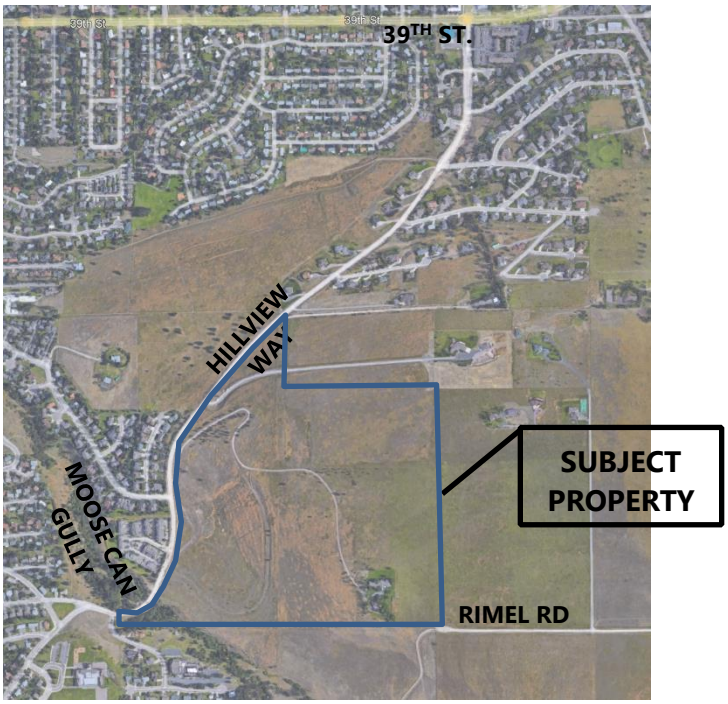
STORMWATER ENGINEERING REPORT
Wildroot



Moose Can Gully - Hillview Way,
Missoula, Montana 59803

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November 29, 2023

PRELIMINARY – FOR REVIEW PURPOSES ONLY

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1.0 INTRODUCTION

The Wildroot project is a proposed 105-acre residential subdivision development with a total count of 450 units. This unit count includes the approved multi-family development of 203 units and an additional 21 townhome lots and 226 single family lots. Approximately 66 acres is located within the City of Missoula limits, 39 acres is in Missoula County and will be annexed as part of the subdivision process. The subject property has an approved stormwater management system for the multi-family development which anticipated runoff flows from the proposed subdivision. The proposed design manages flows from the 226 single family lots into two basins.

The intent and purpose of this report is to provide an overview of the stormwater design for the proposed subdivision. An existing approved Stormwater report for the Multi-Family Development addresses the south drainage basin. This report addresses modifications to the south basin and the design of the north basin. The report provides calculations and documentation to meet the requirements of the Montana DEQ (MTDEQ) and City of Missoula (COM).

The following references were used in the stormwater drainage design.

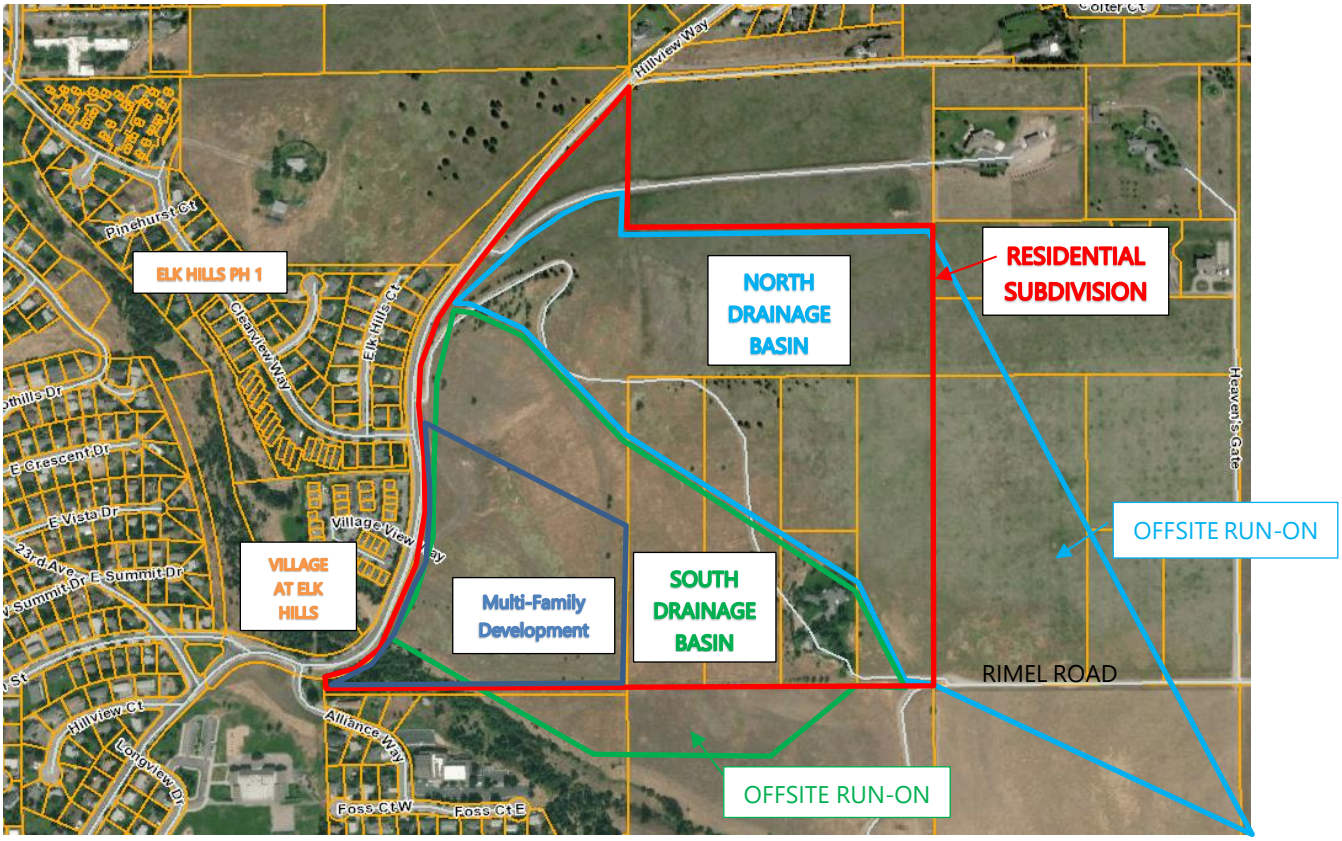
- Missoula City Public Works Standards and Specifications Manual (MCPWSS)
- Montana Post-Construction Storm Water BMP Design Guidance Manual (BMP Manual)
- Montana Public Works Standard Specifications and City of Missoula Standard Modifications to MPWSS (MPWSS)
- MTDEQ Circular No. 8 (DEQ-8)

1.1 Location

The property is bound to the west by Hillview Way, the south by Moose Can Gully, and the east/north by undeveloped land.

Figure 1.1: Overall Location Map

Figure 1.2: Detailed Location Map



1.2 Description of Property

1.2.1 Area

The subject property in total is approximately 105 acres. The 23.84-acre tract developed under the Multi-Family Development will be modified during the subdivision process.

1.2.2 Ground Cover

The existing ground cover is primarily native grasses and sparse trees.

1.2.3 Land Uses

A 23.84-acre tract of the total 105-acres for the proposed subdivision is currently developed as a multi-family residential complex with five buildings and 203 total units. The development includes landscaping and pavement areas. This area of this tract will be modified in the subdivision process.

The remaining portions of the subdivision are proposed for single family residential properties, townhomes, and associated parks, open spaces, and roads.

1.2.4 Topographic Features and Slopes

Topography ranges from slopes of 0-25 percent with a total elevation gain of approximately 260 feet from the lowest elevation at the north end of the property on Hillview Way to the highest point of the property at the Rimel Road connection. A topographic map with slope delineation is included in Appendix A.

1.2.5 Drainage Ways and Receiving Channels

The only defined drainage way is Moose Can Gully which intersects the southwest corner of the subject property. The existing outfall for the South Basin is directly to Hillview Way where it is conveyed in storm pipes and directed to Moose Can Gully just downstream of Hillview Way. The proposed outfall from the North Basin detention facility will connect directly into Hillview Way storm pipes and conveyed to the north, ultimately into the Bitterroot River.

1.2.6 Existing Drainage Facilities

The Multi-Family development was designed with a storm drainage system that includes detention ponds, inlets, and piping. The storm facilities associated with the Multi-Family development will provide the necessary storage and capacity for the south basin with the amendments described later in this report.

The existing drainage facilities for the north basin are in the City ROW of Hillview Way. The subdivision design proposes to connect to this system.

1.2.7 Flood Hazard Zones

The entire subject property is located in Zone X as defined on FEMA Flood Map 30063C1460E. Zone X is described as 0.2% annual chance flood hazard.

1.2.8 Irrigation Ditches

There are no irrigation ditches within or near the subject property.

1.2.9 Geologic Features

See Appendix E for the geotechnical investigation excerpts from the report prepared by Lorenzen Soil Mechanics, Inc. titled, *"Hillview Subdivision Geotechnical Engineering Report – Phase 2"* dated September 13, 2022.

The material is consistent across the project and consists of cobbles, gravel, sand, silt, clay, and volcanic ash deposits. The report indicates very high infiltration rates which are consistent with known information provided from the city and adjacent developments.

The report does not indicate the presence of groundwater in the project area. In the thirteen test pits excavated to depths between 6.8 and 8.5 feet below ground surface groundwater was not encountered. The report indicates the shallowest groundwater in a nearby well log to be 317 feet below ground surface. See Appendix E for Geotechnical report.

The City of Missoula has communicated deeper geological concerns in this area that impact the overall drainage design. At areas deeper than what was evaluated in the geotechnical report, clay lenses exist that have transmitted infiltrated stormwater downgradient in a manner that has negatively impacted those downgradient properties. As a result, the detention ponds associated with the proposed design will be lined to prevent infiltration of stormwater.

Wetlands within the property are located in Moose Can Gully. The wetlands will not be impact by the proposed project.

The NRCS Soils Report indicates hydrologic soil groups B and C with the majority of the subject property being group C.

1.3 Previous Drainage Studies

No known previous drainage studies exist for the subject property. The City of Missoula could not provide a report for the Hillview Way storm drain system. However, there are no known issues with the capacity of the system or downstream impacts in the existing condition.

1.4 General Project Description

The Wildroot project is a proposed 105-acre residential subdivision development with a total count of 450 units. This unit count includes the approved multi-family development of 203 units and an additional 21 townhome lots and 226 single family lots. Approximately 66 acres is located within the City of Missoula limits, 39 acres is in Missoula County and will be annexed as part of the subdivision process. The subject property has an approved stormwater management system for the multi-family development which anticipated runoff flows from the proposed subdivision. The proposed design manages flows from the 226 single family lots into two basins.

The property conveys runoff in two drainage basins. The proposed stormwater systems are designed to collect, treat and detain stormwater runoff from the proposed residential subdivision located within both drainage basins.

1.5 State or Federal Regulations

Work on the project will fall under the requirements of the MPDES stormwater general permit as administrated by the City of Missoula which is an MS4. No other state or federal stormwater or wetland regulations apply.

1.6 Geotechnical Report

The geotechnical report is included in Appendix E of this Report.

2.0 EXISTING SITE CONDITIONS

2.1 Major Basin Description

See Section 1 for information regarding drainage studies, flood hazard areas, land uses, and ground cover characteristics.

The full property consists of two drainage basins as shown on Figure D.01 located in Appendix B. The north basin, HIST-01 drains to the north on Hillview Way. It is approximately 60-acres, of which 26 acres is run-on from the properties to the east.

HIST-02 is approximately 64-acres, 7 acres of which is offsite run-on from the property to the south. The slopes of this basin range from 0-25% primarily flowing from the east to the west. The following tables describe the basin runoff rate for the 2-year, 10-year, and 100-year storm event of the historic basins. See Section 3 for curve number determination and hydrologic method.

Table 2.1: 2-Year, 24-Hour Peak Runoff

BASIN	CN	Tc (h:mm:ss)	Tc (hr)	AREA (SF)	2-YR P (IN)	S	Ia (IN)	Ia/P	Q (IN)	qu (csm/in)	Am (SQ MI)	Fp	qp (CFS)
HIST-01A	74.00	0:51:31	0.86	2619650	1.17	3.51	0.585	0.500	0.05	180	0.094	1	0.93
HIST-01B	62.30	0:27:34	0.46	415869	1.17	6.05	0.585	0.500	0.00	245	0.015	1	0.00
													0.93

BASIN	CN	Tc (h:mm:ss)	Tc (hr)	AREA (SF)	2-YR P (IN)	S	Ia (IN)	Ia/P	Q (IN)	qu (csm/in)	Am (SQ MI)	Fp	qp (CFS)
HIST-02A	67.89	0:32:39	0.54	1646594	1.17	4.73	0.585	0.500	0.01	225	0.059	1	0.13
HIST-02B	66.85	0:07:13	0.12	1147228	1.17	4.96	0.585	0.500	0.01	490	0.041	1	0.12
													0.26

Table 2.2: 10-Year, 24-Hour Peak Runoff

BASIN	CN	Tc (h:mm:ss)	Tc (hr)	AREA (SF)	10-YR P (IN)	S	Ia (IN)	Ia/P	Q (IN)	qu (csm/in)	Am (SQ MI)	Fp	qp (CFS)
HIST-01A	74.00	0:51:31	0.86	2619650	1.66	3.51	0.703	0.423	0.20	250	0.094	1	4.82
HIST-01B	62.30	0:27:34	0.46	415869	1.66	6.05	0.830	0.500	0.03	245	0.015	1	0.11
													4.93

BASIN	CN	Tc (h:mm:ss)	Tc (hr)	AREA (SF)	10-YR P (IN)	S	Ia (IN)	Ia/P	Q (IN)	qu (csm/in)	Am (SQ MI)	Fp	qp (CFS)
HIST-02A	67.89	0:32:39	0.54	1646594	1.66	4.73	0.830	0.500	0.09	225	0.059	1	1.24
HIST-02B	66.85	0:07:13	0.12	1147228	1.66	4.96	0.830	0.500	0.08	490	0.041	1	1.60
													2.84

Table 2.3: 100-Year, 24-Hour Peak Runoff

BASIN	CN	Tc (h:mm:ss)	Tc (hr)	AREA (SF)	100-YR P (IN)	S	Ia (IN)	Ia/P	Q (IN)	qu (csm/in)	Am (SQ MI)	Fp	qp (CFS)
HIST-01A	74.00	0:51:31	0.86	2619650	2.28	3.51	0.703	0.308	0.49	340	0.094	1	15.61
HIST-01B	62.30	0:27:34	0.46	415869	2.28	6.05	1.140	0.500	0.16	245	0.015	1	0.59
													16.20

BASIN	CN	Tc (h:mm:ss)	Tc (hr)	AREA (SF)	100-YR P (IN)	S	Ia (IN)	Ia/P	Q (IN)	qu (csm/in)	Am (SQ MI)	Fp	qp (CFS)
HIST-02A	67.89	0:32:39	0.54	1646594	2.28	4.73	0.946	0.415	0.29	350	0.059	1	6.07
HIST-02B	66.85	0:07:13	0.12	1147228	2.28	4.96	0.992	0.435	0.27	660	0.041	1	7.21
													13.28

The geotechnical report indicates high infiltration rates for the soils, particularly at depth, but also at the existing grade. The City of Missoula has experienced issues with infiltrated stormwater causing downgradient impacts and has communicated that a minimal amount of infiltration of post-development runoff will be allowed.

2.2 Sub-Basin Description

Both drainage basins were split into two sub-basins, A and B to refine the time of concentration for the basin and route the upper sub-basin (A) through the lower sub-basin (B).

2.3 Groundwater

The geotechnical report did not identify any groundwater within the subject property.

2.4 Waterways and Wetlands

See Section 1.2.5 for information regarding drainage ways and Section 1.2.9 for wetlands.

3.0 STORMWATER DESIGN CRITERIA

3.1 Design Concepts

The first phase of this development (multi-family) is located at the bottom of the south drainage basin. This system (MF Storm) is approved under the Hillview Multi-Family Storm Report dated August 29, 2023. The MF Storm was analyzed with a conservative estimate of the future subdivision development contributing to the basin. The design for the subdivision reduces the size and curve number of three MF Storm basins and collects additional area from the south basin in a proposed intermediate pond located above Building E of the MF Development. This pond outfalls at the MF Storm design rate to the piping in Rimel Road. There are no changes to the MF Storm design. The north basin will be collected in a below ground storage facility and metered to outfall to City storm in Hillview Way. The design intent of the project is to capture runoff using inlets and storm drains, ultimately routing to a regional detention.

Due to issues in this area of Missoula with infiltrated groundwater intercepting clay lenses and then resurfacing downgradient, the surface detention basins will be lined with an HDPE liner and the subsurface storage facility will be solid wall to prevent infiltration.

3.2 Drainage Criteria

Autodesk's Sanitary Sewer and Storm Analysis (SSA) Version 2023 was utilized to model the site hydrology under pre and post-development conditions.

3.2.1 Application Standards or Exceptions

Site storm drainage improvements are designed to comply with the MCPWSS, BMP Manual, and DEQ-8.

3.2.2 Minor and Major Storm Frequencies

Per the MCPWSS the minor storms shall be the 2-year and 10-year, 24-hour storm events and the major storm shall be the 100-year, 24-hour event. All curbs, gutters, swales, and open channels are designed to accommodate the minor storms and all detention facilities have been designed to manage the major storm.

3.2.3 Hydrologic Methods

The storm drainage system is sized for the three storm events utilizing the SCS TR-55 Method. Utilizing this method, peak runoff rates and flow control volumes were calculated. MCPWSS was used for a design precipitation depth of 2.28 inches for the 100-year event, 1.66 inches for the 10-year event, and 1.17 inches for the 2-year event. The storm distribution is a Type-II, 24-hour storm.

Figure 3.1: 10-YR Storm

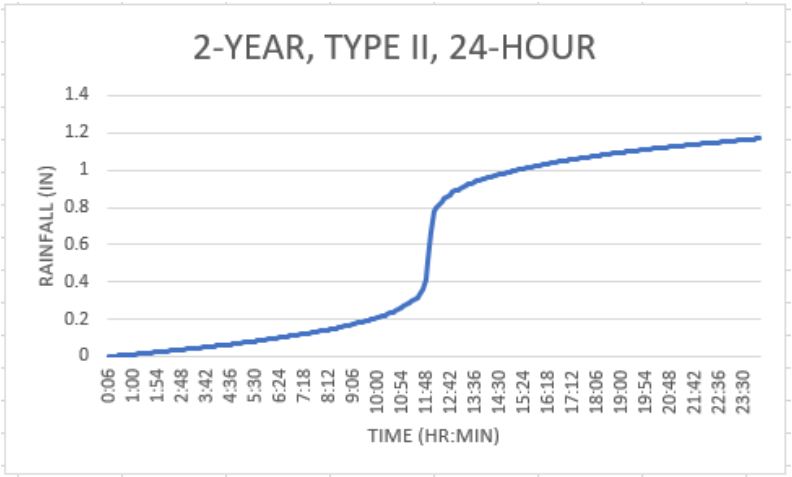


Figure 3.2: 10-YR Storm

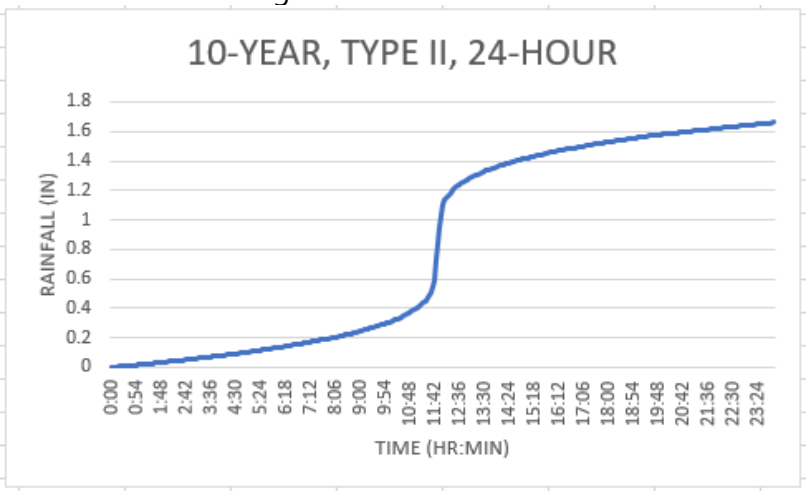


Figure 3.3: 100-YR Storm

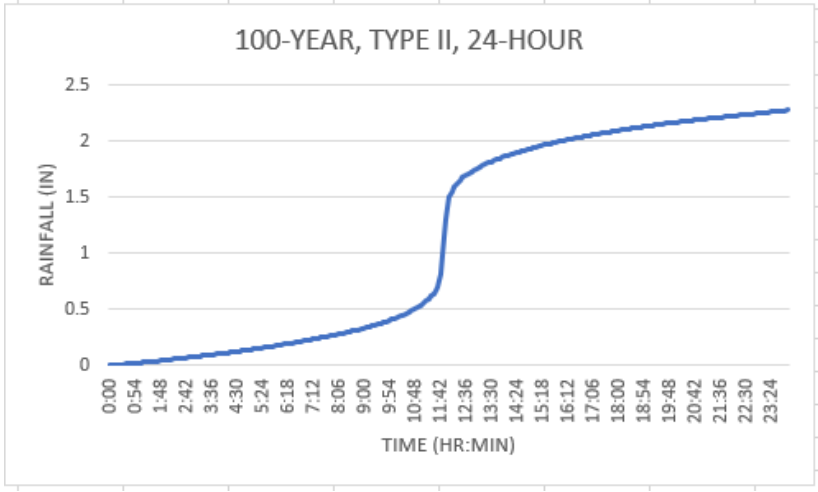


Table 3.1 shows the selected runoff coefficients for both the pre- and post-development conditions. See Table 4.1 and Appendix B for weighted curve numbers.

Table 3.1: Runoff Coefficients

DESCRIPTION	SOIL GROUP	Curve Number	NOTES
Impervious Area	B	98	Roof / Parking
Landscape	B	69	50 - 75% grass cover, Fair
Native	B	61	Pasture, grassland, or range, Good
Native	C	74	Pasture, grassland, or range, Good

Water quality volumes and pre-treatment methods were determined using the BMP Manual. Volumes are determined from the first 0.5 inch of rainfall on impervious areas.

$$RRV = \frac{PR_vA}{12}$$

Where:

RRV= Runoff Reduction Volume (ac-ft)
P = Water Quality Rainfall Depth (0.5 inches)
R_v = Dimensionless Runoff Coefficient, $R_v = 0.05 + 0.9(I)$
I = Percent Impervious Cover Draining to the Facility (decimal)
A = Site Drainage Area (ac)

Time of concentration values were calculated using the SCS TR-55 method. The SCS TR-55 method uses a summation of sheet flow, shallow flow and channelized flow to calculate a total time of concentration. Detailed time of concentration calculations for every sub-basin/basin are included in Appendix D and shown graphically on exhibit D.01. The following criteria were used for calculating time of concentration:

- Minimum total time of concentration was set to 5 minutes in the model
- Maximum sheet flow length of 300'
- Native Vegetation Manning's = 0.13
- Asphalt sheet flow Manning's = 0.012
- Landscape sheet flow Manning's= 0.4

3.2.4 Hydraulic Methods

Storm sewer pipes were sized using Manning's equation for open channel flow with flow rates from the SCS TR-55 hydraulic model. Per the MCPWSS, storm sewer pipes were sized for the 10-year, 24-hour event to maintain a minimum pipe velocity of 2.5 feet per second. See Appendix C for individual pipe calculations.

Rip rap will serve to provide outlet protection where concentrate flows may cause erosion. The rip rap size is confirmed using the Federal Highway Administration (FHWA) equation for culvert outlet rip rap.

The pond outlet weirs and orifice are designed with the following equations.

Weir

$$Q = \frac{2}{3} C_d \sqrt{2g} L H^{\frac{3}{2}}$$

$$C_d = 0.602 + (0.075 * \frac{H}{P})$$

Orifice

$$Q = C_d A \sqrt{2gh}$$

Where:

Q = Discharge (cfs)
C = Discharge Coefficient (weir)
L = Length of Crest (ft)
H = Depth of flow above crest (ft)
C_d = Discharge Coefficient (orifice)
A = Cross-Sectional Area (sf)
g = Gravity Constant (ft/sec^2)
h = Depth to centerline of orifice (ft)

The following discharge coefficients are used

- Sharp-crested rectangular weir (see calculations)
- Orifice = 0.614

Refer to Appendix C for detailed hydraulic calculations.

3.3 Down-Gradient Analysis

It is known that there have been issues with infiltrated stormwater causing down gradient problems due to infiltrated stormwater being intercepting by clay lenses and then resurfacing downgradient. As a result, the proposed design does not infiltrate stormwater and, therefore, does not contribute to any down gradient problems. This is achieved through capturing and routing runoff to HDPE lined detention ponds and a solid wall underground storage facility. There are currently no known issues down gradient in the city storm drain in Hillview Way or in the south outfall location of Moose Can Gully. The proposed design matches the historic runoff peak flow rate and utilizes pre-treatment to avoid any down gradient water quality impacts.

3.4 Analysis Points

The stormwater design is analyzed as an entire basin and individual sub-basins. The analysis evaluated the South Basin at the Intermediate Pond outfall and the North Basin at the subsurface storage outfall. It also evaluated the individual sub-basins at each individual outfall location.

4.0 PROPOSED DESIGN

The proposed subdivision development will increase the amount of impervious surface area such as asphalt, concrete, and building rooftops that will in turn generate a higher volume of runoff. Per the City of Missoula standards, the subdivision will utilize regional impermeable detention facilities for the subdivision to mitigate the effects of the increased runoff rates and volumes. The following table shows the design information for the sub-basins of the South and North Outfall Basins. See Appendix B, D.01, D.02, and D.03 for detailed exhibits of the basins.

The proposed stormwater design captures and controls the stormwater runoff from the overall development improvements. This includes the impervious areas of the roadways, sidewalks, driveways, and vertical structures, as well as the pervious areas of landscape and native grounds. The analysis assumes future impervious area percentages of two different residential lot sizes. The townhome lot is assumed to be 46% impervious and the single-family lot is assumed to be 36% impervious. These assumptions are based on lot size and approximate building footprint with driveway access as shown in Appendix B. The roadways will be constructed of asphalt pavement with the City standard curb and gutter. The curb and gutters will convey storm water to catch basins, a storm pipe network, and ultimately to a regional detention facility. Exhibit D.03 in Appendix B shows a layout of the sub-basins for the sizing of the stormwater storage facilities and pipe conveyance.

As indicated, the Multi-Family development assessed the stormwater runoff from those improvements as well as anticipated south basin areas of this proposed subdivision in the report titled "Stormwater Engineering Report – Hillview Multi-Family Project" dated August 29, 2023. This report is included in Appendix A. The release rates from the Park Pond meet the pre-developed conditions. This report analyzes the release rate from the Intermediate Pond described in Section 4.4 of this report. The release rates from the Intermediate Pond are calculated as a factored flow rate from the approved design basin Sub-02. See Table 4.6.

Table 4.1: Intermediate Pond Sub-Basins

BASIN	AREA (SF)	AREA (AC)	COMPOSITE CURVE NUMBER	2-YR FLOW (cfs)	10-YR FLOW (cfs)	100-YR FLOW (cfs)
SO-40	16316.01	0.37	90.75	0.28	0.51	0.83
SO-41	53481.01	1.23	87.08	0.43	0.94	1.66
SO-42	78080.04	1.79	86.00	0.44	1.02	1.87
SO-43	177013.98	4.06	88.68	1.35	2.73	4.67
SO-44	55551.98	1.28	85.28	0.26	0.62	1.17
SO-45	44075.01	1.01	87.93	0.30	0.63	1.10
SO-46	95301.00	2.19	86.98	0.57	1.24	2.22
SO-47	271955.01	6.24	75.45	0.11	0.80	2.36
SO-48	418527.00	9.61	79.53	0.52	2.08	4.95
SO-49	221173.02	5.08	83.57	0.68	1.88	3.84
SO-50	143751.97	3.30	87.55	1.00	2.13	3.74
SO-51	83762.00	1.92	87.55	0.57	1.21	2.12
SO-52	251204.04	5.77	88.25	1.85	3.83	6.62
SO-53	75926.95	1.74	92.87	1.41	2.43	3.75
INT. TOTAL	1986119	45.60	86.25	9.77	22.05	40.90

Table 4.2: North Sub-Basins

BASIN	AREA (SF)	AREA (AC)	COMPOSITE CURVE NUMBER	2-YR FLOW (cfs)	10-YR FLOW (cfs)	100-YR FLOW (cfs)
NO-60	183117.96	4.20	86.83	1.01	2.23	4.00
NO-61	120576.00	2.77	87.84	0.83	1.74	3.06
NO-62	545186.07	12.52	87.05	3.01	6.57	11.82
NO-63	538171.05	12.35	84.00	1.66	4.19	8.33
NO-64	105990.02	2.43	86.22	0.88	1.92	3.45
NORTH TOTAL	1493041	34.28	86.39	7.39	16.65	30.66

Basis for the above curve numbers and time of concentration is provided in Section 3.2.3 of this report. See Appendix A, D.02 and D.03 for sub-basin flow paths and Appendix D for detailed calculations.

4.1 Run-On Stormwater

The South Basin includes approximately 22 acres of native vegetation stormwater run-on from the adjacent properties. The North Basin includes approximately seven acres of native vegetation stormwater run-on from the adjacent properties. It is not known that any of these properties have planned developments. It is expected that any developments on these properties will manage runoff on the respective property.

4.2 Conveyance

Stormwater runoff from the development is conveyed by curb and gutter and through a subsurface piping system. A pipe sizing analysis has been completed for the minor conveyance system based on the 10-year/24-hour event for the post development conditions with a full flow cleansing velocity of 2.5 feet per second. For the south basin the system conveys stormwater by gravity through pipes to a detention pond located east of Building E of the MF Development and ultimately to the park pond. The north basin conveys stormwater by gravity through pipes to a subsurface detention facility located north of Local A. Conveyance pipes that connect into the detention facilities are sized to accommodate the 100-year/24-hour storm to ensure stormwater from surcharged pipes is still routed to the storage facilities. The conveyance system is sized for the fully developed subdivision and has adequate capacity to accommodate. All conveyance meets the MCPWSS standard minimum and maximum velocity of 2.5 feet per second and a maximum velocity of 12 feet per second.

In storm events greater than the 10-year, 24-hour storm, the pipes will surcharge and the overflow volume will be detained in the curb and gutter and conveyed to the next downstream inlet. Pipes and inlets immediately upstream of the detention systems are sized to convey the 100-year/24-hour storm.

The project proposes that all storm infrastructure within public rights-of-way utilize City of Missoula standard catch basin structures. The storm main manholes will be 60-inch diameter. Missoula standard details STD-612-1 and STD-614 with combination curb inlet grates are utilized for the inlets. These combination curb inlets are analyzed for the 10-year and 100-year storm. See Appendix C for gutter spread calculations.

4.3 Water Quality

Stormwater runoff is proposed to be managed by proprietary pre-treatment methods. The design proposes using a Contech CDS pre-treatment unit for both the north subsurface storage facility and the intermediate pond of the south basin. These are designed to meet the BMP manual requirement to remove 80% TSS in the runoff volume.

4.4 Detention Basins

In order to control the increased runoff from the development detention basins and controlled outfalls are used. The park pond serves as the ultimate storage facility for the south basin, but the proposed design for the subdivision utilizes a second surface pond prior to the park pond. This pond is located east of Building E between the building and Rimel Road and allows more drainage area to be directed to the south basin. This additional area is captured in the "Intermediate Pond" and is released into the approved MF stormwater system. The outfall of the Intermediate Pond will attenuate each design storm to the designed flow rates of the approved MF Storm Design using an orifice and weir system. The stage storage of the facility is shown below in Table 4.3 with a total capacity of 46,181 cubic feet.

The North Storage Facility is a subsurface storage facility proposed to be five, 240-foot long, 7-foot diameter pipes. This facility is designed to be below grade due to the steep existing grades in the proposed storage location. The design proposes a 0.1% slope along the length of the pipes to drain towards the outlet structure and a minimum 4 feet of cover above the top of the pipes. With the outfall structure described in section 4.5 the storage facility will attenuate each of the design storms to the predeveloped rate. The stage storage of the facility is shown below in Table 4.4 with a total capacity of 46,181 cubic feet.

Table 4.3: Intermediate Pond Stage Storage

INTERMEDIATE POND STAGE STORAGE			
ELEVATION (FT)	CONTOUR AREA (SF)	INCREMENTAL VOL. (CF)	CUMULATIVE VOL. (CF)
3,511.50	12,973.07	N/A	0
3,512.00	13,931.68	6726.19	6726.19
3,513.00	15,891.31	14911.5	21637.68
3,514.00	17,907.49	16899.4	38537.08
3,515.00	19,980.22	18943.86	57480.94
3,516.00	22,109.50	21044.86	78525.8

Table 4.4: North Subsurface Stage Storage

NORTH SUBSURFACE STAGE STORAGE			
ELEVATION (FT)	DEPTH (FT)	INCREMENTAL VOL. (CF)	CUMULATIVE VOL. (CF)
3,479.22	N/A	N/A	0
3,480.22	1.00	4046.87	4046.87
3,481.22	2.00	6840.94	10887.81
3,482.22	3.00	8017.22	18905.04
3,483.22	4.00	8371.34	27276.38
3,484.22	5.00	8017.22	35293.60
3,485.22	6.00	6840.94	42134.54
3,486.22	7.00	4046.87	46181.41

The Intermediate Pond will be graded with a 10-foot wide access drive to the bottom of the pond for any required maintenance and the North Storage Facility will have manhole access for any required maintenance.

4.5 Outfall

Metering of the two detention systems is achieved through weirs and orifices. The two outfalls will attenuate each design storm to the pre-developed or approved MF design rate.

As mentioned in Section 4.0 the release rates of the Intermediate Pond are calculated by factoring the full Sub-02 basin from the MF Design. The rates are shown in the table below. The Intermediate Pond is proposed to have an 18-inch diameter pipe with a flared end section outfall the stormwater from the bottom of the pond into the outlet structure. The pipe has more than adequate capacity to convey the 100-year outfall flow from the ponds. The outlet structure will have a concrete baffle with two orifices and one weir. Each orifice will have the invert set at the 2-year and 10-year water surface elevations respectively. The crest of the weir will be set at the 100-year water surface elevation.

Table 4.6: Intermediate Pond Outfall Rates

Intermediate pond outfall							
					INTERMEDIATE POND OUTFALL		
	D.02 Total Area (SF)	Area To INT Pond	Area to Park Pond	% Difference	2yr reduced	10yr reduced	100 yr reduced
Sub-02	703662.01	479083	224579.01	0.681	1.86	5.69	11.85

The North Storage Facility will attenuate the three design storms with a similar structure. A 4-foot by 12-foot baffled concrete box structure with two orifices and a weir. As stated in Section 2.1 of this report the historic outfall rates for the 2-year, 10-year, and 100-year storms are 0.93cfs, 4.93cfs, and 16.20cfs, respectively.

In the event that a storm exceeds the 100-year rainfall an overflow opening and grate are designed for the both outfall structures. The Intermediate Pond has capacity to store an additional 21,045cf in the freeboard and any flow over the 100-year water surface elevation will enter the outlet structure and bypass the control baffle. The North Storage Facility provides an additional 5,050cf

of additional storage above the 100-year storm. Runoff exceeding the 100-year storm will occupy that volume and overflow the top of the baffle. In emergency situations the water can evacuate the outlet structure through a beehive grate and route to the north through the native grassed area, ultimately reaching Hillview Way.

Per the MCPWSS the storage facilities must drain completely in 72 hours or less. This is achieved in both, see the below figures for total pond discharge in each design storm. The total drain time is under 35 hours.

Figure 4.1: North Basin Discharge

Storm	Historic Discharge (cfs)	Offsite Runoff (cfs)	Storage Discharge (cfs)	Total Discharge (cfs)
100 yr max	16.20	1.35	14.82	16.17
10 yr max	4.93	0.39	4.46	4.85
2 yr max	0.93	0.02	0.88	0.90

Figure 4.2: 2-Year Intermediate Pond Storage Curve

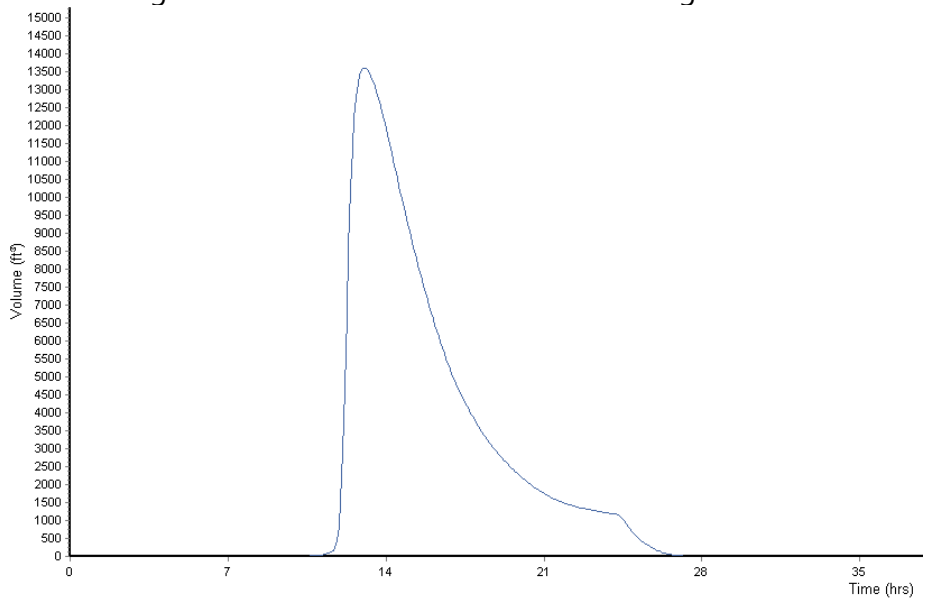


Figure 4.3: 10-Year Intermediate Pond Storage Curve

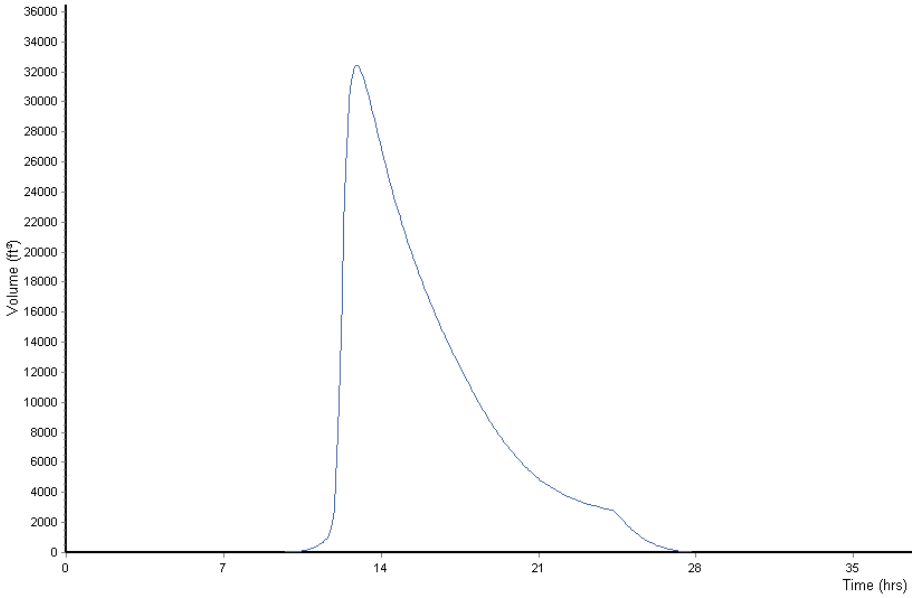


Figure 4.4: 100-Year Intermediate Pond Storage Curve

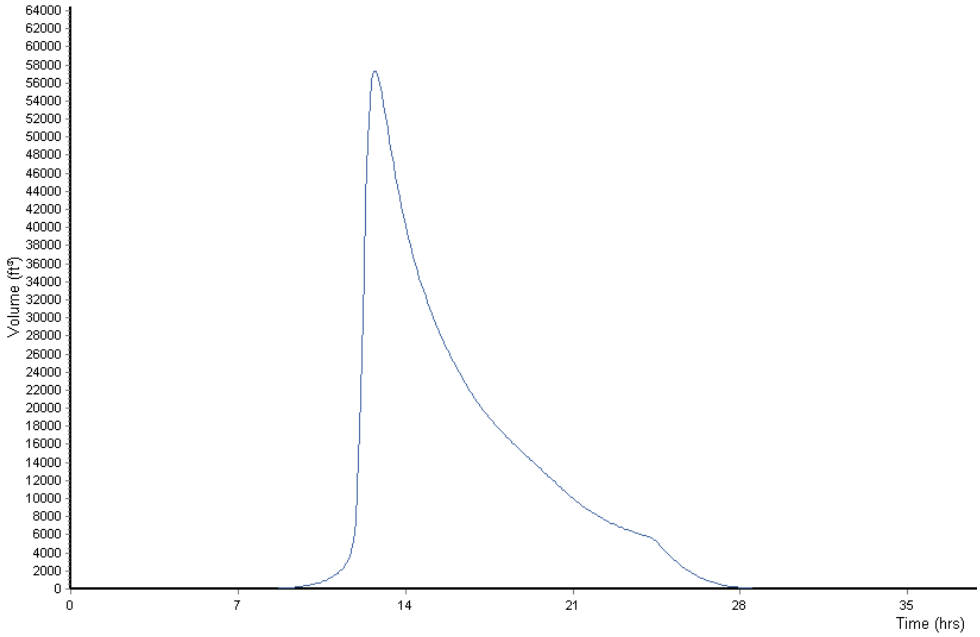


Figure 4.5: 2-Year North Subsurface Storage Curve

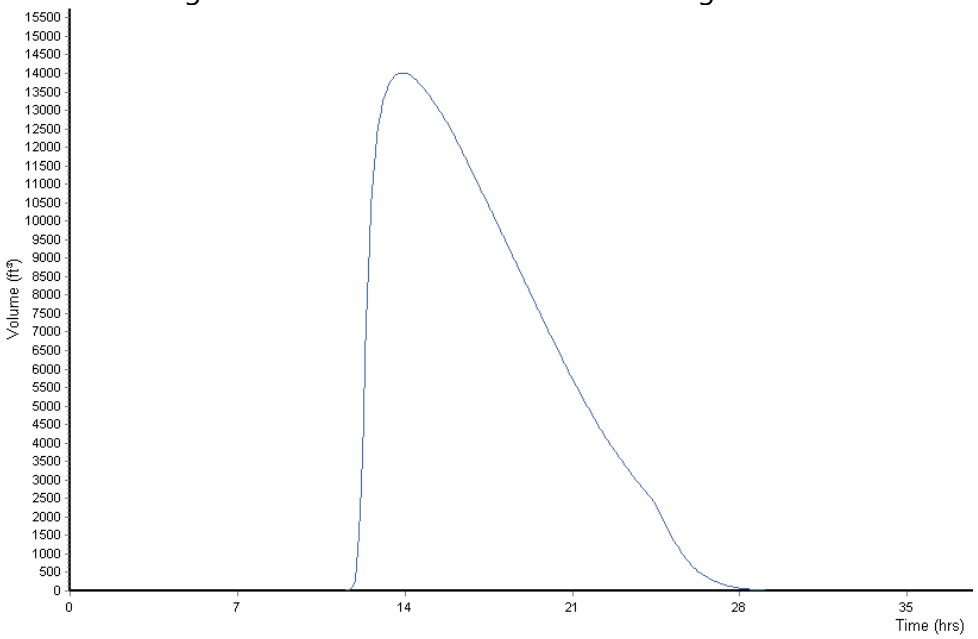


Figure 4.6: 10-Year North Subsurface Storage Curve

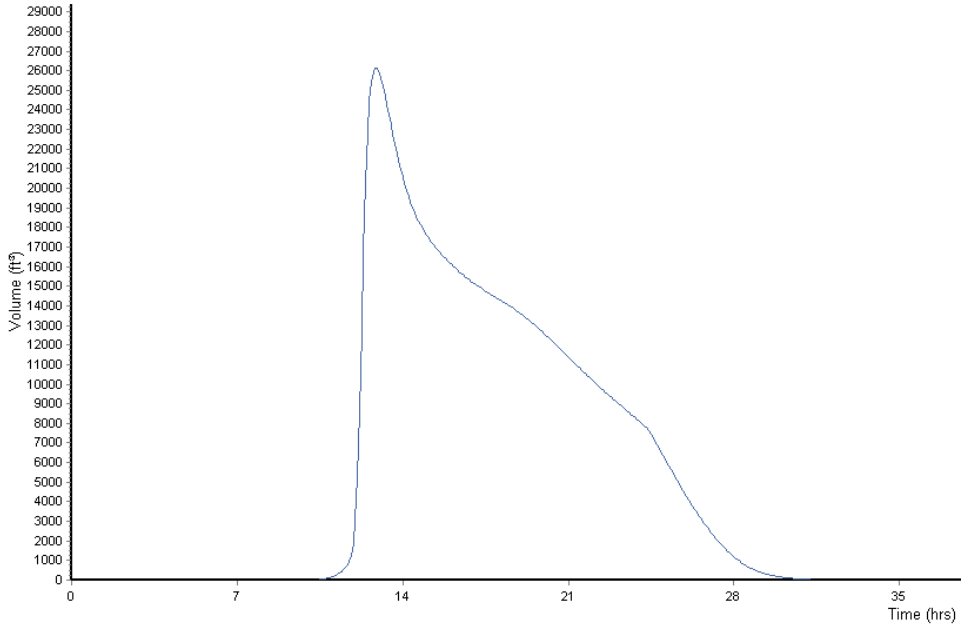
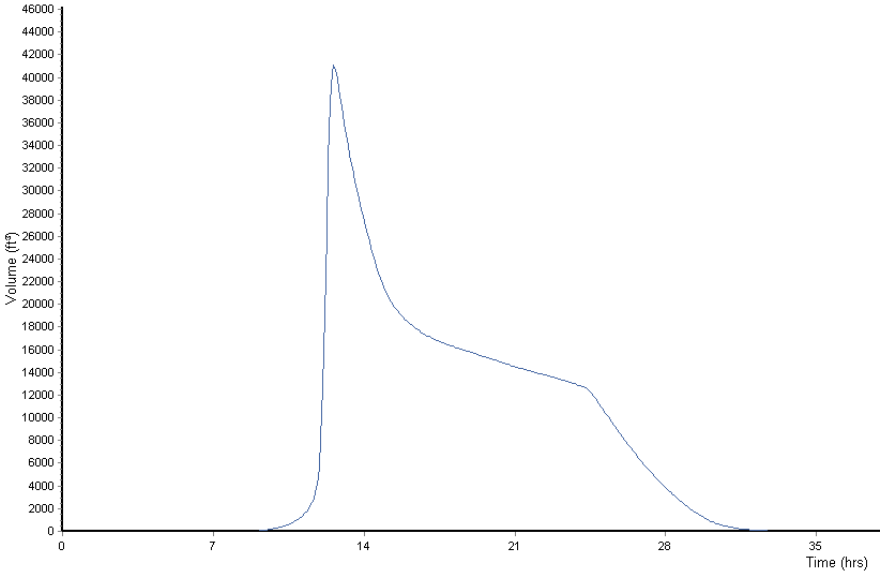


Figure 4.7: 100-Year North Subsurface Storage Curve



5.0 SUMMARY

In conclusion, the proposed stormwater design for the Wildroot Development meets the requirements of the City of Missoula and Montana Department of Environmental Quality. The design has analyzed the pre-development condition to establish a stormwater design solution utilizing pipe conveyance, detention storage, and controlled outfalls to attenuate the post-development runoff rate to the historical rate in each design storm event. In addition, the design mitigates downstream impacts by utilizing proprietary pre-treatment systems to allow for removal of sediment and debris prior to outfall, uses an impermeable storage facilities to prevent infiltration, and provides access to the storage facilities and outlet structures for maintenance.

6.0 OPERATIONS AND MAINTENANCE

6.1 Pavement Areas (Bi-Annual)

Parking area is to be swept twice annually to remove excess sediment. Recommended sweeping should take place once after spring melt and prior to May 1, and once after August 15 and prior to October 15.

6.2 Landscaping and Grounds Maintenance (Monthly)

Regular site maintenance should consist of removal of garbage and fallen debris from the parking lot on an as needed basis. Routine site maintenance will prevent debris from entering the storm water system and will improve storm water runoff quality over the long term.

6.3 Catch Basins/Manholes/Inlets

Each catch basin/inlet should be annually inspected to ensure that inlets and piping inverts are free from blockage. Clean as required, or at least every three years. Vacuum trucks are commonly utilized to remove sediments and debris from catch basins, manholes, and inlets.

6.4 Pipes

During annual inspections, the storm drain lines should also be examined to ensure that sediments are not impacting system performance. At a minimum, each structure should be cleaned out every three years or as required.

6.5 Outlet Structures (Bi-Annual)

Each storage facility outlet structure should be inspected and cleaned at a minimum twice per year. It is recommended the inspections and cleaning should take place once after spring melt and prior to May 1, and once after August 15 and prior to October 15. All orifices, weirs, and trash racks should be free of blockage. If custom fabricated weirs and orifices are used spares must be provided and stored onsite.

7.0 REFERENCES

- Missoula City Public Works Standards and Specifications Manual 2023
- Montana Public Works Standard Specifications (2010)
- Montana Post-Construction Storm Water BMP Design Guidance Manual (2017)
- City of Missoula Standard Modifications to MPWSS
- Montana Department of Environmental Quality Circular DEQ-8 Montana Standards for Subdivision Storm Water Drainage (2017)

Cushing Terrell

Appendix A: Background Data

National Flood Hazard Layer FIRMette

FEMA

114°1'44"W 46°49'35"N

114°1'6"W 46°49'11"N

Feet

0 250 500 1,000 1,500 2,000

1:6,000

Basemap: USGS National Map: Orthoimagery: Data refreshed October, 2020

Legend

SEE FIS REPORT FOR DETAILED LEGEND AND INDEX MAP FOR FIRM PANEL LAYOUT

SPECIAL FLOOD HAZARD AREAS
- Without Base Flood Elevation (BFE) *Zone A, V, A99*
- With BFE or Depth *Zone AE, AO, AH, VE, AR*
- Regulatory Floodway

OTHER AREAS OF FLOOD HAZARD
- 0.2% Annual Chance Flood Hazard, Areas of 1% annual chance flood with average depth less than one foot or with drainage areas of less than one square mile *Zone X*
- Future Conditions 1% Annual Chance Flood Hazard *Zone X*
- Area with Reduced Flood Risk due to Levee. See Notes. *Zone X*
- Area with Flood Risk due to Levee *Zone D*

OTHER AREAS
- NO SCREEN Area of Minimal Flood Hazard *Zone X*
- Effective LOMRs
- Area of Undetermined Flood Hazard *Zone D*

GENERAL STRUCTURES
- Channel, Culvert, or Storm Sewer
- Levee, Dike, or Floodwall

OTHER FEATURES
- 20.2 Cross Sections with 1% Annual Chance
- 17.5 Water Surface Elevation
- Coastal Transect
- 513 Base Flood Elevation Line (BFE)
- Limit of Study
- Jurisdiction Boundary
- Coastal Transect Baseline
- Profile Baseline
- Hydrographic Feature

MAP PANELS
- Digital Data Available
- No Digital Data Available
- Unmapped

N

The pin displayed on the map is an approximate point selected by the user and does not represent an authoritative property location.

This map complies with FEMA's standards for the use of digital flood maps if it is not void as described below. The basemap shown complies with FEMA's basemap accuracy standards

The flood hazard information is derived directly from the authoritative NFHL web services provided by FEMA. This map was exported on 3/9/2021 at 11:02 AM and does not reflect changes or amendments subsequent to this date and time. The NFHL and effective information may change or become superseded by new data over time.

This map image is void if the one or more of the following map elements do not appear: basemap imagery, flood zone labels, legend, scale bar, map creation date, community identifiers, FIRM panel number, and FIRM effective date. Map images for unmapped and unmodernized areas cannot be used for regulatory purposes.

U.S. Fish and Wildlife Service
National Wetlands Inventory

Hillview - National Wetland Inventory Map

March 9, 2021

Wetlands

- Estuarine and Marine Deepwater
- Estuarine and Marine Wetland
- Freshwater Emergent Wetland
- Freshwater Forested/Shrub Wetland
- Freshwater Pond
- Lake
- Other
- Riverine

R5.4 Slopes Table				
Number	Minimum Slope	Maximum Slope	Area (AC)	Color
1	0.00%	15.00%	52.22	
2	15.00%	20.00%	5.55	
3	20.00%	25.00%	1.50	
4	25.00%	100.00%	0.13	

RM0.5 Slopes Table				
Number	Minimum Slope	Maximum Slope	Area (AC)	Color
1	0.00%	15.00%	11.01	
2	15.00%	20.00%	4.71	
3	20.00%	25.00%	4.48	
4	25.00%	100.00%	3.85	

RM1.35 Slopes Table				
Number	Minimum Slope	Maximum Slope	Area (AC)	Color
1	0.00%	15.00%	16.15	
2	15.00%	20.00%	1.95	
3	20.00%	25.00%	2.18	
4	25.00%	100.00%	2.20	

NOTE: THIS PLAN DEPICTS EXISTING GRADE CONTOURS AT 5' CONTOURS INTERVALS.

NORTH

1 X001 SLOPE ANALYSIS

0 75 150 300

SCALE: 1" = 150'

Cushing Terrell.

cushingterrell.com
800.757.9522

MISSOULA, MONTANA
WILDROOT

EXHIBIT

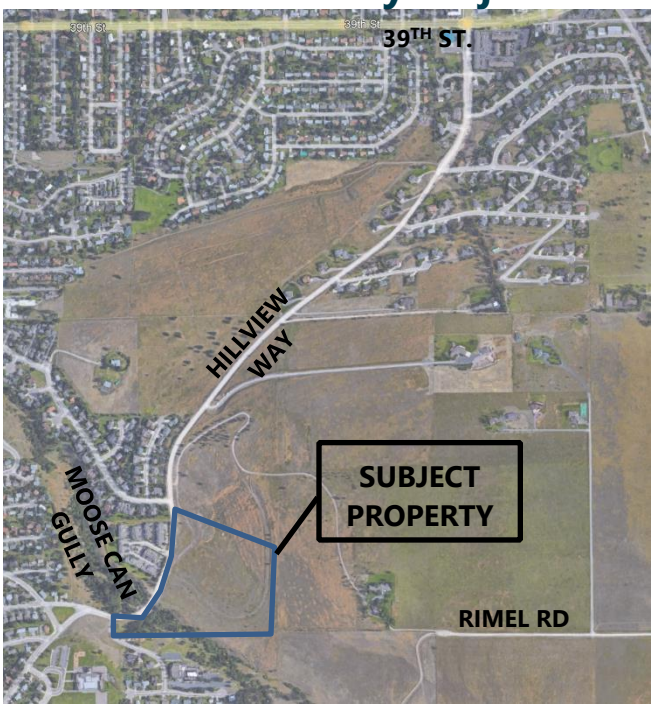
12.05.2023
DRAWN BY | MAHONEY
CHECKED BY | MASCIA
REVISIONS

NOT FOR CONSTRUCTION - EXHIBIT

SLOPE ANALYSIS

X001

STORMWATER ENGINEERING REPORT
Hillview Multi-Family Project



Moose Can Gully - Hillview Way,
Missoula, Montana 59803

Owner/Developer:

PANDO

Kiely Wilson and Lance Gutsch
Pando Holdings
205 Detroit Street, Suite 200
Denver, CO 80206

Engineer:

Cushing Terrell

Sean Mascia, PE
Cushing Terrell

306 Railroad St W #104
Missoula, MT 59802
406.728.9522
www.cushingterrell.com

Cushing Terrell Project No. HILLVIEW_MF
August 29, 2023

MONTANA
SEAN MASCIA
No. 72547
PROFESSIONAL LICENSED ENGINEER
08/29/2023

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APPENDICES

1.0 INTRODUCTION

The Hillview Multi-Family project is a proposed 204-unit multi-family development with 5 separate buildings to be located on a 23.84 acre parcel legally described as Tract C-G-1 of COS 2412 (Parcel IV). The property is wholly located within the City of Missoula limits.

The property lies within an existing 63-acre drainage basin. The proposed stormwater system is designed to collect, treat and detain stormwater runoff from the proposed multi-family development as well as a future adjacent residential subdivision located partially within the 63-acre drainage basin. While a future study and design will address stormwater management for the full proposed subdivision it is necessary to evaluate the portion planned within this drainage basin to provide the necessary detention and stormwater treatment as the planned "regional" detention facility is located on the multi-family property.

The following references were used in the stormwater drainage design.

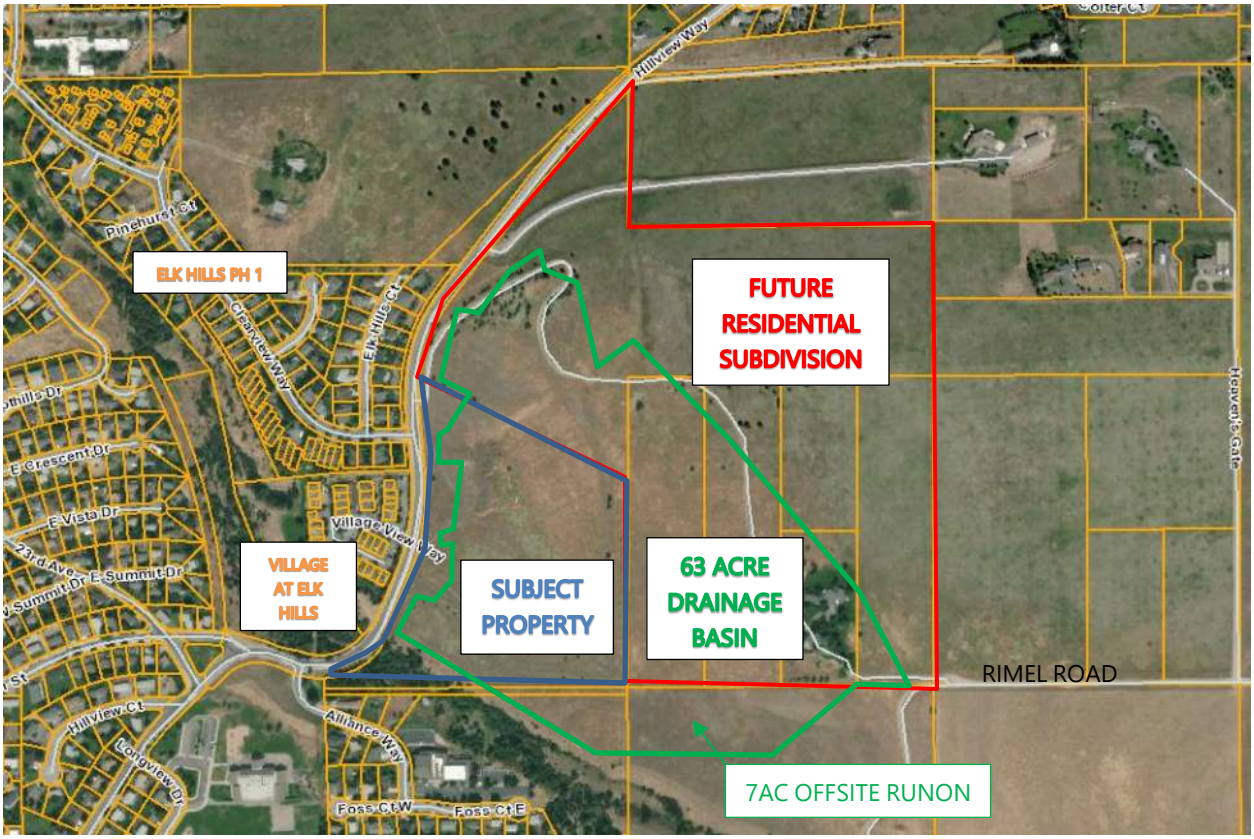
- Missoula City Public Works Standards and Specifications Manual (MCPWSS)
- Montana Post-Construction Storm Water BMP Design Guidance Manual (BMP Manual)
- Montana Public Works Standard Specifications and City of Missoula Standard Modifications to MPWSS (MPWSS)
- MTDEQ Circular No. 8 (DEQ-8)

1.1 Location

The property is bound to the west by Hillview Way, the south by Moose Can Gully, and the east/north by undeveloped land.

Figure 1.1: Overall Location Map

Figure 1.2: Detailed Location Map



1.2 Description of Property

1.2.1 Area

The subject property in total is 23.84 acres. However, this report focuses on the southern drainage basin of approximately 63 acres, including 7 acres of offsite run-on.

1.2.2 Ground Cover

The existing ground cover is primarily native grasses and sparse trees. There is an existing residence within the 63-acre drainage basin comprising approximately 4-acres. For analysis purposes this 4-acres was conservatively assumed to match pre-developed grassland conditions.

1.2.3 Land Uses

The 23.84-acre tract for the proposed multi-family development is currently undeveloped and unused property. Except for the approximately 4-acre residence the remaining property within the 63-acre drainage basin is undeveloped and unused.

The portion east and north of the proposed multi-family is intended for a future residential subdivision consisting of town home and single-family lots. This is described in more detail through

the report as the proposed stormwater management system for the multi-family development is sized for this future development.

1.2.4 Topographic Features and Slopes

Topography ranges from slopes of 0-25 percent with a total elevation gain of approximately 213 feet from the elevation at Hillview Way to the highest point of the drainage basin. A topographic map with slope delineation is included in Appendix A.

1.2.5 Drainage Ways and Receiving Channels

The only defined drainage way is Moose Can Gully which intersects the southwest corner of the subject property. The outfall for the property and the 63-acre basin is currently directly to Hillview Way where it is captured in storm inlets and directed to Moose Can Gully just downstream of Hillview Way. The proposed outfall from the detention facility will maintain this drainage pattern with a direct connection to an existing stormwater inlet in Hillview Way.

1.2.6 Existing Drainage Facilities

There are no existing drainage facilities on the subject property or drainage basin. The existing drainage facility in Hillview Way is City of Missoula owned storm catch basins and associated HDPE piping to the outfall at Moose Can Gully. The City storm pipe that the project proposes to connect to is a 24" diameter HDPE pipe at 0.50% slope.

1.2.7 Flood Hazard Zones

The entire subject property is located in Zone X as defined on FEMA Flood Map 30063C1460E. Zone X is described as 0.2% annual chance flood hazard.

1.2.8 Irrigation Ditches

There are no irrigation ditches within or near the subject property.

1.2.9 Geologic Features

See Appendix A for the geotechnical investigation excerpts from the report prepared by Lorenzen Soil Mechanics, Inc. titled, *"Hillview Subdivision Geotechnical Engineering Report"* dated March 20, 2022.

The material is consistent across the project and consists of cobbles, gravel, sand, silt, clay, and volcanic ash deposits. The report indicates very high infiltration rates which are consistent with known information provided from the city and adjacent developments.

The report does not indicate the presence of groundwater in the project area. In the nine test pits excavated to depths between 7.5 and 8.5 feet below ground surface groundwater was not encountered. The report indicates the shallowest groundwater in a nearby well log to be 317 feet below ground surface. See Appendix E for Geotechnical report.

The City of Missoula has communicated deeper geological concerns in this area that impact the overall drainage design. At areas deeper than what was evaluated in the geotechnical report, clay lenses exist that have transmitted infiltrated stormwater downgradient in a manner that has negatively impacted those downgradient properties. As a result, the detention ponds associated with the proposed design will be lined to prevent infiltration of stormwater.

Wetlands within the property are located in Moose Can Gully. The wetlands will not be impact by the proposed project.

The NRCS Soils Report indicates hydrologic soil groups B and C with the majority of the subject property being group C.

1.3 Previous Drainage Studies

No known previous drainage studies exist for the subject property. The City of Missoula could not provide a report for the Hillview Way storm drain system. However, there are no known issues with the capacity of the system or downstream impacts in the existing condition.

1.4 General Project Description

The Hillview Multi-Family project is a proposed 204-unit multi-family development with 5 separate buildings to be located on a 23.84 acre parcel legally described as Tract C-G-1 of COS 2412 (Parcel IV). The property is wholly located within the City of Missoula limits.

The property lies within an existing 63-acre drainage basin. The proposed stormwater system is designed to collect, treat and detain stormwater runoff from the proposed multi-family development as well as a future adjacent residential subdivision located partially within the 63-acre drainage basin. While a future study and design will address stormwater management for the full proposed subdivision it is necessary to evaluate the portion planned within this drainage basin to provide the necessary detention and stormwater treatment as the planned "regional" detention facility is located on the multi-family property.

1.5 State or Federal Regulations

Work on the project will fall under the requirements of the MPDES stormwater general permit as administrated by the City of Missoula which is an MS4. No other state or federal stormwater or wetland regulations apply.

1.6 Geotechnical Report

The geotechnical report is included in Appendix E of this Report.

2.0 EXISTING SITE CONDITIONS

2.1 Major Basin Description

See Section 1 for information regarding drainage studies, flood hazard areas, land uses, and ground cover characteristics.

The full property consists of two drainage basins as shown on Figure D.01 located in Appendix B. The north basin, HIST-01 drains to the north on Hillview Way. Basin HIST-01 is not analyzed as a part of this report because the project does not propose any construction activities to that basin. The south basin, HIST-02 is the basin of interest for this report.

HIST-02 is approximately 64-acres, 7 acres of which is offsite run-on from the property to the south. The slopes of this basin range from 0-25% primarily flowing from the east to the west. The following tables describe the basin runoff rate for the 2-year, 10-year, and 100-year storm event. See Section 3 for curve number determination and hydrologic method.

Table 2.1: 2-Year, 24-Hour Peak Runoff

BASIN	CN	Tc (h:mm:ss)	Tc (hr)	AREA (SF)	10-YR P (IN)	S	Ia (IN)	Ia/P	Q (IN)	qu (csm/in)	Am (SQ MI)	Fp	qp (CFS)
HIST-02A	67.89	0:32:39	0.54	1646594	1.17	4.73	0.585	0.500	0.01	225	0.059	1	0.13
HIST-02B	66.85	0:07:13	0.12	1147228	1.17	4.96	0.585	0.500	0.01	490	0.041	1	0.12
													0.26

Table 2.2: 10-Year, 24-Hour Peak Runoff

BASIN	CN	Tc (h:mm:ss)	Tc (hr)	AREA (SF)	10-YR P (IN)	S	Ia (IN)	Ia/P	Q (IN)	qu (csm/in)	Am (SQ MI)	Fp	qp (CFS)
HIST-02A	67.89	0:32:39	0.54	1646594	1.66	4.73	0.830	0.500	0.09	225	0.059	1	1.24
HIST-02B	66.85	0:07:13	0.12	1147228	1.66	4.96	0.830	0.500	0.08	490	0.041	1	1.60
													2.84

Table 2.3: 100-Year, 24-Hour Peak Runoff

BASIN	CN	Tc (h:mm:ss)	Tc (hr)	AREA (SF)	10-YR P (IN)	S	Ia (IN)	Ia/P	Q (IN)	qu (csm/in)	Am (SQ MI)	Fp	qp (CFS)
HIST-02A	67.89	0:32:39	0.54	1646594	2.28	4.73	0.946	0.415	0.29	350	0.059	1	6.07
HIST-02B	66.85	0:07:13	0.12	1147228	2.28	4.96	0.992	0.435	0.27	660	0.041	1	7.21
													13.28

The geotechnical report indicates high infiltration rates for the soils, particularly at depth, but also at the existing grade. The City of Missoula has experienced issues with infiltrated stormwater causing downgradient impacts and has communicated that a minimal amount of infiltration of post-development runoff will be allowed.

2.2 Sub-Basin Description

Drainage basin HIST-02 was split into two sub-basins, HIST-02A and HIST-02B to refine the time of concentration for the basin and route the upper sub-basin (HIST-02A) through the lower sub-basin (HIST-02B).

2.3 Groundwater

The geotechnical report did not identify any groundwater within the subject property.

2.4 Waterways and Wetlands

See Section 1.2.5 for information regarding drainage ways and Section 1.2.9 for wetlands.

3.0 STORMWATER DESIGN CRITERIA

3.1 Design Concepts

This first stage of this development (multi-family) is located at the bottom of the drainage basin with future development planned for the top of the drainage basin. Stormwater runoff will be conveyed overland in its existing condition for this upper basin area with future plans to capture and convey that stormwater to the lower basin via inlets and storm drains.

The multi-family area run-off is capture via inlets and storm drains and ultimately routed to a larger regional detention facility at the bottom of the basin. Two smaller onsite detention basins are included within the landscape area between Buildings A and B to reduce the overall detention volume requirement at the regional facility. The regional facility is sized for the future development on the upstream of the basin as well as provides stormwater quality treatment for the full planned future development of the basin.

Due to issues in this area of Missoula with infiltrated groundwater intercepting clay lenses and then resurfacing downgradient, the detention basins will be lined with an HDPE liner to prevent infiltration in the ponds.

3.2 Drainage Criteria

Autodesk's Sanitary Sewer and Storm Analysis (SSA) Version 2020 was utilized to model the site hydrology under pre and post-development conditions.

3.2.1 Application Standards or Exceptions

Site storm drainage improvements are designed to comply with the MCPWSS, BMP Manual, and DEQ-8.

3.2.2 Minor and Major Storm Frequencies

Per the MCPWSS the minor storms shall be the 2-year and 10-year, 24-hour storm events and the major storm shall be the 100-year, 24-hour event. All curbs, gutters, swales, and open channels are designed to accommodate the minor storms and all detention facilities have been designed to manage the major storm.

3.2.3 Hydrologic Methods

The storm drainage system is sized for the three storm events utilizing the SCS TR-55 Method. Utilizing this method, peak runoff rates and flow control volumes were calculated. MCPWSS was used for a design precipitation depth of 2.28 inches for the 100-year event, 1.66 inches for the 10-year event, and 1.17 inches for the 2-year event . The storm distribution is a Type-II, 24-hour storm.

Figure 3.1: 10-YR Storm

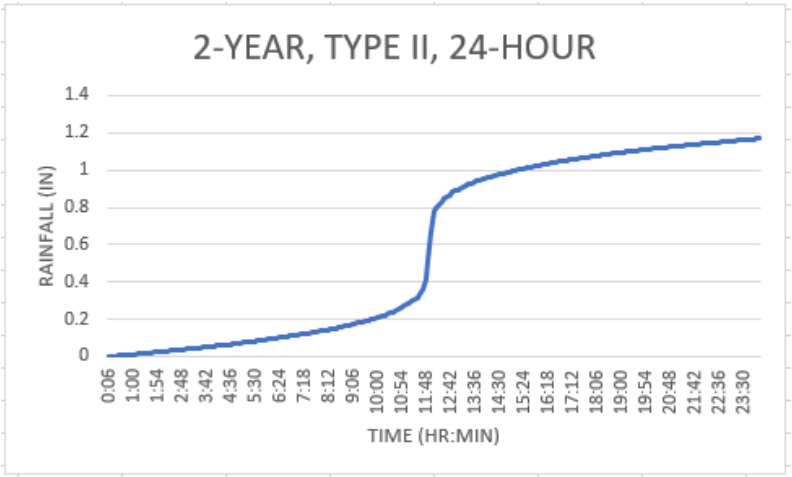


Figure 3.1: 10-YR Storm

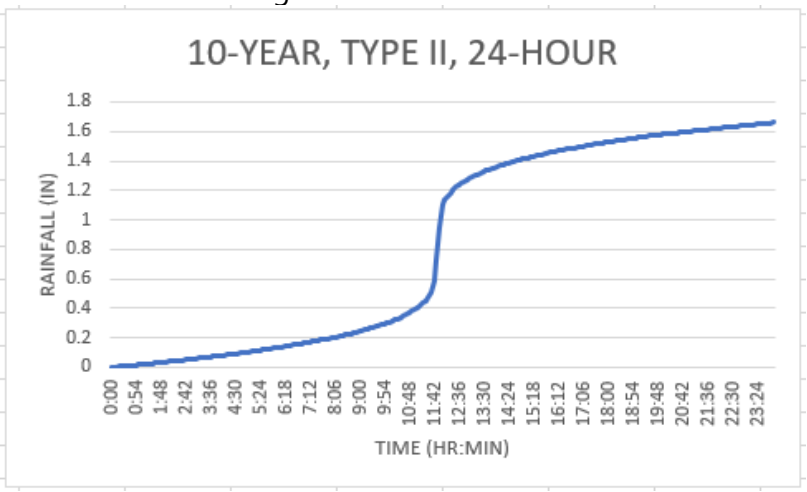


Figure 3.2: 100-YR Storm

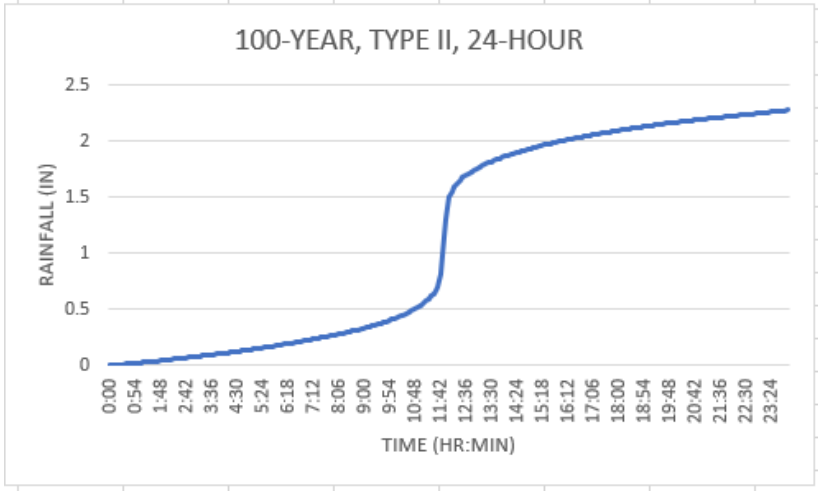


Table 3.1 shows the selected runoff coefficients for both the pre- and post-development conditions. See Table 4.1 and Appendix B for weighted curve numbers.

Table 3.1: Runoff Coefficients

DESCRIPTION	**SOIL GROUP**	**Curve Number**	**NOTES**
Impervious Area	B	98	Roof / Parking
Landscape	B	69	50 - 75% grass cover, Fair
Native	B	61	Pasture, grassland, or range, Good
Native	C	74	Pasture, grassland, or range, Good

Water quality volumes and pre-treatment methods were determined using the BMP Manual equation and confirmed using the DEQ-8 water quality spreadsheet. Volumes are determined from the first 0.5 inch of rainfall on impervious areas.

$$RRV = \frac{PR_vA}{12}$$

Where:

RRV= Runoff Reduction Volume (ac-ft)
P = Water Quality Rainfall Depth (0.5 inches)
R_v = Dimensionless Runoff Coefficient, $R_v = 0.05 + 0.9(I)$
I = Percent Impervious Cover Draining to the Facility (decimal)
A = Site Drainage Area (ac)

Table 3.2: Water Quality Volume

P (in)	% Imp.	Rv	Area (ac)	Runoff Reduction Volume (ac-ft)	RRV (cf)	Forebay Treatment vol (cf)
0.5	0.291	0.312	62.69	0.82	35537	3554

Time of concentration values were calculated using the SCS TR-55 method. The SCS TR-55 method uses a summation of sheet flow, shallow flow and channelized flow to calculate a total time of concentration. Detailed time of concentration calculations for every sub-basin/basin are included in Appendix D and shown graphically on exhibit D.01. The following criteria were used for calculating time of concentration:

- Minimum total time of concentration was set to 5 minutes in the model
- Maximum sheet flow length of 300'
- Native Vegetation Manning's = 0.13
- Asphalt sheet flow Manning's = 0.012
- Landscape sheet flow Manning's= 0.4

3.2.4 Hydraulic Methods

Storm sewer pipes were sized using Manning's equation for open channel flow with flow rates from the SCS TR-55 hydraulic model. Per the MCPWSS, storm sewer pipes were sized for the 10-year, 24-hour event to maintain a minimum pipe velocity of 2.5 feet per second. See Appendix C for individual pipe calculations.

Rip rap will serve to provide outlet protection where there are point discharges into the MF Ponds. The rip rap size is confirmed using the Federal Highway Administration (FHWA) equation for culvert outlet rip rap. Due to low velocities in the 10-year event the rip rap size of 3"-8" washed rock specified in the plans is more than sufficient.

The pond outlet weirs and orifice were designed with the following equations.

Weir

$$Q = \frac{2}{3} C_d \sqrt{2g} L H^{\frac{3}{2}}$$

$$C_d = 0.602 + (0.075 * \frac{H}{P})$$

Orifice

$$Q = C_d A \sqrt{2gh}$$

Where:

Q = Discharge (cfs)
C = Discharge Coefficient (weir)
L = Length of Crest (ft)
H = Depth of flow above crest (ft)
C_d = Discharge Coefficient (orifice)
A = Cross-Sectional Area (sf)
g = Gravity Constant (ft/sec^2)
h = Depth to centerline of orifice (ft)

The following discharge coefficients were used

- Sharp-crested rectangular weir (see calculations)
- Orifice = 0.614

Refer to Appendix C for detailed hydraulic calculations.

3.3 Down-Gradient Analysis

It is known that there have been issues with infiltrated stormwater causing down gradient problems due to infiltrated stormwater being intercepting by clay lenses and then resurfacing downgradient. As a result, the proposed design does not infiltrate stormwater and, therefore, does not contribute to any down gradient problems. This is achieved through capturing and routing runoff to HDPE lined detention ponds. There are currently no known issues down gradient in the city storm drain or in the ultimate outfall location of Moose Can Gully. The proposed design

matches the historic runoff peak flow rate and utilizes pre-treatment to avoid any down gradient water quality impacts.

3.4 Analysis Points

The stormwater design was analyzed as an entire basin and as individual sub-basins. The analysis evaluated the South Basin at the outfall location of the Park Pond. It also evaluated the individual sub-basins at each individual outfall location.

4.0 PROPOSED DESIGN

The proposed site includes five multi-family apartment buildings with associated paving and landscaping. The stormwater design for the project anticipates the future subdivision beyond the subject property. This portion of the South Basin includes, approximately, 63 small (6,000-8,000 SF) single-family lots and 56 townhome lots (4,000 SF). For design purposes the small single-family lots are assumed to be 36% impervious and the townhome lots are assumed to be 46% impervious. The roadways will be constructed of asphalt pavement with the City standard curb and gutter. The curb and gutters will convey storm water to catch basins, a storm pipe network, and ultimately to a regional detention pond. Exhibit D.02 in Appendix B shows a layout of the assumed sub-basins for the sizing of the storm pond and pipe conveyance.

The proposed site development will increase the amount of impervious surface area such as asphalt, concrete, and building rooftops that will in turn generate a higher volume of runoff. Per the City of Missoula standards, the subdivision will utilize a regional impermeable detention pond for Hillview Multi-Family and a portion of the future subdivision, to mitigate the effects of the increased runoff rates and volumes. The following table shows the design information for the sub-basins of the South Outfall Basin. See Appendix B, D.01 for a detailed exhibit of the basins.

Table 4.1: South Basin Sub-Basins

BASIN	AREA (SF)	AREA (AC)	COMPOSITE CURVE NUMBER	TIME OF CONCENTRATION (h:mm:ss)	2-YR FLOW (cfs)	10-YR FLOW (cfs)	100-YR FLOW (cfs)
Sub-01	613793.03	14.09	72.10	0:39:51	0.04	1.02	3.96
Sub-02	703662.01	16.15	80.90	0:13:38	0.16	8.36	17.40
Sub-03	65572.00	1.51	86.05	0:06:25	0.29	1.43	2.59
Sub-03A	64347.01	1.48	65.81	0:14:19	0.00	0.02	0.31
Sub-04	69817.01	1.60	83.35	0:06:38	0.21	1.19	2.31
Sub-05	64419.01	1.48	84.80	0:06:38	0.25	1.25	2.35
Sub-06	311709.00	7.16	71.75	0:16:14	0.03	0.84	3.31
Sub-07	199074.99	4.57	71.54	0:16:28	0.03	0.51	2.05
Sub-08	25182.99	0.58	78.82	0:05:00	0.12	0.27	0.63
Sub-09	266827.00	6.13	77.89	0:16:13	0.11	2.11	5.03
Sub-10	249310.00	5.72	83.23	0:19:13	0.21	3.31	6.48
Sub-11	6205.99	0.14	90.75	0:05:00	0.47	0.20	0.32
SUB-12	31566.02	0.72	69.00	0:05:00	0.01	0.07	0.31
SUB-A	8065.00	0.19	98.00	0:05:00	0.95	0.40	0.56
Sub-OFF1	21285.99	0.49	75.80	0:05:00	0.08	0.16	0.41
Sub-OFF2	30023.99	0.69	67.66	0:05:00	0.00	0.04	0.26
South TOT	2730861	62.69	78.59		2.96	21.18	48.28

Basis for the above curve numbers and time of concentration is provided in Section 3.2.3 of this report. See Appendix A, D.02 for sub-basin flow paths and Appendix D for detailed calculations.

4.1 Run-On Stormwater

The South Basin includes approximately seven acres of native vegetation from the adjacent property. Two of the seven acres is owned by the Christian Missionary Alliance Church and the

additional five acres is owned by the John A Rimel Family Trust. It is not known that either of these properties have planned developments. It is expected that any developments on these properties will manage runoff on the respective property. The historical 100-year, 10-year, and 2-year 24-hour storm run-on from these seven acres is 2.19 cubic feet per second, 0.52 cubic feet per second, and 0.03 cubic feet per second, respectively.

4.2 Conveyance

Stormwater runoff from the site is conveyed through a subsurface piping system. A pipe sizing analysis has been completed for the minor conveyance system based on the 10-year/24-hour event for the post development conditions with a full flow cleansing velocity of 2.5 feet per second (See Appendix D for model calculations). The system conveys stormwater by gravity through pipes to the south side of the property where a detention pond will be constructed. The conveyance system is sized for the future developed subdivision and has adequate capacity to accommodate. See Appendix D for pipe sizing calculations. All conveyance meets the MCPWSS standard minimum and maximum velocity of 2.5 feet per second and a maximum velocity of 12 feet per second.

In storm events greater than the 10-year, 24-hour storm, the pipes within the Multi-Family development will surcharge and the overflow volume will be detained in the parking lot and landscape areas then slowly discharged to park pond. All building finished floor elevations are set above the 100-year water elevation.

The project proposes that all storm infrastructure within Collector A utilize City of Missoula standard catch basin structures. The south side of Collector A will serve as the storm drain main with laterals from the north side of the road connecting into the south side manholes. The main manholes will be 60-inch diameter. Missoula standard details STD-612-1 and STD-614 with combination curb inlet grates are utilized for the Collector A storm main. These combination curb inlets are analyzed for the 10-year and 100-year storm. See Appendix C for gutter spread calculations. The 100-year runoff rate for each respective tributary area (approximately 8000 square feet) is 0.54cfs. During this event 0.07cfs bypasses the inlet. Therefore, the subsequent curb inlet receives 0.61cfs in the 100-year storm and bypasses 0.07cfs. At the bottom of Sub-02 an additional two curb inlets are proposed approximately 40 feet up hill from the final two curb inlets. This allows for STCI-01 and STCI-02 to capture all flow in the 100-year event with no bypass. See Appendix B, Exhibit D.02 for inlet information. In addition, all pipes in Collector A can convey the 100-year storm. Therefore, the storm system in Collector A will have more than adequate capacity and will not have any bypass flow reaching Hillview Way in the 100-year storm. In a storm event greater than the 100-year storm, the runoff will flow down the collector and into the Hillview Way curb and gutter where it will ultimately discharge to Moose Can Gully.

4.3 Water Quality

Stormwater runoff is proposed to be managed by a detention pond pre-treatment forebay per the BMP Manual. The manual recommends the pre-treatment forebay be 4-6 feet deep and store 10% of the runoff reduction volume (RRV). See Table 3.2 for the pre-treatment volume and table

4.2 for forebay stage storage. The forebay will be armored with a concrete bottom to facilitate removal of sediment on a regular maintenance schedule.

In order to increase sedimentation settlement, the flow path from the inlet to the outlet of the forebay is maximized. The earthen berm is 4 feet maximum and a standpipe outlet structure will be installed in the side slope of the forebay. The standpipe structure is designed to have five rows of orifices to discharge the forebay at 2% of the 100-year un-detained peak discharge. The standpipe structure will discharge into the main bay of the detention pond where the flow will be conveyed to the pond outfall by a concrete trickle channel at 0.50% slope. This BMP method is described in the BMP manual as a method to remove 80% TSS in the runoff volume.

Table 4.2: Forebay Stage Storage

PARK POND FOREBAY STAGE STORAGE			
ELEVATION (FT)	CONTOUR AREA (SF)	INCREMENTAL VOL. (CF)	CUMULATIVE VOL. (CF)
3,435.00	1,870.97	N/A	0
3,436.00	2,422.35	2140.73	2140.73
3,436.75	2,882.51	1986.82	4127.56

4.4 Detention Basin

The proposed design utilizes a connected system of three impermeable (to prevent infiltration) detention ponds. Two smaller ponds, North MF Pond and South MF Pond, lie within the Multi-Family development. The larger Park Pond will be constructed on the south side of Collector A adjacent to the future public park. The two MF ponds serve to slow the time of concentration to the Park Pond by capturing runoff from Sub-06 and Sub-07 and metering the outflow to the Multi-Family Storm Main through rectangular weirs (see Section 3.5).

The Park Pond will attenuate each design storm to less than the pre-development discharge (see Figure 4.1). Per the MCPWSS the pond must detain the 100-year volume with a minimum 1 foot of freeboard. The proposed Park Pond achieves this. However, the MF ponds maintain less than 1' of freeboard in the 100-year event. Since these ponds are in succession any overflow will be conveyed to the Park Pond through curb and gutter and pipe conveyance. The required storage volume of the North MF Pond, South MF Pond, and Park Pond is 1866cf, 3510cf, and 38,796cf, respectively, for the 100-year event. See the tables below for stage storage of each pond. The Park Pond volume includes the water quality volume.

Table 4.3: North MF Pond Stage Storage

NORTH MF POND STAGE STORAGE			
ELEVATION (FT)	CONTOUR AREA (SF)	INCREMENTAL VOL. (CF)	CUMULATIVE VOL. (CF)
3,442.00	61.29	N/A	0
3,443.00	211.8	129.01	129.01
3,444.00	536.6	361.84	490.86
3,445.00	961.48	316.49	1028.43
3,446.00	1,445.63	1195.36	2223.78

Table 4.4: South MF Pond Stage Storage

SOUTH MF POND STAGE STORAGE			
ELEVATION (FT)	CONTOUR AREA (SF)	INCREMENTAL VOL. (CF)	CUMULATIVE VOL. (CF)
3,439.50	37.64	N/A	0
3,440.00	79.14	28.56	28.56
3,440.50	210.15	69.71	98.27
3,441.00	343.87	137.14	235.41
3,442.00	715.90	518.65	754.06
3,443.00	1,283.12	985.82	1739.87
3,444.00	2,222.81	1731.59	3471.46
3,444.50	2,711.52	1231.56	4703.02

Table 4.5: Park Pond Stage Storage

PARK POND STAGE STORAGE			
ELEVATION (FT)	CONTOUR AREA (SF)	INCREMENTAL VOL. (CF)	CUMULATIVE VOL. (CF)
3,435.00	6,743	N/A	0
3,436.00	8,401	7548	7548
3,437.00	10,209	9281	16829
3,438.00	12,165	11159	27988
3,439.00	14,274	13194	41182
3,440.00	16,846	15818	57000
3,440.50	17,858	8672	65672
3,441.00	18,841	9171	74843
3,441.50	19,849	9667	84510

The Park Pond is graded with an 10-foot wide access drive to the bottom of the pond for any required maintenance.

4.5 Outfall

Metering of the three detention ponds is achieved through weirs and orifices. The two multi-family ponds are proposed to each have an 8-inch diameter pipe with flared end sections outfall

the stormwater from the bottom of the pond into each outlet structure. The pipes have more than adequate capacity to convey the 100-year outfall flow from the ponds. Each outlet structure will have a concrete baffle with a 2.4-inch diameter orifice set at the pond bottom elevation. See Appendix C for orifice calculations and flow rates.

The Park Pond will attenuate the three design storms with two orifices and a weir within a 4-foot by 8.5-foot concrete box structure. As stated in Section 2.1 of this report the historic outfall rates for the 2-year, 10-year, and 100-year storms are 0.26cfs, 2.84cfs, and 13.28cfs, respectively. The 2-year storm orifice is sized to be 2.52 inches in diameter and convey 0.22cfs. The 10-year storm is attenuated using three 6.36-inch diameter orifices with inverts set at the maximum water surface elevation of the 2-year storm. During a 10-year storm the four orifices will convey 2.62cfs. To attenuate the 100-year storm a rectangular sharp crested weir is designed to be 1.83 feet wide by 1.18 feet tall. The crest of this weir is set at the maximum water surface elevation of the 10-year storm. By summing the four orifices and the discharge of the weir the total flow rate through this structure in the 100-year event is 12.53cfs.

In the event that a storm exceeds the 100-year rainfall an overflow opening and grate are designed for the outfall structure. The Park Pond has capacity to store an additional 45,714cf in the freeboard and any flow over the 100-year water surface elevation will enter the outlet structure and bypass the control baffle.

Per the MCPWSS the pond must drain completely in 72 hours or less. This is achieved in all ponds see the below figures for total pond discharge in each design storm. The total drain time is under 58 hours.

The proposed design captures all sub-basins except Sub-Off1, Sub-Off2, and Sub-12. Sub-Off1 and Sub-Off2 allow for runoff to sheet flow to the west and discharge into the Hillview Way curb and gutter. Those two basins contribute 0.41 and 0.26 cfs, respectively, in the 100-year event. It was discussed with The City that a minimal amount of infiltration would be allowed for areas of no impervious surfaces. Therefore, sub-basin Sub-12 is graded to convey runoff to a drywell to be infiltrated into the ground. Per the geotechnical report the expected infiltration rates at the property are 1860 inches per hour. This is more than enough to infiltrate the 0.31 cfs of runoff in the 100-year event.

Figure 4.1: South Basin Discharge

Storm	Historic Discharge (cfs)	Offsite Runoff (cfs)	Pond Discharge (cfs)	Total Discharge (cfs)
100 yr max	13.28	0.67	12.53	13.20
10 yr max	2.84	0.20	2.62	2.82
2 yr max	0.26	0.03	0.22	0.25

Figure 4.2: 2-Year Park Pond Outfall

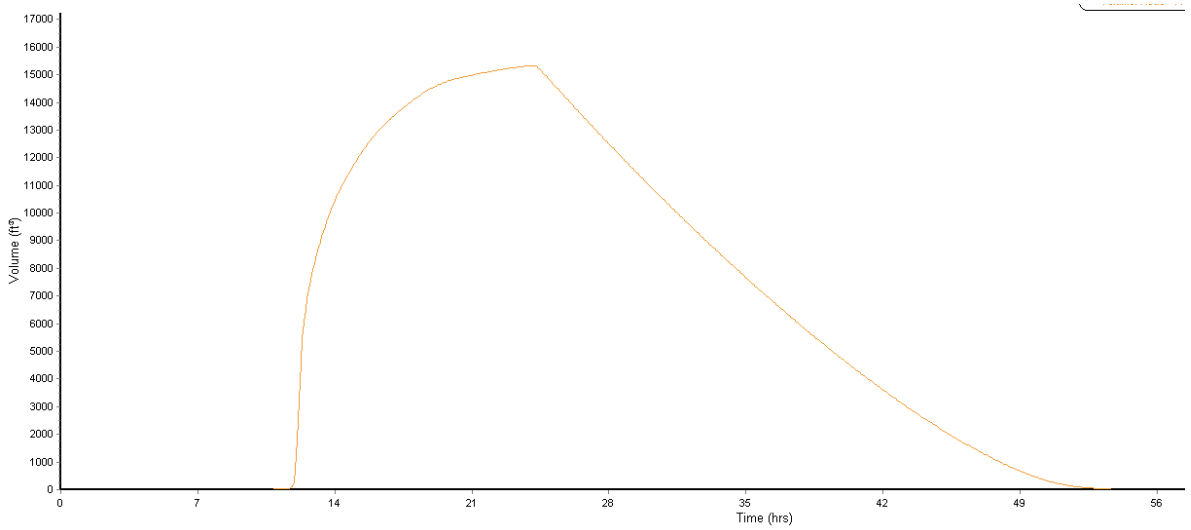


Figure 4.3: 10-Year Park Pond Outfall

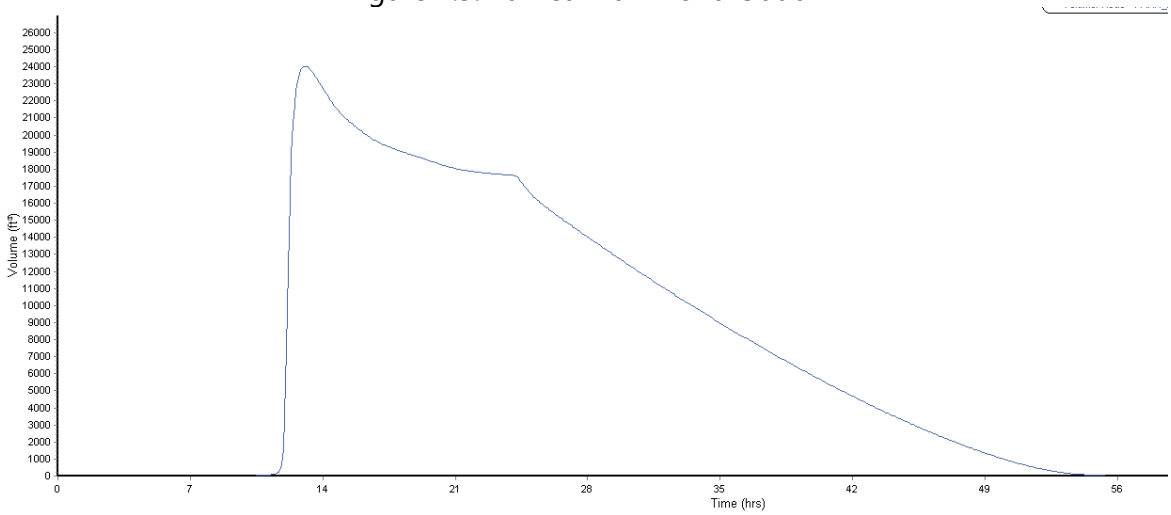
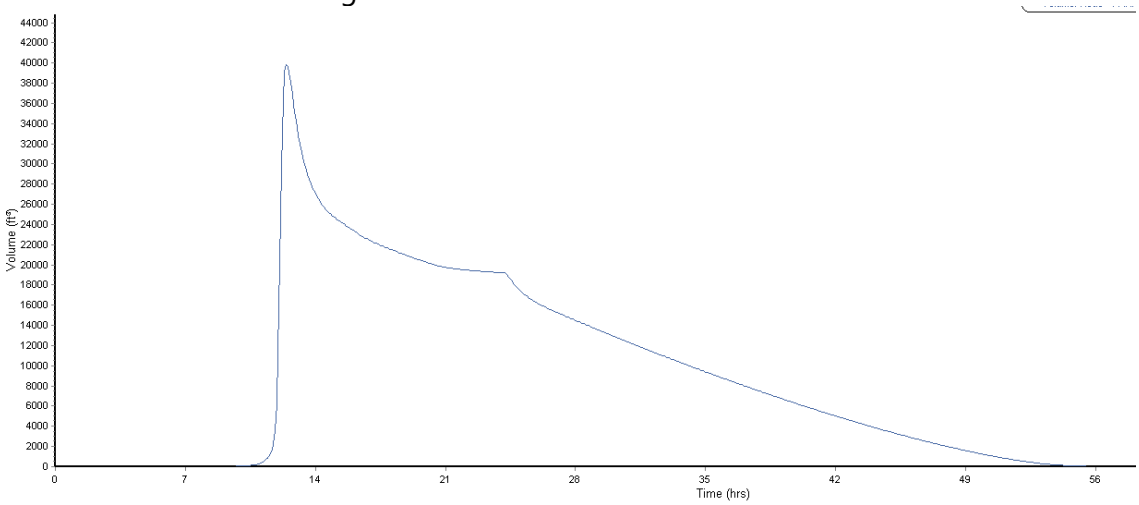


Figure 4.4: 100-Year Park Pond Outfall



5.0 SUMMARY

In conclusion, the proposed stormwater design for the Hillview Multi-Family Development and future subdivision development meet the requirements of the City of Missoula and Montana Department of Environmental Quality. The design has analyzed the pre-development condition to establish a stormwater design solution utilizing pipe conveyance, detention pond storage, and controlled outfalls to attenuate the post-development runoff rate to the historical rate in the 100-year event. In addition, the design mitigates downstream impacts by utilizing a pre-treatment forebay to allow for settlement of sediment and debris prior to outfall, uses an impermeable liner in the ponds to prevent infiltration, and provides access to the detention pond and outlet structures for maintenance.

6.0 OPERATIONS AND MAINTENANCE

6.1 Pavement Areas (Bi-Annual)

Parking area is to be swept twice annually to remove excess sediment. Recommended sweeping should take place once after spring melt and prior to May 1, and once after August 15 and prior to October 15.

6.2 Landscaping and Grounds Maintenance (Monthly)

Regular site maintenance should consist of removal of garbage and fallen debris from the parking lot on an as needed basis. Routine site maintenance will prevent debris from entering the storm water system and will improve storm water runoff quality over the long term.

6.3 Catch Basins/Manholes/Inlets

Each catch basin/inlet should be annually inspected to ensure that inlets and piping inverts are free from blockage. Clean as required, or at least every three years. Vacuum trucks are commonly utilized to remove sediments and debris from catch basins, manholes, and inlets.

6.4 Pipes

During annual inspections, the storm drain lines should also be examined to ensure that sediments are not impacting system performance. At a minimum, each structure should be cleaned out every three years or as required.

6.5 Outlet Structures (Bi-Annual)

Each pond outlet structure should be inspected and cleaned at a minimum twice per year. It is recommended the inspections and cleaning should take place once after spring melt and prior to May 1, and once after August 15 and prior to October 15. All orifices, weirs, and trash racks should be free of blockage. If custom fabricated weirs and orifices are used spares must be provided and stored onsite.

7.0 REFERENCES

- Missoula City Public Works Standards and Specifications Manual 2022
- Montana Public Works Standard Specifications (2010)
- Montana Post-Construction Storm Water BMP Design Guidance Manual (2017)
- City of Missoula Standard Modifications to MPWSS
- Montana Department of Environmental Quality Circular DEQ-8 Montana Standards for Subdivision Storm Water Drainage (2017)

APPENDICES FOR MF REPORT HAVE BEEN ELIMINATED FROM THIS REPORT. MF REPORT APPENDICES CAN BE PROVIDED UPON REQUEST

Cushing Terrell

Appendix D: Detention Facility Computations

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3,440.50	17,858	8672	65672
3,441.00	18,841	9171	74843
3,441.50	19,849	9667	84510

Cushing Terrell

Appendix B: Hydrologic Computations

United States Department of Agriculture

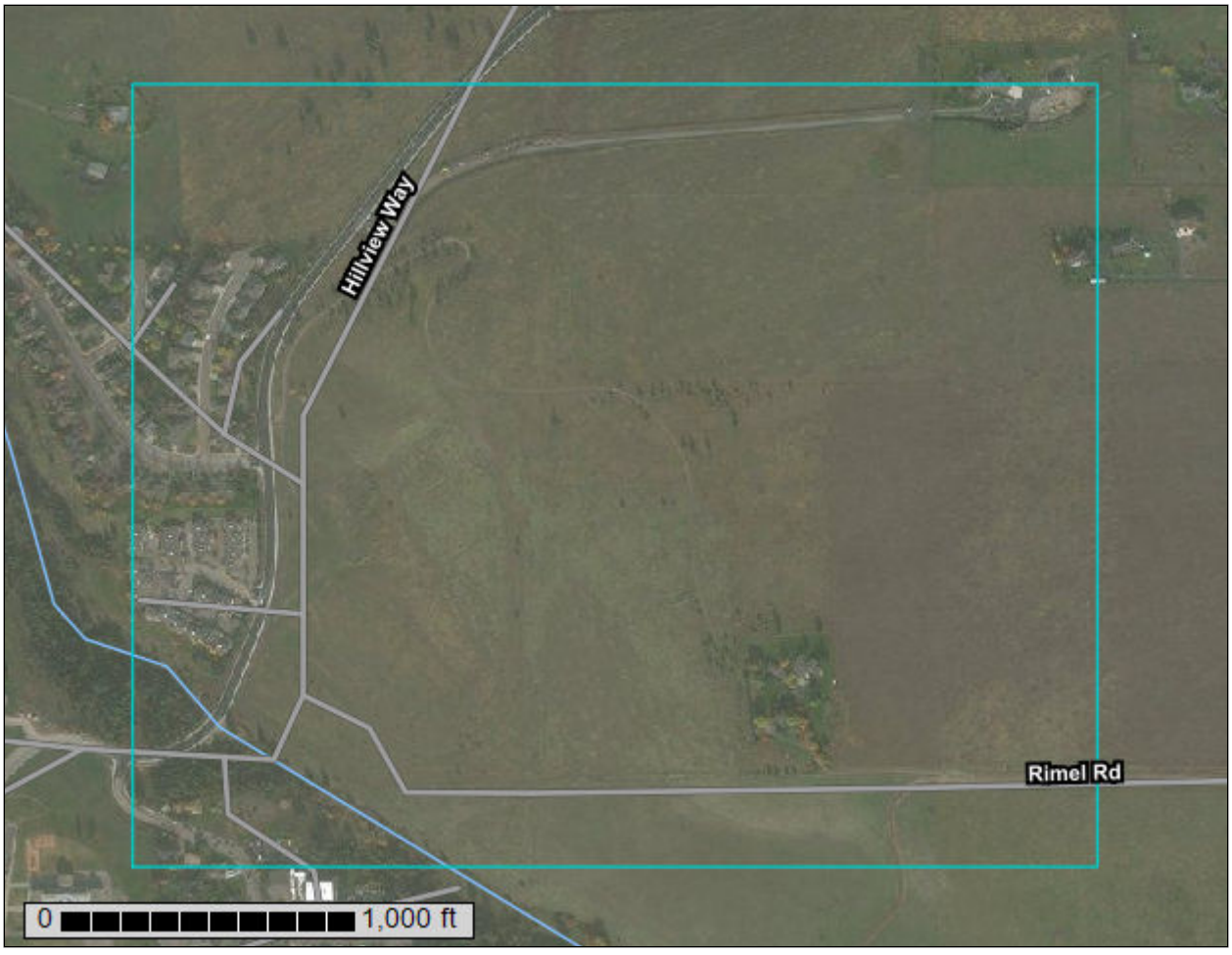
NRCS

Natural Resources Conservation Service

A product of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local participants

Custom Soil Resource Report for Missoula County Area, Montana

HILLVIEW



May 26, 2022

Preface

Soil surveys contain information that affects land use planning in survey areas. They highlight soil limitations that affect various land uses and provide information about the properties of the soils in the survey areas. Soil surveys are designed for many different users, including farmers, ranchers, foresters, agronomists, urban planners, community officials, engineers, developers, builders, and home buyers. Also, conservationists, teachers, students, and specialists in recreation, waste disposal, and pollution control can use the surveys to help them understand, protect, or enhance the environment.

Various land use regulations of Federal, State, and local governments may impose special restrictions on land use or land treatment. Soil surveys identify soil properties that are used in making various land use or land treatment decisions. The information is intended to help the land users identify and reduce the effects of soil limitations on various land uses. The landowner or user is responsible for identifying and complying with existing laws and regulations.

Although soil survey information can be used for general farm, local, and wider area planning, onsite investigation is needed to supplement this information in some cases. Examples include soil quality assessments (http://www.nrcs.usda.gov/wps/portal/nrcs/main/soils/health/) and certain conservation and engineering applications. For more detailed information, contact your local USDA Service Center (https://offices.sc.egov.usda.gov/locator/app?agency=nrcs) or your NRCS State Soil Scientist (http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/contactus/?cid=nrcs142p2_053951).

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

The National Cooperative Soil Survey is a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local agencies. The Natural Resources Conservation Service (NRCS) has leadership for the Federal part of the National Cooperative Soil Survey.

Information about soils is updated periodically. Updated information is available through the NRCS Web Soil Survey, the site for official soil survey information.

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Contents

How Soil Surveys Are Made

Soil surveys are made to provide information about the soils and miscellaneous areas in a specific area. They include a description of the soils and miscellaneous areas and their location on the landscape and tables that show soil properties and limitations affecting various uses. Soil scientists observed the steepness, length, and shape of the slopes; the general pattern of drainage; the kinds of crops and native plants; and the kinds of bedrock. They observed and described many soil profiles. A soil profile is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed or from the surface down to bedrock. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biological activity.

Currently, soils are mapped according to the boundaries of major land resource areas (MLRAs). MLRAs are geographically associated land resource units that share common characteristics related to physiography, geology, climate, water resources, soils, biological resources, and land uses (USDA, 2006). Soil survey areas typically consist of parts of one or more MLRA.

The soils and miscellaneous areas in a survey area occur in an orderly pattern that is related to the geology, landforms, relief, climate, and natural vegetation of the area. Each kind of soil and miscellaneous area is associated with a particular kind of landform or with a segment of the landform. By observing the soils and miscellaneous areas in the survey area and relating their position to specific segments of the landform, a soil scientist develops a concept, or model, of how they were formed. Thus, during mapping, this model enables the soil scientist to predict with a considerable degree of accuracy the kind of soil or miscellaneous area at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-vegetation-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, reaction, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. Soil taxonomy, the system of taxonomic classification used in the United States, is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil

scientists classified and named the soils in the survey area, they compared the individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

The objective of soil mapping is not to delineate pure map unit components; the objective is to separate the landscape into landforms or landform segments that have similar use and management requirements. Each map unit is defined by a unique combination of soil components and/or miscellaneous areas in predictable proportions. Some components may be highly contrasting to the other components of the map unit. The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The delineation of such landforms and landform segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, onsite investigation is needed to define and locate the soils and miscellaneous areas.

Soil scientists make many field observations in the process of producing a soil map. The frequency of observation is dependent upon several factors, including scale of mapping, intensity of mapping, design of map units, complexity of the landscape, and experience of the soil scientist. Observations are made to test and refine the soil-landscape model and predictions and to verify the classification of the soils at specific locations. Once the soil-landscape model is refined, a significantly smaller number of measurements of individual soil properties are made and recorded. These measurements may include field measurements, such as those for color, depth to bedrock, and texture, and laboratory measurements, such as those for content of sand, silt, clay, salt, and other components. Properties of each soil typically vary from one point to another across the landscape.

Observations for map unit components are aggregated to develop ranges of characteristics for the components. The aggregated values are presented. Direct measurements do not exist for every property presented for every map unit component. Values for some properties are estimated from combinations of other properties.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpret the data from these analyses and tests as well as the field-observed characteristics and the soil properties to determine the expected behavior of the soils under different uses. Interpretations for all of the soils are field tested through observation of the soils in different uses and under different levels of management. Some interpretations are modified to fit local conditions, and some new interpretations are developed to meet local needs. Data are assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management are assembled from farm records and from field or plot experiments on the same kinds of soil.

Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can predict with a fairly high degree of accuracy that a given soil will have a high water table within certain depths in most years, but they cannot predict that a high water table will always be at a specific level in the soil on a specific date.

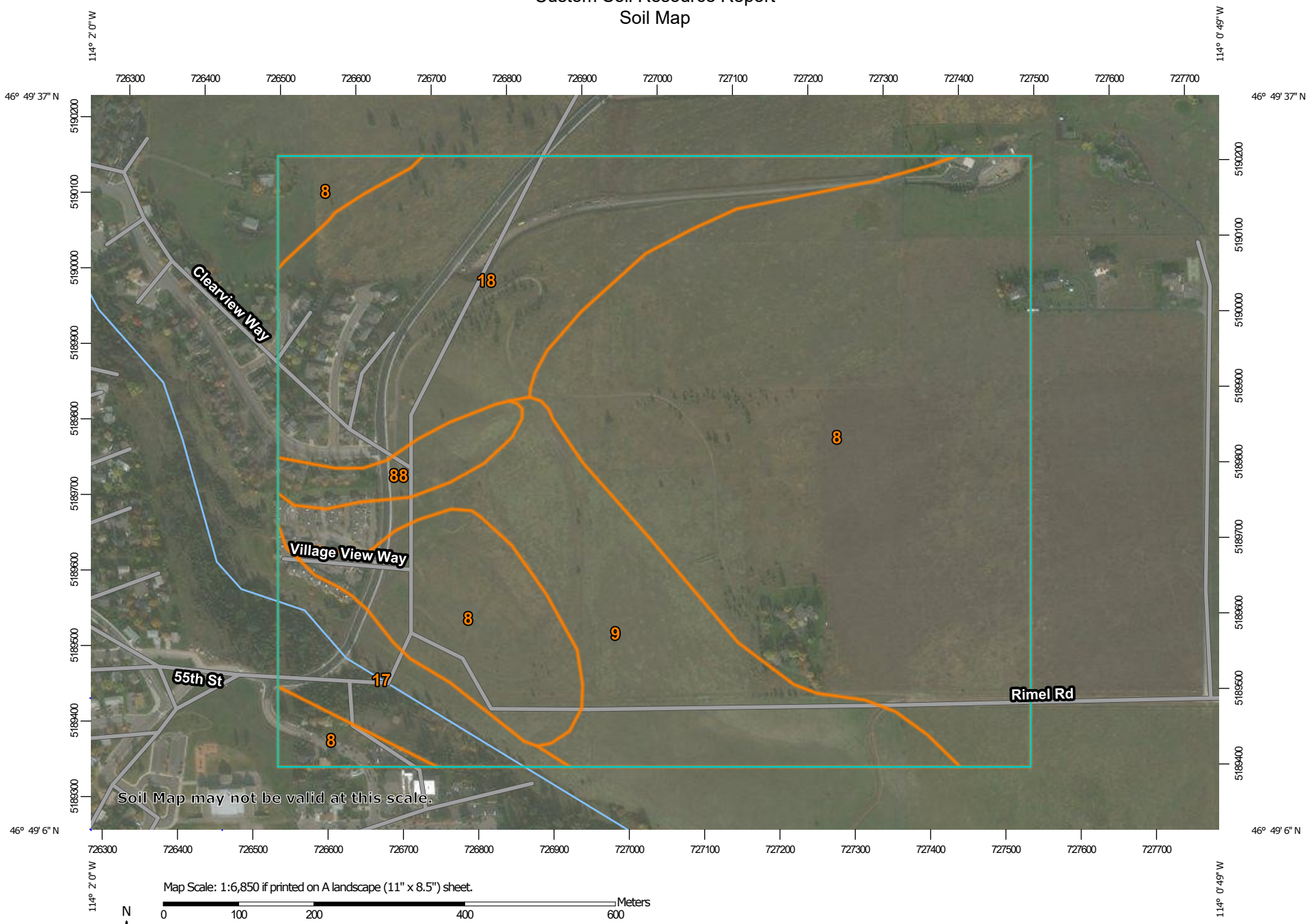
After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and

identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

Soil Map

The soil map section includes the soil map for the defined area of interest, a list of soil map units on the map and extent of each map unit, and cartographic symbols displayed on the map. Also presented are various metadata about data used to produce the map, and a description of each soil map unit.

Custom Soil Resource Report
Soil Map



Map Scale: 1:6,850 if printed on A landscape (11" x 8.5") sheet.

N

0 100 200 400 600 Meters

0 300 600 1200 1800 Feet

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 11N WGS84

MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils
- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

Special Point Features
- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

Water Features
- Streams and Canals

Transportation
- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background
- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Missoula County Area, Montana
Survey Area Data: Version 19, Sep 2, 2021

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Aug 6, 2014—Nov 2, 2016

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
8	Minesinger-Bigarm complex, 4 to 15 percent slopes	111.8	55.8%
9	Bigarm-Minesinger complex, 15 to 30 percent slopes	31.5	15.7%
17	Bigarm gravelly loam, 4 to 15 percent slopes	10.8	5.4%
18	Bigarm gravelly loam, 15 to 30 percent slopes	41.5	20.7%
88	Pits, gravel	4.9	2.4%
Totals for Area of Interest		**200.6**	**100.0%**

Map Unit Descriptions

The map units delineated on the detailed soil maps in a soil survey represent the soils or miscellaneous areas in the survey area. The map unit descriptions, along with the maps, can be used to determine the composition and properties of a unit.

A map unit delineation on a soil map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some minor components that belong to taxonomic classes other than those of the major soils.

Most minor soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, components. They may or may not be mentioned in a particular map unit description. Other minor components, however, have properties and behavioral characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, components. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified by a special symbol on the maps. If included in the database for a given area, the contrasting minor components are identified in the map unit descriptions along with some characteristics of each. A few areas of minor components may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms or landform segments that have similar use and management requirements. The delineation of such segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, however, onsite investigation is needed to define and locate the soils and miscellaneous areas.

An identifying symbol precedes the map unit name in the map unit descriptions. Each description includes general facts about the unit and gives important soil properties and qualities.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer, slope, stoniness, salinity, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Alpha silt loam, 0 to 2 percent slopes, is a phase of the Alpha series.

Some map units are made up of two or more major soils or miscellaneous areas. These map units are complexes, associations, or undifferentiated groups.

A *complex* consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the maps. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas. Alpha-Beta complex, 0 to 6 percent slopes, is an example.

An *association* is made up of two or more geographically associated soils or miscellaneous areas that are shown as one unit on the maps. Because of present or anticipated uses of the map units in the survey area, it was not considered practical or necessary to map the soils or miscellaneous areas separately. The pattern and relative proportion of the soils or miscellaneous areas are somewhat similar. Alpha-Beta association, 0 to 2 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils or miscellaneous areas that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils or miscellaneous areas in a mapped area are not uniform. An area can be made up of only one of the major soils or miscellaneous areas, or it can be made up of all of them. Alpha and Beta soils, 0 to 2 percent slopes, is an example.

Some surveys include *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Rock outcrop is an example.

Missoula County Area, Montana

8—Minesinger-Bigarm complex, 4 to 15 percent slopes

Map Unit Setting

National map unit symbol: 4wdl
Elevation: 2,600 to 5,500 feet
Mean annual precipitation: 14 to 19 inches
Mean annual air temperature: 41 to 45 degrees F
Frost-free period: 90 to 120 days
Farmland classification: Farmland of local importance

Map Unit Composition

Minesinger and similar soils: 60 percent
Bigarm and similar soils: 25 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Minesinger

Setting

Landform: Hills
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Tertiary slope alluvium

Typical profile

A1 - 0 to 6 inches: gravelly loam
A2 - 6 to 13 inches: cobbly loam
Bt - 13 to 24 inches: very gravelly clay
Bk - 24 to 60 inches: very gravelly clay loam

Properties and qualities

Slope: 4 to 15 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 8 percent
Maximum salinity: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water supply, 0 to 60 inches: Low (about 5.4 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4e
Hydrologic Soil Group: C
Ecological site: R044AA036MT - Droughty (Dr) LRU 44A-A
Hydric soil rating: No

Description of Bigarm

Setting

Landform: Hills

Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Tertiary slope alluvium

Typical profile

A1 - 0 to 11 inches: cobbly loam
A2 - 11 to 15 inches: very gravelly loam
Bw - 15 to 40 inches: very gravelly sandy loam
C - 40 to 60 inches: extremely gravelly loamy sand

Properties and qualities

Slope: 4 to 15 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Somewhat excessively drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.71 to 2.13 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: Low (about 5.5 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4e
Hydrologic Soil Group: B
Ecological site: R044AP808MT - UPLAND GRASSLAND ESG 44A LRU P
Hydric soil rating: No

Minor Components

Grassvalley

Percent of map unit: 10 percent
Landform: Hills
Down-slope shape: Linear
Across-slope shape: Linear
Ecological site: R044AA032MT - Loamy (Lo) LRU 44A-A
Hydric soil rating: No

Larry

Percent of map unit: 5 percent
Landform: Drainageways
Down-slope shape: Linear
Across-slope shape: Linear
Ecological site: R046XC518MT - Wet Meadow (WM) RRU 46-C 15-19" p.z.
Hydric soil rating: No

9—Bigarm-Minesinger complex, 15 to 30 percent slopes

Map Unit Setting

National map unit symbol: 4wdy

Elevation: 2,600 to 5,500 feet
Mean annual precipitation: 14 to 19 inches
Mean annual air temperature: 39 to 45 degrees F
Frost-free period: 90 to 120 days
Farmland classification: Not prime farmland

Map Unit Composition

Bigarm and similar soils: 45 percent
Minesinger and similar soils: 40 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Bigarm

Setting

Landform: Hills
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Tertiary slope alluvium

Typical profile

A1 - 0 to 11 inches: gravelly loam
A2 - 11 to 15 inches: very gravelly loam
Bw - 15 to 40 inches: very gravelly sandy loam
C - 40 to 60 inches: extremely gravelly loamy sand

Properties and qualities

Slope: 15 to 30 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Somewhat excessively drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: Low (about 5.5 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: B
Ecological site: R044AP808MT - UPLAND GRASSLAND ESG 44A LRU P
Hydric soil rating: No

Description of Minesinger

Setting

Landform: Hills
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Tertiary slope alluvium

Typical profile

A1 - 0 to 6 inches: gravelly loam
A2 - 6 to 13 inches: cobbly loam
Bt - 13 to 24 inches: very gravelly clay
Bk - 24 to 60 inches: very gravelly clay loam

Properties and qualities

Slope: 15 to 30 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 8 percent
Maximum salinity: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water supply, 0 to 60 inches: Low (about 5.4 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: C
Ecological site: R044AA036MT - Droughty (Dr) LRU 44A-A
Hydric soil rating: No

Minor Components

Grassvalley

Percent of map unit: 10 percent
Landform: Hills
Down-slope shape: Linear
Across-slope shape: Linear
Ecological site: R044AA032MT - Loamy (Lo) LRU 44A-A
Hydric soil rating: No

Hogsby

Percent of map unit: 5 percent
Landform: Hills
Down-slope shape: Linear
Across-slope shape: Linear
Ecological site: R044AP805MT - SHALLOW GRASSLAND ESG 44A LRU P
Hydric soil rating: No

17—Bigarm gravelly loam, 4 to 15 percent slopes

Map Unit Setting

National map unit symbol: 4wbc
Elevation: 2,500 to 5,500 feet
Mean annual precipitation: 14 to 22 inches
Mean annual air temperature: 39 to 45 degrees F
Frost-free period: 90 to 125 days
Farmland classification: Farmland of statewide importance

Map Unit Composition

Bigarm and similar soils: 85 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Bigarm

Setting

Landform: Alluvial fans, stream terraces
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Alluvium

Typical profile

A1 - 0 to 11 inches: gravelly loam
A2 - 11 to 15 inches: very gravelly loam
Bw - 15 to 40 inches: very gravelly sandy loam
C - 40 to 60 inches: extremely gravelly loamy sand

Properties and qualities

Slope: 4 to 15 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Somewhat excessively drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: Low (about 5.5 inches)

Interpretive groups

Land capability classification (irrigated): 4e
Land capability classification (nonirrigated): 4e
Hydrologic Soil Group: B
Ecological site: R044AP808MT - UPLAND GRASSLAND ESG 44A LRU P
Hydric soil rating: No

Minor Components

Biglake

Percent of map unit: 5 percent
Landform: Alluvial fans, stream terraces
Down-slope shape: Linear
Across-slope shape: Linear
Ecological site: R044AB134MT - Shallow To Gravel (Swgr) LRU 44A-B
Hydric soil rating: No

Stony surface layers

Percent of map unit: 5 percent
Ecological site: R044AB036MT - Droughty (Dr) LRU 44A-B
Hydric soil rating: No

Very deep, clayey soils

Percent of map unit: 5 percent
Ecological site: R044AB032MT - Loamy (Lo) LRU 44A-B
Hydric soil rating: No

18—Bigarm gravelly loam, 15 to 30 percent slopes

Map Unit Setting

National map unit symbol: 4wbd
Elevation: 2,500 to 5,500 feet
Mean annual precipitation: 14 to 22 inches
Mean annual air temperature: 39 to 45 degrees F
Frost-free period: 90 to 125 days
Farmland classification: Not prime farmland

Map Unit Composition

Bigarm and similar soils: 85 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Bigarm

Setting

Landform: Hills
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Alluvium and/or colluvium

Typical profile

A1 - 0 to 11 inches: gravelly loam
A2 - 11 to 15 inches: very gravelly loam
Bw - 15 to 40 inches: very gravelly sandy loam
C - 40 to 60 inches: extremely gravelly loamy sand

Properties and qualities

Slope: 15 to 30 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Somewhat excessively drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: Low (about 5.5 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: B
Ecological site: R044AP808MT - UPLAND GRASSLAND ESG 44A LRU P
Hydric soil rating: No

Minor Components

Biglake
Percent of map unit: 5 percent
Landform: Hills
Down-slope shape: Linear
Across-slope shape: Linear
Ecological site: R044AB134MT - Shallow To Gravel (Swgr) LRU 44A-B
Hydric soil rating: No

Stony surface layers
Percent of map unit: 5 percent
Ecological site: R044AB036MT - Droughty (Dr) LRU 44A-B
Hydric soil rating: No

Very deep, clayey soils
Percent of map unit: 5 percent
Ecological site: R044AB032MT - Loamy (Lo) LRU 44A-B
Hydric soil rating: No

88—Pits, gravel

Map Unit Composition
Pits: 100 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

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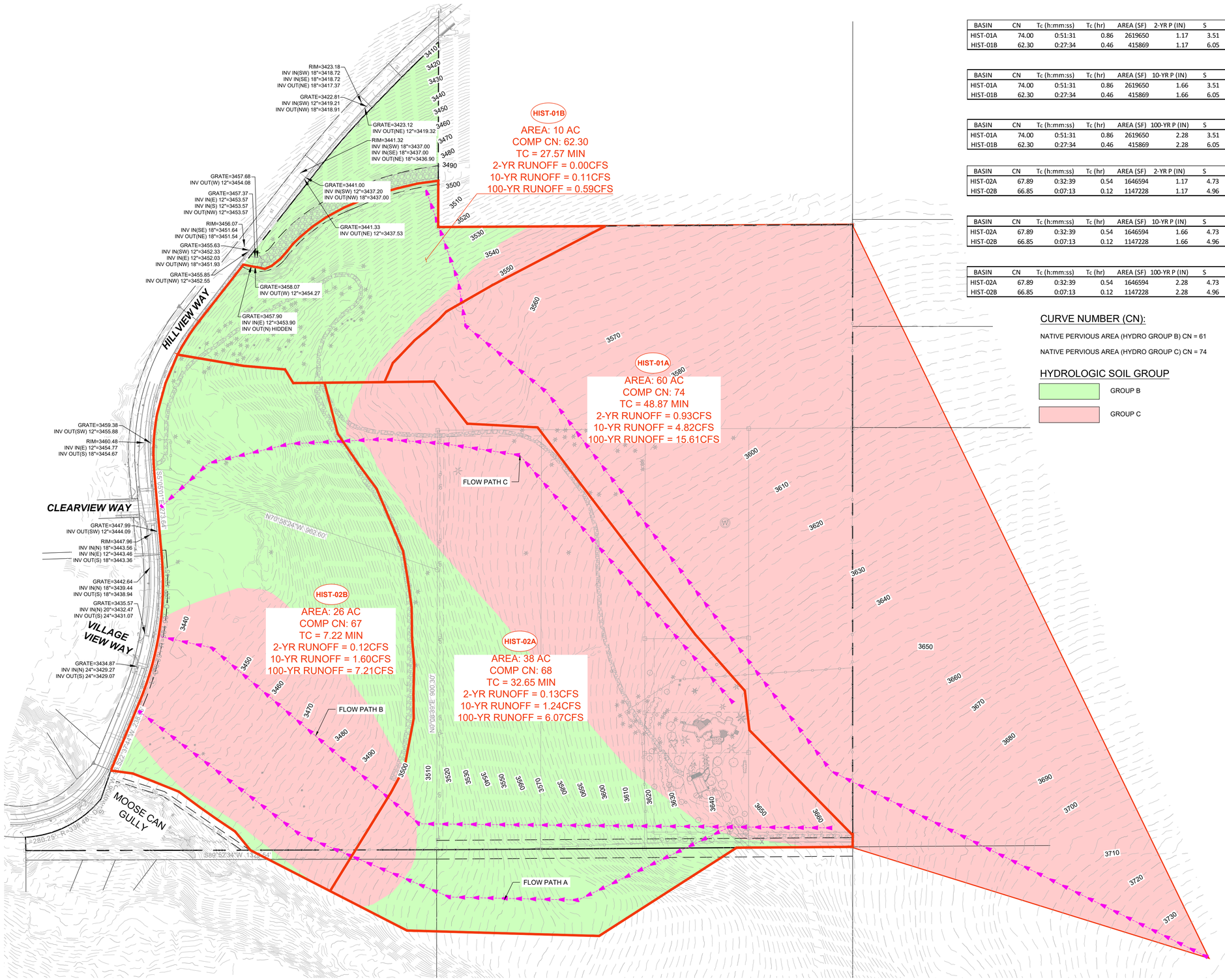

BASIN	CN	Tc (h:mm:ss)	Tc (hr)	AREA (SF)	2-YR P (IN)	S	Ia (IN)	Ia/P	Q (IN)	qu (csm/in)	Am (SQ MI)	Fp	qp (CFS)
HIST-01A	74.00	0:51:31	0.86	2619650	1.17	3.51	0.585	0.500	0.05	180	0.094	1	0.93
HIST-01B	62.30	0:27:34	0.46	415869	1.17	6.05	0.585	0.500	0.00	245	0.015	1	0.00
													0.93

BASIN	CN	Tc (h:mm:ss)	Tc (hr)	AREA (SF)	10-YR P (IN)	S	Ia (IN)	Ia/P	Q (IN)	qu (csm/in)	Am (SQ MI)	Fp	qp (CFS)
HIST-01A	74.00	0:51:31	0.86	2619650	1.66	3.51	0.703	0.423	0.20	250	0.094	1	4.82
HIST-01B	62.30	0:27:34	0.46	415869	1.66	6.05	0.830	0.500	0.03	245	0.015	1	0.11
													4.93

BASIN	CN	Tc (h:mm:ss)	Tc (hr)	AREA (SF)	100-YR P (IN)	S	Ia (IN)	Ia/P	Q (IN)	qu (csm/in)	Am (SQ MI)	Fp	qp (CFS)
HIST-01A	74.00	0:51:31	0.86	2619650	2.28	3.51	0.703	0.308	0.49	340	0.094	1	15.61
HIST-01B	62.30	0:27:34	0.46	415869	2.28	6.05	1.140	0.500	0.16	245	0.015	1	0.59
													16.20

BASIN	CN	Tc (h:mm:ss)	Tc (hr)	AREA (SF)	2-YR P (IN)	S	Ia (IN)	Ia/P	Q (IN)	qu (csm/in)	Am (SQ MI)	Fp	qp (CFS)
HIST-02A	67.89	0:32:39	0.54	1646594	1.17	4.73	0.585	0.500	0.01	225	0.059	1	0.13
HIST-02B	66.85	0:07:13	0.12	1147228	1.17	4.96	0.585	0.500	0.01	490	0.041	1	0.12
													0.26

BASIN	CN	Tc (h:mm:ss)	Tc (hr)	AREA (SF)	10-YR P (IN)	S	Ia (IN)	Ia/P	Q (IN)	qu (csm/in)	Am (SQ MI)	Fp	qp (CFS)
HIST-02A	67.89	0:32:39	0.54	1646594	1.66	4.73	0.830	0.500	0.09	225	0.059	1	1.24
HIST-02B	66.85	0:07:13	0.12	1147228	1.66	4.96	0.830	0.500	0.08	490	0.041	1	1.60
													2.84

BASIN	CN	Tc (h:mm:ss)	Tc (hr)	AREA (SF)	100-YR P (IN)	S	Ia (IN)	Ia/P	Q (IN)	qu (csm/in)	Am (SQ MI)	Fp	qp (CFS)
HIST-02A	67.89	0:32:39	0.54	1646594	2.28	4.73	0.946	0.415	0.29	350	0.059	1	6.07
HIST-02B	66.85	0:07:13	0.12	1147228	2.28	4.96	0.992	0.435	0.27	660	0.041	1	7.21
													13.28

CURVE NUMBER (CN):

NATIVE PERVIOUS AREA (HYDRO GROUP B) CN = 61

NATIVE PERVIOUS AREA (HYDRO GROUP C) CN = 74

HYDROLOGIC SOIL GROUP

GROUP B

GROUP C

NORTH

1 / D.01 HISTORICAL DRAINAGE BASINS

0 75 150 300

SCALE: 1" = 150'

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MISSOULA, MONTANA
WILDROOT

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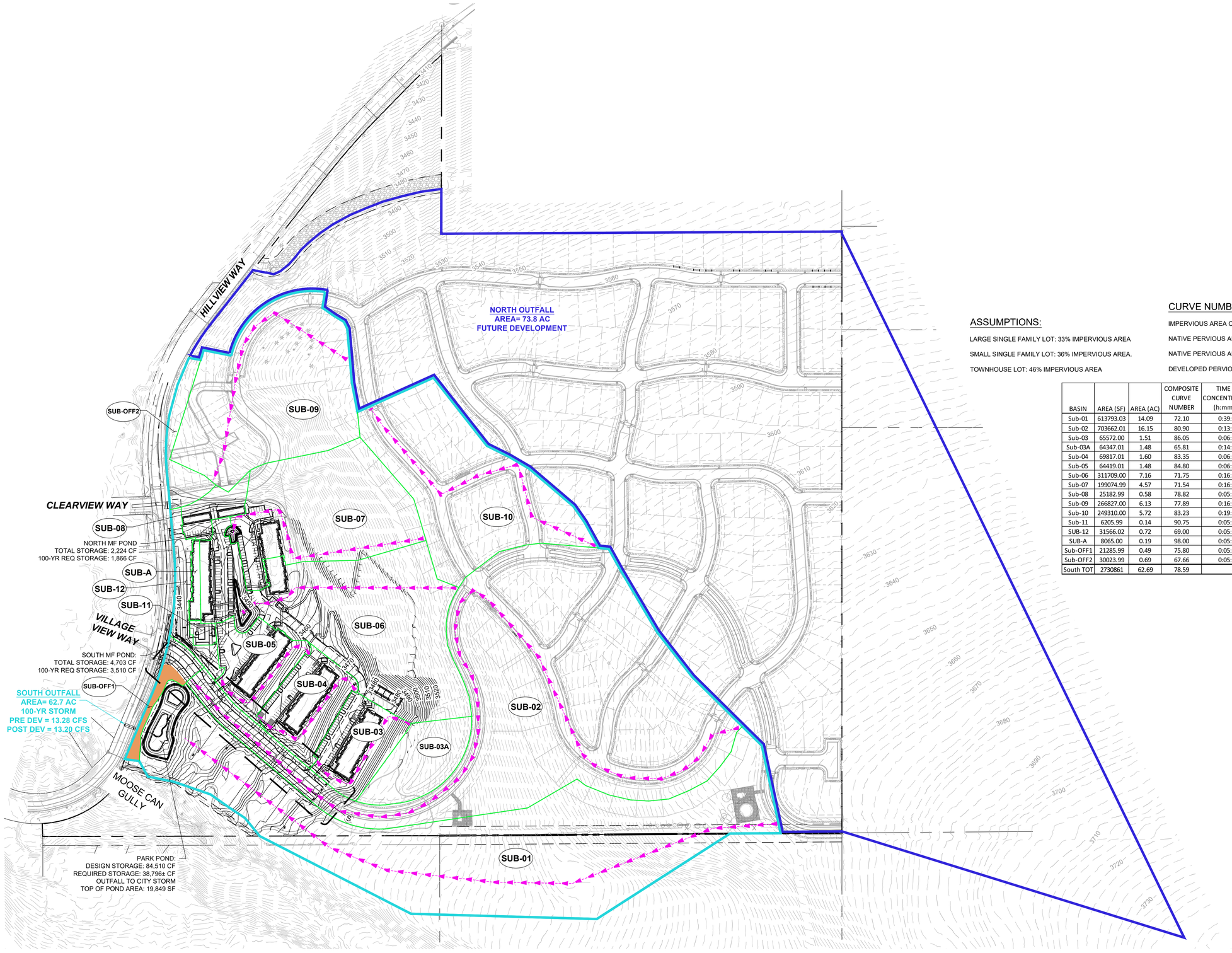
HISTORICAL DRAINAGE BASINS

D.01



ASSUMPTIONS:

LARGE SINGLE FAMILY LOT: 33% IMPERVIOUS AREA

SMALL SINGLE FAMILY LOT: 36% IMPERVIOUS AREA.

TOWNHOUSE LOT: 46% IMPERVIOUS AREA

CURVE NUMBER (CN):

IMPERVIOUS AREA CN = 98

NATIVE PERVIOUS AREA (HYDRO GROUP B) CN = 61

NATIVE PERVIOUS AREA (HYDRO GROUP B) CN = 74

DEVELOPED PERVIOUS AREA CN = 69

BASIN	AREA (SF)	AREA (AC)	COMPOSITE CURVE NUMBER	TIME OF CONCENTRATION (h:mm:ss)	2-YR FLOW (cfs)	10-YR FLOW (cfs)	100-YR FLOW (cfs)
Sub-01	613793.03	14.09	72.10	0:39:51	0.07	1.02	3.96
Sub-02	703662.01	16.15	80.90	0:13:38	2.73	8.36	17.40
Sub-03	65572.00	1.51	86.05	0:06:25	0.64	1.43	2.59
Sub-03A	64347.01	1.48	65.81	0:14:19	0.00	0.02	0.31
Sub-04	69817.01	1.60	83.35	0:06:38	0.46	1.19	2.31
Sub-05	64419.01	1.48	84.80	0:06:38	0.53	1.25	2.35
Sub-06	311709.00	7.16	71.75	0:16:14	0.03	0.84	3.31
Sub-07	199074.99	4.57	71.54	0:16:28	0.02	0.51	2.05
Sub-08	25182.99	0.58	78.82	0:05:00	0.08	0.27	0.63
Sub-09	266827.00	6.13	77.89	0:16:13	0.45	2.11	5.03
Sub-10	249310.00	5.72	83.23	0:19:13	1.26	3.31	6.48
Sub-11	6205.99	0.14	90.75	0:05:00	0.11	0.20	0.32
SUB-12	31566.02	0.72	69.00	0:05:00	0.00	0.07	0.31
SUB-A	8065.00	0.19	98.00	0:05:00	0.28	0.40	0.56
Sub-OFF1	21285.99	0.49	75.80	0:05:00	0.03	0.16	0.41
Sub-OFF2	30023.99	0.69	67.66	0:05:00	0.00	0.04	0.26
South TOT	2730861	62.69	78.59		6.69	21.18	48.28

NORTH

1 / D.02 MULTI-FAMILY DESIGN DRAINAGE BASINS

0 75 150 300

SCALE: 1" = 150'

CONTOUR INTERVAL: 2 FT MINOR, 10 FT MAJOR

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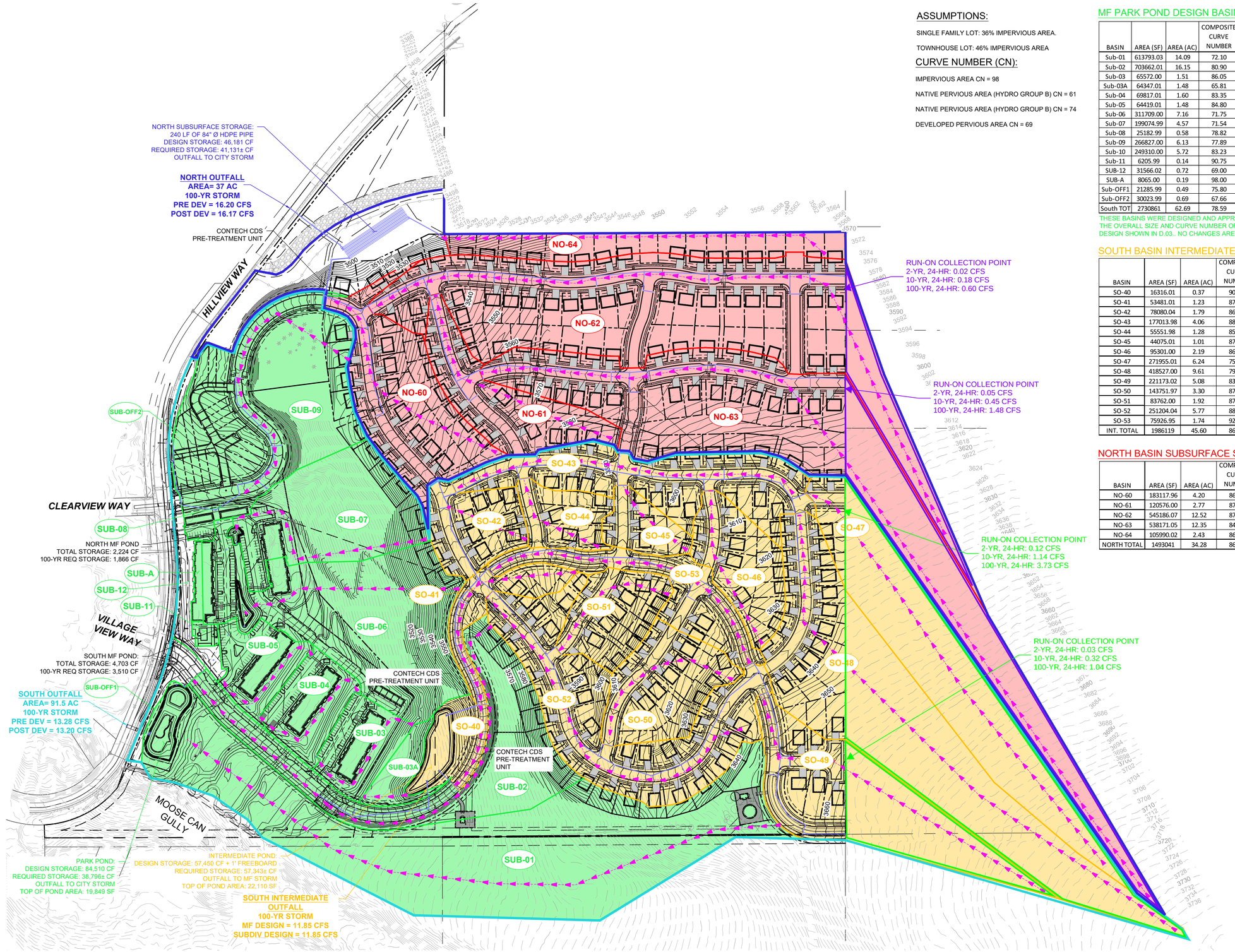
MULTI-FAMILY DRAINAGE BASINS

D.02



ASSUMPTIONS:

SINGLE FAMILY LOT: 36% IMPERVIOUS AREA.

TOWNHOUSE LOT: 46% IMPERVIOUS AREA

CURVE NUMBER (CN):

IMPERVIOUS AREA CN = 98

NATIVE PERVIOUS AREA (HYDRO GROUP B) CN = 61

NATIVE PERVIOUS AREA (HYDRO GROUP B) CN = 74

DEVELOPED PERVIOUS AREA CN = 69

MF PARK POND DESIGN BASINS

BASIN	AREA (SF)	AREA (AC)	COMPOSITE CURVE NUMBER	TIME OF CONCENTRATION (h:mm:ss)	2-YR FLOW (cfs)	10-YR FLOW (cfs)	100-YR FLOW (cfs)
Sub-01	613793.03	14.09	72.10	0:39:51	0.07	1.02	3.96
Sub-02	703662.01	16.15	80.90	0:13:38	2.73	8.36	17.40
Sub-03	65572.00	1.51	86.05	0:06:25	0.64	1.43	2.59
Sub-03A	64347.01	1.48	65.81	0:14:19	0.00	0.02	0.31
Sub-04	69817.01	1.60	83.35	0:06:38	0.46	1.19	2.31
Sub-05	64419.01	1.48	84.80	0:06:38	0.53	1.25	2.35
Sub-06	311709.00	7.16	71.75	0:16:14	0.03	0.84	3.31
Sub-07	199074.99	4.57	71.54	0:16:28	0.02	0.51	2.05
Sub-08	25182.99	0.58	78.82	0:05:00	0.08	0.27	0.63
Sub-09	266827.00	6.13	77.89	0:16:13	0.45	2.11	5.03
Sub-10	249310.00	5.72	83.23	0:19:13	1.26	3.31	6.48
Sub-11	6205.99	0.14	90.75	0:05:00	0.11	0.20	0.32
SUB-12	31566.02	0.72	69.00	0:05:00	0.00	0.07	0.31
SUB-A	8065.00	0.19	98.00	0:05:00	0.28	0.40	0.56
Sub-OFF1	21285.99	0.49	75.80	0:05:00	0.03	0.16	0.41
Sub-OFF2	30023.99	0.69	67.66	0:05:00	0.00	0.04	0.26
South TOT	2730861	62.69	78.59		6.69	21.18	48.28

THESE BASINS WERE DESIGNED AND APPROVED UNDER THE MULTI-FAMILY PROJECT. THE OVERALL SIZE AND CURVE NUMBER OF THE PARK POND BASIN IS REDUCED IN THE DESIGN SHOWN IN D.03.. NO CHANGES ARE PROPOSED TO THE PARK POND DESIGN.

SOUTH BASIN INTERMEDIATE POND

BASIN	AREA (SF)	AREA (AC)	COMPOSITE CURVE NUMBER	2-YR FLOW (cfs)	10-YR FLOW (cfs)	100-YR FLOW (cfs)
SO-40	16316.01	0.37	90.75	0.28	0.51	0.83
SO-41	53481.01	1.23	87.08	0.43	0.94	1.66
SO-42	78080.04	1.79	86.00	0.44	1.02	1.87
SO-43	177013.98	4.06	88.68	1.35	2.73	4.67
SO-44	55551.98	1.28	85.28	0.26	0.62	1.17
SO-45	44075.01	1.01	87.93	0.30	0.63	1.10
SO-46	95301.00	2.19	86.98	0.57	1.24	2.22
SO-47	271955.01	6.24	75.45	0.11	0.80	2.36
SO-48	418527.00	9.61	79.53	0.52	2.08	4.95
SO-49	221173.02	5.08	83.57	0.68	1.88	3.84
SO-50	143751.97	3.30	87.55	1.00	2.13	3.74
SO-51	83762.00	1.92	87.55	0.57	1.21	2.12
SO-52	251204.04	5.77	88.25	1.85	3.83	6.62
SO-53	75926.95	1.74	92.87	1.41	2.43	3.75
INT. TOTAL	1986119	45.60	86.25	9.77	22.05	40.90

NORTH BASIN SUBSURFACE STORAGE

BASIN	AREA (SF)	AREA (AC)	COMPOSITE CURVE NUMBER	2-YR FLOW (cfs)	10-YR FLOW (cfs)	100-YR FLOW (cfs)
NO-60	183117.96	4.20	86.83	1.01	2.23	4.00
NO-61	120576.00	2.77	87.84	0.83	1.74	3.06
NO-62	545186.07	12.52	87.05	3.01	6.57	11.82
NO-63	538171.05	12.35	84.00	1.66	4.19	8.33
NO-64	105990.02	2.43	86.22	0.88	1.92	3.45
NORTH TOTAL	1493041	34.28	86.39	7.39	16.65	30.66

NORTH

1 D.03 POST SUBDIVISION DRAINAGE BASINS

0 75 150 300

SCALE: 1" = 150'

CONTOUR INTERVAL: 2 FT MINOR, 10 FT MAJOR

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MISSOULA, MONTANA
WILDROOT

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POST SUBDIVISION DRAINAGE BASINS

D.03

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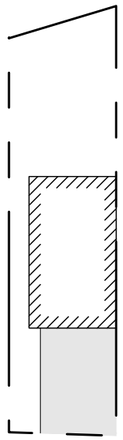
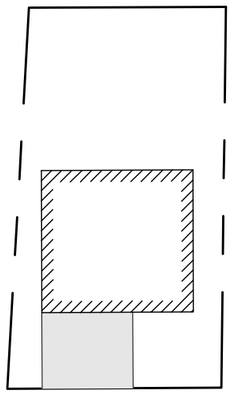
MISSOULA, MT
p 406.728.9522
f 406.728.8287



TOWNHOUSE

LOT SIZE= 3220 SF
BUILDING FOOTPRINT= 920 SF
PAVEMENT AREA= 561 SF
LANDSCAPE= 1594 SF
IMPERVIOUS= 46%



SINGLE FAMILY

LOT SIZE= 6000+ SF
BUILDING FOOTPRINT= 1500 SF
PAVEMENT AREA= 480 SF
LANDSCAPE= 3467 SF
IMPERVIOUS= 36%

WILDROOT

12.05.2023
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1

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REF SHEET

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1000

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Appendix C: Hydraulic Computations

Inlet Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Monday, Jun 13 2022

<Name>

Combination Inlet

Location	= On grade
Curb Length (ft)	= 3.00
Throat Height (in)	= 6.00
Grate Area (sqft)	= -0-
Grate Width (ft)	= 1.50
Grate Length (ft)	= 3.00

Gutter

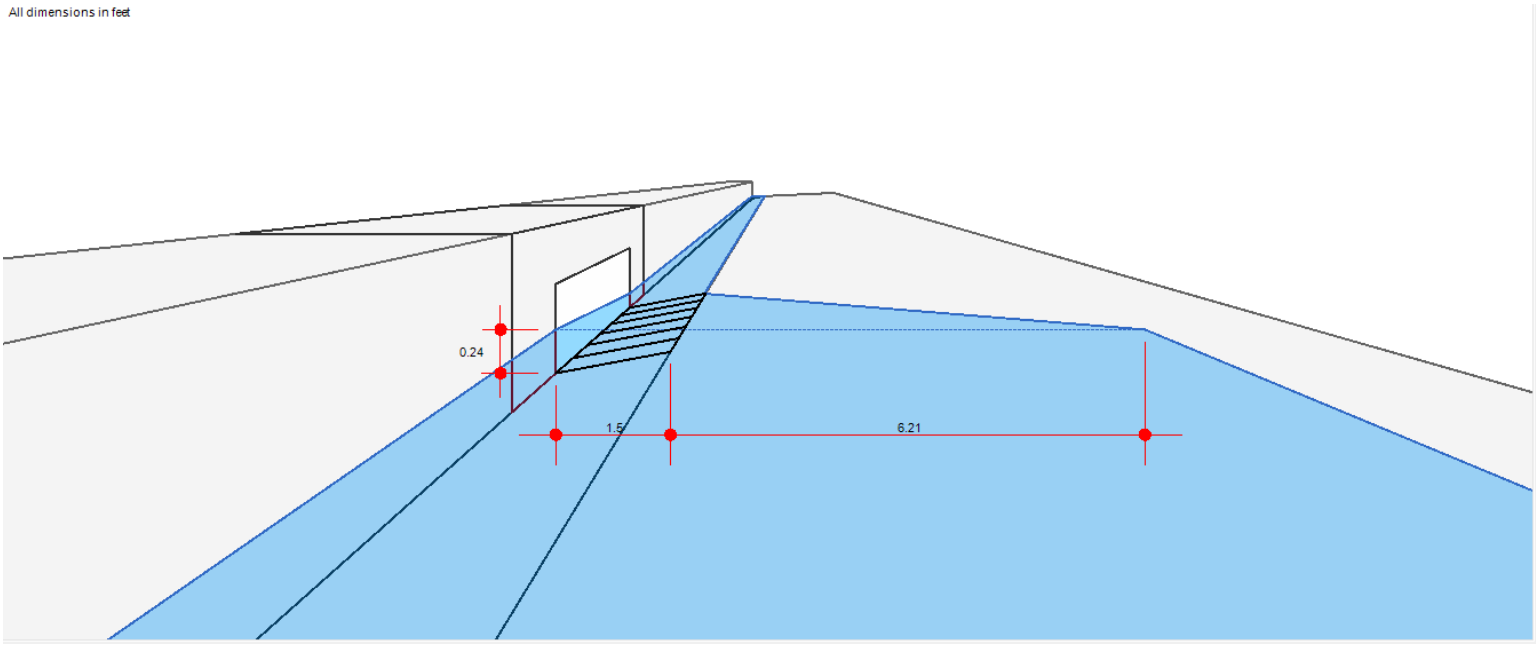
Slope, Sw (ft/ft)	= 0.080
Slope, Sx (ft/ft)	= 0.020
Local Depr (in)	= -0-
Gutter Width (ft)	= 1.50
Gutter Slope (%)	= 0.08
Gutter n-value	= 0.016

Calculations

Compute by:	Known Q
Q (cfs)	= 0.43

Highlighted

Q Total (cfs)	= 0.43
Q Capt (cfs)	= 0.39
Q Bypass (cfs)	= 0.04
Depth at Inlet (in)	= 2.93
Efficiency (%)	= 90
Gutter Spread (ft)	= 7.71
Gutter Vel (ft/s)	= 0.65
Bypass Spread (ft)	= 1.47
Bypass Depth (in)	= 1.41



Inlet Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Monday, Jun 13 2022

<Name>

Combination Inlet

Location	= On grade
Curb Length (ft)	= 3.00
Throat Height (in)	= 6.00
Grate Area (sqft)	= -0-
Grate Width (ft)	= 1.50
Grate Length (ft)	= 3.00

Gutter

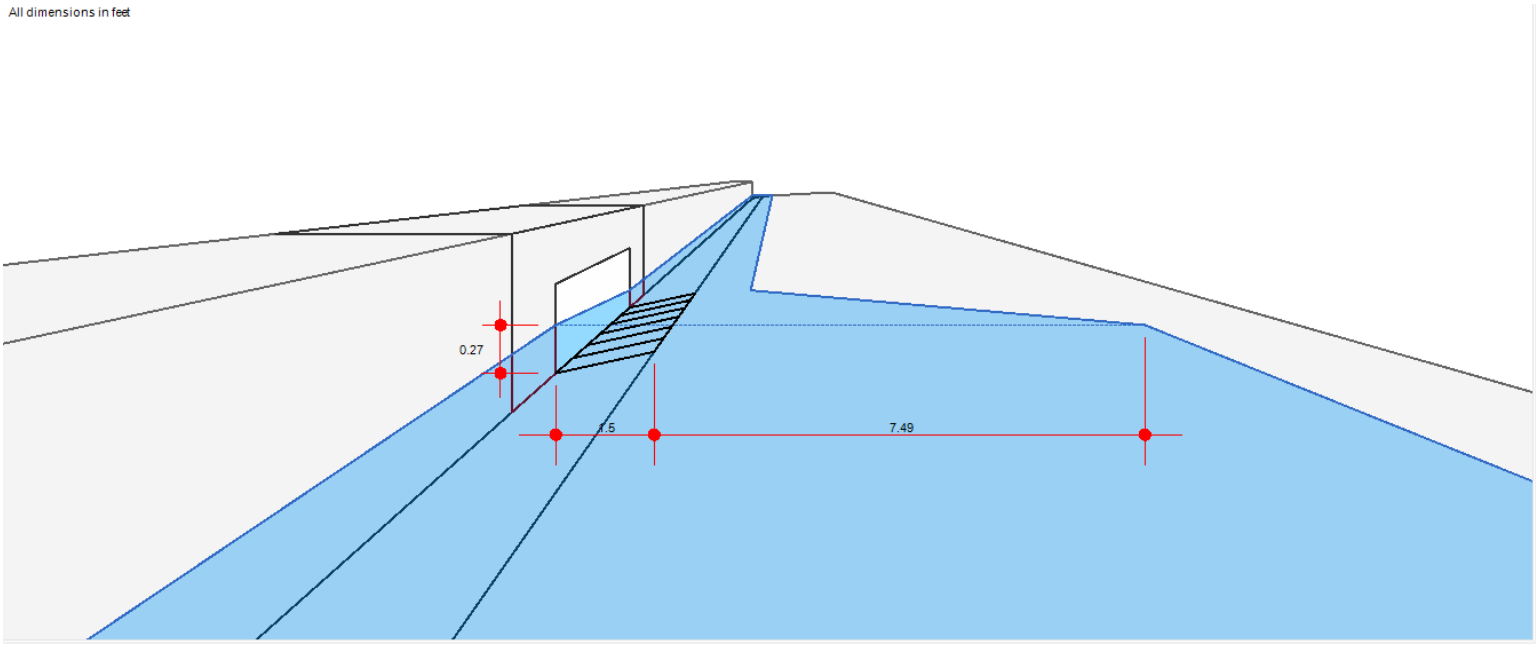
Slope, Sw (ft/ft)	= 0.080
Slope, Sx (ft/ft)	= 0.020
Local Depr (in)	= -0-
Gutter Width (ft)	= 1.50
Gutter Slope (%)	= 0.08
Gutter n-value	= 0.016

Calculations

Compute by:	Known Q
Q (cfs)	= 0.61

Highlighted

Q Total (cfs)	= 0.61
Q Capt (cfs)	= 0.54
Q Bypass (cfs)	= 0.07
Depth at Inlet (in)	= 3.24
Efficiency (%)	= 88
Gutter Spread (ft)	= 8.99
Gutter Vel (ft/s)	= 0.70
Bypass Spread (ft)	= 2.78
Bypass Depth (in)	= 1.75



Storage Nodes

Storage Node : NorthSubStor

Input Data

Invert Elevation (ft)	0.00
Max (Rim) Elevation (ft)	6.00
Max (Rim) Offset (ft)	6.00
Initial Water Elevation (ft)	0.00
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

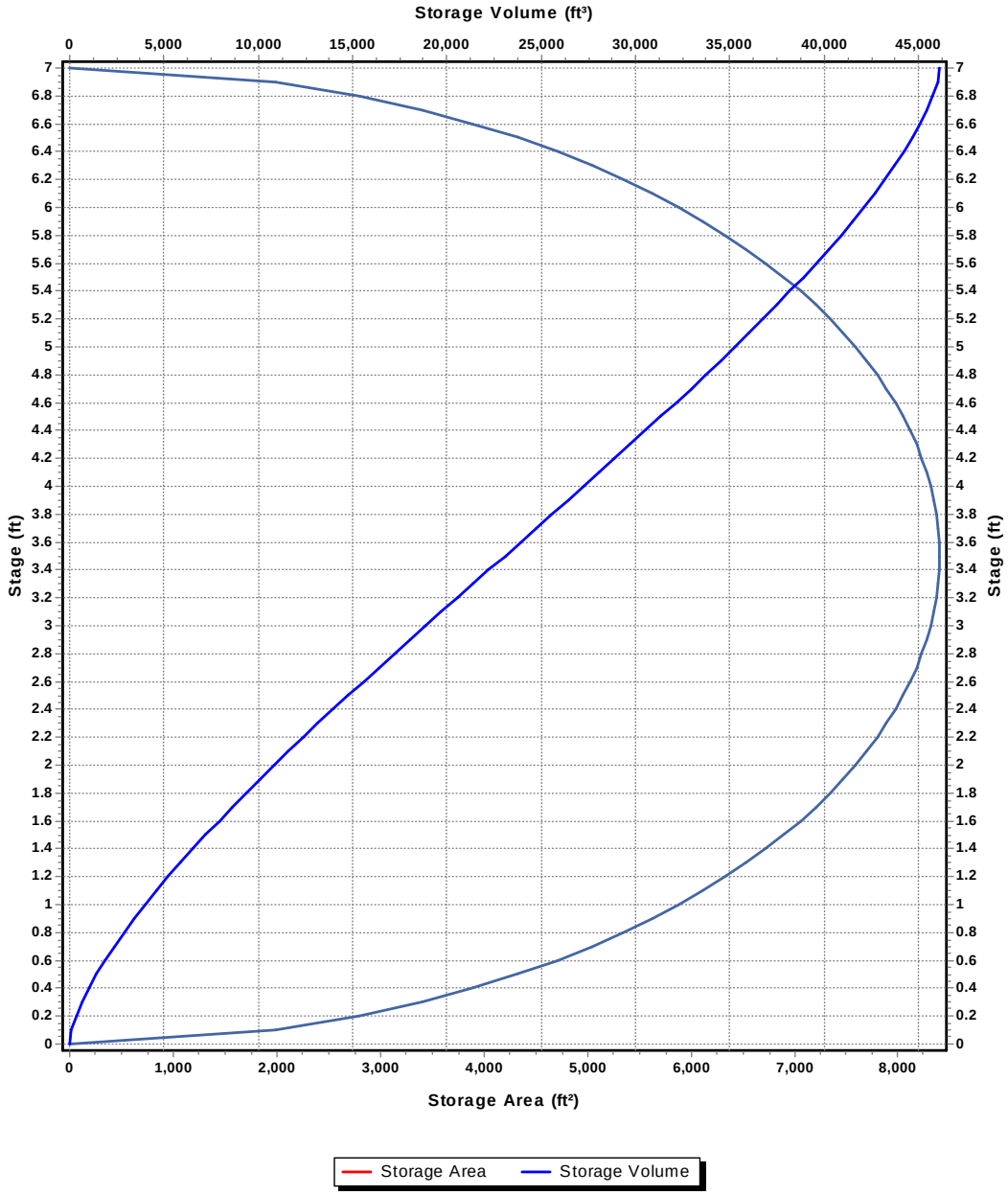
Storage Area Volume Curves

Storage Curve : North Sub Storage

Stage (ft)	Storage Area (ft²)	Storage Volume (ft³)
0	0	0
0.1	1993.5897	99.68
0.2	2798.8569	339.3
0.3	3402.5873	649.37
0.4	3899.5384	1014.48
0.5	4326.6615	1425.79
0.6	4703.0203	1877.27
0.7	5040	2364.42
0.8	5345.0538	2883.67
0.9	5623.3798	3432.09
1	5878.7754	4007.2
1.1	6114.1148	4606.84
1.2	6331.6349	5229.13
1.3	6533.1156	5872.37
1.4	6720	6535.03
1.5	6893.4752	7215.7
1.6	7054.5305	7913.1
1.7	7203.9989	8626.03
1.8	7342.5881	9353.36
1.9	7470.9036	10094.03
2	7589.4664	10847.05
2.1	7698.7272	11611.46
2.2	7799.0769	12386.35
2.3	7890.8555	13170.85
2.4	7974.3589	13964.11
2.5	8049.8447	14765.32
2.6	8117.5366	15573.69
2.7	8177.628	16388.45
2.8	8230.2855	17208.85
2.9	8275.651	18034.15
3	8313.8439	18863.62
3.1	8344.9626	19696.56
3.2	8369.086	20532.26
3.3	8386.2745	21370.03
3.4	8396.5707	22209.17
3.5	8400	23049
3.6	8396.5707	23888.83
3.7	8386.2745	24727.97
3.8	8369.086	25565.74
3.9	8344.9626	26401.44
4	8313.8439	27234.38
4.1	8275.651	28063.85
4.2	8230.2855	28889.15
4.3	8177.628	29709.55
4.4	8117.5366	30524.31
4.5	8049.8447	31332.68
4.6	7974.3589	32133.89
4.7	7890.8555	32927.15
4.8	7799.0769	33711.65
4.9	7698.7272	34486.54
5	7589.4664	35250.95
5.1	7470.9036	36003.97
5.2	7342.5881	36744.64
5.3	7203.9989	37471.97
5.4	7054.5305	38184.9

5.5	6893.4752	38882.3
5.6	6720	39562.97
5.7	6533.1156	40225.63
5.8	6331.6349	40868.87
5.9	6114.1148	41491.16
6	5878.7754	42090.8
6.1	5623.3798	42665.91
6.2	5345.0538	43214.33
6.3	5040	43733.58
6.4	4703.0203	44220.73
6.5	4326.6615	44672.21
6.6	3899.5384	45083.52
6.7	3402.5873	45448.63
6.8	2798.8569	45758.7
6.9	1993.5897	45998.32
7	0	46098

Storage Area Volume Curves



Storage Node : NorthSubStor (continued)

Outflow Weirs

SN	Element ID	Weir Type	Flap Gate	Crest Elevation (ft)	Crest Offset (ft)	Length (ft)	Weir Total Height (ft)	Discharge Coefficient
1	Weir-01	V-Notch	No	3.88	3.88	2.38	2.01	2.40

Outflow Orifices

SN	Element ID	Orifice Type	Orifice Shape	Flap Gate	Circular Orifice Diameter (ft)	Rectangular Orifice Height (ft)	Rectangular Orifice Width (ft)	Orifice Invert Elevation (ft)	Orifice Coefficient
1	N10yr	Side	CIRCULAR	No	0.93			2.42	0.61
2	N2yr	Side	CIRCULAR	No	0.39			0.00	0.61

Output Summary Results

Peak Inflow (cfs)	6.66
Peak Lateral Inflow (cfs)	6.66
Peak Outflow (cfs)	0.88
Peak Exfiltration Flow Rate (cfm)	0
Max HGL Elevation Attained (ft)	2.41
Max HGL Depth Attained (ft)	2.41
Average HGL Elevation Attained (ft)	0.31
Average HGL Depth Attained (ft)	0.31
Time of Max HGL Occurrence (days hh:mm)	0 13:53
Total Exfiltration Volume (1000-ft³)	0
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0

Storage Node : SouthSubPond

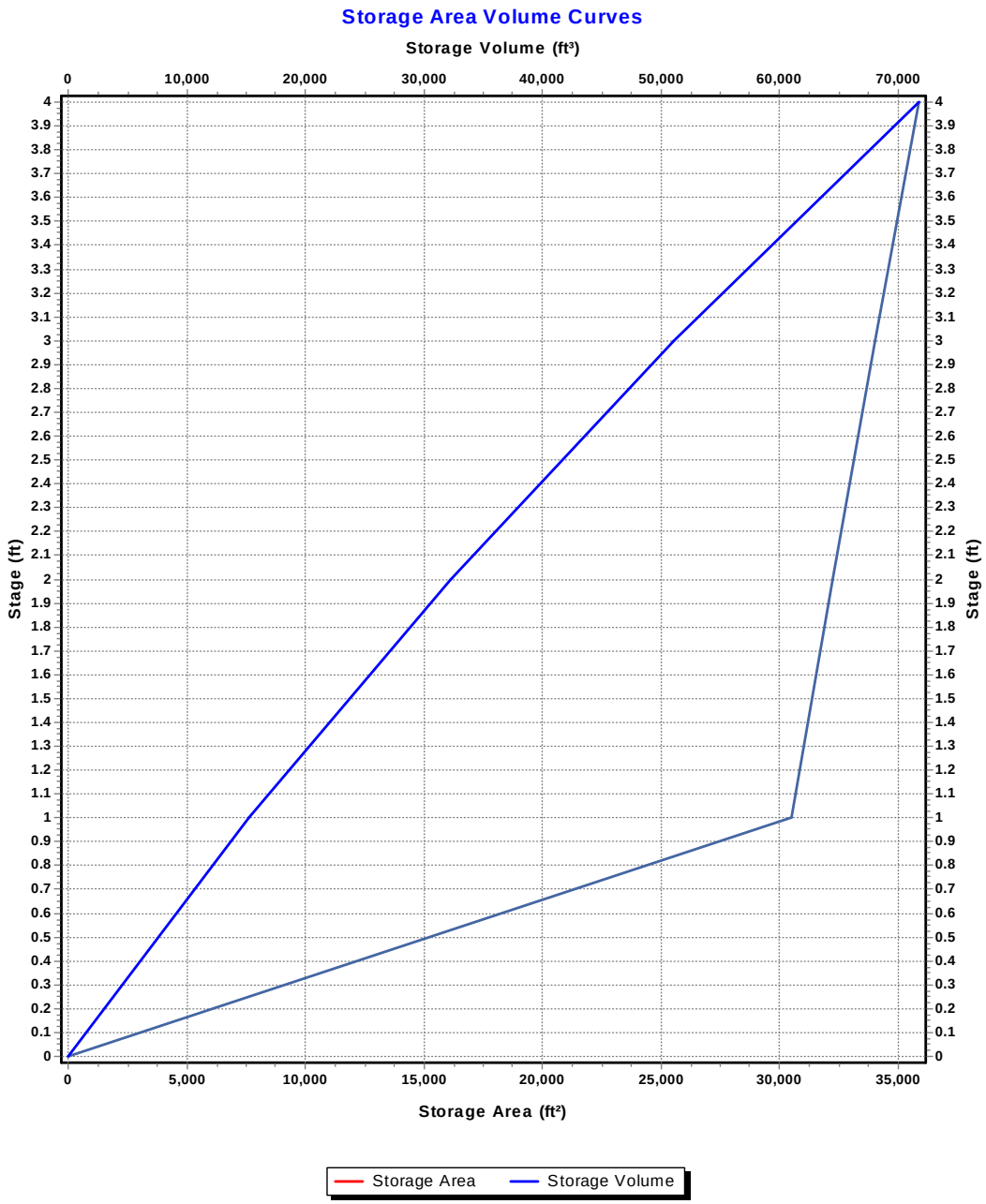
Input Data

Invert Elevation (ft)	0.00
Max (Rim) Elevation (ft)	6.00
Max (Rim) Offset (ft)	6.00
Initial Water Elevation (ft)	0.00
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

Storage Area Volume Curves

Storage Curve : South Sub Pond

Stage (ft)	Storage Area (ft²)	Storage Volume (ft³)
0	0	0
1	30520	15260
2	32272	32272
3	34060.67	51091
4	35887	71774


Storage Area Volume Curves
Storage Volume (ft³)
0
10,000
20,000
30,000
40,000
50,000
60,000
70,000
Stage (ft)
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
1.1
1.2
1.3
1.4
1.5
1.6
1.7
1.8
1.9
2
2.1
2.2
2.3
2.4
2.5
2.6
2.7
2.8
2.9
3
3.1
3.2
3.3
3.4
3.5
3.6
3.7
3.8
3.9
4
Storage Area (ft²)
0
5,000
10,000
15,000
20,000
25,000
30,000
35,000
Storage Area
Storage Volume

Storage Node : SouthSubPond (continued)

Outflow Orifices

SN	Element ID	Orifice Type	Orifice Shape	Flap Gate	Circular Orifice Diameter (ft)	Rectangular Orifice Height (ft)	Rectangular Orifice Width (ft)	Orifice Invert Elevation (ft)	Orifice Coefficient
1	S100yr	Side	CIRCULAR	No	0.96			1.56	0.61
2	S10yr	Side	CIRCULAR	No	1.50			0.95	0.61
3	S2yr	Side	CIRCULAR	No	0.80			0.00	0.61

Output Summary Results

Peak Inflow (cfs)	8.01
Peak Lateral Inflow (cfs)	8.01
Peak Outflow (cfs)	1.83
Peak Exfiltration Flow Rate (cfm)	0
Max HGL Elevation Attained (ft)	0.94
Max HGL Depth Attained (ft)	0.94
Average HGL Elevation Attained (ft)	0.1
Average HGL Depth Attained (ft)	0.1
Time of Max HGL Occurrence (days hh:mm)	0 13:02
Total Exfiltration Volume (1000-ft³)	0
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0

Storage Nodes

Storage Node : NorthSubStor

Input Data

Invert Elevation (ft)	0.00
Max (Rim) Elevation (ft)	6.00
Max (Rim) Offset (ft)	6.00
Initial Water Elevation (ft)	0.00
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

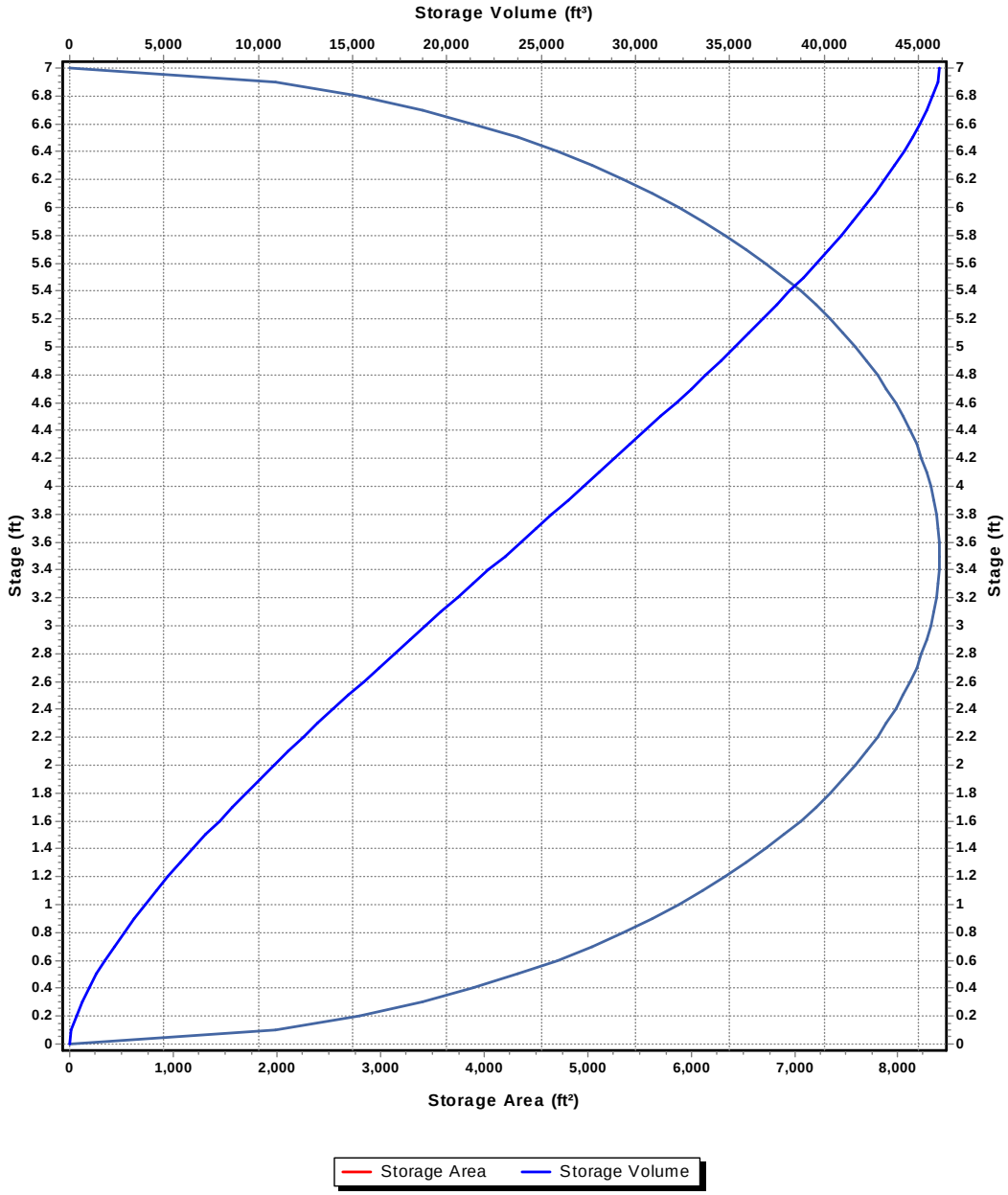
Storage Area Volume Curves

Storage Curve : North Sub Storage

Stage (ft)	Storage Area (ft²)	Storage Volume (ft³)
0	0	0
0.1	1993.5897	99.68
0.2	2798.8569	339.3
0.3	3402.5873	649.37
0.4	3899.5384	1014.48
0.5	4326.6615	1425.79
0.6	4703.0203	1877.27
0.7	5040	2364.42
0.8	5345.0538	2883.67
0.9	5623.3798	3432.09
1	5878.7754	4007.2
1.1	6114.1148	4606.84
1.2	6331.6349	5229.13
1.3	6533.1156	5872.37
1.4	6720	6535.03
1.5	6893.4752	7215.7
1.6	7054.5305	7913.1
1.7	7203.9989	8626.03
1.8	7342.5881	9353.36
1.9	7470.9036	10094.03
2	7589.4664	10847.05
2.1	7698.7272	11611.46
2.2	7799.0769	12386.35
2.3	7890.8555	13170.85
2.4	7974.3589	13964.11
2.5	8049.8447	14765.32
2.6	8117.5366	15573.69
2.7	8177.628	16388.45
2.8	8230.2855	17208.85
2.9	8275.651	18034.15
3	8313.8439	18863.62
3.1	8344.9626	19696.56
3.2	8369.086	20532.26
3.3	8386.2745	21370.03
3.4	8396.5707	22209.17
3.5	8400	23049
3.6	8396.5707	23888.83
3.7	8386.2745	24727.97
3.8	8369.086	25565.74
3.9	8344.9626	26401.44
4	8313.8439	27234.38
4.1	8275.651	28063.85
4.2	8230.2855	28889.15
4.3	8177.628	29709.55
4.4	8117.5366	30524.31
4.5	8049.8447	31332.68
4.6	7974.3589	32133.89
4.7	7890.8555	32927.15
4.8	7799.0769	33711.65
4.9	7698.7272	34486.54
5	7589.4664	35250.95
5.1	7470.9036	36003.97
5.2	7342.5881	36744.64
5.3	7203.9989	37471.97
5.4	7054.5305	38184.9

5.5	6893.4752	38882.3
5.6	6720	39562.97
5.7	6533.1156	40225.63
5.8	6331.6349	40868.87
5.9	6114.1148	41491.16
6	5878.7754	42090.8
6.1	5623.3798	42665.91
6.2	5345.0538	43214.33
6.3	5040	43733.58
6.4	4703.0203	44220.73
6.5	4326.6615	44672.21
6.6	3899.5384	45083.52
6.7	3402.5873	45448.63
6.8	2798.8569	45758.7
6.9	1993.5897	45998.32
7	0	46098

Storage Area Volume Curves



Storage Node : NorthSubStor (continued)

Outflow Weirs

SN	Element ID	Weir Type	Flap Gate	Crest Elevation (ft)	Crest Offset (ft)	Length (ft)	Weir Total Height (ft)	Discharge Coefficient
1	Weir-01	V-Notch	No	3.88	3.88	2.38	2.01	2.40

Outflow Orifices

SN	Element ID	Orifice Type	Orifice Shape	Flap Gate	Circular Orifice Diameter (ft)	Rectangular Orifice Height (ft)	Rectangular Orifice Width (ft)	Orifice Invert Elevation (ft)	Orifice Coefficient
1	N10yr	Side	CIRCULAR	No	0.93			2.42	0.61
2	N2yr	Side	CIRCULAR	No	0.39			0.00	0.61

Output Summary Results

Peak Inflow (cfs)	15.18
Peak Lateral Inflow (cfs)	15.18
Peak Outflow (cfs)	4.45
Peak Exfiltration Flow Rate (cfm)	0
Max HGL Elevation Attained (ft)	3.87
Max HGL Depth Attained (ft)	3.87
Average HGL Elevation Attained (ft)	0.49
Average HGL Depth Attained (ft)	0.49
Time of Max HGL Occurrence (days hh:mm)	0 12:51
Total Exfiltration Volume (1000-ft³)	0
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0

Storage Node : SouthSubPond

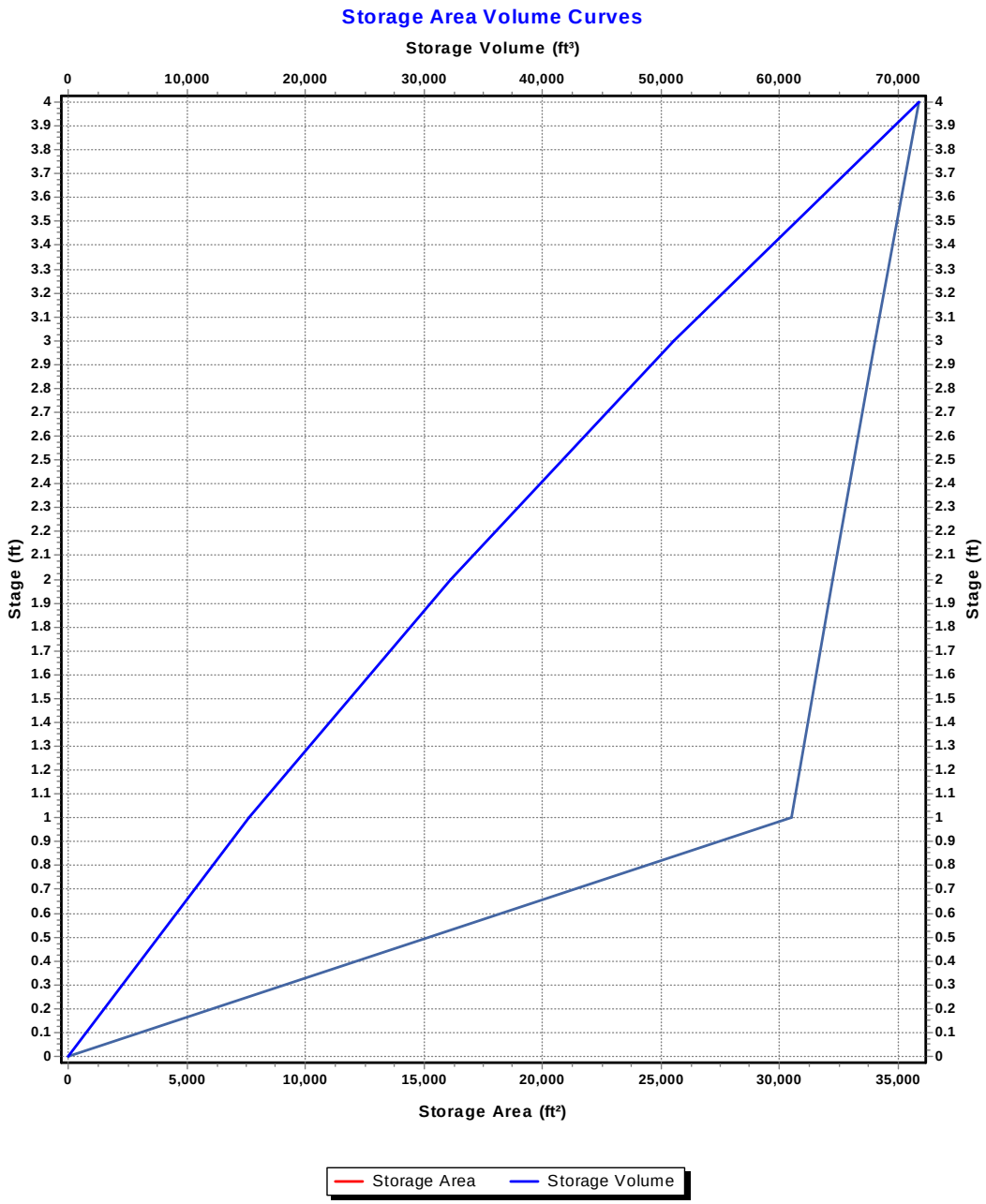
Input Data

Invert Elevation (ft)	0.00
Max (Rim) Elevation (ft)	6.00
Max (Rim) Offset (ft)	6.00
Initial Water Elevation (ft)	0.00
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

Storage Area Volume Curves

Storage Curve : South Sub Pond

Stage (ft)	Storage Area (ft²)	Storage Volume (ft³)
0	0	0
1	30520	15260
2	32272	32272
3	34060.67	51091
4	35887	71774


Storage Area Volume Curves
Storage Volume (ft³)
0
10,000
20,000
30,000
40,000
50,000
60,000
70,000
Stage (ft)
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
1.1
1.2
1.3
1.4
1.5
1.6
1.7
1.8
1.9
2
2.1
2.2
2.3
2.4
2.5
2.6
2.7
2.8
2.9
3
3.1
3.2
3.3
3.4
3.5
3.6
3.7
3.8
3.9
4
Storage Area (ft²)
0
5,000
10,000
15,000
20,000
25,000
30,000
35,000
Storage Area
Storage Volume

Storage Node : SouthSubPond (continued)

Outflow Orifices

SN	Element ID	Orifice Type	Orifice Shape	Flap Gate	Circular Orifice Diameter (ft)	Rectangular Orifice Height (ft)	Rectangular Orifice Width (ft)	Orifice Invert Elevation (ft)	Orifice Coefficient
1	S100yr	Side	CIRCULAR	No	0.96			1.56	0.61
2	S10yr	Side	CIRCULAR	No	1.50			0.95	0.61
3	S2yr	Side	CIRCULAR	No	0.80			0.00	0.61

Output Summary Results

Peak Inflow (cfs)	18.71
Peak Lateral Inflow (cfs)	18.71
Peak Outflow (cfs)	4.59
Peak Exfiltration Flow Rate (cfm)	0
Max HGL Elevation Attained (ft)	1.55
Max HGL Depth Attained (ft)	1.55
Average HGL Elevation Attained (ft)	0.17
Average HGL Depth Attained (ft)	0.17
Time of Max HGL Occurrence (days hh:mm)	0 12:54
Total Exfiltration Volume (1000-ft³)	0
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0

Storage Nodes

Storage Node : NorthSubStor

Input Data

Invert Elevation (ft)	0.00
Max (Rim) Elevation (ft)	6.00
Max (Rim) Offset (ft)	6.00
Initial Water Elevation (ft)	0.00
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

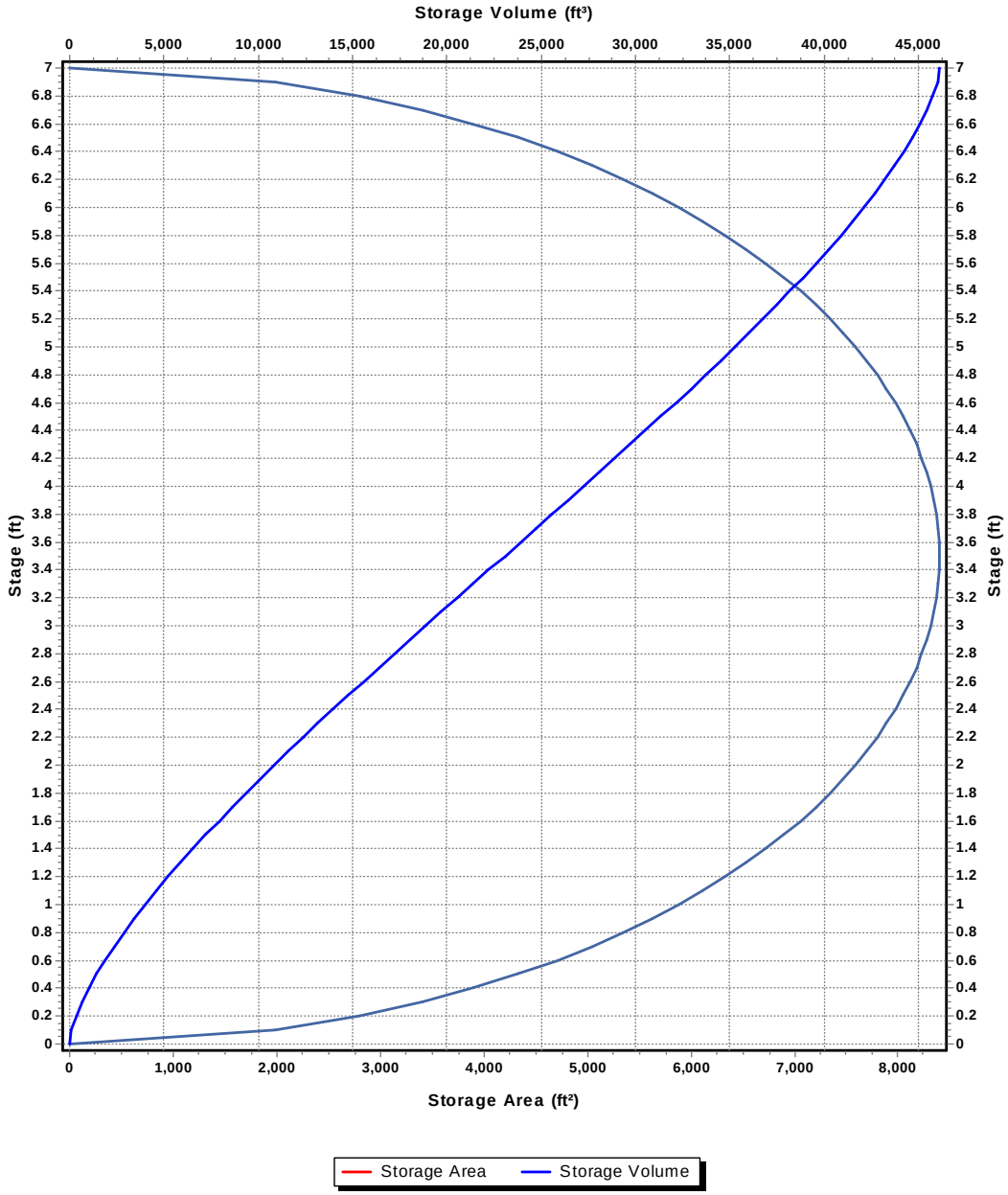
Storage Area Volume Curves

Storage Curve : North Sub Storage

Stage (ft)	Storage Area (ft²)	Storage Volume (ft³)
0	0	0
0.1	1993.5897	99.68
0.2	2798.8569	339.3
0.3	3402.5873	649.37
0.4	3899.5384	1014.48
0.5	4326.6615	1425.79
0.6	4703.0203	1877.27
0.7	5040	2364.42
0.8	5345.0538	2883.67
0.9	5623.3798	3432.09
1	5878.7754	4007.2
1.1	6114.1148	4606.84
1.2	6331.6349	5229.13
1.3	6533.1156	5872.37
1.4	6720	6535.03
1.5	6893.4752	7215.7
1.6	7054.5305	7913.1
1.7	7203.9989	8626.03
1.8	7342.5881	9353.36
1.9	7470.9036	10094.03
2	7589.4664	10847.05
2.1	7698.7272	11611.46
2.2	7799.0769	12386.35
2.3	7890.8555	13170.85
2.4	7974.3589	13964.11
2.5	8049.8447	14765.32
2.6	8117.5366	15573.69
2.7	8177.628	16388.45
2.8	8230.2855	17208.85
2.9	8275.651	18034.15
3	8313.8439	18863.62
3.1	8344.9626	19696.56
3.2	8369.086	20532.26
3.3	8386.2745	21370.03
3.4	8396.5707	22209.17
3.5	8400	23049
3.6	8396.5707	23888.83
3.7	8386.2745	24727.97
3.8	8369.086	25565.74
3.9	8344.9626	26401.44
4	8313.8439	27234.38
4.1	8275.651	28063.85
4.2	8230.2855	28889.15
4.3	8177.628	29709.55
4.4	8117.5366	30524.31
4.5	8049.8447	31332.68
4.6	7974.3589	32133.89
4.7	7890.8555	32927.15
4.8	7799.0769	33711.65
4.9	7698.7272	34486.54
5	7589.4664	35250.95
5.1	7470.9036	36003.97
5.2	7342.5881	36744.64
5.3	7203.9989	37471.97
5.4	7054.5305	38184.9

5.5	6893.4752	38882.3
5.6	6720	39562.97
5.7	6533.1156	40225.63
5.8	6331.6349	40868.87
5.9	6114.1148	41491.16
6	5878.7754	42090.8
6.1	5623.3798	42665.91
6.2	5345.0538	43214.33
6.3	5040	43733.58
6.4	4703.0203	44220.73
6.5	4326.6615	44672.21
6.6	3899.5384	45083.52
6.7	3402.5873	45448.63
6.8	2798.8569	45758.7
6.9	1993.5897	45998.32
7	0	46098

Storage Area Volume Curves



Storage Node : NorthSubStor (continued)

Outflow Weirs

SN	Element ID	Weir Type	Flap Gate	Crest Elevation (ft)	Crest Offset (ft)	Length (ft)	Weir Total Height (ft)	Discharge Coefficient
1	Weir-01	V-Notch	No	3.88	3.88	2.38	2.01	2.40

Outflow Orifices

SN	Element ID	Orifice Type	Orifice Shape	Flap Gate	Circular Orifice Diameter (ft)	Rectangular Orifice Height (ft)	Rectangular Orifice Width (ft)	Orifice Invert Elevation (ft)	Orifice Coefficient
1	N10yr	Side	CIRCULAR	No	0.93			2.42	0.61
2	N2yr	Side	CIRCULAR	No	0.39			0.00	0.61

Output Summary Results

Peak Inflow (cfs)	28.15
Peak Lateral Inflow (cfs)	28.15
Peak Outflow (cfs)	14.81
Peak Exfiltration Flow Rate (cfm)	0
Max HGL Elevation Attained (ft)	5.84
Max HGL Depth Attained (ft)	5.84
Average HGL Elevation Attained (ft)	0.64
Average HGL Depth Attained (ft)	0.64
Time of Max HGL Occurrence (days hh:mm)	0 12:35
Total Exfiltration Volume (1000-ft³)	0
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0

Storage Node : SouthSubPond

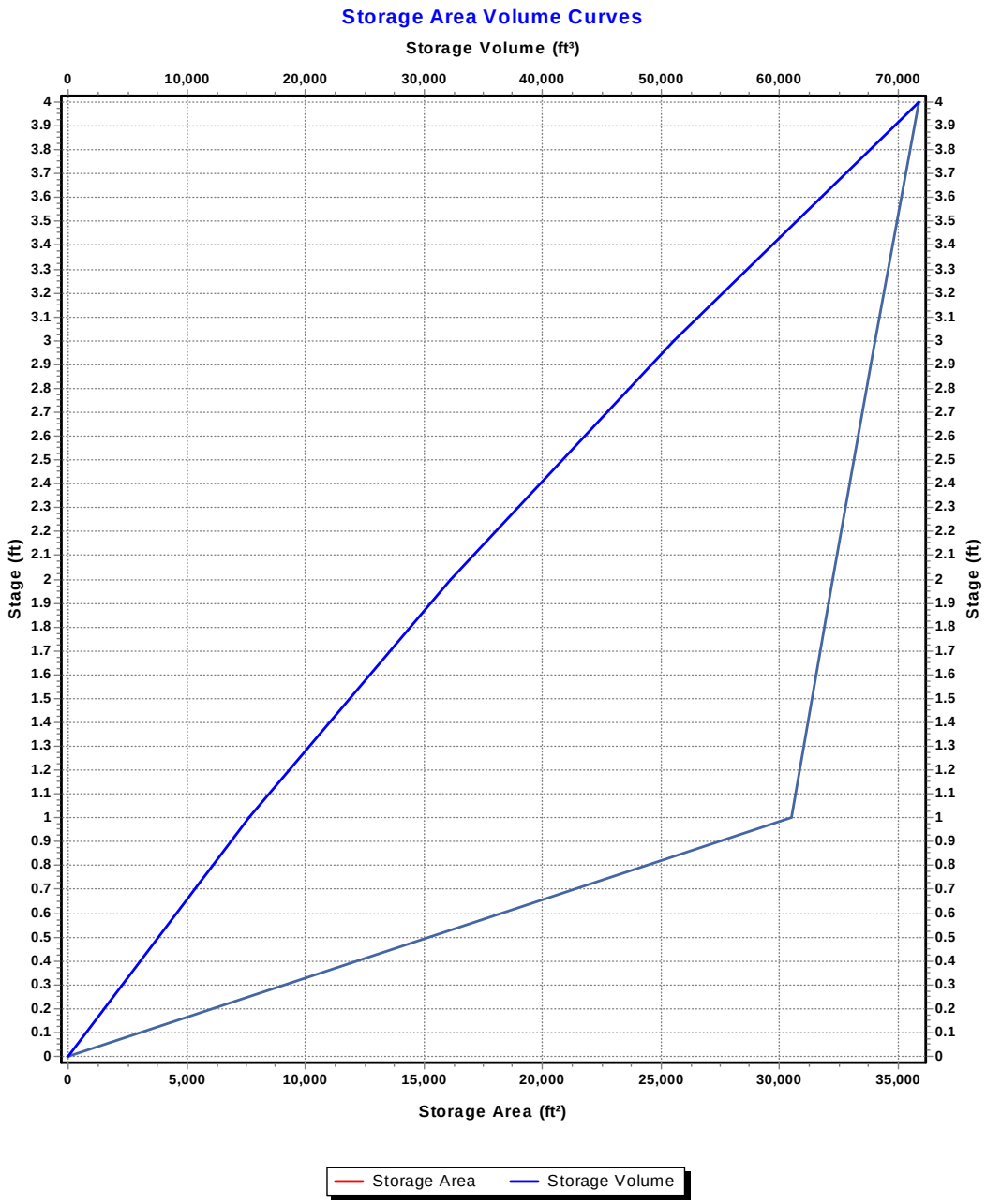
Input Data

Invert Elevation (ft)	0.00
Max (Rim) Elevation (ft)	6.00
Max (Rim) Offset (ft)	6.00
Initial Water Elevation (ft)	0.00
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

Storage Area Volume Curves

Storage Curve : South Sub Pond

Stage (ft)	Storage Area (ft²)	Storage Volume (ft³)
0	0	0
1	30520	15260
2	32272	32272
3	34060.67	51091
4	35887	71774


Storage Area Volume Curves
Storage Volume (ft³)
0
10,000
20,000
30,000
40,000
50,000
60,000
70,000
Stage (ft)
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
1.1
1.2
1.3
1.4
1.5
1.6
1.7
1.8
1.9
2
2.1
2.2
2.3
2.4
2.5
2.6
2.7
2.8
2.9
3
3.1
3.2
3.3
3.4
3.5
3.6
3.7
3.8
3.9
4
Storage Area (ft²)
0
5,000
10,000
15,000
20,000
25,000
30,000
35,000
Storage Area
Storage Volume

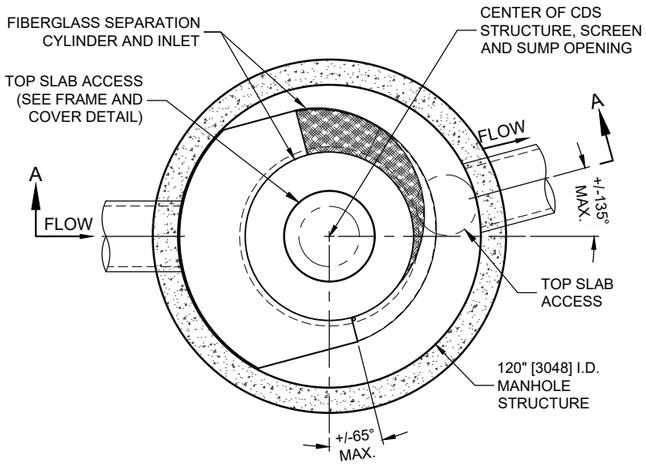
Storage Node : SouthSubPond (continued)

Outflow Orifices

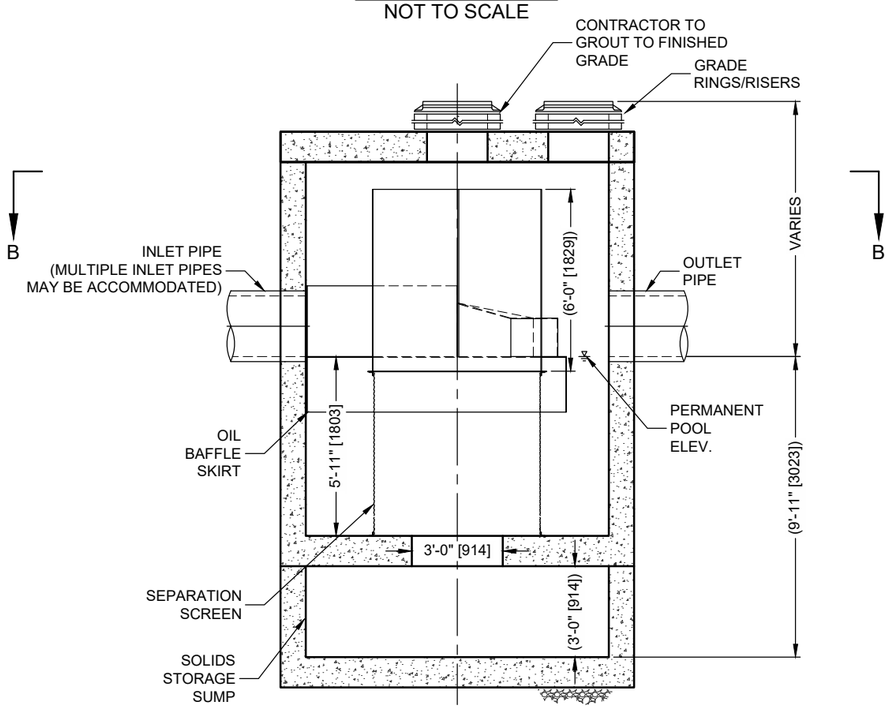
SN	Element ID	Orifice Type	Orifice Shape	Flap Gate	Circular Orifice Diameter (ft)	Rectangular Orifice Height (ft)	Rectangular Orifice Width (ft)	Orifice Invert Elevation (ft)	Orifice Coefficient
1	S100yr	Side	CIRCULAR	No	0.96			1.56	0.61
2	S10yr	Side	CIRCULAR	No	1.50			0.95	0.61
3	S2yr	Side	CIRCULAR	No	0.80			0.00	0.61

Output Summary Results

Peak Inflow (cfs)	35.53
Peak Lateral Inflow (cfs)	35.53
Peak Outflow (cfs)	11.86
Peak Exfiltration Flow Rate (cfm)	0
Max HGL Elevation Attained (ft)	2.33
Max HGL Depth Attained (ft)	2.33
Average HGL Elevation Attained (ft)	0.23
Average HGL Depth Attained (ft)	0.23
Time of Max HGL Occurrence (days hh:mm)	0 12:43
Total Exfiltration Volume (1000-ft³)	0
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0



PLAN VIEW B-B
NOT TO SCALE

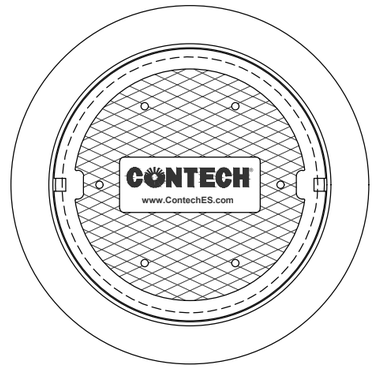


ELEVATION A-A
NOT TO SCALE

CDS5653-10-C DESIGN NOTES

CDS5653-10-C STANDARD CONFIGURATION IS SHOWN.

FOR NJDEP PROJECTS, PLEASE CONTACT YOUR LOCAL CONTECH REPRESENTATIVE FOR APPROVED CONFIGURATIONS.



FRAME AND COVER
(DIAMETER VARIES)
NOT TO SCALE

SITE SPECIFIC DATA REQUIREMENTS

STRUCTURE ID	
WATER QUALITY FLOW RATE (CFS OR L/s)	*
PEAK FLOW RATE (CFS OR L/s)	*
RETURN PERIOD OF PEAK FLOW (YRS)	*
SCREEN APERTURE (2400 OR 4700)	*

PIPE DATA:	I.E.	MATERIAL	DIAMETER
INLET PIPE 1	*	*	*
INLET PIPE 2	*	*	*
OUTLET PIPE	*	*	*

RIM ELEVATION	*

ANTI-FLOTATION BALLAST	WIDTH	HEIGHT
	*	*

NOTES/SPECIAL REQUIREMENTS:

* PER ENGINEER OF RECORD

GENERAL NOTES
1. CONTECH TO PROVIDE ALL MATERIALS UNLESS NOTED OTHERWISE.
2. FOR SITE SPECIFIC DRAWINGS WITH DETAILED STRUCTURE DIMENSIONS AND WEIGHT, PLEASE CONTACT YOUR CONTECH ENGINEERED SOLUTIONS LLC REPRESENTATIVE. www.ContechES.com
3. CDS WATER QUALITY STRUCTURE SHALL BE IN ACCORDANCE WITH ALL DESIGN DATA AND INFORMATION CONTAINED IN THIS DRAWING. CONTRACTOR TO CONFIRM STRUCTURE MEETS REQUIREMENTS OF PROJECT.
4. STRUCTURE SHALL MEET AASHTO HS20 LOAD RATING, ASSUMING EARTH COVER OF 0' - 2', AND GROUNDWATER ELEVATION AT, OR BELOW, THE OUTLET PIPE INVERT ELEVATION. ENGINEER OF RECORD TO CONFIRM ACTUAL GROUNDWATER ELEVATION. CASTINGS SHALL MEET AASHTO M306 AND BE CAST WITH THE CONTECH LOGO..
5. IF REQUIRED, PVC HYDRAULIC SHEAR PLATE IS PLACED ON SHELF AT BOTTOM OF SCREEN CYLINDER. REMOVE AND REPLACE AS NECESSARY DURING MAINTENANCE CLEANING.
6. CDS STRUCTURE SHALL BE PRECAST CONCRETE CONFORMING TO ASTM C-478 AND AASHTO LOAD FACTOR DESIGN METHOD.

INSTALLATION NOTES
A. ANY SUB-BASE, BACKFILL DEPTH, AND/OR ANTI-FLOTATION PROVISIONS ARE SITE-SPECIFIC DESIGN CONSIDERATIONS AND SHALL BE SPECIFIED BY ENGINEER OF RECORD.
B. CONTRACTOR TO PROVIDE EQUIPMENT WITH SUFFICIENT LIFTING AND REACH CAPACITY TO LIFT AND SET THE CDS MANHOLE STRUCTURE.
C. CONTRACTOR TO INSTALL JOINT SEALANT BETWEEN ALL STRUCTURE SECTIONS AND ASSEMBLE STRUCTURE.
D. CONTRACTOR TO PROVIDE, INSTALL, AND GROUT INLET AND OUTLET PIPE(S). MATCH PIPE INVERTS WITH ELEVATIONS SHOWN. ALL PIPE CENTERLINES TO MATCH PIPE OPENING CENTERLINES.
E. CONTRACTOR TO TAKE APPROPRIATE MEASURES TO ASSURE UNIT IS WATER TIGHT, HOLDING WATER TO FLOWLINE INVERT MINIMUM. IT IS SUGGESTED THAT ALL JOINTS BELOW PIPE INVERTS ARE GROUTED.

CONTECH ENGINEERED SOLUTIONS LLC
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9025 Centre Pointe Dr., Suite 400, West Chester, OH 45069
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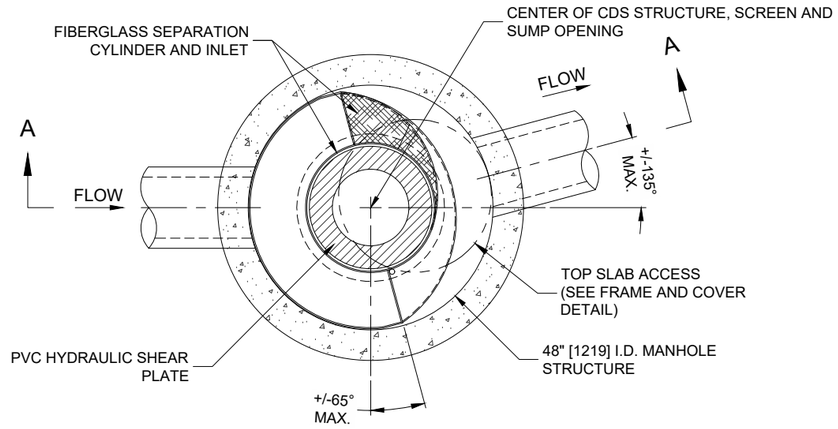
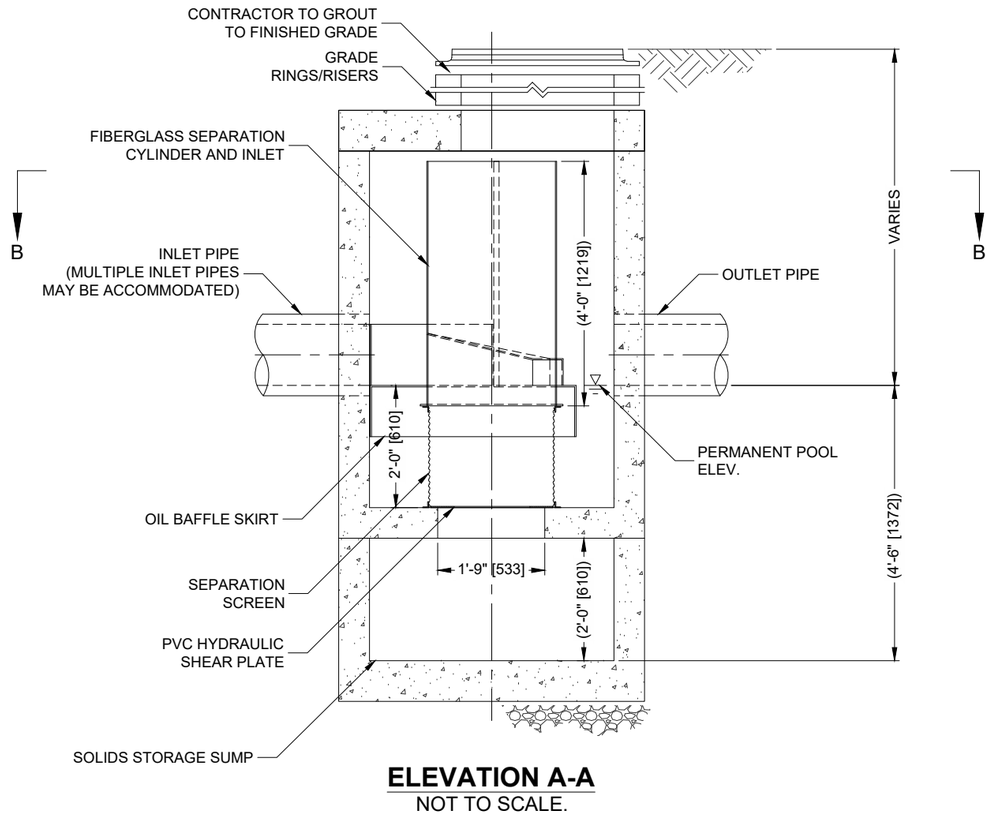
CDS5653-10-C
ONLINE CDS
STANDARD DETAIL



PLAN VIEW B-B
NOT TO SCALE.

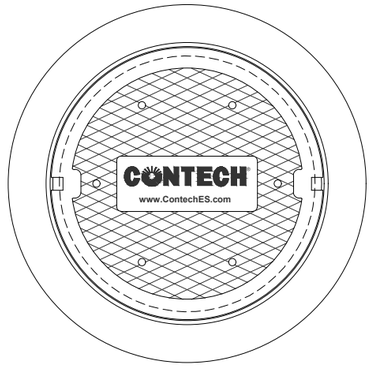


ELEVATION A-A
NOT TO SCALE.

CDS2015-4-C DESIGN NOTES

CDS2015-4-C STANDARD CONFIGURATION IS SHOWN.

FOR NJDEP PROJECTS, PLEASE CONTACT YOUR LOCAL CONTECH REPRESENTATIVE FOR APPROVED CONFIGURATIONS.



FRAME AND COVER
(DIAMETER VARIES)
NOT TO SCALE

SITE SPECIFIC DATA REQUIREMENTS

STRUCTURE ID			
WATER QUALITY FLOW RATE (CFS OR L/s)			*
PEAK FLOW RATE (CFS OR L/s)			*
RETURN PERIOD OF PEAK FLOW (YRS)			*
SCREEN APERTURE (2400 OR 4700)			*
PIPE DATA:	I.E.	MATERIAL	DIAMETER
INLET PIPE 1	*	*	*
INLET PIPE 2	*	*	*
OUTLET PIPE	*	*	*
RIM ELEVATION			*
ANTI-FLOTATION BALLAST		WIDTH	HEIGHT
		*	*

NOTES/SPECIAL REQUIREMENTS:

* PER ENGINEER OF RECORD

GENERAL NOTES
1. CONTECH TO PROVIDE ALL MATERIALS UNLESS NOTED OTHERWISE.
2. FOR SITE SPECIFIC DRAWINGS WITH DETAILED STRUCTURE DIMENSIONS AND WEIGHT, PLEASE CONTACT YOUR CONTECH ENGINEERED SOLUTIONS LLC REPRESENTATIVE. www.ContechES.com
3. CDS WATER QUALITY STRUCTURE SHALL BE IN ACCORDANCE WITH ALL DESIGN DATA AND INFORMATION CONTAINED IN THIS DRAWING. CONTRACTOR TO CONFIRM STRUCTURE MEETS REQUIREMENTS OF PROJECT.
4. STRUCTURE SHALL MEET AASHTO HS20 LOAD RATING, ASSUMING EARTH COVER OF 0' - 2', AND GROUNDWATER ELEVATION AT, OR BELOW, THE OUTLET PIPE INVERT ELEVATION. ENGINEER OF RECORD TO CONFIRM ACTUAL GROUNDWATER ELEVATION. CASTINGS SHALL MEET AASHTO M306 AND BE CAST WITH THE CONTECH LOGO..
5. IF REQUIRED, PVC HYDRAULIC SHEAR PLATE IS PLACED ON SHELF AT BOTTOM OF SCREEN CYLINDER. REMOVE AND REPLACE AS NECESSARY DURING MAINTENANCE CLEANING.
6. CDS STRUCTURE SHALL BE PRECAST CONCRETE CONFORMING TO ASTM C-478 AND AASHTO LOAD FACTOR DESIGN METHOD.

INSTALLATION NOTES
A. ANY SUB-BASE, BACKFILL DEPTH, AND/OR ANTI-FLOTATION PROVISIONS ARE SITE-SPECIFIC DESIGN CONSIDERATIONS AND SHALL BE SPECIFIED BY ENGINEER OF RECORD.
B. CONTRACTOR TO PROVIDE EQUIPMENT WITH SUFFICIENT LIFTING AND REACH CAPACITY TO LIFT AND SET THE CDS MANHOLE STRUCTURE.
C. CONTRACTOR TO INSTALL JOINT SEALANT BETWEEN ALL STRUCTURE SECTIONS AND ASSEMBLE STRUCTURE.
D. CONTRACTOR TO PROVIDE, INSTALL, AND GROUT INLET AND OUTLET PIPE(S). MATCH PIPE INVERTS WITH ELEVATIONS SHOWN. ALL PIPE CENTERLINES TO MATCH PIPE OPENING CENTERLINES.
E. CONTRACTOR TO TAKE APPROPRIATE MEASURES TO ASSURE UNIT IS WATER TIGHT, HOLDING WATER TO FLOWLINE INVERT MINIMUM. IT IS SUGGESTED THAT ALL JOINTS BELOW PIPE INVERTS ARE GROUTED.

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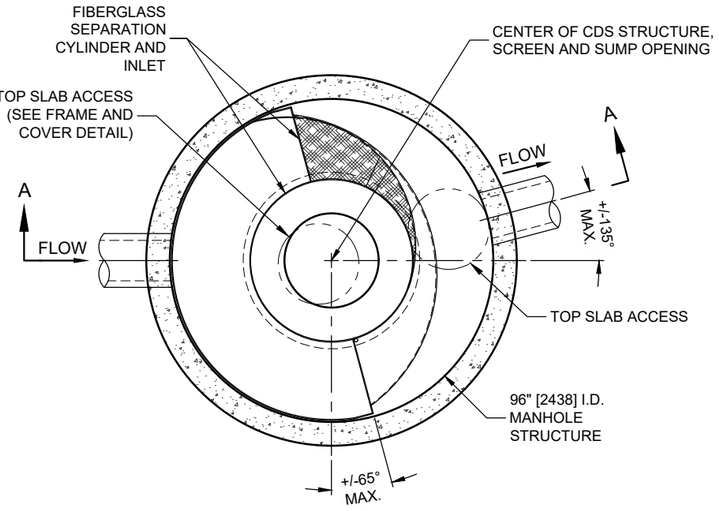
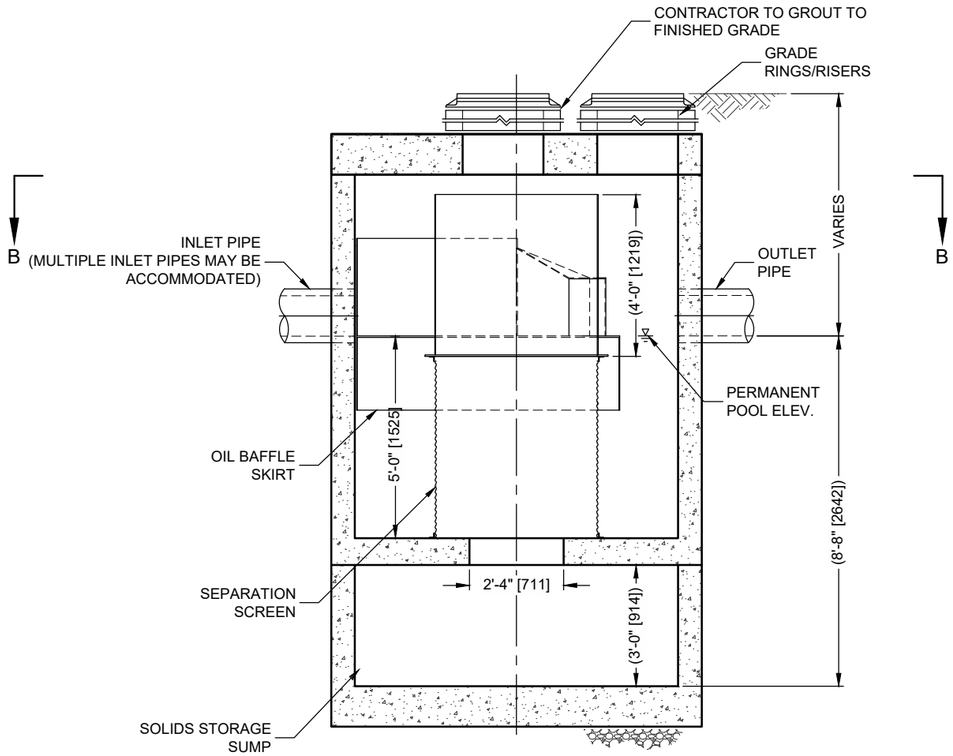
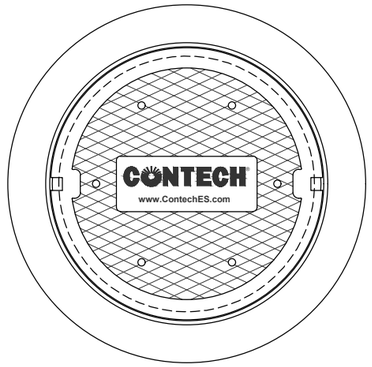
CDS2015-4-C ONLINE CDS STANDARD DETAIL



PLAN VIEW B-B
NOT TO SCALE



ELEVATION A-A
NOT TO SCALE



FRAME AND COVER
(DIAMETER VARIES)
NOT TO SCALE

CDS4045-8-C DESIGN NOTES

CDS4045-8-C STANDARD CONFIGURATION IS SHOWN.

SITE SPECIFIC DATA REQUIREMENTS

STRUCTURE ID	
WATER QUALITY FLOW RATE (CFS OR L/s)	*
PEAK FLOW RATE (CFS OR L/s)	*
RETURN PERIOD OF PEAK FLOW (YRS)	*
SCREEN APERTURE (2400 OR 4700)	*

PIPE DATA:	I.E.	MATERIAL	DIAMETER
INLET PIPE 1	*	*	*
INLET PIPE 2	*	*	*
OUTLET PIPE	*	*	*

RIM ELEVATION	*

ANTI-FLOTATION BALLAST	WIDTH	HEIGHT
	*	*

NOTES/SPECIAL REQUIREMENTS:

* PER ENGINEER OF RECORD

GENERAL NOTES
1. CONTECH TO PROVIDE ALL MATERIALS UNLESS NOTED OTHERWISE.
2. FOR SITE SPECIFIC DRAWINGS WITH DETAILED STRUCTURE DIMENSIONS AND WEIGHT, PLEASE CONTACT YOUR CONTECH ENGINEERED SOLUTIONS LLC REPRESENTATIVE. www.ContechES.com
3. CDS WATER QUALITY STRUCTURE SHALL BE IN ACCORDANCE WITH ALL DESIGN DATA AND INFORMATION CONTAINED IN THIS DRAWING. CONTRACTOR TO CONFIRM STRUCTURE MEETS REQUIREMENTS OF PROJECT.
4. STRUCTURE SHALL MEET AASHTO HS20 LOAD RATING, ASSUMING EARTH COVER OF 0' - 2', AND GROUNDWATER ELEVATION AT, OR BELOW, THE OUTLET PIPE INVERT ELEVATION. ENGINEER OF RECORD TO CONFIRM ACTUAL GROUNDWATER ELEVATION. CASTINGS SHALL MEET AASHTO M306 AND BE CAST WITH THE CONTECH LOGO..
5. IF REQUIRED, PVC HYDRAULIC SHEAR PLATE IS PLACED ON SHELF AT BOTTOM OF SCREEN CYLINDER. REMOVE AND REPLACE AS NECESSARY DURING MAINTENANCE CLEANING.
6. CDS STRUCTURE SHALL BE PRECAST CONCRETE CONFORMING TO ASTM C-478 AND AASHTO LOAD FACTOR DESIGN METHOD.

INSTALLATION NOTES
A. ANY SUB-BASE, BACKFILL DEPTH, AND/OR ANTI-FLOTATION PROVISIONS ARE SITE-SPECIFIC DESIGN CONSIDERATIONS AND SHALL BE SPECIFIED BY ENGINEER OF RECORD.
B. CONTRACTOR TO PROVIDE EQUIPMENT WITH SUFFICIENT LIFTING AND REACH CAPACITY TO LIFT AND SET THE CDS MANHOLE STRUCTURE.
C. CONTRACTOR TO INSTALL JOINT SEALANT BETWEEN ALL STRUCTURE SECTIONS AND ASSEMBLE STRUCTURE.
D. CONTRACTOR TO PROVIDE, INSTALL, AND GROUT INLET AND OUTLET PIPE(S). MATCH PIPE INVERTS WITH ELEVATIONS SHOWN. ALL PIPE CENTERLINES TO MATCH PIPE OPENING CENTERLINES.
E. CONTRACTOR TO TAKE APPROPRIATE MEASURES TO ASSURE UNIT IS WATER TIGHT, HOLDING WATER TO FLOWLINE INVERT MINIMUM. IT IS SUGGESTED THAT ALL JOINTS BELOW PIPE INVERTS ARE GROUTED.

CONTECH ENGINEERED SOLUTIONS LLC
www.contechES.com
9025 Centre Pointe Dr., Suite 400, West Chester, OH 45069
800-338-1122 513-645-7000 513-645-7993 FAX

CDS4045-8-C
ONLINE CDS
STANDARD DETAIL

Cushing Terrell

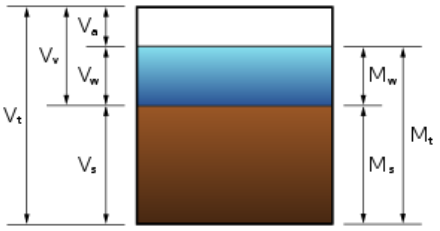
Appendix D: Detention Facility Computations

INTERMEDIATE POND STAGE STORAGE			
ELEVATION (FT)	CONTOUR AREA (SF)	INCREMENTAL VOL. (CF)	CUMULATIVE VOL. (CF)
3,511.50	12,973.07	N/A	0
3,512.00	13,931.68	6726.19	6726.19
3,513.00	15,891.31	14911.5	21637.68
3,514.00	17,907.49	16899.4	38537.08
3,515.00	19,980.22	18943.86	57480.94
3,516.00	22,109.50	21044.86	78525.8

NORTH SUBSURFACE STAGE STORAGE			
ELEVATION (FT)	DEPTH (FT)	INCREMENTAL VOL. (CF)	CUMULATIVE VOL. (CF)
3,479.22	N/A	N/A	0
3,480.22	1.00	4046.87	4046.87
3,481.22	2.00	6840.94	10887.81
3,482.22	3.00	8017.22	18905.04
3,483.22	4.00	8371.34	27276.38
3,484.22	5.00	8017.22	35293.60
3,485.22	6.00	6840.94	42134.54
3,486.22	7.00	4046.87	46181.41

Cushing Terrell

Appendix E: Geotechnical Report



Lorenzen Soil Mechanics, Inc.

Hillview Subdivision

Missoula, Montana

Geotechnical Engineering Report – Phase 2

Prepared for:
Hillview, LLC
205 Detroit Street, Suite 200
Denver, CO 80206
&
Cushing Terrell
306 Railroad Street, Suite 104
Missoula, MT 59802

Prepared by:
Lorenzen Soil Mechanics, Inc.
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Missoula, Montana 59808

September 13, 2022

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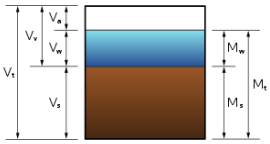


1 INTRODUCTION

On behalf of Hillview, LLC, Cushing Terrell requested Lorenzen Soil Mechanics, Inc. (LSM) to complete a general geotechnical/materials investigation for a subdivision within the southern portion of Missoula, Montana. The purpose of the subsurface investigation was to evaluate the subgrade materials and provide general recommendations for street typical sections, underground utilities, building foundations, slabs-on-grade, retaining walls, water infiltration, and slope stability for roughly 105 acres. Due to scheduling conflicts, the geotechnical investigation was conducted in two phases. The first stage primarily addressed the commercial and multi-family portions of the subdivision and is located within the southwestern portion of the Development. Its streets line up directly with Clearview Way and with Village View Way, each intersecting with Hillview Way. The geotechnical report for the Phase 1 portion was completed March 20, 2022.

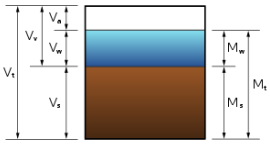
This geotechnical report represents the Phase 2 portion of the project and is mostly east and north of the Phase 1 portion. LSM understands this area will primarily be residential with single-family homes serviced by an array of city streets.

2 SITE EVALUATION

LSM understands the overall site has primarily been used for pasture grazing. A portion of the Development addressed in Phase 1 had been mined for gravel. Grading operations for Phase 1 were underway at the time of LSM's Phase 2 geotechnical investigation which occurred June 30 and July 1, 2022.

Geologically, this area is mapped on the Missoula West 30' x 60' Quadrangle Geologic Map (MBMG Open File Report 373). The geologic map depicts the site primarily as Miocene through Pliocene epochs Alluvial Fan Deposits (Taf) and to a lesser amount, as Eocene through Miocene epochs Gravel and Clay Deposits (Tgc). The Taf materials are characterized in the Open File Report as locally derived, poorly sorted (well-graded), angular to rounded boulders, cobbles, gravel, sand, and silt. It is likely equivalent to the Sixmile Formation of southwest Montana. The Tgc materials are characterized as channel and flood plain deposits of the ancestral Clark Fork River. They include well-sorted (poorly graded) and well-rounded cobbles, gravel, sand, silt, clay, and volcanic ash deposits. The clasts are not locally derived. The Open File Report notes that a marked angular unconformity at the top of the unit near Missoula is overlain by the Taf unit. Its coarser material intervals are permeable, but clay-rich zones are not. They are likely equivalent to the Renova Formation of southwest Montana. A portion of the geologic map is included as Figure 1. The map also notes nearby Belt Supergroup Snowslip Formation (Ysn) from the Middle Proterozoic Period. The Ysn materials are characterized as green and red argillite and siltite in the lower and middle part of the unit and reddish quartzite in the uppermost portion of the unit.

Three nearby water well logs data-based at the Montana Bureau of Mines and Geology were reviewed. The water wells appear to be associated with the three private residences to the



northeast of the Development. The logs indicate depths to the groundwater table ranged from 200 to 340 feet. The water well drilling depths extended from 360 to 440. Bedrock was noted in only one of the water well logs and that was logged as shale at a depth of 410 feet.

LSM conducted its subsurface investigation on June 30 and July 1, 2022. A Caterpillar 308CR mini-excavator, owned and operated by Grant Creek Excavating, was used to dig a total of thirteen test pits (TP). Figure 2 depicts the test pit locations for each of the two geotechnical phases. Horizontal coordinates were obtained using a Garmin eTrex® 10 GPS unit. The elevations were estimated from Google Earth. Figure 2 also includes the general locations for the three water wells.

The materials encountered in the Phase 2 test pits tended to agree with the MBMG Open File Report for the Taf and the Tgc materials in that there were gravel and sand with varying amounts of clayey fines and frequent to occasional cobble-sized particles. TP-11 featured fractured rock clasts with clayey infilling, indicating possible bedrock. Based on the water well logs and the materials encountered during LSM's investigation, the seismic site class is recommended as 'C – Very Dense Soils and Soft Rock'.

The groundwater table was not encountered in any of the test pits, the deepest depth of which extended to 8.5 feet. The moisture conditions of the subgrade materials were generally regarded as being 'damp' or 'moist'. Logs of the test pits and the testing results are provided in Appendix A. The three MBMG water well logs and the seismic spectral acceleration design values are included in Appendix A. Photographs of the test pitting operations and soil samples are included in Appendix B.

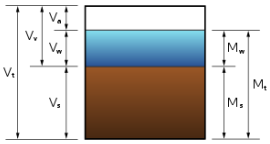
3 RECOMMENDATIONS

In general, LSM believes the gravelly soils encountered during the subgrade investigation are considered excellent for street and building construction. For residential structures, the excavated soils can be stockpiled and re-used on site as backfill, provided the cobble-sized (>3") particles and debris are removed. The recommendations that follow are generic to the test pit investigations completed thus far. LSM recommends including a more in-depth geotechnical for individual structures, or at the very least, a geotechnical review during the residential foundation excavations to verify the soils are consistent with what is provided in this general report. Some locations can expect to encounter perched groundwater zones that may develop into springs upon excavation. French drains and sumps may be necessary in some locations.

3.1 Street Typical Sections

LSM has evaluated a typical section for standard duty street traffic for this site using the Montana Department of Transportation (MDT) and American Association of State Highway and Transportation Officials (AASHTO) methods.

The A-1-a, A-1-b, and A-2-6 soils are considered acceptable as street subgrade soils. The A-1 soils in particular are considered excellent subgrade soils. Missoula County ranks the A-1 soils as 'good' and the A-2-6 soils as 'average'. Using Table 14.2-A in the MDT Geotechnical



Manual, the soil classifications correlate to an R-value ranging from 46 to greater than 70. LSM has conservatively based the typical section design on an R-value of 50, which correlates to a Resilient Modulus (M_R) of 20,000 psi. A California Bearing Ratio (CBR) range of 20 to 80 can be expected for the A-1 soils. A CBR range of 9 to 30 can be expected for the A-2 soils.

The M_R is used to calculate the design structural number for a flexible pavement. The R-value was correlated to a table provided in MDT's Geotechnical Manual. Other variables include the 18-kip equivalent single axle loadings (ESALs), initial serviceability, terminal serviceability, design serviceability loss, reliability level, and the overall standard deviation. Their values and description are provided below.

- Resistance Value, R-value = 50 - a material property used by MDT to characterize the support characteristics of the roadbed soil in flexible pavement design. It measures the response of a compacted sample of soil or aggregate to a vertically applied pressure.

- Roadbed Soil Resilient Modulus, M_R = 20,000 psi - a material property used by AASHTO to characterize the support characteristics of the roadbed soil in flexible pavement design. In general terms, it is a measure of the soil's deformation in response to repeated applications of load much smaller than a failure load.

- Equivalent Single Axle Loadings, ESALs = 1,000,000. This is an assumed value and is intended to take into account residential structure construction.

- Initial Serviceability, p_o = 4.2 - a measure of the pavement's smoothness or rideability immediately after construction. Serviceability is rated on a scale of 0 to 5, with 5 being a perfectly smooth pavement and 0 being a very rough or impassable pavement.

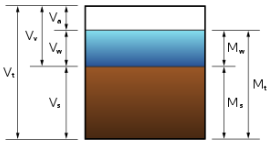
- Terminal Serviceability, p_t = 2.2 - the minimum tolerable serviceability of a pavement, on the same 0 to 5 scale as described in Initial Serviceability.

- Design Serviceability Loss, ΔPSI, = 2.0 – the difference between p_o and p_t.

- Reliability Level, R = 90 percent - the probability that a pavement structure will survive the design period traffic. Generally, as traffic volumes become larger, the consequences of premature pavement failure increases dramatically; therefore, high-volume roadways must be constructed with a much higher level of reliability than low-volume roadways.

- Overall Standard Deviation, S_o = 0.49 - accounts for all variability associated with design and construction inputs, including variability in material properties, roadbed soil properties, traffic estimates, climatic conditions, and quality of construction.

Based on the above criteria, a <u>required Structural Number (SN) of 2.50</u> was calculated using a nomograph developed by AASHTO. The nomograph is included in Appendix A.



The SN represents the ability of a flexible pavement to withstand structural loadings. Using the required SN, the thicknesses of the different material layers within the typical section can be determined as:

$$SN = a_1D_1m_1 + a_2D_2m_2 + a_nD_nm_n$$

The 'a' values represent structural coefficients, the 'D' values represent the layer thicknesses, and the 'm' values represent the drainage coefficients. A value of 0.41 was used for the asphalt cement structural coefficient, a_1. A value of 0.14 for virgin crushed base course was used for its structural coefficient, a_2. The structural coefficients are recommended values from a May 11, 2006 MDT memorandum for 'Revised Surfacing Structural Coefficients and Layer Thicknesses'. The drainage coefficient, m, is a function of the time required for the pavement to drain and the amount of time during the year that the pavement structure is exposed to moisture levels approaching saturation. MDT recommends a conservative drainage coefficient value of 1.0 for the plant mix surfacing and for the base course.

To match or exceed the required SN of 2.50, LSM proposes a typical section of:

Asphalt Plant Mix	4 inches – in two 2-inch thick lifts
3/4-inch Crushed Base	8 inches
Scarified and Wetted Subgrade	6 inches

This typical section produces a design SN of 2.76. LSM believes this to be an appropriate value, given the actual ESAL loadings are unknown at this time but may likely be less than the assumed value of 1,000,000 over a 20-year period in a residential neighborhood.

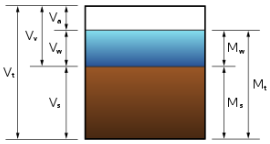
The gradation for the 3/4-inch crushed base course is provided in Table 1.

TABLE 1: 3/4" Crushed Base Course

Sieve Size	Percent Passing
3/4"	90 - 100
3/8"	70 - 90
No. 4	40 - 70
No. 10	25 - 55
No. 200	2 - 8

LSM recommends preparing the new street typical sections by:

1. Grading to the subgrade depth, extending the typical section to at least 1 horizontal foot beyond any curb and gutter section.
2. Scarifying to a depth of at least 6 inches and wetting the scarified surface.
3. Compacting the wetted, scarified surface to a standard relative compaction of at least 95 percent and at a moisture content within 2 percent of its optimum moisture content. The subgrade may be too coarse to have a relevant Proctor moisture density curve and, similar to the perimeter footing and slab-on-graded subgrades, the maximum dry density may need to be established in the field. LSM recommends using a roller compactor having an



operating weight of at least 25,000 pounds and a centrifugal force of at least 50,000 pounds.

4. Providing an 8-inch compacted thickness of 3/4-inch crushed aggregate base course meeting the gradation in Table 1. Recycled concrete can be blended with the base course, provided the end result meets the gradation recommendation.
5. Grading the final surface to drain stormwater to dry well sumps or other City-approved stormwater detention area.

LSM recommends a performance graded PG 58-28 binder for the asphalt concrete and the plant mix surfacing aggregate meeting the Montana Public Work's gradation presented in Table 2. The gradation bands in Table 2 represent the job mix target limits, which determine the suitability of aggregate. Provide the final job mix target gradation within the specified bands and uniformly graded from coarse to fine, not to vary from the low limit on one sieve to the high limit on the adjacent sieve, or vice-versa. For example, using the 3/8" and No. 4 sieves, a gradation of 73 percent and 48 percent passing their respective sieves is acceptable, 73 percent and 62 percent passing their respective sieves is not.

TABLE 2: Plant Mix Surfacing Gradation

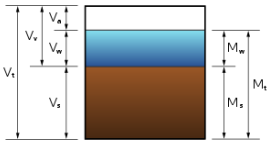
Sieve Size	% Passing Job Mix Target Bands	Job Mix Tolerances
3/4"	100	---
1/2"	83 - 93	+/- 7
3/8"	73 - 87	+/- 7
No. 4	47 - 63	+/- 6
No. 10	32 - 43	+/- 6
No. 40	15 - 25	+/- 5
No. 200	5 - 7	+/- 2

The job mix formula establishes target values. During mix production, the gradations are to fall within the job mix limits presented in Table 2, i.e. if a QA job mix target of 6 has been selected for the No. 200 sieve and since the tolerance is +/-2, the job mix gradation for production would be 4 - 8.

Place the asphalt concrete plant mix surfacing in a two 2-inch thick lifts and compacting each lift to an average relative compaction (ASTM D2041) of at least 93 percent, and no individual sample being less than 92 percent.

3.2 Residential Foundations

The recommendations that follow are very general and are meant to provide preliminary information regarding the construction of home foundations, stem and basement walls, and slabs-on-grade. A total of only thirteen test pits were excavated over a rather wide area that likely exceeds 60 acres. Groundwater studies were outside the scope of the geotechnical report. Perched groundwater zones are known to exist in the general area around the periphery of this development. Moisture conditions during the subsurface investigation indicate water is moving across the site. The clay layers likely act as an aquitard that may cause the groundwater to build



up in localized area. LSM recommends that during residential construction, a site investigation be completed that includes the installation of 1-inch diameter piezometers that can be periodically read to determine if groundwater is moving close to the surface and if it could affect the foundation excavations and lower levels of home sites.

3.2.1 Building Foundations

Continuous and isolated spread footings can be used to support normal building loads. LSM recommends setting the foundation footing elevations at least 3 feet below the final grading.

LSM recommends preparing the continuous foundation subgrades by:

1. Excavating to the subgrade elevation.
2. Scarifying to a depth of at least 6 inches. The scarifying can be completed with the excavator bucket. Remove cobble-sized particles larger than 3 inches that are brought to the subgrade surface and replace with stockpiled smaller granular spoils or imported structural backfill meeting the gradation in Table 3.

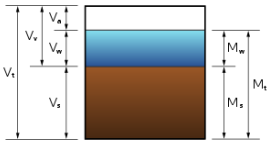
TABLE 3: Structural Backfill

Sieve Size	Percent Passing
3”	100
1”	80 - 100
1/2”	60 - 75
No. 4	35 - 55
No. 40	5 - 30
No. 200	0 - 8

3. Wetting the scarified surface to a moisture content within 2 percent of its optimum moisture content.
4. Compacting the wetted surface to a standard relative compaction (ASTM D698) of at least 98 percent. LSM recommends using a trench roller having an operating weight of at least 3,000 pounds and a centrifugal force of at least 15,000 pounds. The subgrade soils may be too coarse to receive a relevant Proctor moisture/density relationship curve. If so, the maximum dry density for the relative compaction can be established by making repeated passes with the trench roller and checking the dry density values with a nuclear densometer until they no longer increase. That value would then be used as the maximum dry density.
5. Setting the concrete formwork and tying the reinforcement steel.
6. Providing adequate dobies and chairs to support the reinforcement steel to keep it from settling toward the bottom of the footing.

Interior isolated footings can be set directly below the slab-on-grade elevations. They are to receive a subgrade preparation treatment similar to the continuous footings. LSM recommends preparing the isolated footing subgrades by:

1. Excavating to the subgrade elevation and scarifying to a depth of at least 9 inches.
2. Removing cobbles at the subgrade surface larger than 3 inches.



3. Wetting the scarified surface to a moisture content within 2 percent of its optimum moisture content.
4. Compacting the wetted surface to a standard relative compaction (ASTM D698) of at least 98 percent. If the excavated space does not allow room for the trench roller used for the continuous footings, LSM recommends using a plate compactor having an impact force of at least 3,800 pounds.
5. Setting the concrete formwork and tying the reinforcement steel.
6. Providing adequate dobies and chairs to support the reinforcement steel to keep it from settling toward the bottom of the footing.

The scarified and compacted gravels are considered an excellent bearing surface and will offer an allowable soil bearing capacity of 4,000 pounds per square foot (psf). A coefficient of friction, μ, of 0.45 can be used for either the continuous footing or the isolated footing sliding resistance designs.

LSM believes a perimeter drain tile system is prudent for these sites. LSM recommends that after stripping the foundation forms,

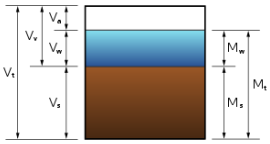
1. Excavating a separate, narrow (~12 inches wide) trench that is graded to drain to daylight on a slope of at least 0.5 percent along the outer edge of the foundation trench.
2. Providing a 4-inch diameter slotted PVC drain tile, geotextile filter sock meeting the engineering characteristics of Geotex® 111F, a 6-inch cover of 3/4-inch drain rock, and a non-woven geotextile meeting the engineering characteristics of Geotex 401 to burrito-wrap the drain tile and drain rock.
3. Installing the perimeter drain tile system along the outer perimeter of the drainage trench.
4. Providing a rodent guard at the drain's outlet and riprap rock to act as a landmark and to control possible erosion.

LSM recommends good building practices by including either wide eaves or rain gutters with downspouts that carry roof runoff water at least 7 horizontal feet away from the buildings and to provide positive drainage on at least a 2 percent slope extending at least 10 feet around the entire perimeter of each of the buildings.

3.3 Foundation Stem Walls/Retaining Walls

The stockpiled gravel soils can be re-used as backfill against the walls, provided all the 3-inch plus sized particles are removed. Prepare the foundation walls for backfilling by:

1. Ensuring there is a water stop at the wall and footing interface.
2. Providing damp proofing or water proofing as per the Architect or Structural Engineer's recommendations. Water proofing is required for living quarters that are below the ground surface.
3. Providing rigid expanded polystyrene (EPS) insulation along the exterior perimeter of the building foundation walls. In addition to insulation, the EPS insulation will provide a cushion to help protect the damp proofing or water proofing on the foundation walls during the backfilling operations.



4. Placing each of the backfill lifts in 8-inch (maximum) thick, loose lifts and compacting each lift to a standard relative compaction of at least 95 percent and at a moisture content within 2 percent of its optimum moisture content.

Compacting these materials as backfill will offer an internal angle of friction (ϕ) of 40°, and a moist unit weight (γ_m) of at least 140 pcf. For the on-site soils being used as backfill, LSM recommends using an active equivalent fluid unit weight (γ_{fa}) of 30.4 pounds per cubic foot (pcf) for wall design where the tops of the walls are allowed to rotate, such as for retaining walls. Where the walls are rigid, such as for foundation walls, LSM recommends an at-rest equivalent fluid unit weight (γ_{f0}) of 50.0 pcf. With a level backfill, the following equations can be used to obtain a resultant lateral force (pounds per lineal foot) acting at the lower one-third of the wall heights (H in feet):

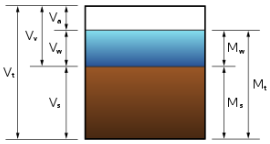
Active Pressure, P_a: $15.2 \times H^2$
Passive Pressure, P_p: $321.9 \times H^2$
At-rest Pressure, P_0: $25.0 \times H^2$
Seismic Pressure, P_E: $9.5 \times H^2$
Seismic Active Pressure, $P_{(E+a)}$: $24.7 \times H^2$

Retaining walls can be designed using the lateral earth pressures provided in this section. The allowable soil bearing capacity for the retaining walls is recommended to be 3,500 psf. The lower value is due to the likelihood the retaining wall base will be buried only 1 foot below the final grade. A 4-inch diameter slotted drain system is recommend directly behind the retaining walls. The drain system includes a PVC drain tile graded to drain to daylight and a 1-foot wide layer of 3/4-inch drain rock that extends from the base of the wall to its full height. The drain rock and drain tile are to be burrito-wrapped in a filter fabric meeting the engineering characteristics of Geotex 111F.

3.4 Slabs-on Grade

It is LSM's belief and opinion that the most important preparations for a slab-on-grade's subgrade include the surfaces being properly compacted and being level. LSM recommends the interior slab-on-grade subgrades be prepared by:

1. Excavating to the subgrade depth + 3 inches and scarifying the excavated surface by at least 6 inches. This can be accomplished with the excavator bucket's teeth or a disc.
2. Removing all cobble-sized particles in excess of 3 inches.
3. Moisture conditioning the scarified surface by wetting the subgrade to within 2 percent of its optimum moisture content.
4. Compacting the moisture conditioned subgrade to a standard relative compaction of at least 98 percent. Similar to the continuous and isolated footing subgrades, the slab subgrade may be too coarse to have a relevant Proctor moisture/density curve and will need to have its maximum dry density established in the field. LSM recommends using a roller compactor having an operating weight of at least 20,000 pounds and a centrifugal force of at least 40,000 pounds.



5. Providing a 3-inch thick leveling course of 3/4-inch minus cushion material meeting the gradation in Table 4. Alternatively, 3/4-inch drain rock can be used as the leveling course. A compacted, level surface prior to placing fresh concrete will help minimize concrete cracking.

TABLE 4: Leveling Course/Base Course

Sieve Size	Percent Passing
3/4”	100
3/8”	70 - 90
No. 4	40 - 70
No. 10	25 - 55
No. 200	0 - 8

6. Ensuring there are no visible rises or depressions across the compacted surface. Grade and compact the surface if it is uneven to make it level prior to placing fresh concrete.
7. Including temperature steel within the slab-on-grade at, or just above, it’s mid-depth.
8. Including sufficient dobies and chairs to provide support for the temperature steel, thereby preventing the steel from moving toward the bottom portion of the slab. LSM suggests a grid of 18-inch to 24-inch centers using No. 5 rebar or greater to provide room for the concrete flatworkers to step over the rebar during placement and finishing.

For slabs placed on the properly compacted and prepared subgrades as described, a modulus of subgrade reaction, k, of 300 pounds per square inch per inch of deflection (pci) can be used for the slab thickness design. Use a coefficient of friction, μ, of 0.45 for sliding resistance design.

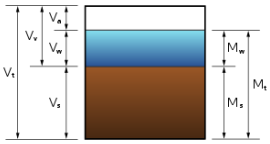
Varying amounts of curling within the slabs are likely to occur due to differences in the moisture content or to temperatures variations between the top and the bottom of the slab. To help mitigate potential slab curling, LSM recommends the following options:

1. Putting a chloride-free retardant additive into the fresh concrete mix;
2. Maintaining a minimum of 1.5 inches clearance on all rebar; and,
3. Placing a 15-mil thick polyolefin vapor barrier across the prepared subgrade surface prior to placing the fresh concrete. If the roof system and walls are in place prior to the slab pour, place the vapor barrier below the leveling course to mitigate edge curling. In addition to being a vapor barrier, the Stego® vapor barrier has a radon diffusion coefficient of 8.8×10^{-12} square meters per second.

The purpose of the retardant in the first option is to slow the set at the surface of the slab. No chlorides are allowed in any of the admixtures for the slabs-on-grade. The concrete at the slab surface will generally harden quicker than the concrete at the bottom of the slab. This is particularly true of concrete placed during hot weather conditions. The use of a retardant can also reduce cold joints, allow smaller crews to finish flat work, and permit later joint sawing.

For joint designs, LSM suggests:

1. Including isolation joints at all interior column locations.



2. Spacing control joints from 24 to 36 times the thickness of the slab in each direction.
3. Terminating reinforcing bars within 2 inches of both sides of control joints to limit the transfer of shrinkage and contraction restraints.
4. Cutting the joints with a conventional saw within 4 to 12 hours after the concrete is finished, or with a dry-cut early entry saw within 1 to 4 hours after the concrete is finished. Extend the saw cuts to one-quarter the thickness of the slab. If fiber reinforcing is used, increase the saw cut to one-third the thickness of the slab. If added correctly, fiber reinforcement can limit the growth of shrinkage cracking.

LSM yields to the Structural Engineer for the joint and steel reinforcement designs.

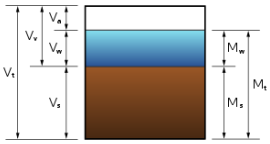
3.5 Exterior Flatwork

Exterior flatwork slabs such as utility and trash container pads, patios, lanais, and sidewalks are not anticipated to be supporting any loads other than the traffic intended for their use. LSM recommends preparing the flatwork subgrades by:

1. Excavating to the exterior flatwork subgrade.
2. Scarifying the excavation to a depth of at least 6 inches and removing all cobble-sized particles in excess of 3 inches that come to the surface.
3. Moisture-conditioning the scarified surface by wetting the subgrade to within 2 percent of its optimum moisture content.
4. Compacting the moisture-conditioned subgrade to a standard relative compaction of at least 95 percent.
5. Providing at least 6 inches of a compacted granular base course meeting the gradation presented in Table 4.
6. Compacting the base course to a relative compaction of at least 95 percent.
7. Ensuring there are no visible rises or depressions across the compacted surface and if needed, grading and further compacting the surface to make it level prior to placing fresh concrete.
8. Forming sidewalk slabs to be at least 4 inches in thickness. Where the sidewalks cross a driveway, form the sidewalk to be at least 8 inches thick.
9. Spacing the contraction joints a maximum of 8 feet apart and providing a maximum width of 1/4-inch, cut at least one-quarter of the depth of the concrete.
10. Installing expansion joints between slabs no more than 40 feet apart and at sidewalk/doorway entry interfaces. At these locations, provide a minimum width of 3/4-inch.
11. Filling all expansion joints with a field-molded sealant to prevent the infiltration of water into the underlying soils.
12. LSM suggests including steel or synthetic fibers with any tensile reinforcement to help prevent widening or horizontal separation of concrete cracks that may form.

3.6 Fresh Concrete

LSM recommends Type I/II cement for the footings and foundation walls. LSM suggests a concrete mix design have a 4-inch maximum slump before any water reducer (plasticizer)



admixture is added or up to 8 inches after it is added. The air content range should range from 5 to 8 percent for footings, foundation walls, and exterior flatwork. The inclusion of entrained air in the footings is a safeguard against concrete being placed and exposed during cold temperatures and if the frost depth extends below the footing elevation.

For the interior slab and exterior flatwork concrete, LSM recommends Type II cement *or* including a shrinkage reducing admixture and/or a hydration control admixture to Type I/II cement. The admixture are to be chloride-free. LSM understands Type II cement is no longer readily available in this region. The purpose of the cement type recommendation is to limit shrinkage cracking. LSM understands Type I/II cement meets the strength requirements for Type I cement and the composition requirements for Type II cement. Type I and Type III cements usually give higher early strengths than Type II cement but all else being equal, will also have higher concrete shrinkage than Type II cement. LSM recommends the maximum aggregate size be 1 ½ inches for the slab mix designs. LSM suggests the mix design have a 3-inch maximum slump before any water reducer (plasticizer) admixture is added or up to 8 inches after it is added. If fiber reinforced concrete is used, give consideration to providing a slump value associated with the fibers. Erect windbreaks and sunshades to limit rapid surface drying. Avoid curing with water that is more than 20°F cooler than the concrete. These recommendations are intended to limit the amount of shrinkage cracking in the slabs.

If the concrete will be freshly cast during cold temperatures, protect the fresh concrete from freezing. Do not cast fresh concrete on frozen ground. LSM recommends the Contractor provide an approved plan for protecting concrete being placed during cold weather.

LSM yields to the Structural Engineer in each of the concrete mix designs for footings, foundation walls, slabs-on-grade, and exterior flatwork.

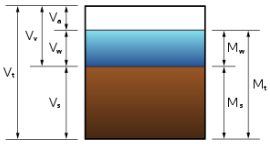
3.7 Slope Stability

It does appear that the current slope geometry is stable. The slopes can be assessed for the individual lots that encroach near the crest or the toe. Following the International Residential Code (IRC) R403.1.7, footings are to be located no closer than one-third the slope height or 4-feet, whichever is less, from a descending slope. The face of the structure is to be no closer than one-half the slope height or 15 feet, whichever is less, from an ascending slope. A geotechnical review is needed to determine is the structures can be closer to the slope surface.

3.8 Groundwater Table and Surface Water

The groundwater table was not encountered during the subsurface investigation, though none of the test pits extended beyond 8.5 feet of depth. Of the three nearby water well logs that were reviewed, the shallowest depth to the groundwater table was 317 feet.

LSM understands the City of Missoula is concerned with stormwater migrating down-gradient to the west and beyond Hillview Way, perhaps expressing itself as a spring or seep downslope. Without conducting extensive groundwater studies, LSM is not prepared to offer design guidelines other than to note the existing ground likely allows a rapid infiltration rate downward.



With hard surfacing and rooftops, plus added irrigation water that has not yet been seen across this property, surface water will likely become localized. LSM is aware there are springs nearby, likely fed by perched groundwater. If a spring is encountered, it is to be developed and routed away from the building sites. LSM can provide recommendations for developing the springs if necessary. Regardless, the residential sites must be graded during construction to limit ponding. LSM recommends berming all open excavations to prevent surface water from entering into them.

3.9 Underground Utilities

For utility trench excavations, the trench materials are expected to meet OSHA's requirements for a Type C soil. The steepest unsupported slope within a Type C soil trench is a 1 1/2H: 1V.

Use bedding soils that are minus 3/4-inch granular materials and are non-corrosive. A non-corrosive soil has a resistivity value greater than 3,000 ohm-centimeters. LSM recommends extending the bedding soil from the bottom of the utility trench to 6 inches above the top of the utility conduits. The native materials can be re-used as trench backfill over the bedding, provided the 3-inch and greater materials are removed. If the excavated cobble-sized materials are placed back in the utility trench, there will likely be uneven settlement due to the confined space in which to get an adequately sized piece of compaction equipment on the over-sized materials.

Soil compaction in utility trenches deeper than 5 feet should be performed using a remote trench compactor and observed by an inspector. The loose lift thickness are not to exceed 8 inches. When the backfill has been brought back to within 5 feet of the surface, perform compaction testing. Compact the trench backfill soils in 8-inch (maximum) thick, loose lifts to a standard relative compaction of at least 95 percent and at a moisture content within 2 percent of its optimum moisture content.

3.10 Seismic Considerations

The Missoula area is within the Northern Intermountain Seismic Belt. The ASCE/SEI 7-22 Hazards Report was used to develop the spectral response values for a seismic site class 'C', "Very Dense Soil and Soft Rock". LSM recommends the maximum credible spectral response accelerations at short 0.2-second periods, S_{MS}, and at 1-second periods, S_{M1}, to determine the seismic design base shear. A risk category of II was used for residential housing. The spectral response acceleration parameters are presented in Table 5.

The seismic backfill pressures against the buried portion of the foundation walls can be determined by adding a seismic event component, P_E, based on Seed and Whitman (1970) to the coefficient of active pressure P_a. The P_E was calculated to be 9.5 x H^2, making the active pressure against the wall during an earthquake equal to 24.7 x H^2 and was presented in Section 3.2. A factor of safety of 1.1 can be used for earthquake design lateral earth pressures and the allowable bearing capacity can be increased by one-third for seismic design.

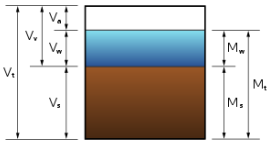


TABLE 5: Seismic Coefficients

ASCE/SEI 7-22, Earthquake Loads	
Site Class Definition	C
Mapped Spectral Response Acceleration Parameter, S_S for 0.2 second	0.42g
Mapped Spectral Response Acceleration Parameter, S_1 for 1.0 second	0.12g
Adjusted Maximum Considered Earthquake Spectral Response Acceleration Parameter, S_{MS}	0.46g
Adjusted Maximum Considered Earthquake Spectral Response Acceleration Parameter, S_{M1}	0.18g
Design Spectral Response Acceleration Parameter, S_{DS}	0.31g
Design Spectral Response Acceleration Parameter, S_{D1}	0.12g
Mean Peak Ground Acceleration, PGA_M	0.19g

Due to the expected groundwater depth being greater than 15 feet, liquefaction is considered to be a low concern at this site during a major earthquake.

3.11 Shrink/Swell Characteristics

The volume change potential for the coarse grained soils is considered low during seasonal moisture fluctuations for this particular site. The fine-grained soils that may be encountered within the foundation and slab-on-grade subgrades should be considered to have a medium to high volume change potential. These sites should be modified to limit its volume change potential. Though the fine-grained soils were not prevalent in the thirteen test pits, the test pit density is light compared to the number of lots across the sites. LSM does recommend that individual lots receive a geotechnical investigation specific to their site prior to design.

The frost heave potential is considered high if the subgrades are on fine-grained soils. Every effort must be made to direct surface water away from building foundation and flatwork subgrades. LSM recommends positive drainage away from the building's exterior perimeters be in place by providing at least 2 percent grades extending at least 10 horizontal feet away from the building's perimeters.

The collapse potential of the on-site soils is considered low due to the age of the soil profile.

3.12 Compaction and Fresh Concrete Testing Frequency

LSM recommends a compaction testing frequency presented in Table 6 for the foundation, slab-on-grade, and street subgrades, wall backfill, and utility trench backfill. LSM recommends concrete sampling and testing for fresh concrete. In addition to the compaction and fresh concrete testing, LSM recommends including applicable special inspections as per the International Building Code, Chapter 17.

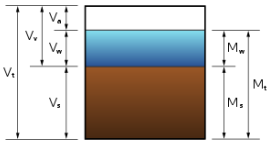


TABLE 6: Testing Frequency

Compaction Testing	
Beneath Column Footings	1 Test per Footing
Beneath Wall Footings	1 Test per 75 Lineal Feet of Wall
Foundation Wall/Column Backfill	1 Test per 100 Lineal Feet of Wall per Lift
Slabs-on-Grade Subgrade	1 Test per 2,000 Square Feet
Exterior Flatwork Subgrade	1 Test per 1,000 Square Feet
Roadway & Parking Subgrade and Aggregates	1 Test per 4,000 Square Feet
Utility Trench Backfill	1 Test per 200 Lineal Feet per Lift
Concrete Testing	
Structural Concrete[1]	1 Test per 50 Cubic Yards per Day
Non-Structural Concrete	1 Test per Day

[1.] Structural concrete includes all footings, foundation walls, slabs, and other load bearing elements.

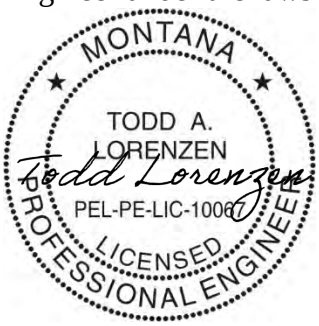
4 BASIS OF RECOMMENDATIONS

The analyses and recommendations submitted in this general report are based upon the subsurface investigation that was used to provide generic instructions for the subgrade preparations. Often, variations occur within the subgrade, the nature and extent of which do not become evident until additional exploration or construction is conducted. The test pits completed thus far are widely spaced but do provide an initial understanding as to the local geology.

This report is for the exclusive use of Hillview, LLC, Cushing Terrell and their design team. In the absence of LSM's written approval, LSM makes no representation and assumes no responsibility to other parties regarding this report. The data, analyses, and recommendations may not be appropriate for other structures or purposes.

Professional Certification

I hereby certify that this report was prepared by me and that I am a duly Licensed Professional Engineer under the laws of the State of Montana.



September 13, 2022

Todd Lorenzen, P.E.
Geotechnical Engineer

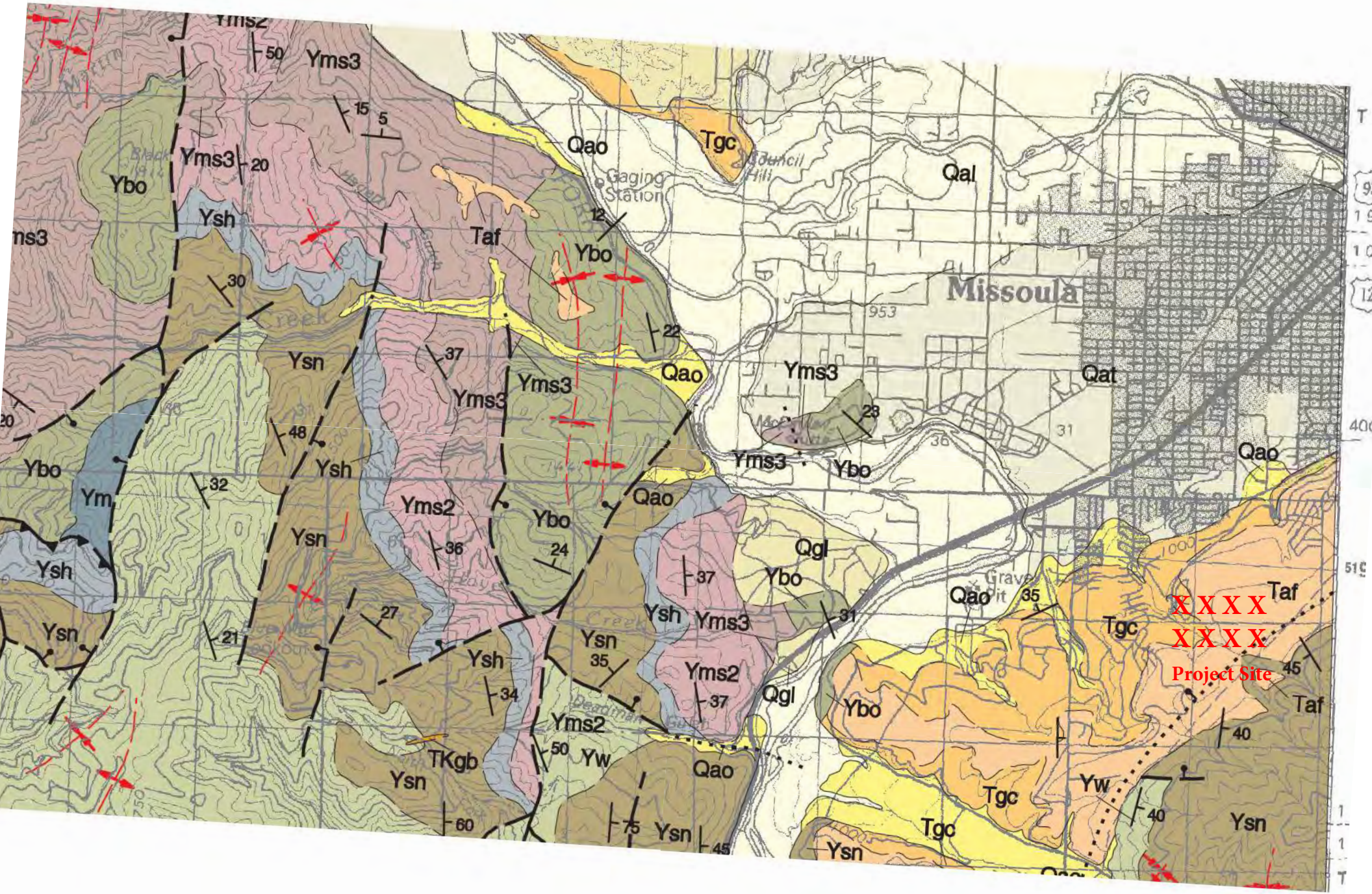


Figure 1: Portion of Montana Bureau of Mines and Geology Open File Report 373, Geologic Map of Missoula-West 30' x 60' Quadrangle; 1998 Reed S. Lewis.

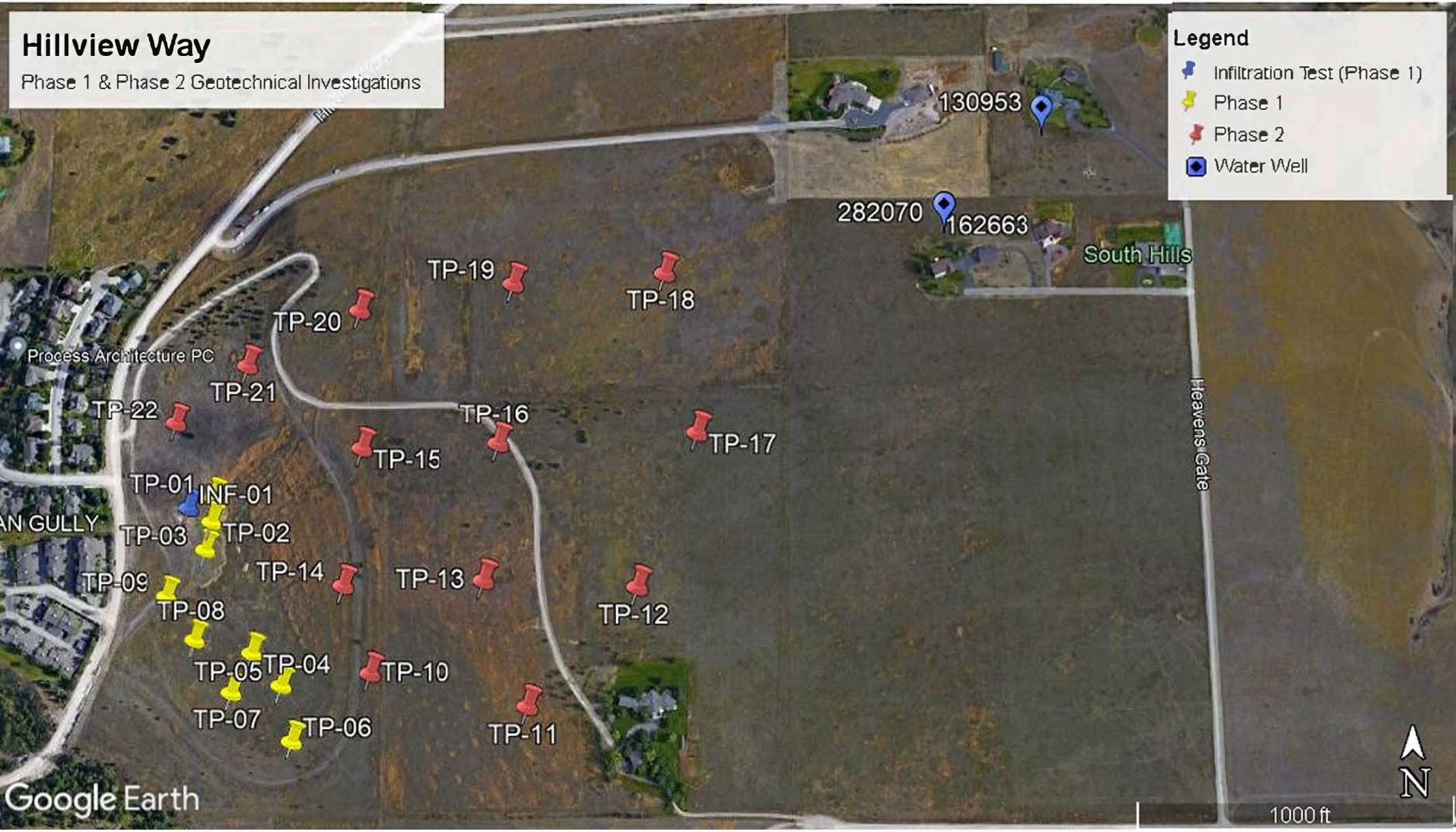
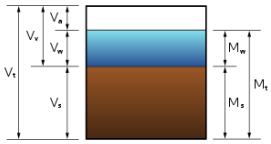


Figure 2: Test Pit Locations - Phase 1 (yellow pin), Phase 2 (red pin) and Water Well Locations (blue balloons)



APPENDIX A. LOGS OF TEST PITS AND TESTING INFORMATION

GENERAL NOTES

DRILLING & SAMPLING SYMBOLS:

SS:	Split Spoon - 1-3/8" I.D., 2" O.D., unless otherwise noted	CA:	Casing Advancer
ST:	Thin-Walled Tube - 2" O.D., unless otherwise noted	DA:	Drill Auger
CB:	California Sampler - 2" I.D., 2.5" O.D., unless otherwise noted	HA:	Hand Auger
DB:	Diamond Bit Coring - 4", NX, unless otherwise noted	RB:	Rock Bit
BS:	Bulk Sample or Auger Sample	GS:	Grab Sample

The number of blows required to advance a standard 2-inch O.D. split-spoon sampler (SS) the last 12 inches of the total 18-inch penetration with a 140-pound hammer falling 30 inches is considered the "Standard Penetration" or "N-value". The field blow counts are reported for each 6-inch interval, or portion thereof if greater than 50 blows are required to advance the full 6-inch interval. For over-sized split spoon samplers, non-standard hammers, or non-standard drop heights, the field penetration values are reported on the bore log. The values must be corrected to obtain the N-value.

WL:	Water Level	WS:	While Sampling	NE:	Not Encountered
WCl:	Wet Cave-In	WD:	While Drilling		
DCI:	Dry Cave-In	BCR:	Before Casing Removal		
AB:	After Boring	ACR:	After Casing Removal		

Groundwater table levels indicated on the boring logs are the levels measured in the borings at the times indicated. Groundwater table levels at other times and other locations across the site could vary. In pervious soils, the indicated levels may reflect the location of groundwater. In low permeability soils, the accurate determination of groundwater table levels may not be possible with only short-term observations.

DESCRIPTIVE SOIL CLASSIFICATION: Soil classification is based on the Unified Soil Classification System. Coarse Grained Soils have more than 50% of their dry weight retained on a #200 sieve; their principal descriptors are: gravel or sand. Cobbles and boulders are not part of the USCS system but are included, when present, as percentages. Fine Grained Soils have less than 50% of their dry weight retained on a #200 sieve; depending on their plasticity, they are described as clay or silt. Major constituents may be added as modifiers and minor constituents may be added according to the relative proportions based on grain size. In addition to gradation, coarse-grained soils are defined on the basis of their in-place relative density and fine-grained soils are defined on the basis of their consistency.

CONSISTENCY OF FINE-GRAINED SOILS

Unconfined Compressive Strength, Qu, psf	Standard Penetration or N-value (SS) Blows/Ft.	Consistency
< 500	0 - 1	Very Soft
500 - 1,000	2 - 4	Soft
1,001 - 2,000	5 - 8	Medium Stiff
2,001 - 4,000	9 - 15	Stiff
4,001 - 8,000	16 - 30	Very Stiff
8,000 +	30 +	Hard

RELATIVE DENSITY OF COARSE-GRAINED SOILS

Standard Penetration or N-value (SS) Blows/Ft.	California Barrel (CB) Blows/Ft.	Relative Density
0 - 4	0 - 6	Very Loose
5 - 10	7 - 18	Loose
11 - 30	19 - 58	Medium Dense
31 - 50	59 - 98	Dense
50 +	99 +	Very Dense

RELATIVE PROPORTIONS OF SAND AND GRAVEL

Descriptive Term(s) of Other Constituents	Percent of Dry Weight
Trace	< 15
With	15 - 30
Modifier	> 30

USCS* GRAIN SIZE TERMINOLOGY

Major Component of Sample	Particle Size
Boulders	Over 12 in. (300mm)
Cobbles	12 in. to 3 in. (300mm to 75 mm)
Gravel	3 in. to #4 sieve (75mm to 4.75 mm)
Sand	#4 to #200 sieve (4.75mm to 0.075mm)
Silt or Clay	Passing #200 Sieve (0.075mm)

*For AASHTO grain size the #4 sieve is replaced with the #10 sieve

RELATIVE PROPORTIONS OF FINES

Descriptive Term(s) of Other Constituents	Percent of Dry Weight
Trace	< 5
With	5 - 12
Modifiers	> 12

PLASTICITY DESCRIPTION

Term	Plasticity Index
Non-Plastic	0
Slightly	1 - 5
Low	6 - 10
Medium	11 - 20
Highly	21 - 40
Very Highly	> 40

GENERAL NOTES

Description of Rock Properties

WEATHERING

Fresh	Rock fresh, crystals bright, few joints may show slight staining. Rock rings under hammer if crystalline.
Very Slight	Rock generally fresh, joints stained, some joints may show thin clay coatings, crystals in broken face show bright. Rock rings under hammer if crystalline.
Slight	Rock generally fresh, joints stained, and discoloration extends into rock up to 1 in. Joints may contain clay. In granitoid rocks some occasional feldspar crystals are dull and discolored. Crystalline rocks ring under hammer.
Moderate	Significant portions of rock show discoloration and weathering effects. In granitoid rocks, most feldspars are dull and discolored; some show clayey. Rock has dull sound under hammer and shows significant loss of strength as compared with fresh rock.
Moderately Severe	All rock except quartz discolored or stained. In granitoid rocks, all feldspars dull and discolored and majority show kaolinization. Rock shows severe loss of strength and can be excavated with geologist's pick.
Highly	All rock except quartz discolored or stained. Rock "fabric" clear and evident, but reduced in strength to strong soil. In granitoid rocks, all feldspars kaolinized to some extent. Some fragments of strong rock usually left.
Very Highly	All rock except quartz discolored or stained. Rock "fabric" discernible, but mass effectively reduced to "soil" with only fragments of strong rock remaining.
Complete/Residual Soil	Rock reduced to "soil". Rock "fabric" not discernible or discernible only in small, scattered locations. Quartz may be present as dikes or stringers.

FIELD HARDNESS (for engineering description of rock not to be confused with Moh's scale for minerals)

Very Hard	Cannot be scratched with knife or sharp pick. Breaking of hand specimens requires several hard blows of geologist's pick.
Hard	Can be scratched with knife or pick only with difficulty. Hard blow of hammer required to detach hand specimen.
Moderately Hard	Can be scratched with knife or pick. Gouges or grooves to 1/4 in. deep can be excavated by hard blow of point of a geologist's pick. Hand specimens can be detached by moderate blow.
Medium	Can be grooved or gouged 1/16 in. deep by firm pressure on knife or pick point. Can be excavated in small chips to pieces about 1-in. maximum size by hard blows of the point of a geologist's pick.
Soft	Can be gouged or grooved readily with knife or pick point. Can be excavated in chips to pieces several inches in size by moderate blows of a pick point. Small thin pieces can be broken by finger pressure.
Very Soft	Can be carved with knife. Can be excavated readily with point of pick. Pieces 1-in. or more in thickness can be broken with finger pressure. Can be scratched readily by fingernail.

Joint, Bedding and Foliation Spacing in Rock [a]

Spacing	Joints	Bedding/Foliation
Less than 2 in.	Very Close	Very Thin
2 in. - 1 ft.	Close	Thin
1 ft. - 3 ft.	Moderately Close	Medium
3 ft.-10 ft.	Wide	Thick
More than 10 ft.	Very Wide	Very thick

Rock Quality Designation (RQD)[b]		Joint Openness Descriptors	
ROD, as a percentage	Diagnostic description	Openness	Descriptor
Exceeding 90	Excellent	No Visible Separation	Tight
90 - 75	Good	Less than 1/32 in.	Slightly Open
74 - 50	Fair	1/32 to 1/8 in.	Moderately Open
49 - 25	Poor	1/8 to 3/8 in.	Open
Less than 25	Very poor	1/2 in. to 1 1/4 in.	Moderately Wide
		Greater than 1 1/4 in.	Wide

a. Spacing refers to the distance normal to the planes of the described feature, which are parallel to each other or nearly so.

b. RQD (given as a percentage) = (Σ of core 4 in. and longer) / (length of run).

References: American Society of Civil Engineers Manuals and Reports on Engineering Practice - No. 56, American Society of Civil Engineers, 1976.
U.S. Department of the Interior, Bureau of Reclamation, Engineering Geology Field Manual.
AASHTO M145, 2010.

UNIFIED SOIL CLASSIFICATION SYSTEM

Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests [A]				Soil Classification	
				Group Symbol	Group Name [B]
Coarse Grained Soils More than 50% retained on No. 200 sieve	Gravels More than 50% of coarse fraction retained on No. 4 sieve	Clean Gravels Less than 5% fines	Cu ≥ 4 and 1≤ Cc ≤ 3	GW	Well-graded Gravel [F]
			Cu < 4 and/or 1 > Cc > 3	GP	Poorly graded gravel [F]
		Gravels with Fines More than 12% fines	Fines classify as ML or MH	GM	Silty Gravel [F,G,H]
			Fines classify as CL or CH	GC	Clayey Gravel [F,G,H]
	Sands 50% or more of coarse fraction passes No. 4 sieve	Clean Sands Less than 5% fines	Cu ≥ 6 and 1 ≤ Cc ≤ 3	SW	Well-graded Sand [I]
			Cu < 6 and/or 1 > Cc > 3	SP	Poorly graded Sand [I]
		Sands with Fines More than 12% fines	Fines classify as ML or MH	SM	Silty Sand [G,H,I]
			Fines classify as CL or CH	SC	Clayey Sand [G,H,I]
Fine-Grained Soils 50% or more passes the No. 200 sieve	Silts and Clays Liquid limit less than 50	inorganic	PI > 7 and plots on or above "A" line	CL	Lean Clay [K,L,M]
			PI < 4 or plots below "A" line	ML	Silt [K,L,M]
		organic	Liquid limit - oven dried / Liquid limit - not dried < 0.75	OL	Organic Clay [K,L,M,N]
					Organic Silt [K,L,M,O]
	Silts and Clays Liquid Limit 50 or more	inorganic	PI plots on or above "A" Line	CH	Fat Clay [K,L,M]
			PI plots below "A" line	MH	Elastic Silt [K,L,M]
		organic	Liquid limit - oven dried / Liquid limit - not dried < 0.75	OH	Organic Clay [K,L,M,P]
					Organic Silt [K,L,M,Q]
Highly organic soils	Primarily organic matter, dark in color, and organic odor			PT	Peat

[A] Based on the material passing the 3-in. (75-mm) sieve

[B] If field sample contains cobbles and/or boulders, add "with cobbles or boulders, or both" as necessary to group name.

[C] Gravels with 5 to 12% fines require dual symbols: GW-GM well-graded gravel with silt, GW-GC well-graded gravel with clay, GP-GM poorly graded gravel with silt. GP-GC poorly graded gravel with clay.

[D] Sands with 5 to 12% fines require dual symbols: SW-SM well-graded sand with silt, SW-SC well-graded sand with clay, SP-SM poorly graded sand with silt, SP-SC poorly graded sand with clay.

[E] $Cu = D_{60} / D_{10} \quad Cc = \dfrac{(D_{30})^2}{D_{10} \times D_{60}}$

[F] If soil contains ≥ 15% sand, add "with sand" to group name.

[G] If fines classify as CL-ML, use dual symbol GC-GM, or SC-SM.

[H] If fines are organic, add "with organic fines" to group name.

[I] If soil contains ≥ 15% gravel, add "with gravel" to group name.

[J] If Atterberg limits plot in shaded area, soil is a CL-ML, silty clay.

[K] If soil contains 15 to 29% plus No. 200, add "with sand" or "with gravel," whichever is predominant.

[L] If soil contains ≥ 30% plus No. 200, predominantly sand, add "sandy" to group name.

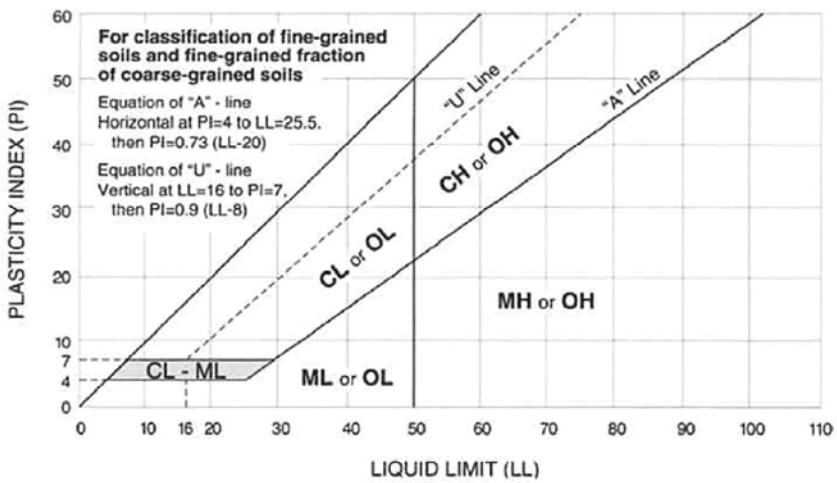
[M] If soil contains ≥ 30% plus No. 200, predominantly gravel, add "gravelly" to group name.

[N] PI ≥ 4 and plots on or above "A" line.

[O] PI < 4 or plots below "A" line.

[P] PI plots on or above "A" line.

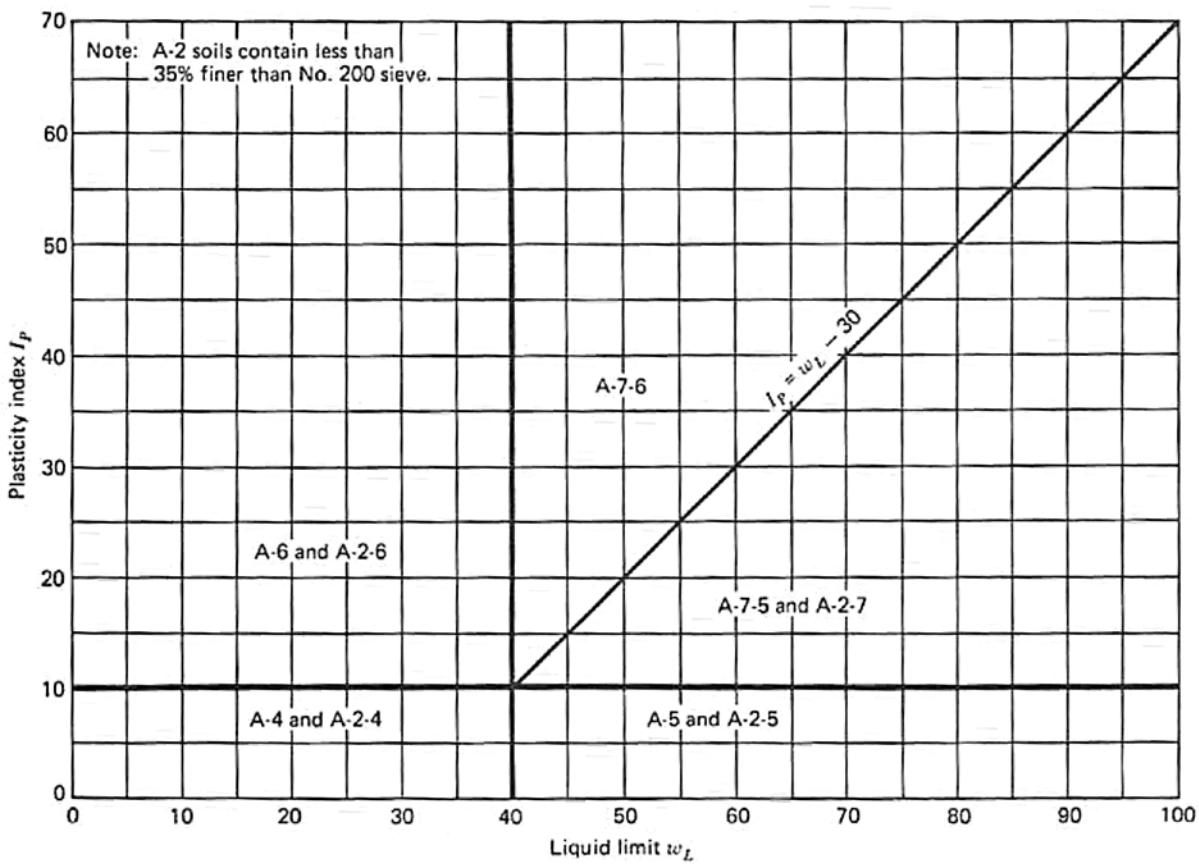
[Q] PI plots below "A" line.



AASHTO SOIL CLASSIFICATION SYSTEM

General classification	**Granular materials** (35 percent or less of total sample passing No. 200)							**Silt-clay material** (More than 35 percent of total sample passing No. 200)			
Group classification	A-1		A-3	A-2				A-4	A-5	A-6	A-7 [1]
	A-1-a	A-1-b		A-2-4	A-2-5	A-2-6	A-2-7				A-7-5 A-7-6
Sieve analysis percent passing No. 10 No. 40 No. 200	 50 max 30 max 15 max	 50 max 25 max	 51 max 10 max	 35 max	 35 max	 35 max	 35 max	 36 min	 36 min	 36 min	 36 min
Characteristics of fraction passing No. 40 Liquid limit, w_L Plastic Index, I_P	 6 max		 NP	 40 max 10 max	 41 min 10 max	 40 max 11 min	 41 min 11 min	 40 max 10 max	 41 min 10 max	 40 max 11 min	 41 min 11 min
Significant constituent materials	gravel and sand		fine sand	silty and clayey gravel and sand				silty soils		clayey soils	

[1] Plasticity index of A-7-5 subgroup is equal to or less than LL minus 30. Plasticity index of A-7-6 subgroup is greater than LL minus 30.



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Missoula, MT 59808
Telephone: 406-830-0633

TEST PIT NUMBER TP-10

CLIENT Hillview, LLC
PROJECT NAME Hillview Subdivision
PROJECT NUMBER E22
PROJECT LOCATION Missoula
DATE STARTED 7/1/22 **COMPLETED** 7/1/22
GROUND ELEVATION 3509 ft **TEST PIT SIZE** 36 inches
EXCAVATION CONTRACTOR Grant Creek Excavating
GROUND WATER LEVELS:
EXCAVATION METHOD CAT 308CR
AT TIME OF EXCAVATION --- GW table was not encountered.
LOGGED BY Lorenzen **CHECKED BY** Lorenzen
AT END OF EXCAVATION --- GW table was not encountered.
NOTES N46° 49.259'; W 114° 01.496'
AFTER EXCAVATION ---

DEPTH (ft)	SAMPLE TYPE NUMBER	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0.0	GB	MC = 12%	ML		(ML) TOPSOIL, Silty Loam, Surface Vegetation; damp; black (10YR 2/1); no reaction to 10% HCl solution. Army Corps of Engineers Cone Penetrometer was pushed 2.75 inches under a 320 psi loading at the ground surface.
1.0					3508.0
			GW-GM		(GW-GM) Well-Graded GRAVEL with Silt and Sand [A-1-a]; subrounded to subangular, flat; dry; dark yellowish brown (10YR 3/4) matrix; no reaction to 10% HCl solution. Fines are slightly plastic.
2.2	GB	MC = 4%			3506.8
2.5			GW		(GW) Well-Graded GRAVEL with Sand [A-1-a]; subrounded to subangular, flat; dry to damp; dark yellowish brown (10YR 3/4) matrix with some very pale brown (10YR 8/2) pendent cement; matrix has no reaction to 10% HCl solution, pendent cement has a strong reaction to 10% HCl solution.
	GB	MC = 4%			Army Corps of Engineers Cone Penetrometer was pushed 5 inches under a 320 psi loading at 3.5 feet.
5.0					
	GB	MC = 4%			Test pit walls were sloughing below 6 feet.
7.5					
8.0	GB	MC = 6%			3501.0

Bottom of test pit at 8.0 feet.

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TEST PIT NUMBER TP-11

CLIENT Hillview, LLC
PROJECT NAME Hillview Subdivision
PROJECT NUMBER E22
PROJECT LOCATION Missoula
DATE STARTED 6/30/22 **COMPLETED** 6/30/22
GROUND ELEVATION 3599 ft **TEST PIT SIZE** 36 inches
EXCAVATION CONTRACTOR Grant Creek Excavating
GROUND WATER LEVELS:
EXCAVATION METHOD CAT 308CR
AT TIME OF EXCAVATION --- GW table was not encountered.
LOGGED BY Lorenzen **CHECKED BY** Lorenzen
AT END OF EXCAVATION --- GW table was not encountered.
NOTES N46° 49.246'; W 114° 01.371'
AFTER EXCAVATION ---

DEPTH (ft)	SAMPLE TYPE NUMBER	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0.0	GB	MC = 5%	ML		(ML) TOPSOIL, Silty Loam, Surface Vegetation, trace fine Gravel; dry; very dark gray (10YR 3/1); no reaction to 10% HCl solution. Gravels are subangular.
0.5					3598.5
					Army Corps of Engineers Cone Penetrometer was pushed 3.5 inches under a 320 psi loading at the ground surface.
					(GC) Clayey GRAVEL with Sand [A-2-6], occasional Cobble; subrounded to subangular; damp to moist; dark brown (7.5YR 3/4) matrix; no reaction to 10% HCl solution. Fines are medium plastic.
	GB	MC = 8%			
2.5			GC		
	GB	MC = 6%			
					Army Corps of Engineers Cone Penetrometer was pushed 1.75 inches under a 320 psi loading at 3 feet.
5.0					5.0 3594.0
					(GC) Clayey GRAVEL [A-2-6], Clasts; subangular to angular, flat; moist infilling between Clasts; yellowish brown (10YR 5/8) matrix; no reaction to 10% HCl solution. Fines are medium plastic.
	GB	MC = 6%	GC		
	GB	MC = 5%			6.8 3592.2

Bottom of test pit at 6.8 feet.

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TEST PIT NUMBER TP-12

CLIENT Hillview, LLC
PROJECT NAME Hillview Subdivision
PROJECT NUMBER E22
PROJECT LOCATION Missoula
DATE STARTED 6/30/22 **COMPLETED** 6/30/22
GROUND ELEVATION 3626 ft **TEST PIT SIZE** 36 inches
EXCAVATION CONTRACTOR Grant Creek Excavating
GROUND WATER LEVELS:
EXCAVATION METHOD CAT 308CR
AT TIME OF EXCAVATION --- GW table was not encountered.
LOGGED BY Lorenzen **CHECKED BY** Lorenzen
AT END OF EXCAVATION --- GW table was not encountered.
NOTES N46° 49.301'; W 114° 01.668'
AFTER EXCAVATION ---

DEPTH (ft)	SAMPLE TYPE NUMBER	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0.0	GB	MC = 8%	ML		(ML) TOPSOIL, Silty Loam, Surface Vegetation, trace fine Gravel; damp; very dark grayish brown (10YR 3/2); no reaction to 10% HCl solution. Gravels are subangular.
0.6					3625.4
					Army Corps of Engineers Cone Penetrometer was pushed 7.75 inches under a 320 psi loading at the ground surface.
					(GC) Clayey GRAVEL with Sand [A-2-6], occasional Cobble; subrounded to subangular, flat; damp; dark yellowish brown (10YR 4/6) matrix; no reaction to 10% HCl solution. Fines are medium plastic.
2.5	GB	MC = 6%	GC		
	GB	MC = 5%			Army Corps of Engineers Cone Penetrometer was pushed 2 inches under a 320 psi loading at 3 feet.
5.0					5.0 3621.0
	GB	MC = 7%	GW-GC		(GW-GC) Well-Graded GRAVEL with Clay and Sand [A-1-b]; subrounded to subangular, flat; moist; yellowish brown (10YR 5/6) to dark yellowish brown (10YR 4/6) matrices; no reaction to 10% HCl solution. Fines are medium plastic.
7.5	GB	MC = 8%			8.0 3618.0
					Bottom of test pit at 8.0 feet.

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TEST PIT NUMBER TP-13

CLIENT Hillview, LLC
PROJECT NAME Hillview Subdivision
PROJECT NUMBER E22
PROJECT LOCATION Missoula
DATE STARTED 6/30/22 **COMPLETED** 6/30/22
GROUND ELEVATION 3587 ft **TEST PIT SIZE** 36 inches
EXCAVATION CONTRACTOR Grant Creek Excavating
GROUND WATER LEVELS:
EXCAVATION METHOD CAT 308CR
AT TIME OF EXCAVATION --- GW table was not encountered.
LOGGED BY Lorenzen **CHECKED BY** Lorenzen
AT END OF EXCAVATION --- GW table was not encountered.
NOTES N46° 49.312'; W 114° 01.406'
AFTER EXCAVATION ---

DEPTH (ft)	SAMPLE TYPE NUMBER	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0.0	GB	MC = 5%	ML		(ML) TOPSOIL, Silty Loam, Surface Vegetation, trace fine Gravel; dry; very dark grayish brown (10YR 3/2); no reaction to 10% HCl solution. Gravels are subangular. Army Corps of Engineers Cone Penetrometer was pushed 4.75 inches under a 320 psi loading at the ground surface.
0.9					3586.1
	GB	MC = 5%	GC		(GC) Clayey GRAVEL with Sand [A-2-6], occasional Cobble; subrounded to subangular, flat; damp to moist; dark yellowish brown (10YR 3/4) to brown (7.5YR 4/4) matrices; no reaction to 10% HCl solution. Fines are medium plastic.
2.5					
	GB	MC = 13%			Army Corps of Engineers Cone Penetrometer was pushed 3.5 inches under a 320 psi loading at 3.2 feet.
4.5					3582.5
5.0			GP-GC		(GP-GC) Poorly Graded GRAVEL with Clay and Sand [A-1-b], occasional Cobble; subrounded to subangular, flat; damp; dark yellowish brown (10YR 4/6) matrix; no reaction to 10% HCl solution. Fines are medium plastic.
	GB	MC = 5%			
7.5					
	GB	MC = 6%			
8.0					3579.0
					Bottom of test pit at 8.0 feet.

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TEST PIT NUMBER TP-14

CLIENT Hillview, LLC
PROJECT NAME Hillview Subdivision
PROJECT NUMBER E22
PROJECT LOCATION Missoula
DATE STARTED 7/1/22 **COMPLETED** 7/1/22
GROUND ELEVATION 3507 ft **TEST PIT SIZE** 36 inches
EXCAVATION CONTRACTOR Grant Creek Excavating
GROUND WATER LEVELS:
EXCAVATION METHOD CAT 308CR
AT TIME OF EXCAVATION --- GW table was not encountered.
LOGGED BY Lorenzen **CHECKED BY** Lorenzen
AT END OF EXCAVATION --- GW table was not encountered.
NOTES N46° 49.107'; W 114° 01.520'
AFTER EXCAVATION ---

DEPTH (ft)	SAMPLE TYPE NUMBER	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0.0	GB	MC = 6%	ML		(ML) TOPSOIL, Silty Loam, Surface Vegetation, trace Gravel, occasional Cobble; damp; black (10YR 2/1); no reaction to 10% HCl solution. Gravels are subangular.
					Army Corps of Engineers Cone Penetrometer was pushed 6 inches under a 320 psi loading at the ground surface.
0.8					3506.2
			GW-GC		(GW-GC) Well-Graded GRAVEL with Clay and Sand [A-1-b], occasional Cobble; subrounded to subangular, flat; damp; dark brown (7.5YR 3/4) to reddish brown (5YR 4/4) matrices; no reaction to 10% HCl solution. Fines are medium plastic.
2.5	GB	MC = 5%			
	GB	MC = 4%			Army Corps of Engineers Cone Penetrometer was pushed 1 inch under a 320 psi loading at 3.5 feet.
4.5					3502.5
5.0			GW		(GW) Well-Graded GRAVEL with Sand [A-1-a]; subrounded to subangular, flat; damp; yellowish brown (10YR 5/6, 5/4) matrix; no reaction to 10% HCl solution.
	GB	MC = 4%			
7.5	GB	MC = 5%			
8.0					3499.0
					Bottom of test pit at 8.0 feet.

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TEST PIT NUMBER TP-15

CLIENT Hillview, LLC
PROJECT NAME Hillview Subdivision
PROJECT NUMBER E22
PROJECT LOCATION Missoula
DATE STARTED 7/1/22 **COMPLETED** 7/1/22
GROUND ELEVATION 3549 ft **TEST PIT SIZE** 36 inches
EXCAVATION CONTRACTOR Grant Creek Excavating
GROUND WATER LEVELS:
EXCAVATION METHOD CAT 308CR
AT TIME OF EXCAVATION --- GW table was not encountered.
LOGGED BY Lorenzen **CHECKED BY** Lorenzen
AT END OF EXCAVATION --- GW table was not encountered.
NOTES N46° 49.381'; W 114° 01.516'
AFTER EXCAVATION ---

DEPTH (ft)	SAMPLE TYPE NUMBER	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0.0	GB	MC = 2%	ML		(ML) TOPSOIL, Silty Loam, Surface Vegetation, trace Gravel; damp; very dark grayish brown (10YR 3/2); no reaction to 10% HCl solution. Gravels are subangular.
0.5					3548.5
					Army Corps of Engineers Cone Penetrometer was pushed 4.25 inches under a 320 psi loading at the ground surface.
					(GP) Poorly Graded GRAVEL [A-1-a]; subrounded to subangular, flat; dry; yellowish brown (10YR 5/4); no reaction to 10% HCl solution.
	GB	MC = 3%	GP		
2.5	GB	MC = 2%			Army Corps of Engineers Cone Penetrometer was pushed 3.5 inches under a 320 psi loading at 2.5 feet.
3.5					3545.5
					(GW) Well-Graded GRAVEL with Sand [A-1-a]; subrounded to subangular, flat; damp to moist; dark yellowish brown (10YR 3/6); no reaction to 10% HCl solution.
5.0			GW		
	GB	MC = 5%			
	GB	Fines = 2%			
	GB	MC = 6%			
7.0					3542.0
					(CL) Lean CLAY with Sand [A-6]; moist; brown (7.5YR 5/4); no reaction to 10% HCl solution; medium plastic; low dry strength, crumbly.
7.5			CL		
	GB	MC = 21%			
8.0					3541.0
					Bottom of test pit at 8.0 feet.

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TEST PIT NUMBER TP-16

CLIENT Hillview, LLC
PROJECT NAME Hillview Subdivision
PROJECT NUMBER E22
PROJECT LOCATION Missoula
DATE STARTED 6/30/22 **COMPLETED** 6/30/22
GROUND ELEVATION 3584 ft **TEST PIT SIZE** 36 inches
EXCAVATION CONTRACTOR Grant Creek Excavating
GROUND WATER LEVELS:
EXCAVATION METHOD CAT 308CR
AT TIME OF EXCAVATION --- GW table was not encountered.
LOGGED BY Lorenzen **CHECKED BY** Lorenzen
AT END OF EXCAVATION --- GW table was not encountered.
NOTES N46° 49.385'; W 114° 01.397'
AFTER EXCAVATION ---

DEPTH (ft)	SAMPLE TYPE NUMBER	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0.0	GB	MC = 7%	ML		(ML) TOPSOIL, Silty Loam, Surface Vegetation, trace Gravel; damp; very dark brown (10YR 2/2); no reaction to 10% HCl solution. Gravels are subangular. Army Corps of Engineers Cone Penetrometer was pushed 5.5 inches under a 320 psi loading at the ground surface.
0.9					3583.1
			GP-GC		(GP-GC) Poorly Graded GRAVEL with Clay [A-1-b], occasional Cobble; subrounded to subangular, flat; dry; yellowish brown (10YR 5/4); no reaction to 10% HCl solution. Fines are medium plastic.
2.5	GB	MC = 6%			
2.5					3581.5
					Poorly Graded GRAVEL with Silt and Sand [A-1-a], occasional Cobble, occasional Boulder at depth; subrounded to subangular, flat; moist; dark yellowish brown (10YR 4/4, 4/6); no reaction to 10% HCl solution. Fines are slightly to non-plastic.
	GB	MC = 6%			Army Corps of Engineers Cone Penetrometer was pushed 0.5 inches under a 320 psi loading at 2.5 feet.
5.0					
	GB	MC = 8%			
7.5					
	GB GB	LL = NP PL = NP Fines = 12% MC = 8%			
8.0					3576.0
					Bottom of test pit at 8.0 feet.

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TEST PIT NUMBER TP-17

CLIENT Hillview, LLC
PROJECT NAME Hillview Subdivision
PROJECT NUMBER E22
PROJECT LOCATION Missoula
DATE STARTED 6/30/22 **COMPLETED** 6/30/22
GROUND ELEVATION 3606 ft **TEST PIT SIZE** 36 inches
EXCAVATION CONTRACTOR Grant Creek Excavating
GROUND WATER LEVELS:
EXCAVATION METHOD CAT 308CR
AT TIME OF EXCAVATION --- GW table was not encountered.
LOGGED BY Lorenzen **CHECKED BY** Lorenzen
AT END OF EXCAVATION --- GW table was not encountered.
NOTES N46° 49.390'; W 114° 01.243'
AFTER EXCAVATION ---

DEPTH (ft)	SAMPLE TYPE NUMBER	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0.0	GB	MC = 12%	ML		(ML) TOPSOIL, Silty Loam with Gravel, Surface Vegetation; damp; black (10YR 2/1); no reaction to 10% HCl solution. Gravels are subangular.
					Army Corps of Engineers Cone Penetrometer was pushed 6 inches under a 320 psi loading at the ground surface.
0.8					3605.3
	GB	MC = 12%	CL		(CL) Lean CLAY with Sand [A-6], occasional Cobble, Rootlets; moist; dark yellowish brown (10YR 3/6); no reaction to 10% HCl solution; medium plastic; medium dry strength, crumbly.
2.5					
	GB	MC = 16%			Army Corps of Engineers Cone Penetrometer was pushed 2.5 inches under a 320 psi loading at 3.2 feet.
5.0					
5.5					3600.5
	GB	MC = 10%	GP-GC		(GP-GC) Poorly Graded GRAVEL with Clay and Sand [A-1-b]; subrounded to subangular, flat; moist; reddish brown (5YR 5/4) matrix; no reaction to 10% HCl solution. Fines are medium plastic. Gravel content increases with depth.
7.5					
	GB	MC = 7%			
8.2					3597.8
					Bottom of test pit at 8.2 feet.

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TEST PIT NUMBER TP-18

CLIENT Hillview, LLC
PROJECT NAME Hillview Subdivision
PROJECT NUMBER E22
PROJECT LOCATION Missoula
DATE STARTED 6/30/22 **COMPLETED** 6/30/22
GROUND ELEVATION 3576 ft **TEST PIT SIZE** 36 inches
EXCAVATION CONTRACTOR Grant Creek Excavating
GROUND WATER LEVELS:
EXCAVATION METHOD CAT 308CR
AT TIME OF EXCAVATION --- GW table was not encountered.
LOGGED BY Lorenzen **CHECKED BY** Lorenzen
AT END OF EXCAVATION --- GW table was not encountered.
NOTES N46° 49.476'; W 114° 01.267'
AFTER EXCAVATION ---

DEPTH (ft)	SAMPLE TYPE NUMBER	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0.0	GB	MC = 8%	ML		(ML) TOPSOIL, Sandy Loam with Gravel, Surface Vegetation; damp; very dark brown (10YR 2/2); no reaction to 10% HCl solution. Gravels are subangular. Army Corps of Engineers Cone Penetrometer was pushed 3.5 inches under a 320 psi loading at the ground surface.
1.0					3575.0
	GB	MC = 3%	GP		(GP) Well-Graded GRAVEL with Sand [A-1-a], occasional Cobble; subrounded to subangular, flat; dry to damp; dark yellowish brown (10YR 4/4, 4/6) matrix; no reaction to 10% HCl solution.
2.5					
	GB	MC = 6%			Army Corps of Engineers Cone Penetrometer was pushed 1 inch under a 320 psi loading at 3 feet.
5.0	GB	Fines = 2%			
5.0					3571.0
	GB	MC = 6%	GW-GC		(GW-GC) Well-Graded GRAVEL with Clay and Sand [A-1-b], occasional Cobble; subrounded to subangular, flat; damp to moist; strong brown (7.5YR 5/6, 4/6) matrix; no reaction to 10% HCl solution. Fines are medium plastic.
7.5					
	GB	MC = 9%			
8.3					3567.8

Bottom of test pit at 8.3 feet.

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TEST PIT NUMBER TP-19

CLIENT Hillview, LLC
PROJECT NAME Hillview Subdivision
PROJECT NUMBER E22
PROJECT LOCATION Missoula
DATE STARTED 6/30/22 **COMPLETED** 6/30/22
GROUND ELEVATION 3565 ft **TEST PIT SIZE** 36 inches
EXCAVATION CONTRACTOR Grant Creek Excavating
GROUND WATER LEVELS:
EXCAVATION METHOD CAT 308CR
AT TIME OF EXCAVATION --- GW table was not encountered.
LOGGED BY Lorenzen **CHECKED BY** Lorenzen
AT END OF EXCAVATION --- GW table was not encountered.
NOTES N46° 49.472'; W 114° 01.385'
AFTER EXCAVATION ---

DEPTH (ft)	SAMPLE TYPE NUMBER	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0.0	GB	MC = 6%	ML		(ML) TOPSOIL, Sandy Loam with Gravel, Surface Vegetation; damp; dark gray (10YR 4/1); no reaction to 10% HCl solution. Gravels are subangular. Army Corps of Engineers Cone Penetrometer was pushed 7.25 inches under a 320 psi loading at the ground surface.
1.0					3564.0
	GB	MC = 8%	GP-GC		(GP-GC) Poorly Graded GRAVEL with Clay and Sand [A-1-b]; frequent Cobbles; subrounded to subangular, flat; moist; yellowish brown (10YR 5/4) to strong brown (7.5YR 4/6) matrices; no reaction to 10% HCl solution.
2.5					
	GB	MC = 7%			Army Corps of Engineers Cone Penetrometer was pushed 1.75 inches under a 320 psi loading at 3 feet.
3.5					3561.5
			GP-GC		(GP-GC) Poorly Graded GRAVEL with Clay and Sand [A-1-b]; frequent Cobbles, occasional Boulder; subrounded to subangular, flat; moist; pale brown (10YR 6/3) to light brownish gray (10YR 6/2) matrices; strong to weak reaction to 10% HCl solution.
5.0					Difficult excavating below 4 feet.
	GB	MC = 6%			
7.5					
	GB	MC = 8%			
8.0					3557.0
					Bottom of test pit at 8.0 feet.

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TEST PIT NUMBER TP-20

CLIENT Hillview, LLC
PROJECT NAME Hillview Subdivision
PROJECT NUMBER E22
PROJECT LOCATION Missoula
DATE STARTED 6/30/22 **COMPLETED** 6/30/22
GROUND ELEVATION 3555 ft **TEST PIT SIZE** 36 inches
EXCAVATION CONTRACTOR Grant Creek Excavating
GROUND WATER LEVELS:
EXCAVATION METHOD CAT 308CR
AT TIME OF EXCAVATION --- GW table was not encountered.
LOGGED BY Lorenzen **CHECKED BY** Lorenzen
AT END OF EXCAVATION --- GW table was not encountered.
NOTES N46° 49.459'; W 114°01.397'
AFTER EXCAVATION ---

DEPTH (ft)	SAMPLE TYPE NUMBER	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0.0	GB	MC = 7%	ML		(ML) TOPSOIL, Sandy Loam with Gravel, Surface Vegetation; damp; very dark gray (10YR 3/1); no reaction to 10% HCl solution. Gravels are subrounded to subangular. Army Corps of Engineers Cone Penetrometer was pushed 5.5 inches under a 320 psi loading at the ground surface.
1.0					3554.0
	GB	MC = 10%	SC		(SC) Clayey SAND with Gravel [A-1-a], occasional Cobble; moist; dark yellowish brown (10YR 4/4) to yellowish brown (10YR 5/4); no reaction to 10% HCl solution. Fines are medium plastic. Gravels are subrounded to subangular.
2.5					
	GB	MC = 12%			
3.5					Army Corps of Engineers Cone Penetrometer was pushed 3.5 inches under a 320 psi loading at 3.2 feet.
					3551.5
			GW-GC		(GW-GC) Well-Graded GRAVEL with Clay and Sand [A-1-b]; frequent Cobbles; subrounded to subangular, flat; moist; dark yellowish brown (10YR 3/6, 4/4) matrix; no reaction to 10% HCl solution. Fines are medium plastic.
5.0					
	GB	MC = 6%			
7.5					
	GB	MC = 7%			
8.5					3546.5

Bottom of test pit at 8.5 feet.

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TEST PIT NUMBER TP-21

CLIENT Hillview, LLC
PROJECT NAME Hillview Subdivision
PROJECT NUMBER E22
PROJECT LOCATION Missoula
DATE STARTED 7/1/22 **COMPLETED** 7/1/22
GROUND ELEVATION 3512 ft **TEST PIT SIZE** 36 inches
EXCAVATION CONTRACTOR Grant Creek Excavating
GROUND WATER LEVELS:
EXCAVATION METHOD CAT 308CR
AT TIME OF EXCAVATION --- GW table was not encountered.
LOGGED BY Lorenzen **CHECKED BY** Lorenzen
AT END OF EXCAVATION --- GW table was not encountered.
NOTES N46° 49.427'; W 114° 01.600'
AFTER EXCAVATION ---

DEPTH (ft)	SAMPLE TYPE NUMBER	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	
0.0			ML		(ML) TOPSOIL, Sandy Loam with Gravel, Surface Vegetation; damp; dark gray (10YR 4/1). Gravels are subrounded to subangular.	3511.5
					0.5	
			GW-GC		(GW-GC) Well-Graded GRAVEL with Clay and Sand [A-1-b]; subrounded to subangular, flat; moist; dark yellowish brown (10YR 4/4) matrix; no reaction to 10% HCl solution. Fines are medium plastic.	
	GB	MC = 5%			Army Corps of Engineers Cone Penetrometer was pushed 7.75 inches under a 320 psi loading at the ground surface.	3510.7
					1.3	
			SP-SM		(SP-SM) Poorly Graded SAND with Silt [A-3]; fine-grained; moist; dark yellowish brown (10YR 4/6); no reaction to 10% HCl solution. Fines are non-plastic.	
	GB	MC = 15%				
					2.3	3509.7
2.5			GP-GC		(GP-GC) Poorly Graded GRAVEL with Clay and Sand [A-1-b], occasional Cobble; subrounded to subangular, flat; moist; dark yellowish brown (10YR 4/4) matrix; no reaction to 10% HCl solution. Fines are medium plastic.	
	GB	MC = 7%				
					Army Corps of Engineers Cone Penetrometer was pushed 1.75 inches under a 320 psi loading at 3.2 feet.	
5.0					5.0	3507.0
			GP-GC		(GP-GC) Poorly Graded GRAVEL with Clay and Sand [A-1-b], occasional Cobble; subrounded to subangular, flat; moist; yellowish brown (10YR 5/6) to dark yellowish brown (10YR 4/6) matrices; no reaction to 10% HCl solution. Fines are medium plastic.	
	GB	MC = 9%				
7.5						
	GB	MC = 7%			8.3	3503.8
					Bottom of test pit at 8.3 feet.	

Lorenzen Soil Mechanics, Inc.
2720 Palmer Street, Unit C
Missoula, MT 59808
Telephone: 406-830-0633

TEST PIT NUMBER TP-22

CLIENT Hillview, LLC
PROJECT NAME Hillview Subdivision
PROJECT NUMBER E22
PROJECT LOCATION Missoula
DATE STARTED 7/1/22 **COMPLETED** 7/1/22
GROUND ELEVATION 3464 ft **TEST PIT SIZE** 36 inches
EXCAVATION CONTRACTOR Grant Creek Excavating
GROUND WATER LEVELS:
EXCAVATION METHOD CAT 308CR
AT TIME OF EXCAVATION --- GW table was not encountered.
LOGGED BY Lorenzen **CHECKED BY** Lorenzen
AT END OF EXCAVATION --- GW table was not encountered.
NOTES N46° 49.399'; W 114° 01.658'
AFTER EXCAVATION ---

DEPTH (ft)	SAMPLE TYPE NUMBER	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0.0	GB	MC = 1%	ML	0.3	(ML) TOPSOIL, Sandy Loam with Gravel, Surface Vegetation; dry; gray (10YR 5/1); no reaction to 10% HCl solution. Gravels are subrounded to subangular. 3463.8
					(GW-GC) Well-Graded GRAVEL with Clay and Sand [A-1-b]; subrounded to subangular, flat; moist; dark yellowish brown (10YR 4/4) matrix; no reaction to 10% HCl solution. Fines are medium plastic.
					Army Corps of Engineers Cone Penetrometer was pushed 3 inches under a 320 psi loading at the ground surface.
	GB	MC = 4%	GW-GC		
2.5					
				3.0	Army Corps of Engineers Cone Penetrometer was pushed 6 inches under a 320 psi loading at 3.2 feet. 3461.0
	GB	MC = 5%			(SW) Well-Graded SAND with Gravel [A-1-a]; damp; yellowish brown (10YR 5/8); no reaction to 10% HCl solution. Gravels are subrounded to subangular.
5.0			SW		
	GB	MC = 5% Fines = 2%			
7.5					
	GB	MC = 5%		8.0	3456.0

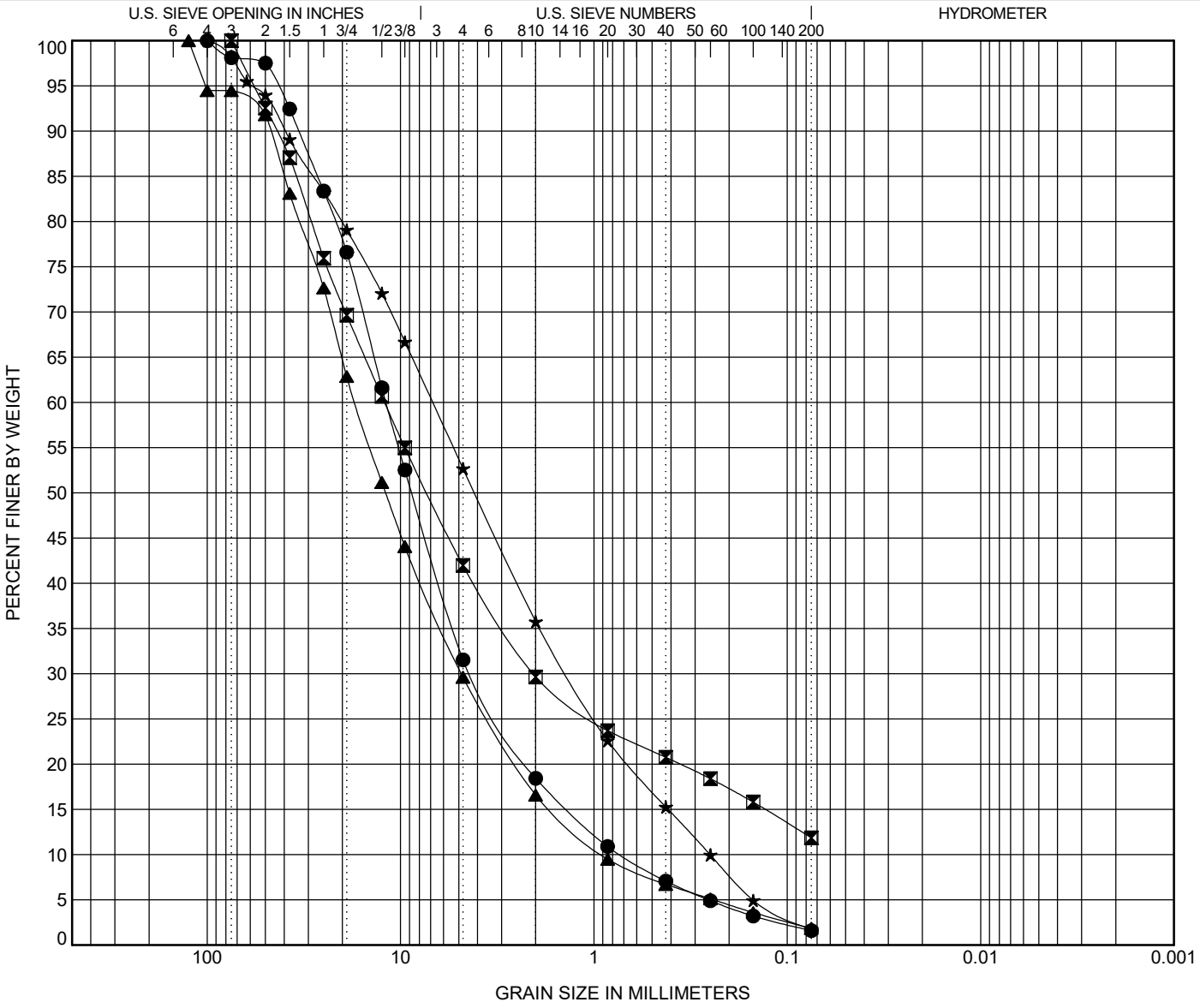
Bottom of test pit at 8.0 feet.

GRAIN SIZE DISTRIBUTION

Lorenzen Soil Mechanics, Inc.
2720 Palmer Street, Unit C
Missoula, MT 59808
Telephone: 406-830-0633

CLIENT Hillview, LLC **PROJECT NAME** Hillview Subdivision

PROJECT NUMBER E22 **PROJECT LOCATION** Missoula



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	BOREHOLE	DEPTH	Classification	LL	PL	PI	Cc	Cu
●	TP-15	6.5	WELL-GRADED GRAVEL with SAND(GW)				2.14	16.47
⊠	TP-16	8.0	POORLY GRADED GRAVEL with SILT and SAND(GP-GM)	NP	NP	NP	6.41	223.72
▲	TP-18	4.5	WELL-GRADED GRAVEL with SAND(GW)				1.51	18.97
★	TP-22	6.4	WELL-GRADED SAND with GRAVEL(SW)				1.10	27.19

	BOREHOLE	DEPTH	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	TP-15	6.5	100	11.902	4.294	0.723	66.6	29.9	1.6	
⊠	TP-16	8.0	75	12.109	2.05		58.0	30.1	11.9	
▲	TP-18	4.5	125	17.15	4.84	0.904	64.9	27.8	1.8	
★	TP-22	6.4	100	6.822	1.375	0.251	45.5	50.9	1.8	

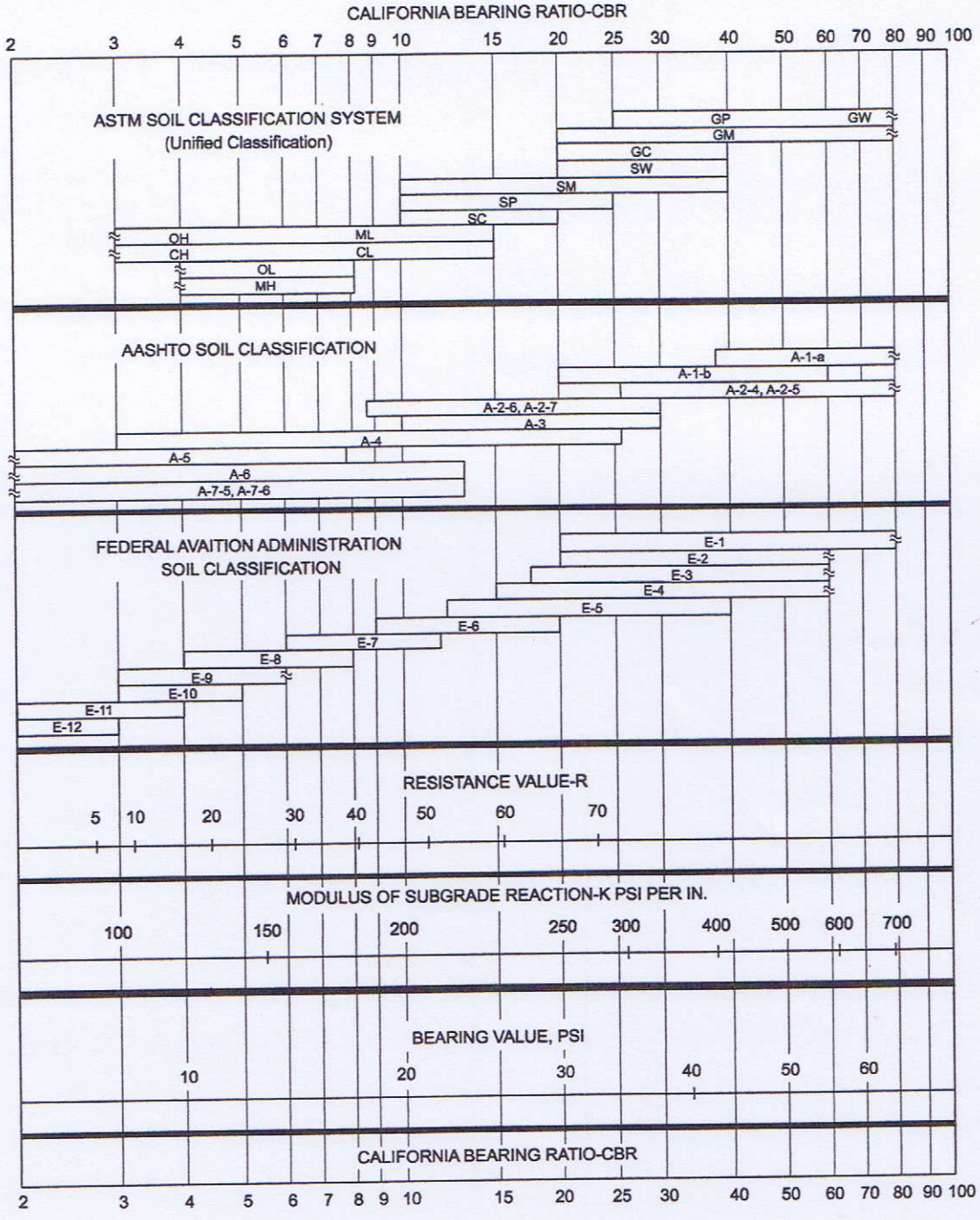
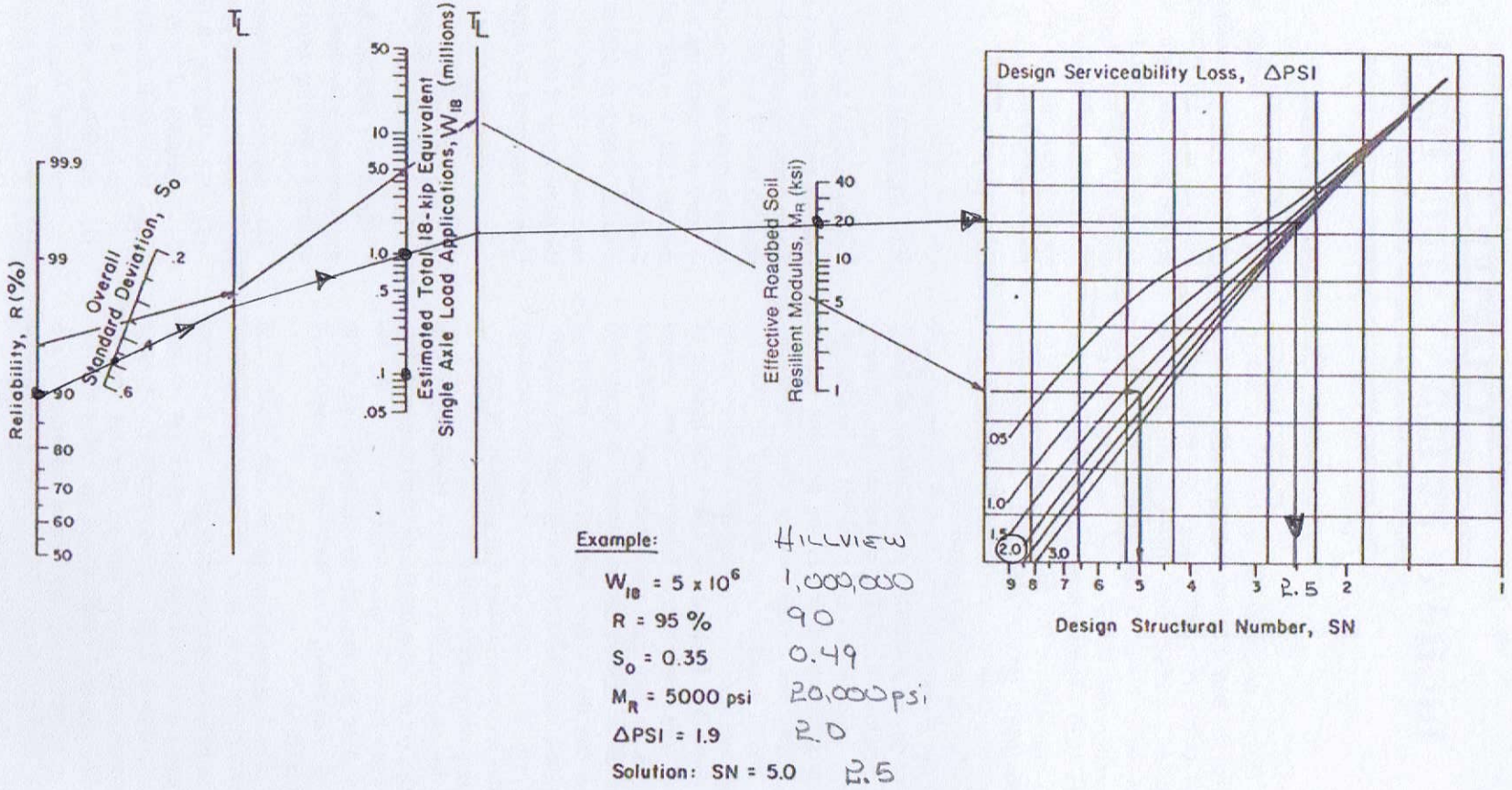


Figure 14.2-A — R-VALUE CORRELATION CHARTS

NOMOGRAPH SOLVES:

$$\log_{10} W_{18} = Z_R * S_o + 9.36 * \log_{10}(SN+1) - 0.20 + \frac{\log_{10}\left[\frac{\Delta PSI}{4.2 - 1.5}\right]}{0.40 + \frac{1094}{(SN+1)^{5.19}}} + 2.32 * \log_{10} M_R - 8.07$$



Example: HILLVIEW

$W_{18} = 5 \times 10^6$	1,000,000
R = 95 %	90
$S_o = 0.35$	0.49
$M_R = 5000$ psi	20,000 psi
ΔPSI = 1.9	2.0
Solution: SN = 5.0	2.5

Figure 3.1. Design Chart for Flexible Pavements Based on Using Mean Values for Each Input

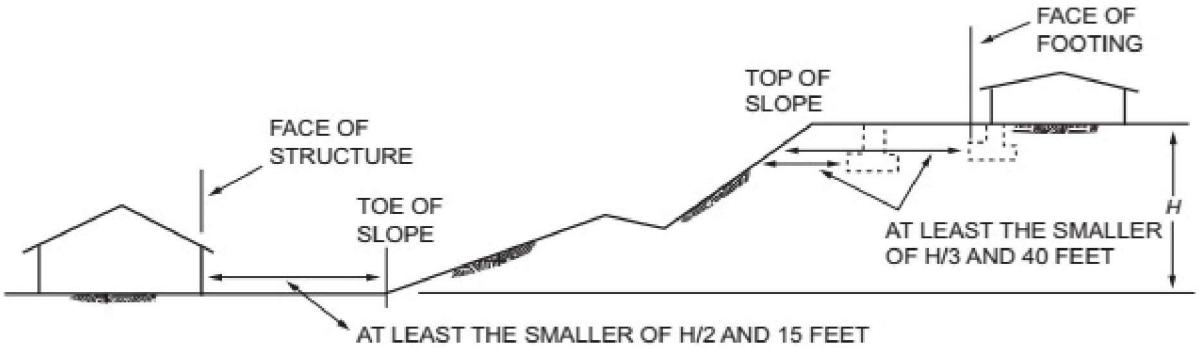
TODD LORENZ @
9/09/22

R403.1.7 Footings on or Adjacent to Slopes

The placement of buildings and structures on or adjacent to slopes steeper than one unit vertical in three units horizontal (33.3-percent slope) shall conform to Sections R403.1.7.1 through R403.1.7.4.

R403.1.7.1 Building Clearances From Ascending Slopes

In general, buildings below slopes shall be set a sufficient distance from the slope to provide protection from slope drainage, erosion and shallow failures. Except as provided in Section R403.1.7.4 and Figure R403.1.7.1, the following criteria will be assumed to provide this protection. Where the existing slope is steeper than one unit vertical in one unit horizontal (100-percent slope), the toe of the slope shall be assumed to be at the intersection of a horizontal plane drawn from the top of the foundation and a plane drawn tangent to the slope at an angle of 45 degrees (0.79 rad) to the horizontal. Where a retaining wall is constructed at the toe of the slope, the height of the slope shall be measured from the top of the wall to the top of the slope.



For SI: 1 foot = 304.8 mm.

FIGURE R403.1.7.1

FOUNDATION CLEARANCE FROM SLOPES

R403.1.7.2 Footing Setback From Descending Slope Surfaces

Footings on or adjacent to slope surfaces shall be founded in material with an embedment and setback from the slope surface sufficient to provide vertical and lateral support for the footing without detrimental settlement. Except as provided for in Section R403.1.7.4 and Figure R403.1.7.1, the following setback is deemed adequate to meet the criteria. Where the slope is steeper than one unit vertical in one unit horizontal (100-percent slope), the required setback shall be measured from an imaginary plane 45 degrees (0.79 rad) to the horizontal, projected upward from the toe of the slope.

R403.1.7.3 Foundation Elevation

On graded sites, the top of any exterior foundation shall extend above the elevation of the street gutter at point of discharge or the inlet of an approved drainage device a minimum of 12 inches (305 mm) plus 2 percent. Alternate elevations are permitted subject to the approval of the building official, provided it can be demonstrated that required drainage to the point of discharge and away from the structure is provided at all locations on the site.

R403.1.7.4 Alternate Setbacks and Clearances

Alternate setbacks and clearances are permitted, subject to the approval of the building official. The building official is permitted to require an investigation and recommendation of a qualified engineer to demonstrate that the intent of this section has been satisfied. Such an investigation shall include consideration of material, height of slope, slope gradient, load intensity and erosion characteristics of slope material.

MONTANA WELL LOG REPORT

This well log reports the activities of a licensed Montana well driller, serves as the official record of work done within the borehole and casing, and describes the amount of water encountered. This report is compiled electronically from the contents of the Ground Water Information Center (GWIC) database for this site. Acquiring water rights is the well owner's responsibility and is NOT accomplished by the filing of this report.

Other Options

Return to menu
Plot this site in State Library Digital Atlas
Plot this site in Google Maps
View scanned well log (4/10/2015 11:41:47 AM)

Site Name: DIGGS, BRIAR AND HEIDI
GWIC Id: 282070

Section 1: Well Owner(s)

1) DIGGS, BRIAR AND HEIDI (WELL)
4875 HEAVENS GATE
MISSOULA MT 59803 [10/23/2014]

Section 2: Location

Township	Range	Section	Quarter Sections
12N	19W	5	NE¼ SW¼

County
MISSOULA

Geocode

Latitude	Longitude	Geomethod	Datum
46.82512968495	-114.0173750055	TRS-SEC	NAD83

Ground Surface Altitude	Ground Surface Method	Datum	Date

Addition	Block	Lot

Section 3: Proposed Use of Water

DOMESTIC (1)

Section 4: Type of Work

Drilling Method: ROTARY
Status: DEEPENED

Section 5: Well Completion Date

Date well completed: Thursday, October 23, 2014

Section 6: Well Construction Details

Borehole dimensions

From	To	Diameter
0	440	6

Casing

From	To	Diameter	Wall Thickness	Pressure Rating	Joint	Type
-2	360	6	0.25		WELDED	STEEL
320	440	5	0.25		WELDED	STEEL

Completion (Perf/Screen)

From	To	Diameter	# of Openings	Size of Openings	Description
340	410	5		3/16 X 3	TORCH OR PLASMA CUTS

Annular Space (Seal/Grout/Packer)

From	To	Description	Cont. Fed?
0	0	BENTONITE	Y

Section 7: Well Test Data

Total Depth: 440
Static Water Level: 340
Water Temperature:

Air Test *

15 gpm with drill stem set at 440 feet for 2 hours.
Time of recovery 0.5 hours.
Recovery water level 340 feet.
Pumping water level _ feet.

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

Section 8: Remarks

Section 9: Well Log

Geologic Source
Unassigned

From	To	Description
0	1	SOIL
1	195	CLAY, GRAVEL
195	347	CLAY, GRAVEL, SOME WATER
347	360	SAND, GRAVEL, WITH WATER
360	410	CEMENTED SAND, GRAVEL, WATER
410	460	SHALE, SAND

Driller Certification

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

Name: RANDAL KOTECKI
Company: JEROMES DRILLING CO
License No: WWC-600
Date Completed: 10/23/2014

MONTANA WELL LOG REPORT

This well log reports the activities of a licensed Montana well driller, serves as the official record of work done within the borehole and casing, and describes the amount of water encountered. This report is compiled electronically from the contents of the Ground Water Information Center (GWIC) database for this site. Acquiring water rights is the well owner's responsibility and is NOT accomplished by the filing of this report.

Other Options

Return to menu
Plot this site in State Library Digital Atlas
Plot this site in Google Maps
View scanned well log (2/13/2009 8:52:43 AM)

Site Name: BENDER RON
GWIC Id: 162663

Section 1: Well Owner(s)

1) BENDER, RON (MAIL)
PO BOX 4747
MISSOULA MT 59806 [06/24/1997]

Section 2: Location

Township	Range	Section	Quarter Sections
12N	19W	5	NE¼ SW¼

County MISSOULA

Geocode

Latitude	Longitude	Geomethod	Datum
46.82513	-114.017375	TRS-SEC	NAD83

Ground Surface Altitude **Ground Surface Method** **Datum** **Date**

Addition **Block** **Lot**

Section 3: Proposed Use of Water

DOMESTIC (1)

Section 4: Type of Work

Drilling Method: ROTARY
Status: NEW WELL

Section 5: Well Completion Date

Date well completed: Tuesday, June 24, 1997

Section 6: Well Construction Details

There are no borehole dimensions assigned to this well.

Casing

From	To	Diameter	Wall Thickness	Pressure Rating	Joint	Type
-2	360	6				STEEL

Completion (Perf/Screen)

From	To	Diameter	# of Openings	Size of Openings	Description
250	260	6		3/16X1	HOLTE PERFORATOR SLOTS

Annular Space (Seal/Grout/Packer)

From	To	Description	Cont. Fed?
0	0	BENTONITE	

Section 7: Well Test Data

Total Depth: 360
Static Water Level: 200
Water Temperature:

Air Test *

3 gpm with drill stem set at _ feet for 3 hours.
Time of recovery _ hours.
Recovery water level _ feet.
Pumping water level _ feet.

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

Section 8: Remarks

JEROMES FILE NO: 6674

Section 9: Well Log

Geologic Source

120SDMS - SEDIMENTS (TERTIARY)

From	To	Description
0	2	SOIL
2	200	SILT CLAY SAND GRAVEL
200	260	GRAVEL WITH WATER
260	360	CLAY GRAVEL

Driller Certification

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

Name:
Company: JEROMES DRILLING CO
License No: WWC-249
Date Completed: 6/24/1997

MONTANA WELL LOG REPORT

This well log reports the activities of a licensed Montana well driller, serves as the official record of work done within the borehole and casing, and describes the amount of water encountered. This report is compiled electronically from the contents of the Ground Water Information Center (GWIC) database for this site. Acquiring water rights is the well owner's responsibility and is NOT accomplished by the filing of this report.

Other Options

Return to menu
Plot this site in State Library Digital Atlas
Plot this site in Google Maps
View scanned well log (2/13/2009 8:56:18 AM)

Site Name: BROWNE TIM & JULIE
GWIC Id: 130953

Section 1: Well Owner(s)

1) BROWNE, TIM/JULIE (MAIL)
1500 SUNFLOWER DR
MISSOULA MT 59802 [08/19/1992]

Section 2: Location

Township	Range	Section	Quarter Sections
12N	19W	5	NE¼ NE¼ SW¼

County
MISSOULA

Geocode

Latitude	Longitude	Geomethod	Datum
46.82604	-114.016033	TRS-SEC	NAD83

Ground Surface Altitude **Ground Surface Method** **Datum** **Date**

Addition **Block** **Lot**

Section 3: Proposed Use of Water

DOMESTIC (1)

Section 4: Type of Work

Drilling Method: CABLE
Status: NEW WELL

Section 5: Well Completion Date

Date well completed: Wednesday, August 19, 1992

Section 6: Well Construction Details

There are no borehole dimensions assigned to this well.

Casing

From	To	Diameter	Wall Thickness	Pressure Rating	Joint	Type
-1.5	360	6				STEEL

Completion (Perf/Screen)

From	To	Diameter	# of Openings	Size of Openings	Description
360	360	6			OPEN BOTTOM *

Annular Space (Seal/Grout/Packer)

From	To	Description	Cont. Fed?
0	18	BENTONITE	

Section 7: Well Test Data

Total Depth: 360
Static Water Level: 317
Water Temperature:

Bailer Test *

10 gpm with _ feet of drawdown after 2 hours.
Time of recovery _ hours.
Recovery water level _ feet.
Pumping water level 342 feet.

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

Section 8: Remarks

Section 9: Well Log

Geologic Source
120SDMS - SEDIMENTS (TERTIARY)

From	To	Description
0	1	TOPSOIL
1	195	GRAVEL IN BROWN CLAY
195	197	GRAVEL- CLAY AND SEEP OF WATER
197	220	TAN CLAY
220	320	GRAVEL IN TAN CLAY
320	347	GRAVEL- CLAY AND SIGNS OF WATER
347	350	SAND- GRAVEL- SOME CLAY AND WATER (7 GPM)
350	359	SAND IN BLUE GRAY CLAY
359	360	SAND- GRAVEL AND WATER

Driller Certification

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

Name:
Company: CKC
License No: WWC-185
Date Completed: 8/19/1992

ASCE 7 Hazards Report

Address:
No Address at This Location

Standard:	ASCE/SEI 7-22	**Elevation:**	3447.59 ft (NAVD 88)
Risk Category:	II	**Latitude:**	46.822003
Soil Class:	C - Very Dense Soil and Soft Rock	**Longitude:**	-114.027134

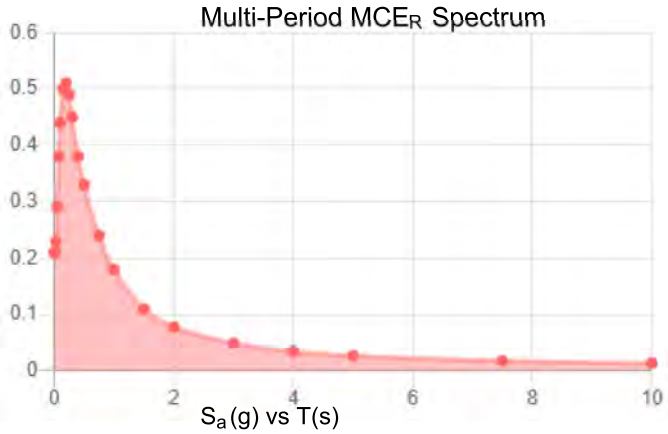
ASCE
AMERICAN SOCIETY OF CIVIL ENGINEERS

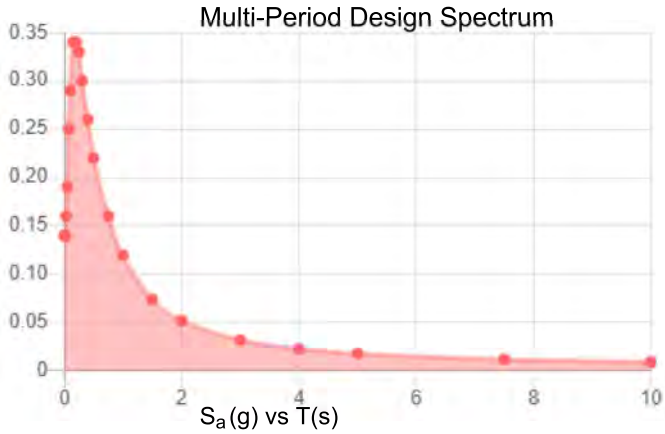
Seismic

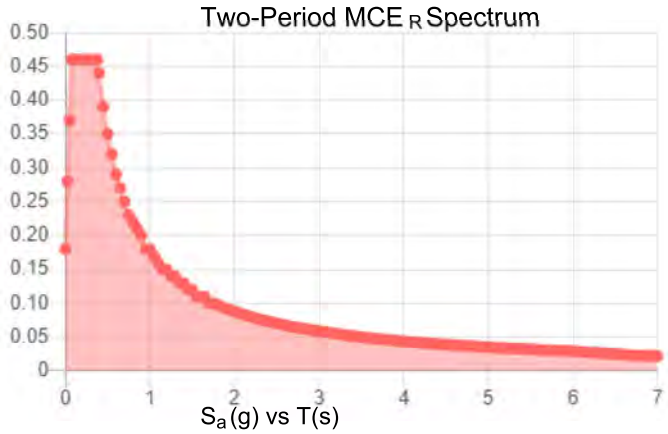
Site Soil Class:

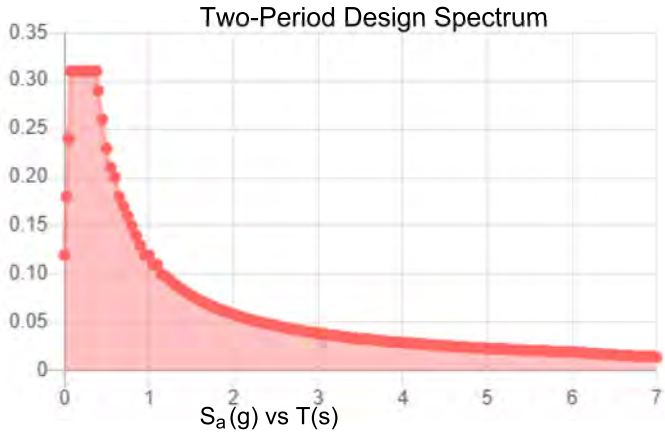
Results:

PGA_M :	0.19	T_L :	6
S_{MS} :	0.46	S_S :	0.42
S_{M1} :	0.18	S_1 :	0.12
S_{DS} :	0.31	S_{DC} :	
S_{D1} :	0.12	V_{S30} :	530









MCE_R Vertical Response Spectrum

Vertical ground motion data has not yet been made available by USGS.

Design Vertical Response Spectrum

Vertical ground motion data has not yet been made available by USGS.

The ASCE 7 Hazard Tool is provided for your convenience, for informational purposes only, and is provided "as is" and without warranties of any kind. The location data included herein has been obtained from information developed, produced, and maintained by third party providers; or has been extrapolated from maps incorporated in the ASCE 7 standard. While ASCE has made every effort to use data obtained from reliable sources or methodologies, ASCE does not make any representations or warranties as to the accuracy, completeness, reliability, currency, or quality of any data provided herein. Any third-party links provided by this Tool should not be construed as an endorsement, affiliation, relationship, or sponsorship of such third-party content by or from ASCE.

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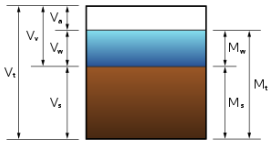
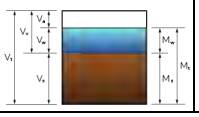


APPENDIX B. PHOTOGRAPHS

Description: TP-10 Location. View is to the southeast.

Description: TP-10 Army Corps of Engineers Cone Penetrometer was pushed 2.75 inches under a 320 psi loading. View is to the southeast.

Lorenzen Soil Mechanics, Inc.



Project: Hillview Way Phase 2 Geotechnical Investigation

Description: TP-13 Location. View is to the west.

Description: TP-13 Location. View is to the east.

Lorenzen Soil Mechanics, Inc.

Project: Hillview Way Phase 2 Geotechnical Investigation

Description: TP-10 Location. View is to the northwest toward Phase 1 grading operations.

Description: TP-10 Jar sample from 2 feet.

Lorenzen Soil Mechanics, Inc.

Project: Hillview Way Phase 2 Geotechnical Investigation

Description: TP-10 Jar sample from 3.5 feet. Cone penetrometer was pushed 5 inches under a 320 psi loading.

Description: TP-10 Jar sample from 6 feet.

Lorenzen Soil Mechanics, Inc.

Project: Hillview Way Phase 2 Geotechnical Investigation

Description: TP-10 Excavated to 8 feet.

Description: TP-10 Excavated to 8 feet. Sloughing of sidewalls below 6 feet.

Lorenzen Soil Mechanics, Inc.

Project: Hillview Way Phase 2 Geotechnical Investigation

Description: TP-10 Jar sample from 8 feet.

Description: TP-10 Spoils pile from above 8 feet. View is to the north.

Lorenzen Soil Mechanics, Inc.

Project: Hillview Way Phase 2 Geotechnical Investigation

Description: TP-11 Cone penetrometer was pushed 3.5 inches under a 320 psi loading. View is to the east.

Description: TP-11 Location. View is to the southwest.

Lorenzen Soil Mechanics, Inc.

Project: Hillview Way Phase 2 Geotechnical Investigation

Description: TP-11 Location. View is to the southeast.

Description: TP-11 Location. View is to the southwest.

Lorenzen Soil Mechanics, Inc.

Project: Hillview Way Phase 2 Geotechnical Investigation

Description: TP-11 Location. View is to the northwest.

Description: TP-11 Jar sample from 1.5 feet.

Lorenzen Soil Mechanics, Inc.

Project: Hillview Way Phase 2 Geotechnical Investigation

Description: TP-11 Jar sample from 3 feet. Cone penetrometer was pushed 1.75 inches under a 320 psi loading.

Description: TP-11 Jar sample from 5.5 feet.

Lorenzen Soil Mechanics, Inc.

Project: Hillview Way Phase 2 Geotechnical Investigation

Description: TP-11 Excavated to 6.8 feet.

Description: TP-11 Excavated to 6.8 feet.

Lorenzen Soil Mechanics, Inc.

Project: Hillview Way Phase 2 Geotechnical Investigation

Description: TP-11 Jar sample from 8.8 feet.

Description: TP-12 Stake Location. View is to the north toward TP-17.

Lorenzen Soil Mechanics, Inc.

Project: Hillview Way Phase 2 Geotechnical Investigation

Description: TP-12 Cone penetrometer was pushed 7.75 inches under a 320 psi loading.

Description: TP-12 Location. View is to the north.

Lorenzen Soil Mechanics, Inc.

Project: Hillview Way Phase 2 Geotechnical Investigation

Description: TP-12 Location. View is to the south.

Description: TP-12 Jar sample from the ground surface.

Lorenzen Soil Mechanics, Inc.

Project: Hillview Way Phase 2 Geotechnical Investigation

Description: TP-12 Jar sample from 2 feet.

Description: TP-12 Jar sample from 3 feet. Cone penetrometer was pushed 2 inches under a 320 psi loading.

Lorenzen Soil Mechanics, Inc.

Project: Hillview Way Phase 2 Geotechnical Investigation

Description: TP-12 Jar sample from 5.5 feet.

Description: TP-12 jar sample from 8 feet.

Lorenzen Soil Mechanics, Inc.

Project: Hillview Way Phase 2 Geotechnical Investigation

Description: TP-12 Excavated to 8 feet.

Description: TP-12 Excavated to 8 feet.

Lorenzen Soil Mechanics, Inc.

Project: Hillview Way Phase 2 Geotechnical Investigation

Description: TP-12 Spoils pile from above 8 feet.

Description: TP-13 Stake location. View is to the south.

Lorenzen Soil Mechanics, Inc.

Project: Hillview Way Phase 2 Geotechnical Investigation

Description: TP-13 Location. View is to the west.

Description: TP-13 Location. View is to the west.

Lorenzen Soil Mechanics, Inc.

Project: Hillview Way Phase 2 Geotechnical Investigation

Description: TP-13 Location. View is to the southeast.

Description: TP-13 Cone penetrometer was pushed 4.75 inches under a 320 psi loading.

Lorenzen Soil Mechanics, Inc.

Project: Hillview Way Phase 2 Geotechnical Investigation

Description: TP-13 Jar sample from the ground surface.

Description: TP-13 Jar sample from 1.5 feet.

Lorenzen Soil Mechanics, Inc.

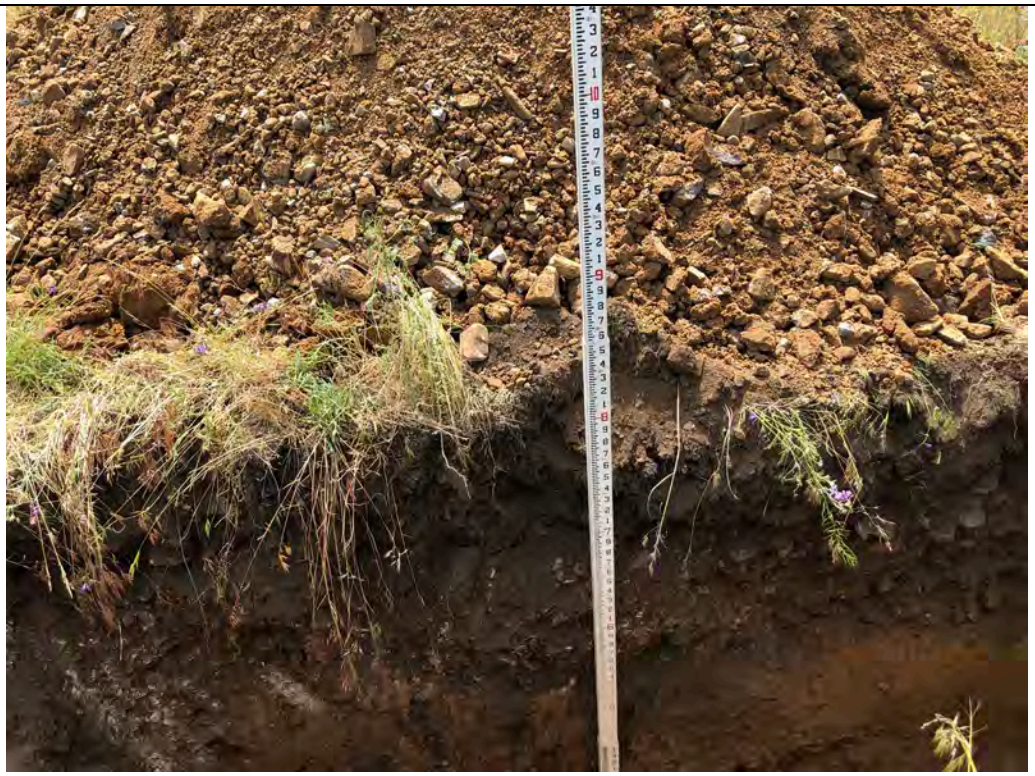
Project: Hillview Way Phase 2 Geotechnical Investigation

Description: TP-13 Jar sample from 3.2 feet. Cone penetrometer was pushed 3.5 inches under a 320 psi loading.

Description: TP-13 Jar sample from 6.7 feet.

Lorenzen Soil Mechanics, Inc.

Project: Hillview Way Phase 2 Geotechnical Investigation



Description: TP-13 Excavated to 8 feet.

Description: TP-13 Excavated to 8 feet.

Lorenzen Soil Mechanics, Inc.

Project: Hillview Way Phase 2 Geotechnical Investigation

Description: TP-13 Jar sample from 8 feet.

Description: TP-13 Spoils pile from above 8 feet. View is to the west.

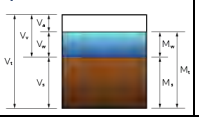
Lorenzen Soil Mechanics, Inc.

Project: Hillview Way Phase 2 Geotechnical Investigation

Description: TP-14 Location. View is to the southwest.

Description: TP-14 Cone penetrometer was pushed 6 inches under a 320 psi loading. View is to the east.

Lorenzen Soil Mechanics, Inc.



Project: Hillview Way Phase 2 Geotechnical Investigation

Description: TP-14 Location. View is to the north.

Description: TP-14 Location. View is to the southwest.

Lorenzen Soil Mechanics, Inc.

Project: Hillview Way Phase 2 Geotechnical Investigation

Description: TP-14 Jar sample from the ground surface.

Description: TP-14 Jar sample from 2 feet.

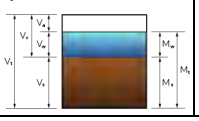
Lorenzen Soil Mechanics, Inc.

Project: Hillview Way Phase 2 Geotechnical Investigation

Description: TP-14 Jar sample from 3.5 feet. Cone penetrometer was pushed 1 inch under a 320 psi loading.

Description: TP-14 Jar sample from 6.25 feet.

Lorenzen Soil Mechanics, Inc.

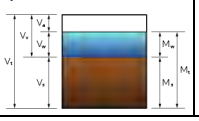


Project: Hillview Way Phase 2 Geotechnical Investigation

Description: TP-14 Excavated to 8 feet.

Description: TP-14 Excavated to 8 feet.

Lorenzen Soil Mechanics, Inc.



Project: Hillview Way Phase 2 Geotechnical Investigation

Description: TP-14 Jar sample from 8 feet.

Description: TP-14 Spoils pile from above 8 feet.

Description: TP-15 Location. View is to the southwest.

Description: TP-15 Cone penetrometer was pushed 4.25 inches under a 320 psi loading. View is to the south.

Lorenzen Soil Mechanics, Inc.

Project: Hillview Way Phase 2 Geotechnical Investigation

Description: TP-15 Location. View is to the south.

Description: TP-15 Location. View is to the west.

Lorenzen Soil Mechanics, Inc.

Project: Hillview Way Phase 2 Geotechnical Investigation

Description: TP-15 Location. View is to the northwest.

Description: TP-15 Jar sample from the ground surface.

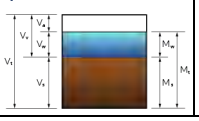
Lorenzen Soil Mechanics, Inc.

Project: Hillview Way Phase 2 Geotechnical Investigation

Description: TP-15 Jar sample from 2.5-foot depth. Cone penetrometer was pushed 4.25 inches under a 320 psi loading.

Description: TP-15 Jar sample from 5.75 feet.

Lorenzen Soil Mechanics, Inc.



Project: Hillview Way Phase 2 Geotechnical Investigation

Description: TP-15 Clean gravel with very few fines.

Description: TP-15 Jar sample from 7.5 feet.

Lorenzen Soil Mechanics, Inc.

Project: Hillview Way Phase 2 Geotechnical Investigation

Description: TP-15 Excavated to 8 feet.

Description: TP-15 Excavated to 8 feet.

Lorenzen Soil Mechanics, Inc.

Project: Hillview Way Phase 2 Geotechnical Investigation

Description: TP-15 Jar sample from 8 feet.

Description: TP-15 Spoils pile from above 8 feet.

Lorenzen Soil Mechanics, Inc.

Project: Hillview Way Phase 2 Geotechnical Investigation

Description: TP-16 Stake location. View is to the south toward the TP-13 location.

Description: TP-16 Location. Cone penetrometer was pushed 5.5 inches under a 320 psi loading. View is to the southwest.

Lorenzen Soil Mechanics, Inc.

Project: Hillview Way Phase 2 Geotechnical Investigation

Description: TP-16 Location. View is to the southeast.

Description: TP-16 Location. View is to the west.

Lorenzen Soil Mechanics, Inc.

Project: Hillview Way Phase 2 Geotechnical Investigation

Description: TP-16 Jar sample from the ground surface.

Description: TP-16 Jar sample from 2 feet.

Lorenzen Soil Mechanics, Inc.

Project: Hillview Way Phase 2 Geotechnical Investigation

Description: TP-16 Jar sample 3.4 feet. Cone penetrometer was pushed 0.5 inches under a 320 psi loading.

Description: TP-16 Jar sample from 6 feet.

Lorenzen Soil Mechanics, Inc.

Project: Hillview Way Phase 2 Geotechnical Investigation

Description: TP-16 Excavated to 8 feet.

Description: TP-16 Excavated to 8 feet.

Lorenzen Soil Mechanics, Inc.

Project: Hillview Way Phase 2 Geotechnical Investigation

Description: TP-16 Jar sample from 8 feet

Description: TP-16 Spoils pile from above 16 feet.

Lorenzen Soil Mechanics, Inc.

Project: Hillview Way Phase 2 Geotechnical Investigation

Description: TP-16 Bucket sample from 8 feet.

Description: TP-17 Stake location. View is to the north toward TP-18.

Lorenzen Soil Mechanics, Inc.

Project: Hillview Way Phase 2 Geotechnical Investigation

Description: TP-17 Location. View is to the east.

Description: TP-17 Location. View is to the west.

Lorenzen Soil Mechanics, Inc.

Project: Hillview Way Phase 2 Geotechnical Investigation

Description: TP-17 Location. View is to the northwest.

Description: TP-17 Cone penetrometer was pushed 6 inches under a 320 psi loading. View is to the southeast.

Lorenzen Soil Mechanics, Inc.

Project: Hillview Way Phase 2 Geotechnical Investigation

Description: TP-17 Jar sample from the ground surface.

Description: TP-17 Jar sample from 1.5 feet.

Lorenzen Soil Mechanics, Inc.

Project: Hillview Way Phase 2 Geotechnical Investigation

Description: TP-17 Jar sample from 3.2 feet. Cone penetrometer was pushed 2.5 inches under a 320 psi loading.

Description: TP-17 Jar sample from 6 feet.

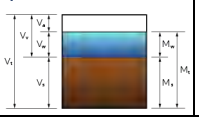
Lorenzen Soil Mechanics, Inc.

Project: Hillview Way Phase 2 Geotechnical Investigation

Description: TP-17 Excavated to 8.2 feet.

Description: TP-17 Excavated to 8.2 feet.

Lorenzen Soil Mechanics, Inc.



Project: Hillview Way Phase 2 Geotechnical Investigation

Description: TP-17 Jar sample from 8.2 feet.

Description: TP-17 Spoils pile from above 8.2 feet.

Lorenzen Soil Mechanics, Inc.

Project: Hillview Way Phase 2 Geotechnical Investigation

Description: TP-18 Stake location. View is to the west toward TP-19 location.

Description: TP-18 Location. View is to the north.

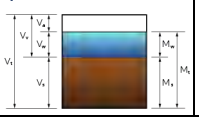
Lorenzen Soil Mechanics, Inc.

Project: Hillview Way Phase 2 Geotechnical Investigation

Description: TP-18 Location. View is to the east.

Description: TP-18 Location. View is to the southwest.

Lorenzen Soil Mechanics, Inc.



Project: Hillview Way Phase 2 Geotechnical Investigation

Description: TP-18 Cone penetrometer was pushed 3.5 inches under a 320 psi loading.

Description: TP-18 Jar sample from the ground surface.

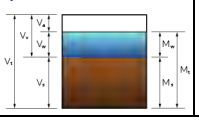
Lorenzen Soil Mechanics, Inc.

Project: Hillview Way Phase 2 Geotechnical Investigation

Description: TP-18 Jar sample from 1.5 feet.

Description: TP-18 Jar sample from 3 feet. Cone penetrometer was pushed 1 inch under 320 psi loading.

Lorenzen Soil Mechanics, Inc.



Project: Hillview Way Phase 2 Geotechnical Investigation

Description: TP-18 Bucket sample from 4.5 feet.

Description: TP-18 Jar sample from 5.75 feet.

Lorenzen Soil Mechanics, Inc.

Project: Hillview Way Phase 2 Geotechnical Investigation

Description: TP-18 Excavated to 8.25 feet.

Description: TP-18 Excavated to 8.25 feet.

Lorenzen Soil Mechanics, Inc.

Project: Hillview Way Phase 2 Geotechnical Investigation

Description: TP-18 Jar sample from 8.25 feet.

Description: TP-19 Spoils pile from above 8.25 feet.

Lorenzen Soil Mechanics, Inc.

Project: Hillview Way Phase 2 Geotechnical Investigation

Description: TP-19 Stake location. View is to the west toward TP-20.

Description: TP-19 Location. View is to the north. Cone penetrometer was pushed 7.25 inches under a 320 psi loading.

Lorenzen Soil Mechanics, Inc.

Project: Hillview Way Phase 2 Geotechnical Investigation

Description: TP-19 Location. View is to the east.

Description: TP-19 Location. View is to the south.

Lorenzen Soil Mechanics, Inc.

Project: Hillview Way Phase 2 Geotechnical Investigation

Description: TP-19 Jar sample from the ground surface.

Description: TP-19 Jar sample from 1.5 feet.

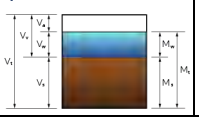
Lorenzen Soil Mechanics, Inc.

Project: Hillview Way Phase 2 Geotechnical Investigation

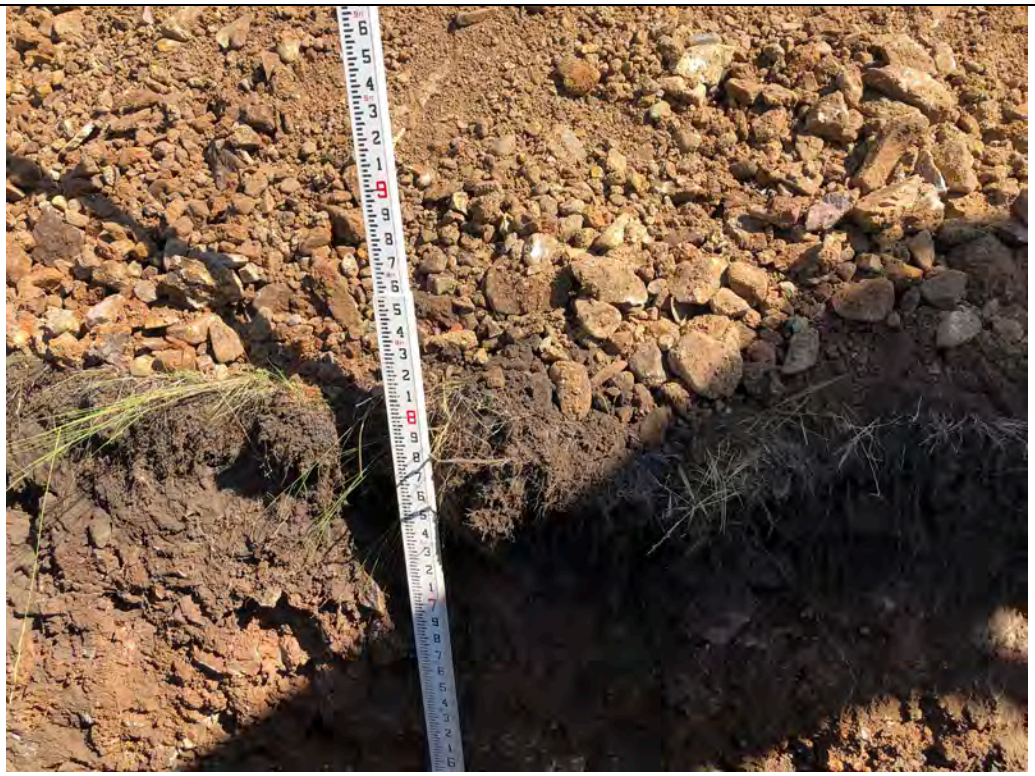
Description: TP-19 Jar sample from 3 feet. Cone penetrometer was pushed 1.75 inches under a 320 psi loading.

Description: TP-19 Jar sample from the 6 feet.

Lorenzen Soil Mechanics, Inc.



Project: Hillview Way Phase 2 Geotechnical Investigation



Description: TP-19 Excavated to 8 feet.

Description: TP-19 Excavated to 8 feet.

Lorenzen Soil Mechanics, Inc.

Project: Hillview Way Phase 2 Geotechnical Investigation

Description: TP-19 Jar sample from 8 feet.

Description: TP-19 Spoils pile from above 8 feet.

Lorenzen Soil Mechanics, Inc.

Project: Hillview Way Phase 2 Geotechnical Investigation

Description: TP-20 Location. View is to the northwest. Army Corps of Engineers Cone Penetrometer (not seen) was pushed 5.5 inches under a 320 psi loading.

Description: TP-20 Location. View is to the west.

Lorenzen Soil Mechanics, Inc.

Project: Hillview Way Phase 2 Geotechnical Investigation

Description: TP-20 Location. View is to the southwest.

Description: TP-20 Jar sample from the ground surface.

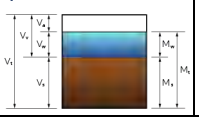
Lorenzen Soil Mechanics, Inc.

Project: Hillview Way Phase 2 Geotechnical Investigation

Description: TP-20 Jar sample from 2 feet.

Description: TP-20 Jar sample from 3.2 feet. Cone penetrometer was pushed 3.5 inches under a 320 psi loading.

Lorenzen Soil Mechanics, Inc.



Project: Hillview Way Phase 2 Geotechnical Investigation

Description: TP-20 Jar sample from 6.5 feet.

Description: TP-20 Jar sample from 8.5 feet.

Lorenzen Soil Mechanics, Inc.

Project: Hillview Way Phase 2 Geotechnical Investigation

Description: TP-20 Excavated to 8.5 feet.

Description: TP-20 Excavated to 8.5 feet.

Lorenzen Soil Mechanics, Inc.

Project: Hillview Way Phase 2 Geotechnical Investigation

Description: TP-20 Spoils pile from above 7.5 feet.

Description: TP-21 Stake location. View is to the south as earthwork grading from Phase 1 is taking place.

Lorenzen Soil Mechanics, Inc.

Project: Hillview Way Phase 2 Geotechnical Investigation

Description: TP-21 Location. View is to the southwest.

Description: TP-21 Location. View is to the east.

Lorenzen Soil Mechanics, Inc.

Project: Hillview Way Phase 2 Geotechnical Investigation

Description: TP-21 Location. View is to the west.

Description: TP-21 Cone penetrometer was pushed 7.75 inches under a 320 psi loading.

Lorenzen Soil Mechanics, Inc.

Project: Hillview Way Phase 2 Geotechnical Investigation

Description: TP-21 Jar sample from 1 foot.

Description: TP-21 Jar sample from 2 feet.

Lorenzen Soil Mechanics, Inc.

Project: Hillview Way Phase 2 Geotechnical Investigation

Description: TP-21 Jar sample from 3.2 feet. Cone penetrometer was pushed 1.75 inches under a 320 psi loading.

Description: TP-22 Jar sample from 6 feet.

Lorenzen Soil Mechanics, Inc.

Project: Hillview Way Phase 2 Geotechnical Investigation

Description: TP-21 Excavated to 8.25 feet.

Description: TP-21 Excavated to 8.25 feet.

Lorenzen Soil Mechanics, Inc.

Project: Hillview Way Phase 2 Geotechnical Investigation

Description: TP-21 Spoils pile from above 8.25 feet.

Description: TP-22 Location. View is to the east.

Lorenzen Soil Mechanics, Inc.

Project: Hillview Way Phase 2 Geotechnical Investigation

Description: TP-22 Location. View is to the south toward grading operations.

Description: TP-22 Location. View is to the south toward grading operations.

Lorenzen Soil Mechanics, Inc.

Project: Hillview Way Phase 2 Geotechnical Investigation

Description: TP-22 Cone penetrometer was pushed 3 inches under a 320 psi loading. View is to the west.

Description: TP-22 Jar sample from the ground surface.

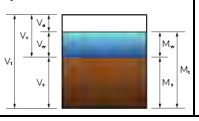
Lorenzen Soil Mechanics, Inc.

Project: Hillview Way Phase 2 Geotechnical Investigation

Description: TP-22 Jar sample from 1.5 feet.

Description: TP-22 Jar sample from 3.2 feet. Cone penetrometer was pushed 6 inches under a 320 psi loading.

Lorenzen Soil Mechanics, Inc.

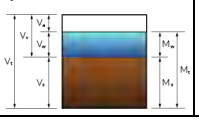


Project: Hillview Way Phase 2 Geotechnical Investigation

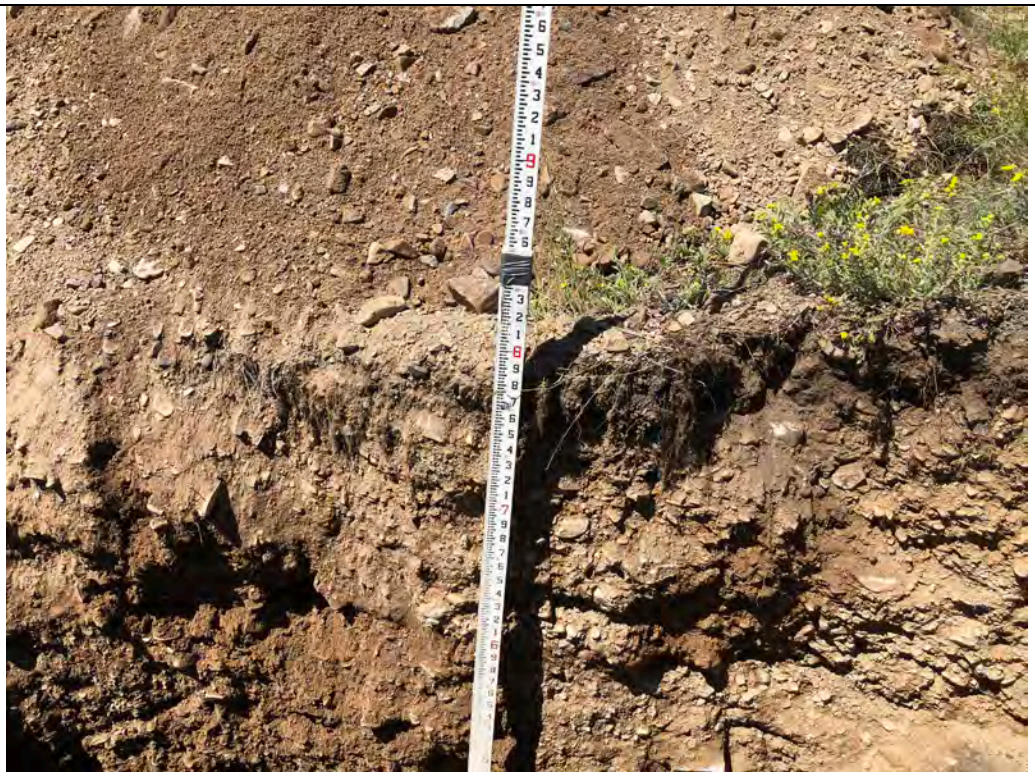
Description: TP-22 Jar sample from 6.4 feet.

Description: TP-22 Jar sample from 8 feet.

Lorenzen Soil Mechanics, Inc.



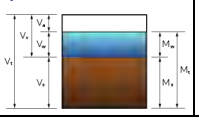
Project: Hillview Way Phase 2 Geotechnical Investigation



Description: TP-22 Excavated to 8 feet.

Description: TP-22 Excavated to 8 feet.

Lorenzen Soil Mechanics, Inc.



Project: Hillview Way Phase 2 Geotechnical Investigation

Description: TP-22 Spoils pile from above 8 feet. View is to the east.

Description: TP-22 Backfilled. View is to the northeast toward the TP-21 location near the crest of the slope.

Lorenzen Soil Mechanics, Inc.

Project: Hillview Way Phase 2 Geotechnical Investigation

Description: TP-10 Moisture content samples prior to being placed into the drying oven.

Description: TP-10 Moisture content samples after being taken out of the drying oven.

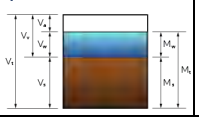
Lorenzen Soil Mechanics, Inc.

Project: Hillview Way Phase 2 Geotechnical Investigation

Description: TP-11 Moisture content samples prior to being placed into the drying oven.

Description: TP-11 Moisture content samples after being taken out of the drying oven.

Lorenzen Soil Mechanics, Inc.



Project: Hillview Way Phase 2 Geotechnical Investigation

Description: TP-12 Moisture content samples prior to being placed into the drying oven.

Description: TP-12 Moisture content samples after being taken out of the drying oven.

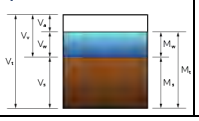
Lorenzen Soil Mechanics, Inc.

Project: Hillview Way Phase 2 Geotechnical Investigation

Description: TP-13 Moisture content samples prior to being placed into the drying oven.

Description: TP-13 Moisture content samples after being taken out of the drying oven.

Lorenzen Soil Mechanics, Inc.



Project: Hillview Way Phase 2 Geotechnical Investigation

Description: TP-14 Moisture content samples prior to being placed into the drying oven.

Description: TP-14 Moisture content samples after being taken out of the drying oven.

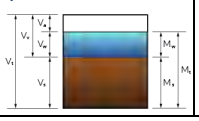
Lorenzen Soil Mechanics, Inc.

Project: Hillview Way Phase 2 Geotechnical Investigation

Description: TP-15 Moisture content samples prior to being placed into the drying oven.

Description: TP-15 Moisture content samples after being taken out of the drying oven.

Lorenzen Soil Mechanics, Inc.



Project: Hillview Way Phase 2 Geotechnical Investigation

Description: TP-16 Moisture content samples prior to being placed into the drying oven.

Description: TP-16 Moisture content samples after being taken out of the drying oven.

Lorenzen Soil Mechanics, Inc.

Project: Hillview Way Phase 2 Geotechnical Investigation

Description: TP-17 Moisture content samples prior to being placed into the drying oven.

Description: TP-17 Moisture content samples after being taken out of the drying oven.

Lorenzen Soil Mechanics, Inc.

Project: Hillview Way Phase 2 Geotechnical Investigation

Description: TP-18 Moisture content samples after being taken out of the drying oven – the pre-drying photo was not taken.

Description: TP-18 Moisture content samples after being taken out of the drying oven.

Lorenzen Soil Mechanics, Inc.

Project: Hillview Way Phase 2 Geotechnical Investigation

Description: TP-19 Moisture content samples prior to being placed into the drying oven.

Description: TP-19 Moisture content samples after being taken out of the drying oven.

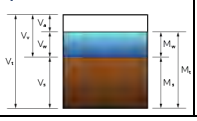
Lorenzen Soil Mechanics, Inc.

Project: Hillview Way Phase 2 Geotechnical Investigation

Description: TP-20 Moisture content samples prior to being placed into the drying oven.

Description: TP-20 Moisture content samples after being taken out of the drying oven.

Lorenzen Soil Mechanics, Inc.

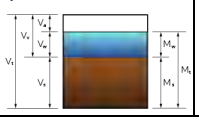


Project: Hillview Way Phase 2 Geotechnical Investigation

Description: TP-21 Moisture content samples prior to being placed into the drying oven.

Description: TP-21 Moisture content samples after being taken out of the drying oven.

Lorenzen Soil Mechanics, Inc.

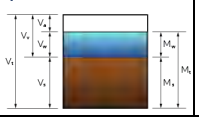


Project: Hillview Way Phase 2 Geotechnical Investigation

Description: TP-22 Moisture content samples prior to being placed into the drying oven.

Description: TP-22 Moisture content samples after being taken out of the drying oven.

Lorenzen Soil Mechanics, Inc.

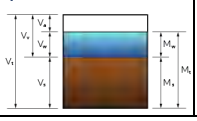


Project: Hillview Way Phase 2 Geotechnical Investigation

Description: TP-15 Bulk sample from 6.5 feet prior to being dried, screened, and sieved.

Description: TP-15 Bulk sample from 6.5 feet after being dried, screened, and sieved.

Lorenzen Soil Mechanics, Inc.



Project: Hillview Way Phase 2 Geotechnical Investigation

Description: TP-16 Bulk sample from 8 feet prior to being dried, screened, and sieved.

Description: TP-16 Bulk sample from 8 feet after being dried, screened, and sieved.

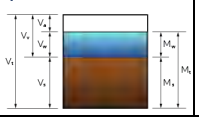
Lorenzen Soil Mechanics, Inc.

Project: Hillview Way Phase 2 Geotechnical Investigation

Description: TP-18 Bulk sample from 4.5 feet prior to being dried, screened, and sieved.

Description: TP-18 Bulk sample from 4.5 feet after being dried, screened, and sieved.

Lorenzen Soil Mechanics, Inc.

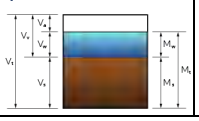


Project: Hillview Way Phase 2 Geotechnical Investigation

Description: TP-22 Bulk sample from 6.4 feet prior to being dried, screened, and sieved.

Description: TP-22 Bulk sample from 6.4 feet after being dried, screened, and sieved.

Lorenzen Soil Mechanics, Inc.



Project: Hillview Way Phase 2 Geotechnical Investigation