Montana Department of Environmental Quality

Water Protection Bureau
P.O. Box 200901
Helena, MT 59620-0901

PERMIT FACT SHEET

MONTANA GROUND WATER POLLUTION CONTROL SYSTEM (MGWPCS)

Permittee:	Shepherd School
Permit Number:	MTX000265
Permit Type:	Domestic wastewater
Application Type:	New
Facility Name:	Shepherd School Wastewater System
Facility Location:	N half of NE quarter of Section 10, T2N, R27E, Yellowstone County Latitude: 45.94139° Longitude: -108.34360°
Facility Address:	7842 Shepherd Road Shepherd, MT 59079
Facility Contact:	Drea O'Donnell, Interim Superintendent Bryan Alexander, PE, Sanderson Stewart
Treatment Type:	Level 2
Receiving Water:	Class I Ground Water
Number of Outfalls:	1
Outfall / Type:	001 / Drainfield
Effluent Type:	Domestic strength wastewater
Mixing Zone:	Standard
Effluent Limit Type:	DBEL
Effluent Limits:	Total nitrogen: 1.42 lbs/day
Flow Rate:	Design maximum: 5,475 gpd (732 ft^3/day) Design average: 2,610 gpd (349 ft^3/day)
Effluent sampling:	Quarterly, EFF-01
Ground water sampling:	Quarterly, MW-1, MW-2, MW-3
Fact Sheet Date:	February 2021
Prepared By:	Darryl Barton

1.0 Permit Information

DEQ issues MGWPCS permits for a period of five years. The permit may be reissued at the end of the period, subject to reevaluation of the receiving water quality and permit limitations. This fact sheet provides the basis for DEQ's decision to grant a new MGWPCS wastewater discharge permit to **Shepherd School** (applicant) for the **Shepherd School** wastewater treatment system.

1.1 Application

DEQ received an application for the new permit via email on January 26, 2021. A hard copy was received on January 28, 2021. Renewal fees accompanied the application. DEQ reviewed the submittal and issued a completeness letter on January 27, 2021.

2.0 Facility Information

2.1 Location

The Shepherd School wastewater treatment system is located in the town of Shepherd, about 11 miles northeast of Billings (**Figure 1**). This permit action is for a discharge to ground water from a new wastewater system associated with construction of a new building addition.

The main building addition will connect the existing elementary school and existing middle school and is intended to provide additional classroom space, library, and a new cafeteria for the entire campus. The main building addition requires the demolition of two existing buildings being the existing library and elementary annex. The building addition will provide two classrooms to the existing building.

The school campus has four existing wastewater systems:

- Elementary School and Kitchen (for entire campus) has a wastewater system located to the west of the elementary school. The wastewater system is to remain as currently constructed; however, the kitchen waste will be removed from the system as a new kitchen is proposed in the main building addition.
- High School and Gym/Football Field has a wastewater system located to the west of the existing football field and track. The wastewater system is to remain as currently constructed. There is no proposed change in use of the existing facility beyond minor interior renovations and replacement of plumbing fixtures in existing bathrooms, which will likely result in reduced water consumption and wastewater flow.
- The CTE building has a new wastewater system constructed in the fall of 2020.
- Library annex has an existing wastewater system. The building will be demolished as will the existing wastewater system for newly constructed improvements.

As described, the existing wastewater systems for the elementary and high school will remain in place and continue to serve their respective buildings. A new wastewater system was installed in the fall of 2020 for the CTE building. A new wastewater system will be constructed for the proposed building addition. The proposed main school addition is designed to accommodate meals for the entire campus. The design is for a full capacity of up to 1,000 students, classroom space for up to 270 students, 5 administrative staff, and events in the commons.

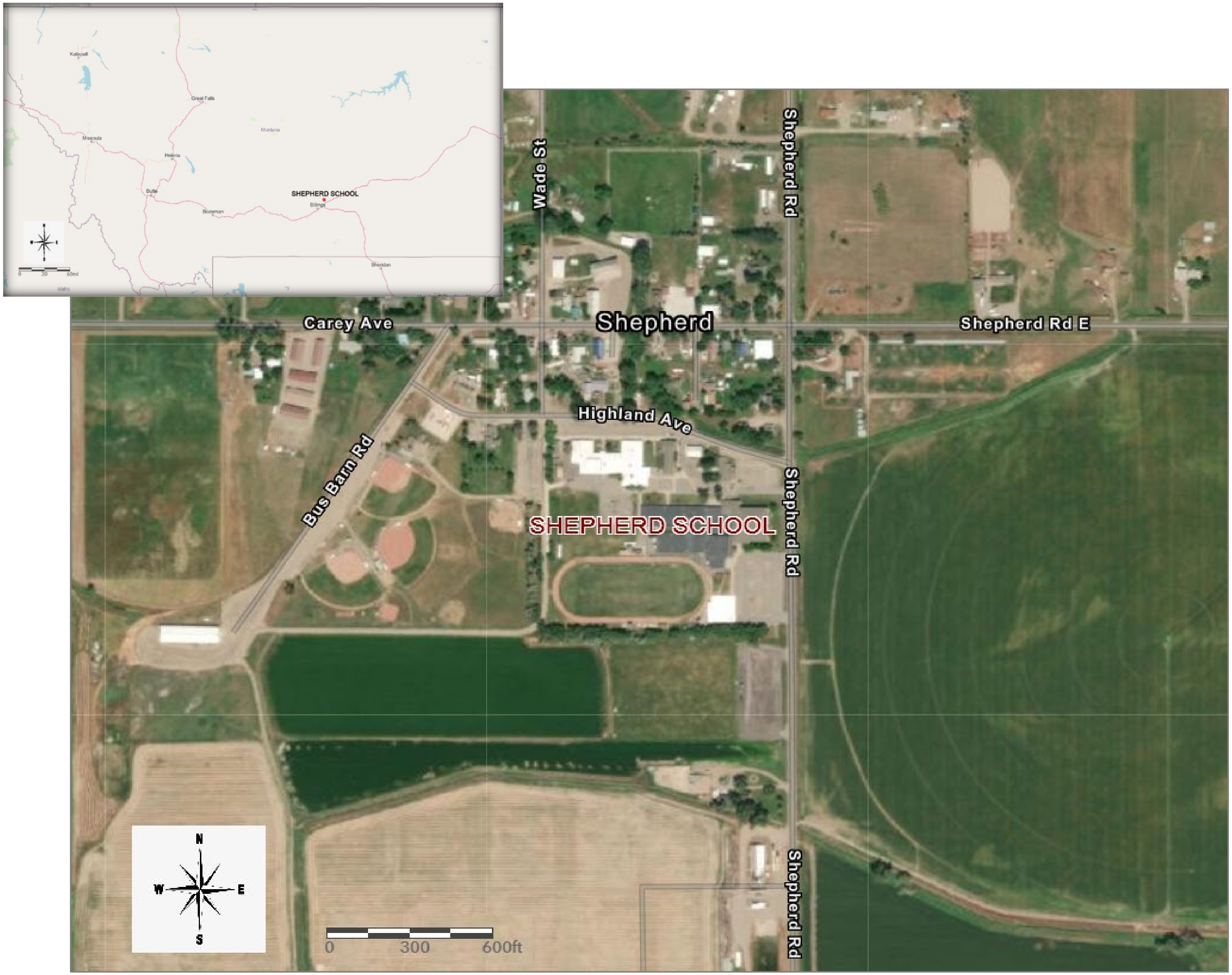


Figure 1. Location of SHEPHERD SCHOOL

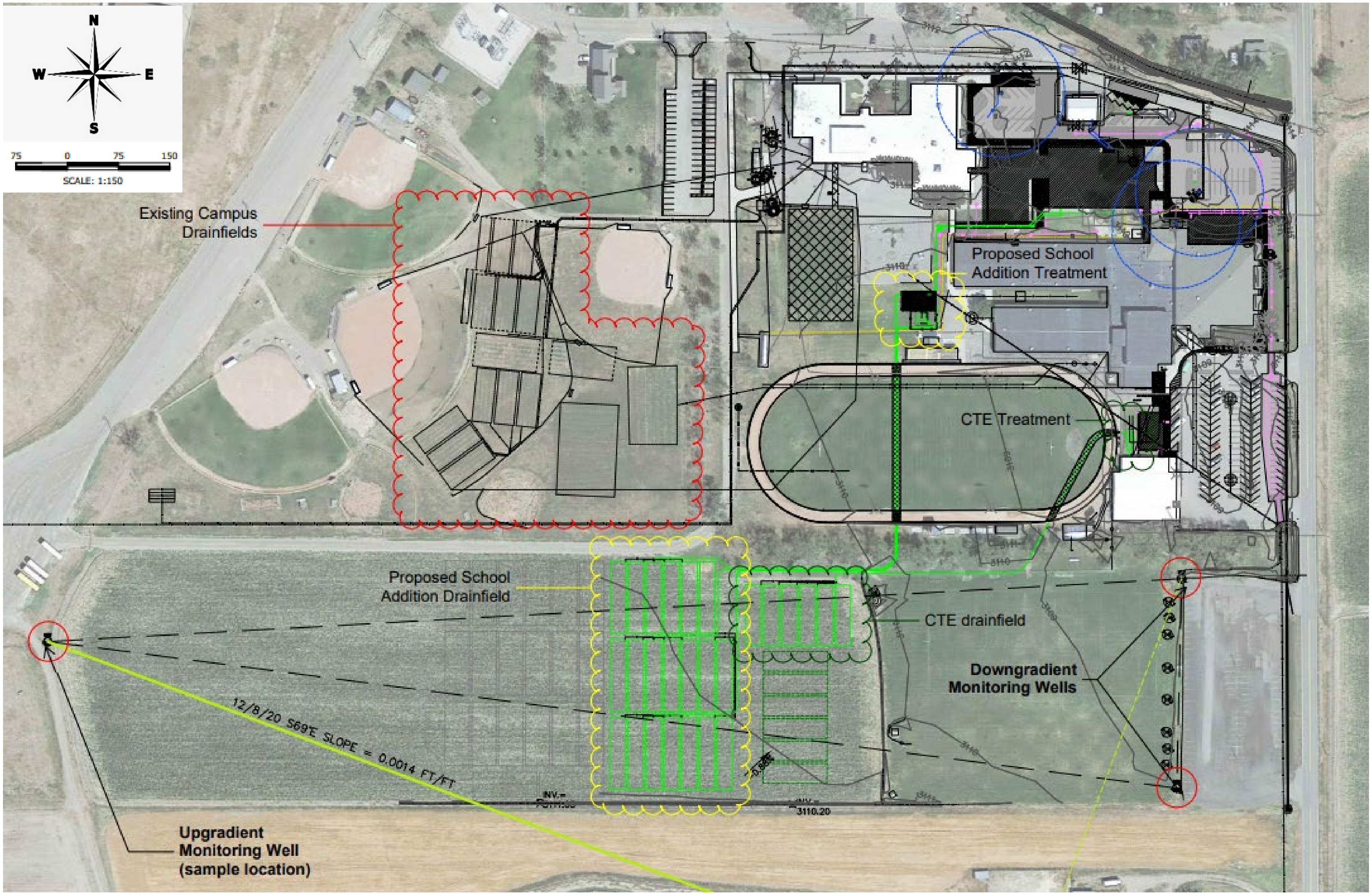


Figure 2. SHEPHERD SCHOOL Wastewater System

2.2 OPERATIONS

System operations are summarized in **Table 1**.

Table 1. Collection, Treatment, and Disposal Summary

Collection	
Contributing sources:	The proposed main school addition is designed to accommodate meals for the entire campus. The design is for a full capacity of up to 1,000 students, classroom space for up to 270 students, 5 administrative staff, and events in the commons.
Standard industrial code(s) of sources:	SIC Code 8211 - Elementary and Secondary Schools
Collection method:	Gravity-driven sewer lines and pressurized effluent piping
Flow volume:	Average daily design flow: 2,610 gallons per day (gpd) Maximum daily design flow: 5,475 gallons per day (gpd)
Treatment	
Treatment level:	Level 2
Treatment technology:	Septic tanks, grease interceptor, equalization, clarification, and recirculating tanks, and Orenco Advantex AX-100 pods
Treatment location:	Latitude: 45.94158 °, Longitude: - 108.34510 °; and Latitude: 45.94103 °, Longitude: - 108.34379 °
Disposal	
Method of disposal:	Infiltration to ground water
Disposal structure:	Subsurface pressure-dosed drainfields (Outfall 001)
Outfall location:	Latitude: 45.93999 °, Longitude: - 108.34687 °

The wastewater system will provide Level 2 treatment with an Advantex system which is a recirculating media trickling filter. Design of the treatment system was prepared by Orenco Systems, Inc. based on typical wastewater strengths for a school and the design population and flow data provided by Sanderson Stewart. A pre-cast grease interceptor is proposed for removal of fats, oils, and grease from the kitchen waste stream. Primary treatment will occur in a septic tank with effluent filter based on Orenco sizing recommendations. A pre-anoxic/equalization tank is located after the septic tank. The equalization portion of the tank will be set above the pre-anoxic volume and be discharged via a time-based dosing schedule to attenuate flow over a 6-day period. After flow equalization, a pre-aeration stage is recommended by Orenco ahead of the Advantex treatment. The pre-aeration stage consists of an aeration compartment and a clarifier compartment and has an expected treatment rate of 50% BOD_5 removal. After the pre-aeration stage, the effluent is treated by two Orenco Advantex AX-100 pods. The pressure-dosed drainfield is divided into 15 pressure zones via three 5-way distributing valves. Three Orenco Model PF5010 pumps are situated in the dosing tank. Each pump is connected to one of the 5-way distributing valves and associated pressure zones. A flow meter is proposed on each force main to the drainfield area. Each pressure zone has 5 laterals, 3-foot wide, and 100 feet long resulting in an absorption area of 1,500 ft^2 (22,500 ft^2 total).The trench depth is proposed to be 30 inches. Hydraulic analysis and dose tank sizing analysis is provided to demonstrate compliance with DEQ-4.

Effluent sampling / monitoring location(s) are at the dose tanks (EFF-001).

Monitoring and sampling requirements are further discussed in **Section 6**.

Figure 3 is a line drawing of the collection, treatment, and disposal process.

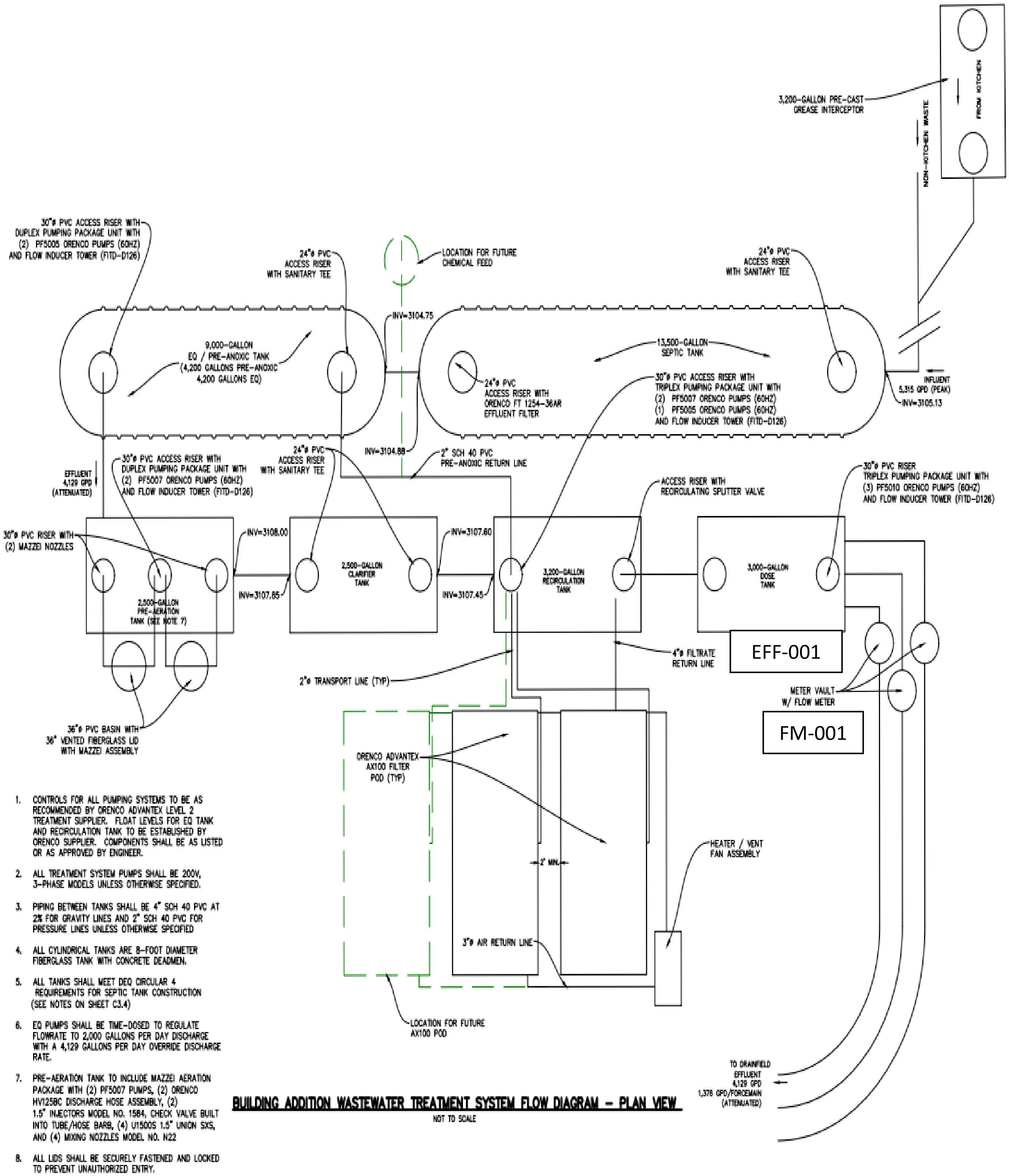


Figure 3. Wastewater Treatment System Line Diagram.

2.3 EFFLUENT CHARACTERISTICS

DEQ requires a new permit applicant to estimate the quality of the effluent so that DEQ may evaluate the potential for pollution of state water. The applicant provided estimated effluent quality based on best professional judgement and effluent characteristics from equivalent facilities.

The applicant worked with Orenco to estimate effluent quality. The system is anticipated to achieve greater than 60% removal of total nitrogen (TN) and less than 10 mg/L BOD_5/$cBOD_5$ and TSS in the effluent. Orenco estimates the TN discharge of about 0.775 lbs/day.

2.4 GEOLOGY

The Yellowstone River valley typically consists of a coarse-grained alluvium topped by fine-grained alluvium. The fine-grained upper layer is 100 feet thick in places. The bottom coarse-grained layer consisting of mostly sand and gravel, ranges in thickness from 10 feet up to 40 feet thick. This sand and gravel produce most of the water for the area. Above the modern Yellowstone River valley is a network of terrace surfaces formed through erosion and deposition. Bedrock units of shale or sandstone are exposed occasionally in the upper terrace surfaces.

The Natural Resources Conservation Service (NRCS) Soil Survey indicates that this site's soils consist of clay to clay loam with clay concentration decreasing with depth (Bew clay classification) **Appendix D.** Soils become a sand and gravel mix at about 6 feet depth. Soils are well-drained. Depth to restrictive layer and water table is generally greater than 80-inches. Slope varies between 0 to 1 percent. Most restrictive soil type from test pits at each zone was clay, which was confirmed by conducting three double-ring infiltrometer tests within the drainfield area. Based on Table 2.1-1 of DEQ Circular 4, an application rate of 0.15 gpd/ft2 was utilized for sizing of the drainfield absorption area.

2.5 HYDROGEOLOGY

Unconsolidated Quaternary deposits in this area consist of alluvium associated with the abandoned channels of the Yellowstone River. This is an alluvial terrace, with abandoned channels and local glacial outwash. Beneath the terrace deposits is a basal layer of coarse gravel and sand. This gravel and sand zone is considered to be the primary ground water-bearing unit in the area. It overlays the Cretaceous Colorado Shale.

The permit application supplies information describing the hydrogeological conditions for the site. Three monitoring wells were used to measure a hydraulic gradient of 0.0014 ft/ft. Ground water is estimated to be moving N79^{o}E. Hydraulic conductivity of 369 ft/day was determined from nearby well logs using the Razack & Huntley equation for transmissivity. Measurements taken from on-site monitoring wells show average depth to ground water is 9 feet above ground surface.

The nearest surface water to the system in terms of groundwater flow is an unnamed irrigation ditch about a half mile to the east / northeast. Crooked Creek is about a mile and a half downgradient of the outfall. The Yellowstone River is about 2.3 miles from the discharge.

Important hydrogeologic characteristics are summarized in **Table 2**.

Table 2. Hydrogeologic Summary

Average depth to ground water	9 Feet
General ground water flow direction	N79ºE
Hydraulic conductivity	369 feet per day
Hydraulic gradient	0.0014 feet/feet
Nearest downgradient surface water	Unnamed irrigation ditch (half a mile)

2.6 Ground Water Monitoring Wells

There are 3 monitoring wells associated with this permit: MW-1, MW-2 and MW-3. Monitoring well, MW-1, represents upgradient ambient groundwater. Monitoring wells, MW-2 and MW-3 are downgradient wells intended to monitor groundwater downstream of the treatment system. These wells are plotted on **Figure 4**. Monitoring well construction details are provided in **Table 3**. Driller's logs for each monitoring well are attached as **Appendix A**.

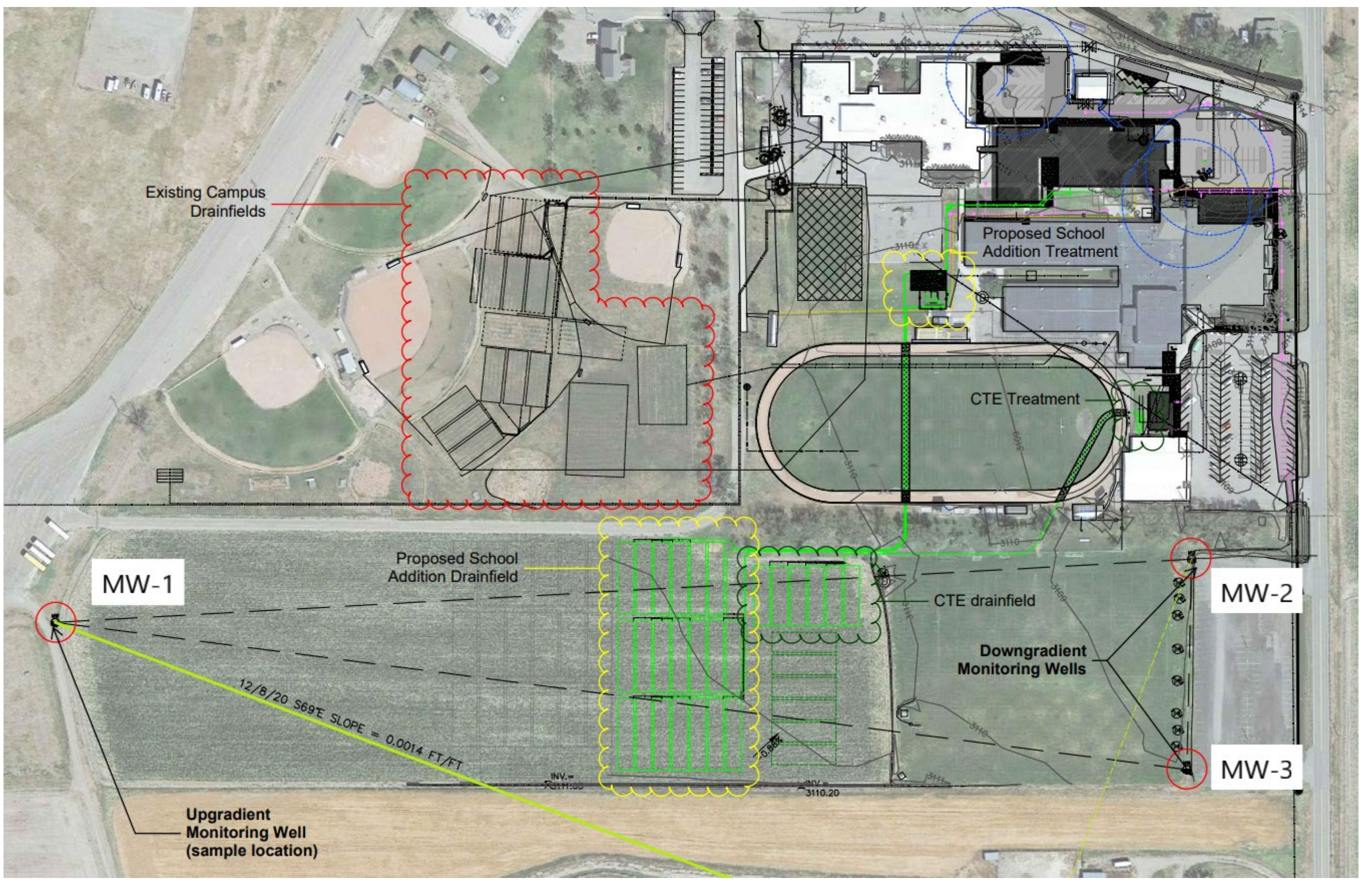


Figure 4. Monitoring Wells

Table 3. Monitoring Well Summary

Monitoring Well MW-1	
MBMG GWIC ID:	312067
Location- latitude/longitude:	Latitude: 45.94019° Longitude: -108.35055°
Location- narrative:	Western edge of open field south of baseball / softball fields.
Rationale:	Ambient upgradient receiving water quality
Depth; screened interval:	Total depth of 22 feet, static water level 10.5 feet, screened 7 to 22 feet.
Monitoring Well MW-2	
MBMG GWIC ID:	312347
Location- latitude/longitude:	Latitude: 45.94036° Longitude: -108.34370°
Location- narrative:	Northeast corner of field south of track
Rationale:	Down gradient ground water quality (post mixing zone)
Depth; screened interval:	Total depth of 23 feet, static water level 7 feet, screened 7 to 23 feet.
Monitoring Well MW-3	
MBMG GWIC ID:	312349
Location- latitude/longitude:	Latitude: 45.93950° Longitude: -108.34370°
Location- narrative:	Southeast corner of field south of track
Rationale:	Down gradient ground water quality (post mixing zone)
Depth; screened interval:	Total depth of 20 feet, static water level 8.2 feet, screened 9 to 19 feet.

If a DEQ-approved monitoring well is abandoned, destroyed or decommissioned, or is no longer able to be sampled due to fluctuations in the ground water table, the permittee must install or designate a new well to replace the abandoned, destroyed, decommissioned, or non-viable well.

2.7 GROUND WATER QUALITY CHARACTERISTICS

Water sampling results from MW-1 are provided in **Table 4**. Based on the 976.5 microsiemens per centimeter (µS/cm) specific conductance, the receiving water is Class I ground water.

Table 4. Ambient Water Quality Reported from Monitoring Well MW-1

Test	Units	Minimum Value	Maximum Value	Average Value	No. of Samples	9/25/2020	11/19/2020	
Specific Conductivity	uS/cm	923	1030	976.5	2	1030	923	
Total Dissolved Solids (TDS)	mg/L	581	652	616.5	2	652	581	
pH	s.u.	7.5	7.81	7.655	2	7.5	7.81	
Chloride	mg/L	51	68	59.5	2	68	51	
Escherichia Coli*	No./100ml	1	1	1	2	1	<1	
Kjeldahl Nitrogen, Total, as N	mg/L	ND	ND	ND	2	ND	ND	
Nitrate + Nitrite, as N	mg/L	0.48	1.94	1.21	2	1.94	0.48	
Total Organic Carbon (TOC)	mg/L	4	4.5	4.25	2	4	4.5	

Total Nitrogen = Nitrate + Nitrite + Total Kjeldahl Nitrogen (as N)

Total nitrogen was not reported; however, it may be calculated as the sum of nitrate + nitrite and total Kjeldahl nitrogen. **The calculated total nitrogen concentration in the receiving water is 1.21 mg/L.**

3.0 WATER QUALITY STANDARDS AND NONDEGRADATION

Part of DEQ's mission is to protect, sustain, and improve the quality of state waters. Water quality standards provide the basis for effluent limits that DEQ applies to discharge permits (**Section 5**). These standards include three components: designated uses, water quality criteria, and nondegradation policy. DEQ protects all designated uses of state water by basing effluent limits on the most restrictive water quality limitations, intended to protect the most sensitive uses.

3.1 DESIGNATED USES

With a specific conductivity of 976.5 µS/cm (**Table 4**), the receiving water is Class I ground water and therefore a high-quality water of the State. Class I ground waters must be maintained suitable for the following uses with little or no treatment:

- Public and private drinking water supplies
- Culinary and food processing purposes
- Irrigation
- Drinking water for livestock and wildlife
- Commercial and industrial purposes

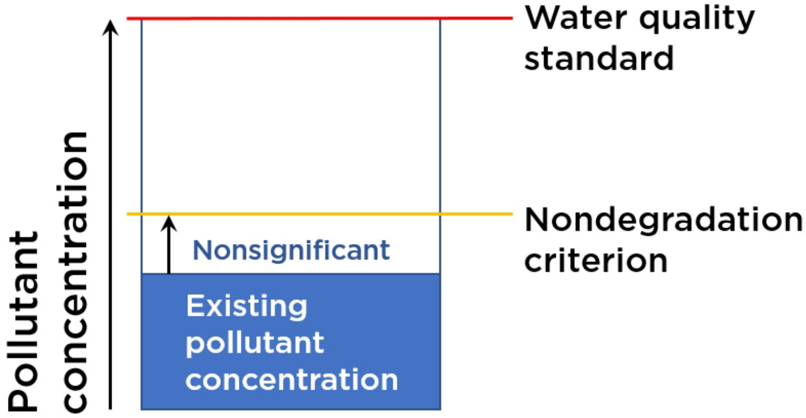
DEQ protects all the assigned beneficial uses by protecting the most sensitive. Drinking water is the most sensitive use of this receiving water.

3.2 WATER QUALITY CRITERIA

Montana has water quality standards for both surface water and ground water. The numeric criteria for each are different because they must support different uses. DEQ writes permits to protect the most sensitive, thereby protecting all uses. DEQ's ground water standard for nitrate is 10.0 mg/L, as is the standard for nitrate + nitrite (as nitrogen). Class I ground water must be maintained suitable for use as a drinking water supply with little or no treatment, and therefore must meet the corresponding human health standard of 10.0 mg/L total nitrogen. These water quality standards may not be exceeded outside a designated mixing zone (**Section 4**).

3.3 NONDEGRADATION

Montana's nondegradation policy is intended to preserve the existing condition of high-quality state waters. Any water whose existing condition is better than the water quality standards must be maintained in that high quality. Nondegradation policy allows discharges to cause only nonsignificant changes in water quality. Changes in water quality that are deemed significant require an authorization to degrade. An authorization to degrade is not an authorization to pollute; the water quality standard must not be exceeded.



DEQ must determine whether the proposed discharge will result in significant changes in water quality.

3.4 Nonsignificance

The proposed activity is a new source resulting in a change of existing water quality. DEQ must determine whether these water quality changes are significant. Some nonsignificant activities are specified in the Administrative Rules of Montana; other activities are evaluated for significance according to a process provided in the Rules. DEQ evaluated the significance of this discharge using the criteria and methods described below.

3.4.1 Ground Water Nonsignificance Criteria

For this discharge to ground water, the following nonsignificance criteria are relevant:

Nitrogen

Under Montana statute, ground water total nitrogen at or below 7.5 mg/L at the downgradient end of the mixing zone (see **Section 4**) is a nonsignificant change in water quality, so long as the discharge does not cause degradation of surface water. Evaluation of the effects to surface water are discussed below in **Section 3.4.2**. Using the nonsignificance criterion of 7.5 mg/L, DEQ established effluent limits that cause the discharge to comply with ground water nonsignificance/nondegradation criteria at the end of the mixing zone. This is discussed in detail in **Section 5.1**.

Phosphorus

A total phosphorus surface water breakthrough time of greater than 50 years is a nonsignificant change in water quality. The phosphorus criterion requires an analysis to determine a breakthrough time. Breakthrough occurs when the subsurface soils lose their capability to adsorb any more phosphorus, and it reaches surface water.

DEQ's phosphorus breakthrough analysis estimates that phosphorus discharged to ground water from Outfall 001 may reach surface water in 116 years. Predicted phosphorus breakthrough greater than 50 years is considered insignificant.

3.4.2 Surface Water Nondegradation

The phosphorus breakthrough analysis is based upon distance and time to nearest surface water, inherently addressing the potential for degradation of surface water. Therefore, the analysis of reasonable potential for surface water degradation in this section is limited to nitrogen.

DEQ uses several mixing scenarios to assess a ground water discharge's potential to degrade surface water. These scenarios estimate in-stream nitrate concentrations. These estimates are simple mass-balance calculations based on instantaneous mixing of the nearest surface. The surface water nitrate concentration, surface water flow, and ground water nitrate concentrations are based upon best available data.

The ground water concentration scenarios are as follows:

- Ground water concentration calculated at the distance to the nearest surface water
- Ground water concentration at the end of the 500-foot mixing zone (ignoring intervening aquifer)
- Undiluted effluent concentration (ignoring mixing zone and intervening aquifer)

Ground water concentrations are calculated using the mixing zone equation (**Section 4**). The scenarios do not account for natural processes that attenuate nitrogen in ground water, and the final one does not even consider dilution. However, this overly conservative approach can be useful for demonstrating nonsignificance.

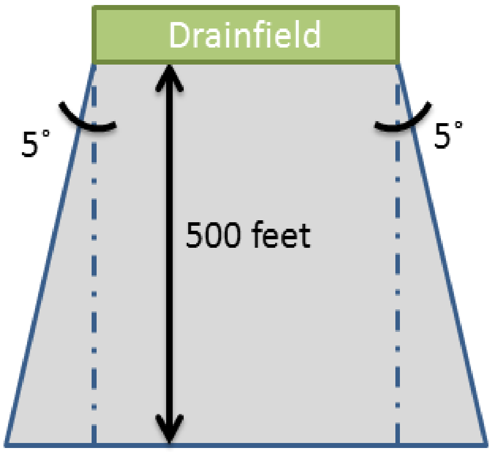
By using recent ground water nitrogen concentrations to identify the available assimilative capacity in the receiving aquifer, DEQ accounts for cumulative impacts of multiple nitrogen sources. These projections may be reanalyzed during every permit renewal cycle to incorporate updated site-specific information, which may include new upgradient or downgradient sources of nitrate.

The calculations underlying these projections are discussed and provided in full in **Appendix B**. These projections demonstrate that nitrate in ground water will not result in degradation of the nearest surface water. Therefore, water quality changes that result from discharges in compliance with this permit are nonsignificant.

4.0 MIXING ZONE

DEQ authorizes a standard mixing zone for total nitrogen discharged from Outfall 001. A mixing zone is a specifically defined area of the receiving water where water quality standards may be exceeded. DEQ evaluates the suitability according to criteria established in the Administrative Rules of Montana. The mixing zone is then defined in the permit. The applicant requested a standard mixing zone for this discharge, consistent with previous permit cycles.

A standard mixing zone extends 500 feet downgradient from the source. The upgradient boundary is equal to the width of the source (measured perpendicular to the of ground water flow direction). The mixing zone widens in the downgradient direction by 5° on either side. The width of the downgradient boundary is calculated by adding the increased width for each side (the tangent of 5° (0.0875) times the mixing zone length) to the width of the upgradient boundary. Standard mixing zones extend 15 feet below the ground water table.



The volume of ground water (Q_{GW}) available to mix with the effluent is calculated using Darcy's Equation: $Q_{GW} = KIA$

Where:
Q_{GW} = ground water flow volume (feet^3/day)
K = hydraulic conductivity (feet/day)
I = hydraulic gradient (feet/feet)
A = cross-sectional area (feet^2) at the downgradient boundary of the mixing zone.

Table 5 summarizes the variables used in Darcy's equation and the resulting volume of ground water available to mix at Outfall 001. These values are drawn from the permit application.

Table 5: Hydrogeologic and Mixing Zone Information - Outfall 001

Parameter	Units	Value
Mixing Zone Type	-	Standard
Authorized Parameters	-	Total Nitrogen
Ambient Ground Water Concentrations, Total Nitrogen	mg/L	1.21
Ground Water Flow Direction	azimuth/bearing	S79°E
Length of Mixing Zone	feet	500
Thickness of Mixing Zone	feet	15
Outfall Width, Perpendicular to Ground Water Flow Direction	feet	265
Width of Mixing Zone at Down Gradient Boundary	feet	352.5
Cross Sectional Area of Mixing Zone (A)	ft^2	5287.5
Hydraulic Conductivity (K)	feet/day	369
Hydraulic Gradient (I)	ft/ft	0.0014
Volume of Ground Water Available for Mixing (Q_{gw})	ft^3/day	2,732

In order to determine whether a mixing zone is allowable, DEQ calculates a predicted concentration at the downgradient end of the mixing zone. This mixing calculation follows the following procedure:

- Volume of ground water times the concentration of the parameter = existing load;
- Volume of discharge times the concentration of the parameter = waste load; and
- (Existing load + waste load) / total volume = predicted concentration.

Because the predicted concentration must satisfy the most stringent nonsignificance criterion (**Section 3**), DEQ can calculate effluent limits by rearranging the equation and solving for the effluent concentration (**Section 5**).

5.0 Permit Conditions

Discharge permits include conditions that ensure compliance with the Montana Water Quality Act and the regulations used to implement it. These conditions include effluent limits as well as any special conditions that DEQ deems necessary to protect the quality of the receiving water.

Montana's numeric water quality standards are published in Circular DEQ-7. Water quality criteria applicable to this permit are summarized in **Table 6**. The permit establishes effluent limits that will meet water quality standards and nondegradation criteria, thereby protecting beneficial uses and existing high-quality waters. The most restrictive criteria in **Table 6** provide the basis for the effluent limits.

Table 6. Applicable Ground Water Quality Criteria

Parameter	Human Health Standard	Beneficial Use Support	Nondegradation Criteria
Nitrate plus nitrite (as Nitrogen[N])	10 mg/L	-	-
Total Nitrogen	-	10 mg/L	**7.5 mg/L**
Total Phosphorus	-	-	**>50-year breakthrough**

This discharge permit includes numeric effluent limits that restrict the strength and volume of the discharge. The ground water nonsignificance criteria (**Section 3.4.1**) provide the basis for the limits. DEQ calculates effluent limits by rearranging the mixing zone equation (**Section 4**) and solving for the effluent concentration that satisfies the water quality criteria. DEQ evaluates and recalculates the limits using updated water quality data as part of every permit renewal cycle. In this way, DEQ protects the receiving water quality by continually assessing cumulative impacts to the receiving water.

5.1 Total Nitrogen Effluent Limit

The nonsignificance criterion of 7.5 mg/L is the most restrictive of the water quality criteria applicable to this permit; therefore, it is the water quality target for this effluent limit. DEQ established the final effluent limit for this discharge by back-calculating the effluent concentration that results in 7.5 mg/L at the end of the mixing zone, given the available dilution. Available dilution is determined by recent ground water quality sampling of the receiving water. Ambient total nitrogen averaged 1.21 mg/L (**Section 2**). DEQ calculates an effluent limit that protects receiving water quality and beneficial uses according to the following equation:

Equation 1: $C_{lmt} = C_{std} + D(C_{std} - C_{gw})$

Where:

C_{lmt} = effluent limitation concentration
C_{std} = limiting water quality criterion
C_{gw} = ambient receiving ground water concentration
D = dilution ratio (Q_{gw} / Q_{eff})
Q_{gw} =ground water flux at the end of the mixing zone
Q_{eff} = average maximum daily discharge

Using the values provided in **Table 5**, the result for C_{lmt} is 31.0 mg/L. This is the final effluent limit expressed as a concentration. Load limits are more appropriate for discharges to ground water since the long-term loading is the greater concern in absence of aquatic life considerations. Additionally, load limits inherently control both the strength and volume of the discharge. A discharge of 5,475 gallons per day containing 31.0 mg/L total nitrogen is equivalent to 1.42 pounds per day. The limit calculations are provided in detail in **Appendix C**.

5.2 Total Phosphorus Effluent Limit

DEQ determined that phosphorous discharged to ground water would reach an unnamed irrigation ditch in 116 years. A phosphorous breakthrough time of greater than 50 years is considered insignificant. Therefore, DEQ establishes an effluent monitoring requirement, but not an effluent limit for this parameter.

Based on the information and analyses presented above, DEQ proposes the following numerical effluent limitations in **Table 7**.

Table 7. Final Effluent Limits

Shepherd School Proposed Effluent Limit			
Parameter Name	**Units**	**Effluent Limitation**	**Rationale**
		Daily Maximum(1)(2)	
Total Nitrogen (as N)	lbs/day	1.42	Nondegradation ARM 17.30.715(1)(d)(iii)

Footnotes:
(1) See definition in Part V of permit.
(2) Highest measured daily value for reporting period on Discharge Monitoring Report (DMR) form.

6.0 Monitoring and Reporting Requirements

DEQ requires effluent and ground water monitoring to assure compliance with the effluent limitations and therefore water quality standards. Effluent monitoring and ground water monitoring is required as a condition of this permit. All monitoring and sampling required by this permit must be representative; therefore, the permit identifies specific monitoring locations. Monitoring requirements and rationale are summarized below.

6.1 Effluent Monitoring

This permit includes numeric effluent limitations with specific magnitudes and durations to ensure the discharge will not cause or contribute to an exceedance of an applicable water quality standard (see **Section 3**). Accordingly, the permittee is required to monitor and report at a specified frequency in order to demonstrate compliance with these limitations.

Effluent samples and discharge flow measurements must be representative of the nature and volume of the effluent. The effluent sample location (EFF-001) is located at the drainfield (**Figure 3)**. The permittee is required to install, maintain and report flow measurements using a flow-measuring device capable of measurements that are within 10 percent of the actual flow. The flow measuring device (FM-001) is located at the meter vault (**Figure 3**). The flow measuring device must be installed and in operating condition prior to discharge. All analytical methods must be in accordance with the Code of Federal Regulations, 40 CFR Part 136 for each monitored parameter. Effluent monitoring and reporting requirements are summarized in **Table 8**.

Table 8. Effluent Monitoring Requirements

Effluent Monitoring and Reporting Requirements – Outfall 001						
Parameter	**Monitoring Location**	**Units**	**Sample Type**(1)(2)	**Minimum Sample Frequency**	**Reporting Requirements**(1)(3)	**Report Frequency**
Effluent Flow Rate(4)(5)(6)	FM-001	gpd	Continuous	Continuous	Daily Maximum and Quarterly Average	Quarterly
Biochemical Oxygen Demand (BOD_5)	EFF-001	mg/L	Grab	1/Quarter	Quarterly Average	Quarterly
Total Suspended Solids (TSS)	EFF-001	mg/L	Grab	1/Quarter	Quarterly Average	Quarterly
Nitrate + Nitrite (as N)(4)	EFF-001	mg/L	Grab	1/Quarter	Daily Maximum and Quarterly Average	Quarterly
Total Ammonia (as N)(4)	EFF-001	mg/L	Grab	1/Quarter	Daily Maximum and Quarterly Average	Quarterly
Total Kjeldahl Nitrogen (as N)(4)	EFF-001	mg/L	Grab	1/Quarter	Daily Maximum and Quarterly Average	Quarterly
Total Nitrogen (as N)(4)(7)	EFF-001	mg/L	Calculate	1/Quarter	Daily Maximum and Quarterly Average	Quarterly
		lbs/day(9)				
Total Phosphorus (as P) (4)(8)	EFF-001	mg/L	Grab	1/Quarter	Daily Maximum and Quarterly Average	Quarterly
		lbs/day(9)	Calculate			

Footnotes:
(1) See definitions in Part V of the permit.
(2) Grab sample will represent concentration for a 24-hour period.
(3) Daily Maximum: Report highest measured daily value for the reporting period on Discharge Monitoring Report (DMR) form.
(4) Permittee is to report the daily maximum and quarterly average.
(5) If no discharge occurs during the reporting period, "no discharge" shall be recorded on the DMR report form.
(6) Requires recording device or totalizing meter, must record daily effluent volume.
(7) Total Nitrogen is the sum of Nitrate + Nitrite and Total Kjeldahl Nitrogen.
(8) Annual maximum load shall be reported on an annual basis on a DMR (due on January 28 of each year of the permit cycle)
(9) Load calculation: lbs/day = concentration (mg/L) x flow (gpd) x [8.34×10^{-6}].

6.2 GROUND WATER MONITORING

This permit requires ground water monitoring to provide long term ambient and downgradient characterization of the aquifer. Ground water monitoring will be required at monitoring wells MW-1, MW-2, and MW-3. Data collected via ground water monitoring will be used for mixing zone evaluation and aquifer characterization in future permit renewals and for compliance monitoring. Sampling and reporting requirements shall commence upon the effective date of the permit. Ground water monitoring and reporting requirements are summarized in **Table 9**. All analytical methods must be in accordance with the Code of Federal Regulations, 40 CFR Part 136 for each monitored parameter.

Table 9. Ground Water Monitoring Requirements

Ground Water Monitoring and Reporting Requirements						
Parameter	**Monitoring Location**	**Units**	**Sample Type**(1)	**Minimum Sampling Frequency**	**Reporting Requirements**	**Reporting Frequency**
Chloride (as Cl)	MW-1, MW-2, MW-3	mg/L	Grab	1/Quarter	Quarterly Average	Quarterly
Escherichia coli Bacteria	MW-1, MW-2, MW-3	CFU/100mL	Grab	1/Quarter	Daily Maximum and Quarterly Average	Quarterly
Nitrate + Nitrite (as N)	MW-1, MW-2, MW-3	mg/L	Grab	1/Quarter	Daily Maximum and Quarterly Average	Quarterly
Total Kjeldahl Nitrogen (TKN)	MW-1, MW-2, MW-3	mg/L	Grab	1/Quarter	Daily Maximum and Quarterly Average	Quarterly
Total Nitrogen (as N)	MW-1, MW-2, MW-3	mg/L	Calculate	1/Quarter	Daily Maximum and Quarterly Average	Quarterly
Specific Conductivity @ 25°C	MW-1, MW-2, MW-3	µS/cm	Instant-aneous	1/Quarter	Quarterly Average	Quarterly
Static Water Level (SWL)(2)	MW-1, MW-2, MW-3	Feet below ground surface	Measured	1/Quarter	Quarterly Average	Quarterly
Footnotes: (1) See definitions in Part V of the permit. (2) Point of reference for SWL measurements shall be from ground surface and measured to within 1/100th of one foot.						

PUBLIC NOTICE

Legal notice information for water quality discharge permits are listed at the following website: http://deq.mt.gov/Public/notices/wqnotices. Public comments on this proposal are invited any time prior to close of business on May 5, 2021. Comments may be directed to:

DEQWPBPublicComments@mt.gov

or to:

Montana Department of Environmental Quality
Water Protection Bureau
PO Box 200901
Helena, MT 59620

All comments received or postmarked prior to the close of the public comment period will be considered in the formulation of the final permit. DEQ will respond to all substantive comments pertinent to this permitting action and may issue a final decision within thirty days of the close of the public comment period.

All persons, including the applicant, who believe any condition of the draft permit is inappropriate, or that DEQ's tentative decision to deny an application, terminate a permit, or prepare a draft permit is inappropriate, shall raise all reasonably ascertainable issues and submit all reasonably available arguments supporting their position by the close of the public comment period (including any public hearing). All public comments received for this draft permit will be included in the administrative record and will be available for public viewing during normal business hours.

Copies of the public notice are mailed to the applicant, state and federal agencies, and interested persons who have expressed interest in being notified of permit actions. A copy of the distribution list is available in the administrative record for this draft permit. Electronic copies of the public notice, draft permit, fact sheet, and draft environmental assessment are available at the following website: http://deq.mt.gov/Public/notices/wqnotices.

Any person interested in being placed on the mailing list for information regarding this permit may contact the DEQ Water Protection Bureau at (406) 444-5546 or email DEQWPBPublicComments@mt.gov. All inquiries will need to reference the permit number (MTX000265), and include the following information: name, address, and phone number.

During the public comment period provided by the notice, DEQ will accept requests for a public hearing. A request for a public hearing must be in writing and must state the nature of the issue proposed to be raised in the hearing.

APPENDIX A – MONITORING WELL LOGS

MW-1

Site Name: SHEPHERD SCHOOL DISTRICT #37 * 1
GWIC Id: 312067

Section 1: Well Owner(s)
1) SHEPHERD SCHOOL DISTRICT #37 (MAIL)
7842 SHEPHERD RD
SHEPHERD MT 59079 [09/03/2020]

Section 2: Location

Township	Range	Section	Quarter Sections
02N	27E	10	NW¼ NE¼

County	Geocode
YELLOWSTONE	

Latitude	Longitude	Geomethod	Datum
45.94	-108.350277777778	NAV-GPS	WGS84

Ground Surface Altitude	Ground Surface Method	Datum Date

Addition	Block	Lot

Section 3: Proposed Use of Water
MONITORING (1)

Section 4: Type of Work
Drilling Method: ROTARY
Status: NEW WELL

Section 5: Well Completion Date
Date well completed: Thursday, September 3, 2020

Section 6: Well Construction Details
Borehole dimensions

From	To	Diameter
0	22	7.825

Casing

From	To	Diameter	Wall Thickness	Pressure Rating	Joint	Type
-1.92	5	6	0.25			STEEL
-1.25	22	2				PVC-SCHED 40

Completion (Perf/Screen)

From	To	Diameter	# of Openings	Size of Openings	Description
7	22	2		.020	SCREEN-CONTINUOUS-PVC

Annular Space (Seal/Grout/Packer)

From	To	Description	Cont. Fed?
0	7	BENTONITE	
14.5	22	SILICA SAND	

Section 7: Well Test Data

Total Depth: 22
Static Water Level: 10.5
Water Temperature:

** During the well test the discharge rate shall be as uniform as possible. This rate may or may not be the sustainable yield of the well. Sustainable yield does not include the reservoir of the well casing.*

Section 8: Remarks

Section 9: Well Log
Geologic Source
Unassigned

From	To	Description
0	2	TOPSOIL
2	6	CLAY
6	22	SAND GRAVEL
23	23	SHALE

Driller Certification
All work performed and reported in this well log is in compliance with the Montana well construction standards. This report is true to the best of my knowledge.

Name: RUSSELL SCHELLE
Company: AMERICAN DRILLING & SUPPLY
License No: WWC-659
Date Completed: 9/3/2020

MONTANA WELL LOG REPORT

Form No. 603 R2-04 02N 27E 10 AD Well ID# II

This log reports the activities of a licensed Montana well driller and serves as the official record of work done within the borehole and casing and describes the amount of water encountered. **This form is to be completed by the driller and filed with MBMG within 60 days of completion of the work. Acquiring Water Rights is the well owner's responsibility and is not accomplished by the filing of this report.**

Well log information is stored in the Groundwater Information Center at the Montana Bureau of Mines and Geology (Butte) and water right information is stored in the Water Rights Bureau records (Helena).

For fields that are not applicable, enter NA. Record additional information in the REMARKS section.

1. WELL OWNER:
Name SHEPHERD SCHOOL DIST #37
Mailing address 7842 SHEPHERD RD
SHEPHERD MT 59079

2. WELL LOCATION: List ¼ from smallest to largest
OK ____ ¼ ____ ¼ SE ¼ NE ¼, Section 10
Township 2 N/S Range 27 E/W County Yellowstone
Lot ____, Tract/Blk ____ Subdivision Name ____
Certificate of Survey ____
Well Address ____
GPS ☑ Yes ☐ No
Latitude 45° 56' 22" W Longitude 109° 20' 36" W
Error as reported by GPS locator (± feet) 25
Horizontal datum ☐ NAD27 ☑ WGS84

3. PROPOSED USE: ☐ Domestic ☐ Stock ☐ Irrigation
☐ Public water supply ☑ Monitoring Well
☐ Geothermal ☐ Closed System ☐ Open System ☐ Reinjection
☐ Extraction H_2O Temp ____ Number of Wells in System ____
☐ Other: ____

4. TYPE OF WORK:
☑ New well ☐ Deepen existing well ☐ Abandon existing well
Method: ☐ Cable ☑ Rotary ☐ Other: ____

5. WELL CONSTRUCTION DETAILS:
Borehole:
Dia. 7" in. from 0 ft. to 23' 4" ft.
Dia. ____ in. from ____ ft. to ____ ft.
Dia. ____ in. from ____ ft. to ____ ft.

Casing:
Steel: Wall thickness .250 ☐ Threaded ☐ Welded
Dia. 6 in. from +2' ft. to 6 ft.
Dia. ____ in. from ____ ft. to ____ ft.
Casing Shoe: ☐ Yes ☐ No

Plastic: Pressure Rating Sch 40 lbs. ☐ Threaded ☐ Welded
Dia. 2 in. from +16" ft. to 23 ft.

Perforations/Slotted Pipe:
Type of perforator used ____
Size of perforations/slots ____ in. by ____ in.
____ no. of perforations/slots from ____ ft. to ____ ft.
____ no. of perforations/slots from ____ ft. to ____ ft.

Screens: ☑ Yes ☐ No
Material PVC
Dia. 2 Slot size 020 from 7 ft. to 23 ft.
Dia. ____ Slot size ____ from ____ ft. to ____ ft.

Gravel Packed: ☑ Yes ☐ No
Size of gravel 020 Silica Sand
Gravel placed from 7 ft. to 23 ft.

Packer: ☐ Yes ☑ No
Type ____ Depth(s) ____

Grout: Material used Bentonite
Depth from 0 ft. to 7 ft. OR ☐ Continuous feed

6. WELL TEST DATA:
A well test is required for all wells. (*See details on well log report cover.*)
☐ Static water level 7 ft. below top of casing or top 18" of casing
☐ Closed-in artesian pressure ____ psi.
How was test flow measured:
bucket/stopwatch, weir, flume, flowmeter, etc ____

Yellowstone Controlled Groundwater Area - Water Temperature ____ °F
☐ AQUIFER TEST DATA FORM ATTACHED

Test - 1 hour minimum
Drawdown is the amount water level is lowered below static level.
All depth measurements shall be from the top of the well casing.
Time of recovery is hours/minutes since pumping stopped.

Air test*
NA gpm with drill stem set at ____ ft. for ____ hours
Time of recovery ____ hrs/min. Recovery water level ____ ft.

OR Bailer test*
____ gpm with ____ ft. of drawdown after ____ hours
Time of recovery ____ hrs/min. Recovery water level ____ ft.

OR Pump test*
Depth pump set for test ____ ft.
____ gpm pump rate with ____ ft. of drawdown after ____ hrs pumping
Time of recovery ____ hrs/min. Recovery water level ____ ft.

OR Flowing Artesian*
____ gpm for ____ hours
Flow controlled by ____

**During the well test the discharge rate shall be as uniform as possible. This rate may or may not be the sustainable yield of the well. Sustainable yield does not include the reservoir of the well casing.*

7. WELL LOG: Record depth(s) that water is encountered. HG

Depth, Feet From	To	Material: color/rock and type/descriptor (example: blue/shale/hard, or brown/gravel/water, or brown/sand/heaving)
0	2	Soil
2	9	Clay
9	23	Sand and Gravel
24		Shale

RECEIVED
JAN 19 2021
MBMG

☐ ADDITIONAL SHEETS ATTACHED

8. DATE WELL COMPLETED: 9-21-20

9. REMARKS: ____

10. DRILLER/CONTRACTOR'S CERTIFICATION:
All work performed and reported in this well log is in compliance with the Montana well construction standards. This report is true to the best of my knowledge.
Name, firm, or corporation (print) American Drilling
Address 70th N Nichols Bls MT
Signature [signature]
Date 9-23-20 License no. 639
License type: ☐ MWC ☑ WWC ☐ WWD

Montana Bureau of Mines & Geology
The University of Montana
1300 West Park Street
Butte, MT 59701

56670
312347

MONTANA BUREAU OF MINES AND GEOLOGY COPY

Form No. 603 R2-04

MONTANA WELL LOG REPORT

02N 27E 10 AD

Well ID# IU

This log reports the activities of a licensed Montana well driller and serves as the official record of work done within the borehole and casing and describes the amount of water encountered. **This form is to be completed by the driller and filed with MBMG within 60 days of completion of the work. Acquiring Water Rights is the well owner's responsibility and is not accomplished by the filing of this report.**

Well log information is stored in the Groundwater Information Center at the Montana Bureau of Mines and Geology (Butte) and water right information is stored in the Water Rights Bureau records (Helena).

For fields that are not applicable, enter NA. Record additional information in the REMARKS section.

1. WELL OWNER:
Name: SHEPHERD SCHOOL DIST #37
Mailing address: 7842 SHEPHERD RD
SHEPHERD, MT 59079

2. WELL LOCATION: List ¼ from smallest to largest
OW ___ ¼ ___ ¼ SE ¼ NE ¼, Section 10
Township 2 (N)/S Range 27 E/W County Yellowstone
Lot ___, Tract/Blk ___ Subdivision Name ___
Certificate of Survey ___
Well Address ___
GPS ☑ Yes ☐ No
Latitude 45° 56' 25' N Longitude 109° 20' 36" W
Error as reported by GPS locator (± feet) 25
Horizontal datum ☐ NAD27 ☑ WGS84

3. PROPOSED USE: ☐ Domestic ☐ Stock ☐ Irrigation
☐ Public water supply ☑ Monitoring Well
☐ Geothermal ☐ Closed System ☐ Open System ☐ Reinjection
☐ Extraction H₂O Temp ___ Number of Wells in System ___
☐ Other: ___

4. TYPE OF WORK:
☑ New well ☐ Deepen existing well ☐ Abandon existing well
Method: ☐ Cable ☑ Rotary ☐ Other: ___

5. WELL CONSTRUCTION DETAILS:
Borehole: 7
Dia. 7 in. from 0 ft. to 19' ft.
Dia. ___ in. from ___ ft. to ___ ft.
Dia. ___ in. from ___ ft. to ___ ft.

Casing:
Steel: Wall thickness .250 ☐ Threaded ☐ Welded
Dia. 6 in. from +2' ft. to 6 ft.
Dia. ___ in. from ___ ft. to ___ ft.
Casing Shoe: ☐ Yes ☐ No

Plastic: Pressure Rating Sch 40 lbs. ☐ Threaded ☑ Welded
Dia. 2 in. from +2' ft. to 19 ft.

Perforations/Slotted Pipe:
Type of perforator used ___
Size of perforations/slots ___ in. by ___ in.
___ no. of perforations/slots from ___ ft. to ___ ft.
___ no. of perforations/slots from ___ ft. to ___ ft.

Screens: ☑ Yes ☐ No
Material PVC
Dia. 2 Slot size .020 from 9 ft. to 19' ft.
Dia. ___ Slot/size ___ from ___ ft. to ___ ft.

Gravel Packed: ☑ Yes ☐ No
Size of gravel .020 Silica Sand
Gravel placed from 9 ft. to 19' ft.

Packer: ☐ Yes ☑ No
Type ___ Depth(s) ___

Grout: Material used Bentonite
Depth from 0 ft. to 9 ft. OR ☐ Continuous feed

6. WELL TEST DATA:
A well test is required for all wells. (*See details on well log report cover.*)
☐ Static water level 9'7" ft. below top of casing or top 25" of casing
☐ Closed-in artesian pressure ___ psi.
How was test flow measured: bucket/stopwatch, weir, flume, flowmeter, etc ___

Yellowstone Controlled Groundwater Area - Water Temperature ___ °F
☐ AQUIFER TEST DATA FORM ATTACHED

Test - 1 hour minimum
Drawdown is the amount water level is lowered below static level.
All depth measurements shall be from the top of the well casing.
Time of recovery is hours/minutes since pumping stopped.

Air test*
NA gpm with drill stem set at ___ ft. for ___ hours
Time of recovery ___ hrs/min. Recovery water level ___ ft.

OR Bailer test*
___ gpm with ___ ft. of drawdown after ___ hours
Time of recovery ___ hrs/min. Recovery water level ___ ft.

OR Pump test*
Depth pump set for test ___ ft.
___ gpm pump rate with ___ ft. of drawdown after ___ hrs pumping
Time of recovery ___ hrs/min. Recovery water level ___ ft.

OR Flowing Artesian*
___ gpm for ___ hours
Flow controlled by ___

**During the well test the discharge rate shall be as uniform as possible. This rate may or may not be the sustainable yield of the well. Sustainable yield does not include the reservoir of the well casing.*

7. WELL LOG: Record depth(s) that water is encountered. HG

Depth, Feet From	Depth, Feet To	Material: color/rock and type/descriptor (example: blue/shale/hard, or brown/gravel/water, or brown/sand/heaving)
0	2	Soil
2	6	clay
6	19'	sand and gravel
20		shale

RECEIVED
JAN 19 2021
MBMG

☐ ADDITIONAL SHEETS ATTACHED

8. DATE WELL COMPLETED: 9-22-20

9. REMARKS: ___

10. DRILLER/CONTRACTOR'S CERTIFICATION:
All work performed and reported in this well log is in compliance with the Montana well construction standards. This report is true to the best of my knowledge.
Name, firm, or corporation (print) American Drilling
Address 7046 N. Frontage Blgs MT
Signature [signature]
Date 9-23-20 License no. 659
License type: ☐ MWC ☑ WWC ☐ WWD

Montana Bureau of Mines & Geology
The University of Montana
1300 West Park Street
Butte, MT 59701

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312347

MONTANA BUREAU OF MINES AND GEOLOGY COPY

APPENDIX B – NONSIGNIFICANCE PROJECTIONS

MONTANA DEPARTMENT OF ENVIRONMENTAL QUALITY (DEQ)

Montana Ground Water Pollution Control System

Ground Water Dilution Projection (GWDP) - Nondegradation Significance Analysis

These projections estimate the parameter concentrations in the aquifer downgradient of the subsurface discharge. After dilution with ground water, the projected concentration is compared to the respective significance criteria in determining nonsignificant changes in water quality (ARM 17.30.715).

Site Name:	Shepherd School
Location:	Shepherd (Town) - about 11 miles northeast of Billings
Permit #:	MTX000265-, Outfall 001
Notes:	Design Capacity = 5475 gpd; 732 ft³/d
	These calculations are for the following parameter of interest: Nitrate
	These calculations use the most restrictive ground water standard.
	These calculations do not credit potential losses due to chemical transformation.
	These calculations do not credit potential losses due to attenuation.

Projected Concentration Calculation

$$Cr = \frac{(Qd)(Cd) + (Qs)(Cs)}{Qd + Qs}$$

The Activity is Not Significant if Cr < Significance Criteria

GWDP(a) - Ground Water Nitrate Projection at the End of the Mixing Zone.

Qd =	**732**	ft³/d	Design capacity - effluent flow rate
Cd =	**24.0**	mg/L	Concentration - effluent (treated wastewater)
	500	ft	Length of ground water dilution zone
	15	ft	Thickness of dilution zone
	265	ft	Outfall width, perpendicular to ground water flow direction
	353	ft	Projected width of downgradient dilution zone
	5288	ft²	Cross sectional area of dilution zone (A)
	369	ft/d	Hydraulic conductivity (K)
	0.0014	ft/ft	Hydraulic gradient (I)
Qs(Qgw) =	**2732**	ft³/d	Ground water volume (Qgw)
Cs =	**1.21**	mg/L	Ambient nitrate concentration in ground water
Cr =	**6.03**	mg/L	Projected concentration - end of the mixing zone
Sign. Criteria =	**7.5**	mg/L	Nonsignificance Criteria, ARM 17.30.715
Sign. Activity?	**<7.5**	mg/L	**The activity is not significant**

GWDP(b) - Ground Water Nitrate Projection just prior to the Downgradient Surface Water.

Qd =	**732**	ft³/d	Design capacity - effluent flow rate
Cd =	**24.0**	mg/L	Concentration - effluent (treated wastewater)
	3140	ft	Length of ground water dilution zone
	15	ft	Thickness of dilution zone
	265	ft	Outfall width, perpendicular to ground water flow direction
	815	ft	Projected width of downgradient dilution zone
	12218	ft²	Cross sectional area of dilution zone (A)
	369	ft/d	Hydraulic conductivity (K)
	0.0014	ft/ft	Hydraulic gradient (I)
Qs(Qgw) =	**6312**	ft³/d	Ground water volume (Qgw)
Cs =	**1.21**	mg/L	Ambient nitrate concentration in ground water
Cr =	**3.58**	mg/L	Projected concentration - just prior to surface water
Sign. Criteria =	**7.5**	mg/L	Nonsignificance Criteria, ARM 17.30.715
Sign. Activity?	**<7.5**	mg/L	**The activity is not significant**

Projections performed by Darryl Barton on March 5, 2021.

MONTANA DEPARTMENT OF ENVIRONMENTAL QUALITY (DEQ)

PHOSPHOROUS BREAKTHROUGH ANALYSIS

SITE NAME: Shepherd School
COUNTY: Yellowstone
Permit #: MTX000265
NOTES: Variables used are based on conservative measurements
- Design Capacity = 5,475 gpd = 732 ft³/day
-

VARIABLES	DESCRIPTION	VALUE	UNITS
Lg	Length of Primary Drainfield as Measured Perpendicular to Ground Water Flow	265	ft
L	Length of Primary Drainfield's Long Axis	300	ft
W	Width of Primary Drainfield's Short Axis	125	ft
B	Depth to Limiting Layer from Bottom of Drainfield Laterals*	9	ft
D	Distance from Drainfield to Surface Water	2640	ft
T	Phosphorous Mixing Depth in Ground Water (0.5 ft for coarse soils, 1.0 ft for fine soils)**	1.0	ft
Ne			
Sw	Soil Weight (usually constant)	100	lb/ft3
Pa	Phosphorous Adsorption Capacity of Soil (usually constant)	200	ppm
#I	Number of proposed wastewater treatment systems	1	
CONSTANTS			
PI	Phosphorous Load per proposed wastewater treatment system	283	lbs/yr
X	Conversion Factor for ppm to percentage (constant)	1.0E+06	
EQUATIONS			
Pt	Total Phosphorous Load = (PI)(#I)	283	lbs/yr
W1	Soil Weight under Drainfield = (L)(W)(B)(Sw)	33750000	lbs
W2	Soil Weight from Drainfield to Surface Water = [(Lg)(D) + (0.0875)(D)(D)] (T)(Sw)	130944000	lbs
P1	Total Phosphorous Adsorption by Soils = (W1 + W2)[(Pa)/(X)]	32939	lbs
SOLUTION			
BT	**Breakthrough Time to Surface Water = P / Pt**	116	years

BY: Darryl Barton
DATE: March 2, 2021

NOTES: ** Depth to limiting layer is typically based on depth to water in a test pit or bottom of a dry test pit minus two feet to account for burial depth of standard drainfield laterals.*

APPENDIX C – EFFLUENT LIMIT CALCULATIONS

The system consists of an Orenco Advantex recirculating filtration system (Class 2 for nitrogen treatment).

To protect beneficial uses [ARM 17.30.1006(1)(b)(ii)], there shall be no increase of a parameter to a level that renders the waters harmful, detrimental, or injurious to the beneficial uses. Therefore, no wastes may be discharged such that the waste either alone or in combination with other wastes will violate or can reasonably be expected to violate any standard. DEQ establishes the effluent limitations for nitrogen based on the projection that the entire nitrogen load in the wastewater stream may ultimately be converted to nitrate (USEPA, 2002a).

The allowable discharge concentrations are derived from a mass-balance equation (ARM 17.30.517) which is a simple steady-state model, used to determine concentration after accounting for other sources of pollution in the receiving water and any dilution as provided by a mixing zone. The mass-balance equation (Equation 1) derived for ground water is as follows:

Equation 1:

$$Q_{gw}C_{gw} + Q_{eff}C_{eff} = Q_{comb}C_{proj}$$

Where:

Q_{gw}	=	ground water available for mixing
C_{gw}	=	ambient receiving ground water concentration
Q_{eff}	=	maximum design capacity of wastewater system
C_{eff}	=	effluent pollutant concentration
Q_{comb}	=	combined ground water and effluent ($Q_{comb} = Q_{gw} + Q_{eff}$)
C_{proj}	=	projected pollutant concentration (after available mixing)

The mass-balance equation has been arranged to calculate effluent limits so that the discharge does not cause or contribute to an exceedance of the most restrictive water quality standard. This equation can be applied to any effluent and receiving water where the applicable dilution ratio is known. This equation will only be used for nitrogen which has been authorized mixing (**Section 4**).

Equation 2:

$$C_{lmt} = C_{std} + D(C_{std} - C_{gw})$$

Where:
C_{lmt} = effluent limitation concentration
C_{std} = water quality standard concentration = 7.5 mg/L
C_{gw} = ambient receiving ground water concentration = 1.21 mg/L
D = dilution ratio (Q_{gw} / Q_{eff}) = 2,732/732 (ft^3/day)

C_{lmt} =7.5 + (2732/732)(7.5 – 1.21) **= 31.0 mg/L**

A mass-balance approach is used to calculate the effluent quality of the discharge that meets the most restrictive water quality standard at the end of the mixing zone. Numeric effluent limitations are expressed as loads since this type of limitation inherently regulates both volume and strength of the effluent as prescribed by 75-5-402(3), MCA. Load limits ensure compliance with the ground water standards at the end of the mixing zone. Based on the proposed design capacity, the respective load effluent limitation is:

1.42 lb/day
[(8.34*10-6)* 31.0mg/L*5,475gpd]
as based on the following equation:

Equation 3:

L_{lmt} =CON * C_{eff} *

DC_{eff} Where:
L_{lmt} = effluent limitation-load
C_{eff} = allowable effluent concentration
DC_{eff} = design capacity of wastewater treatment system
(gpd) CON = conversion factor [$8.34*10^{-6}$]

The Final Effluent Limits are summarized in **Table 7** for Outfall 001.

MASS BALANCE EQUATION
ALLOWABLE DISCHARGE CONCENTRATION DETERMINATION

$$C_2 = \frac{C_3(Q_1 + Q_2) - C_1 Q_1}{Q_2}$$

C1	Ambient ground water (background) concentration (mg/L)	1.21
C2	**Allowable discharge concentration (mg/L)**	**31**
C3	Ground water concentration limit for pollutant (from Circular WQB-7) at the end of the mixing zone.	7.50
Q1	Ground water volume (ft^3 / day)	2732
Q2	Maximum flow of discharge (design capacity of system in ft^3 / day)	732

The volume of ground water that will mix with the discharge (Q_s) is estimated using Darcy's equation: Q1=K I A

Q1	**Ground water flow volume (ft^3 / day)**	**2731.5**
K	hydraulic conductivity (ft/day)	369
I	hydraulic gradient (ft/ft)	0.0014
A	cross-sectional area (ft^2) of flow at the down-gradient boundary of a standard 500-foot mixing zone.	5288

Outfall 001 - Shepherd School, March 4, 2021

APPENDIX D – SOIL INFORMATION

Report — Map Unit Description

Yellowstone County, Montana

Bn—Bew clay, 0 to 1 percent slopes

Map Unit Setting

National map unit symbol: clqd
Elevation: 1,900 to 4,700 feet
Mean annual precipitation: 12 to 14 inches
Mean annual air temperature: 39 to 50 degrees F
Frost-free period: 120 to 135 days
Farmland classification: Farmland of statewide importance

Map Unit Composition

Bew and similar soils: 85 percent
Minor components: 15 percent

Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Bew

Setting

Landform: Fans, terraces
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Alluvium

Typical profile

Ap - 0 to 7 inches: clay
Bt - 7 to 16 inches: clay
Bk - 16 to 46 inches: clay
C - 46 to 60 inches: clay loam

Properties and qualities

Slope: 0 to 1 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 15 percent
Maximum salinity: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water capacity: Moderate (about 8.2 inches)

Interpretive groups

Land capability classification (irrigated): 4s
Land capability classification (nonirrigated): 4s
Hydrologic Soil Group: C
Ecological site: R058AC041MT - Clayey (Cy) RRU 58A-C 11-14" p.z.
Hydric soil rating: No

Minor Components

Vananda

Percent of map unit: 4 percent
Landform: Fans, terraces, lakebeds (relict)
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Ecological site: R058AC041MT - Clayey (Cy) RRU 58A-C 11-14" p.z.
Hydric soil rating: No

Keiser

Percent of map unit: 4 percent
Landform: Terraces, low hills
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Base slope, tread
Down-slope shape: Linear, concave
Across-slope shape: Linear
Ecological site: R058AC040MT - Silty (Si) RRU 58A-C 11-14" p.z.
Hydric soil rating: No

Hesper

Percent of map unit: 4 percent
Landform: Fans, terraces
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Ecological site: R058AC040MT - Silty (Si) RRU 58A-C 11-14" p.z.
Hydric soil rating: No

Bone

Percent of map unit: 3 percent
Landform: Lakebeds (relict), fans, terraces
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Ecological site: R058AC050MT - Saline Upland (SU) RRU 58A-C 11-14" p.z.
Hydric soil rating: No

APPENDIX E – REFERENCES

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