September 6, 2024

Mr. Jim Alford
General Manager, Cenex Zip Trip
16124 E. Marietta Lane
Spokane Valley, WA 99216

Delivered via email: Jim.Alford@chsinc.com

SUBJECT: Groundwater Monitoring Work Plan
Cenex Zip Trip # 72
2801 Harrison Ave, Butte, Silver Bow County, Montana
MDEQ Facility ID 47-05148 (TID 28404); Release #4397; Work Plan 34917
Tetra Tech Project No. 117-7462109A

Dear Mr. Alford:

Tetra Tech is pleased to submit this work plan to conduct groundwater monitoring at the above-referenced facility (Figure 1). This work plan has been prepared in response to a request from Christopher Herman of the Montana Department of Environmental Quality (MDEQ) in correspondence dated August 12, 2024 (MDEQ, 2024). In this correspondence, Mr. Herman made the following requests:

- Use the standardized work plan and report formats found under the Guidance dropdown at the Petroleum Tank Cleanup Section (PTCS). Please submit a Petroleum Tank Release Compensation Board (PTRCB) Groundwater Monitoring and Sampling Unit Cost Worksheet (enclosed and available under the Forms and Worksheets tab at the PTRCB webpage).
- *Monitor groundwater at facility monitoring wells. Gauge fluid levels at all facility monitoring wells. Collect groundwater samples at select monitoring wells by low-flow sampling methodology according to DEQ's Groundwater Sampling Guidance found under the Guidance dropdown at the PTCS webpage.*
- *Analyze groundwater samples for petroleum constituents as required by the Montana Risk-Based Corrective Action Guidance for Petroleum Releases. Analyze samples for intrinsic biodegradation indicators once a year.*
- *Dispose of purge water according to the Disposal of Untreated Purge Water from Monitoring Wells flowchart found under the Guidance dropdown at the PTCS.*
- *Validate all laboratory analytical data using DEQ's Data Validation Summary Form (DVSF) found online under the Guidance dropdown at the PTCS.*
- *Discuss ongoing WP tasks and results with DEQ's project manager; submit written agreed-upon WP modifications as required to complete the WP objectives.*

- *Prepare and submit an Interim Data Submittal (IDS) for each interim groundwater monitoring event. The IDS is expected to include the discussion, data, tables, and figures described in the Groundwater Monitoring Work Plan and Report Guidance for Petroleum Releases found under the Guidance dropdown at the PTCS.*

- *Prepare and submit one Groundwater Monitoring Report detailing the method and results of all groundwater monitoring events completed under this WP.*

- *Submit WP and reports electronically following the PTCS submittal requirements found under the Guidance dropdown at the PTCS.*

The following sections summarize Tetra Tech's proposed scope of work and schedule for completing the requested tasks. The attached Cost Estimate Breakdown and Groundwater Monitoring and Sampling Unit Cost Worksheets in Attachment A present an estimated budget.

BACKGROUND INFORMATION

The site is at 2801 Harrison Ave, Butte, Montana (Figure 1). On February 18, 2005, the facility reported a fuel line leak below pumps #9/10 at the northern pump island (Figure 2). The property resides within an alluvial valley comprised of Tertiary basin deposits and fill (Smedes, 1967). The groundwater on site is approximately seven to eight feet below ground surface (Tetra Tech, 2022). Groundwater flow direction has been to the northeast towards Blacktail Creek, located about 750 feet north of the site (Tetra Tech, 2022).

Water and Environmental Technologies (WET, 2008) advanced five geo probe borings at locations around the pump island in April 2005. WET also installed groundwater monitoring wells MW-1, MW-2, and MW-3 (Figure 2) in January 2006. Since the wells were installed in 2006, groundwater analytical results from samples collected from monitor well MW-3 have exceeded MDEQ Risk-Based Screening Levels (RBSLs; MDEQ, 2024).

Additionally, as part of a due diligence investigation in 2013, five soil borings were advanced to a depth of approximately ten feet below ground surface (bgs) using a hydro-vacuum (hydrovac) system (Tetra Tech, 2013) on the southeast quadrant of the property (HX borings, Figure 2). Soil and groundwater samples were collected during this investigation, and low concentrations of total purgeable hydrocarbons and corresponding petroleum hydrocarbon fractions were detected. However, these concentrations were determined to be estimated as they were below the laboratory's practical quantitation limit and well below MDEQ RBSLs. A review of the laboratory's quality control data shows similar concentrations in the method blank, indicating potential laboratory cross-contamination.

In July 2017, a groundwater monitoring event was conducted. Results from this event indicated hydrocarbon impacts above MDEQ RBSLs for benzene in monitoring well MW-3. However, laboratory analysis of Volatile Petroleum Hydrocarbons (VPH), Extractable Petroleum Hydrocarbons (EPH), and intrinsic biological indicators (IBIs) indicated a decrease in concentrations for most analytes tested. The lateral extent of the petroleum plume appears to be defined on-site (Tetra Tech, 2017).

In 2022 and 2023, Tetra Tech conducted an additional remedial subsurface investigation, further delineating the release (Tetra Tech, 2022). During this investigation, four additional wells, MW-4 through MW-8, were installed (Figure 2). Soil samples collected during this investigation were not reported with results over MDEQ RBSLs. However, groundwater samples collected from MW-6 and MW-8 contained results over MDEQ RBSLs in the subsequent groundwater monitoring event.

The 2022-2023 investigation also identified several underground utility lines on-site (Figure 2). The water and sewer lines are located just west of MW-3, running north/south. A natural gas pipeline is located off the southwest corner of the Zip Trip building. The nearest storm drain is approximately 50 feet away, and the nearest subsurface structure is approximately 200 feet away. No underground utilities associated with the fueling system or the facility's underground electrical system have been located.

SCOPE OF WORK

This project's general scope includes conducting two groundwater monitoring events. The events will be conducted to collect groundwater quality information at high and low groundwater conditions. Each event will include groundwater monitoring at all monitoring wells on-site (Figure 2). The groundwater monitoring event is expected to occur during the fall of 2024 and spring of 2025. A groundwater monitoring report will be prepared, including generating a Release Closure Plan (RCP). The following details describe the methods to be used for this investigation: The following details describe the methods to be used for this investigation. Additionally, Tetra Tech's standard operating procedures are provided in Attachment A.

GROUNDWATER MONITORING

Static water level measurements and groundwater samples will be collected from all monitoring wells on-site using the following methods:

- Depth to groundwater will be measured as described above using a decontaminated electronic oil/water interface meter. The meter will be decontaminated between each measurement.

- Each monitoring well will be purged using the low-flow, slow-purge pumping method, a submersible bladder pump, and dedicated polyethylene tubing. During purging, field instruments will analyze the water for pH, temperature, dissolved oxygen, specific conductivity, oxidation-reduction potential, and turbidity. Purge water will be containerized by the Disposal of Untreated Water from the Monitoring Wells Flow Chart and disposed of appropriately following receipt of laboratory results (MDEQ, 2015). The pump will be decontaminated between wells using a Liquinox® solution followed by a triple rinse technique. Additionally, a new bladder will be installed between sampling each well.

- A groundwater sample from each monitoring well will be collected using a submersible bladder pump and dedicated polyethylene tubing. Groundwater samples will be analyzed for VPH and extractable petroleum hydrocarbons (EPH) via EPA using the Massachusetts Department of Environmental Protection Methods (MADEP, 2004). By MDEQ guidance, if the EPH concentration in water exceeds 1,000 micrograms per liter (µg/L), then an EPH fractionation analysis is required (MDEQ, 2020). During the first groundwater sampling event, intrinsic biodegradation indicators (IBIs) will be analyzed from all groundwater samples. The IBIs include dissolved ferrous iron (Method E200.7), dissolved manganese (Method E200.7/E200.8), sulfate (Method E300.0), nitrates/nitrites (nitrate plus nitrite as nitrogen; Method E353.2), and methane (GS-FID/Kampbell (SW8015 Modified). For cost-estimating purposes, it is assumed that all fourteen monitoring wells will be sampled during the event, and seven water samples will be analyzed for EPH fractions.

DATA VALIDATION

Each analytical data package will include a summary report that cross-references the sample identification with the laboratory identification and identifies variations from standard operating procedures; laboratory analytical results; quality control data, which may include but is not limited to surrogate recoveries, initial and continuing calibration blanks and spikes, method blanks, laboratory control blanks, and spikes, and matrix spike and matrix spike duplicates; FID chromatograms; chain of custody form(s); and a sample receipt checklist. Additionally, data validation will be included with the investigation report and will follow MDEQ's data validation guideline as per *https//deq.mt.gov/Portals/112/Land/State-Superfund/Documents/DataValidationReport.pdf*. It is anticipated that two separate data validations will need to be completed for this project.

REPORTING

Following completion of fieldwork associated with this project, a Groundwater Monitoring Report will be prepared and submitted to MDEQ. The report will present the field and analytical results of this investigation and compare laboratory analytical results to those of MDEQ RBSLs. Conclusions and recommendations detailing site conditions and the extent and magnitude of the plume will be discussed, along with a to-scale map presenting necessary site information. Additionally, the report will include a Release Closure Plan (RCP) to evaluate the potential path for closure of the release.

SCHEDULE AND COSTS

Tetra Tech will initiate this work upon receiving authorization from CHS Inc./dba Zip Trip and approval from the MDEQ. The work described above will be conducted on a unit cost basis per the attached *Cost Estimate Breakdown and Sampling Unit Cost Worksheets* included in Attachment B.

PROPOSAL AUTHORIZATION

Should you find this work plan acceptable, please sign the Work Authorization included in Attachment C and return a signed copy to our Billings, Montana office. If you have questions or comments regarding this work plan, please call us at (406) 248-9161. For your convenience, we have forwarded a copy of this work plan to MDEQ for their review. We appreciate the opportunity to provide you with environmental consulting services.

Sincerely,

Tetra Tech

Jake Conver

Austin Maphis
Hydrogeologist

Jake Conver, PE
Environmental Engineer

Cc: Christopher Herman, MDEQ; christopher.herman@mt.gov

Figures
Attachment A: Tetra Tech Standard Operating Procedures
Attachment B: Unit Cost Worksheets
Attachment C: Work Authorization

REFERENCES

MDEQ, 2018. Montana Tier 1 Risk-Based Corrective Action Guidance for Petroleum Releases. May.

MDEQ, 2023. Form 8 Zip Trip 72 (Former RDs Travel Stop) FID 47-05148 R: 4397. January 12.

Montana Department of Environmental Quality (MDEQ), 2024. Montana Risk-Based Corrective Action Guidance for Petroleum Releases, February.

MDEQ, 2024. Groundwater Monitoring Work Plan Requested for the Petroleum Release at Cenex Zip Trip #72. 2801 Harrison Avenue, Butte, Silver Bow County, Montana: Facility ID 47-05148 (TID 28404), Release 4397, Work Plan ID 34917

Tetra Tech, 2013. Limited Phase II Subsurface Investigation RD's Travel Stop, 2801 Harrison Avenue, Butte, Montana. Report submitted to CHS Inc., January.

Tetra Tech, 2017. Standardized Groundwater Monitoring Report (MR-01) Cenex Zip Trip #72, 2801 Harrison Ave, Butte, Silver Bow County, Montana. September.

Tetra Tech, 2021. Remedial Investigation Work Plan Cenex Zip Trip # 72 2801 Harrison Ave, Butte, Silver Bow County, Montana. December 20.

Tetra Tech, 2022. Remedial Investigation Report Cenex Zip Trip #72 2801 Harrison Ave, Butte, Silver Bow County, Montana. December.

Smedes, 1967. Preliminary geologic map of the Butte South Quadrangle, Montana; U.S. Geological Survey. Scale 1:24,000.

Water & Environmental Technologies, PC (WET), 2008. Ground Water Monitoring Report, RD's Travel Stop Butte, Montana. January.

FIGURES

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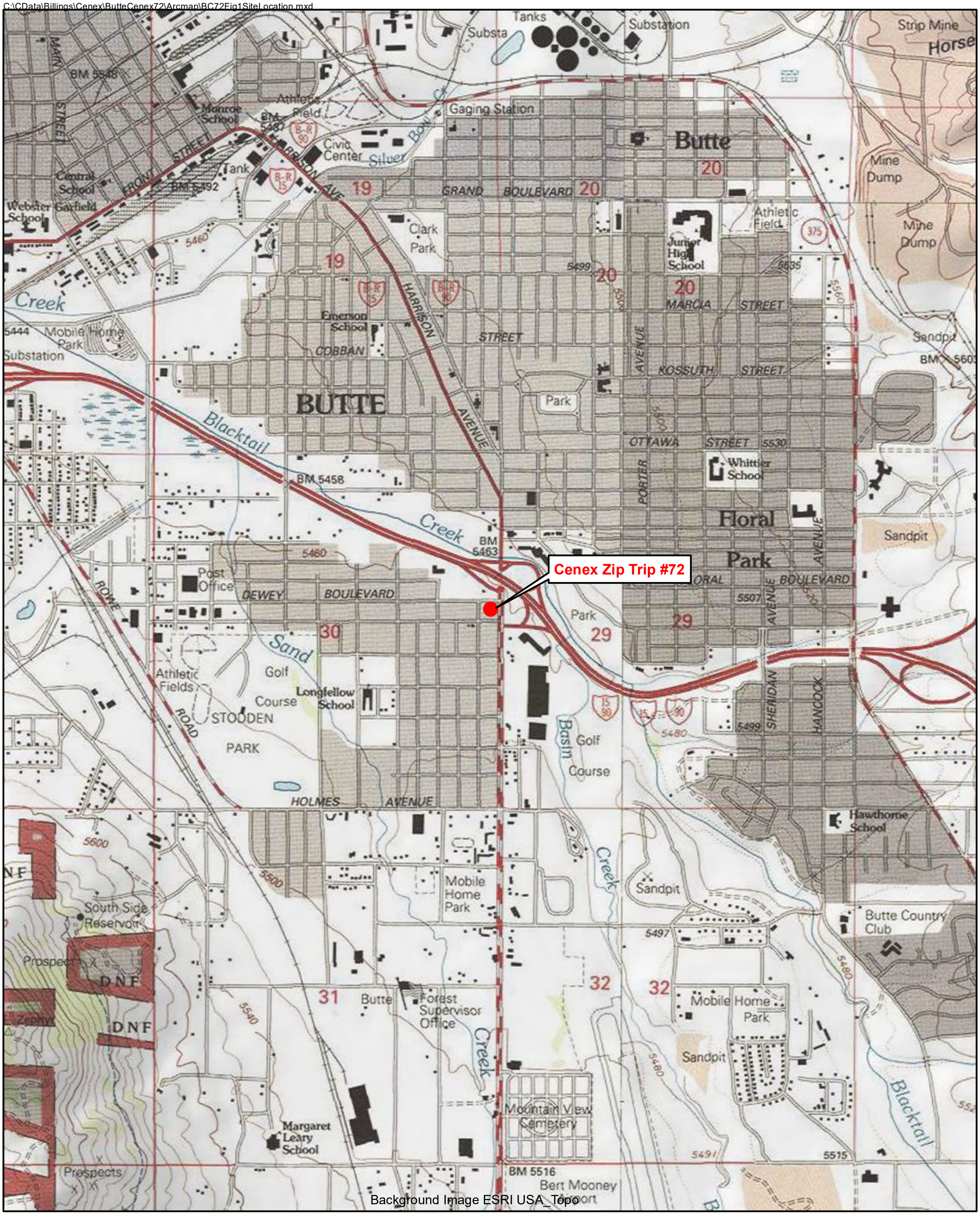

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Site Location Map

Cenex Zip Trip #72

2801 Harrison Avenue

Butte, Montana

Figure 1

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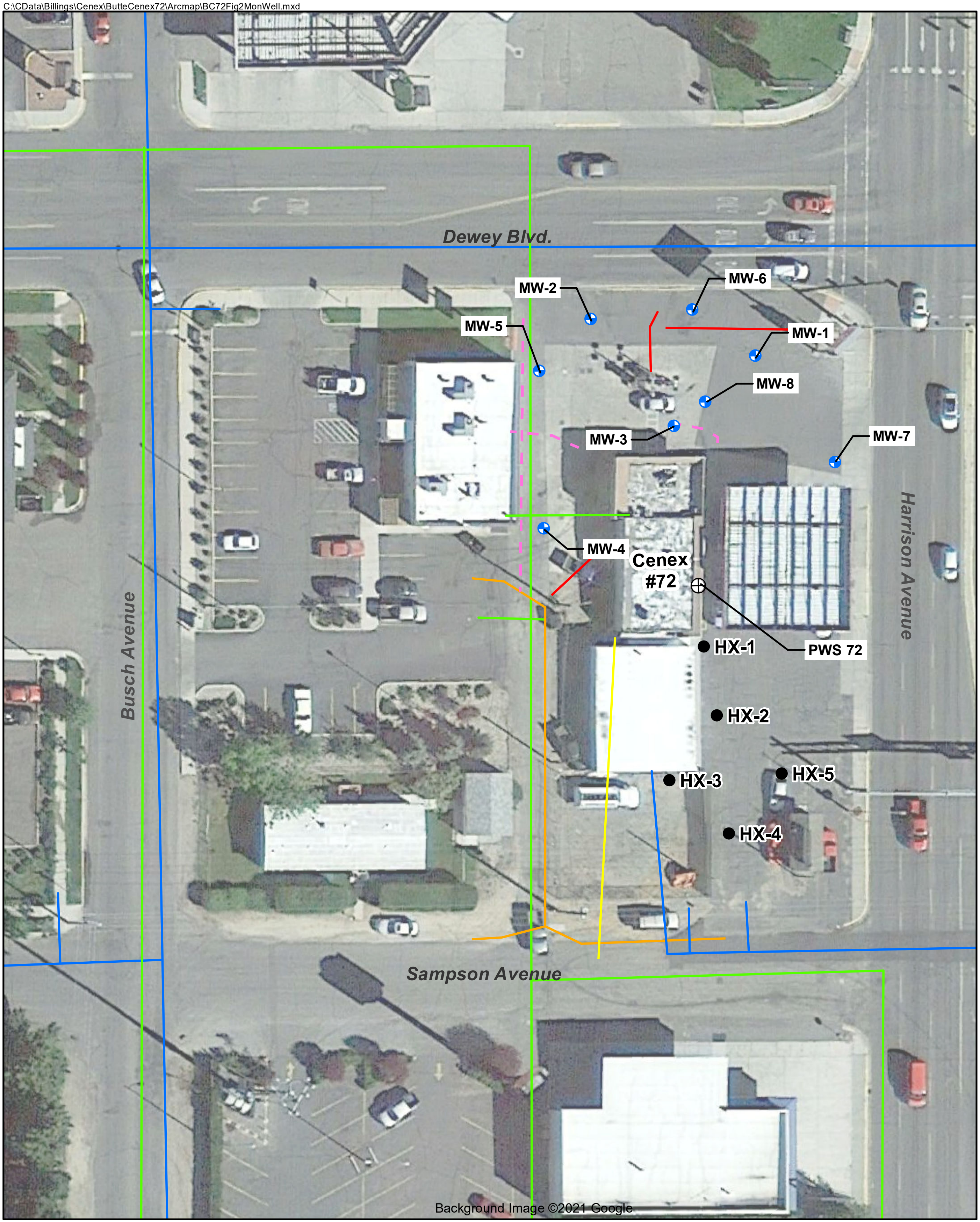

Background Image ©2021 Google

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⊕	Sample Location
●	Bore Hole
◐	Monitor Well

🟧	Communications Line
🟥	Electric Line
🟨	Gas Line
🟩	Sanitary Sewer
🟦	Water Line
▬ ▬	Unknown

Monitor Well Location Map
Cenex Zip Trip #72
2801 Harrison Avenue
Butte, Montana
Figure 2

ATTACHMENT A

TETRA TECH
STANDARD OPERATING PROCEDURES

Table of Contents

Standard Operating Procedures

Standard Operating Procedures (continued)

STANDARD OPERATING PROCEDURE
FIELD SAMPLE FILTRATION

1. Filtration equipment should include glassware to field filter water samples through a 0.45 micron filter paper. Visually inspect filtration equipment for damage. Replace parts or repair equipment as necessary.

2. Vacuum-type filtration apparatus will be decontaminated in accordance with SOP-11.

3. Place 10-15 milliliters of 10% dilute nitric acid into filter apparatus containing 0.45 micron filter. Apply vacuum, discard filtered solution.

4. Repeat above procedure three times using sample water. Discard filtrate. If unable to repeat three times, use a pre-filter before using the 0.45 micron filter.

5. Fill filter vessel with sample water and apply vacuum. Use small quantities of filtered water to rinse sample container three times.

6. Fill labeled sample container to appropriate level with filtered sample and mark level with permanent marker. Add appropriate preservative, if necessary. Invert sample container several times to insure complete sample - preservative mixing.

7. Place sample container into cooler; package and ship in accordance with SOP-09.

8. If extremely turbid sample water is obtained, use same procedure using a pre-filter (usually 3.0 or 5.0 micron paper) followed by 0.45 micron filtration.

9. Decontaminate all equipment in accordance with SOP-11 following use.

STANDARD OPERATING PROCEDURE
FIELD MEASUREMENT OF pH

INSTRUMENT CALIBRATION:

1. Calibrate pH meter before leaving for the field and each day in the field when pH will be measured. Calibrate using following procedure:

    - Rinse pH electrode and temperature probe with distilled water.

    - Immerse electrode and temperature probe in bottle of commercial calibration solution of pH buffer 7.0. Calibrate meter to within 0.1 standard unit (s.u.).

    - Remove electrode and temperature probe from solution, rinse with distilled water.

    - Immerse electrode and temperature probe in second pH calibration buffer having a pH of 3 units higher or lower than the first, bracketing the expected range of natural sample pH.

    - The pH meter should be recalibrated during the field day, especially when air temperatures are changing by 5 or more degrees. To recalibrate pH meter, measure pH of the 7.0 buffer solutions. If the measured value differs from expected value by more than 0.1 units, recalibrate meter using according to meter instructions.

FIELD PROCEDURES:

1. Rinse decontaminated glass beaker with approximately 50 milliliters of sample water three times.

2. Rinse pH electrode with deionized water.

3. Check meter using 7.0 pH buffer. Re-calibrate meter, if not within 0.1 pH units.

4. Fill beaker with sample water.

5. Immerse electrode and temperature probe in sample, agitate probes to provide thorough mixing. Continue to agitate until reading has stabilized. Read pH to nearest 0.1 s.u.

6. Record the sample pH. Note any problems such as erratic readings.

7. Rinse probe with DI water and store according to manufacturer's directions.

MAINTENANCE:

1. Store meter in its case with electrode immersed in a KCl or pH 7.0 buffer solution.

2. If meter is not used often, inspect bi-weekly to make sure electrode is immersed in one of the solutions described above.

3. Check batteries each time meter is used. Carry a spare battery pack and a screwdriver into the field in the pH meter case.

4. It is wise to keep an additional pH electrode available in case of probe malfunction or breakage. Usually probes are replaced as their sensitivity becomes weakened. If stabilized readings take an unusually long time to reach, or the meter cannot be calibrated.

STANDARD OPERATING PROCEDURE
FIELD MEASUREMENT OF WATER TEMPERATURE

1. Carry two NBS-calibrated thermometers inside cases, into the field.

2. Check thermometer for cracks or gaps in the solution. Do not use thermometers if either cracks or gaps are visible. (Some gaps can be closed by submersing tip in a beaker of boiling water, or placing thermometer in a freezer).

3. When possible, measure temperature of surface water at midstream submersing the thermometer for approximately one minute or until temperature stabilizes. Temperatures should be collected from moving water, avoiding still pools which may be warmer than actual conditions.

4. When in situ temperature measurements are not possible, draw sample of at least 200 mL into a decontaminated beaker or sample bottle as soon after sampling as possible.

5. Place thermometer in sample. Do not allow thermometer bulb to touch sides of beaker. Allow to equilibrate (about 1 minute).

6. Record temperature to nearest 0.5^{o}C in field log book or on field data sheet.

7. Rinse thermometer with deionized water.

8. On a quarterly basis, check field thermometers against a NBS-certified laboratory thermometer. Agreement should be within 0.5°C.

STANDARD OPERATING PROCEDURE
FIELD MEASUREMENT OF DISSOLVED OXYGEN

1. Inspect dissolved oxygen (DO) meter for damage. The probe end should be examined to be sure the membrane is in tact. Repair as necessary according to manufacturer's instructions.

2. Rinse probe and cable with deionized water.

3. Prepare probe and DO meter in accordance with instrument manufacturer's operating procedures (in meter box). Make certain probe contains sufficient electrolyte and the oxygen sensor membrane is in good repair.

4. Calibrate probe and meter using the fresh water - air calibration method. Correct calibration value for temperature and altitude; adjust meter accordingly.

5. When possible place probe directly into the stream, or water to be measured. If not possible, place probe into beaker filled with sample. Manually raise and lower probe through sample about 1 foot/second. Allow sufficient time for probe to stabilize to sample temperature and dissolved oxygen concentration.

6. Read dissolved oxygen value. Record appropriate data on field forms.

STANDARD OPERATING PROCEDURE
SAMPLE PACKAGING AND SHIPPING

All environmental samples collected should be packaged and shipped using the following procedures:

PACKAGING:

1. Label all sample containers with indelible ink (on the side, not on the cap or lid). Place labeled sample bottles in a high quality cooler containing an adequate amount of ice and/or frozen blue ice (appropriate for the season), making sure the cooler drain plug is taped shut.

2. Place the samples in an upright position and wrap the samples with absorbent, cushioning material for stability during transport. Samples should not be loose; the cooler should be able to withstand rough handling during shipment without sample breakage.

3. Fill out the appropriate shipping forms, and place the paperwork in a ziploc bag and tape it to the inside lid of the shipping container. Shipping forms usually include: 1) a chain-of-custody form, documenting the samples included in the shipment; 2) an analysis request form, specifying the laboratory analyses for each sample. If more than one cooler is used per chain of custody, put a photocopy in the other coolers and mark them as a copy.

4. Close and seal the cooler using fiberglass strapping tape.

5. Secure the shipping label with address, phone number, and return address clearly visible.

SHIPPING HAZARDOUS MATERIALS/WASTE:

Hazardous materials need to be shipped using procedures specified under Federal Law. Samples need to be shipped in ziploc bags or paint cans depending on the level of hazard. Special package labeling may be needed. Consult the project manager for specific shipping procedures.

STANDARD OPERATING PROCEDURE
FIELD FORMS

All pertinent field investigations and sampling information shall be recorded on a field form during each day of the field effort and at each sample site. The field crew leader shall be responsible for ensuring that sufficient detail is recorded on the field forms. No general rules can specify the extent of information that must be entered on the field form. However, field forms shall contain sufficient information so that someone can reconstruct all field activity without relying on the memory of the field crew. All entries shall be made in indelible ink weather conditions permitting. Each day's or site's entries will be initialed and dated at the end by the author.

At a minimum, entries on the field sheet or in field notebook shall include:

- Date and time of starting work and weather conditions.
- Names of field crew leader and team members
- Project name and type
- Description of site conditions and any unusual circumstances.
- Location of sample site, including map reference, if relevant
- Equipment ID numbers
- Details of actual work effort, particularly any deviations from the field work plan or standard operating procedures
- Field observations
- Any field measurements made (e.g., pH)

For sampling efforts, specific details for each sample should be recorded using Maxim Technologies standardized field forms. Surface water and groundwater field forms contain fill-in-the-blank type information in order that all pertinent information shall be recorded. In addition to the items listed above, the following information is recorded on field forms during sampling efforts:

- Time and date samples were collected
- Number and type (natural, duplicate, QA/QC) of samples collected
- Analysis requested
- Sampling method, particularly deviations from standard operating procedures

Strict custody procedures shall be maintained with the field forms. Field forms shall remain with the field team at all times, while being used in the field. Upon completion of the field effort, photocopies of the original field forms will be made and used as working documents; original field forms shall be filed in an appropriately secure manner.

STANDARD OPERATING PROCEDURE
EQUIPMENT DECONTAMINATION

The purpose of this section is to describe general decontamination procedures for field equipment in contact with mine/mill tailings, soil, or water. During field sampling activities, sampling equipment will become contaminated after it is used. Sampling equipment must be decontaminated between sample collection points if it is not disposable. Field personnel must wear disposable latex or vinyl gloves while decontaminating equipment at the project site. Change gloves between every sample. Every precaution must be taken by personnel to prevent contaminating themselves with the wash water and rinse water used in the decontamination process.

Table A-1 lists equipment and liquids necessary to decontaminate field equipment.

The following should be done in order to complete thorough decontamination:

1. Set up the decontamination zone upwind from the sampling area to reduce the chances of windborne contamination.

2. Visually inspect sampling equipment for contamination; use stiff brush to remove visible material.

3. The general decontamination sequence for field equipment includes: wash with Liquinox or an equivalent degreasing detergent; deionized water rinse; deionized water rinse; rinse with sample water three times.

4. Rinse equipment with methanol in place of the nitric rinse if sampling for organic contamination. Follow with a deionized water rinse.

5. Decontaminated equipment that is to be used for sampling organics should be wrapped in aluminum foil if not used immediately.

6. Clean the outside of sample container after filling sample container.

Alternatively, field equipment can be decontaminated by steam cleaning and rinsing with deionized water.

All disposable items (e.g., paper towels, latex gloves) should be deposited into a garbage bag and disposed of in a proper manner. Contaminated wash water does not have to be collected, under most circumstances. If vehicles used during sampling become contaminated, wash both inside and outside as necessary.

TABLE A-1. EQUIPMENT LIST FOR DECONTAMINATION

5-gallon plastic tubs
5-gallon plastic water-container
5-gallon carboy DI water
1-gallon cube of 10% HNO_3
1-gallon container or spray bottle of 10% Methanol or pesticide grade acetone for organics

Liquinox (soap)
Hard bristle brushes
Garbage bags
Latex gloves
Squeeze bottles
Paper Towels

STANDARD OPERATING PROCEDURE
SAMPLE DOCUMENTATION

Sample documentation is an important step to ensure the laboratory, project manager, and field personnel are informed on the status of field samples. Depending on the specifics required for each project, a number of forms will need to be filled out. Most sample documentation forms are preprinted carbonless triplicates, enabling copies to be filed or mailed from labs or offices. The forms will be completed by field personnel, who have custody of the samples. The office copy will be kept in the project file and subsequent copies sent to the laboratory, or other designated parties. The responsibility for the completion of these forms will be with each field crew leader. It is important the field crew leader is certain field personnel are familiar with the completion process for filling out forms, and the expected information is included.

Potential documents to be completed clearly in ink for each sample generated include:

- Field Form
- Chain-of-Custody
- Custody Seal

If working on Superfund activities, the following additional forms will also be prepared:

- EPA Sample Tags
- SAS Packing Lists
- Sample Identification Matrix Forms
- Organic Traffic Report (if applicable)
- Inorganic Traffic Report (if applicable)

STANDARD OPERATING PROCEDURE
QC SAMPLES

Quality Control (QC) samples are submitted along with natural samples to provide supporting laboratory data to validate laboratory results. QC samples are submitted blind, and do not have any unique identifying codes that would enable the lab or others to bias these samples in any way. Usually, the time or sampling location is modified in a way which will separate blank and standard samples from the rest of the sample train. QC samples are identified only on field forms and in field notebooks. The following codes are typically used:

N - Natural Sample	Soil, water, air, or other of interest material from a field site
SP - Split Sample	A portion of a natural sample collected for independent analysis; used in calculating laboratory precision
D - Duplicate Sample	Two samples taken from the same media under similar conditions; also used to calculate precision
FB - Field Blank	Deionized water collected in sample bottle; used to detect contamination sampling containers
FEB – Field Equipment Blank	Deionized water run through decontaminated equipment and analyzed for Blank residual contamination and deionized water contamination
BFS - Blind Field Standard	Certified materials of known concentration; used to determine laboratory accuracy
TB - Travel or Trip Blank	Inert material (deionized water or diatomaceous earth) included in sample cooler; sent by the lab, the sample is used to determine if contamination by volatiles is present during collection or shipping

In general, selected QC samples will be inserted into the sample train. Unless otherwise specified, QC samples will be prepared in the field. Deionized water blanks will be collected from carboys and cubitainers used in the field. An exception to field preparation of QC samples is the preparation of some blind field standards. Since the concentration of analytes in the sample is to be mixed according to specific manufacturer's instructions, field conditions may not provide the needed laboratory atmosphere. This is especially true for volatile organic compounds, which need to be prepared just before analyzing. Under these circumstances, standards will be shipped to the laboratory for preparation, keeping the concentration or manufacturer's QC Lot Number as blind as possible.

The number and types of samples submitted for each group of natural samples will be determined by the project manager and others, including state or Federal agencies, and will be defined in the project work plan. Each field crew leader will be responsible for all QC samples prepared by that crew.

Methods for computing data validation statements can be found in EPA documents.

SOP-16

STANDARD OPERATING PROCEDURE

MONITORING WELL CONSTRUCTION

Many states require certification and licensing for monitoring well drillers. Be sure you know the State's regulations before arriving on-site, especially if drilling outside your own State.

1. Safety equipment required on-site of the drill rig is mandatory. Personal protective equipment includes (at a minimum): hard hat, ear plugs, safety glasses, steel toed boots, gloves, first aid kit, and site safety plan - with routes to hospitals known by all personnel on-site.

2. Arrive on-site with properly sized drilling equipment and materials for site conditions. All drilling equipment and materials should be properly decontaminated prior to its arrival on-site. Decontamination usually includes steam - or hot water-cleaning methods.

3. Drilling muds or drilling solutions of any kind <u>are not to be used</u> during drilling activities in conjunction with monitoring well construction. Acceptable drilling techniques include air-rotary, cable tool, hollow-stem auger or sonic. If unconsolidated material is encountered, it may be necessary to drive steel casing during drilling to maintain borehole integrity. It is suggested threaded steel casing be used in lieu of welding joints together to minimize this source of potential well contamination. Hydraulic jacks or the drill rig can be used to pull back the steel casing following emplacement of plastic casing.

4. A detailed lithologic log shall be completed during drilling activities. Water bearing characteristics of the formations should also be noted on the log. In addition, details of monitoring well construction should also be described on the well log including total depth, perforated interval, sizes and types of construction materials, etc.

5. Seven (7) - to 10-inch outside diameter hollow-stem augers can used in drilling shallow exploration drill holes in many situations. Care is taken to avoid contamination due to oil and grease from the drill rig and split-spoon sampler. Appropriate decontamination is performed of the drill rig between drill holes. Soil and sediment samples are collected using a standard 1.4-inch inside diameter split-spoon sampler and a 140 pound drive hammer. The number of blows necessary to obtain an 18-inch length of sample is recorded on the exploration log. Appropriate decontamination of the split-spoon sampler is performed between sample depth intervals.
6. Install factory-slotted well screen and blank section of well casing into the borehole, with the well screen set at the desired depth interval, based on site conditions. The well screen and casing will be selected based on the type of contamination present; typically polyvinyl chloride (PVC), stainless steel or polytetrafluoroethylene (PTFE; for organics).
   Either a single- or multi-completion monitoring well can be constructed in a single borehole where hollow-stem auger drilling is not used.

7. Backfill the annular space below and above the perforated well screen and to at least 2-feet above the well screen with chemically-inert silica sand. Place a bentonite plug above the sand to ground surface. Where appropriate, begin pulling temporary steel casing out of borehole as the sand and bentonite are placed. For some sites, states may require bentonite (granular or chips) be placed to 3 feet above the level of silica sand followed by placement of a tremied bentonite slurry or grout to the surface. Monitoring well development is presented in SOP-22.

8. Place a locking well protector over well casing(s) after the outer steel drill casing has been removed from the borehole, if necessary. The locking well protector will either be a flush-mount well cover or steel riser with locking well cap. If a flush-mount well cover is used, an inner locking well cap will be installed. Place bentonite a plug below the bottom of well protector with a 1- to 2-inch layer of sand at the base and within

the flush-mount protector to allow drainage. This will allow water to drain from the flush-mount well to limit the surface casing from accumulating atmospheric water. Grout well protector in place.

9. Lock the well with high quality lock.

STANDARD OPERATING PROCEDURE
MONITORING WELL DEVELOPMENT

1. Visually inspect all well development equipment for damage - repair as necessary.

2. Decontaminate all stingers, air hoses, surge blocks by scrubbing with brush and Liquinox solution, rinsing with dilute nitric acid solution, and rinsing with deionized water. If sampling for organics, replace the nitric acid rinse with 10% methanol as per SOP 11.

3. If using compressed air method for well development, make certain compressor utilized does not produce air laden with hydraulic fluid for lubricating purposes. This may affect the integrity of the monitoring well for producing viable water quality data.

4. Develop well by using surging techniques (surge block or bailer). This is accomplished by rapidly raising and lowering the surge block or bailer within the water column. The purpose of the surging is to disturb the water within the well and suspend sediments. Groundwater should then be evacuated from the well with either a properly decontaminated bailer or submersible well pump. Repeat this procedure until evacuated water is visibly clean and essentially sand-free. In most cases, evacuated water can be disposed of on-site.

5. If specified in the project work plan, during evacuation process, collect water samples for field determinations of temperature, specific conductivity, and pH. Continue developing well until field parameters stabilize to within ±10 % on three consecutive measurements.

6. Report field observations and volume of water removed on standard form.

STANDARD OPERATING PROCEDURE
GROUNDWATER SAMPLING

EQUIPMENT:

- Five gallon bucket graduated in gallons
- Coolers and ice
- Sample bottles
- Preservatives
- Filter apparatus
- Decontamination equipment & fluids
- Water level probe
- pH meter/thermometer (optional)
- specific conductance meter (optional)
- bailer(s)
- bailer rope or Teflon reel
- field sampling forms
- indelible marker
- stop watch

All sampling equipment shall be inspected for damage, and repaired if necessary, prior to arriving on-site.

GENERAL PROCEDURE – PURGING:

Purging must be performed on all wells prior to sample collection. If required by the project work plan, the stability of pH, specific conductivity, and temperature will be evaluated. A minimum of three volumes of groundwater in the well casing shall be withdrawn prior to sample collection. The volume of water present in each well shall be computed using the length of water column, monitoring well inside diameter, and casing diameter. The total volume of water in the well (gallons) can be approximated using the following formula (depth and water level measurements in feet; borehole diameter in inches):

$$\mathbf{(1/25)(Total\ Depth - Measured\ Water\ Level)(Casing\ Diameter)^2 = gallons}$$

Several general methods are used for well purging. Well purging may be achieved using bailers, bladder pumps, peristaltic pumps, and submersible pumps. The specific pumping method shall be chosen based on depth to groundwater, diameter of well, existing well configuration and contaminant(s) of concern. Specific conductance, pH, temperature, and purge volume values will be entered on the Field Sampling Forms. If sampling for hydrocarbon compounds, wells shall be checked for the presence of free product prior to purging and sampling.

If specified by the project work plan, field parameters will be measured periodically during well purging. The well is ready for sampling when either or both of the following conditions are met: 1) measured field parameters stabilize at plus or minus five percent of the reading, over three successive readings or, 2) three to five casing volumes have been evacuated from the well.

If the recovery of a low-yield well exceeds two hours after purging, the sample shall be extracted as soon as sufficient volume is available in the well for a sample to be extracted. At no time will a monitoring well be pumped dry if the recharge rate causes formation water to cascade down the well casing causing an accelerated loss of volatile organics and change in pH.

COLLECTING WATER QUALITY SAMPLES:

1. Generally, wells shall be sampled from the least contaminated to the most contaminated, if known. Open well and measure water level (SOP-20).

2. Decontaminate sampling equipment using the following procedure: scrub with brush and Liquinox solution; rinse with 10% dilute nitric acid; rinse with methanol, if sampling for organic compounds; rinse three times with deionized water. Use disposal latex or vinyl gloves throughout decontamination and sampling procedure and new gloves for each sampling point.

3. Sampling Monitoring Wells

   - To collect a water quality sample, use a decontaminated disposable polypropylene, stainless steel, or teflon bailer and a spool of polypropylene rope or equivalent bailer cord (teflon-coated stainless steel cable). Tie a bowline knot through the bailer loop to secure.

   - Slowly lower bailer or other sample collection device to the bottom of the well and remove an additional 5 feet of rope from the spool. Secure end of rope to steel well casing or wrist.

   - Transfer water from bailer to sample containers filling volatile organic bottles first.

   - A submersible pump or peristaltic pump can also be used. A dedicated length of disposable plastic hose or pipe is inserted into the well to the desired sampling depth. The sample is collected into the appropriate sample bottle by pumping very slowly. New hose or piping is used for each well.

4. Sampling Domestic Wells

   - Turn-on household fixture (preferably an outside faucet without a hose connected) that is on the well-side of any household water conditioning device.

   - Using the above equation, calculate the volume of water to be evacuated. Measure the discharge rate from the faucet in a graduated 5 gallon bucket, or other suitable container, to compute the rate of discharge. Calculate the time needed to evacuate the predicted volume from the well. Record all measurements and calculations on field forms.

   - Samples should be collected directly from hydrant or faucet and prior to entry of the water through any water conditioning devices. Do not collect samples through rubber hoses.

5. If specified by the project work plan, measure pH and specific conductance (SOP-05 and SOP-06). Continue monitoring field parameters (specific conductance and pH) periodically during purging process. The well is ready for sampling when either or both of the following conditions are met: 1) the purged volume is equal to three to five casing volumes and/or, 2) measured field parameters are within plus or minus five percent (± 5%) over three successive readings.

6. If sampling for dissolved metals, field filter sample according to SOP-04.

7. Label each sample container with project number, sample location, well owner, date, military time, sampler's initials, preservative, and analysis required. For inorganics samples, rinse sample containers, without preservatives, three times with sample water before final collection. Do not rinse containers for organics analysis.

8. Pour the sample into the appropriate sample containers and and any needed preservatives in accordance with SOP-42 or the project field sampling plan. Also see ("Handbook for Sampling and Sample Preservation of Water and Wastewater", EPA-600/4-82-029; "Guidelines Establishing Test Procedures for the Analyses of Pollutants Under the Clean Water Act", 40 CFR 136; and "Test Methods for Evaluating Solid Wastes," EPA SW-846). A few common sample preservatives are listed below:

• Dissolved Metals	Add 3-4 ml. Nitric Acid to 500 ml. sample
• Nutrients	Refrigerate to 4°C; Add 3-4 ml. Sulfuric Acid to 500 ml. sample
• Common Ions	Refrigerate to 4°C
• Hydrocarbon VOA	Refrigerate to 4°C; Add HCl to lower pH top 2 (see SOP-42 for details)
• Diesel Range Organics	Refrigerate to 4°C; Add 80 drops (4ml) HCl

For additional bottling and sample preservation information, consult the project field sampling plan.

9. For volatile analyses add preservative to sample vial and fill vials at the rate of 100 milliliters per minute (24 seconds for 40 milliliter vial); form positive meniscus over vial brim and cap. After capping, invert vial, gently tap and look for air bubbles. If bubbles are present, un-cap vial, add more water and repeat procedure.

10. If required by the project work plan, perform field parameter tests including pH, SC, Redox, and temperature on water sampled from the well. Record field measurements on field forms.

11. Complete the necessary shipping and handling paperwork, and record all pertinent information on Field Sampling Form in accordance with SOP-10.

STANDARD OPERATING PROCEDURE
FIELD MEASUREMENT OF GROUND WATER LEVEL

1. Well probe should be calibrated annually or as needed. Note any corrections to well probe measurements on field forms.

2. Check well probe prior to leaving for field for defects by placing probe in water and testing buzzer and light. Repair as necessary. Make certain the well probe, a tape measure calibrated to tenths of feet and extra batteries are in the carrying case.

3. Measure all wells (monitoring and domestic) from the top of the well casing in the north quadrant or from a designated measuring point, as appropriate. Measure and record distance from measuring point to ground level. Make sure measuring point is labeled on well, so future measurements can be made from the same location.

4. Obtain a depth to water from measuring point to the nearest hundredth of a foot. Record data on appropriate field forms.

5. Decontaminate well probe between each measurement by rinsing with deionized water. Additional decontamination, such as *Liquinox*® scrubbing, may be required for certain wells; consult the project work plan.

WATER LEVEL MONITORING LOG

PROJECT:
DATE:
JOB NO.:
WEATHER:
TEMP:
INSTRUMENT:
CALIBRATION DATE:

Station	Time	Reference Elevation	Depth to Product	Depth to Water	Groundwater Elevation	COMMENTS

STANDARD OPERATING PROCEDURE

SOIL SAMPLE COLLECTION

This SOP describes general field equipment and sampling methods for surface and subsurface sampling of soilmaterial. Methods explained in this SOP may be different from those identified in the project specific Sampling and Analysis Plan (SAP). The project specific SAP should be referenced for modifications to the methods noted below. All sampling equipment should be decontaminated before arriving on site and between samples.

FIELD EQUIPMENT

- Sharp shooter and clean-out shovel
- Stainless steel mixing bowl and sampling trowel
- Dilute (10%) hydrochloric acid
- Hand lens (10) power
- Steel tape (10 foot)
- pH and electrical conductivity meters
- Munsel color book
- No. 10 sampling screen
- Field forms and field book
- Bucket augers

SURFACE SOIL SAMPLING

Surface soil/tailings samples are defined as soil <2 feet below grade. Collect the surface soil sample from the depth interval(s) prescribed in the SAP. Sufficient sample needs to be collected for the laboratory analyses that will be requested. This may range from 4 ounces to 1 gallon or greater. Verify with the laboratory on the required volume needed for the associated analyses. Soil samples will be collected in either wide mouth glass jars or resealable polyethylene bags (Ziploc or equivalent).

Describe the lithology of soil encountered according to the procedures outlined in the Unified Soil Classification System (USCS; method ASTM D2487). The SAP may also require logging using: 1) the Soil Conservation Service (SCS) classification system and/or 2) soil texture classification by either the USCS or U.S. Department of Agriculture (USDA). Descriptions shall be recorded in field books or on standard morphological description logs as provided in the SAP.

Samples should be collected from an area of approximately 6 square feet (roughly a 2.5-foot by 2.5-foot square area) by digging up the top inch withthe sampling trowel and placed in the mixing bowl. Rock larger than ¼-inch size should be removed from the sample. If require, the sample should be screened with the 10-mesh sieve if coarse fragments are to be excluded from the sample. If a sod or duff layer is present, this layer should be peeled back to the top of the mineral soil.

The sample placed in the mixing bowl shall be well mixed and then a portion of the sample placed in the sample container. To select a sample from the mixing bowl, quarter the sample in the bowl and place an equal volume of soil from each quarter in the sample container. When sampling soil for organics, the samples should not be mixed.

All equipment used in the sampling of surface soils will be decontaminated using the procedures in SOP-11.All necessary paperwork will be filled out in accordance with SOP-12.

SUBSURFACE SOIL SAMPLING

Subsurface sampling will be completed using a bucket auger, split spoon sampler, or hand dug or backhoe excavated pits. Sampling procedures for each type of equipment is described below. Sample collection, homogenization, and transfer to sampling containers should follow the same procedures as outlined for collection of surface samples.

Bucket Auger

Arrive on-site equipped with stainless steel auger rod and several sizes of stainless-steel bucket augers(e.g. 2-inch, 4-inch, 6-inch, etc.).

Bucket auger holes can be drilled as one size or in a telescoping manner if contamination between sample intervals is a concern. If a single sized, advance the bucket auger to the desired sampling interval depth and empty the contents of the auger in a stainless-steel mixing bowl. For the telescopingmethod, advance the largest auger to an approximate depth of three feet, collecting specified depth increment samples as the auger is advanced. Install temporary decontaminated PVC casing with a diameter slightly smaller than the borehole to keep the hole open and reduce possible cross- contamination between depth intervals. Using the next size smaller bucket auger, repeat the process.

1. Select sample intervals for packaging for laboratory analysis in accordance with procedures describedin the SAP.
2. Fill out appropriate paperwork and bottle labels as necessary prior to leaving site.
3. Decontaminate all equipment between sample locations.

Drilling - Split Spoon Sampler

Request the driller arrive on-site equipped with at least two standard 1.4 inch inside diameter split spoon samplers. If geotechnical information is desired, a 140-pound drive hammer is required.

The driller will install sampler into borehole and advance to the desired depth with the 140-pound drop hammer or equivalent means. If necessary, record the number of blow counts to complete sampling over each 18-inch interval. Retrieve sampler and place on worktable. Using the other sampler, repeat this sequence.

1. Record lithology and percent recovery from cores retrieved from split spoon sampler.
2. Based upon the project work plan or sampling and analysis plan, composite like core intervals by mixing in stainless steel bowl in a similar manner as described for surface sampling. When sampling for organics, the sample should not be mixed.
3. Decontaminate sampling equipment between each interval sampled if required by the SAP. Decontaminate sampling equipment between sampling sites.

Drilling - Sonic Core Samples

Driller will provide plastic core sleeves to extract the continuous, disturbed core samples into. Driller will extract the cores in approximately 5-foot depth increments.

1. Record the top and bottom depths on the core sleeves.
2. Record lithology, including but not limited to grain sizes, moisture, color, staining, or odors observed. Use USCS guidelines to characterize the soil type encountered.
3. Collect soil samples as specified in the project work plan

4. Decontaminate sampling equipment between each interval sampled if required by the SAP. Decontaminate sampling equipment between sampling sites

Backhoe or Hand Dug Excavations

1. Locate the site to be sampled and ensure that equipment can safely access the site. Minimize off road travel to prevent off site damage to surrounding vegetation.
2. Orient excavation to maximize use of the angle of the sun to illuminate the pit for photographs. Placeexcavated material a sufficient distance from the excavation.
3. Remove topsoil that may be present and set it aside from other subsurface soil. Excavate to the prescribed depth. If the pit exceeds 5 feet in depth, OSHA construction standards forshoring or sloping must be observed to prevent accidental burials. Sampling personnel should enter the pit with care during and after excavation.
4. Soil profile descriptions shall be made from a hand cleaned surface along the pit wall. Complete profile descriptions and take photographs before pit is sampled.
5. Soil samples shall be collected from depth intervals specified in the SAP. When a depth interval is sampled, an equal volume of soil should be collected from the entire interval exposed on the pit wall. Soil samples will be collected with a stainless-steel trowel and mixing bowl according to methods described for surface soil sampling. When sampling for organics, the sample should not be mixed.
6. After sampling is completed, the pit should be backfilled with excavated material in the reverse order that it was excavated so that potentially contaminated intervals will be placed relatively in the same interval as removed and topsoil material is returned to the top of the pit. When backfilling is complete the area should be cleaned-up to its original condition.
7. Decontaminate sampling equipment between sampling sites. Excavation equipment should be cleaned between sites with water (where possible) or with a shovel to remove gross dirt and mud.

STANDARD OPERATING PROCEDURE
FIELD MEASUREMENT OF VOLATILE ORGANIC COMPOUNDS HEADSPACE

INSTRUMENT CALIBRATION:

1. Calibrate meter before leaving for the field and each day in the field when headspace will be measured. Calibrate using one of the following procedures:

   A. HNU (PID)

   - Connect probe to the body of the instrument and turn selector switch to desired sensitivity range (typically 0-200)
   - Zero instrument and connect span gas.
   - Adjust span setting to read appropriate concentration for gas type and photoionization bulb.

   B. Photovac Microtip (PID)

   - Assemble instrument and turn on.
   - Press calibrate button and follow instructions as they appear on the screen.

   C. Photovac 2020 (PID)

   - Assemble instrument and turn on.
   - Press set button and follow instructions as they appear on the screen.

   D. Foxboro OVA (FID)

   - Assemble instrument, open H^2 supply valves, put operation and pump toggle switches to "on" position.
   - Allow to run for 3-5 minutes and push in the ignition button for 1/2 second. Check unit with span gas or known volatile to assure instrument is operating.

FIELD PROCEDURES:

1. Place sample to be tested in clean canning type jar. Cover the sample tightly using aluminum foil and the outer ring of the jar lid. Alternately, a new ziploc bag maybe used. Be sure to mark container with sample location (boring/test pit # and depth)!

2. Allow sample to come to room temperature (approximately 70 - 80 °F) by placing in warm location not in direct sunlight. This can be accomplished by placing the container under the heater vent of the vehicle in winter or in a closed vehicle in summer.

3. Insert probe through foil or ziploc opening and record maximum reading.

   NOTE: Consistency in results is enhanced by using approximately equal portions of material, similar jar or bag sizes and similar test temperatures. Moisture content may also affect readings using some instruments.

MAINTENANCE:

1. Disassemble and store meters in their case.
2. Charge batteries after each use as described in user's manual.
3. Occasional routine maintenance may be necessary ie. cleaning or replacing filters. Any maintenance you feel unqualified to perform should be handled by an authorized service representative.

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STANDARD OPERATING PROCEDURE
FIELD MEASUREMENT OF REDOX POTENTIAL (Eh)

1. Inspect the instrument and the probe to insure all parts, as listed in the owner's manual, are in the field case. It is very important that the Eh probe is in good condition, free of cracks, and that adequate solution is contained in the Eh electrode.

2. Calibrate the Eh instrument in accordance with manufacturer's recommendations daily or more frequently if conditions warrant.

3. Decontaminate a sample beaker in accordance with SOP-11.

4. Rinse Eh electrode with deionized water and then with sample water prior to inserting into sample beaker.

5. Obtain sample of water using a method which minimizes agitation of the sample. The more the sample is exposed to oxygen, the more likely it is that erroneous data will be obtained. If possible, obtain an in situ measurement of Eh.

6. If extractive methods are used to obtain water samples, fill the sample beaker with sample water which has been recently evacuated from well and, again, minimize agitation.

7. Immerse the Eh electrode in sample and allow several minutes for the probe to equilibrate with the water.

8. Obtain reading to nearest ten millivolts.

9. Record reading on standardized field forms or in the field book. Note any problems such as erratic or drifting readings.

10. Rinse probe with deionized water and store according to manufacturer's directions.

STANDARD OPERATING PROCEDURE
FIELD MEASUREMENT OF TURBIDITY

1. Obtain water sample in accordance with SOP-03 or by grab sampling, whichever is appropriate for site conditions.

2. Decontaminate turbidimeter in accordance with SOP-11.

3. Calibrate turbidimeter in accordance with manufacturer's recommendations. Be certain to use calibration standards which bracket expected turbidity values.

4. Obtain turbidity measurement from collected sample as soon after sampling as possible.

5. Record data on standardized field forms.

6. Decontaminate turbidimeter in accordance with SOP-11.

STANDARD OPERATING PROCEDURE
DETERMINATION OF LIQUID HYDROCARBON THICKNESS IN WATER TABLE AQUIFER USING MONITORING WELL GAGING MEASUREMENTS

This procedure is used for estimating the actual thickness of a liquid hydrocarbon layer in a near-surface aquifer, using apparent liquid hydrocarbon thicknesses measured in a monitoring well under static conditions. The well must be screened throughout the entire interval from the uppermost liquid hydrocarbon level to a depth at which the liquid hydrocarbon level could potentially fall when the liquid hydrocarbon layer is bailed from the well, allowing for depression of the water level as some groundwater is inadvertently bailed from the well with the liquid hydrocarbon layer.

EQUIPMENT REQUIRED:

1. A bailer with a diameter slightly smaller than the well to be tested, plus bailer cord.
2. A stopwatch.
3. A well gauging probe which can detect both water and liquid hydrocarbons, and which is accurate to at least 0.02 feet.*
4. A 5 gallon bucket, funnel and a D.O.T. approved 55 gallon drum.
5. Decontamination equipment.
6. Regular arithmetic graph paper, pencils and eraser, a scratch pad, field notebook, and a straight edge.

NOTE:* This technique requires accurate depth to water and liquid hydrocarbon measurements. The rapidity of these measurements requires a well gauging probe which is both fast and accurate, and does not present awkward or time consuming operating techniques. The dual interface probe design provides the degree of accuracy needed, while permitting the use of a single probe to gauge hydrocarbons and water. Use of two measurement devices can disturb liquid levels and will demand time for managing equipment at the expense of data collection. Since water level probes only provide half the data needed, another device would be needed to gauge liquid hydrocarbons. Tape and paste can serve this purpose but is awkward, slow and less accurate than an interface probe. Measurement techniques which disturb or affect the thickness or elevation of water or liquid hydrocarbons such as a clear acrylic bailer or a "plopper" well gauge are not acceptable.

PROCEDURE:

1. Decontaminate bailer and well probe as per SOP-11, or use a new disposable bailer.
2. Prepare a graph for recording measurements. The abscissa (X, or horizontal axis) will be used to record time of measurement. The ordinate (Y, or vertical axis) will be used to record depth to groundwater and depth to the liquid hydrocarbon layer.
3. Gauge the depth to groundwater and the depth to the liquid hydrocarbon layer. Plot these two readings at the Time Zero position on the Y axis of the graph paper. The interval between the two readings is the Apparent Liquid Hydrocarbon Thickness in the monitoring well.

4. Bail the liquid hydrocarbon layer from the well. Bail as rapidly as possible. Take care to remove as little water as practical to avoid causing the water level in the well to fall significantly below the liquid hydrocarbon level in the aquifer. Attempt to remove all liquid hydrocarbons from the well. If this is not possible, bail until the no further reduction in liquid hydrocarbon thickness can be achieved. Place bailed hydrocarbons and water in the 5 gallon bucket for later transfer to the 55 gallon D.O.T. approved drum.

5. Immediately upon the cessation of bailing begin to measure and record depth to product, depth to water and time of measurement. Water and liquid hydrocarbon levels will change rapidly at first, then begin to slow with time. During the initial period of rapid liquid level change it will be necessary to take as many measurements as possible. An assistant who may record data as the individual gauging the well calls out measurements would be beneficial at this time.

   As the rate at which changes in the thickness of the liquid hydrocarbon layer begins to slow, it will be possible to reduce the rate at which these measurements are taken. For example, after five minutes you may be able to take a reading every thirty seconds, after ten minutes the measurement rate may be reduced to once per minute, after fifteen minutes once per every five minutes may be sufficient etc...

6. The test is considered complete when the liquid levels in the well have stabilized for three consecutive readings, or when a significant amount of time has elapsed and liquid hydrocarbon thickness readings have approached 90 percent of the original liquid hydrocarbon layer thickness.

7. Plot the depth to water and depth to product measurements against the time elapsed since bailing was ended on the graph paper. Connect data points representing depth to water with a line. Connect depth to liquid hydrocarbon data points with a second line.

8. As the liquid level versus time data are plotted on the graph paper, certain trends will become apparent. The depth to water and depth to liquid hydrocarbon data plots will record the recovery of these fluids as lines (or curves) with a positive slope.

   Initially, the thickness of the liquid product in the well will increase rapidly. After about one half to two hours, the rate of liquid hydrocarbon accumulation will decrease noticeably. Both of the lines connecting depth to water and depth to liquid hydrocarbon data points will then describe a less steep positive slope, or will become flat. This will be apparent as breaks in slope for each of the two lines representing fluid recovery rates. The liquid hydrocarbon thickness at the time of this break in slope is considered to represent the minimum estimated thickness of the liquid hydrocarbon layer in the aquifer.

   A second break in slope will occur at a later time when the rate at which liquid hydrocarbons are accumulating in the well begins to increase again. At this time, the slope of the two lines will increase. The thickness of liquid hydrocarbons at this time represents the maximum theoretical thickness of liquid hydrocarbons in the aquifer.

   The actual thickness of liquid hydrocarbons in the aquifer is therefore considered to range between the theoretical minimum and maximum hydrocarbon layer thicknesses represented by the earlier and later breaks in slope of the two lines depicting depth to groundwater versus time and depth to the liquid hydrocarbon layer versus time.

9. If these breaks in slope are not apparent following completion of the test, an alternate interpretation of the data may be used to estimate the true thickness of the liquid hydrocarbon layer. At the time when liquid hydrocarbons begin to accumulate in the well beyond the true thickness of the liquid hydrocarbon layer in the aquifer, the over accumulation of liquid hydrocarbons begins to depress

the water table. This is represented by the generation of a negative slope in the line representing depth to groundwater readings. The thickness of the liquid hydrocarbon layer in the well at this time is considered to equal the true thickness of the liquid hydrocarbon layer in the aquifer.

10. Transfer bailed fluids from the 5 gallon bucket to the 55 gallon drum. Secure the 55 gallon D.O.T. approved drum for safe storage of recovered liquid hydrocarbons.

11. Decontaminate five gallon bucket, funnel, bailer and well probe as per SOP-11.

12. Complete field documentation of site activities before leaving the site.

STANDARD OPERATING PROCEDURE
PRESERVATION OF HYDROCARBON VOA WATER SAMPLES

1. Collect the sample according to the appropriate SOP.

2. Collect a sub-sample of the same water and test for pH using polyHydrion paper. If the pH is more than 2, add small amounts of preservative, keeping track of the cumulative amount, until subsequent testing with pH paper shows it to be less than 2 s.u.

3. Using preservative at the same ratio to sample volume, adjust the pH of the actual sample by adding drops of the needed preservative.

4. Certain conditions can require an increase in the amount of acid preservative needed.

    - Suspended sediment, especially calcareous material, can neutralize the acid and act as a buffer. This will cause a release of CO_2 when acid is added.

    - Bacteria or organic material can act to neutralize the acid and adjust the pH of the sample.

    - The presence of chemical buffers in the sample can affect the effectiveness of the acid preservative and suppress changes in pH.

Note: Adding more than 4 drops of HCL to standard 40ml voa vials may create chlorinated hydrocarbons and should only be done after consulting with the project manager.

STANDARD OPERATING PROCEDURE
IONIZATION DEVICE (PID or FID) OPERATION

1. Before taking the instrument to the field, check the following:

   - Test the condition of the battery and recharge if necessary.
   - Make sure you have calibration gas.
   - If you are using the FID, check the hydrogen pressure and refill from the supply bottle if below 1000 psi.
   - Check the integrity of the instrument and its accessories. Repair or replace broken parts and clean the sampling tip. On the PID clean the inlet filter.
   - Make sure you have all the accessories you will need for sampling.

2. Arrive on-site with decontaminated equipment in working order. During transport, keep the instrument temperature stable and moderate.

3. Follow the manufacturer's instructions for starting up the instrument. Turn the instrument on and let it run for a few minutes, allowing the electronics to stabilize.

4. For the FID, let the electronics warm up for about 5 minutes and the pump to run for at least 3 minutes before attempting to light the flame. After lighting the flame, test the instrument with a known hydrocarbon to make sure the flame remains lit.

5. Calibrate the instrument by setting the zero and span against the calibration gases. To zero the instrument you may use clean air, if available, or a cylinder of compressed zero gas.

6. Complete your organic vapor readings and record the results according to the SOP covering the test procedure you are using.

7. Shut down the instrument according to the manufacturer's instructions. Decontaminate and carefully pack the instrument before leaving the site.

TABLE 1
COMPARISON OF ORGANIC VAPOR ANALYTICAL FIELD INSTRUMENTS

Instrument	Advantages	Disadvantages	Limitations
Foxboro/Century OVA-128GC (FID)	1. Measures total hydrocarbon content 2.Has fast response. 3.Instant readout of organic vapor level 4.Unaffected by condensing vapor in sample gas. 5.Has simple calibration procedure.	1.Maximum concentration of hydrocarbons must be less than 1000 ppm. 2.Instrument is heavy and awkward to use. 3.Individual hydrocarbons cannot be identified unless used in GC mode. 4.GC mode is difficult and very slow to use. 5.Requires hydrogen gas as fuel. 6.Analog readout.	1.Hydrocarbon concentration must be less than 1000 ppm in the sample stream. 2.A single battery/hydrogen charge will last between 6 and 8 hours. 3.Strong breezes will blow out the flame through the flame arrestor on the chamber inlet. 4.High hydrocarbon concentrations will make the flame go out. The only indication of this will be a constant below zero reading. 5.No filter on the sample probe will allow dirt and dust to be sucked into the instrument. 6.Recommended temperature operating range 10 to 40° C. 7.Accuracy 10 to 20% of full scale reading.
Photovac Microtip MP-100 (PID)	1.Has fast response. 2.Instant readout of organic vapor level. 3.Has simple calibration procedure. 4.Lightweight and very portable. 5.Retains the last maximum reading in memory. 6.Contains a built-in filter on the sample tip to prevent dirt and dust from entering the instrument. 7.Lighted digital display.	1.Susceptible to inaccurate readings due to moisture condensing on the UV lamp. Condensing moisture causes the reading to slowly rise until it reaches a high plateau level or goes off-scale. 2.Measures only hydrocarbons with activation energies below the rating of the lamp (10.6 eV for the standard lamp), 3.Liquid water or condensing vapor in the instrument will cause readings to become increasingly erratic. Eventually the instrument will refuse to operate, giving a "FAULT" message. 4.Not recommended for freezing temperatures.	1.Hydrocarbon concentrations limited to less than 2000 ppm in the sample stream. 2.Accuracy approximately ± 2 to 4 ppm for $0 \le C \le 100$ ppm, ± 20% for $100 \le C \le 1000$ ppm, and ± 25% for $1000 \le C \le 2000$ ppm. 3.Water vapor condensing in the instrument will disable it for hours or days. Immediate disemploy and cleaning will make it useable again. 4.Recommended operating temperature range 0 to 40° C. 5.A single battery charge will last 6 to 8 hours.
HNU PI-101 (PID)	1.Has fast response. 2.Instant readout of organic vapor level. 3.Has simple calibration procedure. 4.Lightweight and very portable.	1.Susceptible to inaccurate readings due to moisture condensing on the UV lamp. Condensing moisture causes the reading to slowly rise until it reaches a high plateau level or goes off-scale. 2.Measures only hydrocarbons with activation energies below the rating of the lamp (10.2 eV for the standard lamp; An 11.6 eV lamp is available). 3.Liquid water or condensing vapor in the instrument will cause readings to become increasingly erratic. Eventually the instrument will refuse to operate. 4.Not recommended for freezing temperatures. 5.Analog readout.	1.Hydrocarbon concentrations limited to less than 2000 ppm in the sample stream. 2.Accuracy estimated to be approximately ± 20% for full scale reading. 3.Water vapor condensing in the instrument will disable it for hours or until cleaned out. 4.Recommended operating temperature range - 10 to 40° C. 5.A single battery charge will last up to 10 hours.

STANDARD OPERATING PROCEDURE
LOW-FLOW (MINIMAL DRAWDOWN) GROUNDWATER SAMPLING

EQUIPMENT:

Peristaltic, bladder, or submersible pump
Tubing
Flow-through cell
Multi-parameter meter
Electronic water level probe
Weighted tape measure
Oil-water interface probe (project-specific)
Calibration fluids
0.45-micron in-line filters (project specific)
Sample bottles and labels
Preservatives
Coolers and ice
Decontamination equipment and supplies
Indelible markers and pens
Field sampling forms
Chain-of-custody forms
Well logs or completion information for all wells being sampled, as available

PROCEDURES

Pre-Field & Daily Calibration:

1. Inspect all sampling equipment for damage, proper calibration, and function prior to field event. Report any damage, calibration, or function issues to equipment manager.

2. Check calibration standard expiration dates. Replace standards as necessary.

3. Decontaminate all equipment prior to arrival at the project site. Keep clean by placing in plastic bags or other container.

4. Calibrate the multi-parameter meter at the beginning of each workday. Document calibration in field notebook. Re-calibrate the meter as needed during the workday if parameter drift is noticed.

Depth to Water and LNAPL Thickness Measurements:

1. Measure the depth to water using an electronic water level probe. Document the depth to water from the north side (default) of the top of the well casing, or other designated location on the top of the casing, as marked. Record depth to water to 0.01-foot accuracy on the field form.

   Project-specific: If indicated, use an oil-water interface probe to document the thickness of LNAPL (free product) in the well. Document the thickness of LNAPL and depth to water from the north side of the top of the well casing, or other designated location on the top of the casing, as marked. Record the depth to water and LNAPL thickness to 0.01-foot accuracy on the field form.

2. If required, measure the total well depth using the probe or a weighted tape measure following low flow purging. Lower the tape slowly so as to not disturb sediment that may reside at the bottom of the well. Document the thickness value on the well log to 0.01-foot accuracy, as possible. Evaluate any changes to the total depth from the well log and/or prior well depth data. This measurement will be used to calculate the water column thickness (depth to water – total depth), as needed.

3. Decontaminate equipment as per SOP-11.

Well Purging:

1. Where possible and if known, sample wells in the order from least contaminated to most contaminated.

2. Conduct well purging and sampling using a peristaltic, bladder, or submersible pump.

3. Place the pump intake at the location of the most contaminated zone within the well screen segment (EPA 2017). If this zone is not known, place the intake of the pump approximately 18 inches below the static water level, within the screened well interval.

4. For wells with LNAPL, seal the pump intake place the pump intake 18 to 24 inches below the base of the LNAPL.

5. Secure the pump/pump tubing to maintain a consistent pump intake level. Pump tubing should be dedicated, disposable tubing unless the well is fitted with a permanent, dedicated pump and tubing system.

6. Lower the electronic water level probe to monitor drawdown. Secure the probe to maintain a consistent monitoring level.

7. Connect the pump tubing to the flow-through cell and attach the multi-parameter meter probe/s.

8. Set the pump purge rate to minimize well drawdown. Adjust the flow rate as needed to maintain EPA's (2017) recommend well drawdown of no greater than 0.3 feet and a purge flow rate of no greater than 0.5 liters per minute to reduce turbulence.

9. Record field parameter readings at every 3- to 5-minute purge intervals (EPA 2017). Standard field parameters include temperature, pH, specific conductance, dissolved oxygen, oxidation-reduction potential, and turbidity.

10. Purge the well until three consecutive field parameter readings indicate stabilization. Stabilization criteria are listed below.

Field Parameter	Stabilization Criteria
pH	±0.1 unit
Temperature (°C)	3%
Specific Conductivity (SC)	3%

Field Parameter	Stabilization Criteria
Oxidation-reduction potential (ORP)	±10 mV
Dissolved oxygen (DO)	10% for values >0.5 mg/l; or three consecutive values if < 0.5 mg/L
Turbidity	10% for values >5 NTU; or three consecutive values if < 5 NTU

11. Once field parameters stabilize, disconnect the flow-through cell from the pump tubing.

12. Fill laboratory-provided sample containers directly from the pump tubing. Preserve samples with preservatives as per laboratory requirements.

13. Place samples in a cooler containing doubled, re-sealable bags filled with ice. Replenish ice as needed during the day, during transport, and prior to shipping to the laboratory.

14. Decontaminate all sampling equipment as per SOP-11.

15. Place disposable field sampling supplies in an approved waste receptacle for disposal at a sanitary landfill, unless specified otherwise in the work plan.

Also Refer to:

U.S. Environmental Protection Agency (EPA), 2017a. Low Stress (low flow) Purging and Sampling Procedure for Collection of Groundwater Samples from Monitoring Wells. Quality Assurance Unit, U.S. Environmental Protection Agency – Region 1. EQASOP-GW4. Revision 4, original date July 30, 1996, revised date September 19, 2017.

STANDARD OPERATING PROCEDURE
MODIFIED FLOW-THROUGH CELL FIELD PARAMETERS SAMPLING
(UNCOLLECTED PURGED WATER)

EQUIPMENT:

Calibrated five gallon bucket to measure gallons purged

Electronic water level indicator

3/8-inch diameter flexible polyethylene (poly) tubing

Field forms

Decontamination equipment and fluids

Stop watch

Flow-through cell:
  - 1000 ml poly sample bottle
  - 15-inch long 3/8-inch diameter stainless steel tubing stinger

3/8-inch diameter hard polyethylene tubing

Low-volume peristaltic pump

Electrical generator, power converter, or appropriate power source

SC, pH, ORP, and DO probes and meters

Calibration fluids for SC, pH, ORP, and DO

GENERAL PROCEDURE:

1. Assemble flow-through cell: Cut a 3/8-inch hole in the top of a 1,000 milliliter (ml) polyethylene (poly) sample bottle adjacent to the lid and insert the 3/8-inch diameter stainless steel tubing stinger. The stainless steel tubing stinger should be installed to within 1/4-inch of the bottom of the poly bottle to eliminate air entrapment and ensure accurate field parameters. Cut another opening on the side of the flow-through cell bottle to allow for installing and removing the field parameter probes and allow purged water to flow into the five gallon bucket for volume measurement. Attach the flow-cell to the five gallon bucket so that overflow from the cell runs into the bucket to ensure accurate readings of purge groundwater.
2. Calibrate field parameter meters (DO, meter, pH meter, temperature gauge, EC/SC meter, and ORP meter) using standard operating procedures SOP-08, SOP-06, SOP-07, SOP-05, and SOP-28, respectively, prior to starting. Field parameters should be observed throughout the sampling event. If the measured value differs from expected value check the meter calibration with calibration standard and recalibrate as necessary.
3. Attach approximately three feet of 3/8-inch flexible tubing to the “in well” dedicated 3/8-inch hard poly tubing. Adjust the tubing length to the desired sample depth as stated in the work plan based on available individual well completion information, previous groundwater monitoring events, current static water level, and depth to bottom. Note: flexible tubing will slide over the hard tubing requiring no additional connections.
4. Attach the flexible poly tubing to the peristaltic pump.

5. Connect the flexible poly tubing to the 3/8-inch stainless steel stinger at the top of the flow-through cell. Note: Maintain the stainless steel stinger within 1/4-inch of the bottom of the poly bottle to eliminate air entrapment and ensure accurate field parameter
6. Position the field parameter probes in the flow-through cell within the bottom 1/3 of the water column. Use caution when installing the field parameter probes; they are very fragile.
7. Prior to initiating purging of the well, measure the static water level in accordance with SOP-20.
8. Begin purging using SOP-46, *Low-flow (minimal drawdown) groundwater sampling method*. Frequent measurements of depth to groundwater will be required to set pump flow rates. Adjust pump speed until the desired flow rate is achieved. Note: Drawdown in the well must be kept to **<0.3** feet.
9. Measure field parameters in the flow-through cell while evacuating. If field parameters stabilize within the limits stated below prior to purging three well volumes, sampling may commence. Record all parameter measurements, measured pumping rate and calculated evacuation amount on the groundwater sampling log as per SOP-10 and 12. The parameters must stabilize within the following limits:
    - DO (±10%)
    - Specific conductivity (±3%)
    - pH (± 0.1 units)
    - ORP/Eh (± 10 millivolts)

      (We use ± 10% on all parameters.)

10. If field parameters do not stabilize prior to purging a minimum of three calculated volumes of groundwater, a groundwater sample may then be collected in accordance with SOP-18. NOTE: Always check the appropriate work plan in such cases to determine the appropriate action. The volume of water present in each well shall be computed using the length of water column, monitoring well inside diameter, and casing diameter. The total volume of water in the well (gallons) can be approximated using the following formula (depth and water level measurements in feet; borehole diameter in inches):

$$\mathbf{(1/25)(Total\ Depth - Measured\ Water\ Level)(Casing\ Diameter)^2 = gallons}$$

11. Upon sample collection, decontaminate and clean field parameter meters and probes according to manufacture's specifications.

TETRA TECH

STANDARD OPERATING PROCEDURE
MODIFIED FLOW-THROUGH CELL FIELD PARAMETERS SAMPLING
(COLLECTED PURGED WATER)

EQUIPMENT:

Callibrated five gallon bucket to measure gallons purged

Electronic water level indicator

3/8 inch diameter flexible polyethylene (poly) tubing

Field forms

Decontamination equipment and fluids

Stop watch

3/8-inch ball valve with tee

15ft x 15ft poly sheeting

Flow-through cell:
1000 ml poly sample bottle
    3/8-inch diameter stainless steel tubing stinger

3/8 inch diameter hard polyethylene tubing

Low-volume peristaltic pump

Electrical generator, power converter, or appropriate power source

SC, pH, ORP, and DO probes and meters

Calibration fluids for SC, pH, ORP, and DO

50-100 gallon graduated transparent collection tank

GENERAL PROCEDURE:

1. Line the sampling vehicle (truck bed or van cargo areas) with poly sheeting for secondary containment of any possible spills. Place 50-100 gallon collection tank on secondary containment in sampling vehicle prior to arriving on site. Check to ensure evacuation valve for collection tank is closed
2. Assemble flow-through cell: Cut a 3/8-inch hole in the top of a 1,000 milliliter (ml) polyethylene (poly) sample bottle adjacent to the lid and insert the 3/8-inch diameter stainless steel tubing stinger. The stainless steel tubing stinger should be installed to within ¼ inch of the bottom of the poly bottle to eliminate air entrapment and ensure accurate field parameters. Cut another opening on the side of the flow cell bottle to allow for installing and removing the field parameter probes and allow purged water to flow into the five gallon bucket for volume measurement. Attach the flow-cell to the five gallon bucket so that overflow from the cell runs into the bucket to ensure accurate readings of purge groundwater.
3. Calibrate field parameter meters (DO, meter, pH meter, temperature gauge, EC/SC meter, and ORP meter) using standard operating procedures SOP-05, SOP-06, SOP-07, SOP-08, and SOP-28, respectively, prior to starting. Field parameter meters should be recalibrated during the field day if the measured value differs from expected value.
4. Attach approximately three feet of 3/8-inch flexible tubing to the “in well” dedicated 3/8-inch hard poly tubing. Adjust the tubing length to the desired sample depth as stated in the work plan based on individual well completion I nformation, previous groundwater monitoring events, current static

water level, and depth to bottom. Note: flexible tubing will slide over the hard tubing requiring no additional connections.

5. Attach the flexible poly tubing to the peristaltic pump.
6. Attach the tee assembly to the discharge side of the peristaltic pump. One branch of the tee assembly should run directly to the collection tank and one should be connected to the 3/8-inch ball valve followed with a short section of tubing into the flwo-through cell stinger. The ball valve should be used to control the amount of water going into the flow-cell. Note: All tubing connections should be air tight to ensure accurate field parameter readings.
7. Position field parameter probes in flow-through cell within the bottom 1/3 of the water column. Use caution when installing the field parameter probes; they are very fragile.
8. Prior to initiating purging of the well, measure the static water level in accordance with SOP-20.
9. Begin purging using SOP-46 *Low-flow (minimal drawdown) groundwater sampling method*. Frequent measurements of depth to groundwater will be required to set pump flow rates. Adjust pump speed until the desired flow rate is achieved. Note: Drawdown in the well must be kept to **<0.3** feet.
10. Adjust water flow into flow-through cell with the ball valve until the desired flow rate is achieved. The intention of the controlled flow is to provide enough water in the flow through cell to collect accurate parameter measurements but not to fill the bucket up during the well purging.
11. Measure field parameters in the flow-through cell while evacuating. If field parameters stabilize within the limits stated below prior to purging three well volumes, sampling may commence. Record all parameter measurements, measured pumping rate and calculated evacuation amount on the groundwater sampling log as per SOP-10 and 12. The parameters must stabilize within the following limits:
    - DO (±10%)
    - Specific conductivity (±3%)
    - pH (± 0.1 units)
    - ORP/Eh (± 10 millivolts)

    (We use ± 10% on all parameters.)

12. If field parameters do not stabilize prior to purging a minimum of three calculated volumes of groundwater, a groundwater sample may then be collected in accordance with SOP-18. NOTE: Always check the appropriate work plan in such cases to determine the appropriate action. The volume of water present in each well shall be computed using the length of water column, monitoring well inside diameter, and casing diameter. The total volume of water in the well (gallons) can be approximated using the following formula (depth and water level measurements in feet; borehole diameter in inches):

$$\mathbf{(1/25)(Total\ Depth - Measured\ Water\ Level)(Casing\ Diameter)^2 = gallons}$$

13. Record the total volume of purged water necessary to reach field parameter stabilization on the groundwater sampling log by using the transparent graduated tank.
14. Decontaminate meters and probes according manufacture's specifications.
15. Dispose of collected water in appropriate collection area.

ATTACHMENT C

WORK AUTHORIZATION

TETRA TECH

WORK AUTHORIZATION

TO: CHS Inc. /Zip Trip

FROM: Tetra Tech, Inc.

WORK AUTHORIZATION NO.: *28*

PROJECT TITLE: *Groundwater Monitoring Work Plan Zip Trip 72*

PROJECT LOCATION: *2801 Harrison Ave, Butte, Silver Bow County, Montana*

Pursuant to the terms and conditions of the Consulting Services Agreement dated *January 1, 2009*, this Work Authorization hereby authorizes *Tetra Tech, Inc.* to perform the specific services and under the particular conditions set forth herein:

1. **SCOPE OF WORK:** *Per the Scope of Work attachment hereto.*
2. **COMPENSATION:** *Time and material not to exceed the attached estimate.*
3. **BILLING SCHEDULE:** *Monthly*
4. **TIME FOR COMMENCEMENT:** *August 2024*
5. **TIME FOR COMPLETION:**. *August 2025*
6. **REPORTING REQUIREMENTS:** *Report in electronic format only.*
7. **OTHER PROVISIONS:** *None.*

Upon execution of this Work Authorization, Client and Tetra Tech agree to be bound by and comply with all the terms and conditions contained in the above-referenced Consulting Services Agreement, except as modified by the specific terms and conditions, if any, contained herein.

APPROVED AND ACCEPTED BY:

CHS Inc. (Client)	Tetra Tech, Inc. (Consultant)
Signed: ______________	Signed: ______________
Name: ______________	Name: Austin Maphis
Title: ______________	Title: Project Manager
Date: ______________	Date: September 6, 2024
Phone: ______________	