*Montana Bureau of Mines and Geology*

# BASELINE GROUNDWATER MONITORING SAMPLING AND ANALYSIS PLAN

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## 1.0 PROJECT PURPOSE AND SCOPE

Public concerns about potential impacts to water resources from hydraulic fracturing and associated activities have increased as oil and gas development continues in Montana and North Dakota. Hydraulic fracturing, which involves the pressurized injection of water, chemical additives, and proppants into a geologic formation, induces fractures in the formation that stimulate the flow of natural gas and oil, thus increasing the volume of gas or oil that can be recovered from coalbeds, shales, and tight sands. Other activities of concern include waste management such as well-head waste pits and injection wells, accidents and spills that occur during transportation of chemicals and product, and related resource extraction activities such as gravel mining and water withdrawals.

The purpose of this sampling and analysis plan (SAP) is to document field sampling procedures and laboratory methods that will be used to ensure that consistent and representative data is collected, and that a uniform method of data reporting to the agencies is established.

The primary objective of this SAP is to identify proper field data collection and data management procedures to: provide consistency in data collection; allow uniform and efficient data handling and transfer; and provide clear documentation of sample locations, field procedures, and analytical methods.

## 2.0 SAMPLING PROCEDURES

The following procedures will be used to collect groundwater samples from selected water sources. Samples will be collected by properly trained field personnel with knowledge of standard industry practices.

### 2.1 FIELD PREPARATION AND MOBILIZATION

Field preparation and mobilization includes tasks that must be conducted prior to the start of field activities. Tasks included in field preparation are:

- Obtain verbal access permission from the landowner
- Contact the landowner or tenant to schedule the sampling event
- Procure all necessary field instruments and sampling equipment, including pre-cleaned sample containers and required sample preservatives from the laboratory.

Wells will be chosen from a subset of previously sampled wells and/or wells in areas/aquifers of concern that lack current information. Information collected at the well-head and example constituents of analysis are listed at the end of this SAP. Specific analytes will be chosen based on the results from ongoing MBMG/DNRC work in the area in 2015 and will be agreed upon by representatives from the DNRC and MBMG.

## 2.2 WELL PURGING

Samples will be collected from a location prior to holding tanks, pressure tanks, or any water treatment system (softeners, reverse osmosis, etc.), if possible. Otherwise, a sample will be collected from the closest sampling location to the well. Sealed water wells should not be opened.

Purging can be considered complete when a sufficient volume of water has been removed from the well and/or stabilization of select groundwater parameters has been achieved. It is important to record the circumstances surrounding each sample collection event. These records can help resolve analytical discrepancies. One of the following four purging methods below will be used prior to sample collection:

### a. Purge by Volume Method

For wells where the completion depth and the depth to water are known, or can be reasonably measured, removal of a *minimum* of three casing volumes of water from the well will be completed prior to collecting a groundwater sample. In addition, groundwater stabilization parameters (temperature, pH, oxidation-reduction potential, specific conductance, dissolved oxygen, and turbidity) will be recorded after removal of every half casing volume of water. Minimum purge volume can be calculated by the following equation:

Minimum Purge Volume = 3 X (total well depth – depth to water) X well capacity

Where total well depth and depth to water is in feet
And where well volume (gallons per foot) is based on well diameter as follows:
2 inch well = 0.163 gallons per foot
4 inch well = 0.653
6 inch well = 1.47
8 inch well = 2.61

### b. Stabilization of Parameters Method

For wells where the completion depth, depth to water, or well diameter are unknown, purging of groundwater until select field parameters have stabilized can be used to demonstrate that a representative sample was collected. Field parameters measured during purging will include temperature, pH, oxidation-reduction potential, specific conductance, dissolved oxygen. Turbidity will be monitored visually. Field parameters should be measured every 5 minutes.

Stabilization can be demonstrated by a variance of no more than +/- 10% for temperature, dissolved oxygen (if > 0.5 mg/L), and specific conductance; +/- 10 mV for oxidation-reduction potential; and +/- 0.2 standard units for pH.

To measure the purge rate of the well, a 5-gallon bucket and a timer capable of measuring time to seconds may be used. Flow rate is measured by recording the time it takes to fill a 5-gallon bucket, and converting to a gallons per minute (gpm) reading.

**c. Low Yield Wells**

Low-yield wells may be pumped at a flow rate that does not compromise the pump or cause excessive drawdown and then sampled after at least one casing volume has been removed and field parameters have stabilized. However, in very low-yield wells that are unable to sustain even low-flow sampling rates (i.e. excessive drawdown), a single casing volume will be removed, and field parameters are not required to stabilize before sampling. Turbidity values of 20 NTU or less may not be achievable in low-yield wells, and samples will be collected as soon as an adequate volume of water has recovered to allow collection of samples.

**d. Sampling from Springs**

Sampling from a spring will be conducted at the location closest to the point of emergence from the ground. For sampling of volatile organic constituents (VOCs, i.e. benzene, toluene, ethylbenzene, xylenes (BTEX), dissolved gasses) groundwater is drawn into a syringe from a depth of approximately 2-inches below the surface of any pool associated with the seep, and then injected into the appropriate sample container for laboratory analysis. For larger volume samples, a stainless steel container may be used to collect the water sample from a depth of approximately 2-inches below the surface of any pool associated with the spring, taking care to not entrain foreign materials into the sample container (debris, insects), then transferring the collected sample into the appropriate sample container for laboratory analysis.

**2.3 SAMPLE COLLECTION**

Groundwater samples will be collected immediately after purging the well. Once purging is complete, the majority of the flow rate should be directed through a completely open side of a Y-type brass splitter attached to the sample point; the sample will be collected through the other side from a reduced flow rate in order to minimize the potential for loss of VOCs. Reducing the flow rate by adjusting a valve should be avoided. Closing of a valve does not decrease the flow rate of the pump, and may induce turbulence into the water column. If a pump is equipped with a variable flow controller, the flow rate should be reduced, and the new flow rate calculated. In addition, if the sampling point is equipped with an aerator, the aerator will be removed, with the consent of the landowner, prior to sampling. If the aerator cannot be removed, no volatile organic carbon samples will be collected.

Groundwater sampling will be conducted by personnel with the proper training and experience. The sampler should wear a new pair of disposable, powder-free ‘exam-type’ gloves in order to reduce cross contamination of the samples prior to sampling. In addition, gloves should be changed between sampling locations.

Unfiltered samples will be collected directly from the sampling point into clean, laboratory-provided, and preserved (if required) sampling containers. Care should be taken when collecting the sample to minimize agitation when filling the sampling containers, and not to overfill sample containers

containing preservatives. Samples collected for volatile constituents such as BTEX and TPH-GRO, will be collected into VOA vials with no headspace. If air bubbles are observed after placing on the cap, a new sample will be collected into a fresh bottle.

**Filtered Samples**
Samples that will be field filtered must be collected using an in-line disposable 0.45-micron glass-fiber filter. When field filtering is performed the in-line filter should be connected directly to the brass Y splitter or pump discharge line. For hand bailed wells, a hand vacuum pump or peristaltic pump and tubing should be used to draw water from the bailer and push it through the filter. In all cases, the tubing and filter should be flushed and the filtered water should be collected directly into the pre-cleaned sample containers provided by the laboratory. New filters must be used for each sample location. For those sample containers with preservative, special care should be taken to not overfill the container. Filtration at the laboratory after receipt followed by appropriate preservation is an acceptable alternative to field filtration.

**Dissolved Gases Samples**
For the purposes of this project, the preferred method for dissolved gas sample collection is RSK-175 headspace analysis. This method utilizes 3 sample containers with aluminum caps and Teflon inserts. The bottles are filled halfway full with water, then capped and stored on ice. No preservation is required, however the hold time cannot exceed 7 days. The headspace is analyzed by the lab upon delivery.

## 2.4 SAMPLE HANDLING

Follow laboratory requirement for sample containers and preservatives. Sample containers will be stored in a cool, dry location, separate from any VOC-containing materials. Sample containers containing laboratory prepared preservatives will not be used if held on-site for an extended period of time or if exposed to extreme temperature conditions. Once opened, the sample containers will be used immediately. If the container is used for any purpose other than sample collection, it will be discarded.

Samples will be identified with a unique sample identification (GWIC ID) number. Sample containers will be labeled using waterproof ink and will indicate the sampler, sample ID, date, time, matrix, and preservatives and analysis requested.

After labeling, samples will be placed in an insulated cooler on ice until packed for shipment to the laboratory. Sample containers will be placed in Ziploc-style baggies and then wrapped in protective packing material (bubble wrap); do not use foam blocks many labs ship the VOA vials in. The foam will insulate the vials and the proper temperature for the sample will not be achieved. Sample containers will then be placed in the insulated cooler in an up-right position (with the exception of the dissolved gas samples) and surrounded with sufficient ice to maintain a 4 degrees Celsius cooler temperature during shipping. Ice will be double bagged into Ziploc-style baggies. If the cooler contains a drain outlet, it must be sealed over with tape on the inside and the outside of the cooler prior to sample packing.

A chain of custody form (COC) will be placed in a Ziploc-style bag and taped to the underside of the cooler lid. The cooler will be sealed with a custody seal and tape and either hand delivered to the laboratory, or shipped by overnight carrier for delivery to the analytical laboratory. The temperature of all coolers will be measured upon receipt at the laboratory. Therefore, a temperature blank will be included with each cooler.

## 2.5 CHAIN OF CUSTODY PROCEDURES

Samples will be shipped under COC procedures to document the custody, transfer, handling, and shipping of samples. The sampler will be responsible for filling out the COC form and will sign the COC when relinquishing the samples to anyone else. One COC form will be completed for each cooler of samples collected. The COC will contain the following information:

- Sampler's signature
- Project number
- Date and time of collection
- Sample identification number
- Sample type
- Analyses requested
- Number of containers
- Preservatives
- Requested turn-around time
- Observations on sample condition that may be pertinent (i.e effervescence)
- Signature of persons relinquishing custody, dates, and times
- Signature of persons accepting custody, dates, and times
- Method of shipment and shipping air bill number (if appropriate)

The person responsible for delivery of the samples to the shipping company will sign the COC form, retain a copy of the COC form, document the method of shipment (shipper/airbill number) and send the original and the a second copy of the COC form with the samples. Copies of the final COC forms from the laboratory documenting sample custody will be kept with the sampling information.

## 2.6 FIELD DOCUMENTATION

All purging data must be recorded on the Site Inventory Sheet (Appendix B) using a permanent ink. The inventory sheet must contain a complete record of all equipment used, activities conducted, measurements of field parameters per well casing volume produced, calculations, and observations including weather and water odor/color/clarity and effervescence. The information must be sufficient to allow the purging procedure to be reconstructed in sufficient detail to evaluate adequacy of the purging procedure. Field notes will also include explanations of problems encountered during well purging and sampling and an explanation of any trouble-shooting techniques that were used.

## 2.7 EQUIPMENT CALIBRATION

The calibration process is necessary to ensure that the instrument is working properly, and that the results are within the range of acceptability as determined by the manufacturer's specifications. Calibration time and date will be recorded to maintain a record of the calibration and proof of acceptability.

Equipment used to collect field measurements will be calibrated at the start of each day. More frequent calibration is commonly necessary, depending on the reliability and inherent stability of the instrumentation, extreme field conditions (weather/climate), continuous or heavy use, or high concentrations of monitored parameters. Where field calibration is possible, calibration should be verified and documented at the end of the day.

## 2.8 DECONTAMINATION

Decontamination of non-dedicated or non-disposable equipment is necessary to prevent cross-contamination of sample locations. Dedicated or disposable equipment should be used whenever possible. All non-disposable equipment (e.g. instruments, buckets, non-dedicated pumps) must be decontaminated prior to use and between sample locations by using the following procedures:
1) Remove any visible surface contamination with a brush (sludge, sediment, etc) and rinse with tap water.
2) Wash with a dilute solution of tap water and non-phosphate laboratory grade detergent such as Alconox or equivalent. Pumps and non-disposable tubing must have water pumped through them.
3) Rinse with tap water.
4) Rinse with distilled or deionized water.
5) Allow to air dry.

Decontaminated equipment should be placed on aluminum foil to allow to dry and then stored in sealed containers when not in use to prevent contamination from airborne particles.

## 2.9 INVESTIGATION DERIVED WASTE

Disposable field equipment (gloves, filters, valves, tubing) will be bagged and disposed of as municipal solid waste. Unused sampling containers and preservatives will be returned to the laboratory, or disposed of as municipal waste after disposing of the preservatives into a municipal sewer system diluted with water. Preservatives should not be disposed of in concentrated form or directly into the ground. Purge water will be discharged onto the ground at least 20-feet from and down-gradient of the water source and/or in a location designated by the landowner. Decontamination water should be collected and disposed of down-gradient from the water source. Purge water and decontamination water, if disposed of onto the surface, will be discharged in a location to allow for infiltration of the water.

## 3.0 QUALITY ASSURANCE

Data quality will be considered adequate if sampling was conducted according to this SAP, samples were analyzed by approved analytical methods by an accredited/certified laboratory, and a data quality review of the field and laboratory data was conducted.

Samples will be analyzed by laboratories that are accredited by the National Environmental Laboratory Accreditation Program (NELAP) or American Association for Lab Accreditation (A2LA) for the analytical methods that will be used as part of the baseline sampling program. Analytical methods will conform to approved methods of the United States Environmental Protection Agency.

## 3.1 QUALITY ASSURANCE (QA) SAMPLES

All field sampling programs require the collection of additional samples to provide quality control for the field or laboratory procedures. These include field duplicates, trip blanks, equipment rinsate blanks, and several kinds of field blanks. A description of each of the various quality control (QC) sample types is provided below. The table below summarizes the minimum rate at which QC samples must be collected.

| QUALITY ASSURANCE SAMPLING SCHEDULE | | |
|---|---|---|
| **Sample** | **Frequency & Analytes** | **Comments** |
| Field Replicates | 1 for every 20 samples or 1 per sampling event<br>Full suite of analytes | A sampling event may be more than one day but is limited to one field trip. |
| Trip Blanks | Every cooler with organics<br>Organics only | Samples will be supplied by the lab. |

***Field replicates*** are independent samples of the same medium collected at the same time from the same location. Replicate samples will be collected for all the same analytes as the parent sample. Replicates/splits must be submitted for analysis "blind", meaning that they should not be identified to the laboratory as duplicate samples. The duplicate samples will be identified with a nonexistent sample location ID that is similar to, but different from the other sample location IDs at the site. All other labeling will be identical to the investigative samples. The true identity of the duplicate samples will be recorded in the field logbook, but not on the COC form or sample labels and tags that are sent to the laboratory.

**Trip blanks** are required only when samples are collected for analysis of VOCs, including BTEX. They are prepared from analyte-free water by the laboratory, and are transported to the sampling site with the VOC sample bottles for the investigative sampling. They are kept with the samples throughout the sampling program and are shipped for analysis with the samples. They are not opened on site, and are designed to evaluate VOC contamination encountered within the coolers during the shipping and handling procedures. Trip blanks are prepared in 40 ml VOA vials with Teflon septum lids, and must be chilled and handled in the same manner as a water sample for VOC analysis. Two trip blank vials per each shipping container or cooler containing VOC samples are required. Trip blanks will be analyzed for BTEX.

**Equipment blanks** or rinse blanks are obtained from the last rinse of analyte-free water during decontamination of sample collection equipment. No extraordinary decontamination procedures should be followed when a rinse blank is collected. The date and time of collection will be noted, as well as the ID number of the investigative sample collected just prior to decontamination, and the ID number of the next sample collected with the decontaminated equipment. ***If dedicated or disposable equipment is used, rinse blanks need not be collected.***

If contamination is detected in a rinse blank, extensive re-sampling may be required, based on the rate of rinse blanks collected, e.g. 20 locations re-sampled if rinse blanks are collected at the rate of 1 per 20 samples; 10 locations resampled if rinse blanks are collected at the rate of 1 per 10 samples. Rinse blanks will be collected for metals and BTEX.

Laboratory quality assurance samples (matrix spike (MS)/matrix spike duplicates (MSD)) will be prepared and analyzed by the laboratory. The results of the laboratory quality assurance samples will be reported with the original sample results. A narrative of any quality issues will be included with the laboratory report from the lab.

## 3.2 DATA QUALITY REVIEW

Data quality reviews will be conducted by a DNRC consultant on all data once finalized laboratory reports have been received. The results of a data quality review will be documented on a Data Quality Review Sheet and reported with the associated laboratory reports. The objective of a Data Quality Review is to ensure that data was collected and reported properly. A data quality review includes review of both field and analytical data.

### 3.2.1 FIELD DATA REVIEW

Field data to be reviewed includes log books and sampling sheets to confirm that this SAP was followed, that data was properly entered and recorded (transcription/spelling errors), proper field/sampling procedures were used, and that there were no conditions that occurred that could affect the reliability of the data.

### 3.2.2 LABORATORY DATA REVIEW

Procedures to validate laboratory data will be derived from the U.S. EPA's Contract Laboratory Program, National Functional Guidelines for Organic Data Review, and Contract Laboratory Program, National Functional Guidelines for Inorganic Data Review. Analytical reports will be checked to verify that holding times were met, proper matrix and units were reported, all requested analyses were conducted, and that proper analytical methods were used. Also, results of all blanks, surrogate spikes, MS/MSDs, laboratory control samples, and target compound identification and quantitation will be reviewed/evaluated to determine if results were within method acceptance limits.

The overall completeness of the data package will also be evaluated. Completeness checks will be administered on all data to determine whether deliverables are present. At a minimum, deliverables

will include sample COC forms, analytical results, and QA/QC summaries. The reviewer will determine whether all required items are present and request copies of missing deliverables. In addition, any deficiencies in the lab reports requiring corrective action will be brought to the attention of the lab. The results of the data validation review will be summarized in a Data Validation Report for each sample report issued by the laboratory and the reviewer will certify if the data was collected in accordance with this SAP and is suitable for use.

## 4.0 DATA MANAGEMENT & REPORTING

Sampling will only be conducted if landowner access is granted and the landowner agrees that the laboratory analytical results will be submitted to the Montana Department of Natural Resources and Conservation and the Montana Bureau of Mines and Geology for posting to a database that can be viewed by the public. Field and analytical results will be provided to the Montana Bureau of Mines Groundwater Information Center, to well owners, and to the DNRC in a final project report.

**Example Constituents for Analysis**

| Analyte | Method | Reporting Limit, mg/l |
|---|---|---|
| Calcium, potassium total | 200.8 | 0.02 |
| Magnesium, total | 200.8 | 0.005 |
| Sodium, total | 200.8 | 0.05 |
| Fluoride, bromide | 300.0 | 0.1 |
| Chloride | 300.0 | 1 |
| Boron | | |
| Sulfate | 300.0 | 5 |
| Total, Carbonate, bicarbonate alkalinity | 2320B | 5 |
| BTEX | 8260 | 0.001 to 0.003 |
| TPH-GRO | 8015 | 0.1 |
| TPH-DRO | 8015 | 0.5 |
| TDS | 2540C | 10 |
| Specific conductance | 2310C | 10 umhos/cm |
| Methane, ethane, ethene | RSK-175 | 0.010 (approx) |
| Iron, total | 200.8 | 0.05 |
| Manganese, total | 200.8 | 0.0005 |
| Strontium, total | 200.8 | 0.0005 |
| Barium, total | 200.8 | 0.0003 |
| Selenium, total | 200.8 | 0.0005 |
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