Engineering Report
For
Gallatin Gateway County Water and Sewer District

Wastewater Collection System Construction and Activation

April 2016

Submitted to:

Montana Department of Environmental Quality
Permitting and Compliance Division
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INTRODUCTION

This design report provides design criteria for a new wastewater conveyance system for the Gallatin Gateway County Water and Sewer District (District). The conveyance system includes a gravity collection system, pumping station, and force main pipe which conveys the wastewater to the Four Corners Water and Sewer District (FCWSD) wastewater treatment plant. The FCWSD wastewater treatment plant is located in the Elk Grove Subdivision.

This report generally follows the format contained in the applicable DEQ Circulars for each portion of the system. This report begins with a recap of important flow and loading information using the Circular DEQ-2 Chapter 11 format. Subsequent design criteria are presented for each major system according to the schedule provided below:

- Gravity Collection: Circular 2 Chapter 30
- Pumping & Force Main: Circular 2 Chapter 40

Appendix A – Design Calculations

CHAPTER 11
FACILITY PLAN

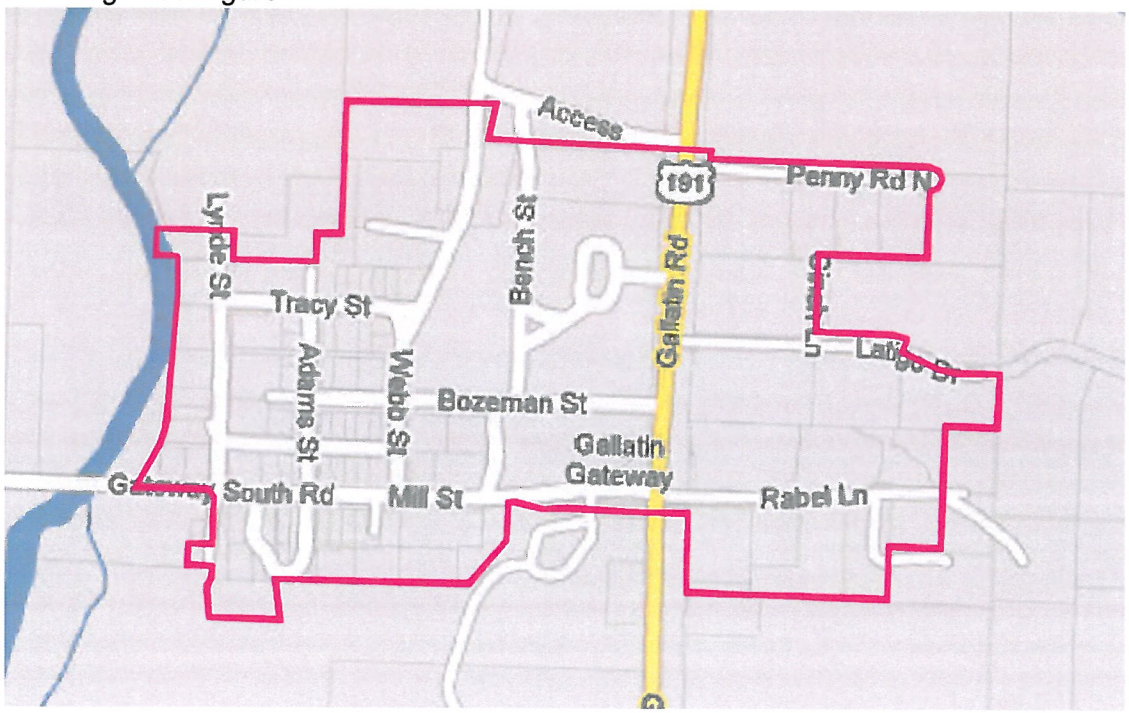
11.21 PROBLEM EVALUATION AND EXISTING FACILITY REVIEW

The community of Gallatin Gateway does not have public wastewater collection or treatment systems. Wastewater treatment and disposal is by individual, on-site wastewater treatment systems, many of which are obsolete and do not properly treat wastewater. This has led to contamination of domestic water wells in some areas of the community. Due to concerns over further water supply contamination and the insufficiency of existing lot sizes for replacement drain fields, a moratorium preventing the installation of new drain field systems has been issued. This moratorium has prevented any growth and development within the community for several years.

11.22 PLANNING AND SERVICE AREA

The FCWSD wastewater treatment plant in the Elk Grove Subdivision will service the existing wastewater flows and organic loads from the Gallatin Gateway County Water and Sewer District. The District boundaries are shown on Figure 11.1 on the following page. The District currently encompasses approximately 109 acres with a 2010 population of approximately 168 residents in 67 dwellings. There are 15 non-residential and commercial users including the Gateway Market, Big Timberworks, Amend Construction, YS Interior Design, Renneberg Hardwoods, Ice Age Performance, Rocky Mountain Choppers, Stacy's Bar & Steakhouse, Post Office Pizza, Gallatin Gateway Inn, Gateway Fire Department, Post Office, Gateway Community Center, Gateway School, and the Buffalo Station Sports Bar.

Planning Area Figure



11.23 POPULATION PROJECTION AND PLANNING PERIOD

There are approximately 135 lots within the District which if developed would increase the population to approximately 336 persons at full build out.Table 11.1 below summarizes the original population projections through planning year 2030.

Because the District lacks any collection, treatment, or disposal facilities, the initial financial commitment to construct these facilities will be substantial. As a result, a conveyance system to the FCWSD wastewater treatment plant will be constructed along HWY 191. The lift station portion of the wastewater conveyance system is sized for the existing population of 168 persons plus the existing non-residential flows. As discussed in later sections of this report, the collection and pumping facilities are designed for the 20 year design population of 336 persons.

Table 11.1 – Population Data

Year	Gallatin Gateway Population (District)	Gallatin County Population	Montana Population
1980	-	42,865	786,690
1990	-	50,463	799,065
2000	183	68,358	903,283
2010	168*	95,166	981,778
2020	234	-	-
2030	336**	-	-

*Current Estimated Population of District

**20-year Design Population for Gallatin Gateway County Water and Sewer District

11.241 FLOW DEFINITIONS AND IDENTIFICATION

Because the service area is a new District that is currently un-sewered, initial design flows were estimated using a residential unit flow of 100 gallons/capita-day as specified in Circular DEQ-2 and the non-residential unit flows specified in Circular DEQ-4. We feel that when compared to nearby communities Bozeman (87 gallons/capita-day) and Manhattan (75 gallons/capita-day), the initial flow estimates are conservative.

11.241.a Design Average Flow

26,720 gallons per day current condition. (16,750 residential +9,970 other)

50,000 gallons per day at full build out.

11.241.b Design Maximum Day Flow

40,000 gallons per day current condition.

75,000 gallons per day at full build out.

11.241.c Design Peak Hourly Flow

78 gallons per minute current based on the calculations provided in 11.243.

142 gallons per minute full build out based on the calculations provided in 11.243.

11.241.d Design Peak Instantaneous Flow

222 gallons per minute based on the pump station design with 2 pumps running. (See Chapter 40)

11.241.e Design Maximum Month Flow

This section is not applicable.

11.242 HYDRAULIC CAPACITY TO SERVE EXISTING COLLECTION SYSTEMS

This section is not applicable.

11.243 HYDRAULIC CAPACITY TO SERVE NEW COLLECTION SYSTEMS

Based on 250 gallons/EDU-day the equivalent dwelling units are determined as follows:

Current condition is 26,720 gallons/day/250=107 EDU

Full Build out is 50,000 gallons/day/250=200 EDU

Using the design average flows divided by 100 gallons per capita/day and Circular 2 equation 10-1 yields a peaking factor of 4.2 for current and 4.1 for full build out conditions.

Current condition design peak hourly flow is 26,720/1440 x 4.2=78 gallons/minute

Full build out design peak hourly flow is 50,000/1440 x 4.1=142 gallons/minute

CHAPTER 30
DESIGN OF SEWERS

Community sewers are designed in accordance with DEQ-2 Chapter 30. The sewer system is designed to accommodate the peak hour of the 20-year build-out design flow of 50,000 gallons per day. Because sewers will likely remain in service longer than 20 years, sewers likely to serve future growth were designed to provide capacity in excess of the 20-year design flow.

Additional sewer design criteria selected by the District are: sewers run in alleys where possible to facilitate easier connection to existing sewer lines; sewer depth sufficient to allow basements where possible in the town core; sewer services provided only to existing occupied buildings with future service connections at the lot owner's expense. The Gallatin Gateway School and the Gallatin Gateway Inn will be served by private sewer mains, due the larger flows of these two users.

31. SEPARATION OF CLEAR WATER

The services will only be connected to existing sanitary sewer services. The connection will occur on the structure side of the existing septic tank. See sheet C3.1 for detail of typical sewer service connection to existing.

32. DESIGN CAPACITY AND DESIGN FLOW

Future growth is anticipated to be to the north of the town of Gallatin Gateway, as well as to the south. Future growth to the north will connect to MH-1 with a new main. Future growth to the south will utilize the existing mains proposed for construction. The section of mains to most likely be used for future growth have been upsized to 10-inch mains between MH-1 to MH-2, and MH-2 to MH-3, and MH-3 to MH-4.

33. DETAILS OF DESIGN AND CONSTRUCTION

33.1 Minimum Size

The mains in this project consist of a majority of 8-inch mains, with a minor amount of 10-inch mains.

33.2 Depth

The minimum depth of the mains in this project is over 5 feet of bury.

33.3 Buoyancy

Buoyancy should not be an issue in this project as the depth to groundwater is at or below the pipe/manhole depth.

33.4 Slope

33.41 Recommended Minimum Slopes

All sewer mains within the project meet or exceed the minimum slopes.

33.42 Minimum Flow Depth

All sewer mains within the project meet or exceed the minimum slopes.

33.43 Minimize Solids Deposition

No oversize sewers are proposed in this project and all meet or exceed the minimum slopes.

33.44 Slope Between Manholes

All sewers are designed with uniform slope between manholes.

33.45 High Velocity Protection

No velocities in excess of 15 feet per second are anticipated in the project.

33.46 Steep Slope Protection

No sewer grades are designed at 20 percent or greater slopes.

33.5 Alignment

All sewers are designed with straight alignment between manholes. It is anticipated that the contractor will lay the sewers utilizing a laser beam between manholes.

33.6 Changes in Pipe Size

Only two locations are designed with changes in pipe size. Both of these locations occur at manholes and are designed with 0.10 feet of drop across the manhole.

33.7 Materials

Eight and ten inch PVC SDR 35 is specified in this project for sewer mains. No abnormal conditions are anticipated that would adversely affect the material of the sewer mains.

33.8 Installation

33.81 Standards

Montana Public Works Standard Specifications are specified and refer to Typical Sewer/Forcemain Trench Detail and Sewer Trench Notes on sheet C3.1.

33.82 Trenching

a. The depth of the sewers will dictate that trench boxes will be needed for the safety of the workers. The necessity to use trench boxes will ensure adequate width.

b. Montana Public Works Standard Specifications are specified and refer to Typical Sewer/Forcemain Trench Details and Sewer Trench Notes on sheet C3.1.

33.83 Pipe Bedding Materials and Placement

a. Montana Public Works Standard Specifications are specified and refer to Typical Sewer/Forcemain Trench Detail and Sewer Trench Notes on sheet C3.1.

b. Montana Public Works Standard Specifications are specified and refer to Typical Sewer/Forcemain Trench Details and Sewer Trench Notes on sheet C3.1.

c. If unsuitable material is encountered, Type 2 Bedding will be used as directed by the Engineer.

d. Six inch lifts will be used and compacted to 95% of Maximum Dry Density.

e. Only a small portion of the project is anticipated to have groundwater encountered during construction. The contractor will be required to obtain a construction Dewatering Discharge Permit, issued by the Department, if water from construction is discharged to state water.

33.84 Trench Backfill

a. Montana Public Works Standard Specifications are specified and refer to Typical Sewer/Forcemain Trench Details and Sewer Trench Notes on sheet C3.1.

b. Final backfill will be placed in such a manner as not to disturb the alignment of the pipe.

33.85 Deflection Test

a. Montana Public Works Standard Specifications will be utilized for testing of the pipe installation to assure quality construction.

b. Montana Public Works Standard Specifications will be utilized for testing of the pipe installation to assure quality construction.

c. Montana Public Works Standard Specifications will be utilized for testing of the pipe installation to assure quality construction.

d. No other flexible pipe, that will require deflection testing, will be used in this project.

33.9 Joints and Infiltration

33.91 Joints

Gasketed joints will be used in the SDR 35 PVC pipe. Air tests will also be utilized to ensure infiltration will not be an issue.

33.92 Leakage Tests

a. It is anticipated that the contractor will use the air test, but the water (hydrostatic) test is an option to the contractor.

b. The air test procedure will be used, as specified in the Montana Public Works Standard Specifications.

33.93 Service Connections

Service connections to the sewer main will be water tight and will not protrude into the sewer. The Typical Sewer Service detail on sheet C3.1 specifies an 8-inch by 4-inch gasketed wye for the service connection to the main.

33.10 Casing Pipe

See the attached manufacturer's documentation for the casing pipe specified at the 2 crossings as shown on the plans.

34. MANHOLES

34.1 Location

Manholes are shown on the plans at all ends of sewer lines; at all changes in grade, size, or alignment; at all intersections; and at distances not greater than 400 feet.

34.2 Drop Type

No drop manholes are included in this project.

34.3 Diameter

All manholes are 48 inches in diameter with minimum access diameters provided.

34.4 Flow Channel

Flow channels will be formed to at least the spring line for 8-inch pipe and to the full height of the crown of the outlet for the 3 runs of 10-inch pipe.

34.5 Bench

A bench will be provided on each side of the manhole channel and will be sloped at least ½ inch per foot.

34.6 Watertightness

Pre-cast concrete manholes will be utilized on this project and will use flexible watertight gasketed connections. The manholes will be tested prior to being placed into service.

34.7 Inspection and Testing

The Montana Public Works Standard Specifications will be used for the testing of manholes.

34.8 Corrosion Protection for Manholes

No corrosive conditions have been anticipated in this project.

34.9 Electrical

No electrical equipment will be installed or used in manholes for this project.

35. INVERTED SIPHONS

No inverted siphons are being used in this project.

36. SEWERS IN RELATION TO STREAMS

36.11 Cover Depth

a. There are no stream crossings in this project.

b. There are no stream crossings in this project.

c. There are no stream crossings in this project.

36.12 Horizontal Location

The sewer mains have been located a sufficient distance from, and outside of the 100 year floodplain of the Gallatin River.

36.13 Structures

The sewer mains, manholes, and other structures have been located a sufficient distance from, and outside of the 100 year floodplain of the Gallatin River.

36.14 Alignment

There are no stream crossings in this project.

36.2 Construction

36.21 Materials

There are no stream crossings in this project.

36.22 Siltation and Erosion

The sewer mains, manholes and other structures have been located a sufficient distance from, and outside of the 100 year floodplain of the Gallatin River.

37. AERIAL CROSSINGS

There are no aerial crossings in this project.

38. PROTECTION OF WATER SUPPLIES

There is not a municipal water supply system in the town of Gallatin Gateway. Care has been taken to locate sewer mains away from public and private water supply wells.

38.1 Cross Connections Prohibited

No connections between a water supply system and a sewer are included in this project.

38.2 Relation to Water Works Structures

38.3 Relation to Water Mains

38.31 Horizontal Separation

a. There are no water mains or municipal water supply system in the town of Gallatin Gateway.

b. There are no water mains or municipal water supply system in the town of Gallatin Gateway.

38.32 Crossings

a. There are no water mains or municipal water supply system in the town of Gallatin Gateway.

b. There are no water mains or municipal water supply system in the town of Gallatin Gateway.

c. There are no water mains or municipal water supply system in the town of Gallatin Gateway.

d. There are no water mains or municipal water supply system in the town of Gallatin Gateway.

e. There are no water mains or municipal water supply system in the town of Gallatin Gateway.

39. SEWER SERVICES AND PLUMBING

The sewer services and plumbing will adhere to relevant plumbing codes.

CHAPTER 40
WASTEWATER PUMPING STATIONS

41. GENERAL

The lift station and forcemain serving the new collection system at Gallatin Gateway Water and Sewer District have been designed in accordance with DEQ-2 Chapter 40. The lift station is located in the northwest corner of town at the natural low point of the collection system. The lift station pumps wastewater approximately 22,560 feet to the Four Corners Water and Sewer District wastewater treatment plant through a 6" HDPE forcemain. The lift station was designed to accommodate the full build out peak hour flow of 142 gallons per minute (gpm), as described in Engineering Report.

The lift station consists of an 8 feet diameter wet well approximately 20.5 feet deep, housing two submersible pumps. Outside of the lift station, a separate underground vault will house check valves, bypass pumping inlet, and a flow meter. The two submersible lift station pumps are each 11 horsepower, with 400-V, 3-phase motors. The design pumping rate of each lift station pump is 200 gallons per minute at 77 feet of total dynamic head. This pumping rate exceeds the peak hour flow of the full build out design flow, and is set by the requirement to maintain a minimum velocity requirement of 2.0 feet per second in the forcemain. With both pumps running the design pumping rate increases to 222 gallons per minute (111 for each pump) at 93 feet of total dynamic head. The lift station will include a stand-alone enclosed backup generator capable of running both pumps. Detailed hydraulic calculations, pump, and system curves are included in Appendix A.

The forcemain is 6" HDPE SDR 11 with a 160 psi pressure rating and an inside diameter of 5.42 inches. The forcemain is approximately 22,560 feet in length with an elevation gain of 37.8 feet from the lift station to the high point, and a drop of 174.5 feet from the high point to the FCWSD wastewater treatment plant. The forcemain has one double pigging station to facilitate cleaning and air vacuum releif. The double pigging station is at the high point of the forcemain to clean down to the lift station to the west and to the next pigging station/air-vacuum valve vault to the north. The flexible forcemain piping allows direction changes to be made with large radius bends to allow free travel for cleaning pigs. Directional fittings are only proposed at the forcemain ends where the pipe can be cleaned by standard methods.

There are a total of 7 pigging ports/air-vacuum valve vaults (includes the double pigging port/air-vacuum valve vault at the high point) spaced throughout the forcemain. View sheet C3.2B for the standard pig port/air-vacuum valve vault detail.

41.1 Flooding

The 100-year floodplain elevation was obtained from the Gallatin County Flood Insurance Rate Map panel 95. The site survey was conducted at the same survey datum as the flood study to determine floodplain extents. The lift station is located approximately 200 feet away from the mapped floodplain. At this location the 100-yr

base flood elevation is approximately 4905 feet. The rim elevation of the lift station is 4915.5 feet, approximately 10 feet above the 100-yr flood elevation.

41.2 Accessibility and Security

The lift station is located along Lynde Street, and is easily accessed year-round. The lift station is beside the street and within a fenced enclosure. Locking hatches are specified on the Plans.

41.3 Grit

The wet well is designed with floors sloped to pump inlets and 1 to 1 beveled sidewalls to ensure grit or debris will move towards the pump inlets. The pumps are capable of pumping typical wastewater grit and debris without operational problems.

41.4 Safety

The lift station is designed to be serviced from above ground. If required, confined space safety equipment will be stored and available at the wastewater treatment plant.

42. DESIGN

42.1 Type

The lift station is a submersible pump configuration.

42.2 Structures

42.21 Separation

The valve vault housing check valves, isolation valves, and flow meter are separated from the wet well. Pipe and electrical penetrations are sealed.

42.22 Equipment Removal

The lift station pumps are installed on a slide rail assembly and can be lifted out of the wet well with a small hoist. Isolation valves located in the separate valve vault allows the remaining pump to be left in operation when a pump is removed.

42.23 Access and Safety Landings

The wet well does not require entry. All lift station service can be provided from the ground surface. No bar screens or mechanical equipment requiring maintenance are located in the wet well.

42.24 Buoyancy

Estimated depth to high groundwater at the lift station is approximately 7' below the rim. To account for extreme events, buoyancy calculations have been done for groundwater at the surface. Minimum tank dimensions required to counteract buoyancy are shown on the Plans.

42.25 Construction Materials

Lift station wet wells are constructed with Type V Portland Cement to withstand corrosion due to exposure from hydrogen sulfide. Mechanical equipment in the lift station pump house is coated with corrosion resistant paint.

42.3 Pumps and Pneumatic Ejectors

42.31 Multiple Units

Two pumps, equal in size, are located in the lift station. The pumping capacity of a single pump (200 gpm) exceeds the full build out peak hour flow of approximately 142 gpm.

42.32 Protection Against Clogging

42.321 Combined Wastewater

This section is not applicable. Storm water runoff does not enter the sanitary sewer system.

42.322 Separate Sanitary Wastewater

The sewer entering the lift station is 10" diameter. Large screens and bar racks are not required. The pumps specified are specifically designed to pump raw wastewater with minimum clogging.

42.33 Pump Openings

The specified pumps are capable of passing 3" spheres, and the specified pump discharge is 3 1/8" diameter.

42.34 Priming

The lift station pumps are submersible and do not required priming.

42.35 Electrical Equipment

The plans specify that all electrical equipment within the lift station comply with NEC for Class 1, Division 1 areas and are suitable for corrosive conditions. Pump control panel are located above grade outside of the lift station wet well. Pump disconnects and 110v GFI outlets are shown on the Plans.

42.36 Intake

Each pump has an individual inlet. The submersible pumps will not fail if a vortex is formed. Minimum pump submergence shown on the plans will reduce the potential for turbulence or vortexes in the wet well.

42.37 Dry Well Dewatering

There is not a dry well with the proposed configuration. The separate valve vault is not subject to leakage or drainage under normal operation.

42.38 Pumping Rates

The lift station full build out peak hourly flow requirement of 142 gpm is provided in Section 11.24 of the Engineering Report. The individual pump pumping rate of 200 gpm is dictated by the requirement to have a minimum forcemain velocity of over 2 feet per second.

42.4 Controls

Pump on/off and high and low water level alarms are determined by a level transducer in the wet well. The specified pump submergence limits turbulence in the wet well that could negatively influence the water level readings. The specified control panel provides automatic lead pump alternation. Backup, redundant floats are provided.

42.5 Valves

The submersible pumps do not require a valve on the suction line. Each pump discharge has a check valve and isolation valve located in a separate vault beside the lift station wet well. The valves are installed in a horizontal pipe run and are easily accessible. There are no valves inside the wet well.

42.6 Wet Wells

42.61 Divided Wells

Since each pump can be removed while leaving the remaining pump operational, a divided wet well is not required.

42.62 Size

The wet well size was selected to provide flexibility and accommodate anticipated full build out conditions. The pump on and off levels are shown on the plan to allow for fill time of under 30 minutes. Levels are provided for both the initial start-up conditions and full build out. The pumps are specified with a soft-start which allows a higher frequency of pump starts. A duty cycle of 8 starts per hour is specified on the plans. Using equation 4-1, pump cycling is approximately 3 starts per hour.

42.63 Floor Slope

The lift station wet well has a 1 to 1 beveled edge to the pump inlets.

42.64 Air Displacement

The lift station wet well has an inverted J-tube vent on the lid.

42.7 Safety Ventilation

42.71 General

The lift stations wet well does not require entry and ventilation is not provided. The safety equipment (provided by the contractor) will include a portable blower along with confined space equipment.

42.72 Air Inlets and Outlets

Not applicable.

42.73 Electrical Controls

Not applicable.

42.74 Fans, Heating and Dehumidification

Not applicable.

42.75 Wet Wells

The safety equipment provided at the wastewater treatment plant will include a portable blower along with confined space equipment.

42.76 Dry Wells

There is not a dry well with the proposed configuration. If ventilation is required for the valve vault, portable equipment will be used.

42.8 Flow Measurement

Flow measurement will be provided by a magnetic flow meter located in the valve vault. The flow meter will read instantaneous and totalized flows and the meter readout will be located above ground near the pump control panel. Flow measurement will also be reported remotely.

42.9 Water Supply

The lift station will not have potable water supply.

43. SUCTION LIFT PUMP STATIONS

This section is not applicable.

44. SUBMERSIBLE PUMP STATIONS – SPECIAL CONSIDERATIONS

44.1 Construction

The submersible pumps specified are specifically designed to pump raw wastewater. The requirement to meet the NEC is specified on the plans. Each pump is specified to have a seal failure sensor and thermal overload sensor.

44.2 Pump Removal

The submersible pumps specified are installed on a rail system that allows pumps to be removed from the ground surface without dewatering the wet well or disconnecting any piping.

44.3 Electrical Equipment

44.31 Power Supply and Control Circuitry

The specified electrical controls can be removed from outside the wet well. Sealed penetrations are specified where electrical lines enter/exit the wet well.

44.32 Controls

The pump control panel is located outside of the wet well. Sealed penetrations are specified where electrical lines enter/exit the wet well. When the pump is raised out of the wet well, the pump power cord can be removed from the pump without disturbing the wet well seal.

44.33 Power Cord

The submersible pumps specified and their power cords are specifically designed for the conditions within the wet well. The plans specify that all electrical equipment within the lift station comply with NEC for Class 1, Division 1 areas and are suitable for corrosive conditions.

44.4 Valves

Discharge check valves and isolation valves are located in a separate valve vault located next to the lift station. Pipe penetrations to the valve vault are water tight. The valve vault is not subject to leakage and drainage under normal conditions and portable dewatering equipment can be used if necessary.

45. SCREW PUMP STATIONS

This section is not applicable.

46. ALARM SYSTEMS

Backup power is provided to the lift station, including the controls. The lift station is equipped with a Mission Communications cellular based remote monitoring system. This system will provide auto-dialing during any alarm condition.

47. EMERGENCY OPERATION

47.1 Objective

The lift station is specifically designed to prevent discharge of raw wastewater and backups.

47.2 Emergency Pumping Capability

The lift station is provided with a backup power generator and automatic transfer switch. Full lift station electrical capacity will be provided by the backup generator. Additionally a

riser and isolation valve is provided in the valve vault that allows a portable pump to be rapidly connected to the forcemain.

47.3 Emergency High Level Overflows

The dedicated backup generator will provide full power within 3 minutes. This quick response is adequate emergency protection.

47.4 Equipment Requirements

47.41 General

A 80 KVA generator is used for emergency back-up power. An automatic transfer switch will sense if grid power fails and will triggers the generator to start-up. When the generator is able to provide full power (after a 3 minute warm-up period) the transfer switch disconnects the station from grid power and connects the generator to the lift station. The lift station pumps will automatically begin pumping when powered up by the generator.

47.411 Engine Protection

The generator is specified to include at a minimum protection for oil pressure and overheating. The general common alarm is connected to the telemetry system which will provide immediate notification of the alarm.

47.412 Size

The back-up generator has capacity to start both pumps simultaneously and provide power to auxiliary equipment.

47.413 Fuel Type

A diesel generator is proposed due to the compact fuel storage. The engine heaters specified will allow cold weather starts.

47.414 Design and Installation of Fuel Storage Tanks

The fuel storage is within the generator skid and a 24-hr capacity is specified. The fuel storage will comply with all state and federal standards.

47.415 Engine Ventilation

The backup generator is above-grade, adjacent to the lift station.

47.416 Routine Start-up

The generator will be automatically test for 20 minutes under load on a weekly cycle in accordance with typical manufacturer's requirements.

47.417 Protection of Equipment

The automatic transfer switch will shut down the generator after grid power has been restored for a timed period. This switch prevents rapid cycling between backup power and grid power for flickering power outages. This switch also isolates the station from irregular power surges that can occur as grid power is first restored.

47.42 Engine-Driven Pumping Equipment

This section is not applicable.

47.43 Engine-Driven Generating Equipment

A permanently installed 80 KVA backup generator is located beside the lift station within the fenced enclosure.

47.431 Generating Capacity

a. The 80 KVA backup generator is adequate to simultaneously start both lift station pumps and power auxiliary equipment.
b. Both pumps are able to be powered by the backup generator without any decrease in pumping capacity.
c. Sequencing controls are not necessary; the generator is capable of starting both pumps simultaneously.

47.432 Operation

An automatic transfer switch will sense if grid power fails and will trigger the generator to start-up. When the generator is able to provide full power (after a 3-minute warm-up period) the transfer switch disconnects the station from grid power and connects the generator to the lift station. The lift station pumps will automatically begin pumping when powered up by the generator.

47.433 Portable Generating Equipment

This section is not applicable.

47.44 Independent Utility Substations

This section is not applicable.

48. INSTRUCTIONS AND EQUIPMENT

An operation manual, emergency procedures, maintenance schedules, tools and spare parts will be provided and stored by the District.

49. FORCEMAINS

49.1 Velocity and Diameter

Pumping rates will provide a minimum velocity of 2 ft/s in the forcemain. The proposed forcemain is 6" 160 psi HDPE pipe with an inside diameter of 5.42". If desired both pumps can be manually operated for short periods of time providing a velocity of over 3 ft/s.

49.2 Air and Vacuum Relief Valve

The forcemain is sloping up continuously from the lift station to a double pigging station with dual air vacuum relief valves. The double pigging station is located at the high point. From the double pigging station, the force main slopes down continuously to the Four Corners Water and Sewer District wastewater treatment plant. Between the double pigging station at the high point and the FCWSD wastewater treatment plant, there are 6 pigging ports/air-vacuum relief valve vaults.

49.3 Termination

The 6" forcemain terminates directly into the Four Corners Water and Sewer District lift station for the wastewater treatment plant.

49.4 Pipe and Design Pressure

The forcemain pipe material is 6" 160 psi HDPE. All pipe joints will be fusion butt-welded or fitted with a fused polyflange adapter. This pipe meets AWWA Standard C-906 for water main strength, and is very durable with very desirable water hammer resistance. Water hammer will be reduced by pump soft-starters and fast acting check valves at the lift station.

49.5 Special Construction

The forcemain meets the installation requirements of Sections 36, 37 and 38 of DEQ 2.

49.6 Freeze Protection

The forcemain is designed with a cover depth of 6 feet or greater.

49.7 Design Friction Losses

49.71 Friction Coefficient

Friction loss calculations are performed using the Hazen and Williams formula using a friction factor of 120. Detailed hydraulic calculations for the forcemain are provided in Figure 40-1 at the end of this report.

49.72 Maximum Power Requirements

Due to the large static head requirements and relatively low friction losses, the variability of "C" values over time has very little effect on the pumping conditions.

49.8 Identification

The forcemain is constructed with black, iron pipe sized (IPS), high density polyethylene pipe (HDPE). This material is rarely if ever used for water line and typical water line fittings sized for cast iron sized pipe will not fit on the forcemain. Furthermore, Gallatin Gateway has no municipal water mains within its area.

49.9 Leakage Testing

The forcemain shall be water tested for pressure and leakage in accordance with the water main testing requirements in Montana Public Works Standard Specifications. The test pressure shall be 160 psi at the FCWSD treatment plant (the lowest point in the forcemain).

49.10 Maintenance Considerations

The forcemain has 7 pigging station to facilitate cleaning. The high point pigging station is located at the high point of the forcemain to clean down to the lift station. Additionally, to facilitate easier maintenance, the forcemain is sloped to drain back to the lift station (from the high point) if the drain back line is opened. The flexible HDPE forcemain piping allows direction changes to be made with large radius bends to allow free travel for cleaning pigs. Directional fittings are only proposed at the forcemain ends where the pipe can be cleaned by standard methods.

APPENDIX A
DESIGN CALCULATIONS

DESIGN FLOWS
AND
PUMP STATION DESIGN

DESIGN FLOWS

Design Flows and EDU's						
TYPE	**Structures/ Homes**	**People per Structure/Home**	**Population**	**Per Capita Flow (gpd)**	**Measured Flow (gpd)**	**Design ADF (gpd)**
Existing Residential	135	2.5	337.5	75	0	25,313
Non-Residential	0	1	7	100	0	700
Future Growth	0	2.5	0	100	0	0
Future Non-Residential			40	100		4,000
20 Year Design ADF	**58**					**30,013**
GG Design ADF						**50,000**

Design Average Daily Flow = **26,720** gpd

Design Max Daily FLow = 1.5 × *Design Average Daily Flow*

Design Max Daily FLow = **40080** gpd

$Pop = \frac{Population}{1000}$

Population = 2.5 × EDU's Population = **168** People

Pop = 0.168

$Q_{max} = 18 + \sqrt{Pop}$ $Q_{avg} = 4 + \sqrt{Pop}$

Q_{max} = 18.41

Q_{avg} = 4.41

n = 4.20

Design Peak Hourly FLow = n × *Design Average Daily Flow*

Design Peak Hourly FLow = **112224.00** gpd

Design Average Daily Flow = **19** gpm

Design Peak Design FLow = **27.83** gpm

Design Peak Hourly FLow = **77.93** gpm

LIFT STATION DESIGN

Design Criteria:

Fill time at design flow must not exceed 30 minutes	DEQ-2
Fill time should not exceed 30 minutes at initial flow	DEQ-2
Maintain minimum 2 ft/sec velocity in force main	DEQ-2
Pumps must pass 3 inch sphere	DEQ-2
Pump discharge piping must be 4 inch minimum	DEQ-2
Tanks must be designed to resist flotation	Site conditions

Design Flows and Fill Times

Initial Phase = 30,000 gal/day
Design Flow = 50,000 gal/day
Intitial phase 30 min fill volume = 625 gallons
Design flow 30 min fill volume = 1042 gallons

Wet Well Dimensions

Diameter (ft)	Area (ft^2)	Volume/ft (ft^3)	Volume/ft (gal)	Total Depth (ft)	Displaced Volume (ft^3)	Displaced water (lb)	Concrete Volume (ft^3)	Concrete wt (lb)	Soil wt on base (lb)
8.00	50.27	50.27	375.99	20.57	1387.18	86559.92	378.33	56748.76	30696.45

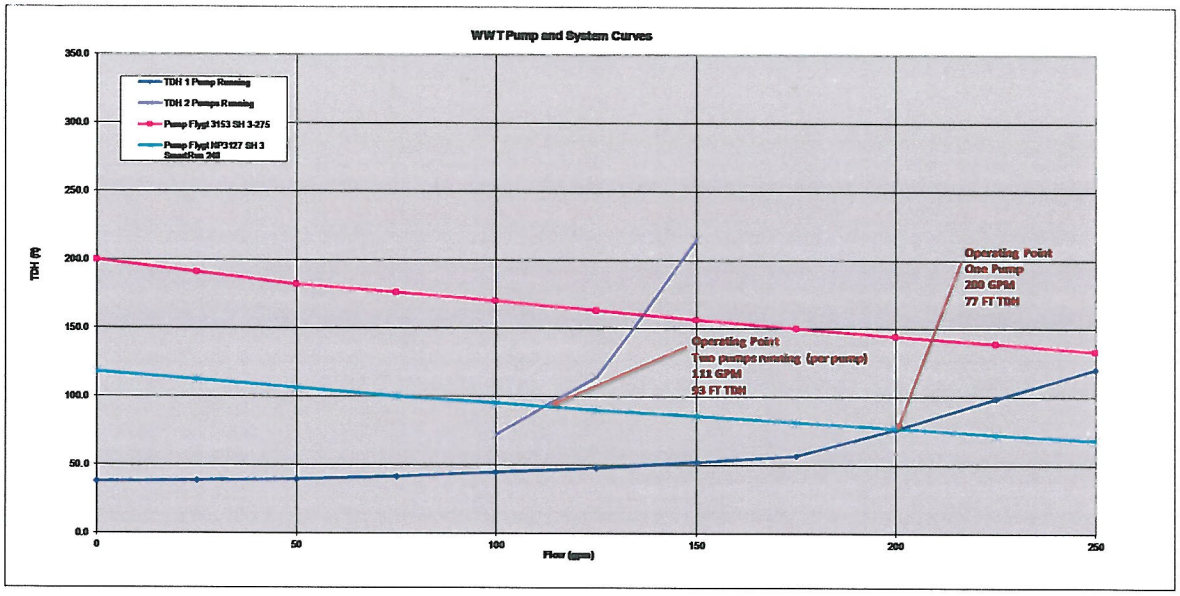
Wet Well Float Settings

Design Flow Settings		
Top of well elevation =	4915.50	
Invert In Elevation =	4903.00	Float Separation
Emergency Level Alarm Elev. =	4902.50	7.57
Lag Pump On Elev. =	4902.00	7.07
Pump On Elev. =	4901.50	6.57
Pump Off Elev. =	4898.73	3.80
Low Level Alarm Elev. =	4898.23	3.30
Bottom of well Elev. =	4894.93	
Dose Volume (gal)=	1042	

Initial Phase Settings		
Top of well elevation =	4915.50	
Invert In Elevation =	4903.00	Float Separation
Emergency Level Alarm Elev. =	4902.50	7.57
Lag Pump On Elev. =	4902.00	7.07
Pump On Elev. =	4901.50	6.57
Pump Off Elev. =	4899.84	4.91
Low Level Alarm Elev. =	4898.23	3.30
Bottom of well Elev. =	4894.93	
Dose Volume (gal)=	625	

Figure 40-1
Gallatin Gateway Forcemain Hydraulics

	System for Single Pump Running											System for 2-Pumps Running						
Total Pipe Flow (gpm)	0	25	50	75	100	125	150	175	200	225	250	200	225	250	270	300	325	350
Flow per pump (gpm)	0	25	50	75	100	125	150	175	200	225	250	100	112.5	125	135	150	162.5	175
(for flows over 200 gpm)																		
Haz-Will coefficient	*120*	*120*	*120*	*120*	*120*	*120*	*120*	*120*	*120*	*120*	*120*	*120*	*120*	*120*	*120*	*120*	*120*	*120*
6" HDPE 160 psi Downhill																		
High Point Elevation	4936.57	4936.57	4936.57	4936.57	4936.57	4936.57	4936.57	4936.57	4936.57	4936.57	4936.57	4936.57	4936.57	4936.57	4936.57	4936.57	4936.57	4936.57
Discharge Elevation	4762.10	4762.10	4762.10	4762.10	4762.10	4762.10	4762.10	4762.10	4762.10	4762.10	4762.10	4762.10	4762.10	4762.10	4762.10	4762.10	4762.10	4762.10
Static Head	-174.5	-174.5	-174.5	-174.5	-174.5	-174.5	-174.5	-174.5	-174.5	-174.5	-174.5	-174.5	-174.5	-174.5	-174.5	-174.5	-174.5	-174.5
length (ft)	20040	20040	20040	20040	20040	20040	20040	20040	20040	20040	20040	20040	20040	20040	20040	20040	20040	20040
inside diameter (in)	5.421	5.421	5.421	5.421	5.421	5.421	5.421	5.421	5.421	5.421	5.421	5.421	5.421	5.421	5.421	5.421	5.421	5.421
Haz-Will coefficient	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120
Friction Loss (ft)	0.00	3.09	11.15	23.60	40.18	60.71	85.07	113.14	144.84	180.11	218.87	144.84	180.11	218.87	252.35	306.66	355.61	407.86
total fitting K	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6
Fitting Loss (ft)	0.00	0.01	0.05	0.10	0.18	0.28	0.41	0.55	0.72	0.91	1.13	0.72	0.91	1.13	1.31	1.62	1.90	2.21
Total Pipe Loss (ft)	0.00	3.10	11.19	23.70	40.36	60.99	85.47	113.69	145.56	181.02	219.99	145.56	181.02	219.99	253.67	308.28	357.51	410.07
Velocity	0.00	0.35	0.70	1.04	1.39	1.74	2.09	2.44	2.78	3.13	3.48	2.78	3.13	3.48	3.75	4.17	4.52	4.87
Total Loss (ft)	-174.47	-171.37	-163.28	-150.77	-134.11	-113.48	-89.00	-60.78	-28.91	6.55	45.52	-28.91	6.55	45.52	79.20	133.81	183.04	235.60
Abs. Total Loss	0	0	0	0	0	0	0	0	0	6.55	45.52	0.00	6.55	45.52	79.20	133.81	183.04	235.60
Hydraulic Grade Slope	0	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.02
Head Required for Gravity Flow In FM	-174.47	-171.53	-162.70	-147.99	-127.40	-100.92	-68.56	-30.32	13.81	63.83	119.72	13.81	63.83	119.72	181.50	249.17	322.72	402.15
from mannings solution	0	0	0	0	0	0	0	0	13.81	63.83	119.72	13.81	63.83	119.72	181.50	249.17	322.72	402.15
6" HDPE 160 psi Uphill																		
Pump Off Elevation	4898.73	4898.73	4898.73	4898.73	4898.73	4898.73	4898.73	4898.73	4898.73	4898.73	4898.73	4898.73	4898.73	4898.73	4898.73	4898.73	4898.73	4898.73
High Point Elevation	4936.57	4936.57	4936.57	4936.57	4936.57	4936.57	4936.57	4936.57	4936.57	4936.57	4936.57	4936.57	4936.57	4936.57	4936.57	4936.57	4936.57	4936.57
Static Head	37.8	37.8	37.8	37.8	37.8	37.8	37.8	37.8	37.8	37.8	37.8	37.8	37.8	37.8	37.8	37.8	37.8	37.8
length (ft)	2489	2489	2489	2489	2489	2489	2489	2489	2489	2489	2489	2489	2489	2489	2489	2489	2489	2489
inside diameter (in)	5.421	5.421	5.421	5.421	5.421	5.421	5.421	5.421	5.421	5.421	5.421	5.421	5.421	5.421	5.421	5.421	5.421	5.421
Haz-Will coefficient	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120
Friction Loss (ft)	0.00	0.38	1.38	2.93	4.99	7.54	10.57	14.05	17.99	22.37	27.18	17.99	22.37	27.18	31.34	38.09	44.17	50.66
total fitting K	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6
Fitting Loss (ft)	0.00	0.01	0.05	0.10	0.18	0.28	0.41	0.55	0.72	0.91	1.13	0.72	0.91	1.13	1.31	1.62	1.90	2.21
Total Pipe Loss (ft)	0.00	0.40	1.43	3.03	5.17	7.82	10.97	14.60	18.71	23.28	28.31	18.71	23.28	28.31	32.66	39.71	46.07	52.86
Velocity	0.00	0.35	0.70	1.04	1.39	1.74	2.09	2.44	2.78	3.13	3.48	2.78	3.13	3.48	3.75	4.17	4.52	4.87
6" DI Pipe																		
length (ft)	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
inside diameter (in)	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6
Haz-Will coefficient	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120
Friction Loss (ft)	0.00	0.00	0.00	0.01	0.01	0.02	0.03	0.04	0.05	0.07	0.08	0.05	0.07	0.08	0.09	0.11	0.13	0.15
total fitting K	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
Fitting Loss (ft)	0.00	0.00	0.01	0.04	0.08	0.12	0.18	0.24	0.32	0.40	0.50	0.32	0.40	0.50	0.58	0.72	0.84	0.98
Total Pipe Loss (ft)	0.00	0.01	0.02	0.05	0.09	0.15	0.21	0.29	0.37	0.47	0.58	0.37	0.47	0.58	0.68	0.83	0.97	1.13
Velocity	0.00	0.28	0.57	0.85	1.13	1.42	1.70	1.99	2.27	2.55	2.84	2.27	2.55	2.84	3.06	3.40	3.69	3.97
4" DI Pump Discharge																		
length (ft)	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36
inside diameter (in)	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
Haz-Will coefficient	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120
Friction Loss (ft)	0.00	0.02	0.09	0.19	0.32	0.48	0.67	0.89	1.14	1.42	1.73	0.32	0.39	0.48	0.55	0.67	0.78	0.89
total fitting K	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
Fitting Loss (ft)	0.00	0.06	0.25	0.57	1.01	1.58	2.28	3.10	4.05	5.13	6.33	1.01	1.28	1.58	1.85	2.28	2.67	3.10
Total Pipe Loss (ft)	0.00	0.09	0.34	0.76	1.33	2.06	2.95	3.99	5.19	6.55	8.06	1.33	1.66	2.06	2.40	2.95	3.45	3.99
Velocity	0.00	0.64	1.28	1.92	2.55	3.19	3.83	4.47	5.11	5.75	6.38	2.55	2.87	3.19	3.45	3.83	4.15	4.47
Total Head loss (ft)	0.00	0.49	1.79	3.84	6.59	10.03	14.13	18.88	24.28	30.30	36.94	20.41	25.43	30.95	35.73	43.49	50.50	57.99
Pump-System Curve Data																		
FLOW (gpm)	0	25	50	75	100	125	150	175	200	225	250	200	225	250	270	300	325	350
FLOW (gpm)												100	112.5	125	135	150	162.5	175
TDH 1 Pump Running	37.8	38.3	39.6	41.7	44.4	47.9	52.0	56.7	75.9	132.0	194.5							
TDH 2 Pumps Running												72.1	127.1	188.5	255.1	330.5	411.1	498.0
Pump Flygt NP3127 SH 3 SmartRun 248	118	112	106	100	95	90	86	81	77	72	68							



MINIMUM VELOCITY CALCULATION

Peak Hourly FLow =	**205000.00**	gpd
Force Main FLow =	**197**	gpm
PHF FM =	**283680**	gpd

PHF FM > Peak Hourly FLow *so use PHF FM*

Design $Flow$ = (PHF FM)$\times \frac{1}{24} \times \frac{1}{3600} \times \frac{1}{7.4805}$

Design $Flow$ =	**0.44**	cfs

A cleaning velocity of 3.0 fps is desired. Max velocity shall not exceed 8.0 fps

$Required\ Pipe\ Area = \frac{Design\ Flow}{Cleaning\ Velocity}$ $Cleaning\ Velocity$ = 2.78 fps

$Required\ Pipe\ Area$ =	**0.16**	ft^2

$Required\ Pipe\ Dia = 2 \times \sqrt{\frac{Required\ Pipe\ Area}{\pi}} \times 12$

$Required\ Pipe\ Dia$ =	**5.38**	in
$Required\ Pipe\ Dia$ =	**6**	in

The minimum force main diameter for raw wastewater is 4 inches

BUOYANCY CALCULATIONS

Wet Well Dimensions

Diameter (ft)	Area (ft^2)	Volume/ft (ft^3)	Volume/ft (gal)	Total Depth (ft)	Displaced Volume (ft^3)	Displaced water (lb)	Concrete Volume (ft^3)	Concrete wt (lb)	Soil wt on base (lb)
8.00	50.27	50.27	375.99	20.57	1387.18	86559.92	378.33	56748.76	30696.45

Buoyancy Determination

Total Weight (lb)	87445.21
Bouyancy force at fully submerged wet well (lb)	86559.92

Total weight exceeds buoyancy force. Wet well will not float

Asssume:
- 6" Thick Walls
- 12" Thick base extending 6" from outside edge of wall
- 6" Thick Cover
- Fully submerged wet well
- Soil around 6" ledge at base (soil = 100 lb/ft^3)