



Chapter 3 Permit to Construct Design Report

Yellowstone Modular Housing Project
Northeast Entrance Government Area
Park County

June 15, 2026

Prepared for:

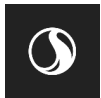
National Park Service

Montana Department of Environmental
Quality

Prepared by:

Stantec Consulting Services, Inc.

Revision	Description	Author		Quality Check		Independent Review	



Sign-off Sheet

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Prepared by:

Signature

Davis Alden, PE

Printed Name

Reviewed by:

Signature

Jill Rosselott, PE

Printed Name

Approved by:

Signature

Benjamin Weaver, PE, PLS, PTOE

Printed Name



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Abbreviations

ADD	Average Day Demand
CIP	Cast Iron Pipe
DEQ	Montana 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



DESIGN REPORT YELLOWSTONE MODULAR HOUSING PROJECT

INTRODUCTION

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 Northeast Entrance Government Area. Separate reports have been prepared for the Canyon and Mammoth Government Areas. The intent of the proposed work at the Northeast Entrance Government Area is to construct two modular housing units. This report will address the utility design at Northeast Entrance 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 two modular / prefabricated buildings. These buildings will be 2-Bedroom Modular units. 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. At this location, there were previously two modular homes that had both water and sewer services. The previous structures have since been removed, but their water and sewer services remain in place. The NPS is proposing to replace the existing water services to the existing 4-inch main that runs along Meridian Rd. In addition to the water service replacements, the NPS is proposing replacement of the existing sanitary services as well as the placement of approximately 190 linear feet of 6-inch PVC sanitary sewer main that will connect to the existing sanitary sewer system via a manhole in Meridian Rd. The existing sanitary sewer system terminates in an existing septic tank and leach field approximately 200-ft to the south of the Project.

The purpose of this design report is to provide DEQ, as required by Circular DEQ-1 and Circular DEQ-2 of the Montana Standards for Water Works information regarding the construction of the proposed water services and sanitary sewer main replacements. The Project is designed according to the requirements of Circular DEQ-1, Circular DEQ-2. 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 Summer of 2026.

2.0 PROJECT AREA DESCRIPTION

The Project is located in the Northeast Entrance Area off portions of Meridian Road. The Project is in the SE ¼ of Section PB 42, Township 9S, Range 14E in Park County, MT.

3.0 PROPOSED PROJECT SYSTEM IMPROVEMENTS

At this location, there were previously two modular homes, but those houses have since been abandoned and removed. Their water and sewer services remain in place. The NPS proposes to install new 2-inch combined HDPE water / fire suppression services to each unit. The NPS also proposes to replace the existing sewer services with 4-inch PVC and connect them to a newly placed 6-inch PVC sanitary sewer main. The proposed sewer main is shown in Appendix A – Permit Drawings. Two manholes will be added, as along with a connection to an existing manhole as part of the Project. Due to this project being constructed in conjunction with the Modular Housing development in Canyon and Mammoth Government Areas, Wyoming, the proposed water services and sewer main will be



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WATER SYSTEM DEMANDS

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 Northeast Entrance water treatment and distribution system. The proposed modifications to the water distribution system will continue to be owned and maintained by Yellowstone National Park.

4.1 WATER DEMANDS

The following estimated maximum water demands were used to analyze the water system modifications:

- Average Daily Demand: 500 gallons per day (Wyoming DEQ Water Quality Rules and Regulations – Chapter 12, Section 8)
- Maximum Daily Demand: 1,360 gallons per day (Wyoming DEQ Water Quality Rules and Regulations – Chapter 12, Section 8)
- Peak Hour Demand: 3.8 gallons per minute (Wyoming DEQ Water Quality Rules and Regulations – Chapter 12, Section 8)
- Automatic Fire Suppression Demand: 150 gallons per minute (Modular Building Design Narrative)

Calculations are included in Appendix C – Potable Water Hydraulic Analysis.

4.2 FIRE FLOW DEMANDS

The existing water distribution line includes two existing hydrants. 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)

5.0 WATER DISTRIBUTION LINE

The Northeast Entrance Area has existing potable water mains and services to the east of the proposed project area. The proposed water distribution system modifications to the Northeast Entrance Area consist of the installation of combined 2-inch HDPE water / fire suppression service connections for the new modular units. Each unit will require approximately 150 LF of service line from the main. A summary of the Circular DEQ-1 requirements and the design parameters are provided in **Table** .



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WATER DISTRIBUTION LINE

Table 1: Water Distribution Line Circular DEQ-2 Requirements and Design Parameters

Circular DEQ-1 Section	Requirement	Design Parameter
8.1.1	All materials including pipe, fittings, valves, and fire hydrants must conform to the latest standards issued by the AWWA and ANSI/NSF, where such standards exist, and be acceptable to MDEQ.	Service connections will be 2" HDPE water pipe certified to meet AWWA C901 standards.
8.1.2.a	pipe and joint materials that are not subject to permeation of the organic compounds must be used; and non-permeable materials must be used for all portions of the system including water main, pipe joint material, service connections, and hydrant leads.	HDPE pipe will be used.
8.2	WATER MAIN DESIGN	The existing water main will not be altered and no additional water mains are planned.
8.2.3	When fire protection is to be provided, system design must be such that fire flows and facilities are in accordance with the recommendations of the fire protection agency in which the water system is being developed, or in the absence of such a recommendation, the fire code adopted by the State of Montana.	Fire suppression system at each unit is designed in accordance with NPS standards.
8.2.4	Dead ends	No dead ends are proposed.
8.3	VALVES	No valves will be added to the water main.
8.4	HYDRANTS	No additional hydrants will be placed in this project.
8.5	AIR RELIEF, VACUUM RELIEF, AND COMBINATION AIR/VACUUM RELIEF VALVES	No air relief, vacuum relief valves will be placed in this project.
8.6	VALVE, METER, AND BLOW-OFF CHAMBERS	No valve, meter, or blowoffs will be located in areas subject to flooding.
8.7	INSTALLATION OF MAINS	No water mains will be installed in this project. Water services will be buried a minimum of 6 feet.
8.8	SEPARATION OF WATER MAINS, SANITARY SEWERS, AND STORM SEWERS	Water services will maintain minimum horizontal and vertical separation at crossings.
8.9	SURFACE WATER CROSSINGS	No surface water crossings are planned in this project.
8.10	CROSS-CONNECTIONS AND INTERCONNECTIONS	No unprotected cross-connection are planned in this project.
8.11.1	Solders and flux containing more than 0.2 percent lead and pipe fittings containing more than 8 0.25 percent lead must not be used on service connections.	No lead materials will be used on the project.
8.11.2	Individual booster pumps are not allowed for any individual residential service from the public water supply mains. Where permitted for multi-story public building services, booster pumps must be designed in accordance with Sections 6.4 through 6.4.4.	No booster pumps are planned on this project.



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EXISTING SANITARY SEWER SYSTEM

Circular DEQ-1 Section	Requirement	Design Parameter
8.12	Each service connection should be individually metered. New water systems should individually meter each service connection.	Water services will be metered in coordinated with Yellowstone National Park plumbing and water operations.
8.13	WATER LOADING STATIONS	No water loading station are planned in this project.
8.14	WATER MAIN ABANDONMENT	No water mains will be abandoned in this project.
8.15	TEMPORARY WATER DISTRIBUTION	No temporary water will be needed on this project.

5.1 WATER STORAGE

The proposed Project will include no additional storage capacity for Park County.

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. The sanitary sewer system at this location all runs to an existing septic system whose design capacity included treatment for the previous two demolished modular units. As the two new modular units are replacing the two previous modular units in kind, it is inferred that the existing septic system has adequate capacity to treat the effluent flows from 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.

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 a slope of 0.1006 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 6-inch sewer consists of approximately 190 feet of PVC and two (2) 48-inch manholes along Meridian Rd. The proposed 6-inch sewer main will be constructed at the proposed slope of 3 feet per 100 feet.

The capacity of the 6-inch main has been evaluated to show that adequate capacity exists to allow for these replacement connections (See Appendix D – Sewer Main Capacity Calculations for the design calculations.). The sewer will be placed with bell and spigot, 6-inch SDR 26 PVC pipe. Design calculations comparing the capacities of the existing sewer main and proposed sewer main are summarized in **Table 2** and provided in Appendix D – Sewer Main Capacity Calculations. The existing septic tank was constructed with a design capacity of 3,000 gallons per day. The combined peak day flows were calculated to be 1,890 gallons per day. No additional flow to the system is anticipated since the two new modular units will be replacing the two abandoned units.

Table 2: Proposed Sewer Main Capacities

Sewer Main	Material Type	Size (in)	Slope (ft/ft)	Full Flow Capacity (gpm)	Full Flow Velocity (ft/sec)
Proposed 6-inch	PVC	6	0.0300	334	3.795
Existing 6-inch (Downstream of Proposed)	VC	6	0.1006	613	6.950

A summary of the Circular DEQ-2 requirements and DEQ policies and the design parameters are provided in **Table 3**.

Table 3: Sewer Line Chapter 11 Requirements and Design Parameters

Circular DEQ-2 Section	Requirement	Design Parameter
31	Sewers must be designed for municipal wastewater only. Rain water from roofs, streets, and other areas, and groundwater from foundation drains must not be permitted in municipal wastewater sewers.	Refer to the Permit Drawings. No storm collection systems are connected to the sanitary sewer system.
32	In general, sewer capacities should be designed for the estimated ultimate tributary population, except in considering parts of the systems that can be readily increased in capacity. Similarly, consideration should be given to the maximum anticipated capacity of institutions, industrial parks, etc. See Sections 11.24 (Hydraulic Capacity) and 20.2 (Plans of Sewers).	Refer to Appendix E – Sewer Main Capacity Calculations
33.1	A gravity sewer main conveying raw wastewater must be at least 8 inches (203 mm) in diameter, except gravity sewer mains within private property. Trailer courts, condominiums, apartments, etc. are allowed	The Sanitary Sewer Main will connect to an existing manhole. The proposed 6-inch main can handle



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PROPOSED SANITARY SYSTEM IMPROVEMENTS

Circular DEQ-2 Section	Requirement	Design Parameter
	mains no smaller than 6 inches in diameter, provided that the 6 inch diameter main can be shown to be hydraulically feasible, that no future expansion is anticipated, and that maintenance will not be increased due to the smaller diameter. shall have a minimum factor of safety of 1.5, and flexible pipes shall have a minimum factor of safety of 1.25.	the flows. Refer to Appendix D – Sewer Main Capacity Calculations
33.2	In general, sewers should be sufficiently deep to receive wastewater from basements and to prevent freezing. The minimum depth of bury must not be less than 4 feet (to the top of pipe) without justification by the design engineer. The prevailing local building code must be used in determining the maximum frost depth; however, the designer must consider increasing that depth if the site is located where local information suggests greater frost penetration. Insulation must be provided for sewers that cannot be placed at a depth sufficient to prevent freezing. Insulation used for this purpose must be specifically designed to withstand compaction and for use in subsurface locations. It must retain the insulating value for the design life of the sewer.	The sewer will maintain a minimum depth of 6 feet.
33.3	Buoyancy of sewers and manholes must be considered and flotation of the component must be prevented with appropriate construction where high groundwater conditions are anticipated.	High groundwater is not anticipated.
33.41	Recommended Minimum Slopes: 0.60 feet per 100 feet for 6-inch pipe.	The sewer meets minimum slope requirements.
33.42	Minimum Flow Depth	The minimum flow depth is not applicable as required minimum slopes are met.
33.43	Minimize Solids Deposition	Refer to Appendix D for flow velocities.
33.44	Sewers must be laid with uniform slope between manholes.	Sewers have uniform slope between manholes.
33.45	Where velocities greater than 15 feet per second (4.6 m/s) are attained, special provision must be made to protect against displacement by erosion and impact.	Velocities do not exceed 15 feet per second. Refer to Appendix D for flow velocities.
33.46	Steep Slope Protection	Slopes are less than 20 percent.
33.5	Alignment: Sewers 24 inches (610 mm) or less in diameter must be laid with straight alignment between manholes. Straight alignment must be checked by either using a laser beam or lamping.	Alignment is straight between manholes. Sewer will be placed using a laser.
33.6	Changes in Pipe Size	Refer to the Permit Drawings. Proposed sewer does not change size from proposed to existing.
33.7	Materials	Sewer pipe will be SDR 26 PVC.



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PROPOSED SANITARY SYSTEM IMPROVEMENTS

Circular DEQ-2 Section	Requirement	Design Parameter
33.81	Installation specifications must contain appropriate requirements based on the criteria, standards, and requirements established by industry in technical publications. Requirements must be set forth in the project specifications for the pipe and methods of bedding and backfilling the pipe so as not to damage the pipe or its joints, impede cleaning operations and future tapping, or create excessive side fill pressures and ovalation of the pipe, or impair flow capacity.	The sewer will be placed according to the Wyoming Public Works Standard Specifications.
33.82	Trenching	Refer to the Permit Drawings. The trench width will be the pipe O.D. plus 24 inches
33.83	Pipe Bedding Materials and Placement	Pipe bedding gradations are presented in the Wyoming Public Work Specifications which complies with this requirement.
33.84	Trench Backfill	Backfill will be performed to meet Wyoming Public Work Specifications, which complies with this requirement.
33.85	Deflection Test	Deflection testing may be required at the discretion of the Contracting Officer. If deflection testing is deemed necessary, the Contractor shall complete this work in accordance with ASTM D3034.
33.91	The installation of joints and the materials used must be included in the specifications. Sewer joints must be designed to minimize infiltration and to prevent the entrance of roots throughout the life of the system.	All sewer pipe will be bell and spigot type with rubber gasket type joints.
33.92	Leakage tests must be specified. This may include appropriate water or low pressure air testing. The testing methods selected should take into consideration the range in groundwater elevations during the test and anticipated during the design life of the sewer. Sewers with active service connections may be leak tested via video inspection.	A leakage test will be performed according to the Wyoming Public Work Specifications.
33.93	Service connections to the sewer main must be water tight and may not protrude into the sewer. If a saddle type connection is used, it must be a pre-manufactured device that is designed to join the types of pipe that are to be connected. All materials used to make service connections must be compatible with each other and with the pipe materials to be joined. All materials must be corrosion resistant.	All service connections will be made with a wye.
33.10	Casing Piping	No casing piping will be used.
34.1	Manhole Location	Manhole locations meet the requirements. Refer to the Permit Drawings.
34.2	Drop Type	No drop manholes are planned.



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PROPOSED SANITARY SYSTEM IMPROVEMENTS

Circular DEQ-2 Section	Requirement	Design Parameter
34.3	The minimum inside diameter for manholes is 48 inches (1.22 m); larger diameters are preferable for large diameter sewers. A minimum access diameter of 22 inches (559 mm) must be provided.	All manholes are 48-inches in diameter. The covers will be 24-inch covers with 22-inch openings.
34.4	Flow Channel	The flow-through channel will be 1/2 the pipe diameter.
34.5	A bench must be provided on each side of any manhole channel when the pipe diameter(s) are less than the manhole diameter. The bench should be sloped no less than 1/2 inch (13 mm) per foot (305 mm) (4 percent). A lateral sewer, service connection, or drop manhole pipe may not discharge onto the surface of the bench.	The manhole benches will be constructed following these requirements.
34.6	Manholes must be of the pre-cast concrete or poured-in-place concrete type. Manholes must be waterproofed on the exterior. Pre-cast concrete manhole sections manufactured in accordance with ASTM C 478M-93 (with Section 16 rejection requirements made mandatory) are exempt from the exterior waterproofing requirement. Manhole lift holes and grade adjustment rings must be sealed with non-shrinking mortar or other material approved by the Department. Inlet and outlet pipes must be joined to the manhole with a gasketed flexible watertight connection or any watertight connection arrangement that allows differential settlement of the pipe and manhole wall to take place.	The manhole inverts will be grouted to allow smooth flow through the manhole and benches will drain to the invert. The manholes will have watertight connections. The manhole will be precast reinforced concrete with a monolithic base.
34.7	The specifications must include a requirement for inspection and testing for watertightness or damage prior to placing into service. Vacuum testing, if specified for concrete sewer manholes, must conform to the test procedures described in ASTM C 1244.	Leakage testing of manholes will be required and is included in the specifications.
34.8	Corrosion Protection for Manholes	Corrosive conditions are not present.
34.9	Electrical	There will be no electrical in manholes.
35	INVERTED SIPHONS	There will be no inverted siphons.
36	SEWERS IN RELATION TO STREAMS	Sewer is not located near a stream.
37	AERIAL CROSSINGS	Sewer has no aerial crossings.
38.1	Cross Connections Prohibited	There will be no cross connections.
38.2	Relation to Water Works Structures	Sewer is not located near any wells.
38.3	Relation to Water Mains	Sewer and water will maintain minimum horizontal and vertical separation requirements.



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PROPOSED SANITARY SYSTEM IMPROVEMENTS

Circular DEQ-2 Section	Requirement	Design Parameter
39	Sewer services and plumbing must conform to relevant local and state plumbing codes, or to the Uniform Plumbing Code as amended by ARM 24.301.301, or other applicable codes.	Sewer services will be constructed in accordance with uniform plumbing code.

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 30-80 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 2 units total) on the site:

- Maximum daily generation: 560 gallons per day for the site
- Peak hour generation: 1.6 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 flattop manholes with barrel sections. A flexible watertight gasket will be used to connect the sewer pipe to the manhole. Details of a typical manhole installation are provided in Appendix A – Permit Drawings.



8.0 REFERENCES



APPENDIX/DIVIDER TITLE

APPENDIX A - PERMIT DRAWINGS



APPENDIX B - SPECIFICATIONS



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

NORTHEAST ENTRANCE 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	2	4	500	1,360	3.8
TOTAL WATER DEMAND				500	1,360	3.8
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 occurring 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 D - SEWER MAIN CAPACITY CALCULATIONS



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

NORTHEAST ENTRANCE 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	2	336	560	1.6
TOTAL NORTHEAST SANITARY SEWER DEMAND				560	1.6

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 occurring 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

Proposed 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)
Min. Slope	=	0.03000	(ft/ft)	Velocity	=	3.795	(ft/s)
				Flow Rate	=	0.745	(cfs)
				Flow Rate (90%)	=	0.671	(cfs)

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)
Min. Slope	=	0.10060	(ft/ft)	Velocity	=	6.950	(ft/s)
				Flow Rate	=	1.365	(cfs)
				Flow Rate (90%)	=	1.228	(cfs)

	DESIGN FLOW PER UNIT	NUMBER OF UNITS	AVERAGE TOTAL, gpd	MAXIMUM TOTAL, gpd	PEAK HOUR, gpm
1- BEDROOM UNIT	150	2	180	300	0.8
2- BEDROOM UNIT	280	2	336	560	1.6
4- BEDROOM UNIT	470	1	282	470	1.3
TOTAL EXISTING SANITARY SEWER DEMAND			798	1330	3.7

Flow Data				
Scenario	Existing	Proposed	Total	Total (cfs)
Average Day	798	336	1134	0.00175
Peak Day	1330	560	1890	0.00292
Peak Hour	3.7	1.6	5.3	0.01169