Wetland Restoration Effectiveness Monitoring

Sampling and Analysis Plan, WQDNPSSAP-06
May 2022

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1.0. INTRODUCTION

This Sampling and Analysis Plan (SAP) defines 2022 data collection under the Wetland Restoration Effectiveness Monitoring Project Plan (Riedl & Carpenedo, 2022). Under this SAP, DEQ will lead pre-restoration nutrient and sediment load reduction data collection at two project areas: the Teller Wildlife Refuge and the upper East Gallatin River. Post-project data collection shall occur subsequent years under an updated SAP. If additional resource are available, or other organizations are interested in evaluating restoration effectiveness, additional restoration projects may adopt this methodology.

In addition to the Project Plan (Riedl & Carpenedo, 2022), data collection activities under this SAP are supported by the Water Quality Planning Bureau Quality Assurance Project Plan (DEQ, 2022), the Nonpoint Source Management Plan (Watershed Protection Section, 2017), and the FY20-FY22 Wetland Program Development Grant (DEQ, 2020).

1.1. PROJECT AREA

This SAP covers pre-project monitoring at two locations: the Teller Wildlife Refuge, and the upper East Gallatin River. Montana classifies its waterbodies according to the present and future beneficial uses they should be able to support. All streams evaluated under this SAP have a B-1 use classification, which means they are to be maintained for drinking, culinary, and food processing purposes, after conventional treatment; bathing, swimming, and recreation; growth and propagation of salmonid fishes and associated aquatic life, waterfowl, and furbearers; and agricultural and industrial water supply (ARM 17.30.623).

1.1.1 Teller Wildlife Refuge

The Teller Wildlife Refuge is in the Bitterroot Watershed (HUC 17010205), the NPS and Wetland Program's Focus Watershed from 2019-2022. The project, located at approximately 3,520 feet elevation, will rewater about 14.7 acres of a wetland area. The restored wetland will be fed by an irrigation ditch and a formerly restored wetland (hereafter referred to as NRCS restored wetland) fed by lower Willow Creek (MT76H004_110). The outlet of the current wetland restoration project is an unnamed spring creek that returns partially to Willow Creek via ditches, and partially the Bitterroot River (MT76H001_020). The creeks in this wetland system are in the Middle Rockies Level III Ecoregion. Willow Creek headwaters are in the Sapphire Mountains, and land use in the watershed includes forestry, rangeland, and agriculture. The Teller Wildlife Refuge is privately owned and historically founded with the goal of preserving floodplain land and preventing habitat fragmentation. Its 1,200 acres span five miles of the Bitterroot River, other creeks, springs, and wetlands. Conservation easements ensure the land will remain undeveloped. The lower Willow Creek watershed, where the project takes place, is heavily influenced by irrigation, with three ditches crossing the stream above the project site. Willow Creek and the middle segment of the Bitterroot River currently do not meet water quality standards as described in **Tables 1.1** and **1.2.**

Table 1.1. Impairment and load reduction information for Willow Creek (MT76H004_110)

Cause	Beneficial Use	Reduction Required*
Sediment	Aquatic life	687 tons/year
Temperature		2.5°F OR meet restoration targets in Table 6-24 (DEQ, 2011)
Alteration in stream-side vegetation		NA

*From the Bitterroot Temperature and Sediment TMDLs (DEQ, 2011). The sediment load reduction is allocated to roads, eroding banks, and upland erosion sources.

Table 2.2. Impairment and load reduction information for the Bitterroot River (MT76H001_020)

Cause	Beneficial Use	Reduction Required*
Temperature	Aquatic life	2.5°F OR meet restoration targets in Table 6-5 (DEQ, 2011)
Flow		NA

*From the Bitterroot Temperature and Sediment TMDLs (DEQ, 2011). The sediment load reduction is allocated to roads, eroding banks, and upland erosion sources.

1.1.2 Upper East Gallatin River

The East Gallatin River is in the lower Gallatin Watershed (HUC 10020008), the NPS and Wetland Program's Focus Watershed from 2023-2026. The project occurs on private land about 0.20 river miles below the confluence of Rocky and Bear (MT41H003_010) at approximately 4,200 feet elevation. The project area will impact approximately 5.5 acres, along 0.5 river miles of the East Gallatin River, which lies in the Middle Rockies Level III Ecoregion. Land uses in the watershed are primarily agriculture and growing residential, with some forestry. The river current does not support beneficial uses due to the impairments described in **Table 1.3.**

Table 1.3. Impairment and load reduction information for the upper East Gallatin River (MT41H003_010)

Cause	Beneficial Use	Reduction Required*
Total nitrogen	Aquatic life Primary contact recreation	15.98 lbs/day
Total phosphorus		0 lbs/day
pH	Aquatic life	NA
Flow		
Alteration in stream-side vegetation		
Algae	Primary contact recreation	

*From the Lower Gallatin TMDLs, based on a 49.5 cfs example flow (DEQ, 2013). The load reduction is assigned a downstream subsection of the upper East Gallatin River (M41H003_010), from the Bozeman Creek confluence to the Bridger Creek confluence, less than 6 river miles downstream from the project site. The TMDL document does not assign a load reduction to the subsection of the upper East Gallatin River where the project will occur. The TN load reduction is allocated to agricultural and residential/developed sources.

2.0. Objectives and Sampling Design

2.1. Monitoring Objectives

The monitoring objective of this SAP is to quantify the sediment and nutrient load reduction effectiveness of off channel wetland restoration within the project reach and to receiving waters.

Inherent components of this objective are to determine (1) how restoration effectiveness of surface water treatment varies by flow condition (i.e., storm, high, and baseflows) and groundwater treatment by associated hydroperiod (2) how effectiveness varies through time, and (3) how measured load reductions compare to modeled load reductions, if a load reduction estimate method exists. Baseflow and stormflow monitoring should be the priorities over high flow monitoring because high flow typically occurs outside of the growing season (e.g., July – September).

2.2. SAMPLING DESIGN AND SCHEDULE

Three groups of samples will be collected for each restoration project (for more information about specific parameters, see **Table 2.1**):

- Upstream and downstream surface water grab samples, both in the receiving water and from the wetland prior to surface water entering the receiving water, of nutrients and TSS and field meter measurements
- Groundwater well continuous data loggers, grab samples of nutrients, and field meter measurements from a matrix of locations in the wetland area
- Sediment accumulation from sediment traps in a matrix of locations in the wetland area

Table 2.1. Water Quality Parameters

Parameter or Data Type	Collection Approach	Justification for Collecting
Surface water and groundwater samples		
Total persulfate nitrogen (TN) and total phosphorus (TP)	Upstream/downstream receiving water, inlet/outlet wetland surface water, and groundwater well grab samples for laboratory analysis	Wetlands should be effective at reducing nutrients. These parameters are total amount of organic and inorganic nutrients. Systems are often either TN or TP limited. Primary indicators for assessing nutrient impairment.
Nitrate + nitrite nitrogen (NO_2+NO_3-N)		Along with ammonia, indicates total amount of nitrogen available for biological uptake. Indicative of septic pollution in groundwater.
Ammonia nitrogen (NH_3+NH_4-N)		Indicative of wastewater pollution in surface water, and toxicity to aquatic life. Combined with NO_2+NO_3-N, indicates total amount of nitrogen available for biological uptake (Total Soluble Inorganic Nitrogen).
Soluble reactive phosphorus (SRP)		Indicative of wastewater and other sources of pollution in surface water, and most of the available phosphorus for biological uptake.
Total suspended solids (TSS)	Upstream/downstream receiving water and inlet/outlet wetland surface water grab samples for laboratory analysis	Wetlands should be effective at reducing sediment and particulates. Nutrients, especially phosphorus, is closely linked to suspended sediment. TSS will not be collected from groundwater wells.
Dissolved Oxygen (DO)	In situ field meter measurement at groundwater and receiving water sample locations	Indicative of biological activity and mixing with the environment.
pH		Can vary because of restoration and ranges will influence nitrogen and phosphorus cycling.
Temperature		Restoration can cause temperature to vary based on groundwater and surface water reconnection and changes in residence time.
Groundwater well in situ *measurers*		
Groundwater level, recharge rate	In situ field meter measurement at groundwater wells	Successful wetland restoration would be indicated by an increase in groundwater level and recharge rate. These measures are indicative of a change in groundwater storage.
Groundwater well continuous data loggers		
Groundwater level fluctuation	Rugged TROLL 100 continuous data logger, 30-minute intervals	The magnitude of diurnal groundwater level fluctuations is an indicator of vegetative health (i.e., evapotranspiration) and therefore nutrient attenuation.
Sediment trap samples		
Sediment load via organic content by loss-on-ignition	Wetland sediment traps	Properly functioning wetlands accumulate organic material. To estimate sediment load reduction, organic material must be subtracted from mass collected in sediment traps.
Flow measures or estimates		
Upstream/downstream receiving water flow volume	In situ field meter measurement at cross section or, for non-wadeable rivers, extrapolation from nearby stream gages and StreamStats	Provides inference abut stream flow condition and water reaching floodplain or off channel wetlands. Important for calculating volumetric loading.

2.3. MONITORING LOCATIONS

See the Project Plan Section 4.0 (Riedl & Carpenedo, 2022) for information about how sample locations are selected.

For both project locations, sites should be located initially using GPS. During subsequent visits, site locations should be confirmed with GPS and from past photos or the presence of a groundwater well or sediment trap (or the steel post portion that may only be visible).

2.3.1. Teller Wildlife Refuge

Four surface water sampling locations and seven groundwater and sediment trap sampling locations will occur at the Teller Wildlife Refuge during 2023 (**Figure 2.1**). Note that surface water sample locations within the wetland restoration area are not anticipated to have water during pre-project conditions; they should be sampled during subsequent post-project years.

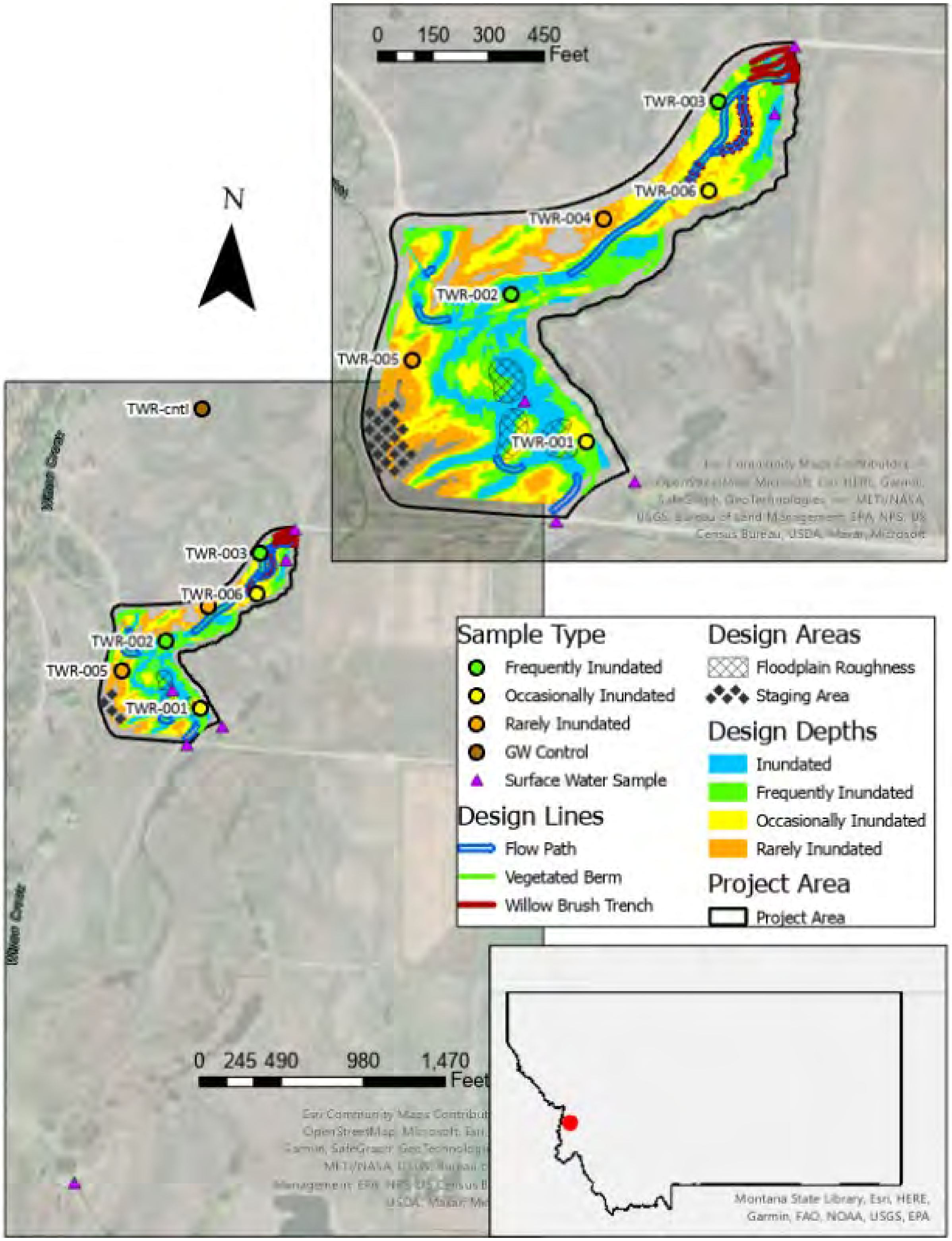

Figure 2.1. Map of Teller sampling locations and anticipated restoration features. Groundwater well and sediment trap locations (circles) were stratified by design depths. Notes that surface water samples within the wetland complex will likely not be sampled until 2023, post-restoration, due to a lack of water pre-restoration.

The objective for the set of surface water samples is to detect project area and receiving water quality change influenced by the wetland restoration. At surface water sites, TN, TP, nitrate + nitrite, ammonia, SRP, and TSS grab samples are collected, along with DO, pH, and temperature measures using the YSI ProPlus; flow is measured or estimated at surface water sites outside of the wetland restoration area (**Table 2.1**). Surface water sampling locations immediately upstream (south) of the restoration site were selected to capture the two incoming water sources: a previously restored wetland complex and an irrigation ditch. The furthest downstream (south) surface water site is intended to document surface water quality entering the NRCS restored wetland. This furthest downstream site should be considered for removal during 2023 sampling depending on how conclusive the data are (i.e., the primary goal of this project is not to evaluate effectiveness of this former restoration site. If data are highly variable, consider keeping the site an additional season. If data point conclusively towards in/effectiveness, drop the site after one season). The downstream surface water sampling locations were selected to represent water quality conditions at the outlet within the project area (likely not sampled pre-project due to a lack of water) and water quality conditions of outlet water after it has mixed with the receiving spring water.

The objective for the set of groundwater and sediment trap samples is to assess how water quality and sediment retention changes throughout the restored wetland complex while controlling for Cowardin wetland type. Similar parameters are collected at these sites as with surface water sites; TSS grab samples are *not* collected, sediment trap samples are collected, and groundwater level and recharge rate are measured. Site selection for groundwater and sediment traps sites at the Teller project followed the rationale for off-channel wetland restoration described in Figure 4.1 and Section 4.0 in Riedl & Carpenedo (2022). At these sites, groundwater grab sample and sediment trap locations were randomly selected within the following constraints: avoiding excavated restoration features and impacts from the bordering road, roughly evenly distributed across the restoration project, and stratified by the four categories of anticipated water depths included in the designs (i.e., anticipated Cowardin wetland type). Additionally, an existing groundwater well outside of the project area will serve as a groundwater control.

Table 2.2. Teller Wildlife Refuge 2022 monitoring locations, by site type, from upstream to downstream*. Groundwater site IDs have been suggested; new surface water site IDs will be assigned by DEQ database manager.

Site ID	Site description	Latitude	Longitude	Parameters to collect (see Table 2.1 for more detail)	Post-restoration Cowardin Wetland Type (see Riedl & Carpenedo, 2022)	Site Rationale
[new site]	Willow creek NRCS wetland inlet	46.31625	-114.13324	Surface water samples Flow measures	*NA*	An opportunity to evaluate the effectiveness of a wetland previously restored by NRCS that is adjacent to the Teller restoration project. Upstream water quality sample for comparison to downstream.
[new site]	NRCS wetland outlet	46.32354	-114.13119	Surface water samples Flow measures	*NA*	An opportunity to evaluate the effectiveness of a wetland previously restored by NRCS that is adjacent to the Teller restoration project. The downstream water quality sample for comparison to upstream for evaluating NRCS wetland restoration effectiveness and the upstream water quality sample for comparison to downstream for evaluating the Teller restoration project.
[new site]	Ditch inlet to Teller wetland restoration site	46.32387	-114.13038	Surface water samples Flow measures	*NA*	Representative of upstream ditch water quality entering the Teller wetland restoration project.
[new site]	Spring creek downstream of Teller wetland restoration site	46.32717	-114.12894	Surface water samples Flow measures	*NA*	Representative of water quality in the spring creek after mixing with outflows from the Teller restoration site.
TWR-001 *[new site]*	Groundwater well in occasionally inundated treatment of Teller restoration project	46.32413	-114.13091	Groundwater samples Groundwater well *in situ* measures Continuous data logger Sediment trap	PEMC	A groundwater well in the anticipated location of an occasionally inundated restoration treatment. Replication across wetland types is required.
TWR-002 *[new site]*	Groundwater well in frequently inundated treatment of Teller restoration project	46.32519	-114.13182		PEMF	A groundwater well in the anticipated location of a frequently inundated restoration treatment. Replication across wetland types is required.
TWR-003 *[new site]*		46.32670	-114.12972			
TWR-004 *[new site]*	Groundwater well in rarely inundated treatment of Teller restoration project	46.32580	-114.13087		PEMA	A groundwater well in the anticipated location of a rarely inundated restoration treatment. Replication across wetland types is required.
TWR-cntl *[new site]*	Groundwater control well for Teller restoration monitoring	46.32779	-114.13243		*NA*	A control groundwater well outside of the project area. This well has already been installed by project partners prior to the development of this SAP.
TWR-005 *[new site]*	Groundwater well in rarely inundated treatment of Teller restoration project	46.32467	-114.13284	Groundwater samples Groundwater well *in situ* measures Sediment trap	PEMA	A groundwater well in the anticipated location of a rarely inundated restoration treatment. Replication across wetland types is required.
TWR-006 *[new site]*	Groundwater well in occasionally inundated treatment of Teller restoration project	46.32605	-114.12976		PEMC	A groundwater well in the anticipated location of an occasionally inundated restoration treatment. Replication across wetland types is required.

*These are proposed sampling locations which may change due to unforeseen access or other issues. Post-project monitoring locations in 2023 may need to be reinstalled to avoid damage during excavation or modified to adhere to anticipated wetland restoration treatments. New site IDs will be assigned by the database manager (**Table 3.1**).

2.3.2. Upper East Gallatin

Three surface water sampling locations and seven groundwater and sediment trap sampling locations will occur at the upper East Gallatin project during 2022 (**Figure 2.2** and **Table 2.3**). Note that surface water sample sites within the wetland project area are not anticipated to have water during pre-project conditions; they should be sampled during subsequent post-project monitoring years.

The objective for the set of surface water samples is to detect water quality change influenced by the wetland restoration. Surface water sampling locations were selected to represent water quality conditions above, below, and within the restoration site. At surface water sites, TN, TP, nitrate + nitrite, ammonia, SRP, and TSS grab samples are collected, along with DO, pH, and temperature measures using the YSI ProPlus; flow is measured or estimated at surface water sites outside of the wetland restoration area (**Table 2.1**).

The objective for the set of groundwater and sediment trap samples is to assess how water quality and sediment retention changes throughout the restored wetland complex while controlling for Cowardin wetland type. Similar samples are collected at these sites as with surface water sites; TSS grab samples are *not* collected, sediment samples are collected, and groundwater level and recharge rate are measured. Groundwater grab sample and sediment trap locations were randomly selected within the following constraints: roughly evenly distributed across the restoration project and stratified by the three categories of anticipated restoration treatments (i.e., anticipated Cowardin wetland type; **Figure 2.2**).

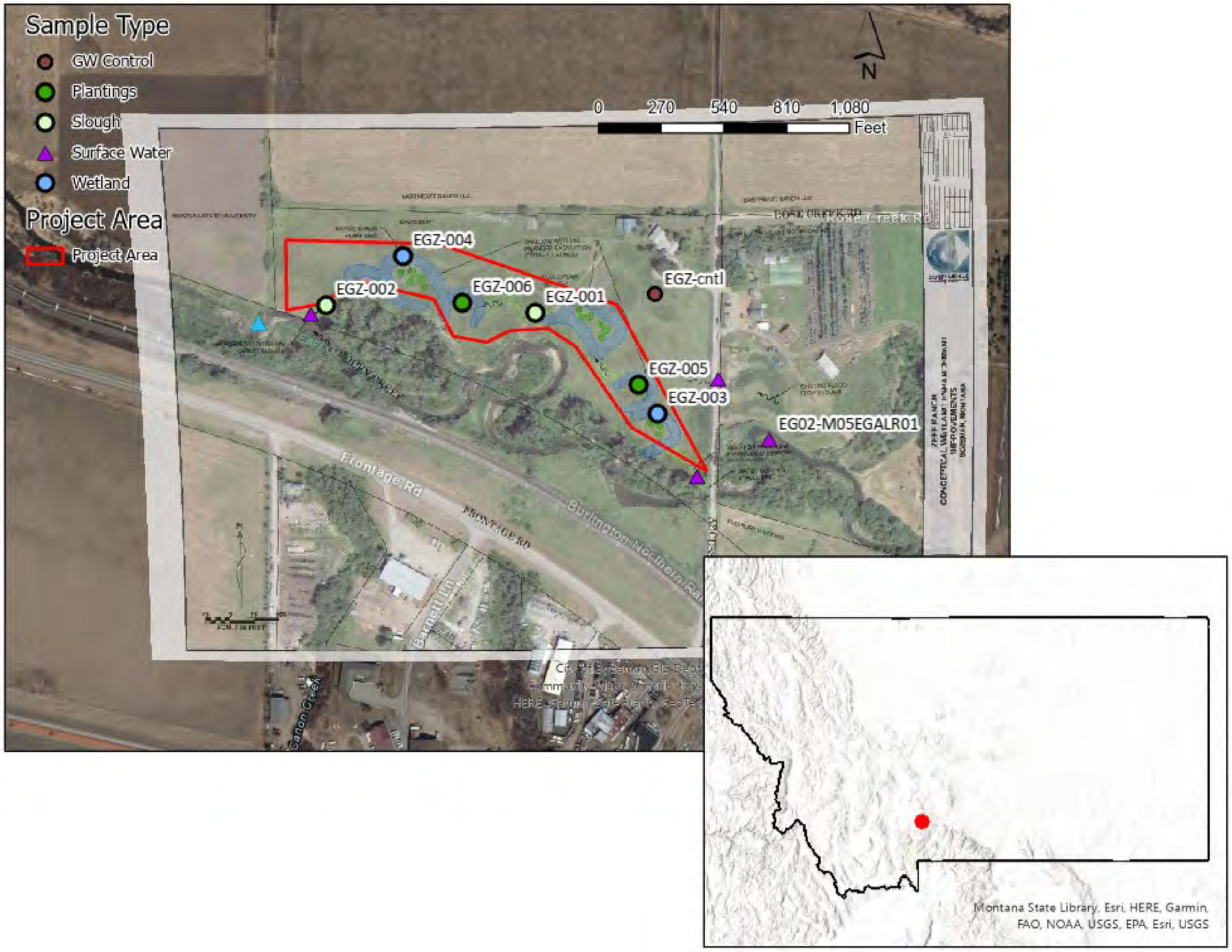

Figure 2.2. Map of upper East Gallatin River restoration project sample locations. Note that the two surface water sampling locations adjacent to the project area but not *in* the East Gallatin are not intended to be sampled until 2023, post-restoration.

Table 2.3. Upper East Gallatin 2022 monitoring locations, by site type, from upstream to downstream*. Groundwater site IDs have been suggested; new surface water site IDs will be assigned by DEQ database manager.

Site ID	Site Description	Latitude	Longitude	Parameters to Collect (see Table 2.1 for more detail)	Post-restoration Cowardin Wetland Type	Site Rationale
EG02-M05EGALR01	East Gallatin River, at Rocky Creek Farm off Kelly Canyon Rd	45.665259	-110.954112	Surface water samples Flow measures or estimates	*NA*	Representative of upstream water quality entering former and upcoming restoration sites at Gallatin Valley Botanical and Zeff properties, respectively
[new site]	Outflow from restored wetland at Gallatin Valley Botanical	45.665724	-110.954720		*NA*	Representative of water quality before entering the Zeff property restoration site, but after flowing through the Gallatin Valley Botanical former restoration site.
[new site]	East Gallatin River downstream of 319 project	45.666127	-110.960182		*NA*	Representative of water quality in the East Gallatin River after mixing with outflows from the Zeff restoration site.
EGZ-cntl *[new site]*	Groundwater control well for Zeff restoration monitoring	45.666444	-110.9554576	Groundwater samples Groundwater well *in situ* measures Continuous data logger Sediment trap	*NA*	A control groundwater well outside of the project area.
EGZ-003 *[new site]*	Groundwater well in wetland treatment of Zeff restoration project	45.665458	-110.9554406		PEMF	A groundwater well in the anticipated location of a shallow wetland meander treatment.
EGZ-001 *[new site]*	Groundwater well in slough treatment of Zeff restoration project	45.666296	-110.9568925		PEMC	A groundwater well in the anticipated location of a floodplain slough treatment.
EGZ-002 *[new site]*		45.666350	-110.9593480			
EGZ-005 *[new site]*	Groundwater well in planting treatment of Zeff restoration project	45.665710	-110.9556550	Groundwater samples Groundwater well *in situ* measures Sediment trap	PEMA	A groundwater well in the anticipated location of a planting treatment.
EGZ-006 *[new site]*		45.666371	-110.9577402			
EFG-004 *[new site]*	Groundwater well in wetland treatment of Zeff restoration project	45.666759	-110.9584418		PEMF	A groundwater well in the anticipated location of a shallow wetland meander treatment.

*These are proposed sampling locations which may change due to unforeseen access or other issues. Post-project monitoring locations in 2023 may need to be reinstalled to avoid damage during excavation or modified to adhere to anticipated wetland restoration treatments. New site IDs will be assigned by the database manager.

2.4. Monitoring Timeframe and Schedule

Table 2.4. Teller Wildlife Refuge and Upper East Gallatin Monitoring Schedule for 2022

Week of Sampling Event	Rationale	Parameters (see Table 2.1 for detail)	
		Teller Wildlife Refuge	
May 16	Prior to sampling	• Install groundwater wells • Deploy continuous data loggers in wells	• Deploy sediment traps
May 23	High flow conditions	• Surface water grab samples • Groundwater grab samples	• Groundwater well *in situ* measures • Flow measures
June 27	Start of low flow conditions	• Surface water grab samples • Collect high flow sediment trap samples	• Flow measures
July 25	Low flow conditions	• Surface water grab samples • Flow measures	
August 29	Low flow conditions	• Surface water grab samples • Groundwater grab samples • Groundwater well *in situ* measures	• Collect low flow sediment trap samples • Flow measures
September 26	Low flow conditions	• Surface water grab samples • Flow measures	
October 24	After-irrigation conditions	• Surface water grab samples • Groundwater grab samples • Groundwater well *in situ* measures	• Collect low flow sediment trap samples if necessary • Flow measures • Collect continuous data loggers from wells
		Upper East Gallatin	
May 30	Prior to sampling	• Install groundwater wells • Deploy continuous data loggers in wells	• Deploy sediment traps
June 6	High flow conditions	• Surface water grab samples • Groundwater grab samples	• Groundwater well *in situ* measures • Flow estimates or measures
July 5	Start of low flow conditions	• Surface water grab samples • Collect high flow sediment trap samples	• Flow estimates or measures
Stormflow sampling as feasible	Stormflow conditions	• Surface water grab samples • Groundwater grab samples	• Groundwater well *in situ* measures • Flow estimates or measures
August 8	Low flow conditions	• Surface water grab samples • Groundwater grab samples • Groundwater well *in situ* measures	• Collect sediment trap samples if necessary • Flow estimates or measures • Collect continuous data loggers from wells
September 12	Low flow conditions	• Surface water grab samples • Flow estimates or measures	• Collect continuous data loggers from wells

3.0. Project Team and Responsibilities

Table 3.1. Project Team Roles and Responsibilities

Individual	Affiliation	Roles	Responsibilities
Hannah Riedl	DEQ	Project leader	Develop SAP Oversee field personnel and training Review field forms Lab coordination Fill field personnel role as available Data analysis Final reporting, after post-project data are collected
Steve Carpenedo	DEQ	Program leader	Provide expertise Finalize SAP Lead initial training Pursue future grant funding Assist with data analysis and reporting Fill field personnel role as available
Eric Trum	DEQ	Section supervisor	Approve QA documents and final reports Pursue future funding
Mark Ockey Ryan Koehnlein WQPB staff as trained and available External partners as trained and available	DEQ Freshwater Partners GWC	Field personnel	Data collection Review field forms Ship or deliver samples
Ryan Koehnlein Steve Carpenedo	DEQ	Equipment technician	Calibrate and maintain equipment
Deanna Tarum	DEQ	Database manager	Validate and upload data into EQuIS QA review data
Leah Swartz	Freshwater Partners	External partners	Landowner coordination Fill field personnel role as available
Lilly McLane	GWC		

4.0. Field Procedures

4.1. Order of Operations

A site access schedule should be communicated with external partners and the landowner at the beginning of the field season, but if requested, provide notification of your intended arrival within a week prior.

Ensure that all materials required for the day's sampling event have been packed (**Appendix B**). Ensure the YSI ProPlus has been calibrated within the week for pH and within the month for EC (McWilliams, 2020a).

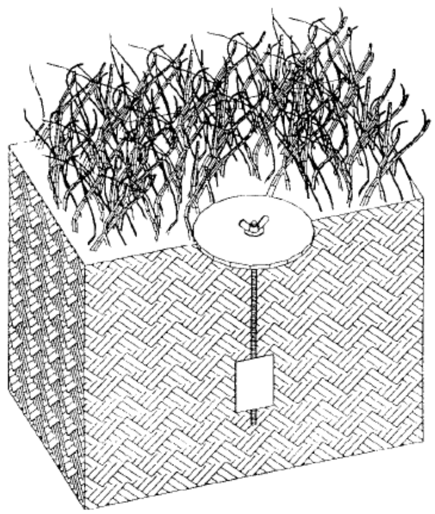

Figure 4.1. Sediment trap schematic (from Kleiss, 1993). Each trap in this SAP is composed of a 16 in^2 Plexiglas square with a small hole in the center. The upper surface is sanded. Use a threaded steel rod, washer, and wingnut to secure the square to the rod in the ground. Try to leave a few inches of rod exposed on the surface and cap it for safety and visibility.

<u>If this is the first time navigating to each site, begin by installing groundwater wells and sediment traps</u> (see equipment list and schematic in **Appendix B**). After installing each well, use a bailer to develop the well (i.e., settle adjacent disturbed soils) and aid in accuracy of future sampling.

<u>After installing a groundwater well, install the Rugged TROLL 100 continuous data logger if required for that site.</u> Use the Win-Situ 5 PC software, docking station, and Rugged TROLL Manual pages 12-15 and 34-36 (In-Situ, 2013) to configure the continuous data loggers. Use "live" event logging method. Use 30-minute log intervals. Use depth to water level reference and "set first logged reading." To secure the data logger, loop each end of the stainless-steel wire around the data logger and the cable lock at the wellhead. Use the stainless-steel oval crimping sleeves to secure the wire to the data logger and wellhead. Loggers should be submerged within the lowest 75-100% depth of water. Record the depth of the logger from the screw holding it in place to the deepest part of the logger. Throughout the sampling season, data loggers will need to periodically communicate with the Win-Situ 5 PC software by bringing a laptop and docking station into the field to check battery level. Loggers may need to be removed for water quality sampling. These time periods should be recorded on the site visit form so that logged data are not interpreted as real. At the end of the sampling season, remove the loggers and download the data according to Rugged TROLL Manual pages 15-18 (In-Situ, 2013).

Next, place four sediment traps (**Figure 4.1**) one meter away in each of the cardinal directions from the well. Placing the trap one meter away ensures that they can be relocated if they are buried. Placing the trap in the upgradient direction ensures that the groundwater well will not interfere with sedimentation.

Water sampling should not occur sooner than five days after well installation. Receiving water and wetland samples should generally be collected in the down- to upgradient direction. This prevents the possibilities of collecting the same water as it moves down gradient or collecting water that was disturbed by upstream sampling activities. Collect unfiltered samples first, and filtered samples last. If personnel are collecting unfiltered and filtered samples simultaneously, ensure the unfiltered samples are not compromised by prepping the filters.

<u>At surface water sample sites</u>, collect grab samples (see **Section 4.1.1** for step-by-step instructions) and up- and down-gradient photos first while DO on the YSI calibrates. Next, record YSI measurements upstream of where grab samples were collected to avoid sampling a disturbed water column (see **Section 4.1.2** for step-by-step instructions).

If flow can be measured in the field using the Marsh McBirney (McWilliams, 2020b), do this last at each site to avoid disturbing the stream bottom before grab sample collection. Establish and monument with capped rebar a bankfull-to-bankful transect at a straight reach with laminar flow, free of bank or flow obstructions. Divide the transect into equidistant sections so that no section contains more than 10% of the transect (e.g., 15 points for narrow streams, 30 points for wide streams). If flow cannot be measured in the field due to high flows preventing establishing a transect, estimate flow in the office later. Use a nearby USGS stream gage to get the flow value at the time-of-day sampling occurred. Then use USGS StreamStats software (https://streamstats.usgs.gov/ss/) to calculate the watershed area above the gage and above the sample site. With this information, extrapolate flow at the site.

At wetland complex sites, begin by measuring the groundwater level if it does not already contain a continuous data logger. Next, use a peristaltic pump to purge at least one full volume (or up to three volumes if recharge rate makes this feasible) of groundwater within the well. This ensures that the sample is representative of groundwater near the well (see **Section 4.1.3** for step-by-step instructions). Ensure that the purged water is directed away in the downgradient direction so that it does not drain back into the well. Take up- and downgradient photos while timing how long it takes for the well to recharge to the original groundwater level and record the time on the field form (**Appendix A**). Begin grab sample collection by rinsing each container three times with filtered or unfiltered well water (if the well is nearly dry, consider omitting sampling at this location). After filling the sample container, add any necessary preservative and store on ice immediately. Collect field meter measurements after grab samples.

If the sampling schedule (**Table 2.4**) includes **sediment trap sample collection** during the sampling event, collect these samples after completing sample collection at each well. If you cannot easily find the sediment trap, use a tape measure to measure one meter in each cardinal direction. Push a thin, sharp object, like a bank pin, into the ground until it “hits” the sediment trap. After the trap is located, measure approximate depth of accumulated material. Use a knife to cut around the end of the square. Scoop ¼ of each square into the sediment jar; the lab only needs 100 g of sample. 100 g looks approximately like ½ cup of sugar. Record the portion of the trap collected on the field form. You do not need to take photos at the sediment traps.

Double check field forms before leaving the field to ensure completeness.

After returning to the Watershed, or prior to visiting a different restoration site, waders and non-electronic sampling equipment used at surface water sites should be decontaminated according to (McWilliams and Esquivel, 2017).

4.1.1. Grab samples

A sample duplicate and field blank for each parameter will be taken at one surface water and one groundwater well site during each sample event. **Table 5.1** summarizes sample volumes, containers, preservation and holding time requirements. Step-by-step instructions from DEQ (2010) Section 7.0 and Makarowski (2019) Sections 10.2.1, 10.2.2 and, if necessary, 10.2.5 are summarized below.

Prior to collecting each sample, use a pencil or a permanent, fine-point marker to fill out the label on the sample bottles needed for each water sample at a site. Include the Sample ID (site ID), date collected, time collected, sample type, preservative, and sampler’s initials. Cover each label with clear plastic tape

to protect the label from water damage. Sample bottles and labels that require preservatives will be color-coded and the label will indicate which acid is required (e.g., yellow cap for sulfuric acid).
To collect the sample at surface water sites:

1. Carry the bottles and wade into the stream to a sampling location that is well-mixed (water is flowing steadily, is not stagnant or an eddy) and upstream from any disturbances (e.g., areas where people or dogs have disturbed the streambed or water).
2. Submerge the bottle (for unfiltered samples) or syringe (for filtered samples) upstream from where you are standing and below the water surface to not collect surface scum, but so the mouth of the bottle is elevated away from the river bottom to not collect sediments from the stream bottom.
3. Follow either unfiltered or filtered grab sampling procedures described below, as applicable, for each sample.
4. Record the sample on the Energy Lab COC and the routine site visit form.

If high streamflows compromise safely wading into a well-mixed portion of the stream, use a telescoping pole sampler to grab samples. In addition to the steps below, triple rinse the collection bottle attached to the pole and use the collection bottle to transfer the sample into the triple rinsed sample container.

At groundwater sites, see **Section 4.1.3.** for information about prepping the well for sampling and see **Unfiltered** and **Filtered Grab Samples** and **YSI ProPlus Measurements** for more information about groundwater sampling.

Unfiltered Grab Samples
The following samples will be collected in high-density polyethylene (HDPE) bottles provided by the lab using unfiltered grab sampling techniques:

- TPN: 250 ml square bottle with white lid
- TP, nitrite plus nitrate (NO_2+NO_3), and ammonia (NH_3+NH_4): 250 ml bottle with yellow lid
- TSS: 1000 ml jug bottle

1. Triple-rinse the bottles and lids. If at a groundwater well, triple rinse using the peristaltic pump and 12V battery. If at a surface water site, face upstream into the direction of the flow, collect a small amount of water in the bottle, replace the lid, and shake gently. Discard this rinse water in the downgradient direction. Repeat this process three times to triple-rinse the bottle.
2. Collect the sample: If at a groundwater well, use the peristaltic pump and 12V battery to fill the sample container. If at a surface water site, submerge the sample bottle deep enough so that the mouth of the bottle is below the water surface but not so deep that you scoop river bottom sediments. Fill the bottle up to the shoulder, leaving a small amount of "head space," and securely tighten the lid.
3. Add the vial of sulfuric acid preservative to the TP, NO_2+NO_3, NH_3+NH_4 sample: Put on rubber gloves, carefully unscrew the lids of the TP, NO_2+NO_3, NH_3+NH_4 sample bottle and sulfuric acid preservative vial, dump the entire contents of the acid vial into the TP, NO_2+NO_3, NH_3+NH_4 sample bottle, securely tighten the lid on the sample bottle, discard the empty vial, and gently invert the sample bottle three times to mix the preservative into the sample.

Filtered Grab Samples
SRP samples will be collected in 250 ml HDPE bottles with white lids provided by the lab using filtered grab sampling techniques:

1. Open the new 60 cc syringe package, remove the syringe, and discard the packaging. If at a groundwater well, pump water into a separate, triple rinsed container to aid in triple-rinsing the syringe. If at a surface water site, triple-rinse the syringe by drawing stream water into the syringe, gently shaking, and compressing the syringe to force the water out three times. Fill the syringe with groundwater or stream water.
2. Open a new 0.45 µm filter package by gripping the blue ring and peeling the cover open. Screw the filter onto the syringe and discard the packaging. Pass a small amount of water through the filter to "prime" it.

<u>Note</u>: Avoid contaminating the filter before and during sample collection by not touching the filter tip anywhere besides the blue ring.

3. Triple-rinse the sample bottle with filtered water. Draw water into the syringe from below the water surface. Plunge a small amount of water (approximately 10-20ml) from the syringe through the filter into the sample bottle. Replace the lid and shake gently. Discard this rinse water behind you. Repeat this process three times to triple-rinse the bottle with filtered water. When finished rinsing, unscrew and discard the filter used for rinsing.
4. Refill the syringe with ambient groundwater or stream water, open and attach a new filter, and pass a small amount of water through the filter to "prime" it.
5. Once the bottle has been rinsed, fill the bottle with 60 ml of filtered water. When the syringe is empty, grip the filter's blue ring, unscrew the filter, and refill the syringe, taking care not to contaminate the filter. If the filter is not clogged, screw the filter back onto the syringe and continue filtering until the bottle is sufficiently full. If the filter clogs mid-way through filtering, unscrew and discard the clogged filter, refill the syringe, screw on a new filter, pass a small amount of water through the new filter, and continue filtering. Repeat this process until the sample bottle is full.

<u>Note</u>: Be sure to leave enough headspace in this sample bottle so it can expand when frozen without breaking, about ¼" below the shoulder of the bottle.

4.1.2. YSI ProPlus Measurements

The following steps will be followed to collect instantaneous measurements using the YSI meter at surface water sites:

1. Remove the YSI meters from its case, attach the cable to the handheld unit if not already connected, and turn the instrument on.
2. Unscrew the calibration cup from the sensor and replace it with the perforated sensor guard so the sensor is protected but exposed to the atmosphere.
3. Place the meter in a safe place in the shade and allow the meter to sit undisturbed for approximately 10 to 15 minutes. This allows the barometric pressure to stabilize and calibrates the meter in preparation for dissolved oxygen readings at each site.
4. Wade with the meter into a safe location of the stream. Field measurements should be taken at a location that is well-mixed, has steady flow, is not excessively turbulent, stagnant or in an eddy, is free of upstream obstructions (for example, not directly downstream from a bridge, boulder, tree, people, dogs), and deep enough so the sensor can be entirely submerged.
5. Facing upstream into the direction of flow, fully submerge the probes. Take care not to kink the cable. If the river bottom is very fine silt or mud, hold the sensors above the river bottom so the sensors are suspended above and not buried in sediment. Gently swirl and shake the sensors to release any air bubbles that are trapped in the sensor guard.
6. Observe the display screen and wait a minute or more until the numbers stabilize.
7. Record the field parameter values on the Site Visit Form, carefully noting the units.

At groundwater sampling sites, use the pump, 12V battery, pump, and flow-through cell to measure parameters with the YSI.

4.1.3. Prepping Groundwater Wells for Sample Collection

Step-by-step instructions summarized from DEQ (2010) Sections 6 and 8 for prepping groundwater wells for sample collection are included below.

Purge Groundwater from the Well Using Portable Pump

1. Open the well and place well cap on tray of sheeting to prevent contamination of equipment.
2. Ensure that the pump and any tubing that enters the well have been triple rinsed between wells. Polyethylene tubing should be replaced between project areas. The pump should have a check valve or similar method to ensure water in the pump/tubing does not flow back into the well.
3. Insert the pump intake so that it is no closer than 2 feet from the bottom of the well. Use a pump rate of less than 0.5 liters/minute or 0.1 gallons/minute to minimize turbidity, and discard water in the downgradient direction so it does not refill the well.
4. In most situations, groundwater wells will have slow recharge rates. Pump the well as dry as possible and collect samples when sufficient water reenters the well. In rarer instances where recharge rate is fast (i.e., 5 minutes to refill), empty at least three well volumes of water.
5. Wells should not be over-purged because it can lead to collection of water that is not representative of the water quality in the immediate vicinity of the well.

Collect Groundwater Level Data

1. Triple rinse the water level indicator probe to measure depth to water (dtw) to 0.01 foot accuracy. Measure dtw from the highest point of the casing.
2. Calculate volume of water in the well (for use in purging). Record on Groundwater Site Visit Form.

4.2 Field Forms and Sample Labels

DEQ's field form and sample label system (Makarowski, 2020) will be followed for this project. All data collection and field activities conducted during a site visit will be recorded on a site visit form (SVF). The SVF will serve as a chain-of-custody form for any samples that are collected for analysis by an analytical laboratory. A unique site visit code (SVC) will be affixed to each individual SVF, and each field form and routine sample produced during the site visit will be labeled with that same SVC. Separate SVFs and SVCs will be used for additional sets of samples collected during the site visit (i.e., duplicate samples and blank samples).

All field forms should be printed on water resistant all-weather paper and filled out using pencil (preferable) or permanent fine-line marker. The field forms used during this project are included in **Appendix A** and include:

- Surface water SVF
- Groundwater SVF
- Total discharge form
- Continuous data logger form

Prior to collecting samples at each site, all sample containers will be labeled, at a minimum, with the SVC, waterbody name, date, and personnel performing the sampling, as well as any other information requested on the label (filtration, transect number, method type). Labels will be filled out with pencil or permanent fine-point marker, affixed to the sample container and covered completely with clear plastic tape to protect the label from being damaged during storage.

All field forms must be reviewed by the field crew prior to departure from each site to verify completeness and accuracy.

4.4 Changes to the Field Sampling Plan

As conditions in the field may vary, it may become necessary to implement minor modifications to sampling as presented in this plan. Field personnel will clearly document any modifications made to the approved plan and will communicate these modifications, preferably before or as soon as possible after, with the project leader. If, for any reason, field staff feel that conditions are unsafe for collecting samples (e.g., swift waters, weather or ice conditions, other site hazards) they are not to collect the samples. Field personnel will make reasonable effort to reschedule any missed sampling events in consultation with the project leader, or to replace samples that are lost or broken during the sampling event. If field personnel suspect that an instrument is malfunctioning or giving inaccurate readings, they will add a comment to the site visit form explaining the issue and will communicate the issue to the project leader and equipment technician. Project leaders will acknowledge modifications in year-end project reports as needed.

4.5 Field Health and Safety Procedures

Field personnel will carry first aid kits with them during each sampling trip. Field personnel will wear personal protective equipment as appropriate, including but not limited to nitrile gloves, eye protection, wading belts, and personal floatation devices. First aid and CPR training is recommended for all field personnel. Chemical safety precautions will be taken in accordance with chemical safety data sheets. Field personnel will adhere to DEQ's Fieldwork and Emergency Response System (Kron *et al*., 2020). Field personnel will be required to adhere to all safety precautions related to driving, including following traffic regulations, avoiding driving while tired, and selecting appropriate vehicles for anticipated driving conditions. Safety measures will be taken when working in and around water, including wearing wading belts and using approved alternate sampling techniques during high flow conditions.

5.0 Sample Handling and Laboratory Analysis

5.1 Sample Handling and Delivery

In the field, samples will be stored according to the preservation requirements shown in **Table 5.1**. Care will be taken to maintain appropriate temperatures (e.g., adequate air circulation or ice supply), and coolers will be drained frequently to avoid contamination from melted ice. Storage time between sample collection and delivery to the lab will be minimized and samples will be received by the lab within the holding times specified in **Table 5.1**.

Samples will preferably be delivered by hand to Energy Laboratories in Helena. If samples must be shipped, the method of delivery (USPS, FedEx, or UPS) will be indicated on the site visit form and packing instructions provided by the lab will be followed. Upon delivery of samples at the laboratory, DEQ will keep the original site visit forms with chain of custody signatures in place and the laboratory will keep a photocopy.

5.2 Chain of Custody

A record of chain-of-custody will be maintained for each sample collected during this project so that physical possession is tracked at all points from sample collection through laboratory analysis. The chain-of-custody section of each site visit form will be used to record signatures, dates and times when samples are relinquished and received during transfers among people including laboratory staff. If samples are shipped, custody seals will be used on the shipping container to ensure that custody is maintained and that samples are not tampered with while in transit.

5.3 LABORATORY ANALYTICAL REQUIREMENTS

Table 5.1. Energy Laboratories monitoring parameter suite, sample handling, analysis & preservation. Note that bioavailable phosphorus, a parameter included in Riedl & Carpenedo (2022), is not included here due to a lack of pre-restoration wetland surface water availability and the labor and expense associated with this parameter. Bioavailable phosphorus should be included in post-project SAPs.

Parameter	**Required Method**	**Required Reporting Limit** (µg/L unless noted otherwise)	**Holding Time** (days unless noted otherwise)	**Container**	**Preservative**	**Justification for Collecting**
Surface water/groundwater grab samples						
Total persulfate nitrogen	A4500-N C	40*	28	250 ml HDPE	Place on ice (≤6°C)	Wetlands should be effective at reducing nutrients. These parameters are total amount of organic and inorganic nutrients. Systems are often either TN or TP limited. Primary indicator for assessing nutrient impairment.
Total phosphorus	EPA 365.1	3*	28	250 ml HDPE	Add provided H_2SO_4, then place on ice (≤6°C)	
Nitrate + nitrite nitrogen (NO2+NO3-N)	EPA 353.2	10*	28			Along with ammonia, indicates total amount of nitrogen available for biological uptake. Indicative of septic pollution in groundwater.
Ammonia nitrogen (NH3+NH4-N)	EPA 350.1	50*	28			Indicative of wastewater pollution in surface water, and toxicity to aquatic life. Combined with NO2+NO3-N, indicates total amount of nitrogen available for biological uptake (Total Soluble Inorganic Nitrogen).
Soluble reactive phosphorus	EPA 365.1	1*	45 if frozen; 2 if on ice	250 ml HDPE	Filter through a 0.45 µm disposable filter, then freeze in field (if confidently returning samples to Energy Lab the following morning, place on ice (≤6°C))	Indicative of wastewater and other sources of pollution in surface water, and available phosphorus for biological uptake.
Total suspended solids (TSS)	A2540 D	4000	7	1000 ml HDPE	Place on ice (≤6°C)	Wetlands should be effective at reducing sediment and particulates. Nutrients, especially phosphorus, is closely linked to suspended sediment.
Sediment trap samples						
Organic content by loss-on-ignition‡	T267, ASTM D2974		3 months	4 oz soil jar	Place on ice (≤6°C)	Properly functioning wetlands accumulate organic material. To estimate sediment load reduction, organic material must be subtracted from mass collected in sediment traps.

*Low level analysis

‡ Request dry weight and loss-on-ignition mass on COC, otherwise results will only be returned in percentages

6.0 Quality Assurance and Quality Control (QA/QC)

6.1 Training and Qualifications

Before sampling commences, all field personnel conducting monitoring for this project will receive training from the project or program leader. Each participant will be provided with a copy of this SAP, applicable SOPs, and field forms, will be required to review them, and must keep these copies with them in the field during all sampling events for reference. Whenever feasible, an experienced professional will accompany inexperienced staff during initial sampling events until each field personnel demonstrates proficiency. If mistakes are identified throughout the sampling period, efforts will be made to provide supplemental training and clarify guidance documents to prevent further issues, and these corrective actions will be revisited during a lesson learned review period.

6.2 Instrument Calibration and Maintenance

See **Section 4.1**.

6.3 Data Quality Indicators

Data quality indicators are attributes of samples that allow data users to assess data quality. These are described in detail in DEQ (2022) Section 1.8.3.

To ensure data quality indicators are met, sites have been chosen to capture spatial variability of wetland complexes with sufficient distance between sites to ensure sample independence. The sample schedule (**Table 2.4**) and data analysis (Section 8.0; Riedl & Carpenedo, 2022) was selected to capture specific flow conditions/hydroperiods. Sampling shall be conducted at approximately the same time of day to reduce temporal heterogeneity. Surface water samples will be collected in the downstream to upstream direction to ensure temporal independence.

Duplicates will be collected at a rate of at least 10% of the total number of samples collected during each sampling event. One blank will be prepared, per parameter, for each batch of samples submitted to Energy Laboratories.

6.4 Laboratory Quality Control

Energy Laboratories shall prepare and analyze the samples in accordance with the chain-of-custody forms and the methods specified in the analytical requirement table (**Table 5.1**). Laboratory standard operating procedures (SOPs) must be controlled under a Laboratory Quality Assurance Program (LQAP) with sufficient rigor for the lab facility to hold a current certification under the State of Montana/EPA Region 8 drinking water certification and/or National Environmental Laboratory Accreditation Conference (NELAC) program. Results from laboratory QC samples (e.g., instrument blanks, method blanks, laboratory control samples, sample matrix spikes) are submitted with the laboratory data report.

7.0 Data Management and Record Keeping

7.1 Data Review and Validation

All data produced by this project will be managed via the WQPB data management and quality control system prior to release to project staff for data use and decision making. The WQPB data flow process is summarized in DEQ's Field Data Collection Activities SOP (Makarowski, 2020) and entails receipt of EDDs from laboratories, merging analytical results with station information and field parameters for each site visit to create a complete data package, quality control review of the entire data package, validating and uploading data into DEQ's EQuIS Water Quality Exchange database (MT-eWQX), and archiving data and records.

The database manager or data technician will verify station information and assign station IDs. EDDs received from the analytical laboratories will undergo QC review by data management staff and will be shared with project leaders for additional quality review in a timely manner to ensure that the analytical results are meeting requirements specified in the project QAPP and SAP. Records from data loggers will be downloaded from the instrument and pre-processed as necessary prior to being uploaded or archived. All site visit forms and other field forms will undergo a quality control review by field personnel prior to departure from each site to verify completeness and accuracy. Forms undergo further quality review throughout the data flow process.

The data management and quality assurance team will produce a QA Oversight & Evaluation report to summarize result qualifiers and other QC issues that may affect the usability of analytical results received from the laboratory. The project manager will document any notable deviations from this SAP and will highlight any QC issues identified during the project, as well as corrective actions, in a year-end review document for the project.

7.2 Data Management

All applicable site information, field measurements and analytical results from laboratories for this project will be uploaded into DEQ's EQuIS Water Quality Exchange database (MT-eWQX). Data uploaded to MT-eWQX is submitted to EPA's National WQX Warehouse and accessible via the Water Quality Portal. All data submitted to DEQ for this project from analytical laboratories and others must adhere to the most current Electronic Data Deliverable (EDD) and submittal requirements published in the MT-eWQX EDD Guidance available on the Water Quality Planning Bureau's WQX webpage: https://deq.mt.gov/water/Programs/sw#accordion1-collapse1.

All raw electronic files, including EDDs, data logger files, and other, will be retained indefinitely on DEQ's server within the WQPB field season data archive and on the annual WQPB field season archive DVDs. Site Visit Forms (SVF) and other field forms used to document field activities, measurements and site information will be scanned and retained indefinitely in the WQPB data archive and field season archive DVDs. All field photos will be named consistently using WQPB's naming convention (Makarowski, 2020) and archived in electronic project files as well as on the field season archive DVDs.

8.0 Data Analysis and Reporting

See Riedl & Carpenedo (2022) Section 8.0 for more detail.

9.0 References

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APPENDIX A – FIELD FORMS

Place Site Visit Label Here

Site Visit Form

Project ID: ________________

Date: ____________ **Time:** ____________ **Personnel:** ________________________________

Waterbody: ______________________________ Location: ______________________________

Station ID: ____________ HUC: ____________ County: ____________ AUID: ____________

Latitude: __ __ . __ __ __ __ __ __ Longitude: __ __ __ . __ __ __ __ __ __ Elevation: ________ ft m

Field Duplicate to ________ ☐ Field Blank ________ ☐ Trip Blank ☐ Field Equipment Blank ☐

Samples Collected		Sample ID	Sample Collection Information/Preservation
Water	☐		GRAB EWI BACT
Analysis:			0.45µ Filtered | HNO_3 H_2SO_4 H_3PO_4 HCL | Ice Frozen
Analysis:			0.45µ Filtered | HNO_3 H_2SO_4 H_3PO_4 HCL | Ice Frozen
Analysis:			0.45µ Filtered | HNO_3 H_2SO_4 H_3PO_4 HCL | Ice Frozen
Analysis:			0.45µ Filtered | HNO_3 H_2SO_4 H_3PO_4 HCL | Ice Frozen
Analysis:			0.45µ Filtered | HNO_3 H_2SO_4 H_3PO_4 HCL | Ice Frozen
Analysis:			0.45µ Filtered | HNO_3 H_2SO_4 H_3PO_4 HCL | Ice Frozen
Analysis:			0.45µ Filtered | HNO_3 H_2SO_4 H_3PO_4 HCL | Ice Frozen
Analysis:			0.45µ Filtered | HNO_3 H_2SO_4 H_3PO_4 HCL | Ice Frozen
Sediment	☐		SED-1
Analysis:			Preserved: None Other:
Benthic Chl-a	☐		Sample Method: C=Core H=Hoop T=Template N=None
Composite at Lab ☐ AFDW ☐ Visual Est. <50 mg/m2 ☐			Sample Location: R=Right C=Center L=Left
Transect: A__-__ B__-__ C__-__ D__-__ E__-__			F__-__ G__-__ H__-__ I__-__ J__-__ K__-__
Phytoplankton Chl-a	☐		D1 Filtered:________mL D2 Filtered:________mL
Phytoplankton CNP	☐		CN Filtered:________mL P Filtered:________mL
Algae	☐		PERI-1-MOD PERI-1 OTHER:
Macroinvertebrates	☐		MAC-R-500 OTHER: | # of Jars:

Field Measurements	Time: am pm
Water Temp: °C °F	Air Temp: °C °F
Bar. Pressure: mm/Hg	SC: uS/cm
pH: DO: mg/L	Turbidity: NTU
Turbidity: Clear ☐ Slight ☐ Turbid ☐ Opaque ☐	
Flow: ft3/sec (Dry Bed ☐ Stranded Pools ☐)	
Meter ☐ Meter-Auto ☐ Float ☐ Gage ☐ Visual Est. ☐	

Field Assessments

Photos ☐ Aquatic Plant Visual Assessment ☐ SAM ☐
Aquatic Plant Tracking ☐ Rosgen ☐ NRCS ☐
EMAP ☐ Total Discharge ☐ Channel X-Section ☐
Wetland ☐ Bacteria ☐ Other:________________
Only Transect F ☐ Total Site Length________m
Transect Length________m Average Wetted Width________m

Data Loggers	
	Temperature ☐ YSI ☐ MiniDOT ☐ EC ☐ TruTrack ☐ AquaRod ☐ Weather Station ☐
	Deployed ☐ Cleaned/Checked ☐ Retrieved ☐

Chemistry Lab Information		
Lab Samples Submitted to:	Account #:	Term Contract Number:
Invoice Contact:		
Contact Name & Phone:		EDD ☒ Format: MT-eWQX Compatible
1) Relinquished By & Date/Time:	1) Shipped By: Hand ☐ FedEx/UPS ☐ USPS ☐	1) Received By & Date/Time:
2) Relinquished By & Date/Time:	2) Shipped By: Hand ☐ FedEx/UPS ☐ USPS ☐	2) Received By & Date/Time:

Lab Use Only - Delivery Temperature: Wet Ice______°C Dry Ice______°C

Rev 04/15/2022

Place Site Visit Label Here

Site Visit Form Continued

Field Meter Calibration		
pH Meter:	Manufacturer & Model:	Date of Last Calibration:
	Comments:	
Multiparameter Meter:	Manufacturer & Model:	
	Date of SC Calibration:	DO calibrated at site visit ☐
	Comments:	

Site Visit Comments
Data Logger Notes:
Time data logger removed:
Time data logger returned:
☐Data logger cleaned
☐Data logger downloaded
☐Data logger re-launched
Photos:
#
#
#
#
#
#
Hydroperiod: Spring runoff ☐ Baseflow ☐ Stormflow ☐ After-irrigation ☐
Wetland Type: Palustrine-Aquatic Bed ☐ Palustrine-Emergent ☐ Palustrine-Shrub-Scrub ☐ Riverine ☐
☐ Sediment Trap Sample Collected Proportion Collected: ¼ ☐ ½ ☐ ¾ ☐ Entire ☐

Place Site Visit Label Here

Project ID: ______________

Ground Water Site Visit Form

(One Station per page)

Date: ____________ **Time:** ____________ **Personnel:** ________________________

Site Name & Description: ________________________ MBMG Well ID: ____________

Station ID: ____________ Visit #: ________ HUC: ____________ County: ____________

Latitude: __ __ . __ __ __ __ __ Longitude: __ __ __ . __ __ __ __ __ Lat/Long Verified? ☐ By:

Elevation: ____________ ft m Geo Method: GPS Other: ________ Datum: NAD27 NAD83 WGS84

Samples Collected:	**Sample ID:**	**Sample Collection Information/Preservation:**
Water ☐		Bailer Pump Dedicated Pump Other:
Analysis:		Preserved: HNO_3 H_2SO_4 H_3PO_4 HCL Ice Frozen None
Analysis:		Preserved: HNO_3 H_2SO_4 H_3PO_4 HCL Ice Frozen None
Analysis:		Preserved: HNO_3 H_2SO_4 H_3PO_4 HCL Ice Frozen None
Analysis:		Preserved: HNO_3 H_2SO_4 H_3PO_4 HCL Ice Frozen None
Analysis:		Preserved: HNO_3 H_2SO_4 H_3PO_4 HCL Ice Frozen None
Analysis:		Preserved: HNO_3 H_2SO_4 H_3PO_4 HCL Ice Frozen None
Analysis:		Preserved: HNO_3 H_2SO_4 H_3PO_4 HCL Ice Frozen None
Analysis:		Preserved: HNO_3 H_2SO_4 H_3PO_4 HCL Ice Frozen None

Equipment Decontamination Methods: 10% Bleach Solution ☐ Deionized Water ☐ Distilled Water ☐ Phosphate-free Soap ☐ Disposable ☐ Other: ____________

Site Characterization:

Air Temp: °C °F | Current Weather Conditions: Clear ☐ Overcast ☐ Precipitation ☐

Wellhead: Above Ground ☐ Below Ground ☐ Flush Mount ☐

Positive Drainage from Wellhead: Y ☐ N ☐

Well Specifications: (bgs = below ground surface)

Well Type: Irrigation ☐ Monitoring ☐ Water Supply ☐ Other: ____________________

Total Well Depth (td): ft bgs | Depth to Water (dtw): ft bgs

Thickness of Water Column (td – dtw): ft | Depth Water Enters Well: from ________ to ________ ft bgs

Well Casing Diameter: in

One Well Volume: gal

Pumping Rate: gpm

Was well pumped dry? Y ☐ N ☐

One Well Volume of Water Calculations (gal)
2" Well = 0.17 x Thickness of Water Column (ft)
4" Well = 0.66 x Thickness of Water Column (ft)
6" Well = 1.47 x Thickness of Water Column (ft)

Site Visit Comments:

Chemistry Lab Information:

Lab Samples Submitted to: | Account #: | Term Contract Number:

Contact Name & Phone: | EDD ☒ Format: MT DEQ Compatible

1) Relinquished By & Date/Time:	1) Shipped By: Hand ☐ FedEx/UPS ☐ USPS ☐	1) Received By & Date/Time:
2) Relinquished By & Date/Time:	2) Shipped By: Hand ☐ FedEx/UPS ☐ USPS ☐	2) Received By & Date/Time:

Lab Use Only - Delivery Temperature: Wet Ice ______ °C Dry Ice ______ °C Rev. 9/15/2010

Place Site Visit Label Here

Ground Water Site Visit Form
Continued Page 2 of 2

Project ID: ________________

Purge Water Quality Data:			
Date:		Station ID:	
Purge Method: Bailer ☐ (material________________) Pump ☐ (type______________) Dedicated Pump ☐ (type______________)			
Field Instrument Used & Date Calibrated:			

Time	Total Purge Volume (gal)	pH	Temp (°C)	SC (umho/cm)	DO (mg/L)	DO Sat. (%)	Salinity	Redox (mV)	Turb (NTU)

Place Site Visit Label Here

Total Discharge – Flow Meter

Date: ________________ **Personnel:** ____

Waterbody: ____

Site ID: ____ **Averaging Interval:** ________________

** circle units used **

	Distance from initial point (ft) or (m)	Depth (ft) or (m)	Velocity (ft/sec) or (m/sec)	Comments (Record LWE and RWE)
1				
2				
3				
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Total Discharge = **cfs**

Rev. 1/6/2017

Continuous Data Logger Field Form

(Three loggers/stations per page)

Project ID:____________________

Date: ____________________

Waterbody: ____________________

Station ID: ____________________

Rugged TROLL 100	
Medium:	Water Air Other:________
Interval *(hh:mm)*:	
Logger Make/Model:	
Serial #:	
Launch Date/Time:	
Deployment Date:	
Deployment Time:	
Latitude (*dd.dddd*):	
Longitude (*ddd.dddd*):	
Deployment Location & Additional Information: Place Site Visit Label Here	
Data Logger Deployment Map:	
Retrieval Site Visit Code:	
Retrieval Date:	
Retrieval Time:	
Retrieval Comment:	
Electronic File Name:	

Rugged TROLL 100	
Medium:	Water Air Other:__________
Interval *(hh:mm)*:	
Logger Make/Model:	
Serial #:	
Launch Date/Time:	
Deployment Date:	
Deployment Time:	
Latitude (*dd.dddd*):	
Longitude (*ddd.dddd*):	
Deployment Location & Additional Information: Place Site Visit Label Here	
Data Logger Deployment Map:	
Retrieval Site Visit Code:	
Retrieval Date:	
Retrieval Time:	
Retrieval Comment:	
Electronic File Name:	

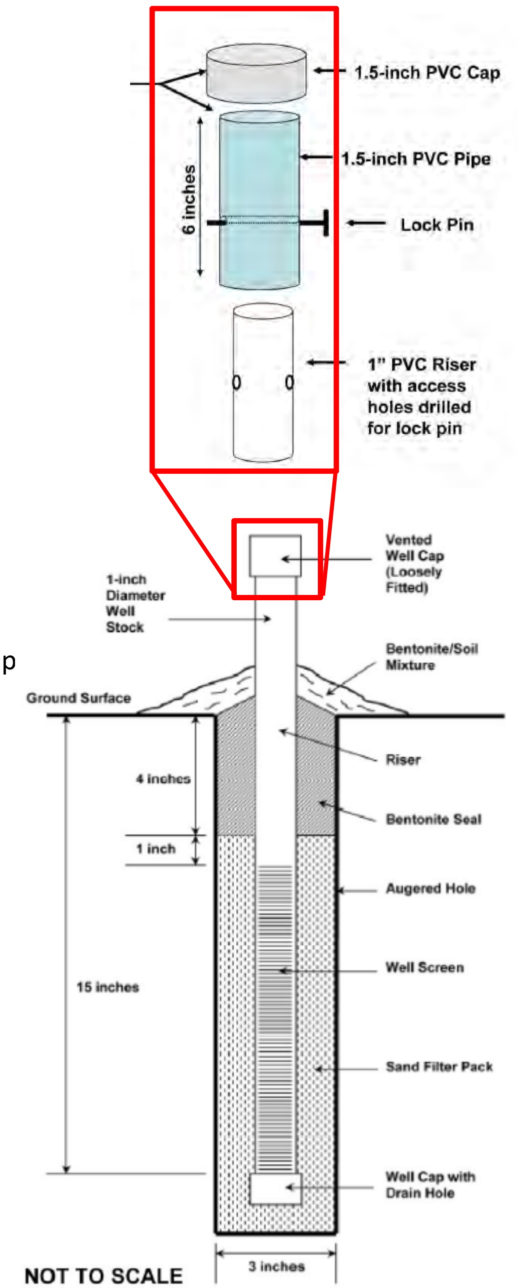
Rugged TROLL 100	
Medium:	Water Air Other:________
Interval *(hh:mm)*:	
Logger Make/Model:	
Serial #:	
Launch Date/Time:	
Deployment Date:	
Deployment Time:	
Latitude (*dd.dddd*):	
Longitude (*ddd.dddd*):	
Deployment Location & Additional Information: Place Site Visit Label Here	
Data Logger Deployment Map:	
Retrieval Site Visit Code:	
Retrieval Date:	
Retrieval Time:	
Retrieval Comment:	
Electronic File Name:	

Rev. 4/16/2014

APPENDIX B – EQUIPMENT AND SUPPLIES

General materials:

- InReach
- Field forms (**Attachment A**)
- Bottle label stickers
- Site Visit code stickers
- Waders/boots/belt
- First aid kit
- 5 gallon drinking water jug
- Personal backpacks, water bottles, clothing layers for all weather
- Tray or sheeting to hold well caps
- Clipboard
- Digital camera with spare batteries and/or battery charger
- GPS unit with spare batteries
- Pencils, waterproof pens, sharpies
- Coolers and ice
- De-ionized water (~1 gallon in liter bottles)
- Packaging tape and preprinted shipping labels
- Silicon and polyethylene tubing for YSI flow through cell and pump



Groundwater well materials (per well, see image right) for install:

- 2” pvc tubing
- 2” pvc couplings
- Two 2” pvc pipe cap (one drilled for drainage)
- 2” screened pvc pipe
- 2.5” pvc pipe (cover with air gap)
- 2.5” pvc pipe cap (cover with air gap)
- 6” pvc pipe (per project area) to stabilize hole while digging
- Drinking water standard course silica sand
- Granular bentonite chips
- Hack saw and extra blades
- Level
- Drill and drill bits
- Cinder block
- PVC primer and glue and adjustable wrench
- Leather and nitrile gloves
- Bailers, post-hole diggers (2), rock bars (2), shovels (2), sand auger and tamp
- Ferrules, carabineers
- Philips #2 screwdriver, scissors and sharp knife
- Filter sock
- Flexible cable lock (for holding cap and data logger)
- Small speed square

Continuous data loggers:

- Rugged TROLL 100 data loggers
  - Stainless steel non-corroding wire
  - Stainless steel oval crimping sleeve (2)
  - Rugged Troll
  - Data download cable
  - Rugged BaroTROLL for correction (1 for each site)
  - Win-Situ 5 Software and docking station for programming and downloading

Surface water and groundwater samples:

- Portable pump, 12V battery, and cable adapter
- 250 ml sampling bottles with white caps for TPN samples (1 for each station per sampling event, field blank, and duplicate)
- 250 ml sampling bottles with yellow caps for total phosphorous, nitrate + nitrite, and ammonia samples (1 for each station per sampling event, field blank, and duplicate)
- Sulfuric acid (1 vial for each sampling event, field blank, and duplicate)
- 250 ml sampling bottles with white caps for soluble reactive phosphorus samples (1 for each station per sampling event, field blank, and duplicate)
- 1000 ml sampling bottle for TSS samples (1 for each station per sampling event, field blank, and duplicate)
- 1-60 cc syringe to collect water for filter (1 for each station per sampling event, field blank, and duplicate)
- 0.45 µm disposable or acid rinsed filters (at least 3 for each routine sample, field blank and duplicate, plus several extras; one used for triple rinsing bottles plus at least one for collecting the sample itself)
- YSI ProPlus, flow through cell, and calibration solutions
- Telescoping Pole Sampler (if high flow conditions)
- 10% bleach solution in squeeze bottle for decontamination between well sites
- Tape measure for distance to groundwater surface (≤15 ft). Extra D-batteries if using electric tape, bring a flashlight if using regular tape

Flow measurements:

- Marsh McBirney flow meter, including sensor and top setting rode, with extra batteries
- Screwdriver (for changing batteries)
- Measuring tap (10^{th} ft increments, at least 100 feet long)
- Bank pins
- Rebar and caps for monumenting receiving water cross sections (1 set for each site)

Sediment trap samples:

- Measuring tape (for measuring 1 meter distance)
- 16 in^2 plexiglass square with hole in the middle (4 for each station)
- Threaded steel rod and cap (1 for each station)
- Washers and wingnuts (1 each for each station)
- Sediment jars (~100 g sample, 1 for each station per sampling event and duplicate)
- Dull knife
- Bank pin
- Small spatula scoop

APPENDIX C – BUDGET (INCLUDES $2\SAMPLE FEE)

Cost for Teller Wildlife Refuge.

Parameter	Required Method	Required Reporting Limit (µg/L unless noted otherwise)	Number of Surface Water Sites	Surface Water Visits/Year	Surface Water QA Samples per visit	Number of Groundwater Sites	Groundwater Events/Year	Groundwater QA Samples per Visit†	Total Samples per Year	Price per Sample	Price per Year
Surface water/groundwater grab samples											
Total persulfate nitrogen	A4500-N C	40*	4	6	2	7	3	2	63	$22.40	$1,411.20
Total phosphorus	EPA 365.1	3*	4	6	2	7	3	2	63	$17.60	$1,108.80
Nitrate + nitrite nitrogen (NO2+NO3-N)	EPA 353.2	10*	4	6	2	7	3	2	63	$20.00	$1,260.00
Ammonia nitrogen (NH3+NH4-N)	EPA 350.1	50*	4	6	2	7	3	2	63	$16.00	$1,008.00
Soluble reactive phosphorus	EPA 365.1	1*	4	6	2	7	3	2	63	$17.60	$1,108.80
Total suspended solids (TSS)	A2540 D	4000	4	6	2				36	$14.40	$518.40
Sediment trap samples											
Parameter	**Required Method**	**Required Reporting Limit (µg/L unless noted otherwise)**	**Number of Sediment Traps**	**Sediment Trap Visits/Year**	**QA Samples per Visit†**	**Total Samples per Year**	**Price per Sample**	**Price per Year**			
Organic content by loss-on-ignition	T267, ASTM D2974		7	3	1	24	$20.00	$480.00			
*Low level analysis											$7,645.20

†Assumes one duplicate and one blank each for surface water and groundwater grab sampling per visit. Assumes one duplicate sediment trap sample per visit

Cost for Upper East Gallatin.

Parameter	Required Method	Required Reporting Limit (µg/L unless noted otherwise)	Number of Surface Water Sites	Surface Water Visits/Year	Surface Water QA Samples per visit†	Number of Groundwater Sites	Groundwater Events/Year	Groundwater QA Samples per Visit†	Total Samples per Year	Price per Sample	Price per Year
Surface water/groundwater grab samples											
Total persulfate nitrogen	A4500-N C	40*	3	5	2	7	3	2	52	$22.40	$1,164.80
Total phosphorus	EPA 365.1	3*	3	5	2	7	3	2	52	$17.60	$915.20
Nitrate + nitrite nitrogen (NO2+NO3-N)	EPA 353.2	10*	3	5	2	7	3	2	52	$20.00	$1,040.00
Ammonia nitrogen (NH3+NH4-N)	EPA 350.1	50*	3	5	2	7	3	2	52	$16.00	$832.00
Soluble reactive phosphorus	EPA 365.1	1*	3	5	2	7	3	2	52	$17.60	$915.20
Total suspended solids (TSS)	A2540 D	4000	3	5	2				25	$14.40	$360.00
Sediment trap samples											
Parameter	**Required Method**	**Required Reporting Limit (µg/L unless noted otherwise)**	**Number of Sediment Traps**	**Sediment Trap Visits/Year**	**QA Samples per Visit†**	**Total Samples per Year**	**Price per Sample**	**Price per Year**			
Organic content by loss-on-ignition	T267, ASTM D2974		7	3	1	24	$20.00	$480.00			
*Low level analysis											$6,317.20

†Assumes one duplicate and one blank each for surface water and groundwater grab sampling per visit. Assumes one duplicate sediment trap sample per visit