples for chemical analysis of dissolved metals. This SOP establishes a reproducible process for field filtration of water samples to maintain the integrity of the subsequent laboratory analytical procedures.

A.1. Summary of Method

Water samples collected for dissolved metals analyses should be filtered in the field immediately after collecting the sample using a 0.45-micron filter prior to chemical preservation. Samples can be filtered using a disposable field filtration unit and a hand vacuum pump or using an in-line filter that attaches directly to the discharge tubing of a sampling pump.

Once the sample is filtered, it is preserved and placed on ice in a laboratory-supplied cooler. A Chain-of-Custody (COC) form is completed in accordance with SOP 602 – Chain-of-Custody Procedures. Samples are then transported to the analytical laboratory under refrigerated conditions and COC procedures.

A.2. Personnel Qualifications and Responsibilities

It is the responsibility of environmental field personnel collecting and filtering the samples to maintain the integrity of the water sample collected. Maintaining the integrity of the sample includes: using the proper Personal Protective Equipment (PPE), proper documentation, proper handling, proper collection techniques, and proper storage and transport. Field personnel should be trained in performing this SOP and are responsible for understanding and implementing this SOP during field activities, as well as acquiring the appropriate laboratory-supplied containers.

B. Health and Safety

Field work should be performed in accordance with the *Braun Intertec Corporate Health and Safety Manual Standard Operating Procedures* and the site-specific health and safety plan (HASP).

Additionally, laboratory-supplied sample containers for dissolved metals are preserved with nitric acid (HNO_3), a caustic solution. While the preservative is typically provided in small quantities, it is important to use safe handling practices when working with known chemicals as contact can be harmful to skin, clothes, eyes, and respiratory systems. Safety Data Sheets (SDSs) are available for all the preservatives used in laboratory-supplied sample containers through the analytical laboratory or through the Braun Intertec Safety Coordinator.

C. Referenced SOPs

- SOP 101 – Field Notes and Documentation
- SOP 311 – Groundwater Sample Collection
- SOP 602 – Chain-of-Custody Procedures
- SOP 701 – Decontamination of Sampling Equipment
- SOP 702 – Management of Investigation Derived Waste

D. Equipment and Supplies

- Unpreserved 1-liter (L) plastic laboratory-supplied sampling container
- 500-milliliter (mL), plastic, HNO_3 preserved, laboratory-supplied sampling container
- Disposable field filtration unit method:
  - Vacuum hand pump
  - Nalgene® Disposable Filter Unit – 500-milliliter (mL) volume equipped with a 0.45-micron or micrometer (µm) diameter filter membrane (or similar). Filter membrane must be capable of filtering particles 0.45-µm or larger from the sample (do not reuse filter units or attempt to decontaminate used filter units).
  - Disposable Nalgene® 0.45-µm pre-filter disks (or similar)
- In-line field filtration method:
  - Disposable, in-line 0.45-µm filter
  - Sampling pump (e.g., peristaltic pump)
  - Silicon tubing
- COC forms (see SOP 602 – Chain-of-Custody Procedure)
- Field Report Form (see SOP 101 – Field Notes and Documentation) or field logbook
- Waterproof and/or indelible ink pens
- Cell phone camera or digital camera
- Decontamination equipment (see SOP 701 – Decontamination of Sampling Equipment)
- PPE

E. Procedure

- Prior to filtering water samples, complete the sample label for the laboratory-supplied containers. The sample label must have the following information:
  - Project Number (listed under “Client”)
  - Sample Name (listed under “Sample ID”)
  - Date Sample Collected (listed under “Collection Date”)
  - Sampler’s Initials (listed under “Collected by”)
  - Time Sample Collected (listed under “Time”)
  - The sample label must indicate that the sample is field-filtered.
- If not already present, affix the appropriate sample label to the laboratory-supplied sample container.
- Collect the water sample into a 1-L unpreserved, plastic, laboratory-supplied sample container using SOP 311 – Groundwater Sample Collection or other applicable SOP.
- Decontaminate all equipment before proceeding to the next sample or at the end of the day in accordance with SOP 701 – Decontamination of Sampling Equipment.

E.1. Using a Disposable Field Filtration Unit

- Place a pre-filter disk in the base of the upper chamber of the filtration unit if the sample is turbid. The water sample should then be immediately decanted into the upper chamber of the filtration unit. The upper chamber should only be partially filled if the sample is turbid. Replace the lid. Attach the vacuum hand pump tubing to the adapter in the center of the filtration unit.

- Squeeze the hand pump to establish a vacuum and draw the sample through the filter into the lower chamber. Maintain the vacuum until all the water from the upper chamber has been filtered into the lower chamber.
- The following procedures should be used if sediment has clogged the filtration membrane or pre-filter disk to the point that water flow through the filtration unit is very slow before filtration of the sample is complete:
  - If the filter membrane is clogged and a pre-filter disk was not used, use a new filtration unit to filter the remainder of the sample.
  - If only a pre-filter disk is clogged, depressurize the unit and unscrew the lower chamber from the upper chamber. Swirl the remaining liquid in the upper chamber, and discard this water sample as investigation derived waste in accordance with the work plan and SOP 702 – Management of Investigation Derived Waste. Remove the used pre-filter disk without damaging it and replace with a new pre-filter disk.
- Continue using the steps described above to filter the water sample until 500 mL of water has been filtered or an adequate sample volume has been filtered based on input from the laboratory. Decant the filtered sample from the lower chamber of the filtration unit into a preserved sample container taking care not to overfill the container. Close the sample container, place the sample on ice, and properly dispose of the filtration unit.

E.2. Using an In-Line Filter

- As the metals aliquot is to be collected, attach a new 0.45-µm in-line filter to the pump discharge tubing. Direct the discharge end of the in-line filter into a preserved sample container and fill the sample container taking care not to overfill the container. Close the sample container and place the sample on ice. Remove and properly dispose of the in-filter.

E.3. Cautions and Interferences

Caution must be taken to ensure that sample devices, sample collectors, and sample containers are as clean as possible. The SOP is designed to minimize interferences from outside contaminants. However, because the water sample is being collected in the field outside contamination cannot always be mitigated.

E.4. Data and Records Management

Field-filtered water samples should be recorded in the field notes (see SOP 101 – Field Notes and Documentation) and on the COC Form (see SOP 602 – Chain-of-Custody Procedures).

E.5. Quality Assurance/Quality Control

Quality assurance/quality control (QA/QC) procedures described in the work plan should be followed.

A. Purpose

The purpose of this Standard Operating Procedure (SOP) is to describe procedures for documenting permanent monitoring well and piezometer installation. Installation of permanent wells or piezometers allows direct comparison of water levels, light non-aqueous phase liquid (LNAPL) thickness, and water quality at the same location and depth over time.

Licensed Braun Intertec drillers or subcontracted drillers will perform the physical installation of wells and piezometers. In either case, field personnel must ensure that wells and piezometers are installed per site-specific work plans or Sampling and Analysis Plans. The specific drilling, sampling, and installation methodology will be determined prior to installation by reviewing the geologic characteristics of the site, the types of contaminants to be monitored, and local and state regulations. Specific project requirements described in applicable work plans take precedence over any general procedures described here.

B. Health and Safety

Field work should be performed in accordance with the *Braun Intertec Corporate Health and Safety Manual Standard Operating Procedures* and the site-specific health and safety plan (HASP).

In addition to potential exposure to hazardous materials, observing the installation of wells and piezometers presents safety risks due to working near drilling equipment.

C. Referenced SOPs

- SOP 101 – Field Notes and Documentation
- SOP 201 – Classification of Soil
- SOP 202 – Organic Vapor Soil Screening
- SOP 203 – Soil Boring Observation and Sampling
- SOP 208 – Soil Grab Sample Collection
- SOP 209 – Soil Composite Sample Collection
- SOP 303 – Monitoring Well Development
- SOP 701 – Decontamination of Sampling Equipment
- SOP 702 – Management of Investigation Derived Waste

D. Equipment and Supplies

- Monitoring Well/Piezometer Data Sheet (Above Grade) (see Attachment A)
- Monitoring Well/Piezometer Data Sheet (At Grade) (see Attachment B)
- Global Positioning System (GPS) unit or measuring tape
- Photoionization detector (PID) with appropriate lamp (see SOP 202 – Organic Vapor Soil Screening)
- Soil sampling equipment (see SOP 208 – Soil Grab Sample Collection and SOP 209 – Soil Composite Sample Collection)
- Soil Boring Log form (see SOP 203 – Soil Boring Observation and Sampling)
- Field Report Form (see SOP 101 – Field Notes and Documentation) or field logbook
- Waterproof and/or indelible ink pens
- Cell phone camera or digital camera
- Personal Protective Equipment (PPE)
- 55-gallon drums, if necessary

E. Procedure

E.1. Disposition of Drill Cuttings, Excess Probe Soil and Removed Groundwater

Before the drilling begins, review the proper procedures for disposition of soil and groundwater in accordance with the work plan and SOP 702 – Management of Investigation Derived Waste. If necessary, ensure that steel drums are provided to contain soil cuttings and/or excess removed groundwater.

E.2. Underground Utility Locates

Perform underground utility clearance in accordance with the Braun Intertec Corporate Utility Clearance Process.

Ensure that utilities are marked and the monitoring well/piezometer is located a safe distance from any buried utility.

According to the Minnesota well code (confirm for your State), monitoring wells should be installed at least 10 feet horizontally from known underground utilities and 10 feet or more from all overhead power lines including high tower lines. Note: the ten feet separation from overhead power lines is measured from the outermost power line, not from the support pole.

E.3. Monitoring Well/Piezometer Location and Numbering

A day or two before the field work, review the applicable work plan with the project manager. The scope should define the drilling method, anticipated lithology, well construction materials and well screen slotting, type of filter pack and grout materials, monitoring well/piezometer numbering scheme, monitoring well/piezometer locations, depths, sample intervals, types of samples to be collected. Make sure that all required field equipment is prepared and in good working condition, and the appropriate well construction and completion materials have been delivered to the site.

Once on site, identify the boring locations with the driller (or drilling subcontractor). Ensure that utilities are marked and the monitoring well/piezometer is located a safe distance from any buried or overhead utility.

If the marked monitoring well/piezometer location must be changed, it is critical that the new location is clear of underground utilities. In some cases, utility marking does not apply to new locations and the work cannot proceed until new locations have been cleared. Use a measuring tape or GPS unit to document monitoring well/piezometer locations relative to the original marked location. This also may be necessary if a monitoring well/piezometer location must be modified due to auger refusal. If the final location of the monitoring well/piezometer were not previously located with a GPS unit, make arrangements for proper location either on the day of the event or later. The elevation of the top of the well casing of each monitoring well/piezometer should be surveyed by a licensed surveyor to 0.01 feet.

E.4. Drilling

Acceptable drilling techniques for the installation of permanent monitoring wells include rotary, cable tool, rotasonic, hollow-stem auger, and direct-push. If unconsolidated material is encountered, it may be necessary to drive steel casing during drilling to maintain borehole integrity. If more than one water-bearing unit will be drilled though, it may be necessary to install outer casing to prevent cross-contamination between water-bearing units.

The driller or probe operator will collect soil samples from the sample intervals and provide the samples to the field personnel. It is the responsibility of the driller or probe operator to decontaminate the sampler and reusable sampling equipment to minimize cross-contamination using a brush in a detergent and water wash, followed by a clean water rinse between intervals.

Field personnel are responsible for making field observations of the soil, screening soil samples for volatile organic vapors, and collecting soil or water samples both for laboratory analysis and geotechnical classification by a Braun Intertec Geotechnical Engineer.

E.5. Soil Description

Note the surface composition (i.e., concrete, asphalt, grass, etc.) and thickness of surface cover.

The driller will bring the sampler to the surface and open it at the request of field personnel. Record the percent recovery and the length of sample recovered in feet. Describe the soil samples recovered as to soil type, color, stratification, and conditions (see SOP 201 – Classification of Soil).

E.6. Soil Screening

Don new disposable gloves. Collect a small sample of the soil from each two-foot interval (or less) for organic vapor screening in the field using a photoionization detector (PID) (SOP 202 – Organic Vapor Soil Screening). Record the results of the vapor screening on the boring log form.

E.7. Soil Sampling

Refer to SOP 208 – Soil Grab Sample Collection and SOP 209 – Soil Composite Sample Collection for collection of soil samples for chemical analyses as specified in the applicable work plan.

As samples are collected for laboratory analysis, note the sample name, including depth, time collected, and analytical test in the Remarks section of the Boring Log.

For example:

- GP-1(8-10') @ 10:15 – DRO, GRO and VOCs
- ST-3 (2-4') @ 10:45 – RCRA Metals

E.8. Geotechnical Logs

To ensure consistent logs across Braun Intertec disciplines, samples of soil cores will be collected and classified by a Braun Intertec Geotechnical Engineer. The Geotechnical Engineer's log is a supplement to the field log and is not meant to be a replacement for the field log.

Place one or more representative portions of each two-foot interval into sealable moisture-proof containers (resealable bag) without ramming or distorting any apparent stratification. Seal the bag to prevent evaporation of soil moisture.

Label the containers bearing job designation, boring number and sample depth. If there is a soil change within the interval, collect a soil sample for each stratum and note its depth.

Deliver the samples to the soil classification lab in the Bloomington office. Include a copy of the soil boring log form.

E.9. Documentation

Logs of borings are required in investigation reports. Use the Boring Log Form included with SOP 203 – Soil Boring Observation and Sampling. Descriptions of soil samples collected in the field are described in SOP 201 – Classification of Soil. Photographs shall be taken of the monitoring well/piezometer location in accordance with SOP 101 – Field Notes and Documentation.

E.10. Monitoring Well/Piezometer Installation

E.10.a. Permits

All well/piezometers shall be constructed in accordance with applicable state water well code and any local regulations. Ensure that the applicable permits and registration have been acquired.

E.10.b. Decontamination

Ensure that the drilling equipment is decontaminated before starting each borehole (see SOP 701 – Decontamination of Sampling Equipment). Furthermore, the casing and well screen will be certified clean from the manufacturer and delivered to the site in a protective wrapping.

E.10.c. Field Notes

Careful notes must be taken during monitoring well installation. The following should be recorded on the Above Grade Monitoring Well/Piezometer Data Sheet (Attachment A) or At Grade Monitoring Well/Piezometer Data Sheet (Attachment B):

- Drilling method used
- Length of screen
- Length of casing
- Diameter and total depth of borehole
- Total depth of well
- Depth of screened interval, filter pack interval, bentonite seal interval, grout interval and surface seal interval
- Type, diameter (where applicable) and quantity of materials used to construct the well including manufacturing markings on pipe, casing, and screens
- Manufacturer type and quantity used of cements, bentonite, grout or additives.
- Depth to water and measuring point (e.g., ground surface or top of well casing)
- Map showing location of the monitoring well labeled with the monitoring well number
- Any deviations from the work plan

E.10.d. Well Casing and Screen

Wells and piezometers will be screened as specified in the applicable work plan. All well screen and well casing will be new and will be of adequate structural integrity. Note that some states have specific requirements for well materials, also ensure that the materials are compatible with site-specific geochemical conditions.

A threaded end cap will be placed on the bottom of the well screen and the screen should be lowered into the open borehole in a manner that minimizes the potential for cross-contamination. The well screen and casing will be placed in the center of the borehole. Well centralizers can be used, if necessary.

For above grade wells, solid well casing in 5-foot or 10-foot lengths will be threaded onto the well screen to complete the well to a height of approximately 2 feet above the ground surface. For at grade wells, the well casing will terminate at the ground surface. A threaded or watertight cap will be placed on the top of the casing. No PVC cement, glues, or solvents should be used to fasten the well casing joints, well screen joints, or end caps as these chemicals will compromise the integrity of the well.

E.10.e. Filter Pack and Bentonite Seal

Once the well screen and casing are placed in the borehole, filter pack material will be placed in the annulus between the borehole wall and the well screen to a depth at least 2 feet above the well screen or as specified by the work plan. Submerged wells and deep wells will require that the filter be extended further above the top of the screen.

Once the filter pack material has been placed, a bentonite seal is installed above the filter pack. Bentonite chips or pellets should be used for construction of water table wells. The chips or pellets should be placed in a manner that avoids bridging and void spaces, and be hydrated with clean, potable water to create a seal. A bentonite slurry placed by the tremie method should be used for construction of wells with totally submerged well screens. The bentonite seal should be between two feet and five feet thick (deeper wells, or submerged wells require a thicker seal).

Water used to prepare grout mixtures and drilling muds and to decontaminate equipment and well materials should be obtained from a potable water source stored in a clean container. Record the specific source of any water placed inside the monitoring well/piezometer during construction in the field report form or field logbook.

Verify placement of the filter pack and bentonite seal by measuring the depth to these materials using a weighted tape. Record these measurements in the Above Grade Monitoring Well/Piezometer Data Sheet or the At Grade Monitoring Well/Piezometer Data Sheet.

E.10.f. Grout

After the bentonite seal has been placed, the remainder of the borehole annulus will be grouted with neat cement or high solids bentonite grout. The grout will be placed with a tremie pipe from the bottom of the annular space to a depth of two feet below the ground surface.

The remaining annular space will be completed to the ground surface with concrete.

E.10.g. Above Grade Well

Above grade (stuck up) wells will be completed at least two feet above grade (see Attachment A). A steel protective casing with locking cap will be installed over the well casing to a depth of at least 3 feet below the ground surface. The well casing will have a sealing cap (J-plug). The protective casing will be cemented into place with a concrete pad at the ground surface. The concrete pad will be sloped away from the well to divert surface water. Bumper posts may also be installed to protect the well depending upon the location of the well.

E.10.h. At Grade Well

At grade well completions (flush mount) are only allowed in traffic areas (i.e., roadways, driveways, sidewalks, or parking lots), unless a variance has been received (confirm the rules for at grade versus above grade wells as the rules vary from State to State). The casing must be no lower than the surrounding grade and a manhole or vault must be installed around the well. The well casing will be fitted with a locking, water-tight cap. The well casing will be contained in a protective vault with a water-tight, bolted cover. The top of the vault will be no less than 2 inches above the ground surface. The vault will be installed in a concrete pad at least 4 inches thick and 4 feet square. The concrete pad will be sloped away from the well to divert surface water and to allow traffic movement and snow plowing.

E.10.i. Development

Prior to use, the well/piezometer should be developed to restore the natural hydraulic properties of the formation that were disturbed during drilling operations (See SOP 303 – Monitoring Well Development). Well development should occur at least 48 hours after installation.

E.10.j. Well Record

Following installation, the well driller will affix a unique well tag to the protective well casing. The driller will also prepare a report of the well construction and file the official well record with the State. A copy of the report and well record should be provided to Braun Intertec.

E.11. Data and Records Management

Field observations and measurements should be documented in accordance with SOP 101 - Field Notes and Documentation.

E.12. Quality Assurance/Quality Control

Quality assurance/quality control (QA/QC) procedures described in the work plan should be followed.

MONITORING WELL / PIEZOMETER DATA SHEET

(ABOVE GRADE)

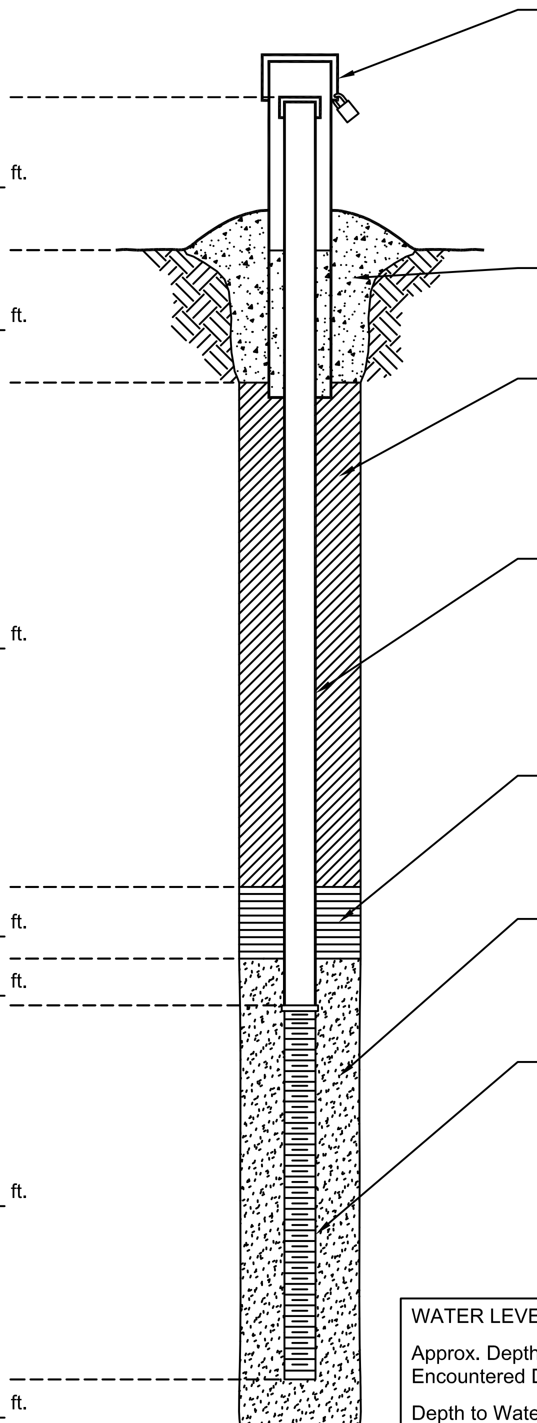
Unique Well Number ______________ Boring / Well ID ______________

Project Number ______________ Project Name ______________ Location ______________

Well Location ______________ Date of installation ______________

Driller ______________ Field Personnel ______________ Weather ______________

Drilling Method ______________ Borehole Diameter ______________



Casing Height Above Ground ______________ ft.

Surface Seal Interval ________ ft. to ________ ft.

Grout Interval ________ ft. to ________ ft.

Seal Interval ________ ft. to ________ ft.

Filter Pack Above Screen ________ ft. to ________ ft.

Screen Interval ________ ft. to ________ ft.

Total Depth of Boring ______________ ft.

PROTECTIVE CASING:

Type ______________

Lock No. ______________

BUMPER POST:

Installed Yes ☐ No ☐

SURFACE SEAL:

Concrete Surface Seal Yes ☐ No ☐

GROUT:

Type of Grout Material ______________

Amount of Material Used (lb.) ______________

Proportions: Bentonite ________ Cement ________

CASING:

Type ______________

Diameter (in.) ______________

Length bgs (ft.) ______________

Cap / S-Plug Yes ☐ No ☐

SEAL:

Type of Seal Material ______________

Amount of Material Used (lb.) ______________

FILTER:

Type of Filter Material ______________

Amount of Material Used (lb.) ______________

SCREEN:

Type ______________

Slot Size ______________

Length (ft.) ______________

Diameter (in.) ______________

Cap / Plug on Bottom Yes ☐ No ☐

WATER LEVEL:

Approx. Depth to First Water Encountered During Drilling ______________

Depth to Water From Top of Casing (Date / Time) ______________

____

____

Completed By ______________ Date ______________ Reviewed By ______________

BRAUN INTERTEC

MONITORING WELL / PIEZOMETER DATA SHEET

(AT GRADE)

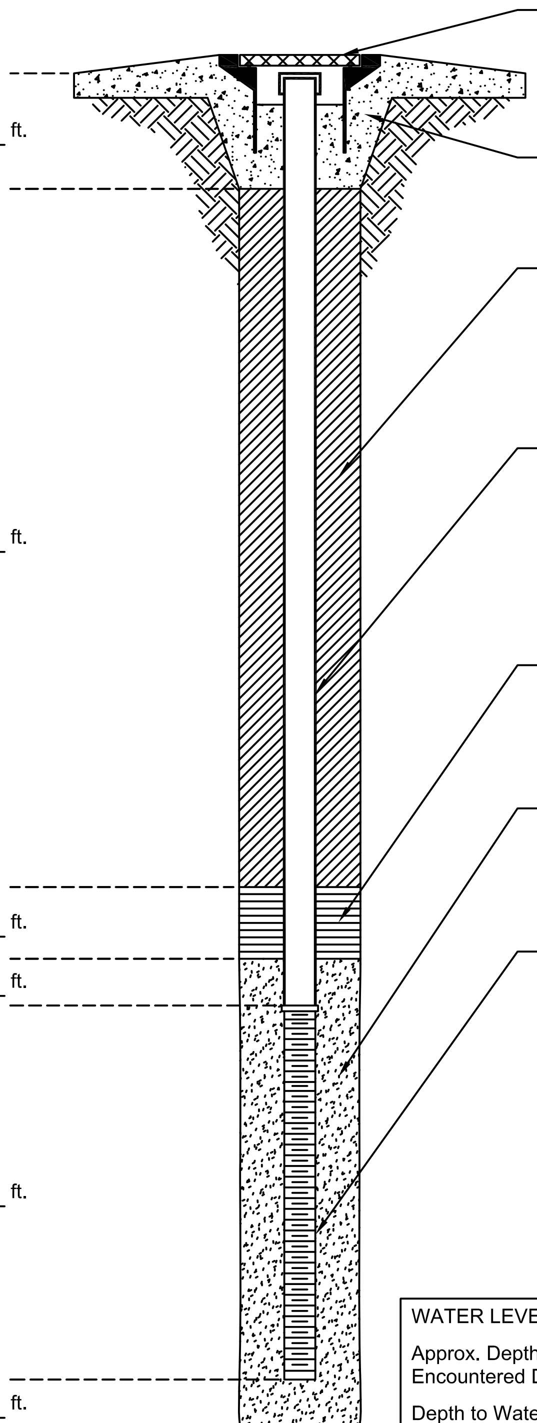
Unique Well Number ______________ Boring / Well ID ______________

Project Number ______________ Project Name ______________ Location ______________

Well Location ______________ Date of installation ______________

Driller ______________ Field Personnel ______________ Weather ______________

Drilling Method ______________ Borehole Diameter ______________



Surface Seal Interval ______ ft. to ______ ft.

Grout Interval ______ ft. to ______ ft.

Seal Interval ______ ft. to ______ ft.

Filter Pack Above Screen ______ ft. to ______ ft.

Screen Interval ______ ft. to ______ ft.

Total Depth of Boring ______________ ft.

PROTECTIVE COVER:

Description ______________

Lock No. ______________

SURFACE SEAL:

Concrete Surface Seal Yes ☐ No ☐

GROUT:

Type of Grout Material ______________

Amount of Material Used (lb.) ______________

Proportions: Bentonite ______ Cement ______

CASING:

Type ______________

Diameter (in.) ______________

Length bgs (ft.) ______________

Cap / S-Plug Yes ☐ No ☐

SEAL:

Type of Seal Material ______________

Amount of Material Used (lb.) ______________

FILTER:

Type of Filter Material ______________

Amount of Material Used (lb.) ______________

SCREEN:

Type ______________

Slot Size ______________

Length (ft.) ______________

Diameter (in.) ______________

Cap / Plug on Bottom Yes ☐ No ☐

WATER LEVEL:

Approx. Depth to First Water Encountered During Drilling ______________

Depth to Water From Top of Casing (Date / Time) ______________

____

____

Completed By ______________ Date ______________ Reviewed By ______________

A. Purpose

This Standard Operating Procedure (SOP) provides guidelines for collection of groundwater samples for laboratory analytical testing. Groundwater samples can be collected from temporary wells (e.g., polyvinyl-chloride [PVC] casing pipe and screen installed in a soil boring) and from permanent monitoring wells. Groundwater samples can be analyzed for the presence of organic compounds, inorganic constituents, biological parameters, and radiological parameters.

Note: Wells with measurable levels of light non-aqueous phase liquid (LNAPL) are usually not sampled. Check with the project manager prior to proceeding with sampling.

B. Health and Safety

Field work should be performed in accordance with the *Braun Intertec Corporate Health and Safety Manual Standard Operating Procedures* and the site-specific health and safety plan (HASP).

C. Referenced SOPs

- SOP 101 – Field Notes and Documentation
- SOP 301 – Water Level Measurement
- SOP 308 – Trip Blanks
- SOP 309 – Field Filtering of Groundwater Samples
- SOP 312 – Well Purging and Stabilization
- SOP 316 – Calibration of Water Quality Meters
- SOP 602 – Chain-of-Custody Procedures
- SOP 603 – Sample Shipping
- SOP 701 – Decontamination of Sampling Equipment

D. Equipment and Supplies

- Pumping equipment (see applicable Sampling and Analysis Plan):
  - Low-flow submersible pump with appropriate tubing,
  - Peristaltic pump with appropriate tubing (polyethylene or silicon)
  - Inertial pump (e.g., Waterra, Solinst) with foot/check valve and appropriate tubing,
  - Tubing with bottom filling check valve (hand actuated), or
  - Bottom filling disposable bailer and rope (polypropylene or cotton)
- Appropriate laboratory-supplied containers and preservatives (see applicable Sampling and Analysis Plan)
- Sample container labels
- Trip blank, if necessary (see SOP 308 – Trip Blanks)
- Temperature blanks (one per sample cooler)
- Chain-of-Custody (COC) forms (see SOP 602 – Chain-of-Custody Procedures)
- Sample coolers
- Ice
- Gallon-size plastic bag
- Electronic water lever indicator (see SOP 301 – Water Level Measurement)
- Water quality meters (if purging and stabilization required by Sampling and Analysis Plan) and purge bucket
- Spare batteries for pump equipment

- Hand tools (such as wrenches or sockets for at grade wells or knife for cutting tubing/rope)
- Well keys, if necessary
- Groundwater Monitoring Data Sheet (see Attachment A)
- Field Report Form (see SOP 101 – Field Notes and Documentation) or field logbook
- Waterproof and/or indelible ink pens
- Cell phone camera or digital camera
- Decontamination products (see SOP 701 – Decontamination of Sampling Equipment)
- Personal Protective Equipment (PPE)

E. Procedures

E.1. Prior to Leaving for the Field

- Several days before field work is scheduled to begin, call or email the laboratory to order sample containers. It is a good idea to order extra bottles to allow for breakage, extra samples, etc. If you are unsure of the required sample volumes or proper laboratory sample containers for specific analytical parameters, ask that a written description be included with the bottle order clarifying sample container requirements.
- Before you leave for the field, be sure that you have the appropriate sample containers (including appropriate preservative) and that extra containers are included, if requested.
- **Be sure you are aware of sample volume and container requirements (discuss with analytical laboratory or project manager if unsure).**
- Place ice into each sample cooler before collecting any samples. Double-bag the ice in sealable gallon bags or sealed garbage bags to avoid potential contact of water in the cooler with sample containers.
- Place a temperature blank in each cooler and under the ice.
- If some samples will be analyzed for gasoline range organics (GRO), benzene, ethylbenzene, toluene and xylenes (BETX), or volatile organic compounds (VOCs), include a trip blank in each cooler.

E.2. Prior to Groundwater Sample Collection

- Don appropriate PPE as prescribed by the HASP.
- Sample from the least to the most contaminated well or as specified in the Sampling and Analysis Plan.
- Measure the depth to groundwater either from the top of the well casing pipe or from the ground surface. Measure the depth to groundwater to the nearest 0.01 foot using an electronic water level indicator in accordance with SOP 301 – Water Level Measurement.
- Prior to sampling the well, purging and stabilization may be required by the Sampling and Analysis Plan (see SOP 312 – Well Purging and Stabilization).

E.3. Groundwater Sample Collection

There are several ways to bring groundwater to the surface for sample collection including pumps, bailers, check valves, etc. Follow the procedure below for the appropriate sampling device.

E.3.a. Submersible Pump for Sampling

When using a submersible pump ensure that the appropriate decontamination has been completed prior to sampling and between sampling points (see SOP 701 – Decontamination of Sampling Equipment). When sampling, direct a steady stream of water into the appropriate sample container(s) at a rate specified on the applicable Sampling and Analysis Plan.

E.3.b. Peristaltic Pump for Sampling

- Insert a length of new plastic tubing inside the well. Attach the top end of the tubing to a fitting on the peristaltic pump.
- Activate the pump to draw water into the tubing and direct the stream of water into appropriate sample container(s).
- For VOCs/GRO, the water for the sample cannot pass through the peristaltic pump body. Fill the sample vials for VOCs/GRO with water that has not passed through the pump body. Manually kink the tubing to temporarily prevent water from flowing back down the tubing, remove the tubing from the sampling point and pour the water into the sample containers after removing the kink in the tubing. Alternatively, the peristaltic pump may be reversed to push water out of the tubing into the sample containers.
- Once the sample containers are filled, remove the tubing and properly dispose (temporary well) or leave in well (permanent well) for future sampling.

E.3.c. Inertial Pump (Plastic Tubing with a Bottom Check Valve) for Sampling

- Insert a length of new or dedicated plastic tubing with a clean, bottom-mounted, stainless steel or plastic check/foot valve inside the temporary or permanent well.
- Manually or mechanically oscillate the tubing up and down. The tubing will fill with water as the ball repeatedly lifts and seats.
- Once the tubing is filled, either lift the tubing out of the well and pour the water into the sample containers or fill the sample containers from the top while the tubing is being oscillated.
- Once the sample containers are filled, remove the tubing and properly dispose (temporary well) or leave in well (permanent well) for future sampling.

E.3.d. Bailer for Sampling

- Attach an appropriate length of new polypropylene or cotton rope to a bailer.
- Lower the bailer slowly into the well, allow it to fill, and then lift it out while preventing the bailer or the rope from contacting any potentially contaminated surface, such as the ground. When using a bailer to remove the groundwater sample, take care to minimize agitation or aeration of the water as this could lead to the loss of volatiles and a non-representative sample.
- For sample collection, slowly pour the contents of the bailer into the appropriate sample container(s).

E.4. Guidelines for Filling Sample Containers:

- Containerize samples by order of the volatilization potential of the desired analytes. For example, volatile organic analysis (VOA) vials should be filled first, followed by semi-volatiles.
- For VOCs/GRO samples, fill the container to the top so that a positive meniscus is formed. Allow air bubbles to rise to the surface, carefully and quickly screw the cap onto the container and finger tighten. Invert the sample and tap it gently, looking for any air bubbles. If the sample contains air bubbles, open the container to add more water. If bubbles continue to form because the preservative is reacting with the sample matrix there are two options: 1) discard the sample with preservative, rinse the vial with sample water, discard the rinse water, and fill the container with unpreserved sample water or 2) collect the water sample in a new unpreserved sample container. The sample with preservative and the rinse water from the sample vial should be discarded with the purge water. Note that the allowable sample hold time is reduced from 14 days to 7 days for unpreserved samples. For unpreserved samples, make a note on the COC stating that the VOC sample is unpreserved and notify the technical project manager.
- For sample containers with preservative, be careful not to overfill the container, since this would dilute the preservative.
- If the sample analysis requires field filtering of the groundwater (e.g., samples for dissolved metals analysis) follow SOP 309 – Field Filtering of Groundwater Samples.
- Complete an appropriate sample container label on all containers. Include the following information: sample identification number, date and time of collection, field personnel, job site location, well number, preservation, and analysis requested. Complete the information related to sample collection and containers used on the bottom of the Groundwater Monitoring Data Sheet (Attachment A).
- Place all samples on ice in a cooler.

E.5. After Groundwater Sample Collection

- If groundwater sampling equipment is re-used between sampling points, refer to SOP 701 – Decontamination of Sampling Equipment for decontamination of groundwater sampling equipment.
- Water samples collected in the field should be recorded on the COC (see SOP 602 – Chain-of-Custody Procedures). Information recorded on the COC should be identical to the information listed on the sample container label(s).
- Arrange for pick-up/drop off of groundwater samples in laboratory-provided coolers to the analytical laboratory. If shipping of groundwater samples to the analytical laboratory is required, follow SOP 603 – Sample Shipping.

E.6. Data and Records Management

Observations should be documented on the Groundwater Monitoring Data Sheet, field report form or field logbook in accordance with SOP 101 – Field Notes and Documentation.

E.7. Quality Assurance/Quality Control

Quality assurance/quality control (QA/QC) procedures described in the work plan should be followed.

BRAUN INTERTEC

Groundwater Monitoring Data Sheet

Client Name:	Project Name:	Well # or Sample ID:
Contact:	Project Number:	Date:
Weather Conditions:		Field Personnel:

Well Information

Chronology:	Key Number:	Casing Locked: Y N
Casing Diameter, in:	X (casing conversion), gal/ft: *2" = 0.16, 4" = 0.65, 6" = 1.5*	Well Material:
Depth to Water (DTW), ft:	Well Depth (WD), ft:	Tubing Material:
Water Column (WC), ft (WD - DTW):	Well Volume, gal: WC x X =	
Equipment Used:	Pump Intake Depth, ft:	Purge Start Time:
Well Purging Procedure(s): Volume Purge Low-Flow Micropurge		

Stabilization Information

Water Meter Used: Calibrated Today? Y N

	Time	Depth to Water (ft)	Purge Rate* ( )	Volume Purged ( )	Temp (°C)	Spec. Cond. (µS/cm)	pH	ORP** (mV)	D.O.** (mg/L)	Turbidity** (NTU)
1										
2										
3										
4										
5										
6										
7										
8										
9										
10										

* Purge Rate (GPM) = Volume (ml) * 0.00026 / Time (minutes) ** If required by sampling plan

Stabilization Criteria (difference in final three well volumes or final turbidity result)	±0.1˚C	±5%	±0.1	±10 mV	±0.5 mg/L	±5% if >10 NTU
Stabilization Criteria in units (conductivity and turbidity)						
Actual differences or turbidity in final 3 well volumes						

Stabilized: Y N	Purge Rate ( ):	**Comments/Observations:**
Purge Stop Time:	Purged Dry: Y N	
Duration, min:	Final Depth to Water (ft.):	
Total Volume Purged ( ):	No. of Well Volumes Purged = Total Volume Purged / Well Volume =	

Sample Collection

Sample Date:	Color:	Odor:
Sample Time:	Phases:	Sampling Method:
Field Filtered?: Y N	Filter Method:	Parameters Filtered:

ID	Quantity	Vendor	Sample Parameter	Material	Type	Volume	Pres.

Duplicate Collected Here?	Y	Duplicate ID:	

A. Purpose

This Standard Operating Procedure (SOP) describes requirements for purging and stabilization of a monitoring well or temporary well prior to collecting a groundwater sample. Field parameters that may be measured to assess well stabilization include pH, temperature, specific conductance, dissolved oxygen (DO), oxidation/reduction potential (ORP) and turbidity. The goal of well purging and stabilization is to produce a groundwater sample that contains fresh water that is representative of the aquifer.

The use of low flow pumping methods for the purging of the well are highly preferred over the use of a bailer.

Note: Wells with measurable levels of light non-aqueous phase liquid (LNAPL) are usually not sampled. Check with the project manager prior to proceeding with sampling.

B. Health and Safety

Field work should be performed in accordance with the *Braun Intertec Corporate Health and Safety Manual Standard Operating Procedures* and the site-specific health and safety plan (HASP).

C. Referenced SOPs

- SOP 101 – Field Notes and Documentation
- SOP 301 – Water Level Measurement
- SOP 311 – Groundwater Sample Collection
- SOP 316 – Calibration of Water Quality Meters
- SOP 701 – Decontamination of Sampling Equipment
- SOP 702 – Management of Investigation Derived Waste

D. Equipment and Supplies

Purging with a Pump (Preferred Method)

- Pumping equipment (see applicable Sampling and Analysis Plan):
    - Low-flow submersible or bladder pump with appropriate tubing,
    - Peristaltic pump with appropriate tubing (polyethylene or silicon),
    - Inertial pump (e.g., Waterra, Solinst) with foot/check valve and appropriate tubing, or
    - Tubing with bottom filling check valve (hand actuated)
    - Flow-through cell
- Appropriate tubing to be provided by Braun Intertec only (do not use tubing provided by a subcontractor unless it can be confirmed to meet QC requirements of the Sampling and Analysis Plan)

Purging with a Bailer

- Bottom filling disposable bailer (bailers should not be used when another purging method is available)
- New polypropylene or cotton rope

All Purging

- Electronic water level indicator (see SOP 301 – Water Level Measurement)
- Multiple parameter or individual parameter water quality meters for temperature, pH, specific conductance, ORP, dissolved oxygen, and/or turbidity (as required by Sampling and Analysis Plan). A YSI 556 meter is common, but other meters may be used. The YSI 556 does not measure turbidity.
- Spare batteries for pump equipment or stabilization instruments
- Decontamination products (see SOP 701 – Decontamination of Sampling Equipment)
- Hand tools (such as wrenches or sockets for at grade wells or knife for cutting tubing/rope)
- Well keys (if necessary)
- Purge bucket
- Graduated cylinder or bottle with a known volume
- 55-gallon drums, if necessary
- Paper towels
- Groundwater Monitoring Data Sheet (see Attachment A)
- Field Report Form (see SOP 101 – Field Notes and Documentation) or field logbook
- Cell phone camera or digital camera
- Waterproof and/or indelible ink pens
- Personal Protective Equipment (PPE)

E. Procedure

1. Determine the appropriate place to discharge the water or provide an appropriate container per SOP 702 – Management of Investigation Derived Waste.

2. Prior to sampling the first well, calibrate the water quality meters according to SOP 316 – Calibration of Water Quality Meters.

3. Don appropriate PPE, as prescribed by the HASP.

4. Locate the desired monitoring well using a current Site Map. Note the following information in the Groundwater Monitoring Data Sheet (Attachment A):

   - Date
   - Client Name, Client Contact, Project Name & Project Number
   - Well identification number (common and unique)
   - Well sampling sequence
   - Ambient weather conditions
   - Name of field personnel
   - Equipment used
   - Any other field observations such as damage or evidence of tampering with the well casing, standing water, etc.

5. Remove the lock, well cover and well cap.

6. Measure the depth to water (DTW) level from the top of the well casing to the nearest 0.01 foot using an electronic water level indicator in accordance with SOP 301 – Water Level Measurement. Record the measurement on the Groundwater Monitoring Data Sheet.

7. If not previously recorded, measure the total well depth (WD) from the top of the casing using the water level indicator. Record this measurement on the Groundwater Monitoring Data Sheet.

8. Calculate the length of the water column (WC) in the well using the following equation:

   WD − DTW = WC (feet)

9. Calculate the well volume using the following equation:

   WC × *X* = Well Volume (gallons)

   Where *X* is the conversion factor for the volume of water in a well casing of a certain diameter per linear foot (gallons per foot) as follows:

Casing Diameter (in)	*X* (gal/ft)
2	0.16
4	0.65
6	1.5

E.1. Purging with a Pump (Preferred Method)

1. When purging with a pump, be sure that the pump has been decontaminated according to SOP 701 – Decontamination of Sampling Equipment. Slowly lower the pump or tubing into the well so that the pump intake is approximately two or three feet above the bottom of the well. Operate the pump at a constant, low flow rate during purging.

2. Start the pump at a low speed (0.2 - 0.5 Liters per minute). If necessary, slowly increase pumping rate until discharge occurs. Adjust the discharge rate to minimize the drawdown as much as possible. If this is not possible, but the amount of drawdown remains stable or stabilized, continue purging.

3. Once drawdown has stabilized, use a graduated cylinder or bottle with a 1,000-mL volume to calculate the discharge rate from the monitoring well. This can be done by timing how long it takes to fill a 1,000-mL sample container in seconds. Calculate the discharge rate using the following equation:

$$\frac{1{,}000\text{ mL}}{\_\_\_\_\text{ s}} \times \frac{1\text{ L}}{1{,}000\text{ mL}} \times \frac{60\text{ s}}{1\text{ min}} = \_\_\_\_\text{ LPM (Liters per minute)}$$

   The discharge rate in LPM can be converted to gallons per minute (GPM) using the following equation:

$$\_\_\_\_\text{ LPM} \times \frac{1\text{ gal}}{3.8\text{ L}} = \_\_\_\_\text{ GPM (gallons per minute)}$$

4. The discharge rate can be used to calculate the time required to remove one well volume from the well in minutes or seconds.

$$\frac{\_\_\_\_\text{ Well Volume (gallons)}}{\_\_\_\_\text{ GPM}} = \_\_\_\_\text{ min per well volume}$$

$$\_\_\_\_\text{ min per well volume} \times \frac{60\text{ s}}{1\text{ min}} = \_\_\_\_\text{ s per well volume}$$

5. Connect the discharge line to the flow through cell to monitor stabilization of field parameters. Bring varying sizes of connectors. Depending on the pump being used different fittings may be needed.

6. Once every 2 minutes or after each well volume, record the field parameter measurements on the Groundwater Monitoring Data Sheet. A well is considered stabilized if the following parameters are within the target criteria (shown below) for 3 consecutive readings and significant drawdown has not occurred:

Parameter	Criteria
Temperature	± 0.1°C
pH	± 0.1 standard unit
Specific Conductance	± 5%
ORP	± 10 mV
Dissolved Oxygen	±0.5 mg/L
Turbidity	± 5% if >10 NTU

7. Upon stabilization, record the total volume of water purged from the well in the Groundwater Monitoring Data Sheet.

8. Following purging and stabilization, sample the water from the well immediately as described in SOP 311 – Groundwater Sample Collection.

   If 5 well volumes have been purged but field measurements have not stabilized, sample collection may begin (see SOP 311 – Groundwater Sample Collection). Record on Groundwater Monitoring Data Sheet if the well was stabilized or not. In some situations, the hydraulic conductivity of the geology surrounding the monitoring well can limit the recharge of the well. Wells with low recharge rates (less than 0.1 Liters per minute) should be dewatered or purged dry, allowed sufficient time to recharge, and then sampled upon recovery. Record this and any other observations on the Groundwater Monitoring Data Sheet.

9. Decontaminate all equipment before proceeding to the next well or at the end of the day in accordance with SOP 701 – Decontamination of Sampling Equipment.

E.2. Purging with a Bailer

NOTE: Well purging with a pump is preferred.

1. When purging with a bailer, slowly lower the bailer into and out of the well. Raise the bailer out of the well by grasping a section of rope using each hand alternately. This bailer lift method is used so that bailer rope will not come into contact with the ground or other potentially contaminated surfaces.

2. Collect the purge water in a 5-gallon bucket to measure the amount of water that has been removed from the well.

3. After each well volume is removed measure the field parameters in an aliquot of water (additional parameters may be included as described in the Sampling and Analysis Plan). Record the readings on the Groundwater Monitoring Data Sheet. Continue bailing the well until three consecutive rounds of field measurements stabilize. Stabilized readings fall within the following ranges:

Parameter	Criteria
Specific Conductance	± 5%
pH	± 0.1 standard unit
Temperature	± 0.1° C

4. Record the amount of water removed from the well in the Groundwater Monitoring Data Sheet.

5. If the well purges dry, allow the water level in the well to recover and then sample the well (see SOP 311 – Groundwater Sample Collection).

6. Following purging and stabilization, sample the water from the well immediately as described in SOP 311 – Groundwater Sample Collection.

7. Decontaminate all equipment before proceeding to the next well or at the end of the day in accordance with SOP 701 – Decontamination of Sampling Equipment.

E.3. Data and Records Management

Observations should be documented in accordance with SOP 101 – Field Notes and Documentation.

E.4. Quality Assurance/Quality Control

Quality assurance/quality control (QA/QC) procedures described in the Sampling and Analysis Plan should be followed.

F. References

Sampling Procedures for Ground Water Monitoring Wells by Minnesota Pollution Control Agency, Water Quality Division, approved September 2006.

Sampling Protocol Template for Monitoring Wells by Superfund and Voluntary Investigation and Cleanup Programs, Minnesota Pollution Control Agency, dated April 7, 2001.

BRAUN INTERTEC

Groundwater Monitoring Data Sheet

Client Name:	Project Name:	Well # or Sample ID:
Contact:	Project Number:	Date:
Weather Conditions:		Field Personnel:

Well Information

Chronology:	Key Number:	Casing Locked: Y N
Casing Diameter, in:	X (casing conversion), gal/ft: *2" = 0.16, 4" = 0.65, 6" = 1.5*	Well Material:
Depth to Water (DTW), ft:	Well Depth (WD), ft:	Tubing Material:
Water Column (WC), ft (WD - DTW):	Well Volume, gal: WC x X =	
Equipment Used:	Pump Intake Depth, ft:	Purge Start Time:
Well Purging Procedure(s): Volume Purge Low-Flow Micropurge		

Stabilization Information

Water Meter Used:	Calibrated Today? Y N

	Time	Depth to Water (ft)	Purge Rate* ( )	Volume Purged ( )	Temp (°C)	Spec. Cond. (µS/cm)	pH	ORP** (mV)	D.O.** (mg/L)	Turbidity** (NTU)
1										
2										
3										
4										
5										
6										
7										
8										
9										
10										

* Purge Rate (GPM) = Volume (ml) * 0.00026 / Time (minutes)

** If required by sampling plan

Stabilization Criteria (difference in final three well volumes or final turbidity result)	**±0.1˚C**	**±5%**	**±0.1**	**±10 mV**	**±0.5 mg/L**	**±5% if >10 NTU**
Stabilization Criteria in units (conductivity and turbidity)						
Actual differences or turbidity in final 3 well volumes						

Stabilized: Y N	Purge Rate ( ):	**Comments/Observations:**
Purge Stop Time:	Purged Dry: Y N	
Duration, min:	Final Depth to Water (ft.):	
Total Volume Purged ( ):	No. of Well Volumes Purged = Total Volume Purged / Well Volume =	

Sample Collection

Sample Date:	Color:	Odor:
Sample Time:	Phases:	Sampling Method:
Field Filtered?: Y N	Filter Method:	Parameters Filtered:

ID	**Quantity**	**Vendor**	**Sample Parameter**	**Material**	**Type**	**Volume**	**Pres.**
Duplicate Collected Here?		Y	Duplicate ID:				

A. Purpose

This Standard Operating Procedure (SOP) provides guidelines for sampling water supply wells. A pump is typically already installed in the water supply well to be sampled. If not, refer to SOP 311 – Groundwater Sample Collection for groundwater sample collection procedures. Groundwater samples can be analyzed for the presence of organic compounds, inorganic constituents, biological parameters, and radiological parameters.

B. Health and Safety

Field work should be performed in accordance with the *Braun Intertec Corporate Health and Safety Manual Standard Operating Procedures* and the site-specific health and safety plan (HASP).

C. Referenced SOPs

- SOP 101 – Field Notes and Documentation
- SOP 308 – Trip Blanks
- SOP 309 – Field Filtering of Groundwater Samples
- SOP 311 – Groundwater Sample Collection
- SOP 312 – Well Purging and Stabilization
- SOP 316 – Calibration of Water Meters
- SOP 602 – Chain-of-Custody Procedures
- SOP 603 – Sample Shipping
- SOP 701 – Decontamination of Sampling Equipment

D. Equipment and Supplies

- Field Report Form or field logbook (see SOP 312 – Well Purging and Stabilization)
- Personal Protective Equipment (PPE)
- Thermometer
- Filtering apparatus (if applicable)
- Appropriate sample containers and preservatives (see applicable Sampling and Analysis Plan)
- Sample container labels
- Chain-of-Custody (COC) form (see SOP 602 – Chain-of-Custody Procedures)
- Temperature blanks (one per sample cooler)
- Trip blank, if necessary (see SOP 308 – Trip Blanks)
- Sample coolers
- Ice
- Waterproof and/or indelible ink pens
- Large resealable bags (e.g., 1- or 2-gallon Ziplocs) or garbage bags
- Decontamination products (see SOP 701 – Decontamination of Sampling Equipment)
- Hand tools (such as wrenches or sockets or knife for cutting tubing)
- Spare batteries for equipment or instruments
- Paper towels
- Purge bucket and stabilization instruments, such as a water quality meter (if required by Sampling and Analysis Plan)
- Cell phone camera or digital camera
- Groundwater Monitoring Data Sheet

E. Procedures

E.1. Bottle Order and Cooler Preparation

Several days before field work is scheduled to begin, call or email the laboratory to order sample containers. It is a good idea to order extra bottles to allow for breakage, extra samples, etc. If you are unsure of the required sample volumes or proper laboratory sample containers for specific analytical parameters, ask that a written description be included with the bottle order clarifying sample container requirements.

Before you leave for the field, be sure that you have the appropriate sample containers (including appropriate preservative) and that extra containers are included, if requested. **Be sure you are aware of sample volume, hold time and container requirements (discuss with analytical laboratory or project manager if unsure).**

Place ice into each sample cooler before collecting any samples. Double-bag the ice in sealable gallon bags or sealed garbage bags to avoid potential contact of water in the cooler with sample containers.

Place a temperature blank in each cooler and under the ice. If some samples will be analyzed for gasoline range organics (GRO), benzene, ethylbenzene, toluene and xylenes (BETX), or volatile organic compounds (VOCs), include a trip blank in each cooler.

E.2. Prior to Water Supply Sample Collection

- Don appropriate PPE as prescribed by the HASP.
- If stabilization parameters are required by the work plan, calibrate the stabilization instruments according to the manufacturers' instructions (see SOP 312 – Well Purging and Stabilization).

E.3. Supply Water Sample Collection

Water supply well samples will be collected directly from a designated water tap. This tap should be as close to the well head as the plumbing system reasonably allows and prior to any water treatment systems (such as water softeners, pressure tanks, filter units or chlorinators), if possible.

- Locate the tap to be used for purging and sample collection. Inspect the tap: remove aeration or the filter if present.
- Draw a diagram of the plumbing, including the area sampled. Note the sample collection point(s).
- If a hose is used to divert purged water away from the well site, connect it to the tap.
- Place the end of hose or the tap into a graduated bucket and turn the tap on for a slow, but steady, flow that minimizes aeration or disturbance of the water to be collected. Determine the purge rate in gallons per minute and record.
- There are two criteria that may be used for determining when purging is complete depending on the requirements of the work plan: 1) temperature, or 2) stabilization parameters. Note: The purpose of purging is to obtain a groundwater sample that is representative of the formation water.

If temperature is used to determine when to collect a sample:

- Purge the water supply well, taking a temperature reading every 2 minutes.
- The temperature should change as stagnant water from the water column in the well is purged and formation water enters the system.
- When the temperature has stabilized (less than 1 degree variation) for three successive readings purging is considered complete. Record the total gallons removed.

If stabilization parameters are required:

- Prior to sample collection, record successive pH, conductivity, and temperature readings at 5-minute intervals until stabilization is achieved, as described in SOP 312 – Well Purging and Stabilization.
- Use longer time intervals if the purged volume appears to be inadequate for the well sampled.
- Once the well has been stabilized, purging is considered complete. Record the total gallons removed.

Once purging is complete:

- If a hose has been used to divert water, disconnect it from tap.
- Collect samples from the same tap used to purge the well. Follow the sampling guidelines outlined in Section E.4. below.

E.4. Guidelines for Filling Sample Containers

- Containerize samples by order of the volatilization potential of the desired analytes. For example, volatile organic analysis (VOA) vials should be filled first, followed by semi-volatiles.
- For VOCs/GRO samples, fill the container to the top so that a positive meniscus is formed. Allow air bubbles to rise to the surface, carefully and quickly screw the cap onto the container and finger tighten. Invert the sample and tap it gently, looking for any air bubbles. If the sample contains air bubbles, open the container to add more water. If bubbles continue to form because the preservative is reacting with the sample matrix, discard the sample with preservative, rinse the vial with sample water, discard the rinse water, and fill the container with unpreserved sample water. The sample with preservative and the rinse water from the sample vial should be discarded with the purge water. Note that the allowable sample hold time is reduced from 14 days to 7 days for unpreserved samples. For unpreserved samples, make a note on the COC stating that the VOC sample is unpreserved and notify the technical project manager.
- For sample containers with preservative, be careful not to overfill the container, since this would dilute the preservative.
- If the sample analysis requires field filtering of the groundwater (e.g., samples for dissolved metals analysis) follow SOP 309 – Field Filtering of Groundwater Samples.
- Complete an appropriate sample container label on all containers. Include the following information: sample identification number, date and time of collection, sampling personnel, job site location, well number, preservation, and analysis requested.
- Place all samples on ice in a cooler.

E.5. After Water Supply Sample Collection

- If supply water sampling equipment is re-used between sampling points, refer to SOP 701 – Decontamination of Sampling Equipment for decontamination of groundwater sampling equipment.
- Water samples collected in the field should be recorded in the field log (see SOP 101 – Field Notes and Documentation) and on the COC (see SOP 602 – Chain-of-Custody Procedures). Information recorded in the field log and on the COC should be identical to the information listed on the sample container label(s). Additionally, note how many water sample containers were filled for each uniquely identified water sample.
- Arrange for pick-up/drop off groundwater samples in laboratory provided coolers to the analytical laboratory. If shipping of groundwater samples to the analytical laboratory is required, follow SOP 603 – Sample Shipping.

E.6. Data and Records Management

Observations should be documented in accordance with SOP 101 – Field Notes and Documentation.

E.7. Quality Assurance/Quality Control

Quality assurance/quality control (QA/QC) procedures described in the work plan should be followed.

A. Purpose

The purpose of this Standard Operating Procedure (SOP) is to provide a framework for calibrating field instruments used to measure water quality parameters for groundwater and surface water, commonly referred to water quality meters. Water quality parameters include temperature, pH, dissolved oxygen, specific conductance, oxidation/reduction potential (ORP), and turbidity. Not every project will require the measurement of all parameters. The site-specific Sampling and Analysis Plan should define the field parameters to be measured.

Most projects will require at least two standards, or calibration solutions, to bracket the expected measurement range for pH (this means that one standard is less than the expected value and one is higher) and a one point calibration for specific conductance and air % saturation calibration for dissolved oxygen. Braun Intertec typically rents turbidity meters. A pre-calibrated turbidity meter should be acquired from the rental firm and a one point calibration validation performed with a one point turbidity standard. When an environmental sample measurement falls outside the calibration range, the instrument must be re-calibrated to bracket the new range before continuing measurements.

Note: Temperature is not calibrated daily, but should be verified annually with a laboratory grade thermometer.

B. Health and Safety

Field work should be performed in accordance with the *Braun Intertec Corporate Health and Safety Manual Standard Operating Procedures* and the site-specific health and safety plan (HASP).

Calibration of water quality meters can pose a hazard to human health unless appropriate precautions are taken. Potential hazards include, but are not limited to:

- Exposure to acidic or basic solutions used to calibrate the instrument.

C. Referenced SOPs

- SOP 101 – Field Notes and Documentation

D. Equipment and Supplies

- Multiple parameter or individual parameter water quality meters for temperature, pH, specific conductance, ORP, dissolved oxygen, and/or turbidity. A YSI 556 meter is common, but other meters may be used. The YSI 556 does not measure turbidity.
- Spare batteries for the meter
- Appropriate unexpired solutions for each stage of the calibration including:
    - pH standards at 4 and 7 standard units (10 standard units optional)
    - Specific conductivity standard, such as 1,413 microsiemens per centimeter (µS/cm)
    - Zobell solution
    - Turbidity, such as 0 nephelometric turbidity unit (NTU), 1.0 NTU, and/or 10 NTU
- Deionized water
- Small cup for the calibration solutions
- Calibration instructions for each meter
- Paper towels
- Water Quality Meter Calibration Record (Attachment A)
- Field report form (see SOP 101 – Field Notes and Documentation) or field logbook
- Cell phone camera or digital camera

- Waterproof and/or indelible ink pens
- Personal Protective Equipment (PPE)

E. Procedure

E.1. Calibration

- At a minimum, calibrate the instrument prior to use on the first day the measurements are to be performed. If the instrument is rented and calibration documentation is provided by the rental company, no calibration is required on the first day of use. Provide a copy of the calibration record with the field notes. Instruments must be calibrated on subsequent days of use. However, for multiple days of use on a single site, it is acceptable to omit the calibration and verify the calibration by checking against standard solutions before use on each day (see Section E.2.).
- Ideally, the temperature of the calibration solutions, used for calibration or verification of the calibration, and probes should be close to the temperature of the water being tested.
- Ensure that the sensors are completely submersed during calibration. Use recommended volumes when performing calibrations.
- Fill a bucket with ambient temperature water to rinse the probe module between calibration solutions.
- Use paper towels to dry the probe module between rinses and calibration solutions. Shake excess rinse water off of the probe module, especially when the probe sensor guard is installed. Dry off the outside of the probe module and probe sensor guard. Making sure that the probe module is dry reduces carry-over contamination of calibration solutions and increases the accuracy of the calibration.
- Make certain that port plugs are installed in all ports where sensors are not installed. It is extremely important to keep these electrical connectors dry.
- Check the expiration date of standards. Do not use expired standards.

E.1.a. pH

- Choose appropriate buffered standards that will bracket the expected values at the sampling locations. If the pH of the water to be tested is unknown, three standards are needed for the calibration (i.e., three point calibration): one close to seven, one at least two pH units below seven, and the other at least two pH units above seven.
- When calibrating pH, always calibrate with buffer 7 first, regardless if performing a 1, 2, or 3 point calibration.
- Follow the manufacturer's instructions to calibrate the instrument.
- Upon successful completion of the calibration, complete the Water Quality Meter Calibration Record.

E.1.b. Dissolved Oxygen

- Dissolved oxygen (DO) is reported on the water quality meter as either % saturation or milligrams per Liter (mg/L). The meter is calibrated to % saturation, and the dissolved oxygen concentration is recorded on the field log as mg/L.
- To ensure proper operation, the DO probe's membrane and electrolyte should be inspected prior to use. Failure to perform this step may lead to erratic measurements. Before performing the calibration/measurements, inspect the membrane for air bubbles and nicks.
- If you use the Transport/Calibration Cup for a water-saturated air calibration, make certain to loosen the seal to allow pressure equilibration before calibration.
- The DO calibration may require input of the atmospheric pressure. Use an appropriate barometer application on your phone to accurately determine the current atmospheric pressure in your area in units of millimeter of mercury (mmHg).

- Follow the manufacturer's instructions to calibrate the instrument.
- Upon successful completion of the calibration, complete the Water Quality Meter Calibration Record.

E.1.c. Specific Conductance

- Specific conductance, also referred to as conductivity, electrical conductivity or specific electrical conductance, is a measure of the ability of a water to conduct electricity. In general, the higher the concentration of dissolved salts in the water, the easier it is for electricity to pass through water. Conductivity is reported in micromhos (µmhos) or microsiemens (µS) per centimeter (cm).
- Most instruments are calibrated against a single standard which is near the specific conductance of the environmental samples. The standard can be either below or above the specific conductance of the environmental samples.
- Record the standard used in calibration on the Water Meter Calibration Record. Indicate whether the results are being reported as specific conductance (conductivity adjusted to temperature of 25°C) or specific conductivity (not temperature adjusted). Ensure that the correct units are being reported. Some field instruments will switch the reporting units to millisiemens per centimeter (mS/cm) if water sample is salty/brackish.
- Follow the manufacturer's instructions to calibrate the instrument.
- Upon successful completion of the calibration, complete the Water Quality Meter Calibration Record.

E.1.d. Oxidation/Reduction Potential

- The oxidation/reduction potential (ORP) is the electrometric difference measured in a solution between an inert indicator electrode and a suitable reference electrode. The electrometric difference is measured in millivolts and is temperature dependent.
- Follow the manufacturer's instructions to calibrate the instrument.
- Upon successful completion of the calibration, complete the Water Quality Meter Calibration Record.

E.1.e. Turbidity

- The turbidity method is based upon a comparison of intensity of light scattered by a sample under defined conditions with the intensity of light scattered by a standard reference suspension. A turbidimeter is a nephelometer with a visible light source for illuminating the sample and one or more photo-electric detectors placed ninety degrees to the path of the light source. The turbidity meter will normally be calibrated by the rental company prior to use. This SOP requires verification of the instruments with one standard. If available, verify with a second or third standard.
- Follow the manufacturer's instructions to verify the instrument.
- Upon successful completion of the verification, complete the Water Quality Meter Calibration Record.

E.2. End of Day Verification

- Verification at the end of the day is required to determine if the instrument drifted out of calibration during daily use. It is acceptable to perform verification instead of calibration if monitoring of the same site exceeds one day.
- Immerse the probe in each of the standard solutions and compare the reading to the standard. Readings that meet the following criteria are in control:

Parameter	Criteria
pH	± 0.3 pH unit with pH 7 buffer
Specific Conductance	±5% of standard or ± 10 µS/cm (whichever is greater)
Dissolved Oxygen	± 0.5 mg/L of sat. value < 0.5 mg/L for the 0 mg/L solution, but not a negative value
ORP	± 10 mv
Turbidity	± 5% of standard

- Note the results of the verification on the Water Quality Meter Calibration Record. Make a note of readings that are not in control.

E.3. Data and Records Management

Calibrations and verifications should be recorded on the Water Quality Meter Calibration Record. Observations should be documented in accordance with SOP 101 – Field Notes and Documentation. Any deviations from the procedures outlined in this document or in a site-specific document should be described in detail in a field report form or field logbook, otherwise referencing existing procedures is sufficient.

E.4. Quality Assurance/Quality Control

Quality assurance/quality control (QA/QC) procedures described in the Sampling and Analysis Plan should be followed.

F. References

Standard Operating Procedure, Calibration of Field Instruments by Quality Assurance Unit of U.S. Environmental Protection Agency — Region 1 dated January 19, 2010.

BRAUN INTERTEC

Water Quality Meter Calibration Record

Project Name:					Project No.:				
Location:					Field Personnel:				
Instrument(s) Used:									
		Date		**Date**		**Date**		**Date**	
Parameter		**Conditions During Calibration**							
Air Temperature (°C)									
Barometric Pressure (mmHg)									
Temperature of Standard Solutions (°C)									
Parameter	**Standard Value**	**Calibrated ?**	**End of Day Reading**	**Calibrated ?**	**End of Day Reading**	**Calibrated ?**	**End of Day Reading**	**Calibrated ?**	**End of Day Reading**
Specific Conductance Standard #1	_______ µS/cm	YES NO NA		YES NO NA		YES NO NA		YES NO NA	
Specific Conductance Standard #2	_______ µS/cm	YES NO NA		YES NO NA		YES NO NA		YES NO NA	
pH	7	YES NO NA		YES NO NA		YES NO NA		YES NO NA	
pH	4	YES NO NA		YES NO NA		YES NO NA		YES NO NA	
pH	10	YES NO NA		YES NO NA		YES NO NA		YES NO NA	
ORP Zobell Solution	_________mV	YES NO NA		YES NO NA		YES NO NA		YES NO NA	
Dissolved Oxygen 100% saturated water	__________mg/L	YES NO NA		YES NO NA		YES NO NA		YES NO NA	
Dissolved Oxygen 0% dissolved oxygen solution	_________mg/L	YES NO NA		YES NO NA		YES NO NA		YES NO NA	
Parameter	**Standard Value**	**Start of Day Reading**	**End of Day Reading**	**Start of Day Reading**	**End of Day Reading**	**Start of Day Reading**	**End of Day Reading**	**Start of Day Reading**	**End of Day Reading**
Turbidity Standard #1	________ ntu								
Turbidity Standard #2	________ ntu								
Turbidity Standard #3	________ ntu								

Verification Criteria

Specific Conductance ±5% of standard or ± 10 µS/cm (whichever is greater)
pH ± 0.3 pH unit with pH 7 buffer
ORP ± 10 mv
Dissolved Oxygen ± 0.5 mg/L of saturated value for the fully saturated solution
< 0.5 mg/L for the 0 mg/L solution, but not a negative value
Turbidity ± 5% of standard

A. Purpose

The purpose of the Chain-of-Custody (COC) Standard Operating Procedure (SOP) is to control environmental samples from the time they are collected until custody of the samples is accepted by the laboratory sample custodian. COC documentation serves three main purposes:

- Communicates the analytical instructions from the sampler to the analytical laboratory.
- Provides a permanent record of samples provided to the laboratory.
- Documents that samples were handled only by authorized personnel and were not available for tampering prior to analysis.

A.1. Scope and Applicability

Although few environmental samples will ever be used in criminal or civil litigation cases, most samples are collected in support of government-regulated activities. In addition, it is possible that the results of the sample analyses will be used in future litigation even if none was contemplated at the time the samples were collected. Therefore, it is important that a record of sample possession (i.e., COC) be maintained, so that control of the samples from the time of collection to the time of sample laboratory check-in can be demonstrated.

Laboratory-related sample control is described in laboratory operating and quality-control documents and is not discussed in this standard operating procedure (SOP).

This procedure should be used for control of environmental samples that include, but are not limited to those of groundwater (see SOP 311 – Groundwater Sample Collection), surface water (see SOP 314 – Surface Water Sampling), soil (see SOP 208 – Soil Grab Sample Collection and SOP 209 – Soil Composite Sample Collection), air (see SOP 402 – Indoor Air Sampling), soil vapor (see SOP 403 – Soil Vapor Sampling from a Borehole and with a Hand Probe and SOP 405 – Sub-Slab Soil Vapor Sampling), and waste.

A.2. Summary of Method

Environmental samples are collected using methods specified in the work plan or other SOPs. The samples are collected in sampling containers for the desired analyses, preserved as appropriate, and a label is affixed to each container specifying the project name and number, sample identification, date and time of collection, and sample collector. The information is entered onto the COC form and the desired analyses are indicated on the form, which also serves as the analytical request. Sample custody (possession) is maintained individually until the samples are delivered to the laboratory sample check-in. Transfer of custody is documented on the COC form by printed name, signature, date and time.

A.3. Personnel Qualifications and Responsibilities

The sampler is responsible for understanding, implementing and documenting activities related to this SOP during field activities. The sampler is responsible for transmitting a copy of field notes that have not been forwarded to the project manager or designee, as well as a copy of the COC form(s) immediately after sample check-in. If there is more than one sampler, the lead field sampler assumes these responsibilities.

A.4. Definitions

Chain-of-Custody Procedure: A procedure whereby a sample or set of samples is maintained under physical possession or control.

Custody: Samples and data are considered to be in your custody when:

- They are in your physical possession,
- They are in your view, after being in your physical possession,
- They are in your physical possession and then locked in a room or vehicle so that tampering cannot occur, or
- They are kept in a secured area, with access restricted to authorized personnel only.

Chain-of-Custody Form: Form used to record sample identification information, test(s) requested, result reporting instructions, and sample custody.

Sample: A portion of an environmental or source matrix that is collected and used to characterize the matrix.

B. Health and Safety

Field work should be performed in accordance with the *Braun Intertec Corporate Health and Safety Manual Standard Operating Procedures* and the site-specific health and safety plan (HASP).

Department of Transportation (DOT), United States Postal Service (USPS), and Federal Aviation Administration (FAA) shipping/labeling regulations must be followed for shipped samples.

C. Referenced SOPs

- SOP 208 – Soil Grab Sample Collection
- SOP 209 – Soil Composite Sample Collection
- SOP 314 – Surface Water Sampling
- SOP 402 – Indoor Air Sampling
- SOP 403 – Soil Vapor Sampling from a Borehole and with a Hand Probe
- SOP 405 – Sub-Slab Soil Vapor Sampling

D. Equipment and Supplies

- Field Report Form (see SOP 101 – Field Notes and Documentation) or field logbook
- Waterproof or indelible ink pens
- Sample labels
- Custody seals
- Chain-of-Custody (COC) forms (see SOP 602 – Chain-of-Custody Procedure)

E. Procedure

E.1. General Guidelines

- Keep the number of people involved in collecting and handling samples and data to a minimum.
- Only personnel associated with the project should handle samples and data.
- Always document the transfer of samples and data from one person to another on the COC form.
- Always accompany samples and data with the COC form.
- Samples should be uniquely identified, legibly, in permanent ink.
- Fill out the COC form as completely as possible. The sample identification information on the sample containers must match the COC form.
- Use a separate COC form for each cooler.

E.2. Completing COC Form

The COC form should be filled out by the sampler or designee as the samples are being collected and containerized.

E.3. Securing Samples

If you cannot maintain personal possession of the samples prior to sample check-in, they may be secured. A locked vehicle is considered controlled access (i.e., secured). A cooler sitting on the tailgate of a pickup truck or under an unlocked topper, out of direct view of the custodian is not secure. An unsecured cooler in a locked hotel room is also not within controlled access as hotel staff have access to the room. In this case, the cooler could be padlocked or custody seals could be used to secure the samples or cooler.

E.4. Data and Records Management

The original COC form is maintained by the laboratory in accordance with their file retention guidance. A copy of the record should be provided to the project manager or designee with a copy of the sampling field notes by the sampler immediately after sample check-in.

E.5. Quality Assurance Quality Control

Quality assurance/quality control (QA/QC) procedures described in the work plan should be followed.

The project manager or designee should review the COC form as soon as possible after sample check-in to verify that the information on the COC form is correct.

A. Purpose

The purpose of this Standard Operating Procedure (SOP) is to describe the procedure used for proper packaging methods and shipment of samples by overnight carrier via Chain-of-Custody (COC) procedures (see SOP 602 – Chain-of-Custody Procedures).

A.1. Scope and Applicability

If samples cannot be delivered to the laboratory in person and must be shipped, the following procedures should be used.

This procedure should be used for shipping of environmental samples that include, but are not limited to those of groundwater (see SOP 311 – Groundwater Sample Collection), surface water (see SOP 314 – Surface Water Sampling), soil (see SOP 208 – Soil Grab Sample Collection and SOP 209 – Soil Composite Sample Collection), air (see SOP 402 – Indoor Air Sampling), soil vapor (see SOP 403 – Soil Vapor Sampling from a Borehole and with a Hand Probe and SOP 405 – Sub-Slab Soil Vapor Sampling), and waste.

A.2. Summary of Method

Environmental samples are collected using methods specified in the work plan or other SOPs. The samples are collected in sampling containers for the desired analyses, preserved as appropriate, and a label is affixed to each container specifying the project name and number, sample identification, date and time of collection, and sample collector. The information is entered onto the COC form and the desired analyses are indicated on the record, which also serves as the analytical request. Sample custody (possession) is maintained individually until the samples are delivered to the laboratory sample check-in. Transfer of custody is documented on the COC form by printed name, signature, date, and time.

A.3. Personnel Qualifications and Responsibilities

The sampler is responsible for understanding, implementing, and documenting activities related to this SOP during field activities. The sampler is responsible for transmitting a copy of field notes that have not been forwarded to the project manager or designee, as well as a copy of the COC form(s) immediately after samples are shipped. If there is more than one sampler, the lead sampler assumes these responsibilities.

A.4. Definitions

Chain-of-Custody Procedure: A procedure whereby a sample or set of samples is maintained under physical possession or control.

Custody: Samples and data are considered to be in your custody when:

- They are in your physical possession.
- They are in your view, after being in your physical possession.
- They are in your physical possession and then locked up so that tampering cannot occur.
- They are kept in a secured area, with access restricted to authorized personnel only.

Chain-of-Custody Form: Form used to record sample identification information, test(s) requested, result reporting instructions and sample custody.

B. Health and Safety

Field work should be performed in accordance with the *Braun Intertec Corporate Health and Safety Manual Standard Operating Procedures* and the site-specific health and safety plan (HASP).

Department of Transportation (DOT), United States Postal Service (USPS), and Federal Aviation Administration (FAA) shipping/labeling regulations must be followed for shipped samples.

C. Referenced SOPs

- SOP 208 – Soil Grab Sample Collection
- SOP 209 – Soil Composite Sample Collection
- SOP 308 – Trip Blanks
- SOP 314 – Surface Water Sampling
- SOP 402 – Indoor Air Sampling
- SOP 403 – Soil Vapor Sampling from a Borehole and with a Hand Probe
- SOP 405 – Sub-Slab Soil Vapor Sampling
- SOP 602 – Chain-of-Custody Procedures

D. Equipment and Supplies

- Sample coolers or similar shipping containers (solid or liquid samples)
- Sturdy cardboard boxes (steel air canister)
- Protective wrapping and packaging materials
- Ice
- Appropriate laboratory-supplied containers and preservatives (when applicable)
- Sample labels
- Temperature blanks (one per sample cooler)
- Trip blanks, if necessary (see SOP 308 – Trip Blanks)
- Gallon-size plastic bags
- Waterproof and/or indelible ink pens
- COC forms (see SOP 602 – Chain-of-Custody Procedure)
- Custody seals
- Clear packing tape
- Shipping labels for the exterior of the shipping container
- Bill of lading for selected carrier

E. Procedure

E.1. General Guidelines

- Sample containers with solids or liquids should be placed inside of sealable plastic bags to reduce the potential for cross contamination, breakage, and melted ice getting into the samples.
- The drain plug on the cooler, if present, should be taped shut from the inside and outside.
- A layer of protective material such as bubble wrap should be placed in the bottom of the cooler.

E.2. Cooler Guidelines

- If possible, place all contents of the cooler into a large plastic bag that is tied or taped shut to avoid melted ice from leaking out of the cooler during shipping.
- Sample containers should be placed upright in the cooler, and protective material such as bubble wrap should be placed around the sample containers. Do not stack glass containers or lay them on their side, as doing so increases the chance of them breaking.
- Fill the cooler no more than 50 percent with sample containers. Fill all the remaining void space in the cooler with protective material and ice to avoid breakage during transport. At least 1/3 of total cooler space should be taken up by ice. When in doubt, use more ice.
- Ice that is double bagged in sealable plastic bags should be distributed over the top of the samples.
- Additional protective material should then be added to the cooler.
- Ensure that a temperature blank bottle and trip blank (if needed) is in each cooler and included on the COC form.
- Total weight must be less than 30 pounds.

E.3. Air Canister Guidelines

- If possible, reuse the cardboard box provided by the laboratory. If not possible, use a sturdy cardboard box to contain the air canister and associated regulator.
- Include bubble wrap as necessary to reduce movement of the canister and regulator during shipment.
- Use clear packing tape to secure the box during shipment.

E.4. COC Guidelines

- The sampler should relinquish the samples by signing and indicating the date and time that the samples were relinquished to the shipper. The shipping company agent is not required to sign the COC form.
- Field personnel should retain a copy of the COC form and attach it to the field notes.
- The COC form should be placed in a sealable plastic bag and taped to the inside of the cooler lid or placed inside the cardboard box. At least one COC form should be placed in each cooler that is sent to the laboratory.

E.5. Custody Seal Guidelines

- Close the top of the cooler and rotate/shake the cooler to verify that the contents are packed so that they do not move. Add additional protective material if needed and reclose.
- Place one custody seal on the front and on the back of the cooler in such a way that the opening of the cooler will destroy the seal. If shipping air canisters, place the custody seal where the cardboard box flaps meet.
- Tape the cooler or the cardboard box shut with clear packing tape, wrapping all the way around each end. Be sure to tape over the custody seals.

E.6. Shipping Guidelines

- Samples sent by private carrier (UPS, FedEx, etc.) will be accompanied by a bill of lading or other shipping document. Shipping documentation should be saved as part of the permanent record. DOT, USPS, and FAA shipping/labeling regulations must be followed. The contents should be described on the shipping documents as "non-hazardous environmental samples" unless the samples are known to be hazardous such as methane gas samples. If hazardous, contact the laboratory for special shipping instructions. Fill out the correct shipping paperwork with the correct shipping address for the laboratory and tape to the top of the cooler or shipping box. Wrap packing tape around the entire cooler or shipping box. Retain copies of all shipment records as provided by the shipper.
- The cooler or shipping box should be shipped to "Laboratory Sample Receiving" marked "Deliver to addressee only," and the laboratory should be notified of its approximate delivery date and time.
- Deliver the cooler or have the cooler picked up by an overnight carrier that guarantees 24-hour delivery. Consideration should be given to the expected delivery date and the weather. The preferred carriers are shown below in order of preference.
  - Contract shipper such as Speedee (Minnesota only).
  - UPS through Braun Intertec Document Center or front desk (Minneapolis only).
  - UPS through retail outlet.
  - FedEx – may require an explanation stating the container is <u>non-hazardous</u> or the canister <u>is not a cylinder</u>, contains air, is non-flammable, and <u>is not under pressure</u>.
  - US mail – no special marking required.

E.7. Data and Records Management

The original request for COC form is maintained by the laboratory in accordance with their file retention guidance. A copy of the record should be provided to the project manager or designee with a copy of the sampling field notes by the field personnel immediately after sample check-in.

E.8. Quality Assurance Quality Control

Quality assurance/quality control (QA/QC) procedures described in the work plan should be followed.

The project manager or designee should review the COC form as soon as possible after sample check-in to verify that the information on the COC form is correct.

A. Purpose

The purpose of the Standard Operating Procedure (SOP) is the procedure of decontaminating reusable equipment involved in soil, groundwater, and soil vapor activities. Reusable equipment must be properly decontaminated to provide chemical analysis results which are reflective of the actual concentrations present at sampling locations, and to minimize the potential for cross-contamination between sampling locations and the transfer of contamination off-site.

Applicable soil SOPs include SOP 203 – Soil Boring Observation and Sampling, SOP 208 – Soil Grab Sample Collection, SOP 209 – Soil Composite Sample Collection, SOP 210 – Soil Stockpile Sampling, and SOP 211 – Test Pit and Test Trench Observation and Sampling.

Applicable water SOPs include SOP 301 – Water Level Measurement, SOP 302 – LNAPL Level Measurement, SOP 303 – Monitoring Well Development, SOP 304 – Slug Testing, SOP 309 – Field Filtering of Groundwater Samples, SOP 310 – Monitoring Well and Piezometer Installation, SOP 311 – Groundwater Sample Collection, SOP 312 – Well Purging and Stabilization, SOP 314 – Surface Water Sampling, and SOP 316 – Calibration of Water Meters.

The applicable soil vapor SOP includes SOP 405 – Sub-Slab Soil Vapor Sampling.

Be sure to follow the site-specific sampling plan that may require special cleaning or rinsing methods, and/or special handling and disposal of wash and rinse water (also see SOP 702 – Management of Investigation Derived Waste). Additional rinses with solvents such as hexane, acetone, or acid may be required by the site-specific sampling plan, but are not covered in this SOP.

B. Health and Safety

Field work should be performed in accordance with the *Braun Intertec Corporate Health and Safety Manual Standard Operating Procedures* and the site-specific health and safety plan (HASP).

Nitrile gloves should be worn during decontamination activities to reduce the incidence of skin contact with potentially contaminated soil/groundwater and to reduce the risk of cross-contamination. In certain situations, long-sleeved rubber gloves may be needed to prevent contact.

C. Referenced SOPs

- SOP 101 – Field Notes and Documentation
- SOP 203 – Soil Boring Observation and Sampling
- SOP 208 – Soil Grab Sample Collection
- SOP 209 – Soil Composite Sample Collection
- SOP 210 – Soil Stockpile Sampling
- SOP 211 – Test Pit and Test Trench Observation and Sampling
- SOP 301 – Water Level Measurement
- SOP 302 – LNAPL Level Measurement
- SOP 303 – Monitoring Well Development
- SOP 304 – Slug Testing
- SOP 309 – Field Filtering of Groundwater Samples
- SOP 310 – Monitoring Well and Piezometer Installation
- SOP 311 – Groundwater Sample Collection
- SOP 312 – Well Purging and Stabilization
- SOP 314 – Surface Water Sampling
- SOP 316 – Calibration of Water Meters

- SOP 405 – Sub-Slab Soil Vapor Sampling
- SOP 702 – Management of Investigation Derived Waste

D. Equipment and Supplies

- Clean tap water (for washing and rinsing soil sampling equipment)
- Distilled or deionized water (for washing and rinsing groundwater sampling equipment)
- Clean container for wash water (bucket, spray bottle, etc.)
- Phosphate-free detergent (i.e., Alconox or Liquinox in bulk containers or individual packets)
- Scrub brush (soil sampling equipment decontamination)
- Paper towels
- Field Report Form (see SOP 101 – Field Notes and Documentation) or field logbook
- Personal Protective Equipment (PPE)

E. Procedures

E.1. Soil Sampling Equipment

E.1.a. Hand Tools

Hand tools used for sampling include shovels, hand trowels, hand augers, etc. Before collecting each new soil sample, clean the equipment as follows:

- Remove loose or attached soil from the tool with a gloved hand, paper towel, or brush.
- Wash and brush the tool in a solution of phosphate-free detergent in tap water.
- Rinse the tool with tap water.
- Inspect for remaining particles or surface film, and repeat cleaning and rinsing procedures if necessary.

E.1.b. Direct-Push Sampling Equipment and Split Spoon Sampler

The drilling contractor is responsible for cleaning reusable sampling equipment; however, field personnel must ensure that proper procedures are followed. Prior to collecting each sample the reusable sampling equipment should be cleaned as follows:

- Remove loose or attached soil from the sampler components.
- Wash the sampler components in a solution of phosphate-free detergent in tap water.
- Rinse the sampler components with tap water.
- Inspect for remaining particles or surface film, and repeat cleaning and rinsing procedures if necessary.

E.1.c. Drill Rig Auger Flights

The drilling contractor is responsible for providing clean auger equipment; however, field personnel must ensure that proper procedures are followed. Prior to each use the auger flights should be cleaned as follows:

- Remove loose or attached soil from the auger flight.
- Wash the auger flight with a pressure washer and clean tap water.
- Inspect for remaining particles or surface film, and repeat cleaning and rinsing procedures if necessary.

E.2. Groundwater Sampling Equipment

E.2.a. Groundwater Measuring and Sampling Equipment

This procedure applies to all reusable equipment that will be placed into a well (including water level indicators, transducers, slugs, groundwater sample equipment, and pumps). Groundwater measuring and sampling equipment should be decontaminated after use at each well or sampling point as follows:

- Wash the exterior with a solution of phosphate-free detergent in distilled or deionized water.
- Rinse with distilled or deionized water.
- Inspect for remaining particles or surface film and repeat cleaning and rinsing procedures if necessary.
- Do not wipe dry.

E.3. Product Interface Probe

The product interface probe is only used in wells that may contain light non-aqueous phase liquid (LNAPL). Prior to each use the product interface probe should be cleaned as follows:

- After fluid levels in each well are measured, wipe the probe and tape with a paper towel.
- After returning to the office, clean the probe and tape in a solution of phosphate-free detergent and tap water. Allow the probe and tape to soak in the solution up to 24 hours, if possible.

E.4. Vapor Sampling Equipment

E.4.a. Vapor Pins® – Used for Sub-Slab Soil Gas Sampling

This office-only procedure applies solely to the Vapor Pin® itself that will be used to obtain a soil gas sample. Once the Vapor Pin® has been used it will be brought back to the office and cleaned as follows:

- Remove the silicone sleeve and discard.
- Wash the Vapor Pin® in a hot water and phosphate-free detergent wash.
- Bake in an oven to a temperature of 130°C (266°F) for at least one hour.

E.5. Data and Records Management

Observations should be documented in accordance with SOP 101 – Field Notes and Documentation.

E.6. Quality Assurance/Quality Control

Quality assurance/quality control (QA/QC) procedures described in the work plan should be followed.

A. Purpose

In the process of collecting environmental samples during field investigation activities, several different types of waste may be generated. These wastes are referred to as investigation derived waste (IDW). Some of these waste materials may be hazardous wastes and must be properly managed in accordance with Environmental Protection Agency (EPA) regulations. Materials which may become IDW requiring proper management include:

- Used Personal Protective Equipment (PPE) such as gloves, boots, Tyvek® clothing, spent respirator cartridges, etc.
- Disposable sampling equipment including bailers, filters, rope, sleeves from soil probes, tubing, sealable plastic bags, etc.
- Soil cuttings from drilling, probing, hand augering, or test trenching.
- Drilling mud or water used for rotary drilling.
- Groundwater obtained through well development or purging.
- Light non-aqueous phase liquid (LNAPL) combined with groundwater obtained through well development or purging.

B. Health and Safety

Field work should be performed in accordance with the *Braun Intertec Corporate Health and Safety Manual Standard Operating Procedures* and the site-specific health and safety plan (HASP).

C. Referenced SOPs

- SOP 101 – Field Notes and Documentation

D. Equipment and Supplies

Some or all of the following materials may be needed for the proper management of IDW:

- Plastic or galvanized tubs or pails
- Plastic garbage bags
- 55-gallon drums
- Drum wrench
- Roll-off dumpster
- Poly-sheeting (10 mil or thicker)
- Self-adhesive labels and permanent marker
- Field Report Form (see SOP 101 – Field Notes and Documentation) or field logbook
- PPE

E. Procedure

E.1. Characterization of IDW

IDW must be characterized in accordance with applicable state and federal hazardous waste regulations. In some cases, wastes are hazardous waste regardless of test results (i.e., listed hazardous wastes). Characterization of IDW includes activities performed before, during, and after the wastes are generated. IDW characterization may include:

- **Historical Research** – A Phase I Environmental Site Assessment (ESA), Phase II ESA, prior analytical data, and/or environmental permits can provide information regarding potential and existing contaminants of concern. In cases where prior investigations and/or analytical data are not available, additional steps should be taken to properly characterize IDW.

- **Visual and Olfactory Observations** – Some contaminants of concern can be detected using visual and/or olfactory observations such as the presence of staining and odors, respectively. However, visual and olfactory observations should only be used as a qualitative determination regarding the presence or absence of contamination.
- **Field Screening** – Field screening equipment such as a photoionization detector (PID), Draeger tubes, and/or colorimetric tubes can provide an approximation of the magnitude of contamination present. Appropriate field screening equipment should be selected based on historical research and applicable site-specific work plans.
- **Laboratory Analysis** – Analytical data provides the highest degree of accuracy regarding the magnitude of contamination present. Analytical parameters should be selected based on historical research and analytical data from site investigations. Disposal facilities may require toxicity characteristic leaching procedure (TCLP) analysis if elevated contaminants are present in IDW.

E.2. Temporary Storage of IDW

IDW may require temporary storage pending characterization. Containers should be selected based on the physical and chemical characteristics of the contaminants of concern being investigated using available characterization data. Other considerations include weather conditions, security of the storage facility, mobility of the container, and duration of storage. Commonly used waste disposal containers include 55-gallon drums, garbage bags, and roll-off dumpsters. IDW containers must be labeled with the following information:

- Date of generation
- Description of contents
- Emergency contact information

IDW may also be stockpiled on site by placing the material on polyethylene sheeting or an impermeable surface such as asphalt or concrete, covering the material with polyethylene sheeting, and anchoring polyethylene sheeting to prevent infiltration of contaminants of concern from precipitation.

When containing IDW in drums, solids and liquids must be kept in separate drums. Each drum should be labeled with:

- “Braun Intertec” and a contact phone number,
- A unique identification number,
- Date(s) material was containerized,
- Source locations (if applicable), and
- Collector’s initials.

Secure the drum cover and take precautions to ensure that the drum will not be disturbed.

Appropriate characterization must precede disposal of contained materials. The site-specific Sampling and Analysis Plan or project manager will determine the appropriate testing based on the anticipated contaminants of concern in the IDW and the anticipated disposal method.

E.3. Disposal of IDW

IDW should be managed as described in Attachments A and B or as determined by the project manager and/or the site-specific Sampling and Analysis Plan. Field personnel should consult with the project manager to assess if leaving IDW on-site has the potential to endanger human health or the environment. More conservative IDW management methods may be appropriate if the client does not own the property where field activities are performed and during winter conditions.

Information regarding IDW requiring off-site disposal should be recorded in the field logbook or on the field report form, including the drum number or stockpile identifier, a description of the waste including location generated and estimated volume, and a list of samples collected for characterization of the IDW.

If the IDW is classified as non-hazardous waste or petroleum, or as potentially hazardous, it should be disposed of promptly where permitted (see Attachment A and Attachment B).

If the IDW is classified as hazardous waste, it must be labeled, stored, handled, transported and treated/disposed according to state and federal hazardous waste regulations and the generator's classification (large, small, or very-small quantity generator).

In all cases, IDW must be properly disposed in 90 days or fewer. Braun Intertec field personnel should not sign waste profiles or shipping documents on behalf of clients or as an "agent" for clients unless a formal agreement has been executed with the client.

E.4. Data and Records Management

Observations should be documented in accordance with SOP 101 – Field Notes and Documentation.

E.5. Quality Assurance/Quality Control

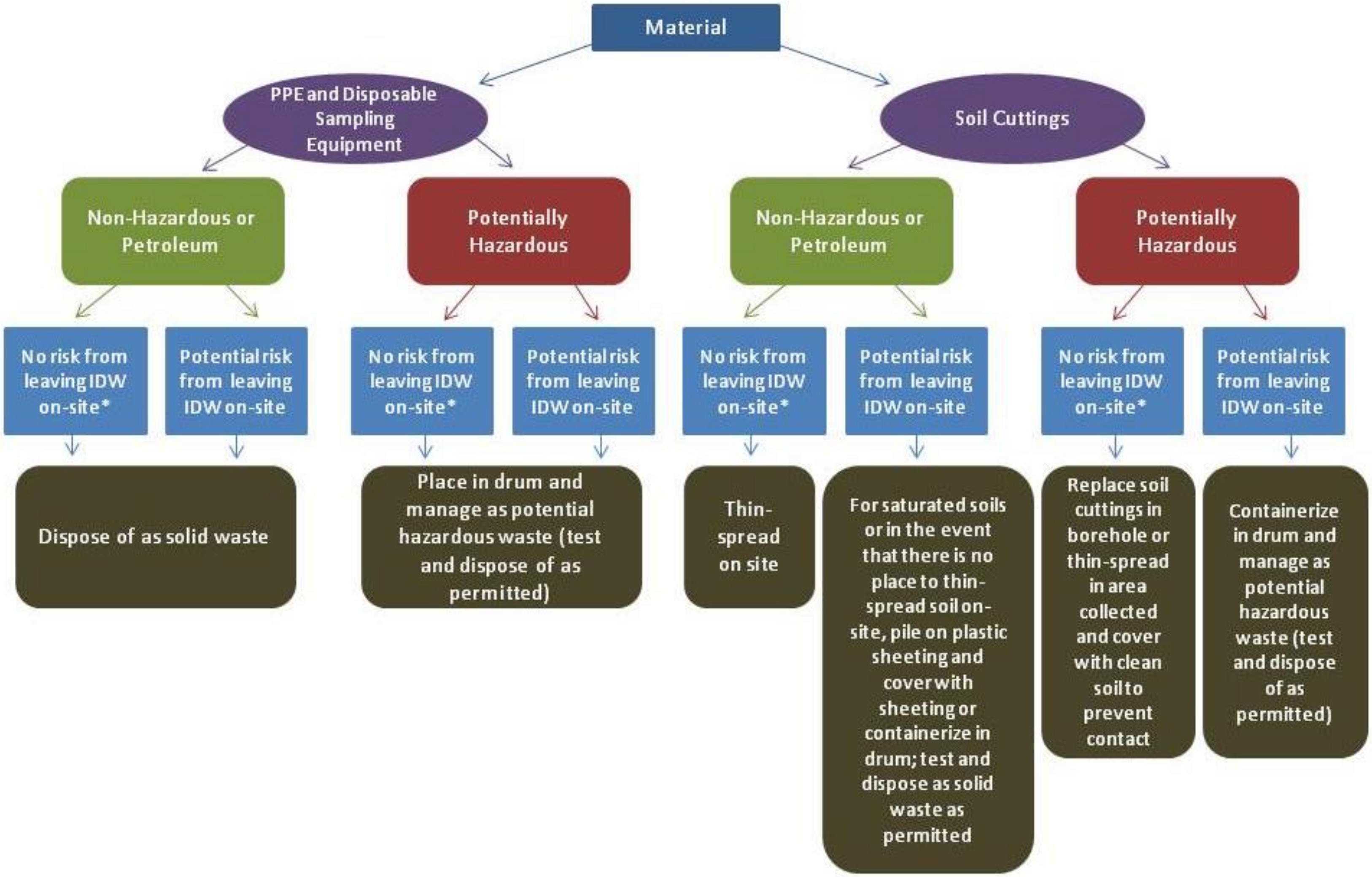
Quality assurance/quality control (QA/QC) procedures described in the work plan should be followed.

F. References

United States Environmental Protection Agency, July 3, 2014, Region 4, Science and Ecosystem Support Division Operating Procedure, Management of Investigation Derived Waste, SESDPROC-202-R3, Athens, GA.

BRAUN INTERTEC

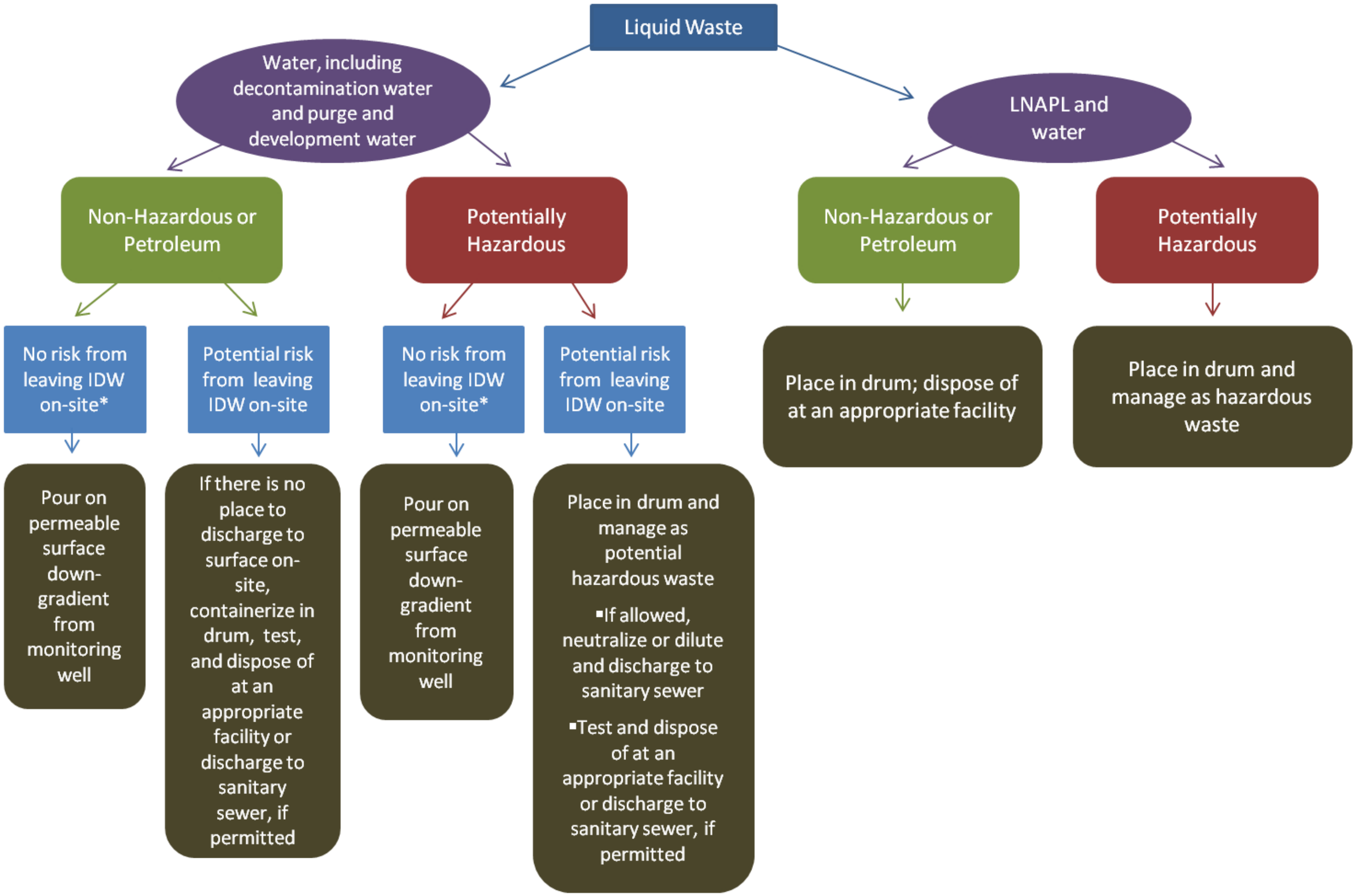
Attachment A
Management of Solid Investigation Derived Waste



* Management method for IDW at sites with no known areas of significant contamination and no known hazardous waste issues and where leaving IDW on-site will not endanger human health or the environment. Use more conservative method if the site history or regulatory status warrants. Field personnel should consult with the project manager before thin-spreading soil.

BRAUN INTERTEC

Attachment B
Management of Liquid Investigation Derived Waste



* Management method for IDW at sites with no known areas of significant contamination and no known hazardous waste issues and where leaving IDW on-site will not endanger human health or the environment. Use more conservative method if the site history or regulatory status warrants. Field personnel should consult with the project manager before pouring liquids on permeable ground surfaces.