Paisley Park Subdivision

A major subdivision in Missoula, Montana

Sewer Engineering Report

Revision	*Date*
First Element Review	March 3, 2025

Prepared for:

OO Land Holding, LLC
16309 East Marietta Avenue
Spokane Valley, WA 99216

405 Third Street NW, Suite 206
Great Falls, MT 59404
(406) 761-1955

WOITH ENGINEERING, INC.
ENGINEERS & SURVEYORS

3860 O'Leary Street, Suite A
Missoula, MT 59808
(406) 203-0869

Table of Contents

List of Figures

List of Tables

This design report provides the criteria used as a basis of design for the sanitary sewer system to be constructed to serve Paisley Park Subdivision located in Missoula, Montana. This report is submitted in conjunction with the Preliminary Plat and preliminary construction plans. It is organized following the outline recommended in Department Circular DEQ-2, Chapter 10, Section 11.1.

11.11. PROBLEM DEFINED

The proposed major subdivision is in the Sxʷtpqyen Master Planned area, which is northwest of downtown Missoula and immediately southeast of Missoula Montana Airport. The Sxwtpqyen Area is a rapidly developing neighborhood of Missoula, with a mixture of single-family and multifamily residential subdivisions in varying stages of development.

The Sxʷtpqyen Area is served by a gravity sewer system. In 2020 and 2021, the City of Missoula undertook the Mullan BUILD Project, a transportation project, which prompted the City to fund construction of new sanitary sewer trunk mains to serve anticipated development in the Sxʷtpqyen Area. The City funded installation of a new 18-inch sewer main in Remington Drive, a City street in the first phase of the Remington Flats Subdivision. The Remington Flats Subdivision is immediately south of the proposed Paisley Park Subdivision; the gravity sanitary sewer system proposed to serve Paisley Park Subdivision will ultimately discharge flows to the existing sewer infrastructure and the 18-inch sewer main in the Remington Flats Subdivision.

The existing sanitary sewer infrastructure is shown in Figure 1. A new sanitary sewer main will be extended in Chuck Wagon Drive, an existing public right-of-way along the western boundary of Remington Flats, to serve Paisley Park Subdivision. This report will evaluate the existing conditions, discuss the design criteria, and fully explain the proposed design and constraints of the proposed gravity sewer system serving Paisley Park Subdivision.

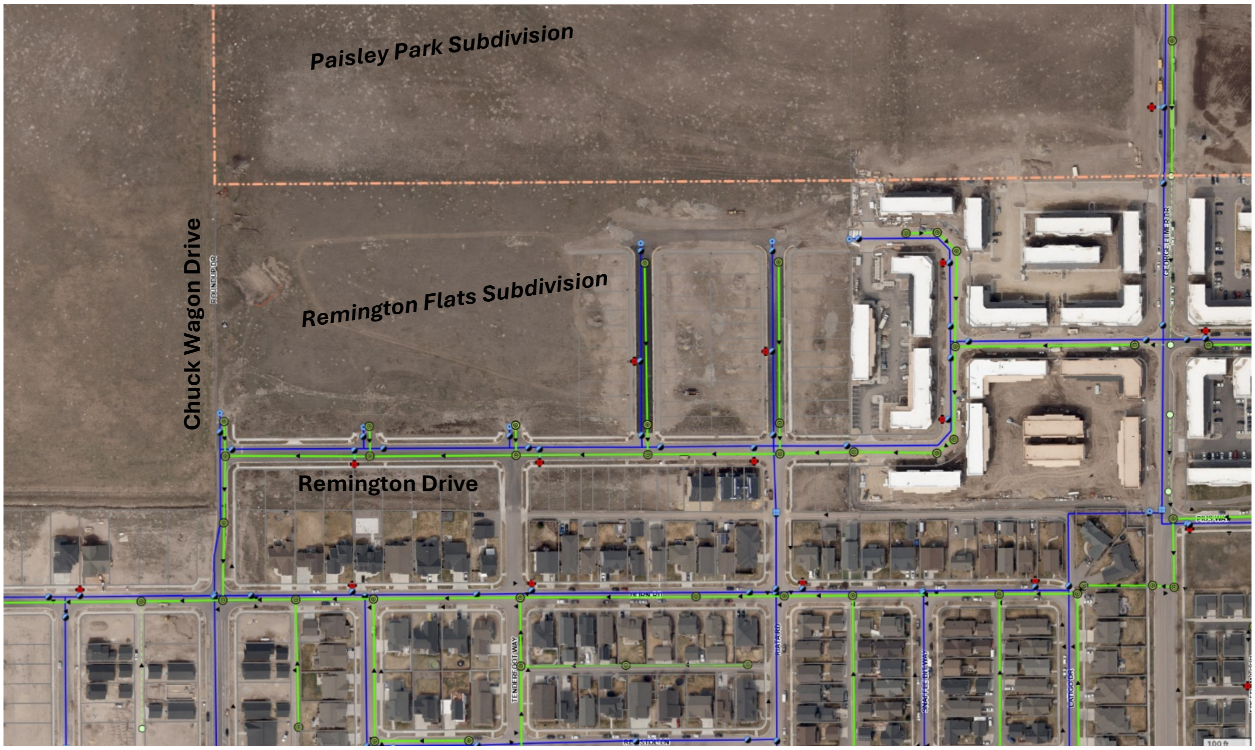

Figure 1. Existing Sanitary Sewer Infrastructure South of Paisley Park Subdivision.

11.12. Design Conditions

Paisley Park Subdivision is a proposed form-based code subdivision with 100 lots. The Sxʷtpqyen Master Plan is a form-based zoning code which permits a rich variety of building types and configurations. Thus, Paisley Park Subdivision will be developed with a mixture of single-family homes, duplexes, townhomes, and apartment buildings. The subdivision will ultimately include 671 residential units of these varying types, distributed across the 100 lots.

New City streets will be constructed to access Paisley Park Subdivision, with multiple cross-sections and classifications ranging from neighborhood collector streets to alleys. The proposed sanitary sewer mains will be located in these streets, alleys, and access easements. The configuration of the proposed sanitary sewer main extensions is shown on Attachment 8.10 and in the Preliminary Construction Plans, Attachment 15, submitted in conjunction with the subdivision application. The sewer system must be sized to convey the anticipated average and peak sanitary sewer flows produced by the subdivision.

A. Wastewater Flow

The average daily wastewater flows, in gallons per day per unit (gpd/unit), are shown in Table 1. These residential wastewater flows are taken from Department Circular DEQ-4, Section 3.1.2. For the purposes of this analysis, duplex, triplex, and townhome units are considered as single-family dwellings. Single-family dwellings are considered to have an average of three bedrooms, and apartment living units are assumed to have an average of 2.5 residents per unit, with an average daily wastewater flow of 100 gallons per day per resident.

Table 1. Average Daily Wastewater Flow by Source.

Wastewater Source	Average Wastewater Flow (gpd/unit)
Single-family Dwelling	300
Apartment Living Unit	250

To analyze the average and peak wastewater flows contributed to each proposed sewer main extension, the subdivision is divided into 11 catchment areas, each of which contributes wastewater flow to a designated design point in the system. The design points and subsequent sizing of gravity sewer main pipes are discussed in detail in Section 11.12.B. The wastewater catchment areas are shown graphically in Figure 2. Table 2 shows the number of units and average daily wastewater flow for each catchment area. Catchment 5 represents potential future offsite development on the parcel located immediately to the west.

Table 2. Calculation of Average Daily Wastewater Flow.

Catchment Area	Single-family Units	Apartment Units	Average Daily Wastewater Flow (GPD)		Total Average Daily Flow (GPD)
			(single-family)	*(apartment)*	
1	0	125	0.0	31250.0	31250.0
2	12	6	3600.0	1500.0	5100.0
3	4	0	1200.0	0.0	1200.0
4	0	140	0.0	35000.0	35000.0
5	0	0	0.0	0.0	0.0
6	0	60	0.0	15000.0	15000.0
7	10	98	3000.0	24500.0	27500.0
8	0	60	0.0	15000.0	15000.0
9	0	20	0.0	5000.0	5000.0
10	5	0	1500.0	0.0	1500.0
11	20	111	6000.0	27750.0	33750.0

Full Buildout	51	620	15300.0	155000.0	170300.0

The calculation of the peak wastewater flow contributed by each catchment area requires calculation of a peaking factor for each area. Equation 1 shows the peaking factor calculation.

Equation 1. $$PF = \frac{18+\sqrt{P}}{4+\sqrt{P}}$$

Where $PF = Peaking\ Factor$
$P = Population\ (thousands\ of\ people)$

With the average daily wastewater flows calculated in Table 2 and the peaking factor shown in Equation 1, the peak instantaneous wastewater flow can be calculated for each catchment. Equation 2 shows the calculation of the peak instantaneous wastewater flow.

Equation 2. $$PID = \frac{PF * ADD}{1{,}440}$$

Where $PID = Peak\ Instantaneous\ Wastewater\ Flow\ (gallons\ per\ minute)$
$PF = Peaking\ Factor$
$ADD = Average\ Daily\ Wastewater\ Flow\ (gallons\ per\ day)$

The peak flows, calculated in Table 3, will subsequently be used to analyze the capacity of the existing sewer system and to size the new sewer system serving Paisley Park Subdivision. The calculations include a conversion to cubic feet per second (cfs), which will be used in the analysis of sewer main capacity.

Table 3. Calculation of Peak Instantaneous Wastewater Flow.

Catchment Area	Total Average Daily Flow (GPD)	Peaking Factor	Peak Instantaneous Wastewater Flow (PID)	
			(GPM)	(CFS)
1	31250.0	4.07	88.34	0.197
2	5100.0	4.31	15.28	0.034
3	1200.0	4.41	3.67	0.008
4	35000.0	4.05	98.41	0.219
5	0.0	4.50	0.00	0.000
6	15000.0	4.19	43.66	0.097
7	27500.0	4.09	78.19	0.174
8	15000.0	4.19	43.66	0.097
9	5000.0	4.31	14.98	0.033
10	1500.0	4.40	4.58	0.010

11	33750.0	4.06	95.07	0.212
Full Buildout	126000	3.64	430.37	0.959

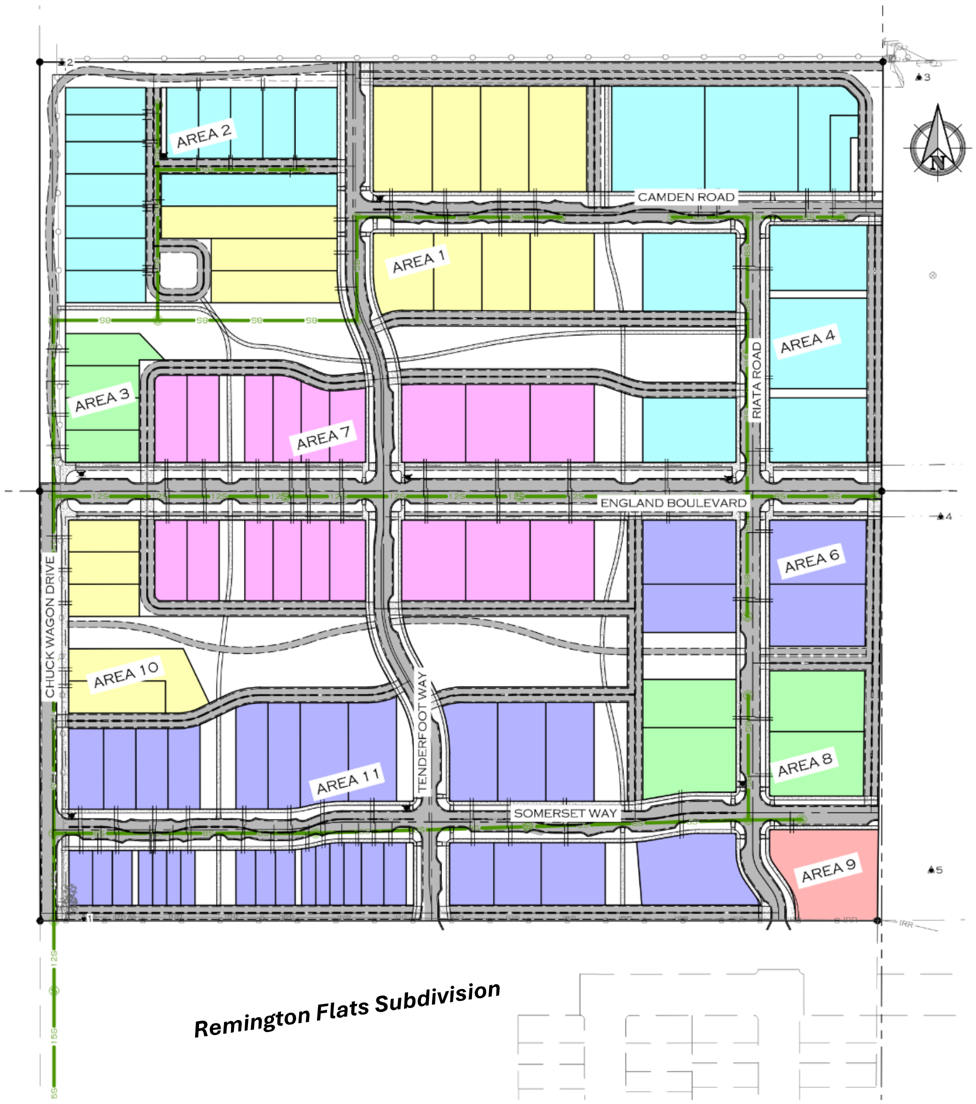

Figure 2. Map of Sanitary Sewer Catchment Areas.

B. Design of Sewers

After establishing the average and peak wastewater flows, the gravity sewer mains serving the subdivision can be designed. Due to the depth of the existing sewer infrastructure and the flat topography of the project site (further discussed in Section 11.17), the majority of the sewer mains serving Paisley Park Subdivision will be constructed to the minimum slopes specified in Department Circular DEQ-2, Section 33.41. The sewer system capacity is analyzed at various design points within the system, each of which receives wastewater flows from one or multiple catchments. As an additional safety factor, travel time through the piping system is ignored when calculating the peak wastewater flow at each design point. The design points are shown graphically in Figure 3. Table 4 shows the catchments contributing to each design point, based on the layout of the system. The peak instantaneous wastewater flow at each design point is the sum of the peak flow from its contributing catchments.

Table 4. Calculation of Peak Instantaneous Wastewater Flow per Design Point.

Design Point	Contributing Catchments	Peak Instantaneous Wastewater Flow (CFS)
1	1	0.20
2	2	0.03
3	1, 2, 3	0.24
4	4	0.22
5	5	0.00
6	6	0.10
7	4, 5, 6, 7	0.49
8	8	0.10
9	9	0.03
10	1, 2, 3, 4, 5, 6, 7, 10	0.74
11	8, 9, 11	0.34
12	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11	1.08

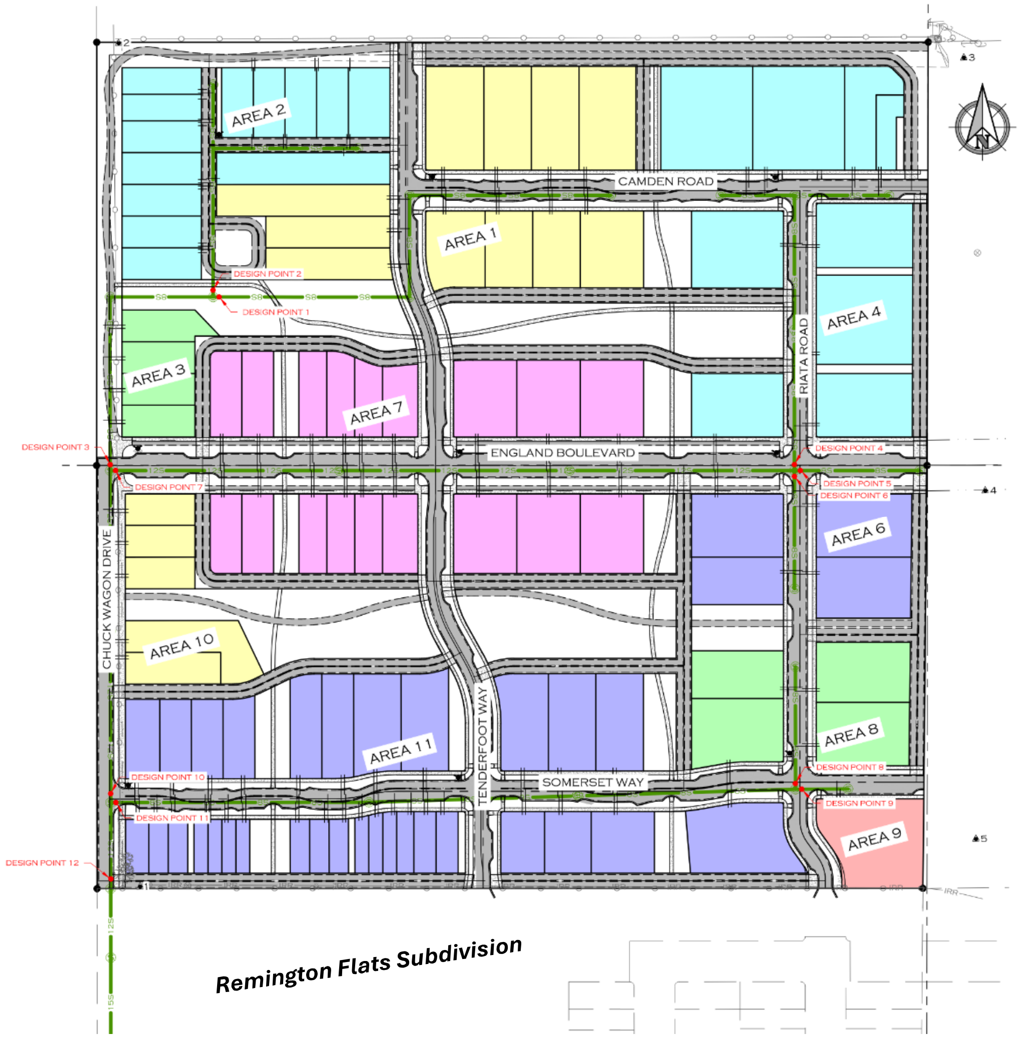

Figure 3. Map of Sanitary Sewer Design Points.

Next, the sewer mains are sized based on the ratio of the peak flow they must accommodate to their theoretical capacity. The theoretical capacity is calculated using Equation 3.

Equation 3. $$Q_P = \frac{1.49}{n} A \left(\frac{A}{P}\right)^{2/3} S^{1/2}$$

Where Q_P = *Pipe Capacity at Full Flow Depth (cubic feet per second)*
n = *Manning's Roughness*
A = *Cross-sectional Area of Flow (square feet)*
P = *Perimeter of Flow (feet)*
S = *Slope of Pipe (feet per foot)*

For plastic sanitary sewer pipes, the Manning's Roughness value is 0.013. To determine the appropriate pipe sizes, the capacity of each sewer main is checked assuming the minimum 8-inch diameter pipe allowed by Circular DEQ-2. Table 5 compares the capacity of 8-inch pipes to the peak instantaneous wastewater flows expected at each design point. The capacity ratio is calculated using Equation 4, and the safety factor is calculated using Equation 5.

Table 5. Capacity Analysis for 8-inch Gravity Sewer Mains.

Design Point	Pipe Diameter (in)	Pipe Slope (ft/ft)	Capacity (cfs)	Peak Flow Rate (cfs)	Capacity Ratio	Safety Factor
1	8	0.004	0.77	0.20	25.69%	3.89
2	8	0.004	0.77	0.03	4.44%	22.52
3	8	0.004	0.77	0.24	31.19%	3.21
4	8	0.004	0.77	0.22	28.61%	3.49
5	8	0.004	0.77	0.00	0.00%	n/a
6	8	0.004	0.77	0.10	12.69%	7.88
7	8	0.004	0.77	0.49	64.04%	1.56
8	8	0.004	0.77	0.10	12.69%	7.88
9	8	0.004	0.77	0.03	4.36%	22.96
10	8	0.004	0.77	0.74	96.57%	1.04
11	8	0.004	0.77	0.34	44.69%	2.24
12	8	0.004	0.77	1.08	141.26%	0.71

Equation 4. $$CR = \frac{PID}{Q_P} * 100$$

Where CR = *Capacity Ratio (%)*
PID = *Peak Instantaneous Wastewater Flow (cubic feet per second)*
Q_P = *Pipe Capacity at Full Flow Depth (cubic feet per second)*

Equation 5. $$SF = \frac{Q_P}{PID}$$

Where SF = *Safety Factor*
PID = *Peak Instantaneous Wastewater Flow (cubic feet per second)*
Q_P = *Pipe Capacity at Full Flow Depth (cubic feet per second)*

The design safety factor for the project shall be 2.0. Therefore, any sewer mains which have a safety factor below 2.0 with an 8-inch diameter must be upsized to accommodate the peak wastewater flows with an acceptable safety factor. Table 6 shows the final design pipe diameter, slope, capacity ratio, and safety factor at each design point. The pipe connecting design point 4 to the northeast corner of Paisley Park, as well as the pipe connecting design point 5 to the neighboring parcel to the east, will be upsized to 12 inches to maximize the development potential and depth of sewer for that parcel. These upsizes have been coordinated with City Engineering staff.

Table 6. Design Sewer Main Diameter, Capacity Ratio, and Safety Factor.

Design Point	Pipe Diameter (IN)	Pipe Slope (FT/FT)	Capacity (CFS)	Peak Flow Rate (CFS)	Capacity Ratio	Safety Factor
1	8	0.004	0.77	0.20	25.69%	3.89
2	8	0.004	0.77	0.03	4.44%	22.52
3	8	0.004	0.77	0.24	31.19%	3.21
4	12	0.0022	1.68	0.22	13.09%	7.64
5	12	0.0022	1.68	0.00	0.00%	n/a
6	8	0.004	0.77	0.10	12.69%	7.88
7	12	0.0022	1.68	0.49	29.29%	3.41
8	8	0.004	0.77	0.10	12.69%	7.88
9	8	0.004	0.77	0.03	4.36%	22.96
10	12	0.0022	1.68	0.74	44.16%	2.26
11	8	0.004	0.77	0.34	44.69%	2.24
12	15	0.0015	2.51	1.08	43.15%	2.32

11.13. Impact on Existing Wastewater Facilities

The wastewater flows produced by Paisley Park Subdivision will impact existing gravity sewer mains, a lift station, sanitary sewer force main, and the City of Missoula's wastewater treatment plant. The proposed sewer mains will connect to an existing 15" sanitary sewer stub in the Remington Flats Subdivision, at the intersection of Remington Drive and Chuck Wagon Drive. This stub subsequently confluences with the 18-inch sewer main.

From this point, wastewater will flow through an existing network of gravity sewer mains to an existing lift station at 1234 Kelly Island Court. The City's engineering staff has analyzed the capacity of this existing infrastructure and confirmed that available capacity exists to accommodate the additional wastewater produced by Paisley Park Subdivision. Likewise, the City's wastewater treatment plant has available capacity to treat the additional wastewater from the subdivision. The City's letter affirming the available capacity of their existing system is attached to this report submittal.

11.14. Project Description

A written description of the project is required.

11.15. Drawings

Preliminary construction drawings are attached to this report.

11.16. Design Criteria

Engineering design criteria to be used in design of the project include Montana Department of Environmental Quality Circular 2, Missoula City Public Works Standards and Specifications Manual, and Montana Public Works Standard and Specifications, 7th Edition.

11.17. Site Information

A. Topography

The project site is entirely devoid of significant topographic features; it is a flat plain which slopes from an elevation 3,154 feet above mean sea level (MSL) in the southeast corner to 3,146 feet MSL in the northwest corner. This equates to an average topographic slope of 0.42%, with almost no variation across the site. The site has historically been used for agriculture: hay production and cattle grazing.

B. Geology and Soils

In general, silty sand and sandy silt overlie high-quality sand and gravel aggregates across the site. Geologically, this area is mapped on the Missoula West 30' x 60' Quadrangle Geologic Map (MBMG Open File Report 373) as Quaternary period Alluvium of Alluvial Terrace Deposits (Qat). These deposits are characterized as well-rounded cobbles, gravel, and sand in deposits with flat topped surfaces that are 10 to 30 feet above the present flood plain. Bedrock was not encountered in the geotechnical investigation and is sufficiently deep beneath the site to not be a consideration in the design of the sewer system.

C. Hydrology

In preparation for a project to realign Grant Creek, which is northwest of Paisley Park, Newfields prepared a Groundwater Modeling Study for the City of Missoula in 2023. According to the study, seasonal high groundwater rises to within 6'-15' of the ground surface on the property. Groundwater may be encountered during the deep sanitary sewer installations in Chuck Wagon Drive and Somerset Way, along with the installation of water mains in areas where they must be installed at a depth sufficient to pass under sanitary sewers; the construction plans will include provisions to address groundwater if encountered during construction.

According to FEMA Flood Insurance Rate Map 30063C1190E, the proposed subdivision is not within a FEMA-designated 100-year or Shaded Zone X floodplain. The project site does not feature any major drainageways, receiving channels, or surface waters. The nearest surface water is Grant Creek, approximately 650 feet northwest of the project site.

11.18. Alternatives Analysis

The proposed sewer main extensions connect to existing gravity sewer mains directly adjacent to the proposed development. No other alternate plans were considered due to the proximity of the available City of Missoula sewer collection system.

11.19. Environmental Impacts

Environmental impacts will be negligible since the sewer main is a closed piping system that has eliminated any path for water mitigation. There are no known potential sources of adverse environmental impact on the project site.

11.20. Operation and Maintenance

Construction of the proposed sewer main extensions will be privately funded. Ultimately, these sewer main extensions will be owned, operated, and maintained by the City of Missoula.