Chapter 3 Permit to Construct Design Report

Yellowstone Modular Housing Project

Canyon Government Area

Park County

June 19, 2026

Prepared for:

National Park Service

Wyoming Department of Environmental Quality

Prepared by:

Stantec Consulting Services, Inc.

Sign-off Sheet

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Project Manager _____

Signature

Jesse Carlson, PE

Printed Name



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Abbreviations

ADD	Average Day Demand
CIP	Cast Iron Pipe
DEQ	Wyoming Department of Environmental Quality
DIP	Ductile Iron Pipe
FT	Feet
GPM	Gallons Per Minute
NPS	National Park Service
PHD	Peak Hour Demand
PDD	Peak Day Demand
PSI	Pounds per Square Inch
PVC	Polyvinyl Chloride
VC	Vitrified Clay
WWDC	Wyoming Water Development Commission
WYDOT	Wyoming Department of Transportation



1.0 INTRODUCTION

The National Park Service (NPS) is planning to construct modular housing developments for utilization by employees working in the Canyon, Mammoth and Northeast Entrance Government Areas. This report addresses the proposed work at the Canyon Government Area. Separate reports have been prepared for Mammoth and Northeast Entrance. The intent of the proposed work at the Canyon Government Area is to construct 10 modular housing units. This report will address the utility design consisting of potable water service, fire suppression, and sanitary sewer mains and services (hereby referred to as the Project). No additional water treatment, wastewater treatment, pumping facilities or water storage are proposed with this project.

The proposed modular building design includes the installation of 10 modular prefabricated buildings. These buildings will be 2-bedroom modular units for all locations. An initial review of existing information and site reconnaissance was performed to determine the location and capacity of existing potable water and sanitary sewer infrastructure for the Project. The NPS is proposing to install a new 8-inch PVC main (AWWA C900 DR18) and connect 10 water services to the proposed main. Approximately 1,460 LF of the 8” water main and approximately 50 to 80 LF of service line for each unit will be installed.

In addition to the waterline replacement, the NPS is proposing placement of approximately 1,030 LF of new 8-inch SDR26 PVC sanitary sewer main. This will tie into the existing sewer. Additional improvements include ten (10), 4-inch SDR26 PVC sanitary sewer services.

The purpose of this design report is to provide DEQ, as required by Chapter 11 and Chapter 12 of the Wyoming Water Quality Rules and Regulations information regarding the construction of the proposed water services and sanitary sewer main replacements. The Project is designed according to the requirements of Chapter 11, Chapter 12. This report includes a brief description of the Project area, the Project, the proposed design, and appendices containing supporting information. Construction of the Project is anticipated to begin Fall of 2026.

2.0 PROJECT AREA DESCRIPTION

The Project is located in Canyon Government Area on portions of Badger Road and Wolf Road. The Project is in the SE ¼ of Section 17 and SW ¼ of Section 16, Township 55 N, Range 113 W in Park County, WY.

3.0 PROPOSED PROJECT SYSTEM IMPROVEMENTS

The NPS is proposing to install a new 8-inch PVC main (AWWA C900 DR18) and connect ten (10) HDPE water services to the proposed main. Approximately 1,460 LF of the 8” water main will be installed. In addition to the waterline replacement, the NPS is proposing placement of approximately 1,030 linear feet of a new 8-inch SDR26 PVC sanitary sewer main. This will tie into the existing sewer. Additional improvements include ten (1)0, 4-inch SDR26 PVC sanitary sewer services. The proposed water and sewer mains are shown in Appendix A – Permit Drawings.

The proposed water distribution line and sewer main will be constructed to meet the Wyoming Public Works Standard Specifications (2023 edition), herein referred to as the State Specifications.

4.0 WATER SYSTEM DEMANDS

An initial review of existing information and site reconnaissance was performed to determine the location and capacity of existing potable water infrastructure for each area of the Project. Yellowstone National Park owns and maintains the Canyon water treatment and distribution system. The proposed modifications to the water distribution system will continue to be owned and maintained by Yellowstone National Park. The existing water treatment system has adequate capacity for the water demands described below.

4.1 WATER DEMANDS

The proposed water man and service lines are in an area that is not looped. EPANET® was used to model the water demands in the proposed water distribution line for peak hour and fire suppression scenarios.

Stantec utilized field hydrant testing for the analysis presented below. The following estimated maximum water demands were used to analyze the water system modifications:

• Average Daily Demand: 2,500 gallons per day (Wyoming DEQ Water Quality Rules and Regulations – Chapter 12, Section 8)

• Maximum Daily Demand: 6,800 gallons per day (Wyoming DEQ Water Quality Rules and Regulations – Chapter 12, Section 8)

• Peak Hour Demand: 18.9 gallons per minute (Wyoming DEQ Water Quality Rules and Regulations – Chapter 12, Section 8)

• Automatic Fire Suppression Demand: 55 gallons per minute (Modular Building Design Narrative)

Stantec believes the EPANET model provides an acceptable assessment for this Project. Analyses are included in Appendix C – Potable Water Hydraulic Analysis.

The modified system provides dynamic pressures range from 55.38 psi minimum to 81.72 psi maximum during peak hour demand conditions. The system maintains a minimum of 55.14 psi of residual pressure at the location of fire suppression and a minimum of 58.05 psi of residual pressure in the rest of the system, during fire suppression demand conditions. However, this does not include additional 7.5 psi drop from the water meter and pit at 55 gpm per the manufacturer's documents for the Sensus iPerl 1" water meter. The maximum pressure fluctuation at any location within the pressure zone between peak hour demand and minimum hour demand does not exceed 30 psi.

4.2 FIRE FLOW DEMANDS

The existing water distribution line includes the two existing hydrants where hydrant testing was completed. The EPANET model was also used to show that the proposed system worked under fire flow conditions with a new

hydrant flowing 1000 gallons per minute at the end of the water main. The following estimated maximum water demands were used to analyze the water system:

1-hour Site Fire Flow: 1,000 gallons per minute (2018 International Fire Code - Section B105.1, Table B105.1(1) for Residential Group R-3 and R-4 (0-3, 600SF)

The existing system fire flow analysis is included in Appendix C – Potable Water Hydraulics Analysis. This analysis confirms that the proposed system meets the Chapter 12 requirement to maintain a minimum of 20-psi during all flow scenarios. **Table 1** shows the modeled pressures in the Project area during the fire flow analysis.

Table 1: Project Area Pressures during Fire Flow Plus Peak Hour Demand Scenario

Hydrant Name	Fire Flow Required (gpm)	Calculated Residual Pressure at Available Fire Flow (psi)
Hydrant 1	1,000	32.36

5.0 WATER DISTRIBUTION LINE

The proposed water distribution system modifications to the Canyon Government Area consists of the installation of an 8” PVC main (AWWA C900 DR18) and individual 2-inch HDPE water and fire service connections to each of the 10 modular units. Approximately 1,460 LF of the 8” water main and new service lines for each unit will be installed. Valves will be installed at the beginning of each new and intermediate location on the main lines as shown on the Permit Drawings. The Canyon Government Area proposed potable water main extension will be a dead-end potable water main, with the end being past the last proposed residential service. This dead-end potable water main will have a fire hydrant and will require periodic flushing to maintain suitable water quality in the main line associated with this area. The proposed potable water system connection will be adjacent to the existing maintenance facilities located approximately 650 feet south of the proposed modular units. This distribution line has a single air release valve at the highest point and gate valve spacing is no greater than 500 feet. A summary of the Chapter 12 requirements and the design parameters are provided in **Table 2**.

Table 2: Water Distribution Line Chapter 12 Requirements and Design Parameters

Chapter 12 Section	Requirement	Design Parameter
16.b.i.	PVC pipe: Less than four inches diameter, ASTM D 2241; or four inches and larger diameter, AWWA C900	Buried water distribution pipeline will be PVC water pipe certified to meet AWWA C900 standards.
16.b.ii	Ductile iron, AWWA C151	These materials are not proposed.
16.b.iii	Fiberglass pressure pipe, AWWA C950	These materials are not proposed.
16.b.iv	Polyethylene pipe: 3/4 inch through three inches diameter, AWWA C901; four inches through 65 inches diameter, AWWA C906	Service connections will be 2" HDPE water pipe certified to meet AWWA C901 standards.

Chapter 12 Section	Requirement	Design Parameter
16.b.v	Other material submitted with the permit application and approved by the Administrator	These materials are not proposed.
16.c	Flanged piping shall not be allowed for buried pipe except for connection to valves.	These materials are not proposed.
16.d	New water mains shall be sized after the hydraulic analysis required by Section 9(l)(i) of this Chapter and the design shall demonstrate that: (i) At maximum day demand plus current State of Wyoming-required fire flow, or the fire flow of an authority having jurisdiction, the pressure in the municipal distribution system will not fall below 20 pounds per square inch (psi); and (ii) The normal system working pressure shall be greater than 35 psi.	Refer to the hydraulic calculations. The calculations show the fire flow scenario and associated pressures; residual pressures are maintained above 20-psi in all cases.
16.e	When fire protection is provided, the water main system shall be designed to also serve fire flows.	Refer to the hydraulic calculations. The distribution line has been designed to carry fire flows.
16.f	Hydrants shall: (i) Have hydrant leads that are a minimum of six inches in diameter; (ii) Have valves installed; (iii) Be protected from freezing at hydrant leads and barrels; (iv) Where groundwater levels are above the gravel drain area, hydrants shall be pumped dry or otherwise dewatered and hydrant weep holes shall not be used; and (v) Have drains that are not connected to or located within 10 feet of a sanitary sewer or storm drain.	The proposed fire hydrant will meet these requirements and will be placed in accordance with State Specifications.
16.g	Fire hydrants or active service taps may be substituted for air relief in 6- and 8-inch lines.	A fire hydrant will be placed.
16.h	Where excavation is performed for distribution systems: (i) The trench bottom shall be excavated for the bell of the pipe; (ii) All rock shall be removed within six inches of the pipe; and (iii) The trench shall be dewatered for all work.	The trench shall be over excavated to provide a minimum depth of cradle of 6 inches.
16.i	Distribution system bedding for rigid pipe shall be designed in accordance with ASTM C12 Classes A, B, or C. Flexible pipe bedding shall be designed in accordance with ASTM D2321 Class I, II, or III.	Bedding used will meet Type A or B in accordance with State Specifications.
16.j	Distribution system pipe shall be joined to ensure a watertight fitting and installed in accordance with the following standards, as applicable: (i) For ductile iron pipe, AWWA C600; (ii) For PVC pipe, AWWA M23; and (iii) For HDPE pipe, AWWA M55.	The water system will be installed to the manufacturer's recommendations, and AWWA M23. Pressure and leakage testing will be performed on all installed pipe. All fittings will be watertight.
16.k.i	Backfill for distribution systems shall: (i) Be performed without disturbing pipe alignment; (ii) Not contain debris, frozen material, unstable material, or large clods; (iii) Not contain rocks or stones that are greater than three inches in diameter within two feet of pipe; and (iv) Be compacted to a density equal to or greater than the surrounding soil	Backfill will be performed to meet State Specifications.



Chapter 12 Section	Requirement	Design Parameter
16.l.i	Separation of water mains from sanitary and storm sewers: Where the minimum vertical or horizontal separation distances required by incorporation by reference of 2018 TSS parts 8.8.2 and 8.8.3 of paragraph (a) of this Section cannot be met, the sewer or water line shall be placed in a separate conduit pipe or meet the flow-fill requirements of paragraphs (ii) and (iii) of this Paragraph (l)	Separation from sewers will be maintained. If unanticipated conditions necessitate the use of flow fill, cement-treated backfill shall be installed in accordance with Chapter 12 requirements.
16.l.ii.A	Flow-fill for pipelines shall comply with the following: Cement-treated fill, non-shrink backfill, low-density concrete backfill, or structural backfill may be used as flow-fill when the material has a 28-day compressive strength of 30-60 psi	These materials are not proposed.
16.l.ii.B	Flow-fill for pipelines shall comply with the following: The pipe to be encased shall be laid on a four to six-inch bed of washed gravel that has been widened, with the walls of the trench benched away from the center-line of the trench, so the pipe is uniformly supported over the length or supported on blocks no further than 10 feet apart	These materials are not proposed.
16.l.ii.C	Flow-fill for pipelines shall comply with the following: The flow-fill and washed gravel or blocks shall rest on an undisturbed trench bottom	These materials are not proposed.
16.l.ii.D	Flow-fill for pipelines shall comply with the following: The pipe shall not move laterally or float during placement of the flow-fill and the line and grade of the pipe shall be maintained	These materials are not proposed.
16.l.ii.E	Flow-fill for pipelines shall comply with the following: The flow-fill shall extend from trench sidewall to trench sidewall and extend at least two inches above the top of the pipe	These materials are not proposed.
16.l.iii.A	Flow-fill for pipe crossings shall comply with the following: To the extent possible, there shall be no joints or taps within nine feet of the crossing	These materials are not proposed.
16.l.iii.B	Flow-fill for pipe crossings shall comply with the following: The flow-fill shall extend from undisturbed earth at the bottom of the lower pipe to at least two inches above the top of the upper pipe	These materials are not proposed.
16.l.iii.C	Flow-fill for pipe crossings shall comply with the following: The block of flow-fill shall be wide enough to ensure the structural integrity of the installation	These materials are not proposed.
16.l.iii.D	Flow-fill for pipe crossings shall comply with the following: Pipes that cross one another shall be separated by a minimum of two inches when encased in flow-fill	These materials are not proposed.
16.m.i.A.I	Require backflow prevention devices for each water service connection in accordance with Table 4 of this Section, with the exception of (B)(I) residential water service connections	All water connections are considered residential water service connections.

Chapter 12 Section	Requirement	Design Parameter
16.m.i.B.I	Residential water service connections shall be considered to be low hazard back-siphonage connections unless determined otherwise by a Hazard Classification.	All connections will be considered low hazard back-siphonage.
16.m.i.E	All backflow prevention devices shall be in-line serviceable (repairable), in-line testable except for devices meeting ASSE 1024, and installed in accordance with manufacturer instructions and applicable plumbing codes.	Backflow prevention devices will be in-line serviceable (repairable), in-line testable except for devices meeting ASSE 1024, and installed in accordance with manufacturer instructions and applicable plumbing codes.
16.m.i.F	All backflow prevention devices must have a certification by an approved third-party certification agency. Approved certification agencies are: (I) American Society of Sanitary Engineers (ASSE); (II) International Association of Plumbing/Mechanical officials (IAPMO); and (III) Foundation for Cross-Connection Control and Hydraulic Research, University Of Southern California (USC-FCCCHR).	Backflow prevention devices will be certified by an approved third party.
16.m.i.G.I	Backflow prevention devices at water service connections shall be inspected and certified by a certified backflow assembly tester at the time of installation. Certification of the assembly tester shall be by one of the following: (I) The American Society of Sanitary Engineers (ASSE); or (II) American Backflow Prevention Association (ABPA)	Backflow prevention devices at water service connections will be inspected and certified by a certified backflow assembly tester at the time of installation.

5.1 WATER STORAGE

The proposed Project will include no additional storage capacity for the Town of Mammoth.

5.2 PUMPING SYSTEM

The proposed Project will include no pumping system.

5.3 TREATMENT FACILITIES

The proposed Project does not include any treatment facilities or revisions to the current Town water treatment plant.

6.0 EXISTING SANITARY SEWER SYSTEM

An initial review of existing information and site reconnaissance was performed to determine the location and capacity of existing sanitary sewer infrastructure for each area of the Project. Yellowstone National Park owns and maintains the sanitary sewer collection infrastructure serving the project areas. The proposed sewer collection modifications will also be maintained and owned by Yellowstone National Park. The existing wastewater treatment plant was designed to maximum month flows of 0.5 MGD and has adequate capacity to handle the flows described

below (See Rehabilitate/Replace Canyon Village Wastewater Treatment Plant Schematic Design and Supplemental Services YELL 310402 Basis of Design Report).

6.1 EXISTING SEWER MAIN SLOPE

Invert elevations measured at manhole locations, were used to establish the existing sewer main slopes and identify system components for design purposes within the Project area. Invert elevation measurements indicate that the existing 6-inch sewer main has slopes that range from 0.0103 to 0.0468 ft/ft.

7.0 PROPOSED SANITARY SYSTEM IMPROVEMENTS

7.1 SANITARY SEWER MAIN DESIGN

The Project will consist of placing the sanitary sewer main and manholes as shown in Appendix A – Permit Drawings. The proposed 8-inch sewer consists of approximately 1030 feet of PVC and 6 new 48-inch manholes. The proposed slope of the sewer main is approximately 0.60 to 3.70 feet per 100 foot. The sanitary services shall have a minimum slope of 2.00 feet per 100 foot. The sanitary sewer pipe material will be 8-inch SDR 26 PVC pipe. The thicker SDR 26 pipe is preferred by the NPS and exceeds the minimum DEQ pipe material requirements.

The capacity of the existing 6-inch main being tied into has been evaluated and adequate capacity exists to allow for these new connections (See Appendix D – Sewer Main Capacity Calculations for the design calculations). A variance is requested by NPS to go from proposed 8-inch to tie into the existing 6-inch sewer line as existing capacity is adequate.

Design calculations comparing the capacities of the existing sewer main and proposed sewer main are summarized in **Table 3** and provided in Appendix D – Sewer Main Capacity Calculations.

Table 3: Proposed Sewer Main Capacities

Sewer Main	Material Type	Size (in)	Min. Slope (ft/ft)	Full Flow Capacity (gpm)	Full Flow Velocity (ft/sec)
Proposed Sewer Main Extension	PVC	8	0.0060-0.0370	322	2.057
Existing Sewer	PVC	6	0.0103	332	2.224

A summary of the Chapter 11 requirements and DEQ policies and the design parameters are provided in **Table 4**.

Table 4: Sewer Line Chapter 11 Requirements and Design Parameters

Chapter 11 Section	Requirement	Design Parameter
9.a	Separate sewers. Separate sewers shall be provided for collection of stormwater and wastewater. Roof, areaway, drive or foundation drains shall not be connected to sanitary sewers.	Refer to the Permit Drawings. No storm collection systems are connected to the sanitary sewer system.
9.b.i	Wastewater characteristics. Pipe materials shall resist acid and alkaline solutions, organic solvents, and other wastewater constituents and environmental conditions encountered.	All sewer pipe will be manufactured of PVC plastic.
9.b.ii	Pipe loadings. Pipe materials shall be chosen and the pipeline shall be designed to withstand all trench and superimposed surface live loads with a minimum factor of safety. Rigid pipes shall have a minimum factor of safety of 1.5, and flexible pipes shall have a minimum factor of safety of 1.25.	Refer to the Permit Drawings for a typical sanitary sewer trench detail.
9.b.iii	Soil characteristics. Pipe materials shall be chosen to resist corrosion due to aggressive soil characteristics by the soil it contacts. Iron or steel pipe shall be protected from corrosion with polyethylene encasement or cathodic protection.	All sewer pipe will be manufactured of PVC plastic.
9.b.iv	Joints. Pipe joints shall be flexible, durable and designed to minimize infiltration/exfiltration and exclude roots.	All sewer pipe will be bell and spigot type with rubber gasket type joints.
9.b.v	Performance tests. Piping shall be subjected to leakage tests. Leakage tests shall be infiltration, exfiltration, or air tests.	All constructed sewer pipe will be subjected to an exfiltration test.
9.b.v.D	Deflection. Maximum five percent deflection after flexible pipe is backfilled for 30 days. A mandrel of 95 percent of pipe diameter shall be used. No mechanical pulling of mandrel is permitted.	Sewer line will be installed using a laser to ensure grade and a mandrel test will be conducted on the constructed sewer main.
9.b.vi	Approved pipe material specifications. Type of commercial pipe approved for gravity sanitary systems include: (B) PVC sewer pipe and fittings: ASTM D3034-80, SDR35, ASTM F679-81, or ASTM F794-83.	All sewer pipe will be SDR 26 PVC manufactured in accordance with ASTM D3034.
9.c.i.A	Depth. Sewers shall be located to protect them from freezing and frost heave as prudently possible.	The proposed sanitary sewer lines will have depths of cover over 6 feet in all locations.
9.c.i.B	Size. Sewers to be aligned straight shall be 8-inch diameter or larger except 6-inch sewers may be used in cul-de-sacs, or other dead end locations where the sewer cannot be extended in the future. Eighteen-inch or larger sewers may be laid on curves. Lines shall be sized for 200 percent of maximum daily flow or more. In the absence of data deriving maximum daily flow, the chart on Figure 1-1 shall be used to determine maximum daily flow.	The proposed sewer mains are 8-inch. Refer to Section 7.1 of this report for an explanation of sewer main capacity. The existing line being tied into is 6-inch but has adequate capacity. Refer to Appendix E.

Chapter 11 Section	Requirement	Design Parameter
9.c.i.C	Slope. Sewers shall be laid with uniform slope between manholes. Minimum slopes shall be: 0.40' per 100' for 8" pipe	The proposed 8-inch sewer main has a slope of approximately 0.60 to 3.70 feet per 100 foot. An explanation of this slope is included in Section 7.1.
9.c.i.D	Velocity. Minimum velocities shall be 2 fps when flowing full. Velocities greater than 10 fps require special design considerations.	The proposed 8-inch sewer main has a velocity of 2.06 fps when flowing full. Refer to Section 7.1 of this report for an explanation of sewer main velocities.
9.c.i.E	Increasing size. All sewer pipe size changes shall be at manholes. Pipe size shall not be decreased in the direction of flow. The energy gradient line should be maintained when a smaller sewer joins a larger one.	Refer to the Permit Drawings. Proposed sewer does not change size between manholes.
9.c.i.F.I	Excavation. Trench width from the trench bottom to a point one foot above the top of the pipe shall be no less than the outside diameter of the pipe plus 8 inches but not more than 24 inches plus the pipe O.D. The trench bottom shall be excavated for the pipe bell. All rock shall be removed within six inches of pipe. The trench shall be dewatered for all work.	Refer to the Permit Drawings. The trench width will be the pipe O.D. plus 24 inches.
9.c.i.F.II	Bedding. Bedding shall be designed in accordance with: Flexible pipe. Types I, II, III, ASTM D2321-74.	Bedding used will meet Type I or II in accordance with ASTM D2321.
9.c.i.F.III	Backfill. Backfill shall be performed without disturbing pipe alignment. Backfill shall not contain debris, frozen material, unstable material, or large clods. Stones greater than three inches in diameter shall not be placed within two feet of pipe. Compaction shall be to a density equal to or greater than the surrounding soil.	Backfill will be performed to meet Wyoming Public Work Sections 02225.
9.c.ii	Force mains and pressure sewers.	The Project does not contain force mains or pressure sewers.
9.c.iii.A	Size: minimum size shall be four (4) inches (10.2 cm).	Services will be 4 inches.
9.c.iii.B	Slope: minimum slope shall be 2 feet/100 feet (2 m/100 m).	The minimum slope for services will be 2 feet per 100 foot.
9.c.iii.C	Flow: flow shall be determined from a fixture unit count and the sewage size based on flowing full.	Sewer size is based on sewage flowing full.
9.c.iii.D	Connections: all service connections to sewage collection lines shall be made with a wye or tee for new construction and a tapping saddle for connection to existing collection lines.	Service connections will be made with a wye.
9.d.i	Location. Manholes shall be located at all changes in pipe size, vertical or horizontal alignment, pipe intersections, and the end of lines. Maximum spacing for various line sizes are as follows: maximum M.H. spacing of 400 ft for line size 15 in or less	Spacing of the proposed manholes are less the maximum spacing requirement.

Chapter 11 Section	Requirement	Design Parameter
9.d.ii	Size. Minimum manhole interior size is four feet.	All proposed manholes are 4 feet in diameter.
9.d.iii	Drop manhole. Drop manholes must be constructed where the change in elevation between two lines is greater than 24 inches. Concrete encasement shall be provided around the drop pipe.	The Project does not contain drop manholes.
9.d.iv	Invert. Manhole inverts shall be constructed to conform to the shape of the sewer. The bench shall drain to the invert. Connections to the manhole shall be watertight and allow differential settlement between the manhole and pipe. Minimum fillet height shall be one half of the pipe diameter.	Refer to the Permit Drawings. The manhole inverts will be grouted to allow smooth flow through the manhole and benches will drain to the invert. The flow-through channel will be 1/2 the pipe diameter and the manhole will have a watertight connection
9.d.v	Cover. The manhole cover shall be suitable to withstand all loads, including impact loading without deformation, slip or rattle. The manhole cover shall be watertight in areas subject to flooding and a bolt-down type in areas subject to unauthorized dumping or vandals.	Manhole covers will be rated for HS-20 loading. The manholes are not located within a floodplain and therefore are not prone to flooding.
9.d.vi	Steps. Access to manholes shall be with portable ladders, or with cast iron manhole steps spaced at 16 inches maximum.	Access to the proposed manholes will be by cast steps at appropriate spacing.
9.d.vii	Materials. Manholes shall be constructed watertight and durable using cast-in-place concrete, or precast concrete with gasketed joints. Where precast concrete bases are used, the first 12 inches of wall will be monolithically cast with the base.	The manhole will be precast reinforced concrete with a monolithic base.
9.d.viii	Access. A 22 inch minimum diameter clear opening shall be provided on all manholes. All manholes shall be located to be accessible by motorized equipment for maintenance.	The covers will be 24-inch covers with 22-inch openings.
9.e	Special structures.	No special structures are proposed on this Project.
9.f.i	Cross connections. There shall be no cross connections between sewer lines and potable water lines.	No cross connections between sewer lines and water lines will occur.
9.f.ii	Horizontal and vertical separation from water mains. Minimum horizontal separation shall be ten feet where the water main is less than 1.5 feet above the elevation of the sewer. Minimum vertical separation shall be 1.5 feet at crossing. Joints in sewers at crossing shall be located at least ten feet from water mains. The upper line of a crossing shall be specially supported. Where vertical and/or horizontal clearances cannot be maintained, the sewer shall be placed in a separate conduit pipe.	Separation from water mains will be maintained.

7.2 SANITARY SEWER SERVICES

All sanitary sewer service connections to the sewer main will be placed with new PVC SDR 26 pipe. The sizes of the sanitary sewer services will be 4” with a minimum slope of 2%. Each unit will require a service of approximately 35 feet in length. The following estimated maximum sanitary sewer generation was used to analyze the sewer system modifications for each of the new services (serving 10 units total) on the site:

• Maximum daily generation: 2,800 gallons per day for the site

• Peak hour generation: 7.8 gallons per minute for the site using a peak factor of 4

7.3 SANITARY SEWER MANHOLES

Manholes for the Project will be 4-foot diameter precast reinforced concrete manholes with barrel sections. A flexible watertight gasket will be used to connect the sewer pipe to the manhole. The exterior of each manhole will be coated with two coats of approved asphalt sealant. Details of a typical manhole installation are provided in Appendix A – Permit Drawings.

APPENDIX/DIVIDER TITLE

APPENDIX A - PERMIT DRAWINGS

SUBMITTED SEPARATELY

APPENDIX B - SPECIFICATIONS

YELLOWSTONE NATIONAL PARK

MODULAR HOUSING UNITS
YELL 326141

PROJECT SPECIFICATIONS

NATIONAL PARK SERVICE (NPS)
DENVER SERVICE CENTER (DSC)

100% Final CDs

June, 2026

SECTION 33 14 00 - WATER UTILITY TRANSMISSION AND DISTRIBUTION

PART 1 GENERAL

1.1 WORK SUMMARY

A. This section covers the requirements to perform work including but not limited to furnishing and installing waterlines, valves, meters, fire hydrants, other appurtenances, enclosures, and waterline drains for a complete water system as shown on the Drawings, and as otherwise directed by NPS.

B. Provide all labor, materials, tools, equipment, services, and incidentals as necessary to perform the work as described in this section and in accordance with the Contract Documents and Drawings and to the satisfaction of NPS.

C. Contractor shall provide all cleaning, flushing, disinfection and testing services, unless noted otherwise.

D. This section does not apply to irrigation systems nor plumbing systems within buildings, unless noted otherwise.

1.2 RELATED WORK

A. Attention is directed to the General Requirements and related work specified in other sections includes, but is not limited to:

1. Section 03 30 50 - Minor Concrete
2. Section 31 23 00 - Excavation and Fill
3. Section 31 50 00 - Excavation Support and Protection
4. Section 32 16 00 - Concrete Curbs, Sidewalks, Aprons, and Pads

1.3 DEFINITIONS

A. Not used.

1.4 SUBMITTALS

A. Submittals shall be in conformance with Contracting Requirements, Specifications, and Division 1 - General Requirements.

B. Submit supporting documentation, certificates of compliance, shop drawings, and supplier or manufacturer information prior to ordering materials or placement in the work for each proposed material and product, for review and acceptance of NPS for conformance to the material specifications.

C. Submittals include but are not limited to construction methods, manufacturer's descriptive literature, performance and test data, and manufacturer's data for sizes, pressure rating, rated capacity, listing/approval stamps, labels and other marking on equipment made to the specified standards for materials and settings of selected models for the following:

1. Pipe and fittings
2. Gaskets, couplings, sleeves, casing spacers, and assembly bolts and nuts
3. Gate valves and ball valves
4. Air release and vacuum valves
5. Pressure reducing valves
6. Backflow preventers
7. Clean outs and drains
8. Valve boxes, frames, covers, and grates
9. Service saddles and corporation stops
10. Water meters and boxes. Water meter product data shall include information on the radio read system and confirmation that the meters will be compatible with the Park's existing FlexNet radio read system.

D. Provide the following test reports where applicable.

1. Water Pressure Report: Contractor shall perform or engage a qualified testing service to conduct or complete a flow test of the existing supply system. Provide date and location of test, type and method of test performed, static pressure and residual pressure in psig, observed flow in gpm, and orifice size.
2. Hydrostatic Pressure Testing: Provide copy of standard test procedures; and certified test results to NPS for compliance. Provide records of calibrated testing equipment and gauges. For failing tests, provide proposed corrective actions to NPS for review and approval.
3. Bacteriologic (Bac-T) Testing: Provide copies of the test results indicating water sample meets Wyoming Drinking Water Standards.

1.5 REFERENCES

A. The Standard Specifications for Construction of Roads and Bridges on Federal Highway Projects (FP-24), dated 2024; and published revisions thereto. https://flh.fhwa.dot.gov/resources/specs/

1. Payment descriptions in the FP-24 Standard Specifications shall not apply. Refer to Section 01 27 00 – Definition of Contract Line Items.
2. In case of conflict with the FP-24 Standard Specifications, the most stringent specification shall apply.

B. Wyoming Public Works Standard Specifications (WPWSS), 2023 Edition.

C. Applicable ASTM, AASHTO, American Water Works Association (AWWA), American National Standards Institute (ANSI), and Underwriters Laboratory (UL) standards.

D. Uniform Plumbing Code, 2024 Edition (International Association of Plumbing and Mechanical Officials, IAPMO/ANSI UPC1-2024).

E. A reference within parentheses to a law or regulation is included in the Contract for convenience only and is not a comprehensive listing of related laws and regulations. Lack of a reference does not indicate no related laws or regulations exist.

F. Where the version of a referenced document is not specified, use the most recent version in effect on the date of the Notice to Bidders.

G. A code not specified as a federal code is a Wyoming code.

H. An agency or a department not specified as a federal or local agency or department is a Wyoming agency or department.

1.6 QUALITY ASSURANCE

A. Conform to the Contract Documents including but not limited to Permits, Technical Conditions, Drawings, and Standard Specifications.

B. The Contractor shall furnish manufacturer's certificates of compliance. A certificate of "Compliance with Specification" or suitable alternative shall be furnished for all materials to be supplied.

C. All Contractor required 'Quality Control' materials testing shall be based upon applicable ASTM and AWWA Test Methods referenced herein for the materials specified, including manufacture recommendations for testing procedures. All equipment, material, and labor necessary for Quality Control testing shall be supplied by and all costs borne by the Contractor.

1. Provide copies of all applicable testing procedures and standards (per ASTM, AWWA, and manufacture recommendations).
2. Provide certifications for calibration of all testing equipment.
3. A report of the test results shall be furnished.
4. All defects which become present from testing shall be rectified, and the piping system shall be retested, until passed.

D. All tests shall be performed in the presence of the Contracting Officer.

1.7 PROJECT CONDITIONS AND REQUIREMENTS

A. In confined linear areas where protection of existing infrastructure, vegetation, and/or soils is specified only equipment that can be safely operated in the confined construction corridor will be permitted.

B. Work performed under this Section shall meet the requirements of the Uniform Plumbing Code, and applicable Wyoming Building Standards Code(s), current editions. In cases where the Drawings or National Codes conflict with local codes, the local codes shall apply.

C. The following codes and standards will apply to disinfecting water mains and components of the water system.

1. ANSI / AWWA Standard C651
2. AWWA Manual M20, "Water Chlorination/Chloramination Practices and Principles".

D. Deliver materials to site in unopened cartons or bundles as appropriate, clearly identified with manufacturer's name, standards label, grade or identifying number.

E. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect equipment and material from dirt, water, construction debris, and traffic.

1.8 TOLERANCES

A. Horizontal locations, grades and elevations for water systems facilities are to be established from referenced benchmarks, as shown on the Drawings, and as otherwise directed by the Contracting Officer.

PART 2 PRODUCTS

2.1 GENERAL

A. All materials shall conform to sizes, capacities, qualities and quantities as shown on the Drawings and described in the specifications.

B. All water system components and materials must be NSF/ANSI 14 & 61 compliant, be wetted surface Lead Free, approved for potable water service, and acceptable to the Wyoming Department of Environmental Quality.

C. All pipe and fittings of a similar material type shall be from a single manufacturer, who is fully experienced, reputable and qualified to provide continuous quality control through plant inspection and certification of materials.

1. The pipe manufacturer must certify compliance with the specified materials and standards.
2. All pipe shall be clearly marked with type, class and/or thickness as applicable. Lettering shall be legible and permanent under normal conditions of handling and storage.

D. Materials shall be from new stock, delivered in good condition, and no used or damaged stock is allowed.

E. Where no material certification or method of test materials is specified, the latest certification or test specified by ASTM or AWWA shall be enforced.

2.2 PIPE AND FITTINGS

A. Polyethylene Pipe, Tubing and Fittings:

1. Polyethylene pipe, tubing and fittings shall be made from resin meeting the requirements of the Plastic Pipe Institute as PE4710, cell class per ASTM D3350, with 2% minimum carbon black for UV stabilizer.
2. Polyethylene pressure pipe/tubing and fittings (nominal size 1/2-inch through 3-inch) designated for construction of water lines shall comply with AWWA C901.
    a. Polyethylene pipe, tubing and accessories for 1/2-inch through 3-inch diameter (IPS/SDR) shall be pressure class 250psi, SDR 9 rated pipe/tubing, manufactured and tested in accordance with applicable ASTM and AWWA standards.

b. Dimensions and workmanship shall be as specified by ASTM D3035 (pipe), and ASTM D2737 (tubing).

3. Polyethylene fittings, transitions, connections and accessories shall have a pressure rating equal to or greater than the associated pipe, manufactured and tested in accordance with applicable ASTM and AWWA standards.
4. Polyethylene fittings and transitions shall conform to the following:
   a. Butt fusion and associated fittings shall conform to ASTM D3261
   b. Electrofusion and associated fittings shall conform to ASTM F1055
   c. Socket type fittings and accessories shall conform to ASTM D2683
5. Joints for service fittings and valve coupling to polyethylene pipe shall be bronze body meeting ASTM B584 for 3/4-inch pipe (IPS) or compression service fittings and adaptors for 2 inch and smaller pipe (IPS).
   a. All service brass shall comply with AWWA C800 and be approved for potable water services.
6. Butt heat fusion for joining polyethylene pipe shall conform to ASTM F2620.

B. Galvanized Steel Pipe and Fittings:

1. Galvanized steel pipe shall conform to the requirements of ASTM Specification A-120 and approved for use with potable water. The pipe shall be standard weight Schedule 40, hot dipped zinc coated, and shall have ends prepared with male iron pipe threads.
2. Galvanized steel pipe fittings shall be 150 lb., malleable iron, banded fittings with the material conforming to ASTM Specifications A-47 and the dimensions and threads conforming to ASA Specifications B-16.3 and B-2.1. The fittings shall be hot dipped galvanized in accordance with ASTM Specification A-153 and approved for use with potable water. Ends shall be prepared with female iron pipe threads.

C. Polyvinyl Chloride (PVC) Pipe and Fittings:

1. Pipe and fittings shall be manufactured as a system and be the product of one manufacturer.
2. PVC pipe for water mains shall meet the requirements of AWWA C900 made to ductile iron O.D.'s for "push-on" joints. Pipe joints shall be with an elastomeric gasket or joint. Pipe class shall be as shown on the Drawings.
3. PVC pipe with a nominal pipe size of 3 inches and smaller shall be solvent weld pressure pipe, Schedule 80 (IPS). Pipe shall be NSF approved, manufactured from virgin rigid PVC and meet the requirements of ASTM D1785.
4. PVC fittings for nominal pipe size of 3 inches and smaller shall be of compatible size and same material as the pipe it serves, minimum Schedule 80 (IPS). Fittings shall be NSF approved and meet the requirements of ASTM D2467. PVC threaded fittings shall be Schedule 80 and conform to ASTM D2464.
5. PVC solvent cements and primer for use with PVC pipe and fittings shall comply with the Uniform Plumbing Code Installation Standard IAPMO IS 8-92, 316.1.5 and a type recommended by pipe manufacturer. Conform to ASTM D2564.
6. Any connections to pipe 4-inches and larger installed below ground shall make changes in direction with Ductile Iron Flanged fittings of the same size and class as to the pipe it serves. All PVC and Ductile Iron fittings shall be joined together using a Mechanical Joint (MJ).

D. Pipe Thread Sealing Paste:

1. Pipe sealant compound shall be a non-hardening, non-seizing, and non-toxic sealing paste containing TFE-Fluorocarbon approved for use with potable water.

E. Casing Spacers:

1. Casing spacers shall be polyethylene, with configuration for centered restrained.
2. Casing spacers shall be compatible with carrier pipe, and sleeve/casing material.
3. Casing spacers may be required for single or multi-pipe clusters per Drawings.
4. Provide compatible end seals from same manufacture as casing spacers.
5. A minimum of two casing spacers per joint or every 5-feet of pipeline is required.

2.3 VALVES

A. Provide valves approved for water systems with ends as appropriate for the adjoining pipe, fitting or accessory.

B. Provide valves for service sizes as shown on the Drawings, conforming to applicable AWWA and ASTM standards.

C. Gate Valves

1. Gate valves shall be iron body, bronze mounted, double disc gate valves with non-rising stems with design, construction and pressure rating conforming to AWWA C515, with modifications specified herein.
2. Stem seals shall be double “O” ring seals designed so the seal above the stem collar can be replaced with the valve under pressure in full-open position.
3. Gate valves for underground installation shall have a two-inch square nut wrench nut for key operation. All valves shall open counterclockwise unless indicated otherwise.

D. Resilient Seated Gate Valves

1. Resilient seated gate valves shall be iron body, with non-rising stems with design, construction and pressure rating confirming to AWWA C515, standard for Reduced Wall, Resilient Seated Gate Valves with modifications specified herein.
2. Waterway shall be smooth and have no depressions or cavities in the seat area where foreign material can lodge and prevent closure or sealing.
3. Stem seals shall be “O” ring seals designed so that the seal above the stem collar can be replaced with the valve under pressure in full-open position.
4. Resilient seated gate valves for underground installation shall have 2-inch square wrench nut for key operation. All valves shall open counterclockwise unless indicated otherwise on the Drawings.
5. The resilient seated gate valves’ interior parts and surfaces shall be coated in accordance with AWWA C550.

E. Valve Boxes

1. Valve boxes shall be cast iron, 5-1/4-inch diameter adjustable valve boxes. Valve boxes shall be screw type and sufficient length for the bury depth specified. The cast iron cover of the valve box shall have an arrow indicating the direction of opening and the word “Water” stamped thereon. Cast iron covers shall be traffic rated for H20 loading.

2. Reinforced concrete collars shall be placed as shown on the Drawings.
3. Valve boxes shall be wrapped in polyethylene encasement.

F. Ball Curb Stop Valves (2-inch and smaller)

1. Conform to ANSI / AWWA C800.
2. Rated for 300-psi maximum working pressure.
3. Operating nut and handle.

G. Air Valves

1. Provide air release (ARV), air/vacuum (AVV), or combination air (CAV) valves for service size as shown on the Drawings, and where there are high points and changes in gradient of the water pipeline system, and high/mid points of long horizontal runs (1500-ft plus).
2. Air valves shall conform to AWWA C512, have a cast-iron body and cover, and stainless steel float. A simple or compound lever system. At least a standard 150-psi maximum operating pressure.
3. Air valve vents shall be installed in accordance with the Drawings and shall include an inflow preventor and bug screen installed on the outlet orifice. Valves shall be installed centered in vault or utility box as shown on Drawings.

H. Check Valve (Backflow Protection)

1. Provide dual check valves for service size as shown on the Drawings, for continuous pressure applications and backflow protection for point of use health hazard cross-connections.
2. Backflow pressure devices shall be in-line testable except for devices meeting American Society of Sanitary Engineers (ASSE) 1024 and installed in accordance with manufacturer's instructions and applicable plumbing codes.
3. Provide insulated enclosure or enclosure with heat tape for backflow prevention devices.
4. Brass/stainless steel materials meeting wetted surface “Lead Free” requirements for potable water systems, with at least a 125psi maximum working pressure.
5. Approved backflow prevention devices must meet the requirements of the Wyoming Department of Environmental Quality (WDEQ) Current Rules and Regulations, Chapter 12: Design and Construction Standards for Public Water Supplies.
6. Backflow prevention devices shall be certified by an approved third-party agency.
7. Backflow prevention devices at water service connections shall be certified by a certified backflow assembly tester at the time of installation.

I. Pressure Reducing Valves

1. Pressure reducing valves (PRV) shall be installed at the meter pit for any service with pressures exceeding 80 psi or as directed by the Contracting Officer.
2. The Contractor shall provide enough PRVs to install one on each new service. At the time of installation and in the presence of the Contracting Officer, the Contractor will complete pressure testing at each new service location to confirm whether a PRV is needed at that location. Any uninstalled PRVs will be given to the Contracting Officer as spares.

3. Direct acting water PRV shall be bronze body construction, with renewable stainless steel seat, and stainless steel integral strainer, with a 300 psi maximum working pressure.
    a. Provide a standard capacity PRV, with a standard adjustable pressure range of 25 to 75 psi.
        1) Static Pressure setting at 60 psi, or as directed by NPS.
    b. Pressure regulator shall have built-in thermal expansion by-pass feature.

2.4 FIRE HYDRANTS

A. Direct Bury Fire Hydrants

1. Conforming to ANSI / AWWA C502.
2. Mueller Super Centurion 250
3. Main valve opening size
4. UL listed fire main hydrant
5. 584 N cast on barrel between groundline flange and bonnet
6. UL / AWWA (4” shoe AWWA only)
7. Ten year limited warranty
8. 250 psi working pressure; 500 psi test pressure
9. 24” from bury line to nozzle centerline
10. Hydrant A423 with Option 901
11. Hydrants shall have one pumper connection and 2 hose connections

2.5 WATER METERS AND BOXES

A. Water meters shall be installed at the locations shown on the Drawings.

B. All meters shall meet the requirements of NSF Standard 61 and comply with ANSI/AWWA C-700 latest revision.

C. All meters shall be able to withstand complete water submersion of the unit and remain fully functional.

D. All meters shall be compatible with advanced metering infrastructure monitoring system for automated meter readings.

E. 1 in. Water Meters

1. Service: Potable Water
2. Measuring Element: Electromagnetic
3. Register: Programmable electronic with LCD display, hermetically sealed. Electronic communications register fully compatible with remote reader.
4. End Connections: Threaded per ANSI B1.20.1
5. Manufacturer: Sensus iPERL with radio read capabilities
6. The Contractor shall submit documentation verifying the meters will be compatible with the Park’s existing FlexNet radio read system. This submittal shall be approved by the Contracting Officer in writing prior to ordering meters or components.

F. Water meters shall be installed in thermal coil meter boxes. Water meter installation shall include dual check valves. Pressure reducing valves shall be installed on all services with

pressures exceeding 80 psi or as directed by the Contracting Officer. Boxes shall have cast iron locking lids with pentagon nuts.

2.6 WATER SERVICE LINE

A. All newly installed water service lines will be butt-fused HDPE certified to meet AWWA C901. Tubing shall be PE4710, Class 250 with a SDR of 9.0. Contractor shall minimize tubing connections and ensure continuous service lines without joints to the extent feasible.

2.7 CORPORATION STOPS

A. Corporation stops shall be brass with inlet and outlet as specified on the Drawings.

2.8 COMPRESSION CONNECTIONS

A. Ends of polyethylene tubing inserted in compression connections should be fitted with insert reinforcement.

2.9 SERVICE CLAMPS

A. Service clamps, where required, shall be flat double strap, bronze or other noncorrosive material, with neoprene gaskets and corporation stop threads. Service clamps for PVC shall provide full support around the circumference of the pipe and have a bearing area of sufficient width along the axis of the pipe so that the pipe will not be distorted when tightened.

2.10 PIPE INSULATION

A. Pipe insulation shall be high density, extruded polystyrene foam insulation board for buried service.

B. The 5-year aged R value per inch shall be 5 when tested at 75 degrees F mean temperature in accordance with ASTM C518.

C. Minimum compressive strength of 25 psi when tested in accordance with ASTM D1621.

D. Maximum water absorption of 0.1% by volume when tested in accordance with ASTM C272.

2.11 MARKING TAPE AND TRACING WIRE

A. Marking tape shall be minimum 3 inches wide, colored in APWA approved blue color, and imprinted with “Caution Buried Waterline Below” in black uniformly located along its entire length. Tape shall be minimum 5-mil tape with aluminum backing for locate using a non-ferrous locator. Where more than one utility is located in a common trench, marking tape shall be 6 inches wide with the imprint “Caution – Buried Utility Lines Below”.

B. Locating wire shall be minimum No. 10 gauge solid, coated, soft drawn copper wire (#10-AWG). Locating wire shall be strapped to any run of water pipeline to facilitate pipe location, stubbed inside valve/utility boxes, and marked with an irremovable aluminum tag with the corresponding utility. Connection of any bare wire ends shall be approved splice kit for underground use to secure electrical joint.

2.12 THRUST BLOCKS

A. Thrust blocks shall be installed as shown on the Drawings.

B. Concrete for thrust blocking shall be a dry mix, less than 1” slump and a minimum of 4000 psi break in 28 days.

C. Blocking shall be placed between solid ground and the fitting to be anchored. The area of bearing on the pipe and on the ground shall be as shown on the Drawings.

D. The blocking shall be placed so that the pipe and fitting joints will be accessible for repair.

E. Conform to Section 03 30 50 - Minor Concrete.

2.13 PIPE BEDDING AND BACKFILL

A. Furnish a pipe bedding material conforming to Section 704.01 of the FP-24 Standard Specifications. Pipe zone backfill (up to 12-inches over pipe) shall be consistent with pipe bedding material.

B. Pipe bedding shall meet Class I or Class II ASTM D2321.

C. Pipe trench backfill material may be native materials conforming to Section 704.01 of the FP-24 Standard Specifications, for plastic pipe.

D. Pipe backfill shall not contain debris, frozen material, unstable material or large clods. No rocks or stones greater than three (3) inches in diameter shall be within two (2) feet of the pipe. Pipe backfill shall be compacted as shown on the Drawings and to a density equal to or greater than the surrounding soil.

PART 3 EXECUTION

3.1 GENERAL

A. Conform to Section 611, Water Systems of the FP-24 Standard Specifications and WPWSS 2023. In case of conflict, the more stringent specification shall apply.

B. Applicable construction operations for excavation, bedding and backfill shall conform to Section 31 23 00 - Excavation and Fill.

C. Conform to state and federal guidance criteria for the separation of water and non-potable pipelines/facilities. Refer to Drawings and provide additional materials for proper construction as required.

D. Marking tap, tracing wire, and above ground utility posts/markers shall be installed as shown on the Drawings and details.

E. Care shall be taken in loading, transporting and unloading to prevent damage to materials. Store and protect materials according to manufacture recommendations.

F. All pipe, fittings, valves, enclosures, accessories and materials shall be examined before installation, and no piece shall be installed which is found to be defective. If any defective materials is discovered after it has been installed, it shall be removed and replaced in a satisfactory manner as directed by NPS.

G. Provide temporary blockage, plugs, caps and diversions in existing facilities, and dewatering of excavations as necessary to complete the work.

H. Install all pipe, valves and facilities at minimum depths specified on the Drawings.

I. Excavation width shall be as shown on the Drawings but should be no wider than what is required to safely place material.

J. Excavations shall meet all applicable safety provisions as described in Section 31 50 00 - Excavation Support and Protection.

K. Open excavations shall not be permitted during non-working hours. Cover pipe and facility openings and backfill all excavations, and/or cover with temporary trench plate protection at the end of each working day, for protection and public safety.

L. Additional information for installation, inspections, tests and safety considerations for construction of polyethylene piping systems can be found in the "Handbook of Polyethylene (PE) Pipe" published by The Plastics Pipe Institute, Inc. https://www.plasticpipe.org/PPI-Home/Shared_Content/Shop/PE-Handbook.aspx

3.2 PIPES AND FITTINGS (POLYETHYLENE AND PVC)

A. Polyethylene pipe and fittings shall be installed per the manufacturer's recommendations and standard practices, conforming to ASTM D2774.

B. PVC pipe and fittings shall be installed per the manufacturer's recommendations and standard practices, conforming to ASTM F1668 and D2774.

C. All pipe and fittings shall be cleaned and flushed before installation and protected from contaminates during installation.

D. Pipe shall be laid to the lines and grades shown on the Drawings.

E. Polyethylene and PVC pipe must be allowed to adjust to temperature of trench surrounding soil at the time of installation and prior to connections to fittings, valves, mechanical couplings and other accessories to protect against excessive thermal deflections and pull-out forces. Covering extended horizontal runs of pipe with embedment will facilitate cooling.

F. Cold field bending of polyethylene and PVC pipe shall conform to manufacturer requirements and must not exceed (long-term) minimum bend radius. Temporary blocks or restraints must be removed before final backfill.

G. Join solvent weld PVC pipe and fittings in two-step process with specified primer and solvent cement, following manufacturer recommendations and standard practices, conforming to ASTM D2855.

H. Join polyethylene pipe, prefabricated fittings, and butt end transitions/adaptors to mechanical joints by the method of butt fusion. Conform to manufacture recommendations and ASTM F2620 and D3261 for heat fusion joining procedures.

1. The supplier of the pipe and fittings shall provide a person certified by the pipe manufacturer and the fusion equipment manufacturer to train contractor fusion equipment operators and inspectors representing NPS.
2. The fusion equipment operator shall receive training using the recommended procedure. The Contractor shall be responsible to verify that the fusion equipment is in good operating condition and that the operator has been trained within the past twelve months. The fusion equipment shall be equipped with a Datalogger. Records of the welds (heater temperature, fusion pressure, and a graph of the fusion cycle) shall be maintained for five (5) years. Fusion beads shall not be removed.

I. Install polyethylene fabricated fittings to more than one pipe in sequence according to manufacture requirements. Additional trench widths/excavations may be required for proper heat fusion joining methods.

J. Mechanical and flange connections of pipe to valves, services, and other auxiliary equipment shall conform to manufacturer recommendations. Mechanical joints to polyethylene pipe must be resistant to pullout loads that develop in PE piping systems. Internal stiffeners may be required for small diameter pipe/tubing insert type fittings and compression couplings.

K. Anchor polyethylene pipe at connections or transitions to differing pipe materials, valves, and other auxiliary equipment to resistant pullout loads that develop in PE piping systems.

L. No pipe shall be installed in the trench until the trench and bedding have been inspected and approved. Valves and other control devices shall be installed in the line where shown on the Drawings.

M. Pipe passing through sleeves shall include casing spacers compatible with the carrier pipe and sleeve/casing, including multi-pipe configurations. End seals shall be installed on sleeves/casings.

N. Tracing wire shall be attached to pipe and other components, and marking tape shall be placed in all trenches as shown on the Drawings. Wire and tape shall be continuous in the trench. Wire shall be spliced and tape overlapped minimum of 12 inches if needs to be cut or joined.

O. Support pads, anchors and thrust blocks using minor concrete and reinforcing bars shall be installed as required at material changes, fittings, valves, services, and other auxiliary equipment to resistant loads typical of pressure pipe water systems. Concrete shall be hand placed to not interfere with bolts, connections, and normal operation of equipment.

3.3 VALVES

A. Valves shall be installed at locations specified and as shown on the Drawings. Adjustments for actual field conditions and pipeline profiles shall be as required and directed by the Contracting Officer. Final location of all valves shall be accepted by NPS prior to installation.

B. Provide all fittings, transitions and adaptors as required per manufactures requirements, and applicable ASTM and AWWA standards.

C. Valves shall be installed, and located in utility/valve boxes where specified, in such positions that they are readily accessible for normal operations without binding. All valves shall be installed with stems pointing up, including proper position for specified handles and accessibility of accessory key handles.

3.4 FIRE HYDRANTS

A. All hydrants shall stand plumb with the pumper nozzle facing the street. Hydrant shall be set with the ground line at the location indicated by the hydrant manufacturer. Hydrants shall be installed such that they have drainage away from them at the surface. Proper boot length shall be used to avoid hydrants installed in holes or depressions.

B. Drainage shall be provided at the base of the hydrant by placing clean gravel under and around the base of the hydrant. Sufficient gravel shall be placed as shown on the Drawings. Hydrants shall be braced against unexcavated earth at the end of the trench with concrete backing as shown on the Drawings.

3.5 THRUST BLOCKS, ANCHORING AND PIPE RESTRAINTS

A. Provide thrust blocks, anchorages, and mechanical pipe restraints at all fittings and auxiliary facilities, and changes in angle, alignments or elevation as specified, shown on the Drawings, and required by manufacturer’s recommendations.

3.6 BOXES AND ENCLOSURES

A. All valves and specified auxiliary equipment shall be installed in boxes or enclosures as shown on the Drawings. Sizes and dimensions shall be as specified or required to allow for accessibility and normal operations of the facility.

B. Provide risers and extensions for utility boxes as required for full depth access to facility and setting of box and cover to proposed grades.

C. Utility boxes and enclosures shall be properly set and centered on facility and buffered to avoid transmitting any shock or physical stress impacts to the pipeline, valve or other enclosed equipment.

D. The subgrade area on which the box sets shall be well compacted (no less than 95%) to fully support the box and protect the valve and assembly from traffic loading.

E. Backfill and compact the area around the utility box or enclosure using backfill material consistent with the trench backfill or structural fill and aggregate base where specified in pavements.

F. Misaligned boxes and enclosures shall be excavated, plumbed, reset and backfilled as directed by NPS at no additional cost.

G. Construct concrete collar to dimensions as shown on the Drawings, under Section 03 30 50 - Minor Concrete.

3.7 CORROSION PROTECTION

A. Isolate, dielectrically, all piping from all other metals including reinforcing bars in concrete slabs, other pipe lines, and miscellaneous metal.

B. Provide dielectric unions as needed for transitions between different metals in a given pipe.

3.8 FLUSHING / CLEANING

A. At the conclusion of the installation/construction work, thoroughly clean and flush all of the new pipe lines to remove all dirt, sand, particles, debris, or other material which may have entered during the construction period by flushing.

B. Flushing velocities shall be a minimum of 2.5 feet per second. All flushing shall be coordinated with the Contracting Officer. Debris and flushing waters shall be properly disposed conforming to specifications, permits and SWPPP.

3.9 HYDROSTATIC TESTING

A. GENERAL

1. Pressure testing of pipe and appurtenances shall be conducted in accordance with the appropriate AWWA Standard depending on the pipe material. PVC pipe and fittings shall be tested according to AWWA C605. Polyethylene pipe shall be tested according to AWWA M55 and ASTM F 2164, Field Leak Testing of Polyethylene Pressure Piping Systems Using Hydrostatic Pressure. All pipe, fittings and joints shall be examined during the testing.
2. For safety reasons, hydrostatic testing only will be allowed.
3. Piping systems shall only be tested after the lines have been flushed and cleaned as specified within this specification and where applicable.
4. All concrete thrust blocks and anchors must be in place a minimum of 5 days prior to testing. All piping and system components must be restrained prior to testing. If backfill provides restraint, it must be properly placed and compacted. Follow all safety procedures to ensure protection of personnel during testing.
5. Testing may be conducted on the full system or in sections. Test section length is determined by the capacity of the testing equipment, and locations of systems valves and components. Lower capacity pressurizing or filling equipment may not be capable of completing the test within permissible time limits. If so, use higher capacity test equipment or select a shorter test section.
6. In all tests, all apparatus, which may be damaged by the test pressure, shall be isolated from the system.
7. Any defective material shall be replaced with sound material and test repeated until satisfactorily completed and approved.
8. All visible leaks at exposed joints and all leaks evident on the surface where joints are covered, shall be replaced, regardless of total leakage shown.
9. The test liquid should meet appropriate industry standards for safety and quality so that the environment, system, test equipment and disposal are not adversely affected. The recommended test liquid is water. The test liquid shall not to exceed 80 degrees (F).
10. Disposal of test liquid shall meet all permit and SWPPP requirements.

11. Provide copy of standard test procedures and certified test results to the Contracting Officer for compliance. For failing tests, provide proposed corrective actions to the Contracting Officer for review and approval.

B. PVC TESTING

1. The hydrostatic test pressure shall not be less than 1.25 times the maximum sustained working pressure of the pipeline measured at the highest elevation along the test section and not less than 1.5 times the sustained working pressure at the lowest elevation of the test section. However, in no case shall the test pressure exceed the rated pressure for any joint, thrust restraint, valve, fitting or other connected appurtenance of the test section.
2. Properly assembled PVC pipe joints do not leak. The testing allowance shall be defined as the allowed quantity of makeup water supplied to the pipe section during the test to maintain a pressure within 5 psi of the required hydrostatic test pressure as defined in the contract documents. No test section shall be accepted if the quantity of makeup water is greater than that determined by the formula:

$$Q = \frac{LD\sqrt{P}}{148{,}000} \qquad \text{(Eq 1)}$$

Where:

Q = quantity of makeup water, in gal/h
L = length of pipe section being tested, in ft
D = nominal diameter of the pipe, in in.
P = average test pressure during the hydrostatic test, in lb/in.^{2} (gauge)

*Source: AWWA C605. Formula based on a testing allowance of 10.5 gpd/mi/in of nominal diameter at a pressure of 150 psi.

C. POLYETHYLENE TESTING

1. For leak testing purposes, the maximum allowable test pressure in polyethylene pipe is 150% of the pipe's design pressure rating (at the lowest elevating in the test section) for the application and the application service temperature. Do not subject lower pressure rated, non-polyethylene parts or devices to pressures above their pressure rating. Lower pressure rated parts may be removed or isolated from the test section to avoid damage or failure. Vent isolated parts or equipment to atmosphere.
2. All thermoplastic pipes have reduced strength at elevated temperature. Adjust testing pressures based on environmental and testing conditions. Before applying test pressure, allow time for the test fluid and the test section to equalize to a common temperature.
3. When testing at pressures above system design pressure up to 150% of the system design pressure, the maximum test duration is eight (8) hours including time to pressurize, time for initial expansion, time at test pressure, and time to depressurize the test section. CAUTION – Testing at excessive pressure or for excessive time may damage the system.

3.10 DISINFECTION

A. After all other work has been completed and prior to placing the water system in service, including all mains, service lines and appurtenances installed under this contract completely disinfect the system in accordance with procedures as contained in the latest revision to ANSI / AWWA Standard C651 for disinfecting water mains, including manufacturer recommendations.

B. ANSI/AWWA C651 uses liquid chlorine, sodium hypochlorite, or calcium hypochlorite to chemically disinfect the main. Disinfecting solutions containing chlorine should not exceed 12% active chlorine, because greater concentration can chemically attack and degrade polyethylene. Operational disinfection practices should limit available chlorine levels to <=5ppm for temperatures up to 75°F.

C. The two acceptable methods of chlorination are tablet (calcium hypochlorite tablets) and continuous-feed (direct chlorine solution injection).

D. Water used in disinfection shall be supplied through a temporary connection that shall include an appropriate cross-connection control device, consistent with the degree of hazard, for backflow protection of the active distribution system.

E. During the retention period, all valves and other appurtenances shall be operated to ensure internal exposure with the chlorinated water. Chlorinated water shall be retained in the pipeline for a minimum of 24 hours.

F. Following the chlorination retention period, the system shall be thoroughly flushed until the chlorine residual of the section being flushed is equal to or less than the distribution system required operational levels.

G. Disposal of flushed chlorinated water is the responsibility of the Contractor and shall be carried out in strict observance of the water pollution control requirements, permits and specifications.

1. Conform to federal, state, and local regulations for the disposal of heavily chlorinated water.
2. Where applicable the Contractor shall apply a reducing agent to the chlorinated solution to neutralize residual chlorine or chloramines remaining in the flush waters to protect ecological conditions. Under no circumstances shall discharge to surface waters occur.

H. Bacteriological (Bac-T) Testing

1. Following flushing the water system must sit undisturbed for a period of 24-hours.
2. The Contractor shall have tests conducted for chlorine residual. The chlorine concentration level in the new water facility must meet the distribution system required operational levels, or if unknown meet the following requirements:
    a. Greater than or equal to 0.2 ppm free chlorine and less than or equal to 3 ppm free chlorine.
3. When the chlorine residual levels are compliant, the Contractor may proceed with the Bac-T testing.
4. The Contractor shall have a State certified laboratory perform the Bac-T tests.
    a. Samples shall be taken 24 hours or more after final flushing of the system.

b. At least one set of samples shall be collected from every 1200 ft (366 m) of the new water main, plus one set from each dead-end main section, and at least one set from each branch.
c. A suggested combination blow off and sampling tap is recommended.
d. Samples for bacteriological analysis shall be collected in sterile bottles treated with sodium thiosulfate and tested for bacteriological quality as required by Standard Methods for the Examination of Water and Wastewater.

5. Report Bac-T test results to NPS. If test results indicate "Absent" for both E. coli and Coliform bacteria, then the water line has passed the testing process and can be placed in service and connected to the existing distribution system.

3.11 PROTECTION

A. The Contractor shall protect newly installed facilities for the duration of the work.

B. Repair and replace any damaged parts with new materials.

C. The water system shall be placed into service or winterized as directed by the Contracting Officer following completion, testing and acceptance of the work.

3.12 DEMONSTRATION AND TRAINING

A. The Contractor shall provide demonstration and training, as requested by the Contracting Officer, on the operation and maintenance of valve, vault, hydrant, backflow devices, meter or manhole components. All training shall be completed by a factory-authorized service representative.

END OF SECTION 33 14 00

SECTION 33 30 00 - SANITARY SEWERAGE

PART 1 GENERAL

1.1 WORK SUMMARY

A. This section covers the requirements to perform work including but not limited to furnishing and installing gravity and force sewer system piping, sanitary sewer manholes, and all associated connections and appurtenances as shown on the Drawings, and as otherwise directed by NPS.

B. Provide all labor, materials, tools, equipment, services, and incidentals as necessary to perform the work as described in this section and in accordance with the Contract Documents and Drawings and to the satisfaction of NPS.

C. All sewage system materials and construction work shall conform to local, state and federal health standards for sewage disposal systems.

1.2 RELATED WORK

A. Attention is directed to the General Requirements and related work specified in other sections includes, but is not limited to:

1. Section 03 30 50 - Minor Concrete
2. Section 31 23 00 - Excavation and Fill
3. Section 31 50 00 - Excavation Support and Protection
4. Section 32 16 00 - Concrete Curbs, Sidewalks, Aprons, and Pads

1.3 DEFINITIONS

A. Not used.

1.4 SUBMITTALS

A. Submittals shall be in conformance with Contracting Requirements, Specifications, and Division 1 - General Requirements.

B. Submit supporting documentation, certificates of compliance, shop drawings, and supplier or manufacturer information at least fourteen days (14) prior to ordering materials or placement in the work for each proposed material and product, for review and acceptance of NPS for conformance to the material specifications.

1. For precast structures, submit design drawings, details, and supporting calculations for review and approval prior to casting. Design drawings, shop drawings and calculations

must be sealed and signed by an engineer who is registered as a civil engineer in the State of Wyoming.

2. Contractor must account for lead times on manufacture and delivery and allow for review of submittals by NPS. Design drawings, shop drawings and calculations shall include the following:
   a. Design parameters, loadings, earth cover, buoyancy, and design standards (i.e. ASTM, AASHTO, ACI) used for anticipated field conditions
   b. Dimensions, location of openings, and invert elevations
   c. Reinforcement, splice type and location, joint details, and gaskets
   d. Frames, covers, risers, fittings, seals, hardware and other accessories

C. Submittals include but are not limited to construction methods, manufacturer's descriptive literature, performance and test data, and manufacturer's data for sizes, pressure rating, rated capacity, listing/approval stamps, labels and other marking on equipment made to the specified standards for materials and settings of selected models for the following:

1. Pipe and fittings
2. Cleanouts, caps, covers, and utility boxes
3. Gaskets, couplings, sleeves, and assembly hardware
4. Dye for sanitary sewer tracing
5. Force sanitary main components
6. Grinder pump

D. Provide the following test reports where applicable.

1. Leakage Testing (*structures/vaults*): Provide copy of standard test procedures; and certified test results to NPS for compliance. For failing tests, provide proposed corrective actions to NPS for review/approval.
2. Low-air Pressure Testing (*sewer pipelines, exceeding 50-ft*): Provide copy of standard test procedures; and certified test results to NPS for compliance. For failing tests, provide proposed corrective actions to NPS for review/approval.

1.5 REFERENCES

A. The Standard Specifications for Construction of Roads and Bridges on Federal Highway Projects (FP-24), dated 2024; and published revisions thereto. https://flh.fhwa.dot.gov/resources/specs/

1. Payment descriptions in the FP-24 Standard Specifications shall not apply. Refer to Section 01 27 00 – Definition of Contract Line Items
2. In case of conflict with the FP-24 Standard Specifications, the most stringent specification shall apply.

B. Wyoming Public Works Standard Specifications (WPWSS), 2023 Edition.

C. Applicable ASTM, AASHTO, American Concrete Institute (ACI), American National Standards Institute (ANSI), and Underwriters Laboratory (UL) standards.

D. Uniform Plumbing Code, 2024 Edition (International Association of Plumbing and Mechanical Officials, IAPMO/ANSI UPC1-2024).

E. A reference within parentheses to a law or regulation is included in the Contract for convenience only and is not a comprehensive listing of related laws and regulations. Lack of a reference does not indicate no related laws or regulations exist.

F. Where the version of a referenced document is not specified, use the most recent version in effect on the date of the Notice to Bidders.

G. A code not specified as a federal code is a Wyoming code.

H. An agency or a department not specified as a federal or local agency or department is a Wyoming agency or department.

1.6 QUALITY ASSURANCE

A. Conform to the Contract Documents including but not limited to Permits, Technical Conditions, Drawings, and Standard Specifications.

B. The Contractor shall furnish manufacturer's certificates of compliance. A certificate of "Compliance with Specification" or suitable alternative shall be furnished for all materials to be supplied.

C. All 'Quality Control' materials testing shall be based upon applicable ASTM and/or Plumbing Code test methods referenced herein for the materials specified, including manufacture recommendations for testing procedures. All equipment, material, and labor necessary for Quality Control testing shall be supplied by and all costs borne by the Contractor.

1. Provide copies of all applicable testing procedures and standards (per ASTM, Plumbing Code, and manufacture recommendations).
2. Provide certifications for calibration of all testing equipment.
3. A report of the test results shall be furnished.
4. All defects, which become present from testing shall be rectified, and the system shall be retested, until passed.
5. All tests shall be performed in the presence of the Contracting Officer.

D. For precast concrete structures, units may be rejected at the site upon visual inspection and where exhibiting any of the following:

1. Cracks passing through walls more than 1/16 inch wide
2. Nonrepairable honeycombed or spalled areas of more than 6 square inches
3. Noncompliance with reinforcement tolerances or cross sectional area shown
4. Wall, floor or lid less than minimum thickness
5. Internal dimensions less than plan dimensions by 1 percent or 1/2 inch, whichever is greater
6. Defects affecting performance or structural integrity

1.7 PROJECT CONDITIONS AND REQUIREMENTS

A. In confined linear areas where protection of existing infrastructure, vegetation, and/or soils is specified only equipment that can be safely operated in the confined construction corridor will be permitted.

B. Work performed under this Section shall meet the requirements of the Uniform Plumbing Code, 2024 Edition.

C. Deliver materials to site in unopened cartons or bundles as appropriate, clearly identified with manufacturer's name, standards label, grade or identifying number.

D. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect equipment and material from dirt, water, construction debris, and traffic.

1.8 TOLERANCES

A. Horizontal locations, grades and elevations for sanitary sewer system facilities are to be established from referenced benchmarks, as shown on the Drawings, and as otherwise directed by NPS.

PART 2 PRODUCTS

2.1 GENERAL

A. All materials shall conform to sizes, capacities, qualities and quantities as shown on the Drawings or described in the specifications.

B. All pipe and fittings of a similar material type shall be from a single manufacturer, who is fully experienced, reputable and qualified to provide continuous quality control through plant inspection and certification of materials.

1. The pipe manufacturer must certify compliance with the specified materials and standards.

C. Materials shall be from new stock, delivered in good condition, and no used or damaged stock is allowed.

D. Where no material certification or method of test materials is specified, the latest certification or test specified by ASTM or applicable Code shall be enforced.

2.2 PIPE AND FITTINGS

A. All new force sewer lines should be SDR 26 PVC of the size shown on the Drawings.

B. Gravity sewer pipe/conduit shall be of the size shown on the Drawings. The pipe shall be PVC, have a minimum pipe wall thickness equivalent to SDR 26, and conform to the requirements of ASTM D3034. Joints with bell and spigot ends, and reinforced gasket joints. The rubber gasket shall be of composition rubber suitable for sewer service.

C. All fittings and accessories shall be from the same manufacturer of the pipe and have bell and/or spigot configurations compatible with that of the pipe.

D. Connections shall consist of PVC fittings, gaskets, couplings, adapters and other accessories for a watertight connection. Connections to structures shall consist of couplings precast into structure wall, or mechanical fittings for a watertight connection.

2.3 BEDDING, FOUNDATION AND BACKFILL

A. Sanitary sewer (solid) pipe ‘bedding material’ shall be as shown on the Drawings, and conforming to Section 704.01 of FP-24 Standard Specifications and Section 31 23 00 - Excavation and Fill.

B. Sanitary sewer structure foundation material shall be a coarse aggregate granular backfill as shown on the Drawings, and conforming to AASHTO M43, and Section 703, Aggregate of the FP-24 Standard Specifications.

C. Sanitary sewer structure and plastic pipe ‘backfill material(s)’ shall be as shown on the Drawings, and conforming to Section 704.01 of FP-24 Standard Specifications and Section 31 23 00 - Excavation and Fill.

2.4 CLEANOUTS

A. Cleanouts shall be installed at the locations shown on the Drawings or marked in the field by the Contracting Officer. Cleanouts shall be of the same size and material as the sewer line it serves.

2.5 UTILITY BOXES

A. Contractor shall verify utility box sizes required for sewer system facilities as shown on the Drawings, and actual sizes and dimensions of materials placed in the work.

B. Provide precast concrete boxes with steel or cast iron covers marked “SEWER” and traffic rated for H20 loading. Provide risers and extensions as required.

C. Concrete collars around utility boxes shall conform to Section 03 30 50 - Minor Concrete.

2.6 MARKING TAPE AND TRACING WIRE

A. Marking tape shall be minimum 3 inches wide, colored in APWA approved green color, and imprinted with “Caution Buried Sewer Line Below” in black uniformly located along its entire length. Tape shall be minimum 5-mil tape with aluminum backing for locate using a non-ferrous locator. Where more than one utility is located in a common trench, marking tape shall be 6 inches wide with the imprint “Caution – Buried Utility Lines Below”.

B. Locating wire shall be minimum No. 14 gauge solid, coated, soft drawn copper wire (#14-AWG). Locating wire shall be strapped to any run of sewer pipeline (over 5-ft in length) to facilitate pipe location, stubbed inside valve/utility boxes, and marked with an irremovable aluminum tag with the corresponding utility. Connection of any bare wire ends shall be approved splice kit for underground use to secure electrical joint.

2.7 GRINDER PUMP

A. The grinder pump shall be installed as shown on the Drawings. The pump shall be provided with isolation and check valves. The sump shall be over 50 gallons.

B. The pump shall be a Zoeller 922 Simplex 30″ x 84″ Grinder Package with EI820 or approved equal in terms of size, performance and functionality.

C. The operating point for the pump is 46.6 gpm @ 22.5 ft of total dynamic head.

D. The control panel for the pump shall include hand / off / auto switches, an elapsed time meter, and a pump cycle counter.

E. As shown on the Drawings, the wet well shall include a bolted solid fiberglass cover.

2.8 SEWER SYSTEM PRECAST MANHOLES

A. Manholes for sewer systems shall be precast concrete, conforming to the applicable requirements of ASTM C478 (manhole sections).

B. Structural design loads for precast concrete structures shall meet anticipated field conditions (as shown on Drawings), and conform to minimum design loading under ASTM C890 and ACI 318 and 350 codes, whichever is more stringent.

C. All underground sewer structures, and inlet/outlets and access openings shall be constructed to withstand corrosion and/or decay and shall be watertight. All joint seals, gaskets, connectors and fittings shall be watertight conforming to applicable ASTM and AASHTO standards for anticipated hydrostatic pressures and field conditions.

D. Manholes shall be of the general size and dimensions as shown on the Drawings, including:

1. Manholes shall be designed to withstand AASHTO HS20 (MS10) loading.
2. Manholes shall be constructed of precast concrete rings with frames and covers and steps in accordance with AASHTO M199 and as shown in the Drawings.
3. Adjusting rings may be used for adjusting the manhole top elevation to coincide with existing ground elevations, except the total height of adjusting rings used per manhole shall not exceed 12 inches. Adjusting rings shall be reinforced with the same percentage of steel as the riser and top.
4. Precast concrete rings shall conform to ASTM C478.
5. When required, noncorrosive steps of rubber encased steel, aluminum, or nylon shall be used. Steps shall withstand vertical loads of 400 pounds and pull out resistance of 1,000 pounds.

PART 3 EXECUTION

3.1 GENERAL

A. Conform to Section 612, Sanitary Sewer Systems or the FP-24 Standard Specifications and WPWSS 2023. In case of conflict, the most stringent specification shall apply.

B. Applicable construction operations for excavation, bedding and backfill shall conform to Section 31 23 00 - Excavation and Fill.

C. Conform to state and federal guidance criteria for the separation of potable water and sanitary sewer pipelines/facilities. Refer to Drawings and provide additional materials for proper construction as required.

D. Care shall be taken in loading, transporting and unloading to prevent damage to materials. Store and protect materials according to manufacture recommendations.

E. All structures, pipe, fittings, accessories and materials shall be examined before installation, and no piece or facility shall be installed which is found to be defective. If any defective materials is discovered after it has been installed, it shall be removed and replaced in a satisfactory manner as directed by NPS.

F. Provide temporary blockage, plugs, caps and diversions in existing facilities, and dewatering of excavations as necessary to complete the work.

G. Install all pipe, structures and facilities at minimum or maximum depths as specified on the Drawings.

H. Excavation width shall be as shown on the Drawings but should be no wider than what is required to safely install proposed improvements.

I. Excavations shall meet all applicable safety provisions as described in Section 31 50 00 - Excavation Support and Protection.

J. Open excavations shall not be permitted during non-working hours. Cover pipe and facility openings and backfill all excavations, and/or cover with temporary trench plate protection at the end of each working day, for protection and public safety.

K. Clean the interior of pipe and structures as work progresses. All finished sanitary sewer system piping, structures and facilities shall be flushed, clean and free of any debris and sediment before final acceptance.

3.2 SANITARY SEWER TRACING

A. Prior to commencing with construction, the Contractor shall dye test the existing 4-plex in the Northeast Entrance project area to determine the location and connectivity of the existing sanitary service(s). Available survey records show multiple cleanouts on the exterior of the building. The Contractor shall provide the Contracting Officer with the test results immediately. If it is determined that the existing sanitary service(s) for the 4-plex will be impacted by the proposed sanitary main, and the Contracting Officer approves the work, the existing sanitary service(s) shall be connected to the proposed sanitary main. Continuous operation of the 4-plex’s existing sanitary service(s) shall be maintained throughout construction activities.

B. Dye for sanitary sewer tracing shall be non-toxic, biodegradable and environmentally safe fluorescent dye certified for use in sanitary sewer systems. Dilution limits shall follow the dye manufacturer's recommendations.

C. All materials and labor associated with the sanitary sewer tracing test and connection of existing services to the proposed sanitary main, if completed, are considered incidental to the work and no additional payment shall be made.

3.3 SEWER SYSTEM PIPING

A. Install all pipe, fittings and cleanouts to the lines and grades as shown on the Drawings, in accordance with the pipe manufacturer’s specifications, ASTM D2321, and as otherwise directed by NPS.

B. In-situ trench foundation shall be undisturbed earth no less than 90% relative compaction; any materials placed to stabilize trench bottom foundation shall be no less than 95% relative compaction.

C. No pipe shall be laid until the trench, foundation, sub-grade preparation and bedding have been inspected and approved by the Contracting Officer.

D. All piping, fittings, and accessories shall be assembled per the manufacturer's recommendations. Lay pipe from the lower end with spigot ends pointing in the direction of flow.

E. Do not damage pipe sections, fittings, joints or gaskets during assembly. Use pipe lubricant, installation stub, etc. and follow manufacture recommendations to ensure all pipe sections are pushed "home." A come-along or other suitable method should be used; construction equipment such as an excavator bucket, etc. must not have direct contact with the plastic pipe end sections unless an installation stub and large timber or other suitable cushioning medium is utilized.

F. Only upon authorization of NPS may changes in direction, without the use of elbows or other fittings, be accomplished through joint deflection or longitudinal bending, but not both on the same length of pipe. Allowable joint deflection or longitudinal bending is dependent on pipe size and/or joint design, and shall not exceed the pipe manufacturer's published limits. Deflection testing will be required. The Contractor shall complete this work in accordance with ASTM D3034 and Section 2700 of the WYPWSS.

G. Install sewer cleanouts at locations as shown on the Drawings, and within 5-feet of a building footprint or facility connection pad on sewer export/discharge lines. Cleanouts require a utility box enclosure as specified, except where installed within footprint of the concrete apron of a utility host site connection pad.

H. Install tracing wire and marking tape as shown on the Drawings, per manufacture recommendations.

I. Do not drive or operate equipment directly over sewer system piping during backfilling, or until minimum cover is achieved per the manufacture installation requirements.

J. Contractor is responsible to protect sewer system piping from damage during the course of the project work.

K. Restore and stabilize barren soils and disturbed areas according to Section 32 90 00 - Restoration.

3.4 SEWER SYSTEM PRECAST STRUCTURES

A. Install all structures at the locations and to the lines and grades as shown on the Drawings, in accordance with the manufacturer's specifications, and as otherwise directed by the Contracting Officer.

B. Field repair precast concrete structures to correct damage from handling or manufacturing imperfections before installation, where authorized by the Contracting Officer.

C. Applicable construction operations for excavation, foundation, bedding and backfill shall conform to Section 31 23 00 - Excavation and Fill.

D. Precast concrete structures shall be constructed and/or assembled and placed in excavations on properly compacted foundations as shown on the Drawings and details. Structures shall be set to grade and oriented for connections, and to provide the required dimensions and clearances from other facilities.

E. In-situ excavation foundation shall be undisturbed earth no less than 90% relative compaction; any materials placed to stabilize excavation bottom foundation shall be no less than 95% relative compaction.

F. No structure shall be installed until the excavation, foundation, sub-grade preparation and any bedding have been inspected and approved by the Contracting Officer.

G. Pipe connections and access openings for precast structures shall be watertight and constructed to the tank manufacturer's recommendations. Center pipes in openings and seal with resilient connectors or mechanical seals. Fittings, couplings, adapters, gaskets, seals, band clamps, grout, concrete collars and other miscellaneous materials as required for completion of the work is included in payment for the structure bid item of work involved.

H. Match fit any keyed joints to ensure uniform alignment of walls and lids. Clean keyed joint surfaces and seal for a watertight structure per manufacturer requirements. Joint surfaces must be free of imperfections that may affect the joint integrity.

I. Construct manhole access openings to grade using risers, extensions or grade rings, and install frame and cover as shown on the Drawings, and conforming to manufacturer requirements. All extensions and access openings shall be watertight and sealed.

J. Prior to backfilling of precast structures, all lifting holes, cracks, and other remnant voids shall be filled with non-shrink grout and polyurethane sealant to provide for a watertight structure.

K. Do not drive or operate equipment directly over sewer system structures during backfilling, or until minimum cover is achieved per the manufacture installation requirements.

L. Contractor is responsible to protect sewer system structures from damage during the course of the project work.

M. Restore and stabilize barren soils and disturbed areas according to Section 32 90 00 - Restoration.

3.5 TESTING

A. Sewer system structures and tanks shall be inspected and tested for leakage prior to final backfill, and being finished and accepted. Hydraulic or vacuum testing is permitted. Leakage testing shall conform to manufacturer recommendations and Section 02700 of the WPWSS.

B. The Contractor shall perform a light test between manholes to check alignment and grade for displacement of pipe in accordance with Section 02700 of the WPWSS.

C. New sewer line will not be accepted until deflection and leakage tests have assured the Contracting Officer that pipe laying and joint are satisfactory. Deflection testing shall be performed in accordance with Section 02700 of the WPWSS and shall consist of pulling a mandrel through the pipe. Maximum deflection shall not exceed 5 percent of the pipe's internal diameter for final inspection.

D. Water Test

1. Where groundwater is a minimum of 2 feet above the sewer line, tests shall be made by sealing off the section of lines between manholes and measuring the infiltration by collecting or pumping the discharge into barrels or other approved methods. Tests shall be continued over a period of at least 4 hours for each section tested. Sufficient time shall be allowed to soak lines and manholes in advance of performing tests.
2. When groundwater is not above the pipe, testing shall be as follows:
    a. On flat slopes where the depth over the centerline of the pipe in the lower manhole of the section being tested will be not more than 10 feet, the upper manhole shall be filled to a depth of 2 feet over the top of the pipe and the lower manhole blocked. When the above conditions cannot be met, the Contracting Officer may order the Contractor to test the line in sections between manholes. The leakage shall be measured by checking the drop in water level in the manhole over a period of 4 hours.
    b. The maximum allowable infiltration or exfiltration, including manholes, shall not exceed 200 gallons per day per mile of sewer, per inch of pipe diameter. This does not preclude the fact that obvious and concentrated leaks, such as open joints, pinched gaskets, cracked barrels or bells, etc will not be allowed. The Contractor shall make repairs on concentrated leaks, and as necessary to reduce infiltration or exfiltration below the specified rate, and at their own expense.
    c. Manhole joints shall be checked by leakage by means of water testing as specified above.

E. Air Test (Alternate)

1. As an alternate to water testing, Contractor may utilize low pressure air as a means of testing the sewer mains. Sewer system pipelines (solid/tight lines) in excess of 50-feet shall be tested for leakage using low-pressure air testing (dry conditions), conforming to ASTM F1417, manufacturer recommendations, industry standards and Section 02700 of the WPWSS.

F. All testing shall be completed in the presence of the Contracting Officer. Provide all test results to NPS.

G. Existing manholes to which new connections are made shall be subject to the same testing requirements as new manholes.

H. Disposal of testing waters is the responsibility of the Contractor and shall be carried out in strict observance of the water pollution control requirements, permits and specifications.

3.6 DEMONSTRATION AND TRAINING

A. The Contractor shall provide demonstration and training on the operation and maintenance of the grinder pump to the NPS. The training shall be completed by a factory-authorized service representative.

B. The Contractor shall provide demonstration and training, as requested by the Contracting Officer, on the operation and maintenance of valve or manhole components. All training shall be completed by a factory-authorized service representative.

END OF SECTION 33 30 00

SECTION 33 40 00 - STORMWATER UTILITIES

PART 1 GENERAL

1.1 WORK SUMMARY

A. This section covers the requirements to perform work including but not limited to furnishing, fabrication, fitting, excavation, installation, and backfill efforts required to construct concrete culverts as shown on the Drawings, conforming to the Specifications, and as otherwise directed by the Contracting Officer.

B. Provide all labor, materials, tools, equipment, services, and incidentals as necessary to perform the work as described in this section and in accordance with the Contract Documents and Drawings and to the satisfaction of NPS.

C. Provide dewatering as necessary for completion of work and conformance to project Permits and SWPPP. Where possible perform applicable work and installations during the dry portion or low flow periods of the construction season (typically in the summer and fall).

1.2 RELATED WORK

A. Attention is directed to the General Requirements and related work specified in other sections includes, but is not limited to:

1. Section 03 30 50 - Minor Concrete
2. Section 31 23 00 - Excavation and Fill
3. Section 31 37 00 - Riprap
4. Section 31 50 00 - Excavation Support and Protection
5. Section 32 11 00 - Base Courses

1.3 DEFINITIONS

A. HDPE: high density polyethylene; synthetic thermoplastic resin.

B. PVC: polyvinyl chloride; synthetic thermoplastic resin.

C. RCP: reinforced concrete pipe

1.4 SUBMITTALS

A. Submittals shall be in conformance with Contracting Requirements, Specifications, and Division 1 - General Requirements.

B. A Certificate of Compliance(s) shall be furnished to NPS for review and acceptance, for each type of pipe material including fittings and special sections. Submit a certificate of compliance for each classification of joint systems and couplers.

C. If water-tight joints are specified, also provide documentation of source quality control testing for water-tight joints.

D. Provide product data and material certifications for all pipe and fitting materials and components.

1.5 REFERENCES

A. The Standard Specifications for Construction of Roads and Bridges on Federal Highway Projects (FP-24) dated 2024; and published revisions thereto. https://flh.fhwa.dot.gov/resources/specs/

1. Payment descriptions in the FP-24 Standard Specifications shall not apply. Refer to Section 01 27 00 – Definition of Contract Line Items.
2. In case of conflict with the FP-24 Standard Specifications, the most stringent specification shall apply.

B. Applicable ASTM and AASHTO standards.

C. A reference within parentheses to a law or regulation is included in the Contract for convenience only and is not a comprehensive listing of related laws and regulations. Lack of a reference does not indicate no related laws or regulations exist.

D. Where the version of a referenced document is not specified, use the most recent version in effect on the date of the Notice to Bidders.

E. A code not specified as a federal code is a Wyoming code.

F. An agency or a department not specified as a federal or local agency or department is a Wyoming agency or department.

1.6 QUALITY ASSURANCE

A. Conform to the Contract Documents including but not limited to General Conditions, Special Conditions, Permits, Technical Conditions, Drawings, and Standard Specifications.

B. Comply with the quality control and assurance requirements, per the applicable FP-24 Standard Specifications for materials to be used in the work.

1.7 PROJECT CONDITIONS AND REQUIREMENTS

A. Deliver materials to site in unopened cartons or bundles as appropriate, clearly identified with manufacturer's name, standards label, grade or identifying number.

B. Pipe, fittings, gaskets, and other components shall be stored in a way that protects materials from the weather, heat sources, and corrosive liquids. Plastic pipe and fittings shall be protected

from direct sunlight by storing in containers and/or covering with tarpaulins or other suitable materials.

C. In confined linear areas where protection of existing infrastructure, vegetation, and/or soils is specified only equipment that can be safely operated in the confined construction corridor is permitted.

1.8 TOLERANCES

A. Not Used.

PART 2 PRODUCTS

2.1 CONCRETE PIPE MATERIAL

A. Conform to Section 706, Concrete Pipe of the FP-24 Standard Specifications.

B. Circular reinforced concrete pipe shall be Class V, under minimum cover for pipe diameter sizes 24 inches or less, conforming to AASHTO M 170.

C. Elliptical reinforced concrete pipe shall be Class V, under minimum cover for equivalent pipe sizes 24 inches or less, conforming to AASHTO M 207.

D. Joints for storm utility drainage piping shall meet the requirements for “standard, soil-tight” pipe joints, unless otherwise specified as “water-tight” joints.

E. Sealing materials for soil-tight pipe joints may be cement mortar or rubber gaskets.

2.2 BEDDING

A. Pipe bedding material shall conform to Section 704.01 of the FP-24 Standard Specifications and Section 31 23 00 – Excavation and Fill. Bedding material shall be used, except as shown on the Drawings or otherwise allowed by NPS.

B. In cases where native free-draining granular material is suitable for use as bedding and authorized by NPS, the trench may be excavated and bottom hand-shaped so that bottom segment of the pipe is firmly supported on undisturbed material.

C. Use the same bedding material for the entire length of the culvert.

2.3 INITIAL BACKFILL OR PIPE EMBEDMENT

A. Suitable material for the initial backfill or pipe embedment (up to minimum 12 inches above top of pipe) including the haunch area and pipe zone shall conform to requirements for pipe bedding or structural backfill material per Section 704, Soil of the FP-24 Standard Specifications.

B. In cases where native free-draining granular material (free of organics) is suitable for use as pipe embedment and accepted by NPS, the Contractor shall screen the native material to 1.5-inch minus prior to placement in the work.

PART 3 EXECUTION

3.1 GENERAL

A. All existing facilities to remain shall be located and protected from damage during operations. Additional requirements are specified in Section 02 01 00 - Maintenance of Existing Conditions.

B. Layout and place survey stakes for proposed storm water facilities for review and approval on-site by the Contracting Officer prior to excavation and installation.

C. Prior to starting operations, remove any brush and other obstructions that interfere with installation of storm water utilities, conforming to Section 31 11 00 - Clearing and Grubbing.

D. All areas disturbed by the Contractor's operations shall be restored and stabilized as specified in Section 32 90 00 - Restoration.

E. Dewatering may be required to properly complete the work. The excavation and general work area shall be sufficiently dry to allow for the proper construction and inspection of the excavation, subgrade, bedding and backfill materials, and installation of storm water facilities for a complete job in place.

F. Applicable construction operations for excavation and backfill shall conform to Section 31 23 00 - Excavation and Fill, and the applicable provisions of Section 209, Structure Excavation and Backfill of the FP-24 Standard Specifications.

G. Trench and/or excavation widths shall be as shown on the Drawings, but should be no wider than what is required to safely place and compact the backfill material on either side of the pipe or facility.

H. The bottom of the trench and/or excavation shall be graded and prepared to provide a firm and uniform bearing for the facility along its entire length. Unsuitable materials shall be addressed as specified in Section 31 23 00 - Excavation and Fill.

I. In-situ trench and/or excavation foundations shall be no less than 90% relative compaction; any materials placed or added to stabilize trench and/or excavation bottom foundation shall be no less than 95% relative compaction.

J. No storm water facility shall be placed in service until a suitable outfall and specified outlet protection is provided and/or constructed.

3.2 CONCRETE PIPE

A. Concrete piping shall be installed conforming to Section 602, Culverts and Drains of the FP-24 Standard Specifications.

B. Minimum bedding thickness shall be 4 inches (for 4" - 24" pipe) and 6 inches (for 30" -60" pipe) or as shown on the Drawings. For joints, a bell hole or coupling joint depression shall be created to accommodate pipe joint connections and install of the pipe with true grades and continuity of the specified invert elevation.

C. Any pipe fittings, couplers, adapters, connections, etc. as required for the proper construction of the project shall be as specified by the pipe manufacturer and shall be at least equal to that of the pipe joint performance requirements. Where applicable, the Contracting Officer shall review methods and materials proposed for connections to existing structures or pipes of differing material and/or sizes.

D. Where pipes are installed in manholes, drainage inlets, junction boxes or other structures, the connection shall be at least equal to that of the pipe joint performance requirements.

1. Where soil-tight pipe joints are specified, the ends of the pipes shall be placed flush or cut off flush with the inside face of the structure, and be grouted in place with hydraulic cement “non-shrink” grout, unless otherwise shown on the Drawings or directed by the Contracting Officer. Concrete collars (minor concrete, 8-inch thick min) shall be constructed at the exterior of the pipe penetration.
2. Where water-tight pipe joints are specified, the ends of the pipes shall be placed flush or cut off flush with the inside face of the structure. Gaskets or mechanical joints shall be used as provided or recommended by the pipe manufacture to provide the degree of water-tight joint specified.

E. Pipe shall not be placed or backfilled until the Contracting Officer has approved the trench excavation, foundation and bedding materials.

F. Provide the necessary equipment, tools and facilities for lowering and properly placing pipe sections in the trench, without damage to the pipe, or disturbance to the trench.

1. For concrete pipe with lift hole(s), after placing the pipe, fill the open lift holes with cement mortar or concrete plugs before backfilling.

G. Install concrete piping at the locations, along the alignments, and to the grades shown on the Drawings. Install piping beginning at low point. Place bell ends of piping, where appropriate, facing upstream. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions or standards referenced.

H. The final installed alignment shall be such that no reverse grades exist and no point shall vary from a straight line drawn from inlet to outlet by more than 2 percent horizontally and vertically of the culvert length or 1 foot, whichever is less, unless otherwise shown on the Drawings. Position pipe with a longitudinal joint so the joint is opposite the invert.

I. Care shall be taken not to damage pipe sections, joints, or gaskets during assembly. Contractor shall make use of pipe lubricant, installation stub, etc. and follow manufacture recommendations to ensure all pipe sections are pushed “home.” A “come-along” or other similar method should be used; mechanical construction equipment such as an excavator bucket, etc. must not have direct contact with the pipe end sections unless an installation stub and large timber or other suitable cushioning medium is utilized.

J. Pipe shall be firmly joined by form-fitting coupling bands. End sections shall be attached to pipe by connecting bands or other means as recommended by the manufacturer.

K. Changes in direction, without the use of elbows or other fittings, may be accomplished through joint deflection or longitudinal bending, but not both on the same length of pipe. Allowable

joint deflection or longitudinal bending is dependent on pipe size and/or joint design, and shall not exceed the pipe manufacturer's published limits. No deflection in pipe shall be allowed without prior written acceptance by the Contracting Officer.

L. Initial backfill shall be placed and shoveled under the pipe to fill all voids and fully compacted up to the springline to complete the haunch area. Fill shall be placed and compacted uniformly on each side of the pipe to avoid disturbance to the pipe alignment and grade. Mechanical compactors shall not be used directly on the pipe.

M. Pipe zone backfill shall be structural backfill material and placed and compacted to a minimum of 12 inches above the top of pipe as shown on the Drawings. Mechanical compactors shall not be used directly on the pipe.

N. The final backfill section (starting 1-foot above pipe) shall be structure backfill, aggregate base, or "accepted" native soils, as shown on the Drawings, and in conformance with the Specifications.

O. Any trench backfill shall be placed in uniform lifts (not to exceed 8 inches) and shall be compacted as shown on the Drawings, except in no case shall be less than 90 percent relative compaction in structural areas.

P. Where conditions (i.e. space constraints, poor trench wall soil qualities, etc.) are cause for the Contractor's inability to achieve the backfill compaction requirements, flowable fill or controlled low strength material (CLSM) shall not be placed in the work without prior acceptance of the Contracting Officer.

Q. During the use and removal of trench wall supports or boxes, it is critical that the initial backfill, haunch, or pipe embedment material (up to minimum 12 inches above top of pipe) is not to be disturbed once placed and compacted in the trench. It is recommended that a sub-trench, sidewall benches or other methods be utilized to support the bottom bearing section of trench boxes in order to minimize disturbance of the pipe or said backfill material.

R. Pipe distorted more than 5 percent of nominal dimensions, ruptured, or broken shall be replaced.

S. The Contractor shall clean the interior of the pipeline as work progresses and the pipeline shall be clear and free of debris and sediment before acceptance.

3.3 PROTECTION

A. During and after installation and structure backfill, pipe and/or inlet structures shall be protected by an adequate backfill, cover of embankment or other load distribution facility, where applicable, to protect the in place pipe and/or inlet structures from equipment and construction loading.

B. After completion of the final surface improvements, live load traffic from the Contractor's operations shall not exceed the pipe or structure design loads.

END OF SECTION 33 40 00

APPENDIX C - POTABLE WATER HYDRAULIC ANALYSIS

PROPOSED WATER DEMAND CALCULATIONS

AVERAGE DAY DEMAND [1]	125	gpd
MAXIMUM DAY DEMAND [1]	340	gpd
PEAK HOUR FACTOR [3]	4	PHF

CANYON GOVERNMENT AREA: PROPOSED WATER DEMAND						
	OCCUPANCY PER UNIT [5]	NUMBER OF UNITS [5]	TOTAL OCCUPANCY [4]	AVERAGE TOTAL, GPD	MAXIMUM TOTAL, GPD	PEAK HOUR, GPM
2- BEDROOM UNIT	2	10	20	2,500	6,800	18.9
			TOTAL WATER DEMAND	2,500	6,800	18.9
FIRE FLOW	B105.1 ONE-AND-TWO FAMILY DWELLINGS. THE MINIMUM FIREFLOW AND FLOW DURATION REQUIREMENTS FOR ONE AND TWO FAMILY DWELLINGS HAVING A FIRE FLOW CALCULATION AREA THAT DOES NOT EXCEED 3,600 SQUARE FEET (344.5 M2) SHALL BE 1,000 GALLONS PER MINUTE (3785.4 L/MIN) FOR 1 HOUR					

[1] water demand based on daily rates from the WYDEQ CH 12, Section 8

[2] sewer demand based on daily flow rates from the WYDEQ CH 25, Section 5, Table 1

[3] peak hour factor based on busiest hour occuring during the busiest quarter of the day

[4] IFC - appendix b, Table B105.1, one-and two family dwellings period each night

[5] occupancy/bedroom count based on current developmental program

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******************************************************************
*                          E P A N E T                           *
*                   Hydraulic and Water Quality                  *
*                   Analysis for Pipe Networks                   *
*                         Version 2.2                            *
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Input File: canyonvillage_water.net

prueba

Link - Node Table:

Link ID	Start Node	End Node	Length ft	Diameter in
p1	n1	n2	23.51	6
p4	n6	n7	3.669	6
p8	n5	n11	722.6	6
p10	n14	n15	168.8	6
p20	n32	n33	815.5	4
p21	n34	n1	225.9	6
p24	n36	n37	513.9	6
p28	n43	n42	73.69	6
p79	n137	n138	35.91	6
p107	n183	n184	17.96	6
p110	n7	n36	402.3	6
p115	n189	n3	411	4
p118	n11	n193	41.61	6
p120	C7	n196	5	2
p121	n196	n197	77.55	2
p122	C8	n199	5	2
p123	n199	n200	20	2
p124	n200	n201	52.67	2
p125	C6	n203	5	2
p126	n203	n204	39.85	2
p127	n204	n205	16.79	2
p131	C5	n211	5	2
p132	n211	n212	75.44	2
p133	C4	n214	73.11	2
p134	C3	n216	73.84	2
p135	C2	n218	54.06	2
p136	C1	n220	42.56	2
p137	C9	n222	80.38	2
p138	C10	n224	89	2
p139	n209	Hyd-1	10	6
1	n37	n175	150	6
2	n175	n2	20	6
3	n12	n33	200	4
4	n33	n16	253	4
5	n16	n137	200	8
6	n137	n14	250	6
7	n15	n34	400	6

Link - Node Table: (continued)

Link ID	Start Node	End Node	Length ft	Diameter in	
8	n6	n184	100	6	
9	n184	n34	700	6	
10	n3	n13	100	4	
11	n13	n4	260	4	
12	n13	n189	200	4	
13	n189	n12	10	4	
14	n5	n43	10	6	
15	n43	n32	230	6	
16	n32	n4	10	4	
17	n16	n194	783.7	8	
18	n194	n220	85	8	
19	n220	n206	85	8	
20	n206	n218	10	8	
21	n218	n216	30	8	
22	n216	n214	100	8	
23	n214	n212	50	8	
24	n212	n208	75	8	
25	n209	n224	15	8	
26	n224	n201	50	8	
27	n201	n222	10	8	
28	n222	n197	40	8	
29	n197	n205	30	8	
30	n205	n208	10	8	
Hyd-C5	Hyd-C5	n138	#N/A	#N/A	Pump
Hyd-C4	Hyd-C4	n183	#N/A	#N/A	Pump

Energy Usage:

Pump	Usage Factor	Avg. Effic.	Kw-hr /Mgal	Avg. Kw	Peak Kw	Cost /day
Hyd-C5	0.00	0.00	0.00	0.00	0.00	0.00
Hyd-C4	100.00	75.00	33877.88	111.88	111.88	0.00
				Demand Charge:		0.00
				Total Cost:		0.00

Node Results:

Node ID	Demand GPM	Head ft	Pressure psi	Quality
n1	0.00	8087.48	81.23	0.00
n2	0.00	8087.48	81.24	0.00
n3	0.00	8086.97	64.55	0.00
n4	0.00	8086.97	64.11	0.00
n5	0.00	8086.97	62.81	0.00
n6	0.00	8087.60	79.99	0.00
n7	0.00	8087.60	79.99	0.00
n11	0.00	8086.97	58.48	0.00
n12	0.00	8086.97	65.85	0.00
n13	0.00	8086.97	64.55	0.00
n14	0.00	8087.14	76.75	0.00
n15	0.00	8087.23	76.79	0.00
n16	0.00	8086.97	74.51	0.00
n32	0.00	8086.97	64.11	0.00
n33	0.00	8086.97	70.18	0.00
n34	0.00	8087.46	82.52	0.00
n36	0.00	8087.55	79.10	0.00
n37	0.00	8087.50	79.08	0.00
n42	0.00	8086.97	62.81	0.00
n43	0.00	8086.97	62.81	0.00
n137	0.00	8087.00	76.69	0.00
n138	0.00	8087.00	76.69	0.00
n175	0.00	8087.48	81.24	0.00
n183	0.00	8087.62	80.52	0.00
n184	0.00	8087.61	80.42	0.00
n189	0.00	8086.97	65.85	0.00
n193	0.00	8086.97	58.05	0.00
n194	0.00	8086.86	66.67	0.00
C7	0.00	8086.79	63.61	0.00
n196	0.00	8086.79	63.61	0.00
n197	0.00	8086.79	63.61	0.00
C8	0.00	8086.79	61.44	0.00
n199	0.00	8086.79	61.44	0.00
n200	0.00	8086.79	61.44	0.00
n201	0.00	8086.79	61.44	0.00
C6	0.00	8086.80	63.61	0.00
n203	0.00	8086.80	63.61	0.00
n204	0.00	8086.80	63.61	0.00
n205	0.00	8086.80	63.61	0.00
n206	0.00	8086.84	65.79	0.00
n208	0.00	8086.80	63.61	0.00
n209	0.00	8086.78	59.70	0.00
C5	0.00	8086.81	64.91	0.00
n211	0.00	8086.81	64.91	0.00
n212	0.00	8086.81	64.91	0.00
C4	0.00	8086.82	64.92	0.00
n214	0.00	8086.82	64.92	0.00

Node Results: (continued)

Node ID	Demand GPM	Head ft	Pressure psi	Quality	
C3	0.00	8086.83	65.36	0.00	
n216	0.00	8086.83	65.36	0.00	
C2	0.00	8086.84	65.79	0.00	
n218	0.00	8086.84	65.79	0.00	
C1	0.00	8086.85	66.23	0.00	
n220	0.00	8086.85	66.23	0.00	
C9	0.00	8086.79	61.44	0.00	
n222	0.00	8086.79	61.44	0.00	
C10	55.00	8076.27	55.14	0.00	
n224	0.00	8086.78	59.70	0.00	
Hyd-1	0.00	8086.78	59.70	0.00	
Hyd-C5	0.00	0.00	0.00	0.00	Reservoir
Hyd-C4	-55.04	0.00	0.00	0.00	Reservoir

Link Results:

Link ID	Flow GPM	Velocity fps	Unit Headloss ft/Kft	Status
p1	-22.23	0.25	0.10	Open
p4	22.23	0.25	0.13	Open
p8	0.01	0.00	0.00	Open
p10	-55.04	0.62	0.56	Open
p20	0.04	0.00	0.00	Open
p21	-22.23	0.25	0.10	Open
p24	22.23	0.25	0.10	Open
p28	0.00	0.00	0.00	Open
p79	0.04	0.00	0.00	Open
p107	55.04	0.62	0.54	Open
p110	22.23	0.25	0.10	Open
p115	0.09	0.00	0.00	Open
p118	0.01	0.00	0.00	Open
p120	0.00	0.00	0.00	Open
p121	0.00	0.00	0.00	Open
p122	0.00	0.00	0.00	Open
p123	0.00	0.00	0.00	Open
p124	0.00	0.00	0.00	Open
p125	0.00	0.00	0.00	Open
p126	0.00	0.00	0.00	Open
p127	0.00	0.00	0.00	Open
p131	0.00	0.00	0.00	Open
p132	0.00	0.00	0.00	Open
p133	0.00	0.00	0.00	Open
p134	0.00	0.00	0.00	Open
p135	0.00	0.00	0.00	Open
p136	0.00	0.00	0.00	Open
p137	0.00	0.00	0.00	Open

Link Results: (continued)

Link ID	Flow GPM	Velocity fps	Unit Headloss ft/Kft	Status
p138	-55.00	5.62	118.16	Open
p139	0.00	0.00	0.00	Open
1	22.23	0.25	0.10	Open
2	22.23	0.25	0.12	Open
3	-0.05	0.00	0.00	Open
4	-0.01	0.00	0.00	Open
5	-55.00	0.35	0.14	Open
6	-55.04	0.62	0.56	Open
7	-55.04	0.62	0.56	Open
8	-22.23	0.25	0.11	Open
9	32.81	0.37	0.22	Open
10	0.09	0.00	0.00	Open
11	0.05	0.00	0.00	Open
12	0.04	0.00	0.00	Open
13	-0.05	0.00	0.00	Open
14	-0.01	0.00	0.00	Open
15	-0.01	0.00	0.00	Open
16	-0.05	0.00	0.00	Open
17	55.00	0.35	0.14	Open
18	55.00	0.35	0.14	Open
19	55.00	0.35	0.14	Open
20	55.00	0.35	0.15	Open
21	55.00	0.35	0.13	Open
22	55.00	0.35	0.14	Open
23	55.00	0.35	0.14	Open
24	55.00	0.35	0.14	Open
25	0.00	0.00	0.00	Open
26	-55.00	0.35	0.14	Open
27	-55.00	0.35	0.15	Open
28	-55.00	0.35	0.13	Open
29	-55.00	0.35	0.13	Open
30	-55.00	0.35	0.15	Open
Hyd-C5	0.00	0.00	0.00	Closed Pump
Hyd-C4	55.04	0.00	-8087.62	Open Pump

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*********************************************************************
*                          E P A N E T                              *
*                   Hydraulic and Water Quality                     *
*                   Analysis for Pipe Networks                      *
*                         Version 2.2                               *
*********************************************************************
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Input File: canyonvillage_water.net

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Link - Node Table:

Link ID	Start Node	End Node	Length ft	Diameter in
p1	n1	n2	23.51	6
p4	n6	n7	3.669	6
p8	n5	n11	722.6	6
p10	n14	n15	168.8	6
p20	n32	n33	815.5	4
p21	n34	n1	225.9	6
p24	n36	n37	513.9	6
p28	n43	n42	73.69	6
p79	n137	n138	35.91	6
p107	n183	n184	17.96	6
p110	n7	n36	402.3	6
p115	n189	n3	411	4
p118	n11	n193	41.61	6
p120	C7	n196	5	2
p121	n196	n197	77.55	2
p122	C8	n199	5	2
p123	n199	n200	20	2
p124	n200	n201	52.67	2
p125	C6	n203	5	2
p126	n203	n204	39.85	2
p127	n204	n205	16.79	2
p131	C5	n211	5	2
p132	n211	n212	75.44	2
p133	C4	n214	73.11	2
p134	C3	n216	73.84	2
p135	C2	n218	54.06	2
p136	C1	n220	42.56	2
p137	C9	n222	80.38	2
p138	C10	n224	89.52	2
p139	n209	Hyd-1	10	6
1	n37	n175	150	6
2	n175	n2	20	6
3	n12	n33	200	4
4	n33	n16	253	4
5	n16	n137	200	8
6	n137	n14	250	6
7	n15	n34	400	6

Link - Node Table: (continued)

Link ID	Start Node	End Node	Length ft	Diameter in	
8	n6	n184	100	6	
9	n184	n34	700	6	
10	n3	n13	100	4	
11	n13	n4	260	4	
12	n13	n189	200	4	
13	n189	n12	10	4	
14	n5	n43	10	6	
15	n43	n32	230	6	
16	n32	n4	10	4	
17	n16	n194	783.7	8	
18	n194	n220	85	8	
19	n220	n206	85	8	
20	n206	n218	10	8	
21	n218	n216	30	8	
22	n216	n214	100	8	
23	n214	n212	50	8	
24	n212	n208	75	8	
25	n209	n224	15	8	
26	n224	n201	50	8	
27	n201	n222	10	8	
28	n222	n197	40	8	
29	n197	n205	30	8	
30	n205	n208	10	8	
Hyd-C5	Hyd-C5	n138	#N/A	#N/A	Pump
Hyd-C4	Hyd-C4	n183	#N/A	#N/A	Pump

Energy Usage:

Pump	Usage Factor	Avg. Effic.	Kw-hr /Mgal	Avg. Kw	Peak Kw	Cost /day
Hyd-C5	100.00	75.00	33820.06	1409.10	1409.10	0.00
Hyd-C4	100.00	75.00	33872.96	621.06	621.06	0.00
				Demand Charge:		0.00
				Total Cost:		0.00

Node Results:

Node ID	Demand GPM	Head ft	Pressure psi	Quality
n1	0.00	8083.16	79.36	0.00
n2	0.00	8083.22	79.39	0.00
n3	0.00	8065.67	55.32	0.00
n4	0.00	8065.67	54.89	0.00
n5	0.00	8065.67	53.59	0.00
n6	0.00	8085.95	79.27	0.00
n7	0.00	8085.94	79.27	0.00
n11	0.00	8065.67	49.25	0.00
n12	0.00	8065.67	56.62	0.00
n13	0.00	8065.67	55.32	0.00
n14	0.00	8074.96	71.48	0.00
n15	0.00	8077.23	72.46	0.00
n16	0.00	8065.67	65.29	0.00
n32	0.00	8065.67	54.89	0.00
n33	0.00	8065.67	60.95	0.00
n34	0.00	8082.60	80.42	0.00
n36	0.00	8084.93	77.96	0.00
n37	0.00	8083.65	77.41	0.00
n42	0.00	8065.67	53.59	0.00
n43	0.00	8065.67	53.59	0.00
n137	0.00	8071.61	70.02	0.00
n138	0.00	8073.81	70.98	0.00
n175	0.00	8083.27	79.41	0.00
n183	0.00	8086.44	80.01	0.00
n184	0.00	8086.20	79.81	0.00
n189	0.00	8065.67	56.62	0.00
n193	0.00	8065.67	48.82	0.00
n194	0.00	8042.40	47.40	0.00
C7	0.00	8028.30	38.26	0.00
n196	0.00	8028.30	38.26	0.00
n197	0.00	8028.30	38.26	0.00
C8	0.00	8026.81	35.45	0.00
n199	0.00	8026.81	35.45	0.00
n200	0.00	8026.81	35.45	0.00
n201	0.00	8026.81	35.45	0.00
C6	0.00	8029.19	38.64	0.00
n203	0.00	8029.19	38.64	0.00
n204	0.00	8029.19	38.64	0.00
n205	0.00	8029.19	38.64	0.00
n206	0.00	8037.35	44.35	0.00
n208	0.00	8029.48	38.77	0.00
n209	0.00	8024.88	32.88	0.00
C5	0.00	8031.71	41.04	0.00
n211	0.00	8031.71	41.04	0.00
n212	0.00	8031.71	41.04	0.00
C4	0.00	8033.19	41.68	0.00
n214	0.00	8033.19	41.68	0.00

Node Results: (continued)

Node ID	Demand GPM	Head ft	Pressure psi	Quality	
C3	0.00	8036.16	43.40	0.00	
n216	0.00	8036.16	43.40	0.00	
C2	0.00	8037.05	44.22	0.00	
n218	0.00	8037.05	44.22	0.00	
C1	0.00	8039.88	45.88	0.00	
n220	0.00	8039.88	45.88	0.00	
C9	0.00	8027.11	35.58	0.00	
n222	0.00	8027.11	35.58	0.00	
C10	0.00	8025.33	33.07	0.00	
n224	0.00	8025.33	33.07	0.00	
Hyd-1	1000.00	8023.67	32.36	0.00	
Hyd-C5	-694.41	0.00	0.00	0.00	Reservoir
Hyd-C4	-305.58	0.00	0.00	0.00	Reservoir

Link Results:

Link ID	Flow GPM	Velocity fps	Unit Headloss ft/Kft	Status
p1	-123.43	1.40	2.49	Open
p4	123.43	1.40	2.53	Open
p8	0.01	0.00	0.00	Open
p10	-305.58	3.47	13.42	Open
p20	1.04	0.03	0.00	Open
p21	-123.43	1.40	2.50	Open
p24	123.43	1.40	2.50	Open
p28	0.00	0.00	0.00	Open
p79	-694.41	7.88	61.36	Open
p107	305.58	3.47	13.40	Open
p110	123.43	1.40	2.50	Open
p115	2.05	0.05	0.00	Open
p118	0.01	0.00	0.00	Open
p120	0.00	0.00	0.00	Open
p121	0.01	0.00	0.00	Open
p122	0.01	0.00	0.00	Open
p123	0.01	0.00	0.00	Open
p124	0.01	0.00	0.00	Open
p125	0.00	0.00	0.00	Open
p126	0.00	0.00	0.00	Open
p127	0.01	0.00	0.00	Open
p131	0.00	0.00	0.00	Open
p132	0.00	0.00	0.00	Open
p133	0.00	0.00	0.00	Open
p134	0.00	0.00	0.00	Open
p135	0.00	0.00	0.00	Open
p136	0.00	0.00	0.00	Open
p137	0.00	0.00	0.00	Open

Link Results: (continued)

Link ID	Flow GPM	Velocity fps	Unit Headloss ft/Kft	Status	
p138	0.00	0.00	0.00	Open	
p139	1000.00	11.35	120.56	Open	
1	123.43	1.40	2.50	Open	
2	123.43	1.40	2.51	Open	
3	-1.05	0.03	0.00	Open	
4	-0.02	0.00	0.00	Open	
5	-999.99	6.38	29.69	Open	
6	-305.58	3.47	13.42	Open	
7	-305.58	3.47	13.42	Open	
8	-123.43	1.40	2.50	Open	
9	182.16	2.07	5.15	Open	
10	2.05	0.05	0.00	Open	
11	1.05	0.03	0.00	Open	
12	1.00	0.03	0.00	Open	
13	-1.05	0.03	0.00	Open	
14	0.00	0.00	0.00	Open	
15	-0.02	0.00	0.00	Open	
16	-1.05	0.03	0.00	Open	
17	999.98	6.38	29.69	Open	
18	999.98	6.38	29.69	Open	
19	999.98	6.38	29.69	Open	
20	999.98	6.38	29.69	Open	
21	999.98	6.38	29.69	Open	
22	999.98	6.38	29.69	Open	
23	999.98	6.38	29.70	Open	
24	999.98	6.38	29.69	Open	
25	-1000.00	6.38	29.72	Open	
26	-1000.00	6.38	29.69	Open	
27	-999.99	6.38	29.69	Open	
28	-999.99	6.38	29.70	Open	
29	-999.98	6.38	29.69	Open	
30	-999.98	6.38	29.69	Open	
Hyd-C5	694.41	0.00	-8073.81	Open	Pump
Hyd-C4	305.58	0.00	-8086.44	Open	Pump

APPENDIX D - SEWER MAIN CAPACITY CALCULATIONS

Proposed Sewer (8" PVC)

Full Flow Capacity

Inputs				Calculations			
Pipe Diameter	=	0.667	(ft)	Area	=	0.349	(ft2)
k	=	1.49	(constant)	Perimeter	=	2.095	(ft)
Manning's n	=	0.017	(PVC)	Radius	=	0.167	(ft)
Minimum Slope	=	0.00600	(ft/ft)	Velocity	=	2.057	(ft/s)
				Flow Rate	=	0.719	(cfs)
				Flow Rate (90%)	=	0.647	(cfs)

Flow Data			
Scenario	**Flow (cfs)**	**Depth (in)**	**Average Velocity (fps)**
Average Day	0.0044	0.24	1.120
Peak Day	0.0074	0.36	1.330
Peak Hour	0.0294	0.72	2.020

Existing Sewer (6" PVC)

Full Flow Capacity

Inputs				Calculations			
Pipe Diameter	=	0.500	(ft)	Area	=	0.196	(ft2)
k	=	1.49	(constant)	Perimeter	=	1.571	(ft)
Manning's n	=	0.017	(PVC)	Radius	=	0.125	(ft)
Minimum Slope	=	0.01030	(ft/ft)	Velocity	=	2.224	(ft/s)
				Flow Rate	=	0.437	(cfs)
				Flow Rate (90%)	=	0.393	(cfs)

Flow Data			
Scenario	**Flow (cfs)**	**Depth (in)**	**Average Velocity (fps)**
Average Day	0.0044	0.36	1.030
Peak Day	0.0074	0.48	1.200
Peak Hour	0.0294	0.84	1.830

	DESIGN FLOW PER UNIT	NUMBER OF UNITS	AVERAGE TOTAL, gpd	MAXIMUM TOTAL, gpd	PEAK HOUR, gpm
2- BEDROOM UNIT	280	7	1176	1,960	5.4
3- BEDROOM UNIT	390	0	0	0	0.0
TOTAL Canyon EXISTING SANITARY SEWER DEMAND			1176	1960	5.4

Flow Data				
Scenario	**Existing**	**Proposed**	**Total**	**Total (cfs)**
Average Day	1176	1,680	2856	0.004418884
Peak Day	1960	2,800	4760	0.007364807
Peak Hour	5.4	7.8	13.2	0.029448156

PROPOSED SANITARY SEWER DEMAND CALCULATIONS

RESIDENTIAL DESIGN FLOW RATES PER 2 BEDROOM UNIT [2]	280	gpd
RESIDENTIAL DESIGN FLOW RATES PER 3 BEDROOM UNIT [2]	390	gpd
AVERAGE DAILY DEMAND [2]	60%	gpd
PEAK HOUR FACTOR [3]	4	PHF

CANYON GOVERNMENT AREA: PROPOSED SANITARY SEWER DEMAND

	DESIGN FLOW PER UNIT	NUMBER OF UNITS [5]	AVERAGE TOTAL, gpd	MAXIMUM TOTAL, gpd	PEAK HOUR, gpm
2- BEDROOM UNIT	280	10	1680	2,800	7.8
TOTAL CANYON SANITARY SEWER DEMAND				2,800	7.8

[1] water demand based on daily rates from the WYDEQ CH 12, Section 8

[2] sewer demand based on daily flow rates from the WYDEQ CH 25, Section 5, Table 1

[3] peak hour factor based on busiest hour occuring during the busiest quarter of the day

[4] IFC - appendix b, Table B105.1, one-and two family dwellings period each night

[5] occupancy/bedroom count based on current developmental program

APPENDIX E - TREATMENT PLANT BASIS OF DESIGN REPORT

National Park Service

Rehabilitate/Replace Canyon Village Wastewater Treatment Plant
Schematic Design and Supplemental Services
YELL 310402

Basis of Design Report
Final

June 2022

Prepared by:

Jacobs Government Services Company

Loveland, CO

Contract No. 140P2021D0007

Task Order No. 140P2021F0348

Jacobs

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Acronyms and Abbreviations

Acronym	Abbreviations
#	number
%	percent
>	greater than
°C	degree(s) Celsius
°F	degree(s) Fahrenheit
AA	Annual Average
AASHTO	American Association of State Highway and Transportation Officials
ABA	Architectural Barriers Act
ACH	air changes per hour
ACI	American Concrete Institute
AI	Analog Input
AISC	American Institute of Steel Construction
alum	aluminum sulfate
ANSI	American National Standards Institute
AOR	Actual Oxygen Requirement
AOR	Actual Oxygen Requirement
ASCE	American Society of Civil Engineers
ASHRAE	American Society of Heating, Refrigerating and Air-Conditioning Engineers
ASTM	ASTM International
AWT	Advanced Wastewater Treatment
BNR	Biological Nutrient Removal
BOD	biochemical oxygen demand

Acronym	Abbreviations
BOD_5	5-day biochemical oxygen demand
BODR	Basis of Design Report
BUR	buried
CELDI	cement encased lined ductile iron
CI	Continuous Insulation
CLDI	cement-lined ductile iron
CMU	concrete masonry unit
COD	chemical oxygen demand
COP	copper
COR	Contracting Officer's Representative
CPVC	chlorinated poly vinyl chloride
DB	Design-Build
DEQ	Wyoming Department of Environmental Quality
DI	Digital Input
DO	Digital Output
DSC	Denver Service Center
E. coli	*Escherichia coli*
ENC	encased
EXE	exposed exterior
EXI	exposed interior
ft	feet (foot)
ft/sec	feet per second
ft^2	square feet
ft^3/mg	cubic feet per million gallons

Acronym	Abbreviations
g	gravity
gal/ft^2	gallon(s) per square foot
GLDI	glass-lined ductile iron
gpd	gallon(s) per day
gph	gallon(s) per hour
gpm	gallon(s) per minute
HDPE	high-density polyethylene
hp	horsepower
HVAC	heating, ventilation, and air conditioning
I&C	instrumentation and control
I/I	Infiltration and inflow
IBC	International Building Code
ICC	International Code Council
IEBC	International Existing Building Code
IECC	International Energy Conservation Code
IFC	International Fire Code
IP	internet protocol
IT	information technology
kWh	kilowatt-hour(s)
kWh/yr	kilowatt-hour(s) per year
lbs/d	pounds per day
MAU	makeup air unit
MBR	membrane bioreactor
MCC	motor control center

Acronym	Abbreviations
MCER	maximum considered earthquake
mg/L	milligram(s) per liter
mgd	million gallon(s) per day
mg-N/L	milligram(s) nitrogen per liter
mg-P/L	milligram(s) phosphorus per liter
mJ/cm^2	millijoule per square centimeter
MLR	mixed liquor recycle
MLSS	mixed liquor suspended solids
mm	millimeter(s)
MM	Maximum Month
MPN	most probable number
N/A	not applicable
NAVD88	North American Vertical Datum of 1988
NFPA	National Fire Protection Association
NGS	National Geodetic Survey
NPS	National Park Service
NPW	nonpotable water
O&M	operations and maintenance
Park	Yellowstone National Park
PD	Peak Day
PLC	programmable logic controller
psf	pound(s) per square foot
PVC	polyvinyl chloride

Acronym	Abbreviations
RAS	return activated sludge
RFP	request for proposal
SCADA	supervisory control and data acquisition
scfm	standard cubic feet per minute
SD	schematic design
SOR	Standard Oxygen Requirement
SOTE	Standard Oxygen Transfer Efficiency
SRT	solids residence time
SUB	submerged
SWD	side water depth
TDH	total dynamic head
TKN	total Kjeldahl nitrogen
TMP	transmembrane pressure
TRC	Total Residual Chlorine
TSS	total suspended solids
TWAS	thickened waste activated sludge
UIC	Underground Injection Control
UV	ultraviolet
VFD	variable-frequency drive
WAS	waste activated sludge
WWTP	Wastewater Treatment Plant

DISCLAIMER: If using a screen reader, adjustment to your default settings may be required.

Executive Summary

Introduction

The National Park Service owns and operates the Canyon Village Wastewater Treatment Plant (WWTP) located in Yellowstone National Park. The existing Canyon Village WWTP has not had major upgrades since the 1990s construction and has surpassed its useful design life. To address these issues, meet expected permit limits, and allow for continued operation over a 50-year planning period, a new facility is proposed. The upgrades to the Canyon Wastewater Treatment Plant (WWTP) will be performed in two phases identified as Phase 1 and Phase 2 due to budget constraints. Phase 1 is part of this project, while Phase 2 will occur at a future undetermined time. This Basis of Design Report documents the background and criteria for the Schematic Design Phase for both phases.

The following is proposed for the new treatment facility:

- Construct a new headworks with fine screens, grit removal, and septage receiving to reduce solids in downstream processes and allow for easier operation when discharging vault toilet or septage wastes into the facility in Phase 1.
- Install a submersible Intraplant Pump Station. The pump station will serve to pump water from the solids lagoon to the headworks in Phase 1 and permanently take flows directed to the solids lagoon and other process drains in Phase 2.
- Construct a new secondary treatment system with membrane bioreactors and install ultraviolet disinfection to provide to provide high quality permeate discharge.
- Construct a new solids treatment train capable of breaking down solids to meet disposal regulations and add the ability to mechanically dewater sludge to reduce the time required for drying and reduce solids volume for offsite disposal in Phase 2.
- Provide new operations and maintenance facilities and a new laboratory to perform in-house sampling and testing in Phase 2.
- Upgrade supervisory control and data acquisition system in Phase 2.
- Provide backup generators and options for alternative power sources to reduce reliance on unreliable power in Phase 2.
- Maintain existing treatment plant operations during construction.
- Consider treatment and operations during seasonal variations, startup, and shutdown.

Treatment Process Design Criteria

Design flows were analyzed in the Predesign Report and considered future visitation, employee increases, and current infiltration and inflow and assumed future infiltration

and inflow reduction, at Canyon Village. The facility was designed around a maximum month flow in 2075. Current flows and seasonal variation were also considered in the design to allow for operation over the proposed planning period. Table ES-1 summarizes the design flow conditions.

Table ES-1. Canyon Village WWTP Design Influent Flows

Period	2020		2075[a]	
	mgd	gpm	mgd	gpm
Winter flows (November to Early April)	0.04	28	0.04	28
Average season	0.35	243	0.35	243
Maximum month	0.50	347	0.50	347
Maximum-day	0.80	556	0.80	556
Peak hour	1.5	1,042	1.5	1,042
Septage/vault waste flows (trucks per week)[b]	3		9	

[a] 2075 design flows assume substantial infiltration and inflow reduction and low fixture usage.
[b] Septage hauling trucks are approximately 2,500 gallons in capacity.
gpm = gallon(s) per minute
mgd = million gallons per day

In addition to flows, nutrient concentrations and loadings are critical parameters for the WWTP design. The chosen values for these parameters are conservative based on historical data and projected growth. Table ES-2 summarizes the Canyon Village WWTP loading conditions.

Table ES-2. Canyon Village WWTP Design Maximum Month Influent Loads

Parameter		Units	2020	2075
Influent flows [a]	Total suspended solids	(lbs/d)	949	1,499
		(mg/L)	228	359
	BOD_5	(lbs/d)	1,460	2,306
		(mg/L)	350	553
	Total Kjeldahl nitrogen	(lbs/d)	209	329
		(mg/L)	50	79
	Ammonia-N	(lbs/d)	146	231
		(mg/L)	35	55
	Phosphorus-P	(lbs/d)	25	40
		(mg/L)	6	9

Parameter		Units	2020	2075
Septage/vault waste	Total suspended solids	(mg/L)	30,000	30,000
		(lbs/d)	625	1,476
	Chemical oxygen demand (COD)	(mg/L)	30,000	30,000
		(lbs/d)	625	1,476
	Total Kjeldahl nitrogen	(mg/L)	7,800	7,800
		(lbs/d)	162	162
	Phosphorus-P	(mg/L)	940	940
		(lbs/d)	20	46

[a] Influent loading excludes septage and vault waste flows.
BOD_5 = 5-day biochemical oxygen demand
lbs/d = pound(s) per day
mg/L = milligram(s) per liter

The Basis of Design Report describes the requirements that each facility needs to be designed around to treat the previously listed influent parameters and meet the proposed effluent requirements. Additionally, the Basis of Design Report summarizes the civil, site, architectural, landscaping, structural, process mechanical, building services, fire protection, instrumentation and control, electrical, constructability and sustainability requirements for the proposed WWTP at Canyon Village.

Chapter 1 – Introduction

1.01 Project Background

The National Park Service (NPS) owns and operates the Canyon Village Wastewater Treatment Plant (WWTP) located in Yellowstone National Park (Park). The existing Canyon Village WWTP is rated for 0.5 million gallon per day (mgd) and serves the Canyon Village area of the Park. Canyon Village operates seasonally and is open from May to October. The WWTP collects wastewater generated by Park visitors, NPS, and concessions staff in the Canyon Village area as well as septage waste from the various vault toilets and septic tanks throughout the Park. All the facilities are closed for the winter, but a small crew of NPS and concessioner staff remains at the village through the winter. Wastewater flows and loads to the WWTP are greatly reduced in the winter.

The existing Canyon Village WWTP has not had major upgrades since the 1990s construction and has surpassed its useful design life. The collection and treatment system and its components have shown continued signs of deterioration and pose risks for periodic failures that could lead to sewage spills. The WWTP has also exceeded its Wyoming Pollutant Discharge Elimination System permit effluent limits. The WWTP experiences significant infiltration and inflow (I/I), causing operational issues at the treatment plant. Park visitation has been increasing and this trend is expected to continue, which will increase the wastewater generated in the Park. Increased wastewater loads require new design considerations for the Canyon Village WWTP. The existing WWTP is not equipped to remove ammonia, nitrates, or phosphorus and thus is not well-positioned for potential future discharge regulatory limits.

To address these issues and provide continued Canyon Village WWTP operation for the next 50 years, a new facility is proposed. The upgrades to the Canyon Wastewater Treatment Plant (WWTP) will be performed in two phases identified as Phase 1 and Phase 2 due to budget constraints. Phase 1 is part of this project, while Phase 2 will occur at a future undetermined time. This Basis of Design Report documents the background and criteria for the Schematic Design Phase for both phases.

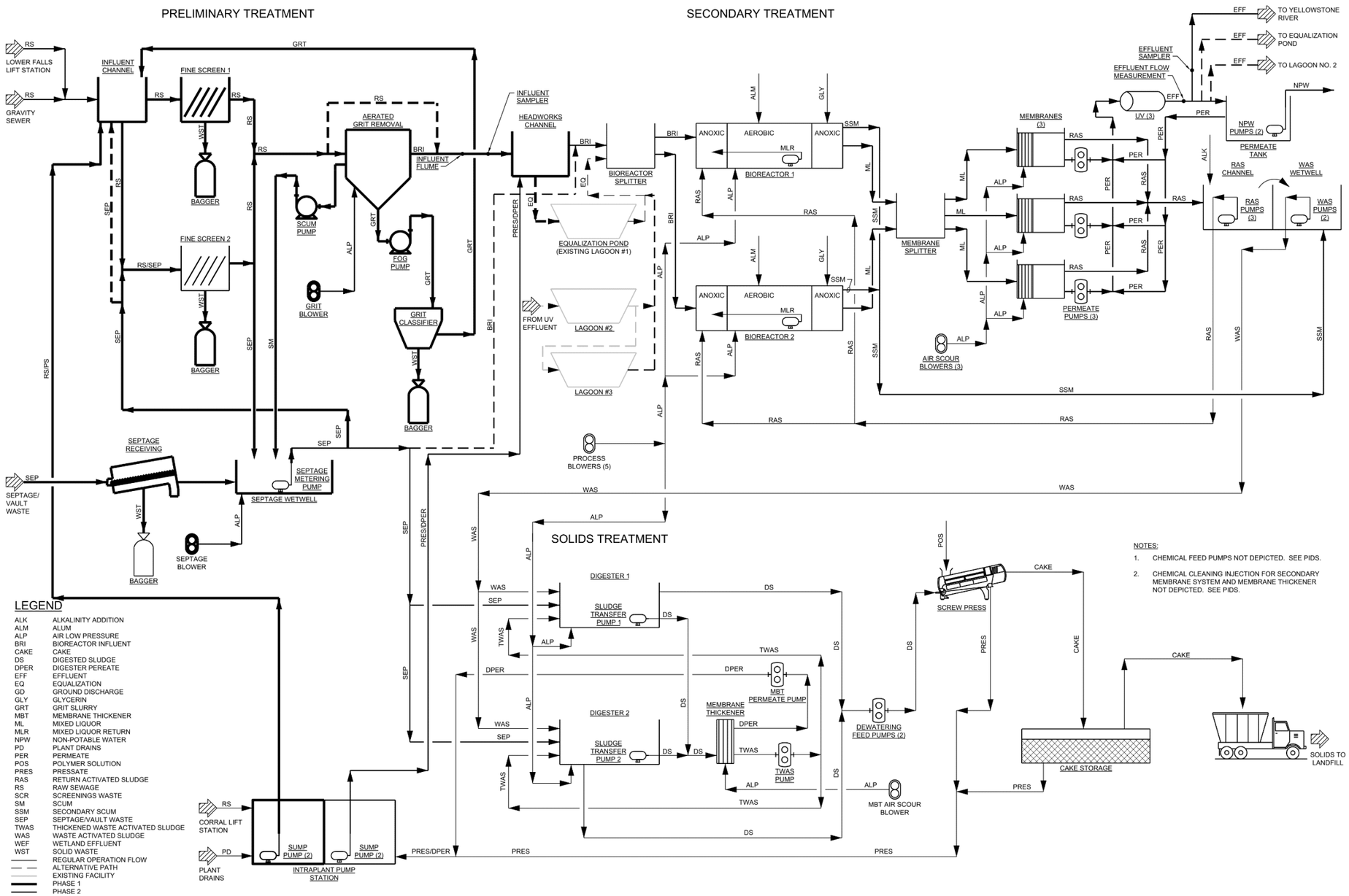
The following is a summary of the project goals:

- Construct a new liquid process train with headworks, membrane bioreactor (MBR) system, and process effluent disinfection capable of treating maximum month flow of 0.5 mgd to the proposed effluent limits.
- Install a submersible Intraplant Pump Station. The pump station will serve to pump water from the solids lagoon to the headworks in Phase 1 and permanently take flows directed to the solids lagoon and other process drains in Phase 2.

- Construct a new solids treatment train capable of breaking down solids to meet disposal regulations and add the ability to mechanically dewater to reduce sludge hauling.
- Maintain existing treatment plant operation during construction.
- Consider treatment and operation during seasonal variations, startup, and shutdown.
- Rehabilitate existing lift stations at the Government Area and Brink of Upper Falls.
- Improve electrical reliability and reduce periods of dirty power through the use of solar power, uninterruptible power supply, and a backup generator.
- Upgrade the supervisory control and data acquisition (SCADA) system.
- Provide the proposed process schematic design.

The proposed plant is designed to meet the effluent limits with the variations in flows and loads. Figure 1-1 shows the proposed treatment system process flow diagram.

Figure 1-1. Process Flow Diagram of the Major Components at Canyon Village Wastewater Treatment Plant



1.02 Phasing

Due to budget constraints, the Canyon Village WWTP project is split into two distinct phases. Phase 1 is part of this project, while Phase 2 will occur at a future undetermined time under a separate request for proposal (RFP) and contract. Engineering and design work was completed for both phases and this Basis of Design Report includes information for both phases.

Phase 1 primarily includes collection system rehabilitation, new headworks, two new lift stations, an Intraplant Pump Station, and additional miscellaneous improvements, while Phase 2 includes the remaining scope (MBR, Process Building, digesters, Dewatering Building, Operations and Maintenance (O&M) Storage Building, Dewatered Cake Storage Building, etc.). Refer to the RFP for additional detail on scope of Phase 1 and Phase 2.

Chapter 2 – Treatment Process Facilities

2.01 Treatment Process Design Requirements

Design flows for current and future conditions were developed by reviewing flows and loads from available data from 2018 to 2021 and projecting future growth based on planned development and future visitation expectations. 2075 loads were projected to increase substantially due to the growth in daily visitors as well as minor growth in overnight housing. Substantial rehabilitation of the collection system will reduce I/I and additions of water efficient plumbing fixtures (that is, toilets, showers, faucets) will also drive flow reductions. Flow increases from daily visitors and overnight population growth are anticipated to be more than offset by the reductions in I/I and savings from water -efficient fixtures. The 2075 flow was assumed to remain similar to existing flow.

Additionally, the plant experiences seasonal flow variations, including substantially lower winter flows. The plant is designed to operate at projected future flow and loading conditions. Table 2-1 summarizes the Canyon Village WWTP design influent flows at various conditions.

Table 2-1. Canyon Village WWTP Design Influent Flows

Period	2020		2075[a]	
	mgd	gpm	mgd	gpm
Winter flows (November to March)	0.04	28	0.04	28
Average season	0.35	181	0.35	243
Maximum month	0.50	382	0.50	347
Maximum-day	0.80	556	0.80	556
Peak hour	1.5	1,042	1.5	1,042
Septage/vault waste flows (trucks per week[b])	3		9	

[a] 2075 design flows assume substantial infiltration and inflow reduction and low fixture usage.
[b] Septage hauling trucks are approximately 2,500 gallons in capacity.
gpm = gallon(s) per minute

In addition to flows, nutrient concentrations and loadings are critical parameters for the WWTP design. The chosen values for these parameters are conservative based on historical data and projected growth. Vault toilet waste has very high 5-day biochemical oxygen demand concentrations, total suspended solids, nitrogen, and phosphorus, while septage has had some biochemical oxygen demand stabilization but more concentrated nitrogen and phosphorus than vault toilet waste. Table 2-2 summarizes the Canyon WWTP design influent loads.

Table 2-2. Canyon WWTP design influent loads

Parameter		Units	2020	2075
Influent loads[a]	Total suspended solids	(lbs/d)	949	1,499
		(mg/L)	228	359
	Total BOD_5	(lbs/d)	1,460	2,306
		(mg/L)	350	553
	TKN-N	(lbs/d)	209	329
		(mg/L)	50	79
	Ammonia-N	(lbs/d)	146	231
		(mg/L)	35	55
	Phosphorus-P	(lbs/d)	25	40
		(mg/L)	6	9
Septage/vault waste	Total suspended solids	(mg/L)	30,000	30,000
		(lbs/d)	625	1,476
	Total COD	(mg/L)	30,000	30,000
		(lbs/d)	625	1,476
	TKN-N	(mg/L)	7,800	7,800
		(lbs/d)	162	162
	Phosphorus-P	(mg/L)	940	940
		(lbs/d)	20	46

[a] Influent loading exclude septage and vault waste flow.
lbs/d = pound(s) per day
mg/L = milligram(s) per liter
TKN-N = total Kjeldahl as nitrogen as nitrogen

The peak hour flow is used to design screening and grit removal equipment, while maximum month flows are used to design bioreactors, membranes, digesters, and solids dewatering systems.

2.01.1 Effluent Requirements

All Yellowstone waters, including Yellowstone River, are classified as Outstanding National Water Resources. Under this classification, the water receives the highest level of protection under the Clean Water Act. The project water quality objectives include meeting the current permit requirements and planning for future regulatory requirements. The Wyoming Department of Environmental Quality (DEQ) stated that more strict limits could be anticipated in the next 10 to 15 years, but specific criteria are

not yet known. The WWTP improvements are designed to meet potential future effluent limits. Total inorganic nitrogen less than 10 milligrams per liter (mg/L) and total phosphorus less than 0.2 mg/L are the effluent nutrient targets for the Canyon WWTP. The future design limits for the Canyon Village WWTP are presented in Table 2-3.

Table 2-3. Canyon Village WWTP Effluent Goals

Parameter	Units	Monthly Average	Weekly Average	Daily Maximum
BOD	mg/L	30	45	90
BOD_5	lbs/d	N/A	N/A	208.5
BOD_5, percent removal, July to September	%	85%	N/A	N/A
TSS	mg/L	30	45	90
TSS	lbs/d	N/A	N/A	208.5
TSS, percent removal, July to September	%	85	N/A	N/A
E. coli (June to October)	MPN colonies/100 mL	126	N/A	235
E. coli (November to May)	MPN colonies/100 mL	630	N/A	630
TRC	mg/L	N/A	N/A	0.5
TRC	lbs/d	N/A	N/A	2.085
pH	Standard Units	6.5 to 9.0		
Ammonia nitrogen	mg-N/L	1.0	N/A	4.0
Total inorganic nitrogen	mg-N/L	10	N/A	N/A
Phosphorus, total	mg-P/L	0.2	N/A	N/A

BOD = biochemical oxygen demand
mg-N/L = milligrams nitrogen per liter
mg-P/L = milligrams phosphorus per liter
mL = milliliter(s)
MPN = most probable number
TSS = total suspended solids

The following sections describe each new facility's design criteria for the new WWTP based on the flows, loads, and effluent discharge requirements discussed in this chapter.

2.02 Headworks (Phase 1)

The existing headworks facility provides operational challenges in receiving septage, and it does not sufficiently remove larger solids that impact downstream treatment processes. Additionally, the building and equipment are beyond their useful life.

The existing headworks will be demolished and replaced with an improved facility. The improved headworks will be able to remove debris and grit through fine screens and aerated grit removal to help prevent debris from damaging downstream equipment and processes. The new facility will also provide a septage receiving facility to allow operators to easily dispose the contents of septic trucks into the plant. The new headworks facility will include the following equipment:

- Removable 3-inch bar rack for large debris removal and two mechanically cleaned fine screens
- One aerated grit removal system and bypass channel
- Influent flow measurement and auto composite sampler
- Headworks splitter structure and gates to equalization and MBRs
- One septage receiving station with septage screening and a septage wetwell pumping station

2.02.1 Mechanical Screening System

Wastewater influent screens are an important treatment process because they remove coarser inorganic materials from the flow stream that could potentially damage or obstruct subsequent process equipment or reduce overall treatment process reliability and effectiveness. To protect the downstream membranes, a fine screen is required to remove particles greater than 2 millimeters (mm). Two mechanical screens will be provided, each capable of peak hour flow capacity for redundancy. Ahead of the fine screen will be a 3-inch bar rack to remove large debris that could damage the fine screens. These bar racks will be removable so they can be taken out of the channels if desired. The mechanical screen will be located in a concrete flow channel. The design criteria are summarized in Table 2-4.

An explosion-proof hot water pressure sprayer will be provided to allow operators to clean the perforate plate screens.

Table 2-4. Mechanical Fine Screening System Design Criteria

Parameter	Value	Units
Number of screens and channels	2 (1 duty, 1 standby)	-
Design flow per screen	1.5	mgd

Parameter	Value	Units
Screen type	Perforated plate screen	-
Screen basket spacing	2	mm
Channel width	18	inches
Channel depth	60	inches
Calculated maximum approach velocity	3.1	ft/sec
Screening production rate	7 to 13.5	ft^3/MG
Power (each)	1.5	hp

2.02.2 Grit Removal System

Grit not removed in the headworks will accumulate in the bioreactors over time and will require substantial effort to remove. Grit can also damage the membranes downstream. An aerated grit removal system is proposed where grit settles and an inverted screw and pump conveys it to a grit classifier causing it to be dewatered before being sent to the dumpster. Because grit problems develop over the long term and the removal system may be bypassed in the short-term, only one grit separator unit will be included. The design criteria for the grit removal system are summarized in Table 2-5.

Table 2-5. Grit Removal System Design Criteria

Parameter	Value	Units
Type of removal	Aerated grit removal	-
Particle removal	95% >75 micrometers	-
Number of channels	1	-
Design flow capacity	1.5	mgd
Surface area	120	ft^2
Headloss at peak hour flow	2.6	inches
Grit bypass channel	1	-
Grit Production rate	2	ft^3/MG
Grit Screw		
Type	Shafted horizontal steel grit transfer screw	-
Power	0.75	hp
Grit Pump		
Number	1	-
Power	3	hp

Parameter	Value	Units
Grease and Scum Removal		
Number	1	-
Power	0.33	hp
Blower		
Number	1	-
Power	0.9	hp
Grit Classifier		
Number	1	-
Power	1.5	hp

ft^3/MG = cubic feet per million gallons
hp = horsepower

2.02.3 Influent Flow Measurement and Sampling

Influent flow will be measured through a Parshall flume with a level sensor. Influent samples will be collected by an automatic composite sampler from the influent channel. The sampler should be rated as Class 1 Division 1 and hardwired as it will be located in a Class 1 Division 1 setting. The sampling location will be provided with a flow-paced sampler controller. The samples will be collected into a large sample bottle to provide a composite sample that accurately captures the flow-paced influent concentrations. Table 2-6 shows the design criteria for the influent flow measurements and influent sampling.

Table 2-6. Influent Flow Measurement, Sampling, and Splitter

Parameter	Value	Units
Type	Parshall flume with level sensor	-
Capacity	1.5	mgd
Throat width	6	inches
Influent sampling	24-hour composite	-

The headworks effluent channel will have two gates that can modulate based on flow and direct flow to either the aeration basin or the Equalization Pond. The modulation of the gates is based on flow measured in the pipe to the bioreactors. If the flow to the bioreactors exceeds peak day flow (0.8 mgd), the gate associated with the Equalization Pond will open to a position that will direct all of the excess flow to the Equalization Pond. Once the total flow is less than peak day flow, the gate directing flow to the Equalization Pond will fully close and all flow will be directed to the bioreactors. Table 2-7 summarizes the design criteria for the effluent channel and splitter.

Table 2-7. Headworks Effluent Channel Design Parameters

Parameter	Value	Units
Gates	2	-
Type	Modulating gates	-
Control	Level and flow sensors	-

2.02.4 Septage Receiving

Septage and vault waste collected from locations around the Park are sent to Canyon Village WWTP. The mixture of these is highly concentrated wastes, when discharged directly into the process, can result in process upsets. To prevent process upsets and improve operation, a new septage receiving system will be installed at the Headworks Building. The septage receiving station will provide an easy way to connect the septage truck to discharge into the plant. The septage receiving facility will remove large debris and then send the waste to one of the fine screens channels where it discharges to the septage wetwell. The septage wetwell will have a submersible pump that meters the septage to the aerobic digester or the bioreactors where it will be further treated. Septage can also be combined with influent flow in the influent channel and sent through the bioreactors and membranes. Aeration will be provided in the septage wetwell to reduce odors and keep the contents mixed. Table 2-8 shows the septage receiving facility design criteria.

Table 2-8. Septage Receiving design parameters

Parameter	Value	Units
Septage receiving	Septage receiving with truck quick connect	-
Capacity	700	gpm
Removal	>10	mm
Power	3	hp
Septage pumps	Submersible pump variable-frequency drive	
Number of Pumps	2 (1 Duty, 1 Shelf Spare)	-
Capacity	100	gpm
Power	3	hp
Septage wetwell		
Volume	8,000	gallons
Aeration Type	Fine bubble diffusers	-
Blower		

Parameter	Value	Units
Power	10	hp

2.03 Secondary Treatment (Phase 2)

Wastewater from the headworks can flow either to the bioreactor splitter structure or to the Equalization Pond where excess flow can accumulate upstream of the bioreactors in the event of high flows. The Equalization Pond will take flow in excess of the peak day flow (0.8 mgd). The Equalization Pond (Existing Lagoon 1) is approximately 1.09 million gallons in capacity. If necessary, additional flows can also be directed from the Equalization Pond to existing Lagoons 2 and 3. This flexibility allows the membranes, which are the rate limiting step, to be smaller and not sized to treat peak hour flows. Effluent from the Equalization Pond can then flow to the bioreactor splitter structure, which can send flow to either parallel bioreactor.

MBR treatment consists of the bioreactors and the membranes. A Biological Nutrient removal (BNR) (4-stage) MBR is proposed for this process which consists of a pre-anoxic zone, aerated zone, post-anoxic zone, and an aerated membrane tank. The pre-anoxic zone combines influent, return activated sludge (RAS) from the RAS channel, and mixed liquor recycle from the aerated zone. The pre-anoxic zone denitrifies nitrates to nitrogen gas. The aerobic zone nitrifies ammonia to nitrate. Additionally, alum is added to precipitate phosphorus in the aerobic zone. The post-anoxic zone further denitrifies nitrates to nitrogen gas and has the option to dose glycerin which helps to further break down nitrates by providing the necessary carbon source. After the post-anoxic zone, the mixed liquor flows to the membranes which only allow permeate to pass through, leaving concentrated mixed liquor. Mixed liquor flows to the RAS channel where it is sent back to the process as RAS or to the waste activated sludge (WAS) wetwell followed by the digesters as WAS.

All zones in the bioreactor are mixed to prevent sludge settling, short circuiting, and to provide bacteria access to nutrient loads. In the anoxic zones, variable-frequency drive (VFD) mixers will agitate the tank to provide mixing. The aerobic zones will be aerated via a fine bubble membrane air diffusion system to provide both mixing and dissolved oxygen for biological needs. Airflow to a bioreactor affects the DO concentration in the aerobic zone, which in turn affects nitrification (ammonia removal) and BOD_5 removal. The aerobic zones will be aerated via a fine bubble membrane air diffusion system to provide both mixing and DO for biological needs. The bioreactors will be equipped with dissolved oxygen sensors and ammonia and nitrate sensors to enable ammonia-based aeration control that will allow air to turn off in the aerobic zones for short periods of time when the ammonia setpoint has been achieved, enabling denitrification. Two bioreactors and three membrane trains are proposed in the design. System capacity was sized such that redundancy requirements for 2075 maximum month flows are met. Additionally, the process was evaluated at current annual average, current maximum month, and 2075 annual average conditions. These four conditions were evaluated for

the flow and loading range as design criteria for the biological process and other treatment equipment.

The secondary treatment has four major components:

- Bioreactor splitter structure and Equalization
- Bioreactors
- Membrane tanks
- RAS and WAS Channel and Pumping

2.03.1 Equalization Pond and Lagoons 2 and 3

Flow equalization is provided upstream of the MBR process to provide operational flexibility during periods of flow greater than the MBR treatment design capacity. Headworks flow is controlled by modulating gates that typically direct all the influent flow to the bioreactors. During periods of high flow greater than the design peak day of 0.8 mgd, excess flow will be diverted to the Equalization Pond, Existing Lagoon 1. If necessary, flow from the Equalization Pond can be directed to Lagoons 2 and 3. The Equalization Pond receives the excess flow until the influent flow rate drops below 0.8 mgd. After the peak flow rate passes, an actuated valve opens from Lagoon 1 to drain to the influent splitter box. To drain from Lagoons 2 and 3, manual valves must be opened to direct the flow to combine with Equalization Pond flow before entering the Bioreactor Splitter Box.

A submersible pressure-based level sensor is installed in all three lagoons to measure level. Potential locations for these sensors include a new Equalization Pond effluent wetwell, the chlorine injection manhole downstream of Lagoon 2, and the effluent structure of Lagoon 3. The level sensors will have a local display and also be able to connect to SCADA. The level sensor should be easily retrieved for maintenance, durable enough to withstand many seasons of ice and snow, and able to read level during winter months.

Table 2-9 summarizes the design criteria for the equalization basin.

Table 2-9. Equalization Pond Design Criteria

Parameter	Value	Units
Number	1	-
Volume	1,092,080	gallons
Maximum month flow retention time	2.2	Days
Aeration type	Existing subsurface pipe with	-

Parameter	Value	Units
	perforations	
Level INDICATOR	Floating (1 level sensor for each lagoon)	-

2.03.2 Bioreactor Splitter Structure

Headworks and the equalization basin flows are routed to the influent splitter structure which has two manual gates that split flow to either of the two aeration basins. Table 2-10 summarizes influent splitter structure design criteria.

Table 2-10. Influent Splitter Structure Design Criteria

Parameter	Value	Units
Volume	5,200	gallons
Gates	Manually operated gate	-
Number	2	-
Gate Width	2	ft

2.03.3 Membrane Bioreactors

Two MBRs are proposed with four zones in each. Design criteria for MBRs are presented in Table 2-11. Table 2-12 presents the MBR sizing, and Table 2-13 provides the MBR equipment.

Table 2-11. Membrane Bioreactor Design Criteria

Parameter	Value	Units
Configuration type	4-stage BNR MBR	-
Number of trains	2	-
Total volume	507,000	gallons
Zones	Pre-Anoxic / Aerobic / Post-Anoxic / Aerated Membrane	-
Percent of total volume for each MBR zone	32 / 46 / 12 / 11	%
Number of bioreactors	2	-
Volume (excluding membrane tanks)	453,000	gallons
Volume per bioreactor (excluding membrane tanks)	226,500	gallons
Width, each	25	feet

Parameter	Value	Units
Length, each (excluding membranes)	75	feet
Depth (side water)	16	feet
Freeboard	3	feet

The MBRs are designed to handle maximum month flows in 2075 but can be operated to handle seasonal flow variations from construction to 2075. Table 2-11 shows the reactor operating parameters at different operating years and conditions.

The design influent water temperature is a key parameter in the design of the bioreactors. Lower temperatures reduce biological nutrient removal. The design temperature of 14°C is the minimum 14-day running average temperature in June based on available data. Influent temperatures will range from 6 to 20°C throughout the year.

Table 2-12. Bioreactor Design Criteria

Parameter	Units	2020 Annual Average	2075 Maximum Month
Influent flow (per bioreactor)	mgd	0.17	0.25
Design temperature[a]	°C	14	
Mixed liquor suspended solids	mg/L	6,000 to 10,000	
Mixed liquor recycle (per basin)	mgd	0.34	0.5
RAS Flow (each)	mgd	0.68	1.0
DO[b]	mg/L	2.0	
Aeration	scfm	700	1,800
Aerobic SRT	Days	13	7.8
Total SRT	days	25	13

[a] Design temperature is the minimum 14-day running average in June. Higher and lower temperature ranges are expected.
[b] DO is designed for 2 mg/L at maximum month conditions.
° C = degree(s) Celsius
MLSS = mixed liquor suspended solids
scfm = standard cubic feet per minute
SRT = solid residence time

Table 2-13 describes the equipment in the bioreactors.

Table 2-13. Membrane Bioreactor Equipment

Parameter	Value	Units
Baffle walls per bioreactor	2, concrete	#, type
Anoxic Zone Mixers, per Bioreactor		
Type	Submersible Propeller, with VFD	#
Number (per train)	1	
Anoxic Zone Mixer size	3	hp
Post-Anoxic Zone Mixers, per Bioreactor		
Type	Submersible Propeller, with VFD	
Number (per train)	1	
Post-anoxic zone mixer size	2.3	hp
Aerobic Zone Aeration		
Type	Fine bubble diffuser aeration grid	-
DO setpoints in aerobic zones	2.0	mg/L
AOR	4,300	lbs O_2/day
AOR/SOR	0.27	-
Minimum SOTE	30%	%
Mixed Liquor Recycle Pumps		
Type	Centrifugal submersible pump on VFDs	
Number (per train)	1	
Internal recycle pump	560	gpm
Power (each)	3	hp
Blowers		
Number	3 (2 duty, 1 standby shared with aerobic digesters and equalization ponds)	
Blower airflow capacity, each	1,000	scfm
Blower motor size	75	hp, each
Scum Collector		
Type	Fiberglass-reinforced plastic rotating scum skimmer in post-anoxic zone	

SOR = Standard Oxygen Requirement
AOR = Actual Oxygen Requirement
SOTE = Standard Oxygen Transfer Efficiency

2.04 Membranes (Phase 2)

Effluent from the bioreactors flows into a splitter structure with three gates that can direct flow to one of the three membrane tanks. Each membrane tank has a dedicated permeate pump that pulls permeate through the membranes leaving behind concentrated mixed liquor. To keep the membranes clean, air scour blowers displace debris that has caked onto the membranes. Cleaning chemicals are also provided for periodic membrane maintenance.

2.04.1 Membrane Splitter Structure

Flow from the bioreactors is conveyed to the membrane splitter structure, which has three manual gates that split flow to any of the three membrane tanks. Table 2-14 summarize the design criteria for the membrane splitter structure.

Table 2-14. Membrane Splitter Structure Design Criteria

Parameter	Value	Units
Volume	5,200	gallons
Gates	Manually operated gate	-
Number	3	-

2.04.2 Membranes

Two membrane types exist for MBR systems: flat plate and hollow fiber. Table 2-15 shows the membrane tanks design criteria, Table 2-16 summarizes the design criteria for the membrane and membrane equipment.

Table 2-15. Membrane Tanks Design Criteria[a]

Parameter	Value	Units
Number of tanks	3	-
Tank depth	18	feet
SWD	15	feet
Length (each)	10	feet
Width (each)	16	feet
Volume	17,950	gallons

[a] Membrane tank sizes designed around flat plate membranes
SWD = side water depth

Table 2-16. Membrane Equipment Design Criteria

Parameter	Value		Units
Membrane type	Flat Plate	Hollow Fiber	-
Number of membrane tanks	3	3	-
Units per tank	3	3	-
Total area	65,400	65,367	ft^2
Membrane flux @ AA (2075)	5	6	gal/ft^2
Membrane flux @ MM (2075)	8	9	gal/ft^2
Membrane flux @ PD (2075)	12	15	gal/ft^2
Air Scour Blowers			
Type	Positive Displacement		
Number	3		
Air flow	259		scfm
Power	20		hp
Permeate Pumps			
Type	Rotary Lobe		
Number	3		-
Flow	400		gpm
Power	10		hp

gal/ft^2 = gallon(s) per square foot

2.04.3 Membrane Chemical Cleaning

Membranes require periodic cleaning to remove any excess solids caked on the membranes and remove mineral buildup. Membrane cleaning should be performed on a regular schedule or when the transmembrane pressure (TMP) reaches a certain design threshold. Two chemicals accomplish this, citric acid, and sodium hypochlorite. Citric acid is used to remove chemical composites on the membranes while sodium hypochlorite is used to remove organic deposits. Membrane cleaning chemicals will be stored in the Process Building.

2.05 RAS/WAS Pumping (Phase 2)

RAS and WAS will flow over a concrete wall from the membrane tanks into a RAS channel. This channel will help to de-aerate and denitrify the RAS before returning the flow to the bioreactors. RAS will be pumped with submersible pumps located in the RAS

channel. Flow rates will be measured, and the pumps will be controlled on VFDs to control the RAS flow going to the bioreactors. WAS will be surface wasted over another concrete weir into a WAS wetwell, where flow will be pumped to the aerobic digesters by submersible pumps to control the solids retention time (SRT) of the system.

2.05.1 RAS Channel/WAS Wetwell

The RAS channel collects overflow from the membrane tanks and contains the submersible RAS pumps. The WAS wetwell located next to the RAS channel contains the WAS pumps and allows for surface wasting from the RAS channel. Table 2-17 summarizes the RAS channel design criteria.

Table 2-17. RAS Channel Design Criteria

Parameter	Value	Units
Number of tanks	1 (Partitioned into 2 sections)	-
Tank depth	18	feet
SWD	15	feet
RAS Channel		
Volume	30,600	gallons
WAS Wetwell		
Volume	3,030	gallons

2.05.2 RAS Pumps

Table 2-18 describes the RAS pumps design criteria.

Table 2-18. RAS Pumps Design Criteria

Parameter	Value	Units
RAS flow percent	400%	%
RAS pump capacity	1,200	gpm
Number of RAS pumps	2 duty, 1 standby	-
Pump type	Submersible with VFDs	
Motor size	10	hp
Total dynamic head	5	feet

2.05.3 WAS Pumps

WAS will overflow from the RAS channel into the WAS wetwell. Pumps in the wetwell will operate based on level to pump flow to the digesters periodically. Table 2-19 describes the WAS pumps design criteria.

Table 2-19. WAS Pumps Design Criteria

Parameter	Value	Units
WAS Pump Capacity	45	gpm
Number of RAS pumps	2 (1 duty, 1 standby)	-
Pump type	Submersible centrifugal with VFDs	-
Motor size	3	hp
Total Dynamic Head	6	feet

2.06 Disinfection (Phase 2)

The ultraviolet (UV) disinfection process inactivates pathogens, making the disinfected permeate safer to human health and the environment before discharge to the Yellowstone River. The existing chlorination system for disinfection will be replaced with a UV disinfection system. Table 2-20 provides the UV disinfection system design criteria.

Table 2-20. UV Disinfection Design Criteria

Parameter	Value	Units
UV system type	Inline	
Peak day flow total	0.8	mgd
Number of units	3 (2 duty 1 standby)	-
Configuration	Series with bypass	-
Capacity (each)	0.48	mgd
UV transmittance	65	Percent, minimum
UV dose	30	mJ/cm^2, minimum
Pipe diameter	8	Inches
Number of lamps per unit	6	-

mJ/cm^2 = millijoule per square centimeter

2.07 Aerobic Digesters (Phase 2)

Aerobic digesters will stabilize waste sludges from the liquid treatment trains prior to dewatering. The Canyon Village aerobic digestion process design will produce Class B biosolids. WAS from the WAS wetwell will be pumped to two aerobic digesters which can operate in parallel or series. The sludge in the digesters will be continually thickened by cycling through a membrane thickener where digester permeate is sent to the Intraplant Pump Station and pumped to the headworks and concentrated sludge returns to the digester.

Table 2-21 presents the aerobic digestion process design criteria. Table 2-22 provides the aerobic digestion process and equipment sizes.

Table 2-21. Aerobic Digestion Process Design Criteria

Parameter	Value	Units
Type	Aerobic Digester	-
Number	2	-
Operation	Parallel or Series	-
Design temperature	20	°C
Digester design		
Type	Rectangle with sloping bottom, uncovered	
Length (each)	70	feet
Width (each)	26.5	feet
SWD	16	feet
Freeboard	3	feet
Volume (each)	0.25	million gallons
Aeration type	Coarse bubble diffusers	
DO concentration	0.5	mg/L
Digester blowers		
Type	Rotary lobe positive displacement with VFD	-
Number	2 duty, (1 standby shared with aeration basins)	-
Digester blower size	1,220	scfm, each
Digester blower size	100	hp, each
Digester transfer pumps		

Parameter	Value	Units
Type	Submersible w/ VFD	-
Number	2	-
Capacity	100	gpm
TDH	30	ft
Power	7.5	hp, each

The aerobic digesters are designed around 2075 maximum month conditions but can operate at various conditions summarized in Table 2-22.

Table 2-22. Aerobic Digester Operation

Parameter	Units	2020 Annual Average	2075 Maximum Month
WAS flow	gallons per day	9,000	27,000
Solids mass flow rate	lbs/day	600	2,400
SRT	days	75	40
Aeration	scfm	800	2,400
Target concentration	%	2 to 3	

2.07.1 Membrane Thickener

The purpose of the thickener is to concentrate the biological solids and reduce the size of the aerobic digester. The membrane thickener draws sludge from the digester and pulls it through a membrane to further thicken the digester sludge. Permeate is sent to the headworks and thickened sludge is pumped back to the digester. Table 2-23 summarizes the membrane thickener design criteria.

Table 2-23. Membrane Thickener Design Criteria

Parameter	Value		Units
Type	Flat plate	Hollow fiber	-
Number of tanks	1	1	-
Units per tank	3	1	-
Total area	5,166	5,160	ft^2
Thickened solids concentration	3.0 to 3.5		%

Parameter	Value	Units
Permeate Pumps		
Type	Progress Cavity	-
Number	2 (1 duty, 1 shelf spare)	-
Power	3	hp
Flow	150	gpm
Total dynamic head	5	feet
Thickened WAS Pumps		
Type	Rotary Lobe w/ VFD	
Number	2 (1 duty, 1 shelf spare)	-
Power	5	hp
Flow	100	gpm
Total dynamic head	20	feet
Air Scour Blowers		
Type	Positive Displacement	-
Number	1	-
Power	20	hp
Capacity	259	scfm

Membrane Thickener Cleaning Chemicals

Similar to the process membranes, the membrane thickeners require periodic cleaning to remove any excess solids caked on the membranes and remove mineral build up. Two chemicals accomplish this, citric acid, and sodium hypochlorite. Chemicals will be stored in the Dewatering Building.

2.08 Sludge Dewatering (Phase 2)

The existing WWTP uses uncovered sludge drying beds to reduce the sludge liquid content from the lagoon. This can take significant time and is subject to wet weather conditions that interfere with the drying process. This sludge dewatering process will be enhanced by providing mechanical dewatering. The mechanical dewatering system removes water from the digested biosolids to reduce hauling and disposal costs and to make the solids easier to handle.

The proposed new dewatering system includes dewatering feed pumps, a screw press, a polymer blending unit, and an inclined shaftless screw conveyor. The screw press separates liquid from the biosolids using a combination of gravity drainage and compaction to achieve a desired dewatered biosolids (cake) solids concentration. The screw press is recommended because it is simple to operate, has a slow rotating speed, low power requirements, and an enclosed process that minimizes odors.

The screw press will have a dedicated inclined shaftless screw conveyor that transports dewatered cake to a dewatered cake storage facility. The sludge can then be hauled to a landfill. The pressate from the screw press flows by gravity to the Intraplant Pump Station and then pumped back to the Headworks Channel, located downstream of the influent sampler, and mix with the influent wastewater for treatment. The dewatering process and equipment sizes are presented in Table 2-24.

Table 2-24. Dewatering Equipment Sizing Design Criteria

Parameter	Value	Units
Dewatering Feed Pumps		
Type	Rotary lobe with VFD	
Number	2 (1 duty, 1 standby)	-
Capacity	80	gpm
Power	7.5	hp
Screw Press		
Number of units	1	#
Capacity	760	lb/hr
Hydraulic feed rate	45	gpm
Horsepower	5	hp
Estimated cake solids	17%	%TS
Screw Conveyor		
Type	Inclined, Shaftless	
Number	1	-
Power	3	hp

lb/hr = pound(s) per hour

2.08.1 Polymer System

The screw press dewatering process requires the polymer addition to flocculate the solids before dewatering. This greatly facilitates the dewatering process. Before polymer

addition biosolids particles typically have a negative charge, which results in a repulsive force between particles. Polymer is used to condition biosolids by reducing or eliminating this negative charge between particles. This reduction or elimination in charge results in biosolids particles no longer repelling each other but instead combining into flocs. Because biosolids particles normally have a negative charge, a cationic polymer is typically used to neutralize the negative charge. It is recommended that bench scale testing be done during the startup of the facility to determine the preferred polymer for use at the site.

One polymer blending unit will be provided. Neat polymer will be delivered in totes which will feed to the blending skid through a progressing cavity metering pump at the same time as nonpotable water is also fed to the blending skid. The neat polymer and water will combine and mix in the skid before injection to the screw press feed pipe and mixing with the digested sludge via a static venturi mixer. The polymer system will be located adjacent to the screw press in the Dewatering Room. Table 2-25 summarizes the polymer system design criteria.

Table 2-25. Dewatering Polymer System Design Criteria

Parameter	Value	Units
Polymer type	Emulsion	N/A
Polymer bulk density	9.2	lb/gal
Emulsion polymer percent active	40	% Active
Polymer density, active	3.7	lb/gal
Average polymer dose, active basis	30	lb/dry ton
Estimated neat polymer usage @ average dose	18	gal per week
Polymer storage type	Totes	N/A
Number of totes	3	-
Polymer tote volume, each	330	gallon(s)
Polymer makeup system	Hybrid mechanical and non-mechanical polymer blending unit	N/A
Total installed polymer blending skids	1	EA
Polymer blending unit motor size, each	0.5	hp
Polymer metering pump type	Progressive cavity	EA

Parameter	Value	Units
Polymer metering pump motor size, each	0.5	hp

2.09 Sludge Drying Beds (Phase 2)

The existing treatment plant uses four solids drying beds for treating partially dewatered solids taken from the lagoons. The existing drying beds will be demolished and replaced with a concrete pad and prefabricated metal building for sludge cake storage out of the weather. The building will have partially open sides to allow airflow for drying.

2.10 Chemical Storage and Feed (Phase 2)

There are three chemical systems in addition to the polymer system for dewatering and membrane cleaning chemicals included in the new Canyon WWTP design. Each requires storage, pumping, and containment. Chemicals will be flow-paced from the influent flow to the process to which they are being dosed, to optimize chemical use. The chemicals included are:

- Magnesium hydroxide for alkalinity supplementation in the secondary treatment process. This chemical may also be dosed based on an online alkalinity analyzer measurement from the clearwell.
- Aluminum sulfate (alum) for phosphorus removal in the secondary treatment process.
- Glycerin for carbon addition in secondary treatment to decrease total nitrates.

Each chemical is described in greater detail here.

2.10.1 Magnesium Hydroxide

Alkalinity is consumed biologically due to nitrification and chemically with the addition of metal salts (alum), which are acids, for phosphorus removal. While there is a small amount of alkalinity in the influent wastewater, additional alkalinity is required for full nitrification as well as to maintain appropriate pH levels throughout the facility. This is especially true in Yellowstone due to low alkalinity source water. Magnesium hydroxide solution is recommended for alkalinity addition. This liquid chemical is a slurry, so continuous mixing is required. Magnesium hydroxide should not be stored for more than 6 months. Table 2-26 presents the magnesium hydroxide system design criteria.

Table 2-26. Magnesium Hydroxide System Design Criteria

Parameter	Value	Units
Dosing control strategy	Influent flow-paced/alkalinity sensor	-
Dosing point	RAS channel	

Parameter	Value	Units
Chemical	$Mg(OH)_2$ liquid slurry	-
Density	12.80	lb/gal
Solution strength	60%	
Storage type	Double-walled chemical tank	-
Number of storage tanks	1	
Volume per storage tank	1,550	gallons
Mixer	Tank Mixer	
Dosing at 2075 MM conditions	63	gallons/day
Days of Storage at 2075 MM conditions	25	days
Dosing pumps	Peristaltic	
Number of pumps	2	
Flow	2.5	gph
Power (each)	0.25	hp

gph = gallon(s) per hour
Mg(OH)2 = magnesium hydroxide

2.10.2 Aluminum Sulfate

Alum solution will be dosed to the bioreactors in the aerated zone. Alum solution is stable and can be stored for up to 12 months and does not require mixing. Outdoor exposed piping will be heat traced. Dose can be expressed as mass of elemental aluminum (mg/L as Al), as hydrated alum chemical (mg/L $Al_2(SO_4)_3$-$14H_2O$), or as alum liquid product (mg/L as alum). Dose is expressed herein as alum product. Dose is calculated based on requirements to meet secondary effluent total phosphorus of 0.2 mg P/L. Table 2-27 presents the alum storage and equipment sizes.

Table 2-27. Alum System Design Criteria

Parameter	Value	Units
Dosing control strategy	Flow-paced/phosphorous sensor	
Dosing point	Bioreactor – aerobic zone	
Chemical	$Al_2(SO_4)_3$-$14H_2O$	
Density	11.1	lbs/gallon
Solution strength	48.5%	%
Storage type	Double-walled chemical tank	-

Parameter	Value	Units
Number of storage tanks	2	-
Size per storage tank	1,015	gallons
Alum target dose	45 to 65	mg/L as alum
Dosing @ 2025 AA	42	gallons/day
Dosing @ 2075 MM	71	gallons/day
Days of storage @ 2075 MM	28	days
Dosing Pump		
Type	Peristaltic	
Number of pumps	2	-
Pump flow	10	gph
Power each	0.5	hp

2.10.3 Glycerin

Supplemental carbon is a means to immediately increase denitrification performance in anoxic conditions and thus reduce the effluent total inorganic nitrogen. Supplemental carbon is expected to be used short-term and infrequently, on peak flow and loading days. Additionally, glycerin may be required during startup or during periods of low flow to maintain the bioreactor's biology. Table 2-28 provides the supplemental carbon addition design criteria.

Table 2-28. Glycerin Feed Pumps Design Criteria

Parameter	Value	Units
Dosing control strategy	Flow-paced from influent flow, also paced on nitrate sensor from post-anoxic zone	-
Chemical	Glycerin ($C_3H_8O_3$)	-
Density	10.2	lbs/gallon
Solution strength	71%	%
Storage type	Totes	-
Number of storage totes	2	-
Size per storage tank	330	gallons
Dosing @ AA	35	gallons/day
Dosing @ MM	55	gallons/day
Days of storage at maximum	12	days

Parameter	Value	Units
month (2 totes)		
Dosing Pump		
Type	Peristaltic	-
Number of pumps	2 duty	-
Flow	2.5	gph
Power (Each)	0.25	hp

2.11 Nonpotable Water and Permeate Tank (Phase 2)

A portion of disinfected effluent from the UV system will be sent to a permeate tank that will contain a nonpotable water (NPW) system. This system will pump water directly to the NPW system to serve plant requirements. When the flow through the effluent channel is too low to meet the NPW needs, a potable water connection to the permeate well will provide redundancy.

The required flow range for the pump station will be developed during the Detailed Design Phase after all the plant water needs have been established. The pumps will be designed with adjustable speed drives and pressure control valves to cover the required flow and pressure range. Table 2-29 presents the NPW design criteria.

Table 2-29. Nonpotable Water Design Criteria

Parameter	Value	Units
Type	Clearwell with submersible pump	-
Volume	6,200	gallons
Pumps	Submersible centrifugal with VFD	-
Flow	260	gpm
Number of pumps	2 (1 duty, 1 standby)	-
Power	25	hp

2.12 Operations during Construction

2.12.1 Headworks:

The new Headworks Building will be constructed at the existing headworks site. Bypassing raw wastewater around the headworks will be required while the existing headworks is demolished, and the new headworks is constructed. This can likely be done using a temporary gravity flow bypass due to the significant hydraulic gradient available from upstream of the headworks to Lagoon 1. The construction contractor will

need to include bypass flow measurement. The construction contractor will also need to provide a means of discharging the 2,500-gallon septage hauling truck to Lagoon 1 while providing some basic manual screening and large debris removal while the new headworks is under construction. The contractor must ensure that septage tank waste is discharged to Lagoon 1 slowly to prevent shock loads to the system, adding a storage tank that can slowly discharge septage waste into the lagoon would help alleviate this issue, or the construction contractor can find a temporary location for septage waste treatment while the headworks are constructed.

2.13 Seasonal Startup, Operations, and Shutdown

Due to the changing flows and loads throughout the year, various seasonal operational strategies need to be considered. Not that it recommended all three membrane trains be operated during peak season; however, one train is fully redundant and can be taken offline. Table 2-30 summarize the seasonal operational parameters.

Table 2-30. Seasonal Operational Parameters for Current Conditions

Parameter	Winter	Spring	Peak Season	Fall
Months	December to March	March to May	June to September	October to November
Bioreactors online	0	Transition from 0 to 2	2	Transition from 2 to 0
Membrane tanks online	0	Transition from 0 to 3	3	Transition from 3 to 0
Digesters online	0	Transition from 0 to 2	2	Transition from 2 to 0
Membrane thickener	No	Yes	Yes	Yes
Septage receiving	No	Yes	Yes	Yes
Dewatering operation	No	No	Yes	Yes
Lagoons/EQ	Yes	Yes	Yes	Yes

2.13.1 Startup and Early Spring (April to May)

Roads to Canyon Village are typically plowed in mid to late March and administrative access is possible in late March to early May. Canyon Village is open to the public by mid to late April. Once the roads are plowed to Canyon Village, seed sludge should be hauled from a nearby nitrifying activated sludge plant (Old Faithful, Bozeman, Moose WWTP in Grand Teton National Park, or Grant Village WWTP since the Canyon Village WWTP is expected to be constructed years after) and added to the bioreactor that is online. A minimum of one to two truckload(s) of 2,500 gallons will need to be added to seed the treatment process. This seed sludge may not be necessary if the biomass was successfully fed and maintained through the winter (refer to alternative winter

operations below). Supplemental feeding (glycerin) of the organisms may be required during this early startup period to build up the mixed liquor suspended solids in the bioreactor. At this point, no wasting should occur, and the digesters will remain offline. Based on process modeling, effluent ammonia levels less than 1 mg/L is estimated to be achieved in 3 to 4 weeks; it will take longer for the system to fully stabilize. Before peak season, the second bioreactor should be brought online once the first bioreactor is acclimated. When both bioreactors are limited and have sufficient mixed liquor suspended solids, WAS can flow to the first digester. No dewatering will need to be performed until both digesters are full and solids concentrations in the digester are between 2 to 3 percent. The membrane thickener should be run to help achieve desired concentration.

2.13.2 Peak Season (June to September)

During the peak season both bioreactors, three membrane tanks, both digesters, and the membrane thickener will be online. Disinfected permeate will be sent to the Yellowstone River. Dewatering will occur as needed to maintain the desired solids concentration and digester SRT. Dewatered sludge can be sent to the dewatered cake storage facility and left through the summer to further reduce the moisture content. Dewatered cake may remain over winter as freeze-thaw cycles through winter will help to lyse bacterial cells and allow for substantially more drying and volume reduction. Lagoon 1 will operate as an Equalization Pond during flow events above the design peak day flows. Once flows have subsided, equalization should flow to the bioreactors for treatment.

2.13.3 Late Season (October to November)

When the flows decrease, one of the two bioreactors should be emptied and cleaned and the submersible pump should be removed from the unused bioreactor. Both digesters should be emptied by dewatering the sludge and either trucking it to the landfill or allowing it to dry over the winter in the dewatered cake storage facility. The digesters and membrane thickener should be cleaned after they are emptied and the submersible pumps in the digester should be removed. Two of the three membrane tanks should be emptied and cleaned. The membrane thickener should be stored in effluent permeate according to manufacturer's recommendations. The membrane tanks must be filled with treated effluent and any chemicals recommended by the manufacturer to maintain the membranes over the winter. Typically, manufacturers recommend maintaining a chlorine residual. The water level and chlorine level will need to be monitored in these tanks through the winter if the membranes are stored in this manner.

2.13.4 Winter (December to March)

All bioreactors should be taken offline, and all membrane tanks must be filled with chlorinated effluent or potable water to protect the membranes as per manufacturer's recommendations. Startup should be done as soon as seasonal conditions allow.

Influent should be sent to the lagoons and stored all winter until operations come online in the spring. Subsurface aeration should occur at the lagoons to prevent them from freezing and reduce odors. Startup should be done as soon as seasonal conditions allow.

2.13.5 Alternative Winter Operations

If startup every spring is undesirable, during the winter, one bioreactor can remain online along with one membrane train. RAS will continue to recirculate through the reactor. Supplemental feeding of the microorganisms may be required to maintain the biomass through winter months (i.e., glycerin and ammonia sources). Permeate can flow to the lagoons. Lagoons 1, 2, and 3 will be used to store permeate flow through the winter. No wasting should occur during the winter.

2.14 Lift Stations

In addition to the improvements to the Canyon Wastewater treatment system, two existing lift stations will be upgraded or reconstructed, and a new pump station at the WWTP will be constructed.

2.14.1 Government Area Lift Station (Phase 1)

Table 2-31 summarizes the Government Area Lift station design criteria.

Table 2-31. Government Area Lift Station Design Criteria

Parameter	Value	Units
Flow		
AA	8	gpm
PH	32	gpm
Pumps		
Type	Submersible centrifugal, VFD	
Number	2	-
Power	3	hp
Total dynamic head	32	feet
Capacity (each)	100	gpm
Generator	Propane	-
Overflow tank	Connects to existing overflow tank	

2.14.2 Brink of Upper Falls Lift Station (Phase 1)

Table 2-32 summarizes the Brink of the Upper Falls Lift Station design criteria.

Table 2-32. Brink of Upper Falls Lift Station Design Criteria

Parameter	Value	Units
Flow		
AA	70	gpm
PH	275	gpm
Pumps		
Type	Submersible centrifugal, VFD	
Number	2	-
Power	23	hp
Total dynamic head	192	feet
Capacity (each)	150	gpm
Power	30	kW
Overflow tank	Connects to existing overflow tank	

2.14.3 Intraplant Pump Station (Phase 1 and Phase 2)

The Intraplant Pump Station will serve as an intermediate pumping station to transfer flows back to the headworks. This pump station consists of two duplex wetwells and the implementation consists of two phases. For Phase 1, two pumps will be added in the primary well to serve to decant and drain the solids holding pond, which currently takes flows from the Corral Lift Station, Advanced Wastewater Treatment (AWT) backwash, water treatment plant backwash and sanitary sewer, and drying beds underdrain. It will have two inlet pipes that connect to the solids ponds. Each pipe will include a shutoff valve in a valve vault adjacent to the lift station with abovegrade manual valve operator. The upper inlet pipe will have an invert of 7,807 feet and will be used to decant the pond. The lower pipe will have an invert of 7,800 feet, matching the pond bottom and will be used to drain the solids pond. For Phase 2, two additional pumps will be added in the secondary well to direct additional flows, such as pressate from the screw press, permeate from the membrane thickener, and process drains throughout the plant, to the headworks. Note that for Phase 2, flow from the primary well will be directed to the raw influent channel in the headworks and go through screening, and flow from the secondary well will be directed to the effluent channel after the Parshall flume as it does not need to go through screening and additional flow metering. Table 2-33 summarizes the Intraplant Pump Station equipment design criteria.

Table 2-33. Intraplant Pump Station Equipment Design Criteria

Parameter	Primary Well (Phase 1)	Secondary Well (Phase 2)	Units
Pumps	Submersible with VFD	Submersible with VFD	-
Number	2 (1 duty, 1 standby)	2 (1 duty, 1 standby)	-
Power	10	5	hp
Total dynamic head	60	60	feet
Capacity (each)	175	40	gpm

2.15 Operator Needs and Certification

The existing four full-time staff at the Canyon Village Water/Wastewater utility should be sufficient to operate the Phase 1 and Phase 2 improvements with no additional staff. The existing headworks and AWT facility demolition will help to offset any additional O&M labor needed for the new WWTP. NPS should plan to have one full-time person dedicated to the O&M of the Canyon Village WWTP, splitting time about 50/50 between operation and maintenance.

DEQ uses the Association of Boards of Certification point system to rate the level of complexity of a wastewater treatment facility and the associated requirements for operator certification. The proposed wastewater plant will be classified as a Level 4 plant which is the highest level of complexity and requires a Level 4 certified operator. In Wyoming a Level 4 operator must meet the following requirements:

- Three years of wastewater experience
- Two years at a Level 3 plant or higher
- 400 hours of wastewater training

Chapter 3 – Discipline Design Criteria

3.01 Introduction

This chapter of the Basis of Design Report (BODR) provides specific design criteria parameters and details as they relate to the project technical disciplines. The stated design criteria have been selected based on the previously stated project goals and objectives.

3.02 Site Civil

3.02.1 General Description

This section defines and documents the site development associated with the Canyon Village WWTP construction project. Items addressed in this section include the basis for layout, such as major site features, access, and site grading as shown on the drawings.

3.02.2 Codes and Standards

The following references are applicable for site improvements:

- Denver Service Center (DSC), Civil (Site) & Environmental Engineering Standards
- American Association of State Highway and Transportation Officials (AASHTO) Policy on Geometric Design of Highways and Streets
- 2021 International Building Code (IBC)
- 2021 International Fire Code (IFC)
- NPS, Yellowstone National Park, Structural Fire Management plan, October 25, 2021
- 2022 Wildland-Urban Interface Code (WUI)
- Energy Independence and Security Act of 2007
- American Water Works Association (AWWA) Standards
- American National Standards Institute (ANSI) Standards

3.02.3 Survey

The site base mapping was prepared based on a topographic and surface utility appurtenances survey of the Canyon Village Water Treatment Plant completed between October 1 and November 12, 2021. The survey is projected in Wyoming State Plane West Central Zone 4903, NAD83 (2011) using units in United States survey feet. The mapping is provided with a 1-foot contour interval and with the following datums:

1. Horizontal Datum – NAD83 (North American Datum of 1983) Epoch 2011
2. Vertical Datum – North American Vertical Datum of 1988 (NAVD88)

Project coordinates are based on National Geodetic Survey (NGS) horizontal control point 25 MDC. Horizontal positions were brought to the site utilizing RTK GPS techniques.

Project elevations are based on NGS First Order Class II Benchmark CVO 85 230 being a standard NGS disk benchmark set in boulder stamped “CVO 85 230” with a published NAVD88 elevation of 7922.68. Vertical control was brought to the site utilizing RTK GPS techniques. Elevations on site control were established utilizing differential leveling.

Subsurface utility information currently shown in the site base mapping is represented by NPS GIS (Geographic Information Systems) data. Utility locates are scheduled for spring of 2022.

3.02.4 Geotechnical Soils Report

Shannon & Wilson developed an Anticipated Geotechnical Conditions Report based on preliminary geotechnical investigations dated February 14, 2022, which is included in the RFP. The preliminary investigations included review of a previous geotechnical report, reviews of available geologic maps and reports, limited field reconnaissance and a geophysical investigation consisting of surveys completed using 2-D Seismic Refraction Tomography. A total of three Seismic Refraction Tomography lines were collected at the plant site. Shannon & Wilson’s report includes preliminary geotechnical recommendations for seismic design considerations, foundations, cut and fill slopes, and retaining walls.

Shannon & Wilson is planning to develop a final geotechnical report in the late spring of 2022 based on subsurface investigations and an additional geophysical investigation. The subsurface investigations include 15 proposed borings and associated laboratory testing. The additional geophysical investigation includes Seismic Refraction Tomography lines along approximately 1,000 feet of the sewer main alignment. The Design-Build (DB) contractor should review this report and collect any other needed information as necessary to complete their design.

3.02.5 Existing Site Layout – Demolition

The existing site layout includes facilities and appurtenances of the existing Canyon Village WWTP. Facilities include the Septage and Headworks Building, AWT Building, Blower Building, Lab Building, three Lagoons, Sludge Holding Pond, and four sludge drying beds. Underground utilities connect each facility to serve wastewater processing and treatment.

The existing buildings to be demolished include the Septage and Headworks Building, Blower and Generator Building, LAB Building, and the AWT Building. The building structures, foundations, and all internal appurtenances will be demolished and removed. The existing AWT clearwell may be abandoned in place and backfilled. The buried propane tanks adjacent to the AWT and Blower and Generator Buildings will be excavated, removed, and backfilled. Backfill must be compacted with suitable material to allow construction of proposed structures or access roads. Before backfill, provide a means for abandoned structures to allow groundwater to drain. The two drying beds and holding pond on the south end of the site will also be demolished. Select buried utilities will also be demolished. Demolition must be done in accordance with the phasing plan.

Removal of site piping scheduled for demolition will need to be approached on the basis of maintaining site operations for as long as possible. Site piping and electric lines between facilities may need to be temporarily rerouted to allow new utilities and structures construction.

Existing access, parking areas, planting areas, and other unused areas, within the new project limits, may be disturbed or removed to allow construction and access to the new facilities.

The demolition approach will be to remove and clear all obstacles that may interfere with new facilities construction. The demolition will take place maintaining critical facilities through construction and removing unused existing facilities required for the new construction. Existing facilities wastewater treatment must be maintained until the proposed treatment facilities and processes can be put into service. Any interruption of wastewater treatment must be coordinated with the Contracting Officer.

Ownership of salvageable material and equipment from demolished buildings and structures will remain the Government's unless determined otherwise. All un-salvaged demolition debris will be removed from the site and disposed of in an appropriate location.

3.02.6 Grading and Drainage Design Criteria

The existing site slopes from north to south with an overall change in elevation of approximately 52+/- feet. Starting at the Septage and Headworks Building, the site slopes down toward the three treatment lagoons, the AWT Building, and then the holding pond. Offsite, the grade continues to slope to the south toward North Rim Road and the Yellowstone River. The proposed grades will follow the existing site grades as much as possible to minimize cut and fill slopes and to maintain existing drainage patterns.

Soil structure disturbance around the three wastewater treatment Lagoons should be done with caution to prevent damage to the pond berms and pond liners.

The site will be graded so that stormwater runoff will sheet flow where possible and be conveyed by ditches. In locations where runoff cannot be conveyed through longitudinal grades, catch basins and reinforced concrete pipe will be used to convey flows to the desired location. Where possible, existing grades and elevations will be maintained as close as possible to the existing elevations during the final grading process. Onsite finish grades will follow the existing pattern of generally sloping from north to south.

Finish grade elevations will be set flush with door aprons and landings and sidewalks at doorways to provide handicap accessibility through select facility access points. Site grading and finished floor elevations will incorporate positive site drainage per the IBC requirements to prevent ponding, water infiltration, and damage to foundations.

With the exception of the loading dock areas, grades around buildings will drop to approximately 0.5 foot below facility finish floor elevations and slope away from the doors, to prevent stormwater from entering through the doors. Positive grades of 2% will be placed on paved surfaces to route stormwater away from the buildings. The loading dock at the Process Building and Dewatering Building will have a height of 4 feet.

In locations around the proposed Headworks Building and Equipment Storage Building where grades are steep, retaining walls may be necessary to accommodate finished floor elevations and access points around the building. Other cut and fill slopes throughout the site will be rounded and varied in final design to prevent abrupt changes in grades, blend with existing topography, and create a more natural appearance.

The following criteria for slopes will be used for site grading:

- Road cross slopes: 2% recommended; 3% maximum
- Access roads: 5% maximum grade where accessibility needs to be maintained, 12% maximum grade in areas that exclude accessibility and require mitigation from the local fire protection district
- Sidewalks: 5% maximum grade for longitude walks to maintain accessibility requirements with 1.5 to 2% cross slopes
- Unpaved cut and fill slopes (to be confirmed by a subsurface investigation and geotechnical report):
  - Fill slopes: 2:1 maximum, 3:1 or flatter – typical
  - Cut slopes: 2:1 maximum, 3:1 or flatter – typical

3.02.7 Site Drainage and Storm Water Runoff

The project area is located in a Zone D on Federal Emergency Management Agency Panel 56029C1625D (this panel is not printed). This indicates an area of undetermined flood hazard. A Federal Emergency Management Agency designated flood risk has not been assigned to this project location.

Site drainage in the existing condition flows overland across the site into natural and constructed channels and roadside ditches. Stormwater is conveyed under roads with culverts. There are no existing storm water detention basins; runoff flows to the south into the forest.

The proposed facilities will impact storm runoff and conveyance. This conveyance will be recalculated and rerouted as needed to allow construction of the buildings and uninterrupted flow of surface drainage. Calculations and stormwater conveyance must be provided for 10-, 25- and 100-year storm events. A project drainage study, including hydrology, hydraulic, and low impact development calculations must be submitted to the Government for review and approval before construction.

Because the project involves a facility or facilities with a footprint (or combined footprints) that exceed 5,000 square feet (ft^2), storm water runoff management measures must meet the guidance and requirements of Section 438 of the Energy Independence and Security Act of 2007.

Storm water management strategies include reducing impervious cover to the extent feasible, through use of smallest-acceptable circulation routes; disconnecting impervious areas, by providing open landscaped areas between the paved areas and drainage channels; and by providing bio-basins or bio-swales in the open areas to capture and filter storm water before discharging or infiltrating. The existing subsurface soils are generally expected to be the fat clays and clayey gravels, although some areas contain silty gravel and sands. Due to this and general observations of the site, infiltration is not expected to be a feasible storm water management strategy.

The contractor's Engineer of Record will provide analysis of the site with regard to the storm water management requirements and provide storm water management techniques to maintain or improve the pre-development drainage runoff characteristics in accordance with State and Federal mandates. If feasible, more natural looking stormwater management applications that are smaller and central to the site are preferred, as opposed to a single larger basin that may result in more clearing of vegetation.

3.02.8 Site Layout

All proposed WWTP facilities treatment plant are situated to fit within the existing site boundary. The proposed water treatment Process Building will be constructed just north of the existing WWTP Building to allow for continued water treatment during construction. A set of four drying beds will be placed in the existing location of the Backwash Pond 2, at the northwest corner of the site. The proposed Generator Building will be constructed just southeast of the WWTP Process Building.

One Generator Building will be constructed near the proposed WWTP Process Building. Two buried propane tanks will be installed near the proposed Generator Building, two

installed near the WWTP Process Building, and one installed by the Headworks Building, with adequate access for refilling. The separation distance between buildings and away from the propane tanks must meet applicable codes.

The proposed access roads will be a minimum of 20 feet wide to provide maneuverability for the larger trucks and emergency vehicles accessing the facility. The turning radii for the roadways will be adequately sized so that a 40-foot fire apparatus and a 40-foot single unit (SU-40) chemical truck can both enter and exit the site. The SU-40 chemical delivery truck must have adequate space to maneuver and back up to the loading dock. Loop around the site is not required but a turnaround for the fire apparatus must still be provided.

Access road sections will be designed to accommodate chemical delivery trucks and a 60,000-pound (minimum) fire apparatus.

Contractor must design and build any new roads/parking surfaces and maintain existing roads/parking surfaces onsite to ensure continued access to sites for chemical delivery trucks, fire trucks and other vehicles that may visit the site.

The access roads will be designed to follow existing grades as closely as possible, to minimize cut and fill slopes and maintain existing drainage patterns to the west.

Any reinforced concrete pavements will be designed to accommodate heavy truck traffic designed for HS-20 loading.

General conceptual arrangement is depicted on conceptual drawings in this Design Build RFP.

3.02.9 Parking

At the Headworks Building, sufficient space will be provided to allow vehicle parking and delivery truck parking.

The access driveway around the proposed WWTP Process Building will allow for vehicle parking on the south side. One Architectural Barriers Act (ABA) accessible parking space is required closest to the main entrance along with an accessible route to the building. There is room for approximately six parking spaces along the south side of the building. Minimum parking stall dimensions are 18 feet long by 9 feet wide. This area will be equipped with two electric vehicle charging stations. The Process Building will have a 4-foot high loading dock to accommodate delivery trucks and plant service equipment.

The ABA accessible parking area will be paved with reinforced concrete. The proposed paving slopes, including the accessible route to the building, must comply with DSC

Accessible Route Design Standards. Striping and signage for accessible parking must meet ABA Standards and should follow Yellowstone National Park standards as well.

A second parking location on the southeast side of the Dewatering Building will accommodate chemical delivery trucks and the plant's service equipment. This side of the building will also have a 4-foot-high loading dock with a concrete slab below to prevent any chemical spills from falling directly onto gravel or soil.

3.02.10 Construction Soil Stabilization

During construction, erosion control measures in accordance with the best management practices, in accordance with NPS and county requirements will be implemented to prevent adverse environmental degradation that would affect downstream or surrounding lands. The erosion control measures will be tailored to the site to prevent sediment-laden water from leaving the site. The following erosion control measures will be used onsite:

- Site development considerations with construction scheduling
- Maintenance of buffer zones
- Disturbed-soil areas will be stabilized with coconut fiber or jute netting or erosion control blankets
- Sediment runoff control with coconut husk wattles or rock socks
- Dust control on disturbed areas and access roads
- Diversion of runoff with earthen dikes, brow ditches, and berms to protect excavations
- Energy dissipaters, riprap channel protection, or outlet protection for discharge pipes, channels, and ditches
- Silt fence at limits of clearing
- Check dams to control velocity along ditches and long longitudinal grades
- Stabilized construction entrance to all permanent road surfaces (paved or gravel)
- Materials management with material delivery, storage, and waste management

Vehicle and equipment management with construction practices, cleaning, fueling and maintenance.

3.02.11 Cultural Resources (Historical)

No existing structures on the project site have been identified as historic by the NPS.

The National Historic Preservation Act (NHPA) is the primary Federal Statute governing historic resources. Section 106 of the NHPA (16 USC 470f) requires that federal

agencies consider the effects of their undertakings on historic properties, identify ways to avoid or reduce adverse effects, and give the State Historic Preservation Officer and the Advisory Council on Historic Preservation a reasonable opportunity to comment on any such undertakings.

There are no culturally sensitive areas presently identified. If sensitive resources are encountered, archeologist must be present for all trenching and excavation activities in a culturally sensitive area. Any area that is to be over-excavated in a culturally sensitive area or in proximity to an avoidance area, will require the contractor to notify the Contracting Officer's Representative (COR) and this action will be reviewed and approved before commencement of the excavation. Excavators will skim each excavating layer of soil in 20 centimeter increments and place in a separate spoil pile. Each spoil pile will be identified as to the specific trench and level it was excavated as specified by the archeological monitor. Provide site plan to the cultural resource monitor that shows all trenches locations.

3.03 Yard Piping

3.03.1 Existing Utilities

The project is a previously developed site, and several existing utilities are buried throughout.

Potable water service is available from the nearby water treatment plant. A 6-inch water line supplies the site, then tees off reaching up to the Headworks Building (4-inch line) and down toward the AWT Building (6-inch line).

Assess existing utilities to remain in place and in service for final plant operation. Verify utility sizes, capacities, conditions, potential conflicts, and available pressures. Replace, reroute, or upsize as necessary for proposed plant design and operating demands.

Sanitary sewer service is provided at the AWT Building and Septage/Headworks Building. These sewer drains are routed back to the wet well at the Headworks Building.

The project does not have a natural gas supply. Locally stored propane tanks, buried underground, are used as a fuel supply for the AWT Building. An underground diesel fuel tank supplies the backup generator at the Blower Building.

Existing utilities locations shown are based on the best available data including as-built drawings and topographic survey. Contractor will field verify the presence, location, and elevation of all utilities during construction and notify Engineer of any discrepancies. Contractor will maintain service to buildings that are to remain in operation during the construction such as water, power, gas, fuel, and sanitary service connections.

3.03.2 Proposed Utilities

Proposed utilities on the project site will include potable and nonpotable water, sanitary sewer, storm drains, electric power, communications, and propane gas.

Proposed process piping will include, but not limited to, raw sewage, sanitary sewer influent, effluent, pressate, septage, decant, mixed liquor, sludge, chemical, drains, overflows, underdrains, and air lines.

Routing of proposed utilities and process piping between facilities, shown in the drawings, are conceptual and diagrammatic, and intended to convey general scope requirements. Electrical power and communications lines are not shown for clarity. Design Build Contractor and Engineer of Record to provide final layout designs.

Locations of existing and proposed fire hydrants must be placed in appropriate locations to provide 300-foot radius coverages to be approved by the fire department. The fire hydrant supply line will connect to the potable water line. Further investigation will be required to evaluate pressure and flow rate from the connected line.

Yard hydrants, supplied by the nonpotable water system, are to be installed throughout the sites as shown and where determined to be required by O&M needs.

All pressurized piping onsite must have mechanically restrained joints with mechanical fittings such as gland and harness. Thrust blocks, in addition to restrained joints, are to be installed for potable water mains and any fire suppression supply lines, if installed. Materials for process lines are defined on the pipe schedule, but must be confirmed during final design.

All potable water pipes must be properly flushed, chlorinated, disinfected, pressure tested, and bacteriologically tested. Maintain 10 feet minimum horizontal separation distances between potable water lines and sources of pollution, such as sanitary sewer lines. When crossing these lines, provide 18-inch minimum vertical separation. Water lines should generally be located above sewer lines.

Minimum depth of bury (from top of pipe) is 7 feet where possible. Exceptions to the minimum depth of bury must be approved by the Owner.

3.04 Site and Physical Security

3.04.1 Fencing

Continuous fence surrounding the entire site. This fence will be replaced entirely with a new drilled-stem steel fence with wildlife wire fencing. Entry gates for vehicles and personnel will be installed around the perimeter where shown and as confirmed by the Contracting Officer.

3.04.2 Doors

The new and existing facilities will have manual door locks. Key card access will not be provided. There will not be remote monitoring of door locks provided at this time.

3.05 Architectural

3.05.1 Codes, Standards, and Regulations

All new buildings will be designed to conform to the following codes, standards, and regulations, as required by the federal, state, and local authorities.

- 2021 IBC
- 2021 IFC
- 2018 International Energy Conservation Code (IECC)
- 2021 International Existing Building Code (IEBC)
- International Code Council (ICC) / ANSI A117.1 and 2021 IBC, Chapter 11
- American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) Standard 90.1 2016 Energy Standard for Buildings Except Low-Rise Residential Buildings
- ASHRAE Standard 189.1 2014 Standard for the Design of High-Performance, Green Buildings Except Low-Rise Residential Buildings
- Occupational Safety and Health Administration General Industry Safety Orders
- 2015 ABA
- NPS Management Policies

3.05.2 Code Compliance

A preliminary code analysis has been performed for each new building, based on compliance with the 2021 IBC and other applicable codes identified above. Basic code data is included below in the Building Overview discussion and a more detailed code analysis is documented on the design drawings. Refer to drawings for additional information.

As site and building design evolves, the code analysis will need to be updated by the final designer to reflect the latest design decisions and approaches.

3.05.3 Fire Suppression System

The new buildings of the WWTP are generally not required to have automatic fire suppression systems based on IBC requirements unless otherwise indicated in building code analysis. However, the Parks Fire Policy generally requires an automatic fire

suppression system for all new buildings. After discussion with the Fire Chief, it was agreed that an automatic fire suppression system is not required for these facilities based on anticipated noncombustible construction materials and use. However, automatic fire suppression will be provided at locations required by IBC. Portable fire extinguishers are required and will follow code requirements for type and maximum spacing.

Where automatic fire suppression system is deemed necessary for any building, a dry-type chemical system will be used in lieu of a fire sprinkler system.

3.05.4 Sanitary and Safety Provisions

Required WWTP plumbing fixtures for will be provided at the new Process Building. The minimum quantity of required fixtures (toilets, lavatories, service sinks and drinking fountains) is based on the total building area and corresponding occupancy group and occupant load. Safety shower and eyewash stations will be provided near hazardous chemical storage, loading and use locations. Washdown facilities, utility sinks, and hand-washing stations will be provided at new process buildings, where appropriate.

The calculated number of occupants and corresponding required plumbing fixtures is shown below (for all buildings). The calculated number of occupants is significantly higher than the expected actual use of only two operators. It is recommended that a waiver be pursued to base the required plumbing fixtures only on the non-process areas of the building. In this case the total occupant load will be less than 15, which would allow for a single unisex restroom and no drinking fountain.

Table 3-1. IBC Plumbing Fixture Requirements

Occupancy Group	B (Business)	F (Industrial) & S (Storage)
Building square footage	1,195 ft^2	21,174 ft^2 (Note 2)
Occupant Load Factor (IBC Table 1004.5)	150	300
Occupant Load (Calculated)	7.9 (8)	70.58 (71)
Female (50%)	4	36
Male (50%)	4	36
Toilets Required for Female (Note 1)	1 per 25, 1 per 50 for the remainder exceeding 50 = 1	1 per 100 = 1
Toilets Provided for Female	Note 4	1 (Note 3)
Toilets Required for Male (Note 1)	1 per 25, 1 per 50 for the remainder exceeding 50 = 1	1 per 100 = 1
Toilets Provided for Male	Note 4	1 (Note 3)

Occupancy Group	B (Business)	F (Industrial) & S (Storage)
Lavatories Required for Female (Note 1)	1 per 40, 1 per 80 for the remainder exceeding 80 = 1	1 per 100 = 1
Lavatories Provided for Female	Note 4	1 (Note 3)
Lavatories Required for Male (Note 1)	1 per 40, 1 per 80 for the remainder exceeding 80 = 1	1 per 100 = 1
Lavatories Provided for Male	1	1 (Note 3)
Service Sink Required (Note 1)	1	1
Service Sink Provided	1	1 (Note 3)
Drinking Fountain Required (Note 1)	1 per 100	1 per 400
Drinking Fountain Provided	0 (Note 5)	0 (Note 5)

Note 1: 2021 IBC, Table 2902.1
Note 2: Area of all F and S building area combined.
Note 3: Required fixtures provided at Process (operations) Building.
Note 4: Unisex restroom with one toilet and one lavatory. A waiver from the building official is required because the total calculated occupant load exceeds 15.
Note 5: Drinking fountain not required for occupant load of 15 or less. A waiver from the building official is required because the total calculated occupant load exceeds 15.

3.05.5 Energy Code Data

The energy code analysis will be updated throughout the design process and essential code data will be included for each building in the Design Documents. Table 3-2 lists the basic applicable data provided in the IECC.

Table 3-2. IECC Building Envelope Insulation Prescriptive Requirements

Building Envelope Element	Required for Climate Zone 7
Roofs, Insulation entirely above roof deck	R-35 CI
Roofs (Metal Building)	R-30 + R-11 Linear System
Walls, Mass	R-15.2 CI
Walls (Metal Building)	R-13 + R-13 CI
Walls, Below Grade	R-10 CI
Floors, Unheated Slab	R-15 for 24 inches below
Doors, Non-swinging	R-4.75
Door, Swinging	U-0.37
Fenestration (Entrance Doors)	U-0.77
Fenestration (Vertical – Fixed)	U-0.29
Fenestration (Vertical – Operable)	U-0.37

Building Envelope Element	Required for Climate Zone 7
Air Barrier (IECC C402.5)	Yes

Source: 2018 IECC, Tables C402.1.3, Table C402.1.44, and C402.4
Project is in Teton County, Wyoming.
CI = Continuous Insulation

3.05.6 Accessibility and Universal Design

Building and site design will follow defined accessibility requirements and the Universal Design Checklist (provided in the RFP). Mechanical equipment and process spaces are not required to be accessible (in accordance with ABA Section F203.6). Therefore, only select spaces of the Process Building are expected to have accessibility design elements, including an accessible parking stall and ramp to the main entry of the building. Finally, public tours are not anticipated for any of the proposed buildings. However, if public tours are desired for any building, the tour route will need to meet ABA accessibility requirements for interior and exterior areas where tours will occur. Public tour routes will require early definition in the Final Design Phase to ensure that code required accessibility requirements are incorporated in the planned roadways, sidewalks, and buildings.

3.05.7 Design Concepts

Buildings will be designed to provide functional space appropriate for the function, processes and the equipment being housed. Space size will be determined by functional needs, equipment size, and operator need for access, egress, and ease of equipment maintenance.

New facilities will be designed with forms, details and materials that provide a consistent architectural theme. Additionally, design of the facilities will be in accordance with NPS Management Policies. Response to climate and local environment will be met by conformance to the IECC requirements.

In general, building operating floors will be elevated approximately 3 to 4 feet above grade unless shown otherwise on drawings. Where operating floors are elevated provide docks with ramps and elevated walkways with stairs for access to grade. Locate door entries on gable ends, high roof (peak) sides of buildings, or recessed into building to avoid the possibility of sliding snow blocking doors or falling on building occupants. Where possible, locate or protect entrances from prevailing south-southwest winter winds. Provide significant roof overhangs, wall enclosures, and extended soffits to provide maximum weather protection at exterior docks, walkways, ramps, and stairs.

Major Exterior Systems

Exterior building envelope materials and finishes will be selected for limited maintenance and corrosion resistance. Additionally, exterior envelope components will

be evaluated and selected for energy performance. Major components will be as follows:

- Roofs
  - Sloped standing seam metal roofing over high-temperature underlayment on vented nailbase rigid insulation on metal deck. The vented nailbase insulation to include an air space to promote venting and minimize thermal transfer of warm air from inside the building to the outside of the roof. Inlets and outlets for the air space will be at the low eaves and ridges or high eaves.
  - Roofs for pre-engineered metal structures will have standing seam sheet metal roof panels or insulated metal roof panels as required for thermal performance.
  - All buildings will have a minimum roof slope of 3:12 and a minimum roof overhang of 3 feet past face of building. Additional roof overhang distance will be provided at elevated docks, ramps, stairs, and entrances to provide weather protection.
  - Continuous metal soffit panels to cover eaves and rakes. Joint of soffit panel to wall to be completely sealed.
  - Fall protection anchors to be provided at roofs, locations to be determined during final design.
- Walls
  - Concrete masonry unit (CMU) veneer anchored to structural CMU wall. Air and water barrier over structural CMU and rigid insulation in cavity to meet thermal requirements.
    - Exposed CMU veneer units to have integral color and texture. Use at least two distinct unit types and employ banding coordinated with opening features to present an organized building facade composition.
  - Walls for pre-engineered metal structures will have sheet metal wall panels or insulated metal wall panels as required for thermal performance.
  - Sheet metal wall panels will be used for enclosing the extended soffits at loading docks.
- Doors and Frames
  - Steel hollow metal with galvanized coating, factory primer and field painted.
  - Aluminum storefront with factory finish at select locations of primary Operator entry.
- Door Hardware
  - Heavy-duty mortise type lockset; stainless steel.
  - Panic devices at Electrical Room doors and doors at hazardous occupancies.

- Overhead Doors
  - Galvanized steel with polyvinylidene fluoride factory finish. Operation to be motorized. Minimum size as required for largest piece of equipment served.
- Windows
  - Aluminum thermally broken frames with double-pane insulated glass with Low-E-coatings. Windows to have operable function.
  - Translucent wall panels with aluminum frames having factory finish.
- Louvers
  - Drainable blade type with insect screen, aluminum with factory finish.
- Signage
  - Safety, informational and hazardous material signs will be provided as required by code and safety standards.
  - Facility Entrance Sign.
- Colors
  - Generally, colors will follow the established Park color scheme which has dark brown or bronze colored roofs and walls. Final colors to be determined during final design.
- Integrated Pest Management
  - Bat and bird screens at openings to weather enclosures. The building envelope will be sealed to prevent pest intrusion, specifically rodents and bats.

Major Interior Systems

Interior surfaces and finishes will be selected for appropriateness to the individual spaces. Consideration will be given to the need for washdown, corrosion resistance, slip resistance, light reflectance, comfort, and maintenance.

- Walls
  - Process and utilitarian spaces: Cast-in-place concrete or CMU, painted for light reflectance
- Non-Process Spaces
  - Painted gypsum wallboard over metal stud furring
- Floors: Concrete with Appropriate Finish
  - Resilient flooring in occupied office and support spaces
  - Ceramic tile in restrooms



  - Clear hardener in areas subject to vehicular traffic or heavy use
  - Clear sealer at general process areas
  - Chemical resistant coating at chemical containment areas as appropriate for corrosion and slip resistance
- Ceilings
  - Epoxy painted metal structure and metal deck at process and equipment spaces
  - Suspended 2-foot by 2-foot acoustical ceiling in non-process spaces
  - Suspended gypsum board ceiling at restrooms, shower and locker rooms and janitor closet
- Doors and Frames
  - Steel hollow metal with galvanized coating, factory primer and field painted
- Door Hardware
  - Heavy-duty mortise type locksets; stainless steel
  - Panic devices at Electrical Room doors and doors at hazardous occupancies
- Acoustical Treatment
  - Surface mounted metal panels with acoustical insulation will be considered in final design for any spaces that exceed an 85 decibel (A-weighted scale) sound level
- Safety Equipment
  - Fire extinguishers will be located near egress doors at minimum spacing requirements. First aid cabinets will be provided at select locations. Additional safety equipment for working with specific chemicals and spill clean-up will be identified as the design progresses.
- Signage
  - Selected rooms will be provided with door nameplates; safety, informational and hazardous material signs will be provided, as required by code, safety standards and the Park Fire Chief

3.05.8 Overview of Buildings

A brief description of each proposed building is included below. Process treatment tanks, basins and related non-habitable structures are discussed in Chapter 3, Treatment Process Facilities.

Facility 310 Headworks Building

A new one-story building with basement to house process and electrical equipment. Main operating floor to be elevated above grade by 4 feet and loading docks, elevated walkways, stairs and ramps to be provided. Refer to drawings for additional information.

- Building Enclosure:
  - Concrete foundation and floor slab
  - Load-bearing CMU walls with air and water barrier, rigid insulation, and CMU veneer
  - Standing seam sheet metal roofing system over underlayment on vented nailbase rigid insulation on metal decking
  - Translucent wall panels for daylighting
  - All building enclosure elements will be insulated to meet or exceed code minimum
- Room Requirements: For a detailed listing of additional requirements for each room of this facility, refer to the room requirements, which is attached to this document
- Actual Area: approximately 3,057 ft^2 (942 ft^2 for basement), final area to be determined during final design
  - The separation distance between facilities is greater than 30-feet and not required to have any fire-rated exterior walls
- Occupancy Group = F-1 (Moderate Hazard Industrial)
- Construction Type IIB; noncombustible construction
- An automatic fire suppression system is not required and will not be provided. Portable fire extinguishers are required and will be provided
- National Fire Protection Association (NFPA) 820: Building will not be ventilated to declassify space. Therefore, the Process Equipment Room and Basement are Class 1 Division 1. The Electrical Room is physically separated from the Process Equipment Room and is not classified.
- Chemical Storage and Hazardous Materials: None

Facility 320, Process (Operations) Building

A new one-story building with a basement. This building will house several uses including operations, maintenance, process equipment, chemical storage, and support equipment. Main operating floor to be elevated above grade by 4 feet and loading docks, elevated walkways, stairs and ramps to be provided. Refer to drawings for additional information.

- O&M spaces to include the following:
  - Control Room
  - Water Quality Laboratory
  - Break Room
  - Restroom, Shower, Locker Room
  - Maintenance Shop
- Building Enclosure
  - Concrete foundation and floor slab
  - Load-bearing CMU walls with air and water barrier, rigid insulation and CMU veneer
  - Standing seam sheet metal roofing system over underlayment on vented nailbase rigid insulation on metal decking
  - Aluminum framed windows for daylighting at occupied spaces
  - Translucent wall panels for daylighting at non-occupied spaces
  - All building enclosure elements will be insulated to meet or exceed code minimum
- Room Requirements: For a detailed listing of additional requirements for each room of this facility, refer to the room requirements, which is attached to this document
- Actual Area = approximately 7,255 ft^2 (5,758 ft^2 for basement), final area to be determined during final design
  - The separation distance between facilities is greater than 30-feet and not required to have any fire-rated exterior walls
- Occupancy Group = Mixed:
  - F-1 (Moderate Hazard Industrial)
  - B (Business)
  - H-4 (Hazardous)
- Construction Type IIB; noncombustible construction
- An automatic fire suppression system is required for the basement including the Chemical Storage Room and will be provided in the form of a clean agent or dry chemical system. Portable fire extinguishers are required and will be provided.
- Potential Chemical Storage and Hazardous Materials
  - Citric Acid: Irritant
    - Maximum Allowable Storage: no storage limitations



        - Actual Storage: 330 gallons
    - Sodium Hypochlorite (12.5%): Corrosive
        - Maximum Allowable Storage: 500 gallons
        - Actual Storage: 330 gallons
    - Aluminum Sulfate Solution (48.5%): Corrosive
        - Maximum Allowable Storage: 500 gallons
        - Actual Storage: 2,030 gallons (requires H-4 occupancy group)
    - Magnesium Hydroxide solution (60%): nonhazardous
        - Maximum Allowable Storage: no storage limitations
        - Actual Storage: 1,550 gallons
    - Glycerin solution (71%): nonhazardous
        - Maximum Allowable Storage: no storage limitations
        - Actual Storage: 660 gallons
    - Chemicals used for laboratory will be far below the maximum allowable quantities set by the IFC
- Laboratory:
    - The laboratory will include work areas to support key laboratory functions:
        - Solids area with counterspace, sink, vacuum filtration pump and manifold, drying oven, desiccator, and analytical balance
        - Cooler preparation area with counterspace for preparing samples for shipment, ice machine, upright refrigerator, and utility cart
        - Wet chemistry areas with counterspace for spectrophotometer and probe measurements, a double bowl sink, and a glassware washer
        - A 4-foot canopy hood will be included to house the drying oven and muffle furnace
        - Life safety equipment will include a combination safety shower/eye wash with floor drain, fire extinguisher, fire blanket, and first aid kit
        - Desk height work area with file storage, bookshelves, and computer data connection
        - Architectural Barrier Act-accessible lab sink and counter area
        - Storage of chemicals will be below maximum allowable quantities
- Design laboratory to meet requirements of DEQ Chapter 12 Design and Construction Standards

Table 3-3 lists equipment to support daily and routine wastewater processes, as well as laboratory equipment.

Table 3-3. Laboratory Testing and Equipment – Preliminary Design

	Test Performed	Equipment
1	pH	pH Meter
2	Alkalinity	Buret Buret stand
3	Dissolved oxygen	Dissolved oxygen meter
4	Total suspended solids/VSS	Vacuum pump Vacuum manifold Drying oven
5	TDS	Muffle furnace Desiccator Analytical balance
6	BOD	HACH test kits, HACH spectrophotometer
	Nitrates/nitrites	
	Ammonia, nitrogen (as N)	
	Total phosphorus	
7	*E. coli*, MPN	Incubator Tray sealer UV light
8	Total residual chlorine	HACH test kits, HACH colorimeter
9	Oil and grease	HACH oil and grease analyzer
10	N/A	Upright refrigerator
11	N/A	Ice Machine
12	N/A	Lab water system
13	N/A	Laboratory glassware washer
14	N/A	Deionized Water System
15	N/A	4-foot canopy hood

BOD = biochemical oxygen demand
N = nitrogen
N/A = not applicable
TDS = total dissolved solids
VSS = volatile suspended solids

Facility 330, Aeration and Digester Basins

A new one-story pre-engineered metal building will be used to provide weather protection for the basins. Refer to drawings for additional information.

- Building Enclosure:
  - Concrete foundation
  - Pre-engineered metal structural primary frames with purlin and girt secondary framing as required to support roof and wall panels
  - Translucent wall panels for daylighting
  - Sheet metal wall and roof panels (noninsulated)
- Room Requirements: For a detailed listing of additional requirements for each room of this facility, refer to the room requirements, which is attached to this document
- Actual Area = approximately 13,122 ft^2, final area to be determined during final design
  - The separation distance between facilities is greater than 10 feet and not required to have any fire-rated exterior walls
- Occupancy Group = F-2 (Low Hazard Industrial)
- Construction Type IIB; noncombustible construction
- An automatic fire suppression system is not required and will not be provided. Portable fire extinguishers are required and will be provided
- Chemical Storage and Hazardous Materials:
  - None

Facility 340 Dewatering Building

A new one-story building to house process and electrical equipment, and chemical storage. Main operating floor to be elevated above grade by 4 feet and loading dock, stair, ramp and elevated walkway to be provided. Refer to drawings for additional information.

- Building Enclosure:
  - Concrete foundation and floor slab
  - Load-bearing CMU walls with air and water barrier, rigid insulation and CMU veneer
  - Standing seam sheet metal roofing system over underlayment on vented nailbase rigid insulation on metal decking
  - Translucent wall panels for daylighting
  - All building enclosure elements will be insulated to meet or exceed code minimum

- Room Requirements: For a detailed listing of additional requirements for each room of this facility, refer to the room requirements, which is attached to this document
- Actual Area: approximately 2,423 ft^2, final area to be determined during final design
  - The separation distance between facilities is less than 10 feet, the Cake Storage Building (350) and Dewatering Facility (340), have been considered together to avoid a fire-rated separation between facilities
  - Total Building Area (340 + 350) = approximately 7,507 ft^2, which is less than allowable area, final area to be determined during final design
- Occupancy Group = F-2 (Low Hazard Industrial)
- Construction Type IIB; noncombustible construction
- An automatic fire suppression system is not required and will not be provided. Portable fire extinguishers are required and will be provided
- NFPA 820: The Dewatering Room is ventilated with 6 air changes per hour (ACH) to declassify the space. The Electrical Room is physically separated from the Dewatering Room and is not classified
- Chemical Storage and Hazardous Materials
  - Polymer: Irritant
    - Maximum Allowable Storage: no storage limitations
    - Actual Storage: 990 gallons
  - Citric Acid: Irritant
    - Maximum Allowable Storage: no storage limitations
    - Actual Storage: 330 gallons
  - Sodium Hypochlorite (12.5%): Corrosive
    - Maximum Allowable Storage: 500 gallons
    - Actual Storage: 330 gallons

Facility 350, Cake Storage Building

A new one-story pre-engineered metal building will be used to provide weather protection and storage of cake sourced from the nearby Dewatering Building. Large openings will be provided in the wall system to allow for passive drying. Refer to drawings for additional information.

- Building Enclosure:
  - Concrete foundation



  - Pre-engineered metal structural primary frames with purlin and girt secondary framing as required to support roof and wall panels
  - Translucent wall panels for daylighting
  - Sheet metal wall and roof panels (noninsulated)
- Room Requirements: For a detailed listing of additional requirements for each room of this facility, refer to the room requirements, which is attached to this document
- Actual Area = approximately 5,084 ft^2, final area to be determined during final design
  - The separation distance between facilities is greater than 30 feet except on east side of structure which is only 5-feet. For the purposes of fire separation distance, the Dewatering Building (340) and Cake Storage Building (350) will be considered one to avoid the need for any fire-rated exterior walls.
  - Total Building Area (340 + 350) = approximately 7,507 ft^2, which is less than allowable area, final area to be determined during final design
- Occupancy Group = F-2 (Low Hazard Industrial)
- Construction Type IIB; noncombustible construction
- An automatic fire suppression system is not required and will not be provided. Portable fire extinguishers are required and will be provided
- Chemical Storage and Hazardous Materials:
  - None

Facility 360, Equipment Storage Building

A new one-story pre-engineered metal building will be used to provide weather protection for large equipment. Refer to the drawings for additional information.

- Building Enclosure:
  - Concrete foundation and slab
  - Pre-engineered metal structural primary frames with purlin and girt secondary framing as required to support roof and wall panels
  - Insulated metal wall and roof panels
- Room Requirements: For a detailed listing of additional requirements for each room of this facility, refer to the room requirements, which is attached to this document
- Actual Area = approximately 3,200 ft^2, final area to be determined during final design
  - The separation distance between facilities is greater than 30-feet and not required to have any fire-rated exterior walls
- Occupancy Group = S-2 (Low Hazard Storage)

- Construction Type IIB; noncombustible construction
- An automatic fire suppression system is not required and will not be provided. Portable fire extinguishers are required and will be provided.
- Chemical Storage and Hazardous Materials:
  - None

Facility 390, Generator Building

- A new single-story building to house a standby generator and appurtenances. Refer to drawings for additional information.
- Building Enclosure:
  - Concrete foundation and floor slab
  - Load-bearing CMU walls with air and water barrier, rigid insulation and CMU veneer
  - Standing seam sheet metal roofing system over underlayment on vented nailbase rigid insulation on metal decking
  - All building enclosure elements will be insulated to meet or exceed code minimum
- Room Requirements: For a detailed listing of additional requirements for each room of this facility, refer to the room requirements, which is attached to this document
- Actual Area = 498 ft^2, final area to be determined during final design
- Occupancy Group = F-1 (Moderate Hazard Industrial)
- Construction Type IIB; noncombustible construction

  An automatic fire suppression system is not required and will not be provided. Portable fire extinguishers are required and will be provided.

3.06 Landscape Protection and Restoration

3.06.1 General Description

All areas disturbed by construction and not otherwise designated for roads, walkways, pavements, buildings, utility appurtenances, and wastewater facilities will be revegetated with native grass and wildflower species. Tree and shrub plantings will be limited to locations where screening of facilities from public view is required. NPS staff will be responsible for seeding and plantings. Contactor will be responsible for all other work, including, but not limited to, preparing topsoil for planting and mulching the areas seeded and planted by NPS staff.

3.06.2 References, Codes, and Standards

- 2006 ICC Wildland-Urban Interface
- 2021 Yellowstone Structural Fire Management Plan
- ANSI Z133.1-2006: American National Standard for Tree Care Operations
- ANSI A300: Tree, Shrub, and Other Woody Plant Management – Standard Practices
- Guide for Plant Appraisal – Current Edition: Authored by the Council of Tree and Landscape Appraisers; published by the International Society of Arboriculture
- Vegetation Management for Construction Disturbance in Yellowstone National Park

3.06.3 Definitions

- Subsoil: All soil beneath the topsoil layer of the soil profile and typified by the lack of organic matter and soil organisms.
- Surface Soil: Soil that is present at the top layer of the existing soil profile at the project site. In undisturbed areas, the surface soil is typically topsoil; but, in disturbed areas such as urban environments, the surface soil can be subsoil.
- Topsoil: Top layer of the soil profile consisting of existing native surface topsoil or existing in-place surface soil and is the zone where plant roots grow.
- Plant Protection Zone: Area surrounding individual trees, groups of trees, shrubs, or other vegetation to be protected during construction, and indicated on drawings.
- Tree Protection Zone: Area surrounding individual trees or groups of trees to be protected during construction and indicated on drawings or defined by a circle concentric with each tree with a radius 1.5 times the diameter of the drip line unless otherwise indicated. Areas of ground covered by pavement, buildings, or other permanent structures where the presence of roots is minimal or negligible, are excluded. The area under or within the tree’s dripline is also referred to as the "Critical Root Zone" (refer to the following).
- Dripline: The outermost edge of the tree's canopy or branch spread. The area within a tree's dripline is all the ground under the total branch spread.
- Critical Root Zone: Generally, all of the ground area included in the dripline.
- Vegetation: Trees, shrubs, groundcovers, grass, and other plants.
- Caliper: Diameter (Caliper) size (in inches) of a tree's trunk is measured as follows in accordance with guidelines established in the "Guide for Plant Appraisal”: Six inches abovegrade for trunk diameters up to and including 4 inches.

- Twelve inches above grade for trunk diameters from 4 inches up to and including 8 inches.
- Four and a half feet above grade for trunk diameters greater than 8 inches.
- All measurements should be rounded to the nearest inch.

3.06.4 Soil, Tree, and Vegetation Protection

- General: Protect soils, trees, and plants remaining onsite
- Soil, Tree, and Vegetation Protection
- General: Protect soils, trees, and plants remaining onsite
- Repair or replace trees, shrubs, and other vegetation indicated to remain or be relocated that are damaged by construction operations, in a manner approved by the owner
- Plant Condition Review: Before any construction operations, the contractor and Contracting Officer will perform an onsite review of trees, shrubs, and other natural features in the entire project site together. Previous damage to trees and vegetation will be noted on the site plan and photographs will be taken to document existing damage
- Locate and clearly identify trees, shrubs, and other vegetation to remain or to be relocated. Wrap a 1-inch blue vinyl tie tape flag around each tree trunk at 54 inches above the ground

The following practices are prohibited within designated tree or wetland protection zones:

- Storage of construction materials, debris, or excavated material
- Parking vehicles or equipment
- Erection of sheds or structures
- Impoundment of water
- Excavation or other digging unless otherwise indicated
- Attachment of signs to or wrapping materials around trees or plants
- Do not direct vehicle or equipment exhaust toward protection zones
- Prohibit heat sources, flames, ignition sources, and smoking within or near protection zones
- Should access be necessary within designated protection zones, the existing grade will be covered with plywood. Exposed tree roots will not be driven over. The

Contracting Officer will be notified and will approve of the access and driving surface before its use.

- Should temporary storage be necessary within designated protection zones, the existing grade will be covered with double, overlapping sheets of 0.75-inch-thick plywood, or 6 to 8 inches of wood mulch to help distribute the weight of materials or supplies and to minimize soil compaction.
- In areas that would otherwise be undisturbed and that have only grasses and low shrubs, protect soils and vegetation from damage by construction equipment movements by overlapping sheets of 0.75-inch-thick plywood placed on top of 6 to 8 inches of wood mulch to distribute weight. The weight distribution material must be removed after construction to allow the soil and plants access to light and air.
- Avoid heavy equipment use in wetlands if at all possible. Plywood or ground-protecting mats (providing protection equal to or better than that of plywood) will be placed on the ground under any equipment driving into wetland areas. The number of trips driving through wetlands will be minimized to the maximum extent possible. Minimize soil and plant root disturbance and preserve preconstruction ground and water surface elevations to the maximum extent possible during construction.
- Before beginning any construction, consult with the Park's natural resource specialist for any required, removal, trimming, and pruning of encroaching vegetation.
- Contractor will protect all trees and high-value vegetation from injury due to trenching or other work. All injuries to trees and high-value shrubs will be mitigated to the satisfaction of the Contracting Officer, and, if appropriate in accordance with guidelines established in the "Guide for Plant Appraisal." All costs of such mitigating will be charged to and paid by the contractor.
- Protect exposed roots from contamination by stabilization materials and concrete.
- Locate concrete washout areas away from roots, tree protection areas, and gradients that may create run off into tree protection areas.
- Ripping or tearing of roots will be avoided at all times when working around all trees.
- When excavating, excavated soil will be deposited in trucks and hauled off or deposited temporarily on ¾ inch thick plywood outside the critical root zone. Excavated and fill soil will not be deposited, even temporarily, on unprotected natural grade.
- Limit grading to a maximum of 2 inches of fill over natural grade within critical root zones. Fill should consist of sandy loam topsoil. Clay soils will not be used as fill. When using fill soil, the existing surface to receive fill should be scarified before filling. Any filling operation should not occur during water saturated soil conditions.

- If the contractor destroys or injures trees and shrubs within the project area, either inside or outside of the construction limits, the contractor will be assessed damages. Replacement costs for damaged vegetation will be computed according to the method described in the International Society of Arboriculture's latest Guide for Plant Appraisal. This method is based on the cost of the largest commonly available tree or shrub, with modifications based on species value, condition and location. A trained arborist or professional plant appraiser will be hired to make the damage appraisal. The arborist's fees will be included in the damage assessment.
- Cuts and damaged areas will be treated in accordance with tree and plant repair practices specified by the National Arborist Association, the International Society of Arboriculture, or a qualified arborist.

3.06.5 Tree and Vegetation Removal for New Construction

- Do not remove trees, shrubs, and other vegetation indicated to remain or to be relocated.
- Remove trees to create an irregular pattern at the edges to avoid the creation of straight lines, which are not natural in appearance. This will require removal of additional trees and potentially selective thinning of trees within stands.
- Pull stumps and remove trees from the site.
- Fill depressions caused by clearing and grubbing operations with satisfactory soil material unless further excavation or earthwork is indicated. Place fill material in horizontal layers not exceeding a loose depth of 6 inches, and compact each layer to a density equal to adjacent original ground.

3.06.6 Topsoil Stripping and Storage

- Following topsoil management guidelines, all topsoil will be retained prior to construction in the immediate area. Following the work, topsoil would be returned to the area and monitored for invasion by non-native species. Any tracks remaining from equipment will be raked and fluffed.
- Strip topsoil to minimum depth of 6 inches, or to full depth of topsoil that is present, in a manner to prevent intermingling with underlying subsoil or other materials. Perform only when the topsoil is dry or slightly moist.
- Stockpile topsoil away from edge of excavations without intermixing with subsoil where it was removed. Identify removal areas and stockpiles so that the topsoil may be placed over the same general location(s) they were conserved from. Grade and shape stockpiles to drain surface water. Limit height of topsoil stockpiles to 36 inches.
- If it is impractical to windrow topsoil adjacent to the disturbed area or objectionable to the CO due to environmental or other concerns, remove the topsoil and stockpile

at an approved location. Haul excess topsoil to the nearest area requiring topsoil but lacking in quantity.

- Use equipment capable of excavating small, isolated pockets of topsoil. Hand rake topsoil in areas where topsoil cannot be mechanically removed. Do not compact or drive upon topsoil during removal. Remove the topsoil to be conserved in one pass. Do not mix topsoil with subsoils.
- Stockpile wetland sod conserved from impacted wetlands in rolls or pieces in a windrow.
- Place and water stockpiled wetland topsoil to ensure survivability as determined by the Contracting Officer if wetland topsoil is to be stockpiled longer than 24 hours.
- If hydric soils are to be stockpiled for longer than 14 calendar days, they will be covered with impermeable material or otherwise protected from desiccation in a manner approved by the Contracting Officer.
- Topsoil will not be moved from the jobsite unless specifically authorized by the Contracting Officer.
- If topsoil is to be stockpiled for equal to or greater than one month, the contractor will be responsible for conducting monthly spot-spraying for weeds in the stockpiled topsoil. This cannot take place when the ground or topsoil is snow-covered, when it is raining, or conditions are otherwise detrimental to the work.
- Do not stockpile topsoil for longer than two months in sagebrush/rabbitbrush zones; longer than 4 months in grass dominated zones; or longer than 6 months in forested zones unless approved by the Contracting Officer.
- Stockpiling soil over the winter is not permitted.

3.06.7 Weed Spraying

- NPS will provide all herbicide required. The contractor will be responsible for applying the herbicides in the situations and locations discussed in the project specifications. The contractor will apply herbicide according to federal and state laws, including conditions and requirements of the federal registered herbicide label.
- Each herbicide applicator will possess a Wyoming, Montana, or Idaho Commercial Herbicide Applicator's License held in the individual's name. Submit this certification each time a new applicator begins herbicide application work on the project.
- The contractor will schedule a plant identification training with the Contracting Officer. Each herbicide applicator will pass a plant identification test prior to spraying.
- The contractor will provide a submittal describing their plan for spraying weeds.

- The contractor will provide a record of areas sprayed, species treated, and undiluted products used (type and quantity) by December 31 of each year.
- For certain areas identified by the Contracting Officer, the contractor will plan to conduct spot-spraying prior to ground disturbance. The contractor will plan on completing this spraying for up 4 total acres. Within the months of May through September, spraying may take place between one month and one week ahead of ground disturbance. For other months, consult the Contracting Officer regarding the allowable timeframe for the specific location of work.
- After topsoil has been replaced and a site has been reseeded and mulched, the contractor will conduct spot-spraying for weeds two times. The first treatment will be completed after weeds have had time to emerge from the replaced topsoil but not later than one month after the topsoil has been replaced. The second treatment will be approximately 3 weeks later, depending on weather. Consult with the Contracting Officer regarding the allowable timeframe based on the location of each site and season of topsoil replacement.

3.06.8 Vegetation and Material Removal for Fire Protection

- Remove trees and other vegetation in fire protection zones in the following manner:
  - Less than 10 feet from a structure – Clear trees, tree limbs, shrubs, and dead vegetation. Grasses and groundcovers are allowed but must be maintained at a height less than 6 inches.
  - 10 feet to 30 feet from a structure – Remove trees under 20 feet in height or less than 5-inch caliper. Prune remaining trees up to 6 feet vertical clearance from ground. Remove trees with height greater than the distance from their base to the nearest structure. Clear to create minimum clearance of 10 feet between crowns and maximum 30% canopy cover. Remove all vegetation less than 6 feet in height. Remove all dead plant material. Grasses and groundcovers are allowed but must be maintained at a height less than 6 inches.
- Flammable material that results from mowing or clearing should be removed from the defensible space.

3.06.9 Topsoil Spreading and Fine Grading

- Scarify compacted subgrade to a 3-inch depth in areas that have become crusted or hard-packed to bond topsoil to subsoil. Protect existing tree roots and roughen soil as needed for topsoil adhesion to subsoil. Place topsoil to a minimum depth of 2 inches after settlement. Topsoil will be free from weeds, sod, and material larger than one inch, toxic substances, litter or other deleterious material. Spread evenly and grade to elevations and slopes shown on Contract drawings. Hand rake areas inaccessible to machine grading.

- Do not place topsoil when the ground or topsoil is frozen, excessively wet, or otherwise in a condition detrimental to the work.
- No topsoil will be imported from outside the Park or moved internally within the Park unless approved by the Contracting Officer. Any material brought into the Park from outside sources must be certified weed-free fill obtained from a recently certified facility. All excess fill and topsoil will be removed from the Park. If fill material cannot be disposed of offsite, the material is to be stored at a location approved by the Contracting Officer.

3.06.10 Restoration Planting, Seeding, and Mulching

- Restoration planting and seeding will be performed by NPS staff. Mulching will be performed by contractor in accordance with "Vegetation Management for Construction Disturbance in Yellowstone National Park."
- The seeded area will be mulched within 8 hours of seeding using weed-free wood chips obtained from a recently certified facility.
- Mulching will not be installed when surface water is present resulting from rain, melting snow, irrigation, or other causes.
- Areas not properly mulched, or any damage that may occur during construction is the responsibility of the contractor and will be repaired and re-mulched in an acceptable manner at the contractor's expense. Mulching removed by wind, rain, or other causes before acceptance will be re-established by the contractor at their own expense.
- Contractor will remove all mulch from surface areas not specified for seeding, including but not limited to plant materials, fences, paved areas, signs, mulch beds, irrigation components and all other objects as directed by the Contracting Officer.
- Perform cleaning during installation of the work and upon completion of the work. Remove from all excess materials, debris and equipment from site. Repair any damage resulting from seeding operations.
- Erect temporary fencing or barricades and warning signs as required to protect newly planted areas from traffic. Maintain fencing and barricades throughout initial maintenance period and remove after plantings are established.

3.07 Structural

The structural design criteria and approach for the new facilities will be grouped into two key categories (1) Operations and people spaces, and (2) Industrial and process treatment areas. For both groups of facilities, minimum design loads will be developed from the governing building codes and its supplemental standard reference documents.

This section describes the structural engineering design and construction quality standards for design and construction. If this section overlaps or conflicts with governing

codes, standards, or manufacturer's directions and instructions, the most stringent requirement will govern unless otherwise directed by the Owner.

The following structural loading and material specific codes will be used during Detailed Design.

- 2021 IBC by International Code Council
- 2016 American Society of Civil Engineers (ASCE) 7 – Minimum Design Loads and Associated Criteria for Buildings and Other Structures
- 2019 American Concrete Institute (ACI) 318 – Building Code Requirements for Structural Concrete and Commentary
- 2006 ACI 350 – Code Requirements for Environmental Engineering Concrete Structures and Commentary
- 2006 ACI 350.3 – Seismic Design of Liquid-Containing Concrete Structures and Commentary
- 2016 TMS 402/602 – Building Code Requirements and Specification for Masonry Structures
- 2016 American Institute of Steel Construction (AISC) 360 – Specifications for Structural Steel Buildings
- 2016 AISC 341 – Seismic Provisions for Structural Steel Buildings
- 2020 Aluminum Association – Design Manual
- Metal Building Manufacturer's Association Metal Building System Manual
- Steel Joist Institute Standard Specifications and Load Tables
- Steel Deck Institute Design Manual for Composite Decks, Form Decks, and Roof Decks

3.07.1 General

- Facility Risk Category III
- Groundwater depth 13 to 19 feet
- Frost Depth 4 feet below finish grade minimum

3.07.2 Structural Systems

Table 3-4. Structural Systems for Each Facility

Facility	Structural System
310 – Headworks	Reinforced cast-in-place concrete foundation, cast-in-place concrete and CMU load-bearing walls, CMU shear walls, Steel roof members supported

Facility	Structural System
	by CMU walls with steel deck roof diaphragm. Cast-in-place concrete basins.
330 – Aeration and Digester Basin and Building	Rectangular open top basins with reinforced cast-in-place concrete base slab, walls, and elevated walkway slab. Metal Building enclosure with concrete foundations.
320 – Process Building	Reinforced cast-in-place concrete foundation, cast-in-place concrete and CMU load-bearing walls, CMU shear walls, Steel roof members supported by CMU walls with steel deck roof diaphragm. Cast-in-place concrete basins.
340 – Dewatering Building	Reinforced cast-in-place concrete foundation, cast-in-place concrete and CMU load-bearing walls, CMU shear walls, Steel roof members supported by CMU walls with steel deck roof diaphragm. Cast-in-place concrete basins.
350 – Cake Storage Building	Rectangular open top basins with reinforced cast-in-place concrete base slab, and walls. Metal Building enclosure.
360 – Storage Building	Metal Building founded on spread column footings and wall foundation. Slab on grade floor.

3.07.3 Loads

Dead Load

Dead loads will include the self-weight of all structure construction materials, including walls, floors, roofs, ceilings, stairways, built-in partitions, finishes, cladding, and other similar structural and architectural items. Fixed-service equipment, including process equipment, cranes, and heating, ventilation, and air conditioning (HVAC), plumbing, roof mounted photovoltaic panels and electrical equipment will be included as part of the total dead load.

Live Loads

Live loads are loads produced by the use and occupancy of the structure. The minimum uniformly distributed and concentrated live loads values provided in 2021 IBC Table 1607.1 will be used for design. The following table presents additional uniform live loads applicable to this project that will be used for the design of structures. Additionally, deflections of roof and floor members subject to live loads will be in accordance with 2021 IBC Table 1604.3.

Table 3-5. Design Live Loads

Location	Live Load
Corridors/lobbies/stairs/exits	100 psf
Offices	100 psf

Location	Live Load
Walkways and elevated platforms	60 psf
Electrical rooms	300 psf
Process mechanical areas	200 psf, Equipment + 50 psf, whichever governs
Light storage	125 psf
Heavy storage	250 psf
Monorail and bridge crane	As indicated on the drawings

Seismic Loads

- The seismic design of building structures will be performed in accordance with ASCE 7-16, Chapter 12.
- Seismic design of non-building structures, such as basins, will be performed in accordance with the 2021 IBC; ASCE 7-16, Chapter 15; and ACI 350.3-06.
- The following table presents the seismic design parameters, which will be used for both types of structures.

Table 3-6. Design Seismic Loads

Parameter	Value
Risk category	III
Importance factor (I_e)	1.25
Mapped MCER spectral response acceleration at short periods, 5% damped (S_S)	1.084g
Mapped MCER spectral response acceleration at 1 sec period, 5% damped (S_1)	0.333g
Site Class	C (assumed before geotech investigation)
Design spectral response acceleration at short periods, 5% damped (S_{DS})	0.867
Design spectral response acceleration at 1 sec period, 5% damped (S_{D1})	0.33
Seismic design category	D

g = gravity

Wind Loads

Wind loads will be developed based on the specific geometry of each applicable structure based in accordance with the 2021 IBC and ASCE 7-16.

- Basic Wind Speed (Strength level): 114 miles per hour
- Exposure category: Exposure C
- Risk Category III

Snow Loads

Snow loads will be developed based on existing building design criteria, Montana State University snow load finder and ASCE 7-16, whichever produces the largest roof snow load, but not less than the roof snow load specified in Table 3-7.

Table 3-7. Design Structural Snow Loads

Parameter	Value
Minimum roof snow load (pf)	140 psf
Importance factor (Is)	1.1
Terrain category	C
Roof exposure	Partially Exposed
Exposure factor (Ce)	1.0
Thermal factor (Ct)	1.2 (Unheated/open structures) 1.0 (All other structures)

Rain Loads

In accordance with ASCE 7-16 Chapter 8.

Icing Loads

In accordance with ASCE 7-16 Chapter 10.

Fluid Loads

Fluid loads will be applied to fluid-holding basins and channels based on the maximum water surface elevations provided on the hydraulic profile, in the controlling combination of adjacent full and empty basins, and without resisting pressures due to the presence of soil backfill. Fluid density for determination of fluid loads will assume 63 pcf.

Earth Loads

Vertical and lateral earth loads will be applied to structures incorporating the recommendations from the geotechnical investigation. Lateral loads will use either at-rest or active pressure based on the specific geometry of the earth retaining structure and will consider the presence of groundwater based on the recommendations from the geotechnical investigation. A minimum 2-foot soil surcharge at grade level will be used

unless larger surcharge loads are present accounting for adjacent structures, traffic, or equipment loading.

Crane Loads

Crane live load for design of crane components, connections and supports in accordance with ASCE 7-16, Section 4.9.

- Vertical Impact: 25% rated load for monorails, 10% rated load for pendant-operated bridge cranes
- Lateral Impact: 20% rated load + weight of trolley and electrically powered hoist
- Longitudinal Impact: 10% max wheel load

Load Combinations

Load combinations in accordance with ASCE 7-16, Chapter 2, will be investigated. In addition to the code prescribed load combinations, the following four load cases will be investigated for the design of water-retaining structures:

- Load Case I: Design operating water surface elevation with no backfill (leakage testing)
- Load Case II: Backfill at finished grade with no liquid inside tank. A surcharge of a minimum 2 feet of soil will be added to walls where there will be vehicle traffic or wheeled traffic adjacent to the wall.
- Load Case III: Increased soil backfill and liquid pressures due to seismic conditions (no additional surcharge indicated in Case II) and operating water surface elevations. Combinations of basin cells being full or empty will be considered.
- Load Case IV: Maximum design water surface—wall overtopping or passive overflow elevation plus 1 foot and backfill
- Load Case V: Maximum design ground water elevation with water-retaining structures empty for maximum buoyancy load

3.07.4 Foundation and Retaining Walls

Provide a stability safety factor of 1.5 for both sliding and overturning.

Buoyancy and uplifting forces will be included in calculation the position of resultant force and factor of safety against overturning.

3.07.5 Framing Load Deflections

Cast-in-place concrete framing members will not exceed the maximum deflections listed in Table 3-8.

Table 3-8. Cast-in-Place Concrete Framing Load Deflections

Member	Allowable Live Load Deflection[a]
Flat roof slabs	L/180
Roof beam	L/240[b]
Roof beam supporting plaster ceiling below	L/360[b]
Floor beam	L/360
Floor beam supporting ceiling below	L/480
Floor beam supporting masonry wall	L/480

[a] Refer to ACI 318, for limitations affecting deflection calculations.
[b] Beam may be cambered for dead load and partial live load deflection. Ponding will be investigated.

Steel framing members will not exceed the maximum deflections listed in Table 3-9.

Table 3-9. Structural Steel Framing Load Deflections

Member	Allowable Live Load Deflection[a]
Roof beam	L/240
Roof beam support ceiling below	L/360
Floor beam	L/360
Crane support beam and monorails	L/600
Monorails for underslung hoists	L/800 (not including impact)
Girt (horizontal)	L/450
Girt (vertical)	L/240
Girt supporting window (vertical)	1/8 inch for L<100 inches
	L/480 for L>100 inches
Pre-engineered Building sway due to lateral load	H/100

[a] Beam may be cambered for dead load and partial live load deflection. Ponding will be investigated. The span length L is in inches.

3.07.6 Design and Construction

Where above – or below – grade structures are subject to wet or corrosive atmosphere, floors, walls, and ceilings will be made of concrete. Materials for other structures or components in corrosive areas are described in the drawings unless otherwise indicated.



Concrete

- Design of reinforced concrete structures will conform to the latest editions of ACI 318, and IBC 2021
- Formwork will conform to the latest editions of ACI 117, 318, and 347
- Concrete structures which contain fluid or below grade structure will be designed in accordance with the latest editions of ACI 350. Structure will be designed for the following conditions:
  - Liquid level to the underside of roof slab or normal operating level whichever, is greater. Design will be done with no soil backfill for load condition.
  - Empty basin with soil backfill, ground water if presented, and increased pressures due to seismic loads and uplift pressure due to ground water
  - The above load conditions will be for any combination of cell empty and full, whichever results in higher stresses
- Structure will be designed to resist hydrostatic uplift and hydrostatic pressures
- Concrete protection for reinforcement will conform to ACI 318 and ACI 350 for structures that contain fluid

Leakage Testing

All liquid holding structures will be tested in accordance with ACI 350.

Steel

- Structural design will conform to the requirements of IBC, AISC 360, the AISC Manual of Steel Construction, and the Seismic Provisions for Structural Steel Buildings AISC-341
  - All structural steel will conform A992, grade 50. Fastener connecting bolts will be ASTM International (ASTM) A325
  - All structural steel exposed to weather will be hot-dip galvanized. Materials in contact with or in proximity to liquid will be 316 stainless steel

Masonry

All CMU will be reinforced, and all cells will be fully grouted in compliance with applicable ASTM standards.

3.08 Process Mechanical

This section presents the general design guidance and baseline approach for the development of the mechanical systems for Canyon Village WWTP. The purpose of this design report is to present the general design philosophies and considerations for the mechanical systems located throughout the Canyon Village WWTP.

3.08.1 Applicable Codes and Standards

The mechanical design of the Canyon Village WWTP will make use of many applicable industry standards and design guidance for piping, valves, and process equipment. The following is a list of the more significant resources for design and specification standards. Others will be cited in specific mechanical topics.

- American Society of Mechanical Engineers (ASME)
  - ASME B31.3 Process Piping
- ASTM
- AWWA
- AASHTO
- Hydraulic Institute Standards
- Crane Manufacturers Association of America (CMAA)
- CMAA 74-10 Top Running and Under Running Single Girder Electric Overhead Cranes, Utilizing Under Running Trolley Hoist
- 10 State Standards
- NSF International Standard
  - NSF/ANSI 61 – 2016 Drinking Water System Components – Health Effects

3.08.2 Process Equipment Layout and Access

The following will be implemented to make the WWTPs functional, operable, and maintainable. When developing process equipment layouts, the following minimum requirements will apply:

- All equipment must be accessible and at functional working height where possible, with sufficient clearances around equipment to facilitate all maintenance activities, including sufficient room and laydown area to remove the largest component. The laydown area must be reachable by lifting devices.
- Locate maintainable equipment in accessible locations; maintainable equipment will not to be installed in false ceiling or underfloor grating
- Equipment requiring routine maintenance and lubrication more than once per year is required to have stairs, platforms, guard rails, and anchor points provided
- Locate equipment with ample space and lighting for inspection and maintenance and adequate provision for removal for maintenance or replacement without interrupting WTP operations
- Equipment maintenance, overhaul, or removal will not require the dismantling of permanent infrastructure or the relocation of other fixed equipment

- Provide manufacturer-recommended clearances, or a 3-foot minimum distance, for access between all equipment and valves, pipework, and structures to facilitate O&M activities and ensure all equipment can be safely isolated to allow maintenance work to proceed. In some cases, less clearance is acceptable but must be evaluated to ensure proper maintenance and safety requirements are adhered to.
- Include adequate and appropriately located flushing connections and drain points to relieve pressure and drain fluid/gases at point of disassembly and provide non-obstructive access to adjustment points, test points, and filling and draining points on all equipment
- Provide simple and safe means to access, isolate, purge, and remove all installed instrumentation components without disrupting the treatment process
- Arrange equipment, piping, and pipe support components so as not to interfere with any utility corridors, create tripping hazards or impede walking without crouching head clearance
- Arrange the orientation of pumps, compressors, and other rotating equipment where parallel units are provided such that rotation is identical
- Provide equipment removal corridors to enable access for removing the largest piece of equipment in the facility with a minimum of 2 feet on all sides
- Provide access paths or walkways at least 3 feet wide where only person access is required.
- Confirm all equipment is accessible and at functional working height where possible, with sufficient clearances around equipment to facilitate all maintenance activities, including sufficient room and laydown area to remove the largest component. The laydown area must be reachable by a lifting device.
- Extend equipment pads beyond the extents of equipment to meet anchoring requirements.

3.08.3 Hydraulic Calculations

Replica hydraulic modeling software was used to perform the hydraulic evaluation for this project. Replica is based on a library of hydraulic blocks that are used to model treatment plant hydraulics for both gravity and pump flow, including blocks for pipes, fittings, pumps, equipment, storage tanks, etc. Each block uses industry-standard equations and coefficients to calculate the pressure or gravity hydraulics occurring within the block. Replica also includes a library of control blocks that can be used to program the model similar to an actual treatment plant so that the model can be used as a digital twin. Additional information on the control logic used, specific equipment information, or the hydraulic calculations inherent to Replica can be provided on request.



Pump Selection and Hydraulic Calculations

Hydraulic calculations will be prepared for all pump applications. Selected pump operating points will be centered near the pump best efficiency point at the design condition. A rating point selected to the right of best efficiency flow will allow higher efficiency at reduced flow and speed. Caution will be exercised in selecting pump operating points at the extremes of the pump operating curve due to possible excessive pump shaft radial loading, reduced bearing life, and possible shaft failure.

Care will be exercised in providing adequate overlap of pump performance when multiple parallel pump installations are provided. Proper pump sequencing requires that pumps have sufficient performance overlap to allow transition adding or dropping pumps in operation.

3.08.4 Piping Systems

Process piping includes yard piping, which may be entirely designed and specified outside of the mechanical discipline. Piping for process services and mechanical utilities in the yard also requires civil engineering coordination and consideration for earth loads and traffic loads.

Design Codes and Standards

- ANSI B31.3 – Process Piping
- MSS SP 58 – Pipe Hangers and Supports
- MSS SP 127 – Bracing for Piping Systems: Seismic, Wind, Dynamic Design, Selection, and Application

Pipe Materials and Applications

Table 3-9 presents a preliminary piping schedule indicating piping services planned for the Canyon Village WWTP. The schedule is organized by identifying service symbol (legend) and identifies materials, coatings, linings, and test pressures to be used for these services. Updates will be made as design progresses, to become the Piping Schedule included in the construction documents.

The contractor must ensure metals are protected from potential corrosion. Soils at Canyon Village are known to be corrosive. Any buried metal pipes such as steel air piping must have protective coatings or other corrosion prevention measures.

Table 3-9. Pipe Schedule

Service	Flow Stream Identification	Exposure	Size (inches)	Material
Alkalinity	ALK	EXI	ALL	HDPE

Service	Flow Stream Identification	Exposure	Size (inches)	Material
				CARRIER/CPVC CONT
Alum	ALM	EXE	ALL	HDPE CARRIER/CPVC CONT
		EXI	ALL	PVC
		BUR	ALL	PVC
Air, low pressure	ALP	BUR	ALL	304SS
		EXE	ALL	304SS
		EXI	ALL	304SS
Bioreactor influent	BRI	BUR	ALL	CLDI
		ENC	ALL	CLDI
		SUB	ALL	CLDI
Citric acid	CA	EXI	ALL	HDPE CARRIER/CPVC CONTAINMENT
Digested sludge	DS	BUR	ALL	CLDI
		EXI	ALL	CLDI
		SUB	ALL	CLDI
Digester permeate	DPER	EXI	ALL	PVC
		SUB	ALL	CLDI
Effluent	EFF	BUR	ALL	CLDI
		EXE	ALL	CLDI
		EXI	ALL	PVC
Equalization	EQ	BUR	ALL	CLDI
Glycerin	GLY	BUR	ALL	PVC
		EXE	ALL	PVC
		EXI	ALL	PVC
Process drain	PD	BUR	ALL	CLDI
Mixed liquor recycle	MLR	SUB	ALL	PVC

Service	Flow Stream Identification	Exposure	Size (inches)	Material
Nonpotable water	NPW	BUR	ALL	CLDI
		EXE	ALL	PVC
		EXI	ALL	COP
		SUB	ALL	PVC
Permeate	PER	EXI	ALL	CLDI
		SUB	ALL	CLDI
Polymer solution	POS	EXI	ALL	PVC
Potable water	PW	BUR	ALL	CLDI
		EXE	ALL	PVC
		EXI	ALL	COP
Pressate	PRES	BUR	ALL	PVC
		EXI	ALL	PVC
Process drains	PD	BUR	ALL	PVC
		EXI	ALL	PVC
Return activated sludge	RAS	BUR	ALL	CLDI
		EXI	ALL	CLDI
		ENC	ALL	CLDI
		SUB	ALL	CLDI
Raw sewage	RS	BUR	ALL	CELDI
		ENC	ALL	CELDI
		SUB	ALL	CELDI
Plant sewer	PS	BUR	ALL	CELDI
Secondary scum	SSM	BUR	ALL	GLDI
		EXE	ALL	GLDI
		SUB	ALL	GLDI
Septage/vault waste	SEP	BUR	ALL	CELDI
		EXI	ALL	CELDI
		ENC	ALL	CELDI

Service	Flow Stream Identification	Exposure	Size (inches)	Material
Sodium hypochlorite	SHC	EXI	ALL	HDPE CARRIER/CPVC CONTAINMENT
Grit slurry	SLRY	EXI	ALL	GLDI
Thickened waste activated sludge	TWAS	BUR	ALL	CLDI
		EXE	ALL	CLDI
		EXI	ALL	CLDI
		SUB	ALL	CLDI
Waste activated sludge	WAS	BUR	ALL	CLDI
		EXI	ALL	CLDI
		EXE	ALL	CLDI
		ENC	ALL	CLDI
		SUB	ALL	CLDI
Sodium hypochlorite	SHC	EXI	ALL	HDPE CARRIER/CPVC CONTAINMENT
Grit slurry	SLRY	EXI	ALL	GLDI
Thickened waste Activated Sludge	TWAS	BUR	ALL	CLDI

BUR = buried
EXE = exposed exterior
EXI = exposed interior
SUB = submerged
ENC = encased
PVC = polyvinyl chloride
CPVC = chlorinated poly vinyl chloride
COP = copper
CLDI = cement-lined ductile iron
CELDI = cement-encased lined ductile iron
GLDI = glass-lined ductile iron
HDPE = high-density polyethylene

Pipe Supports

- The general minimum requirements set out in the contract requirements apply to the pipe supports, anchorage, and seismic bracing of process piping.

- The Canyon Village WWTP is in a seismically active region with a Seismic Design Category D. The following design and analysis procedures will be conducted:
  - Normal fluid service and Category D fluid service as identified by ASME B31.3, greater than or equal to 6 inches diameter will require formal pipe stress and flexibility analysis or by-rule analysis as identified in ASME B31.3 Process Piping, using a software-based program such as Caesar II.
  - Category D fluid service as identified by ASME B31.3, less than 6 inches diameter will require by-rule pipe stress and flexibility analysis.
  - All Category M fluid services as identified by ASME B31.3 will have formal pipe stress and flexibility analysis, using a software-based program such as Bentley Autopipe.

Seismic Design – Pipe Supports

Sway struts and braces will be provided to restrain piping seismic forces as required by the codes listed above.

3.09 Building Services

3.09.1 Codes, Standards, and Regulations

All new facilities and existing facilities to be rehabilitated will be designed to conform to the following codes, standards, and regulations, as required by the federal, state, and local authorities.

- 2021 IBC, with Appendices
- 2018 International Mechanical Code (IMC)
- 2021 International Plumbing Code (IPC)
- 2021 IFC, with Appendices
- 2018 IECC
- 2021 IEBC, with Appendices
- 2018 International Fuel Gas Code (IFGC)
- ASHRAE
  - ASHRAE Guideline 0-2013 The Commissioning Process
  - ASHRAE Guideline 1.1-2007 HVAC&R (HVAC and Refrigeration) Technical Requirements for The Commissioning Process
  - ASHRAE 52.2-2012 Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size
  - ASHRAE 55-2010 Thermal Environmental Conditions for Human Occupancy



  - ASHRAE 62.1-2013 Ventilation for Acceptable IAQ (Indoor Air Quality)
  - ASHRAE 62.2-2013 Ventilation and Acceptable IAQ in Low-Rise Residential Buildings
- ANSI/ASHRAE
  - ANSI/ASHRAE 15-2013 Safety Standard for Refrigeration Systems
- ANSI/ASHRAE/IES (Illuminating Engineering Society) 90.1 Energy Standard for Buildings Except Low-Rise Residential Buildings
- ANSI/SMACNA (Sheet Metal and Air Conditioning Contractors' National Association) 006-2006 HVAC Duct Construction Standards - Metal and Flexible
- NFPA Codes and Standards including but not limited to:
    - NFPA 2001 - Standard on Clean Agent Fire Extinguishing Systems
- ICC/ANSI A117.1 and 2021 IBC, Chapter 11
- 2020 National Electrical Code, NFPA 70
- 2020 Standard for Fire Protection in Wastewater Treatment and Collection Facilities, NFPA 820
- Occupational Safety and Health Administration General Industry Safety Orders
- NPS Management Policies

3.09.2 Code Compliance

All new facilities and existing facilities to be rehabilitated will be designed to conform to the weather information and temperature data that is detailed in Table 3-10.

Table 3-10. ASHRAE Fundamental Weather Information

Heating Dry Bulb (99.6%) Temperature	-19.4°F
Heating Dry Bulb (5 year Extreme) Temperature	-34.4°F
Cooling Dry Bulb (0.4%) Temperature	77.0°F
Cooling Wet Bulb (0.4%) Temperature	52.0°F
Cooling Dry Bulb (5 year Extreme) Temperature	82.5°F
Mean Coincident Wind Speed (0.4% Dry Bulb)	6.1 miles per hour

Information for weather data is provided from 2017 ASHRAE Handbook, Yellowstone, WY, USA
°F = degree(s) Fahrenheit

- Indoor Design Conditions for Process (unoccupied) spaces:
  - Winter: 50 degrees Fahrenheit (°F)
  - Summer: 100°F

- Indoor Design Conditions for Public, Office, and Living Spaces:
  - Winter: 72°F
  - Summer: 75°F
  - Maximum Relative Humidity: 60%
- Electrical/Information Technology (IT) Rooms: 50 to 80°F
- Indoor Design Conditions for Shop and Storage Spaces
  - Winter: 65°F Summer: 80°F
- Design conditions listed here will be reviewed with and approved by Park staff for each building and space type to identify potential areas of additional energy savings. For example, some storage spaces may allow for less stringent summer or winter design conditions.

3.09.3 Facility Design Criteria

Site HVAC

For building heating, new propane tanks will need to be provided on the site. These tanks are to be buried and sized to provide adequate fuel for the winter period when propane deliveries are not possible. This is approximately from November 7 to April 15 for the Canyon village site. Sizing and location of the propane tanks will also need to account for demand of the site standby generator(s).

Metering of propane and water usage will be provided at each building and include pulse monitoring (or other approved means) to enable remote reads.

Facility 310, Headworks

- A new one-story with lower equipment access-level facility to house the headworks equipment including screening equipment and solids removal equipment. At this Schematic Design Phase, the NFPA 820 requirement of 12 ACH will not be met; therefore, the building would be under the Class I Division 1 electrical area classification. Final HVAC design will be in accordance with the area classification and NFPA 820 requirements as determined by the DB contractor's electrical area classification analysis. Other NFPA 820 requirements will also be reviewed according to that analysis (fire extinguishers, hydrant coverage, combustible gas detection).
- Facility 310 electrical equipment will be in a separate Electrical Room outside the classified area. The electrical equipment will consist of motor control centers (MCCs), electrical panels and vendor supplied package control systems for the Headworks Building processes.

- This building will require propane heating via underground storage tanks located near the facility.
- Facility HVAC.
  - A variable speed makeup air unit (MAU) will be provided and mounted at grade. The MAU will be within a building enclosure to provide weather protection and prevent snow drifts from impacting operation. The MAU will include a propane heater to allow warm air to circulate through the facility to prevent freezing. No mechanical cooling is required for this facility and temperature control will be through general ventilation air flow.
  - The makeup air will be exhausted via exhaust fan that operates simultaneously with the MAU and through louvered wall openings that open upon MAU operation.
  - The MAU will operate at normal minimum speed for ventilation and heating purposes to maintain summer/winter design conditions. A switch at the building entry doors will be provided and upon activation, MAU will go to maximum speed to provide one air change of the process space within 15 minutes. The MAU heating is sized to modulate and temper air at minimum and maximum speeds. This switch function is intended for personnel to “evacuate” the process space before entry during winter conditions. If the area classification analysis determines this space will be continuously ventilated, this “switch” function may no longer be required.
  - The Electrical Room will need heating and ventilation to maintain design conditions for the space.
- Facility Plumbing
  - Water service will be provided and routed throughout the facility to allow for general facility washdown. Included as part of the design will be plumbing water service to an explosion-proof heated pressure washer system that will be used for cleaning of channels and screens. As required per code, the water services will be provided with pressure reducing backflow protection devices to prevent contamination of the system water services.
  - System drainage will be provided and vented through the roof. The drainage will be routed back to the plant headworks for treatment.

Facility 320, Process Operations Building

A new one-story facility with basement to house the following: Electrical Room, Mechanical Room, Maintenance Room, chemical storage, lab and people spaces, Membrane Room, and basement for pumps and blowers.

Propane tanks located near this facility will provide fuel for heating as well as storage for standby generator(s) in the area.

- Facility HVAC
  - Ventilation fans will be provided in the mechanical, maintenance and basement levels to maintain summer design conditions.
  - Heating will be accomplished via duct or unit heaters that are served by a condensing boiler that will provide the heating hot water for Operations Building. The boiler system will be in the Mechanical Room with pumps and other required appurtenances (expansion tank, air separator, etc.).
  - The Chemical Room and Membrane Rooms will be provided a minimum of 1 cubic foot per square foot per minute of ventilation exhaust to satisfy applicable IMC requirements. If the area classification analysis determines this space will be continuously ventilated, the ventilation required will increase to the NFPA 820 required airflow. An MAU, located in the Mechanical Room, will provide ventilation and heating (via heating hot water) to these spaces via ductwork. Exhaust fans located in each room will exhaust the makeup air. The HVAC systems will be provided with the code required system emergency ventilation shutoff switch at the exit of the facility to allow for HVAC shutdown in the event of a chemical leak.
  - The Electrical Room will be heated via electric unit heaters and cooled via DX-packaged unit. During Detailed Design, DX cooling may be replaced if electrical equipment heatloads allow for ventilation instead. Ductless split systems are not a preferred option.
  - The people spaces will be cooled via DX-type cooling system with hot water coil for heating. During Detailed Design, DX cooling may be replaced for ventilation only with approval from YELL Park staff (design conditions review and approval).Exhaust for the restroom area to be activated with lights in that area.
- Facility Plumbing
  - A water service will be provided and routed throughout the facility to allow for general washdown of the facility and service to the break room and restrooms to be completed to help maintain a clean environment and serve the needs of the occupants. As required per code, the water services will be provided with pressure reducing backflow protection devices to prevent contamination of the system water services.
  - System drainage will be provided and vented through the roof. The drainage will be routed back to the front of the plant for treatment of the sanitary sewer water.
  - Safety Showers will be provided in the Chemical Rooms and Membrane Room as required to meet the ANSI Z358.1 regulation for spacing, flow rate and water tempering. Water heater and mixing valve with circulation pump are to be provided.

Facility 330, Aeration and Digester Basins

- Facility HVAC
  - At this Schematic Design Phase, minimal ventilation has been provided for this enclosed facility for humidity and temperature control. Upon the DB contractor's electrical area classification analysis, the design of ventilation will be in accordance with NFPA 820 requirements to match the design requirements.
- Facility Plumbing
  - Nonpotable water (NPW) will be routed in the area to allow for general washdown.

Facility 340, Dewatering Building

- A new one-story facility to house the dewatering equipment including screw press, membrane thickener tank, and multiple pumps and totes for operations. The NFPA 820 requirement of 6 ACH to declassify the process space is currently shown. Final HVAC design will be in accordance with the area classification and NFPA 820 requirements as determined by the DB contractor's electrical area classification analysis. Other NFPA 820 requirements will also be reviewed to confirm design compliance (fire extinguishers, hydrant coverage, fire alarm system).
- Most of the Facility 340 electrical equipment will be in a separate Electrical Room from the process area. The electrical equipment will consist of MCCs, electrical panels, etc., for the Dewatering Building operation.
- At this stage, the Dewatering Building is expected to be shut down during the winter months (approximately 6 months per year).
- Propane tanks near this facility will provide fuel for heating and standby power generation.
- Facility HVAC
  - A supply and exhaust fan will operate simultaneously while the building is in operation. The fans will be variable speed to allow the space ventilation to lower to 1 cubic foot per minute per square foot if the building is shut down but still storing chemicals. The supply fan ductwork will also contain a gas-fired duct heater (propane) to maintain winter design conditions.
  - The Electrical Room will need heating and ventilation to maintain design conditions for the space.
- Facility Plumbing
  - Water service will be provided and routed throughout the facility to allow for general facility washdown. As required per code, the water services will be provided with pressure reducing backflow protection devices to prevent contamination of the system water services.

- System drainage will be provided and vented through the roof. The drainage will be routed back to the plant headworks for treatment.
- A minimum of one safety shower/eyewash combination will be provided in the process area with tepid water supply to meet the ANSI Z358.1 regulation for spacing, flow rate and water temperature. Water heater and associated equipment will be provided inside the building to provide tepid water supply.

Facility 350, Cake Storage Building

This facility at this time does not include HVAC or plumbing equipment.

Facility 360, Equipment Storage Building

This facility at this time does not include HVAC or plumbing equipment.

3.09.4 Building Services Materials

- HVAC Materials
  - Ductwork provided in all process spaces excluding the chemical spaces and Headworks facility will be aluminum to prevent corrosion from water atmospheres.
  - Ductwork in the Headworks facility and within the chemical spaces of the Process Operations Building will be stainless steel to prevent corrosion from the potential levels of chemical fumes and hydrogen sulfide.
  - Ductwork in the non-chemical areas of the Process Operations Building will be G90 galvanized sheet metal. The restrooms within the facility will be provided with aluminum sheet metal to help prevent corrosion.
- Plumbing Materials
  - General water piping will be supplied in copper to meet NSF 61 regulations.
  - General drainage piping will be supplied with schedule 40 PVC (polyvinyl chloride) with DWV fittings. Any supplied piping in an HVAC plenum will be supplied with CPVC to meet 2021 IMC Plenum requirements.

3.09.5 Energy Compliance

A building energy profile and energy usage calculation will be provided with the utilization of approved energy software such as Trane Trace 700 or Carrier HAP. The software will output energy usage in thousand British Thermal Units per square feet per year. The software will supply a baseline ASHRAE 90.1 and compare the improvements that have been achieved by the design staff in comparison to the baseline.

3.10 Fire Protection

Currently, chemical storage capacities do exceed code limitations so fire suppression will be required in certain areas. The likely suppression method would be a clean agent type system that meets the Park's codes/standards and allows for the protection of the space without the use of water. Another concern for this project that led to a clean agent system (in lieu of water suppression) is the availability and pressure of water supply. At this stage of design, fire suppression has been deemed necessary for the Chemical Room and basement level of the Process Operations Building. The basement level fire suppression is required due to being over the code allowed square footage but additional design and code review will be provided to confirm these requirements. Where a clean agent system is used, the design will be compatible with chemicals of the area, meet NFPA 2001, and provide an egress time study to verify potential exposure times.

Based on the DB contractor's final area classification analysis in accordance with NFPA 820, some buildings on this site (e.g., Dewatering Building) may require a fire alarm system.

3.11 Instrumentation and Control

This section establishes basic criteria and control philosophy for the instrumentation and control systems to be used in the design of Canyon WWTP project. The intent is to standardize the equipment and method of control as much as possible, for consistency of O&M.

The instrumentation and control (I&C) drawings will include process and instrumentation diagrams, control system block diagrams, sample loop drawings, and standard design (installation) details.

The specifications for the I&C components, network devices and communication elements will be prepared using the NPS's master specification sections. The project specifications will include, the programmable logic controller (PLC) panel component specifications, an instrument list for instruments to be provided by the process I&C subcontractor and I/O lists for all the I/O points to be communicated to and from the plant control system. The specifications will also include control narratives that will be programmed within the plant PLCs and SCADA system.

The I&C design will also include the equipment tagging standards that will be coordinated with the mechanical and electrical designs.

3.11.1 I&C Design Criteria and Standard Practices

Equipment Control and Monitoring

"On/off" status and "local/remote" status of equipment will be monitored by the SCADA system. Process "enable" and "permissive" interlock functions will be implemented in

the PLC software. However, personnel and equipment safety functions will be hardwired. The plant PLC will be programmed to provide the start–stop signals and the analog signals to control the drives and valves.

Equipment Protection

The controls and interlocks for protecting equipment, such as high discharge pressure, will be hardwired to the equipment starter. Local “reset” pushbuttons will be provided to reset alarm-lockout functions as required at the MCCs or locally at the equipment.

Personnel Safety

All controls and interlocks provided for personnel safety will be hardwired to the equipment starter. Types of personnel safety interlocks are conveyor trip wires and stop-lockout devices. Personnel safety devices will typically send a signal to the SCADA system when activated to alert the operations staff. Local “reset” pushbuttons will be provided to reset lockout functions as required at the MCCs or locally at the equipment.

Pilot-Light Colors

Red/green lights will be used to indicate “run/off” for motors, “opened/closed” for valves, and tripped/closed for circuit breakers.

Surge Protection

All analog field-mounted instrument loops will be provided with surge suppressors. Power line surge suppressors will be provided for all control panels.

Security

All door switches for the PLC panels and network cabinets as well as to the SCADA network closets / offices will be monitored at the SCADA system.

3.11.2 Levels of Control

The Canyon WWTP will house two main plant PLCs in addition to the vendor-provided packaged system PLCs. The two main plant PLCs will be provided with redundant processors.

There will be four levels of control: “local manual,” “local auto,” “SCADA manual,” and “SCADA auto.”

Local Manual Control

All process equipment will have “local/off/remote” selector switches and “start/stop” switches near the equipment. When the switch is in the “local” position, the equipment is controlled from the local “start/stop” switches. When the switch is in the “remote” position, control is passed to the SCADA system.

Motor-operated valves will have “local/off/remote” switches and “open/stop/close” switches at or near the valve. In the “remote” position, control is passed to the SCADA system.

Local controls are for maintenance, testing, and emergency backup operations. In addition to manual control, local control functions include hardwired interlocks for personnel and equipment safety and protection, such as motor overloads, surge protection, and similar.

Local Automatic Control

Some process equipment may have a separate control panel provided by the equipment supplier to control a particular system, unit process, or group of related equipment and devices manually and sometimes automatically. Examples are sludge dewatering and polymer systems.

SCADA Manual Control

The operator manually controls the process from the SCADA HMI workstations. Operator issues manual “start/stop” or “open/close” commands or adjusts controller outputs to set pump speeds or valve positions.

SCADA Automatic Control

This is the normal mode of plant operation. All major control algorithms and functions, including continuous-loop control and sequential control, will be performed in the PLCs. Any SCADA HMI workstation will provide the operator the ability to monitor and control any process in the plant.

3.11.3 Vendor-provided Control Panels

All the vendor-provided control panels will be specified so that their PLCs will be from Rockwell Automation (Allen Bradley) or Schneider Electric (Modicon). The specifications will state that the vendor PLCs will communicate over Ethernet internet protocol (IP) or Modbus to the plant SCADA system. The vendors will be expected to provide the information to be transmitted to and from the plant SCADA system in a predefined array or table. Each vendor will be expected to coordinate with design build contractor’s system integrator to establish the protocols and tables of information that will be transmitted between its systems and the plant SCADA system. Any vendor-provided panel mounted Operator Interface Terminals will be expected to match the main color codes as the plant SCADA system. For example, the same color should be used to indicate motor running as the plant SCADA system.

It is anticipated that the following packaged systems will be provided with their corresponding control panels and PLCs (where necessary).

- Upper Brinks Falls Lift Station:

- Government Area Lift Station:
- Fine Screens: to monitor and control the influent screens
- Aerated Grit Removal System:
- Membrane System: to monitor and control RAS Pumps, WAS Pumps, Permeate Pumps, Air Scour Blowers, and cleaning chemicals
- UV treatment system:
- Screw Press
- Dewatering Polymer System:

3.11.4 Proposed System Monitoring and Control for the new Equipment

Table 3-11. System Monitoring and Control for the New Equipment

Process	Equipment	Monitoring and Control Information	Input / Output Point Summary[a]
Upper Brink Lift Station	Pumps	• Local monitoring and control from the vendor panel	
Government Area Lift Station	Pumps	• Local monitoring and control from the vendor panel	
Headworks	Fine Screens	• Local monitoring and control from the vendor panels • SCADA monitoring	• Soft link to the Plant Control System from the Fine Screen Panels
Septage Receiving	Septage Receiving System	• Local monitoring and control • SCADA monitoring	• Soft link to the Plant Control System from the Septage Receiving Panel
Grit System	Grit Tank and Blower	• Local monitoring and control from the vendor panel • SCADA monitoring	• Soft link to the Plant Control System from the Grit Panel
Bioreactors	Splitter Gates, Anoxic Mixers (2 per Aeration Basin), Air control valves, Recycle Pumps	• Local and SCADA monitoring and control	• Soft links from the VFDs to the Plant Control System • 15 AI, 15 DI, 4 DO

Process	Equipment	Monitoring and Control Information	Input / Output Point Summary[a]
Membrane System	RAS Pumps (3), WAS Pumps (2), Air Scour Blowers (3), Permeate Pumps (3), Cleaning Chemical pumps (2)	• Local monitoring and control from the vendor panel • SCADA monitoring	• Soft link from the vendor panel to the Plant Control System
Chemical Pumps	Glycerin (2), Alum (2), MgOH (1)	• Local and SCADA monitoring and control	
Aeration and Digester Blowers	Total of 5 blowers	• Local and SCADA monitoring and control	• Soft links from the VFDs to the Plant Control System
UV System		• Local monitoring and control • SCADA monitoring	• Soft link from the UV control panel
NPW Pumps	Pumps (2)	• Local and SCADA monitoring and control	• 4 AI
Digesters	Digester Sludge Pumps (2), Membrane Thickener Blower, Digester Permeate Pump	• Local and SCADA monitoring and control	• 6 AI, 20 DI, 5 DO • Soft link from the Membrane Air Blower
Dewatering Polymer	Polymer Pump and Blending unit	• Local monitoring and control • SCADA monitoring	• Soft link from the vendor control panel
Screw Press	Screw Press	• Local monitoring and control • SCADA monitoring	• Soft link from the vendor control panel
Digester Feed Pumps	Pumps (2)	• Local and SCADA monitoring and control	• Soft links from the VFDs to the Plant Control System • 3 AI
Intraplant Pumps	Pumps (4)	• Local and SCADA monitoring and control	• 2 AI, 20 DI, 2 DO

[a] The hardwired Input Output points have been provided as approximate count for each system with AI = Analog Input, DI = Digital Input, and DO = Digital Output.

3.11.5 Draft Control Narratives for the Plant PLC and Vendor-provided Panels

These draft control narratives will provide an overview for the automatic control as programmed by the plant PLC and for the automatic control functions as configured by the vendor-provided panel.

- Lift Stations (Upper Brink Falls and Government Area): vendor-provided panels will control the pumps to start and stop based on the level in each wet well. Each of these pump stations will operate independently from the plant control system. There are no communication links from these two pump stations to the WWTP.
- Fine Screens: vendor-provided panel will control each fine screen to operate based on the influent and effluent level transmitters or on timers.
- Grit Removal System: The vendor-provided panel will operate the grit removal system continuously based on the start and stop signals from the plant SCADA system.
- Flow Split at Splitter Box: The plant PLC will control the flow to the bioreactor and lagoons with from the influent wet well effluent gates. Once the main influent flow (measured at the Parshall flume) exceeds an operator-entered (at SCADA) set point, the bioreactor gate will modulate to send the flow that exceeds the set point to the lagoon.
- Membrane System: The vendor-provided panel will be configured to control all of the vendor-provided equipment as described here:
  - RAS Pumps: The pump speeds will be modulated to maintain an operator-entered flow set point or an operator-entered ratio of the influent flow to the bioreactor.
  - WAS Pumps: The pump speeds will be modulated based on an SRT calculation or to meet an operator-entered total WAS flow daily set point.
  - Permeate Pumps: The pump speeds will be modulated to be equal to the influent to the bioreactors minus the WAS flow.
  - Air Scour Blowers: The blowers will be started and stopped based on the cleaning cycle algorithms determined by the membrane.
    - Cleaning Chemical Pumps: The sodium hypochlorite pump will be operated based on signals from the vendor panel, primarily based on the TMP or based on a cleaning cycle timer. The citric acid pump will be operated from the vendor panel on an as needed basis.
- Bioreactor Mixers: Started and stopped from the plant PLC, when an aeration basin is in service.

- Recycle pumps: Each pump will be operated at a pre-determined speed when an aeration basin is in service.
- Aeration Blowers and Air Flow Control:
  - Aeration Blowers: the plant PLC will operate.
  - Bioreactor Aeration: there will be three modes of control as follows:
    - Air flow: to meet an operator-entered air flow set point with operator setpoints for air off and air on time
    - DO control: to meet an operator-entered DO set point (cascade control to the air flow control mode)
    - Ammonia control: to meet an operator-entered ammonia set point (cascade control the DO control mode)
  - System operates in DO control until ammonia is reduced below an operator-entered setpoint. When ammonia falls below the setpoint, the system switches to alternating on/off aeration with on time and off time entered by the operator until ammonia increases above setpoint at which point the system switches back to DO control.
- Chemical Pumps: Start and stop control from the SCADA system. Flow-paced and feedback alkalinity addition based on alkalinity analyzer output. Flow-paced and feedback alum addition based on phosphate analyzer for phosphorus removal. Flow-paced and nitrate-based glycerin dosing in post-anoxic zone for nitrate removal.
- Dewatering polymer and screw press.
  - Press Feed Pumps: Start and stop from the SCADA system.
  - Polymer System: Start and stop from the SCADA system. The vendor panel will control the individual devices in the system. Linked to the operation of the screw press.
  - Screw Press: Start and stop from the SCADA system. The vendor panel will control the individual devices in the system. Linked to the operation of the Polymer System.
- Digester Pumps and Blowers.
  - Digester Sludge Pumps: Start and stop from the SCADA system based on digester level.
  - Digester Thickener Blower: Start and stop control from the SCADA system to meet an air flow set point.
- UV System: The total permeate flow will be fed to the vendor-provided UV system. The individual UV panels will be controlled by the UV control panel.

- NPW Pumps: The pumps will be controlled by the Plant PLC to maintain an operator-entered pressure set point.
- Intraplant Pumps: The pumps in each wet well will be controlled by the plant PLC to maintain a level set point in each wet well.

3.12 Electrical

A new electrical service will be coordinated with Northwest Power. The electrical service will consist of a new 480Y/277V system, connected to a switchboard arranged with a standby generator and automatic transfer switching to provide automatic standby power to the new plant.

Low-voltage 480-208Y/120-volt transformers will be provided to for smaller loads and panel boards across the plant as needed.

An electrical vehicle charging station will be included near the parking area by the Main Process Building.

3.12.1 Standby Power

A standby propane-fueled generator, sized to carry the load specified below, will provide backup power upon utility failure. An automatic transfer switch will sense loss of utility power, start the generator and transfer to it once it is running. The automatic transfer switch will be programmed to transfer back to utility power once it has sensed restoration of utility power.

Commonly available propane-fueled standby generators are limited in capacity to less than 300-kW. Due to this limitation, standby power systems will serve only:

- Minimum Biological Processes
- Plant Automation Systems (SCADA)
- Communications Systems
- Lighting
- HVAC

3.12.2 Solar Power

Provisions will be made for the future installation of solar photovoltaic (PV) systems and include:

- Solar PV collectors: Future, but with no space allocation.
- Solar PV system control panels: Future, but with 3-foot-wide by 2-foot-deep of wall space reserved in the Electrical Room.

- Storage batteries: Future, but with 6-foot-wide by 2-foot-deep of wall space reserved in the Electrical Room.
- Inverters: Future, but with 3-foot-wide by 2-foot-deep of wall space reserved in the Electrical Room.
- Transfer switch: Future, but with 3-foot-wide by 2-foot-deep of wall space reserved in the Electrical Room.
- Solar PV system power panelboard: To be installed initially, with 120/240V transformer. Used to serve “sensitive electronic load.”

3.12.3 Dark Sky Preservation

Dark Sky Preservation goals, site lighting arrangement, fixtures and features can be selected to meet those goals. Outdoor lighting will be minimized. To the extent practical, motion-sensing technology will be used to dim or extinguish light when personnel are not in the vicinity of the exterior lighting systems.

Summary of
Yellowstone Outdoor Lighting Standards

The goal for outdoor lighting in Yellowstone National Park is to provide the minimum amount of necessary artificial light required for safe pedestrian travel at night while protecting and preserving the natural and cultural resources including the dark night sky.

Before moving forward with any outdoor lighting projects in the park, we should ask whether or not providing artificial light is necessary, and if it is, determine the best design solution to meet the goals. The following standards adopted by Yellowstone will be followed.

Location – Outdoor lighting will only be provided within the park's developed areas where there is a need to access facilities and/or travel at night. Backcountry areas and Yellowstone National Park roads will not have any permanent artificial lights.

Appearance - All fixtures will maintain the character of the historic architecture and periods of significance for the area in which they are installed. If the development is not historic, quality lighting will be subtle in the landscape blending into the natural setting as much as possible.

Style – All outdoor lighting fixtures must be fully shielded providing only downward light. If a fully shielded fixture is not practical the lamp rating must be less than 500 initial lumens.

Performance – The following technical specifications are required.

Brightness: (foot candle)	max of 2 and min of 0.02 at ground level directly below the light
Color (K):	2700-3000 for all lighting

Design – Fixture height and spacing must be designed to insure consistent illumination while meeting the Park's established performance specifications. The maximum allowable fixture height based upon specific lighting applications, include:

Maximum Fixture Height (in feet) from illuminated surface to bottom of light source	Area:	15'
	Pathway:	12-14'
	Bollards:	3'
	Sconces:	8'
	Wall Packs:	10'

Sustainability - All lamps must utilize best practices in energy efficiency (LEDs), including use of lighting controls (timers, daylight sensors, motion sensors and other energy saving devices) where appropriate. Fixtures will withstand harsh environments; snow burial, animal and vehicle encounters appropriate to their setting.

Summary of Yellowstone Outdoor Lighting Standards

3.12.4 Stand-alone Lift Stations

The stand-alone lift stations at the Government Area and at Brink of Upper Falls are being considered for either rehabilitation or replacement. For lift stations that will be rehabilitated, electrical systems will be replaced in their entirety. New electrical systems will be designed to meet modern code requirements and energy efficiency goals. New lift stations will be designed with new electrical systems.

3.13 Supervisory Control and Data Acquisition

The SCADA software will be based on the AVEVA Edge software from AVEVA to be aligned with the Grand Canyon (GRCA) projects and so that the NPS will be able to maintain and update the SCADA programs.

The network within the water treatment plant will be designed so that it is either in a ‘star’ or ‘loop’ configuration, based on the physical locations of the main plant PLCs and the vendor-provided PLCs. The SCADA servers provided for the plant will be redundant and configured in a virtual, hyper-converged environment. In addition, to the SCADA servers, the main server cluster will host a Historian server, remote desktop server, alarming software (i.e., WIN911) and other relevant applications. The SCADA environment will also host a separate backup application and server.

The SCADA network will be configured so that separate virtual private networks (VPN) will be created for the control system and other management networks. If any security cameras are installed within the WWTP, they will be routed on their own VPN. A separate network panel will be provided with the design to house the main network switches and the primary firewall. If possible, the SCADA server and network panels will be in a separate room or closet that can be locked. The DB contractor will coordinate with NPS’s federal IT department for the final IP addressing scheme and configuration rules.

The SCADA network will be designed so that an NPS-approved Network Intrusion Detection system will be installed at each plant. In addition, the DB contractor will work with the Park Service to establish secure remote access into the control system using a Citrix client system. The Network Intrusion Detection system and the secure remote access system will be configured to be adhere to the standards set forth in the SCADA Master Plan for the GRCA NPS projects.

The NPS IT department will establish the following policies and procedures for the Yellowstone facilities, and it is anticipated that these three designs will be aligned with them for the following topics:

- Patch management
- Account management

- Backup plans
- Risk assessment
- Antivirus solutions

3.13.1 Park-wide Communication Design Criteria

The Park Service has been pursuing a new project that will install a fiber-optic loop along the main roads of the Park. The current anticipated completion date for this project is 2024. This fiber loop will be run along the main roads (that loop by each of the Park offices and treatment plants) and will not be run to each treatment plant.

The DB contractor will design and install the infrastructure at each plant to tie into the fiber-optic loop when completed. This would include installing a fiber-optic link from each plant's network cabinet to a manhole and patch panel located right by the main road. The DB contractor would install this fiber with the treatment plant upgrade. The fiber link would be completed under a separate contract once the Park's fiber loop is completed. The Park would have to negotiate to have separate fiber pairs for the control system, management networks, security, alarms and other auxiliary services. Once the fiber-optic loop is installed, the current radio / T1 network will be demolished.

3.14 Constructability

The WWTP upgrade described in this section and throughout the RFP is based on the completed schematic design (SD) from May 2022. The SD includes geotechnical data, wetland delineation, hazardous waste characterization of existing facilities, and survey. The DB contractor will evaluate this information as part of the proposal process.

Based on the SD deliverables, the upgrade to the Canyon Village WWTP will be performed in two phases identified as Phase 1 and Phase 2. Phase 1 will be performed as part of this contract. Phase 2 will occur at an undetermined future time under an additional separate RFP. The project will include:

3.14.1 Phase 1

- Temporary bypass during construction: Bypass existing headworks; ensure coarse screening of bypassed flow and provide a location and means of discharging hauled waste from the NPS septage hauler (2,500-gallon truck) as much as two times per week. Hauled waste should flow through coarse bar screen then into Lagoon 1. Must provide means for hauler to safely clean coarse bar screen as needed during discharge. Hauled waste includes substantial debris such as rags, clothing that quickly clog screens.
- Demolish existing Headworks Building.

- Build new Headworks Building as shown in SD plans including two new fine screens (detailed in equipment specification), septage receiving system and grit removal system.
- Septage screen will discharge to a wet well then flow to the upstream end of the standby 2 mm fine screening channel. This channel will be typically offline but can be used if the first screen is out of service or in the future if septage is received and operators desire to direct septage to digesters.
- Install duplex submersible intraplant lift station (refer to equipment specification). Lift station will serve to pump water from solids lagoon to headworks. Lift station will have two pipes connecting to existing solids lagoon. One pipe will serve as a drainpipe at elevation 7,800 feet and will include a valve near the lift station that will be typically closed. The second pipe will be located at 7,807 feet and will be used to decant the solids lagoon while allowing solids to remain in the lagoon. This pipe will also have a valve near the lift station that will be closed unless decanting. The lift station will pump flow back to headworks.
- New woven wire wildlife fence with recycled drill-stem steel posts with around entire site perimeter matching location of existing fence. Install entry gates for vehicles and personnel where indicated.
- Replace nonfunctional existing valves as shown on site plan.
- Install groundwater monitoring wells as shown on site plan.
- Replace Government Area Lift Station with new duplex submersible lift station and Valve/Control Building (refer to equipment specification and plans); replace 1,000 feet of 4-inch force main with new 4-inch HDPE force main.
- Replace Upper Brink lift station with new duplex submersible lift station and Valve/Control Building (refer to equipment specification and plans).
- Collection system rehab work.
- Install a propane storage tank with enough storage to serve the generator and heating needs of the site during the offseason when roads are closed and propane cannot be delivered.
- Connect potable water for washing of fine screens and septage receiving screens.
- Provide source of hot water for cleaning of fine screens.
- Provide hardwired Class 1 Division 1 explosion-proof automatic influent sampler in Headworks Building.

3.14.2 Phase 2 (in the Sequence Shown)

- Permanently redirect all flows that currently discharge to solids lagoon (AWT backwash, Corrals wastewater, WTP solids, WTP sewage).

  - Temporarily route AWT backwash water to Lagoon 2 during construction; this flow will be terminated when AWT facility is demolished
  - Permanently reroute Corrals wastewater, WTP solids and WTP sewage to connect to Intraplant Pump Station and be pumped to headworks.
- Fill-in solids pond to match surrounding grade.
- Build new activated sludge basins.
  - Two parallel trains
  - Pre-anoxic, aerobic, post-anoxic
  - 0.225 million gallon minimum active volume for each train
  - Concrete basins with most volume below grade
  - Ensure a means of removing scum from areas that may collect scum
- Build new aerobic digesters.
  - Two parallel basins
  - 0.25 million gallon minimum active volume for each basin
  - Concrete basins with most volume below grade
- Add piping, valves, gates needed to convey screened septage directly to the aerobic digesters after it has passed through the one of the 2 mm fine screens.
- Build new Main Process Building.
  - Install blower in Main Process Building to serve existing subsurface diffused aeration system in Lagoon 1; connect air to this system
  - Install new electrical panels in Main Process Building and yard electrical to serve existing surface aerators
  - Three parallel MBR tanks and associated equipment (permeate pumps, chemical cleaning, air scour blowers, instruments and controls, etc.) inside Main Process Building designed to treat 2075 peak day flow with one train offline; Ensure a means of removing scum from areas that may collect scum
  - Aeration basin and aerobic digester process blowers
  - Chemical storage and feed systems (magnesium hydroxide, alum, glycerin, sodium hypochlorite, citric acid)
  - Main Process Building will have loading dock and entrance 4 feet above surrounding grade to keep above winter snowfall
- Build new Dewatering Building and dewatered cake storage facility.
  - Screw press



  - Polymer activation and feed system
  - Cake conveyor
- Headworks, Main Process and Dewatering Buildings will have loading dock and entrance 4 feet above surrounding grade to keep above winter snowfall.
- All building roofs will be designed to shed snow/ice away from walking, driving and parking areas. All roofs will be cold roofs to prevent ice damming.
- Startup and stabilize operation of new facilities.
- After new facilities are fully started up and stabilized.
  - Demolish Blower Building.
  - Demolish AWT Building.
- Build new Equipment Storage Building.
- Build pre-engineered metal structure over aeration basins and aerobic digesters.
- Install a propane backup generator to serve the WWTP.
- Install a propane storage tank with enough storage to serve the generator and heating needs of the site during the offseason when roads are closed and propane cannot be delivered.
- Build a nonpotable water supply system using WWTP effluent with firm capacity of 260 gallons per minute to supply NPW hose bibs at various locations onsite as well as washing needs of fine screens, grit system, septage receiving screen and screw press.
- Install solar energy and storage system at the Main Process Building.
  - Microgrid system to protect sensitive electronics from local power issues
  - Refer to electrical section of RFP, specifications and plans

3.15 Project Sustainability

3.15.1 Approach

The project design sustainability approach is intended to follow the NPS Project Sustainability Checklist which includes the 2016 Guiding Principles for Sustainable Federal Buildings. Refer to attachments to the RFP for a customized version of the checklist, which includes specific project sustainability goals and requirements identified in the SD.

Sustainability measures are grouped by the following categories: Sites, Water Efficiency, Energy/Environment, Materials/Resources, Indoor Environmental Quality, and Additional Federal Design Imperatives.

3.15.2 Estimated Power Usage

Estimated power usage in the plant was developed based on equipment horsepower, run times, and building energy usage. These results are summarized in Table 3-12. The current Canyon Village plant is estimated to cost about $69,000 in energy usage per year based on the same assumptions used to produce Table 3-12.

Table 3-12. Estimated Phase 2 Energy Usage

Equipment	**Estimated** Power Consumption (kWh/yr)	**Annual Cost ($)**[a]
Headworks Equipment	80,400	$14,500
Membrane Bioreactors	1,387,200	$249,700
Digesters	349,400	$62,900
Dewatering	3,200	$600
Building Energy[b]	199,400	$35,900
Total	**2,019,600**	**$363,600**

[a] Energy Price: 0.18 $/kWhr

[b] Assuming 2 watts/ft^2

kWh = kilowatt-hour(s)

kWh/yr = kilowatt-hour(s) per year

Chapter 4 – Permitting

Following completion of the Predesign Phase, the Permitting Assessment Form was updated with minor changes. Overall permitting topics are unchanged from the Predesign Phase. With the completion of Predesign and the additional refinements from SD, a permit list can be prepared including a determination if the permit should be Government Furnished (either DSC or Park staff) or should be provided by the construction contractor. The following is a list of required permits, notes on schedule and timing, and a recommendation on who should obtain the permits. Additionally, a permit assessment form is provided in the attachments to the RFP and provides an additional summary of the permits anticipated for this project

4.01 National Pollutant Discharge Elimination System Permit

Schedule and Timing: The current plant is operating under a permit that was issued in 2020 and is due to be renewed in the fall of 2025. Any increase in design flow will require a modification to the permit and likely new effluent limitations. Based on information received from the DEQ to date, it was DEQ's determination that the effluent limits need to be set such that it there is no increase in loading to the receiving stream. This approach may result in more stringent effluent limits than previously imposed. The permit modifications is not needed until the new facility becomes operational, but the final limits will drive the design so discussions of final effluent limits should begin soon.

- Permit Lead: Construction contractor

4.02 Construction Stormwater Permit/Stormwater Pollution Prevention Plan

Schedule and Timing: Standard process within Wyoming to comply with Clean Water Act requirements for construction projects. There are two potential general permits, one is a large construction stormwater general permit which covers disturbances 5 acres or greater. The other general permit is a small construction stormwater permit which covers disturbance less than five acres. The permit for more than 5 acres, a Notice of Intent requires that the Stormwater Pollution Prevention Plan be developed and submitted to the state as well as the payment of a fee. There is no automatic coverage under the permit. A Stormwater Pollution Prevention Plan is highly dependent on best management practices selected by the construction contractor, who will have the best, site-specific means and methods for compliance. Sites under 5 acres, fall under a permit by rule and do not require a permit.

- Permit Lead: Construction Contractor

4.03 General Permit for Temporary Discharge Involving Construction Activities

Schedule and Timing: The current permit which expires in August 2022 covers construction dewatering of non-contaminated groundwater for up to one year. A Notice of Intent needs to be submitted as well as the payment of a fee. There is no automatic coverage under the permit. Effluent limits must be met on the discharge. The construction contractor will be most knowledgeable about regarding the timing and treatment of the discharge.

- Permit Lead: Construction Contractor

4.04 Section 404 Permit

For discharge of dredge/fill material in waters of the United States /Section 401 Water Quality Certification, triggered by Section 404 permit

Schedule and Timing: Standard processes for the development of a 404 permit where waters of the United States or wetlands is temporarily or permanently impacted. If the areas are small enough that are permanently impacted, it can be covered by a Nationwide Permit (NWP) issued by the U.S. Army Corps of Engineers, likely. NWP 3 (Maintenance) or NWP 58 (Utility Line Activities). If the area impacted exceeds that allowed under a nationwide and individual permit will be required. The type of permit will be based on the amount of wetlands or waters of the United States that will be impacted which will be part of the design and construction, therefore the design build contractor will be in the best position to obtain this permit. A 401 Water quality certification issued by the DEQ will be required. NWP 3 has been conditionally certified in the state of Wyoming and Montana and therefore does not require individual certification. Submission of a preconstruction notification will be required for an NWP and should be applied for at least 30 days or more before the area is impacted. At least 6 months is needed for an individual permit.

- Permit Lead: Construction Contractor

4.05 Permit to Construct

Schedule and Timing: Permit to construct must be obtained for any construction, installation or modification to the WWTP or its collection system. The DEQ will review the design to ensure it conforms to the criteria in Chapter 11 – “Design and Construction Standards for Sewerage Systems, treatment works, disposal systems or other facilities capable of causing or contributing to pollution and mobile home Park and campground sewerage and public water supply distribution systems.” Because this is a design build project, it will be important to work out the process for obtaining the permit when construction will commence before the design being final.

- Permit Lead: Construction Contractor

4.06 Hazardous Waste Removal, Transportation, and Disposal

Schedule and Timing: Known occurrences of lead-based paint will require strict adherence to regulations during removal. Specific removal, transportation, and disposal methods are best left to the construction contractor and their qualified subs.

- Permit Lead: Construction Contractor.

4.07 Other Programs

Cultural resource surveys (aboveground and underground) were not performed nor were evaluations performed for possible endangered species by Jacobs. NPS may have performed above ground surveys for cultural resources. NPS is taking the lead on the National Environmental Policy Act requirements, which include the evaluation of the potential impact on endangered species.

Chapter 5 – Works Cited

U.S. Environmental Protection Agency (EPA). 1974. *Technical Bulletin: Design Criteria for Mechanical, Electrical, and Fluid System and Component Reliability (EPA-430-99-74-001).* Office of Water Program Operations, Washington, D.C. 20460.

Attachment – Room Requirements

ROOM REQUIREMENTS

Below is a list of interior related requirements for each building and associated room for the Canyon WWTP.

Facility 310: Headworks Building; Room Name: Basement (310001)

Space Characteristics

Function/adjacencies: Space for maintenance access to process equipment.

Special Dimensions:
Minimum Room Size: As shown on Drawings.
Minimum Ceiling Height: No ceiling.

Access: One stair for egress to ground level.

Number of Occupants: Not normally occupied

Furnishings: No special requirements.

Floor Finish: Exposed concrete with clear penetrating sealer.

Wall Finish: CMU; painted.

Ceiling Finish: Exposed structure, painted.

Other/Special Requirements: No special requirements.

Facility 310: Headworks Building; Room Name: Equipment Room (310101)

Space Characteristics

Function/adjacencies: Space for process equipment and associated piping.

Special Dimensions:
Minimum Room Size: As shown on Drawings.
Minimum Ceiling Height: No ceiling

Access: Overhead coiling door for equipment access and three personnel doors to exterior for egress.

Number of Occupants: Not normally occupied

Furnishings: No special requirements.

Floor Finish: Exposed concrete with clear penetrating sealer.

Wall Finish: CMU; painted.

Ceiling Finish: Exposed structure, painted.

Other/Special Requirements: Provide concrete equipment pads for floor-mounted equipment.

Facility 310: Headworks Building; Room Name: Electrical Room (310102)

Space Characteristics

Function/adjacencies: Space for electrical equipment.

Special Dimensions:
Minimum Room Size: As shown on Drawings.
Minimum Ceiling Height: No Ceiling; provide adequate clearance for required equipment.

Access: Single door from exterior for egress and equipment access. Minimum door opening height of 9'-2".

Number of Occupants: Not normally occupied

Furnishings: No special requirements.

Floor Finish: Exposed concrete with clear penetrating sealer.

Wall Finish: CMU; painted.

Ceiling Finish: Exposed structure, painted.

Other/Special Requirements: Provide concrete equipment pads for floor-mounted equipment.

Facility 310: Headworks Building; Room Name: HVAC Enclosure (310103)

Space Characteristics

Function/adjacencies: Space for HVAC equipment.

Special Dimensions:
Minimum Room Size: As shown on Drawings
Minimum Ceiling Height: No Ceiling

Access: Double door for access and egress.

Number of Occupants: Not normally occupied

Furnishings: No special requirements.

Floor Finish: Exposed concrete with clear penetrating sealer.

Wall Finish: CMU; painted.

Ceiling Finish: Exposed structure, painted.

Other/Special Requirements: Provide concrete equipment pads for floor-mounted equipment.

Facility 320: Process Building; Room Name: Control Room (320102)

Space Characteristics

Function/adjacencies: Space for desk with minimum of two work stations and administrative storage. Locate adjacent to server room and water quality laboratory.

Special Dimensions:
Minimum Room Size: As shown on Drawings
Minimum Ceiling Height: 9'-0"

Access: Single door, interior access only; provide vision glass.

Number of Occupants: Two

Furnishings: (1) desk, (2) ergonomic task chairs, (1) printer table, (1) HDTV/monitor, (1) 4 drawer lateral file, (1) small wastebaskets, (1) small recycle bins and (1) marker board.

Floor Finish: Resilient material with factory finish.

Wall Finish: Gypsum wallboard; painted.

Ceiling Finish: Acoustical panel ceiling with factory finish.

Other/Special Requirements: Provide windows for daylighting with shading and glare control devices.

Facility 320: Process Building; Room Name: Server Room (320103)

Space Characteristics

Function/adjacencies: Space for server rack and related Telecom equipment; locate directly adjacent to Control Room

Special Dimensions:
Minimum Room Size: As shown on Drawings
Minimum Ceiling Height: No Ceiling

Access: Single door, interior access from Control or Hall only.

Number of Occupants: Not normally occupied.

Floor Finish: Resilient material with factory finish.

Wall Finish: Gypsum wallboard; painted.

Ceiling Finish: Exposed structure, painted.

Other/Special Requirements: Provide fire rated separation from adjacent spaces in accordance with UFC 3-580-10.

Facility 320: Process Building; Room Name: Restroom/ Locker/Shower Room (320104)

Space Characteristics

Function/adjacencies: Space for required plumbing fixtures, service sink, lockers and shower. Locate adjacent to control room, hall and break room.

Special Dimensions:
Minimum Room Size: As shown on Drawings
Minimum Ceiling Height: 9'-0"

Access: Single door from interior only.

Number of Occupants: Not normally occupied

Furnishings: No special requirements.

Floor Finish: Tile with factory finish.

Wall Finish: Tile with factory finish and painted water resistant gypsum board.

Ceiling Finish: Gypsum wallboard, painted.

Other/Special Requirements: Provide toilet accessories including toilet tissue dispenser, paper towel dispenser, waste receptacle, sanitary napkin disposal unit, grab bars, mirror, and soap dispenser. Lockers: Metal, single tier units; 24"x24"x72". Accessible shower and shower bench.

Facility 320: Process Building; Room Name: Break Room (320105)

Space Characteristics

Function/adjacencies: Space for casework, counters and table and chairs to accommodate four people at a single time. Locate adjacent to Control Room.

Special Dimensions:
Minimum Room Size: As shown on Drawings
Minimum Ceiling Height: 9'-0"

Access: Single door from interior or open to Hall.

Number of Occupants: Not normally occupied.

Furnishings: (1) break room table with space to seat four, (4) chairs, (1) wastebasket, and (1) recycle center as required by Sustainability Checklist.

Floor Finish: Resilient material with factory finish.

Wall Finish: Gypsum wallboard; painted.

Ceiling Finish: Acoustical panel ceiling with factory finish.

Other/Special Requirements: Provide refrigerator, dishwasher, garbage disposal, microwave, coffee machine, cabinetry and countertops. Provide windows (where possible) for daylighting with shading and glare control devices.

Facility 320: Process Building; Room Name: Water Quality Laboratory (320106)

Space Characteristics

Function/adjacencies: Space for laboratory grade casework and counters with adequate linear footage of counter (bench) space for use and storage of equipment to perform necessary water quality sampling and testing. Locate adjacent to Control Room.

Special Dimensions:
Minimum Room Size: As shown on Drawings
Minimum Ceiling Height: 9'-0"

Access: Two personnel doors; one for interior access and one for exterior access.

Number of Occupants: One

Furnishings: (2) ergonomic task chairs, (2) ergonomic task stools, (1) wall clock, (1) safety eyewear holder, (1) fire blanket, (1) lab refrigerator, (2) anti-fatigue mats, (1) large garbage can, (2) small wastebaskets, (2) small recycle bins and (1) marker board.

Floor Finish: Resilient material with factory finish.

Wall Finish: Gypsum wallboard; painted.

Ceiling Finish: Acoustical panel ceiling with factory finish.

Other/Special Requirements: Provide combination pH meter, buret & buret stand, dissolved oxygen meter, vacuum pump, vacuum manifold, drying oven, muffle furnace, desiccator, analytical balance, HACH test kit, HACH spectrophotometer, HACH Colorimeter, HACH oil and grease analyzer, incubator, tray sealer, UV light, and miscellaneous glassware and plastic ware.

Provide refrigerator for sample storage, 4-foot canopy hood, laboratory glassware washer, ice machine, lab water system, deionized water system, laboratory grade cabinetry, and epoxy resin countertops.

Safety shower/eyewash station.

Provide windows (where possible) for daylighting with shading and glare control.

Facility 320: Process Building; Room Name: Electrical Room (320107)

Space Characteristics

Function/adjacencies: Space for facility electrical equipment.

Special Dimensions:
Minimum Room Size: As shown on Drawings.
Minimum Ceiling Height: No Ceiling; provide adequate clearance for equipment, cabling, and access.

Access: Double doors with transom from exterior (minimum door opening height of 9'-2") and single personnel door for secondary egress.

Number of Occupants: Not normally occupied

Furnishings: No special requirements.

Floor Finish: Exposed concrete with clear penetrating sealer.

Wall Finish: CMU; painted.

Ceiling Finish: Exposed structure, painted.

Other/Special Requirements: Provide concrete equipment pads for floor-mounted equipment.

Facility 320: Process Building; Room Name: Mechanical Room (320108)

Space Characteristics

Function/adjacencies: Space for facility building mechanical (HVAC/plumbing) equipment.

Special Dimensions:
Minimum Room Size: As shown on Drawings.
Minimum Ceiling Height: No Ceiling; provide adequate clearance for equipment and associated piping and ductwork.

Access: Double doors with transom from exterior and interior personnel doors for secondary egress and access.

Number of Occupants: Not normally occupied

Furnishings: No special requirements.

Floor Finish: Exposed concrete with clear penetrating sealer.

Wall Finish: CMU; painted.

Ceiling Finish: Exposed structure, painted.

Other/Special Requirements: Provide concrete equipment pads for floor-mounted equipment.

Facility 320: Process Building; Room Name: Maintenance Shop (320110)

Space Characteristics

Function/adjacencies: Space for routine maintenance activities, including laydown area and space for equipment and part storage. Locate adjacent to mechanical room.

Special Dimensions:
Minimum Room Size: As shown on Drawings
Minimum Ceiling Height: No Ceiling; provide clear height as required for monorail and maintenance activities.

Access: Provide overhead coiling door and single personnel door from exterior. Provide interior doors for building circulation.

Number of Occupants: Not normally occupied

Furnishings: (1) industrial stool, (1) work bench, (1) pre-engineered industrial tool storage unit, (3) bulk storage racks, (1) small wastebasket and (1) small recycle bin.

Floor Finish: Exposed concrete with clear penetrating sealer.

Wall Finish: CMU; painted.

Ceiling Finish: Exposed structure, painted.

Other/Special Requirements: Provide two-ton monorail. Provide clerestory windows for daylighting.

Facility 320: Process Building; Room Name: Chemical Storage Room (320111)

Space Characteristics

Function/adjacencies: Space for storage of bulk chemical totes and tank and associated metering pumps.

Special Dimensions:
Minimum Room Size: As shown on Drawings
Minimum Ceiling Height: No Ceiling

Access: Overhead coiling door and single personnel door from exterior for egress. Single door from interior for egress and access to remainder of building.

Number of Occupants: Not normally occupied

Furnishings: No special requirements.

Floor Finish: Exposed concrete with clear penetrating sealer.

Wall Finish: CMU; painted.

Ceiling Finish: Exposed structure, painted.

Other/Special Requirements: Safety shower/eyewash station.

Facility 320: Process Building; Room Name: Membrane Room (320112)

Space Characteristics

Function/adjacencies: Space for process equipment, membrane tanks, associated chemical bulk storage tanks and containment structures and piping. Locate adjacent to chemical storage room.

Special Dimensions:
Minimum Room Size: As shown on Drawings
Minimum Ceiling Height: No Ceiling; provide adequate clearance for bridge crane, required equipment, piping and access.

Access: Provide overhead coiling door and single personnel door from exterior for egress.

Number of Occupants: Not normally occupied.

Furnishings: No special requirements.

Floor Finish: Exposed concrete with clear penetrating sealer.

Wall Finish: CMU; painted.

Ceiling Finish: Exposed structure, painted.

Other/Special Requirements: Provide floor hatch for equipment removal from basement

Facility 330: Aeration and Digester Basins; Room Name: Basin Room (330101)

Space Characteristics

Function/adjacencies: Space for weather protection of basins.

Special Dimensions:
Minimum Room Size: As shown on Drawings.
Minimum Ceiling Height: No Ceiling; provide adequate clearance for removal of equipment from basin.

Access: Overhead coiling door for large equipment access and personnel doors from exterior as required for egress.

Number of Occupants: Not normally occupied

Furnishings: No special requirements.

Floor Finish: Exposed concrete with clear penetrating sealer.

Wall Finish: Prefinished wall panels and galvanized steel PEMB framing.

Ceiling Finish: Prefinished roof panels and galvanized steel PEMB framing.

Other/Special Requirements: No special requirements.

Facility 340: Dewatering Building; Room Name: Dewatering Room (340101)

Space Characteristics

Function/adjacencies: Space for dewatering process equipment, chemical storage, and associated piping and appurtenances.

Special Dimensions:
Minimum Room Size: As shown on Drawings.
Minimum Ceiling Height: No Ceiling; provide adequate clearance for required equipment and monorail hoisting system.

Access: Overhead coiling door for equipment removal and single door from exterior for egress.

Number of Occupants: Not normally occupied

Furnishings: No special requirements.

Floor Finish: Exposed concrete with clear penetrating sealer.

Wall Finish: CMU; painted.

Ceiling Finish: Exposed structure, painted.

Other/Special Requirements: No special requirements.

Facility 340: Dewatering Building; Room Name: Electrical Room (340102)

Space Characteristics

Function/adjacencies: Space for electrical equipment.

Special Dimensions:
Minimum Room Size: As shown on Drawings.
Minimum Ceiling Height: No Ceiling; provide adequate clearance for required equipment.

Access: Single door from exterior for egress and equipment access. Minimum door opening height of 9'-2".

Number of Occupants: Not normally occupied

Furnishings: No special requirements.

Floor Finish: Exposed concrete with clear penetrating sealer.

Wall Finish: CMU; painted.

Ceiling Finish: Exposed structure, painted.

Other/Special Requirements: Provide concrete equipment pads for floor-mounted equipment.

Facility 350: Cake Storage Building; Room Name: Cake Storage Room (350101)

Space Characteristics

Function/adjacencies: Space for weather protection and storage of cake sourced from the nearby Dewatering Building

Special Dimensions:
Minimum Room Size: As shown on Drawings.
Minimum Ceiling Height: No Ceiling; provide adequate clearance for required equipment to be stored.

Access: Two overhead coiling doors for large equipment access to move cake and personnel doors from exterior as required for egress.

Number of Occupants: Not normally occupied

Furnishings: No special requirements.

Floor Finish: Exposed concrete with clear penetrating sealer.

Wall Finish: Prefinished wall panels and galvanized steel PEMB framing.

Ceiling Finish: Prefinished roof panels and galvanized steel PEMB framing.

Other/Special Requirements: No special requirements.

Facility 360: Equipment Storage Building; Room Name: Equipment Room (360101)

Space Characteristics

Function/adjacencies: Space for storage and weather protection for large equipment

Special Dimensions:
Minimum Room Size: As shown on Drawings.
Minimum Ceiling Height: No Ceiling; provide adequate clearance for required equipment to be stored.

Access: Overhead coiling door for large equipment access and personnel doors from exterior as required for egress.

Number of Occupants: Not normally occupied

Furnishings: No special requirements.

Floor Finish: Exposed concrete with clear penetrating sealer.

Wall Finish: Prefinished wall panels and galvanized steel PEMB framing.

Ceiling Finish: Prefinished roof panels and galvanized steel PEMB framing.

Other/Special Requirements: No special requirements.

Facility 390: Generator Building; Room Name: Generator Room (390101)

Space Characteristics

Function/adjacencies: Space for standby generator and appurtenances.

Special Dimensions:
Minimum Room Size: As shown on Drawings.
Minimum Ceiling Height: No Ceiling; provide adequate clearance for required equipment and operations.

Access: Single door from exterior.

Number of Occupants: Not normally occupied

Furnishings: No special requirements.

Floor Finish: Exposed concrete with clear penetrating sealer.

Wall Finish: CMU; painted.

Ceiling Finish: Exposed structure, painted.

Other/Special Requirements: No special requirements.