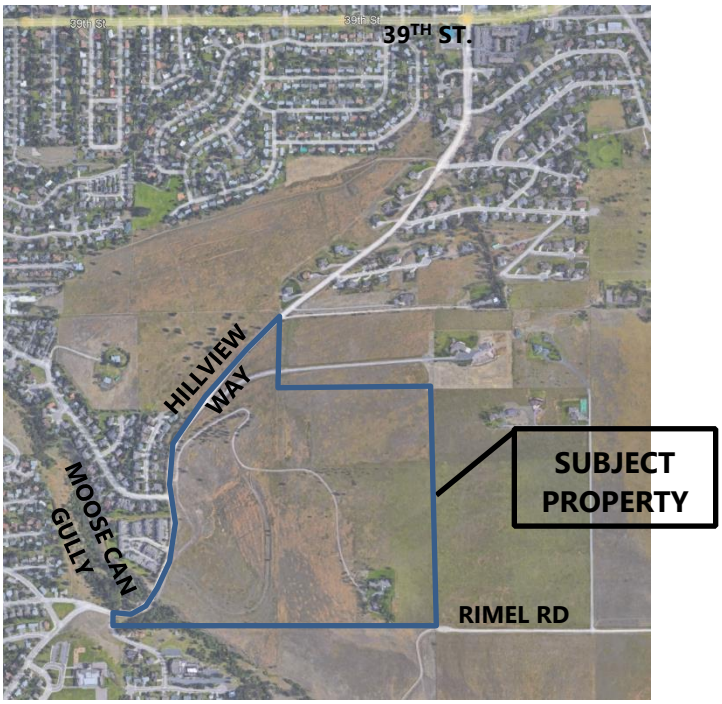
Sanitary Sewer Engineering Report
Wildroot



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_SUBDIV
November 29, 2023

PRELIMINARY – FOR REVIEW PURPOSES ONLY

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

APPENDICES

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 sewer extension serving the multi-family development and townhomes which connects to the Clearview Way sewer main. The proposed 226 single family lots will sewer through a new collection system proposed to connect into the Hillview Way sewer main.

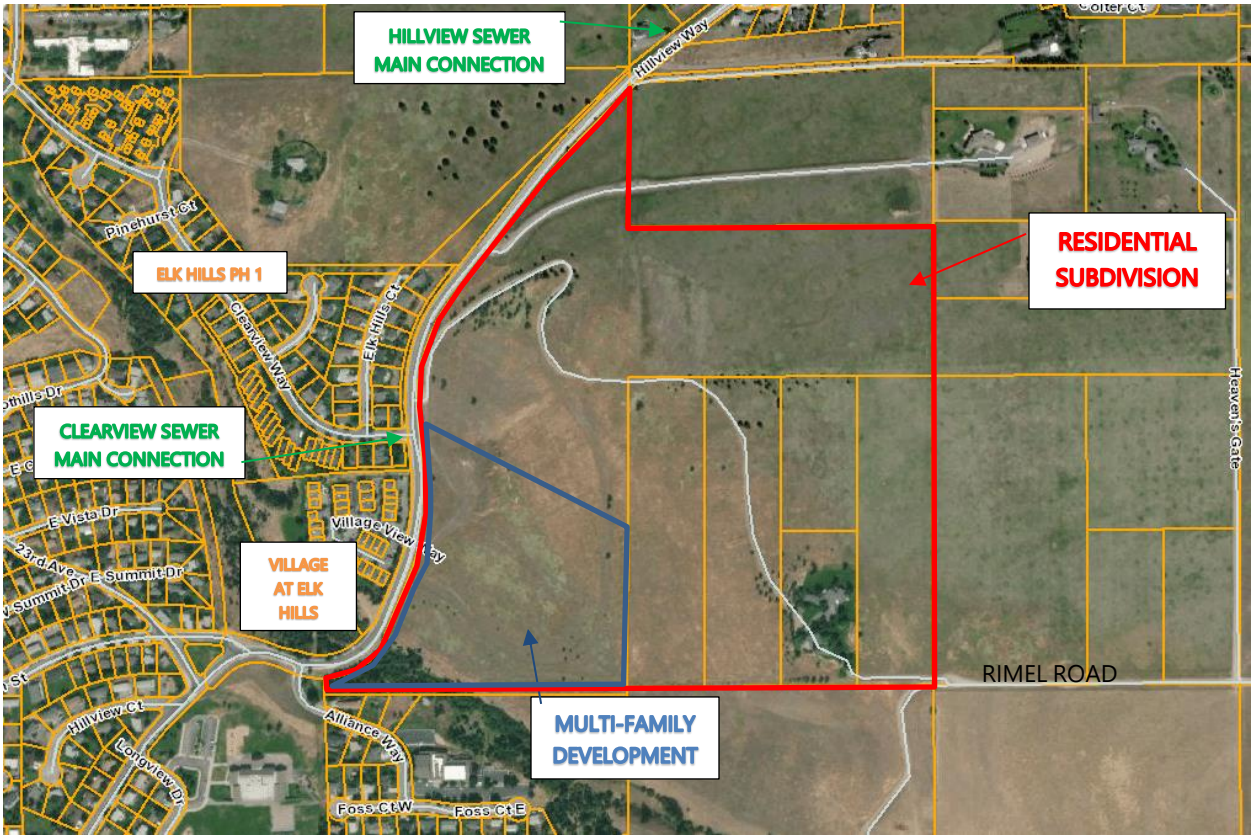
The intent and purpose of this report is to provide the necessary engineering documentation and calculations for the public sewer main extension to service the 226 units in the proposed subdivision. The report provides calculations and documentation to meet the requirements of the Montana DEQ (MTDEQ) and City of Missoula (COM).

The following references were used in the design of the sewer main extension.

- City of Missoula 2019 Wastewater Facility Plan
- Missoula City Public Works Standards and Specifications Manual (MCPWSS)
- Montana Public Works Standard Specifications (MPWSS)
- MTDEQ Circular No. 2 (DEQ2)
- City of Missoula Zoning Map

Figure 1.1: Overall Location Map

Figure 1.2: Detailed Location Map



1.1 Zoning

The portions of the subject property within the city limits are zoned under RM1-35 (residential multi-dwelling), RM0.5 (residential multi-dwelling), R8 (residential), and a small area is zoned B2-1 (community business). Through the subdivision process the zoning is proposed to be changed and the annexed property will be zoned. The property will utilize RM1-35 for the multi-family property, RM0.5 for the townhomes, and R5.4 for the single-family lots.

1.2 Topographic Features and Slopes

The development is proposed on a steep site. Topography ranges from slopes of 0-25 percent. The highest elevation on the property being approximately 3665 feet and the lowest approximately 3405 feet.

1.3 Geologic Features and Geotechnical Data

The bury depth of the sewer system will comply with the City of Missoula and Montana DEQ requirement of 4 feet of cover to top of pipe without insulation. A geotechnical investigation and report is provided for the project. The material at the pipe bury depth is generally poorly graded gravel with frequent cobbles or clayey gravel with sand.

See the geotechnical investigation from the report prepared by Lorenzen Soil Mechanics, Inc. titled, *"Hillview Subdivision Geotechnical Engineering Report – Phase 2"* dated September 13, 2022 provided with this submittal.

1.3.1 Soils

Overall, the report indicates the soils in the area are cobbles, gravel, sand, silt, and clay. Borehole logs and an excerpt on subsurface conditions are located in the geotechnical report.

1.3.2 Groundwater

The report does not indicate the presence of groundwater in the project area. In the 22 test pits excavated to depths between up to 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.

1.3.3 Wetlands

Wetlands within the property are in Moose Can Gully. The project does not propose any work encroaching these wetlands.

2.0 SEWER MAIN DESIGN

2.1 Existing Sewer Supply

There are two connection points available to the proposed subdivision. The first is the permitted and constructed connection to the Clearview Way sewer main which services the multi-family and townhouses. The second existing sewer main is to the north on Hillview Way which flows to 39th Street. Both existing mains are 8-inch diameter PVC terminating at a 48-inch diameter concrete manhole.

2.2 Downstream Impacts

The downstream impacts of the Clearview Way connection were addressed in the 24th Street Sewer Upsize design and report which is approved and constructed. There are no anticipated downstream impacts from the connection to Hillview Way.

2.3 Proposed Sewer System

The sewer is designed to receive wastewater only and will be constructed to meet the requirements of the latest addition of the MPWSS, City of Missoula Modifications, and the MCPWSS.

Per City of Missoula request the design evaluates four adjacent properties for future development in addition to the 226 units proposed in this subdivision. It is assumed each adjacent parcel will be developed to the maximum extent possible under the existing zoning as single-family residential lots. This results in an additional 277 single-family lots to be sewered through the improvements of this subdivision. Therefore, the proposed design anticipates a total of 503 units.

The sewer main extension for Zone 1 will sewer to the north and connect to the Hillview Way sewer main. The proposed design connects into an existing concrete sanitary sewer manhole in the Hillview Way ROW that currently does not accept any wastewater. The proposal is to core and connect a new 8-inch PVC sewer main to the south side of this manhole and begin the sewer main extension to an existing 48-inch diameter concrete manhole that connects to a second existing 48-inch diameter manhole on the east side of Hillview Way. From there the extension will continue to the south and southeast to serve the 226-units associated with this project. The entirety of the sewer main extension will exist either in existing or proposed right-of-way or in its own 20-foot wide utility easement. The design maintains more than the minimum horizontal separation to water main of 10-feet wall to wall.

2.4 Design Analysis

The sewer main is designed to be the minimum 8" diameter per the DEQ2 and meets the slope and velocity requirements. To analyze the sewer flow rate of the development the peaking factor was established. The peaking factor was evaluated for the Zone 1 sewer zone using the peaking factor equation from DEQ2.

$$\frac{\text{Design Peak Hourly Flow}}{\text{Design Average Flow}} = \frac{\left(18 + \sqrt{P}\right)}{\left(4 + \sqrt{P}\right)} \qquad (10\text{-}1)$$

P = population in thousands

Peak flows were calculated for the Hillview Way Connection as shown in Table 2.2.

Table 2.1: Zone 1 Sewer Peak Flow

ZONE 1 - Hillview Way							
UNIT TYPE	UNITS	Density (Persons/Unit)	Total No. of People	Avg. Daily Flow Rate (gpd)	Peaking Factor	Peak Flow Rate (gpd)	Peak Flow Rate (cfs)
Single Family	226	2.3	520	51,980	3.69	191,995	0.288
Adjacent Dev.	277	3.3	914	91,410	3.69	337,634	0.506
TOTAL	503		1434	143,390		529,629	0.794

Sewer capacity is evaluated in the pipe connecting the existing sewer manholes at the Hillview Way crossing. This 8" PVC pipe will carry the full flow rate of Zone 1. Per the topographic survey for this project the pipe slope is 1.32%. However, City of Missoula recorded information is a 1.0% pipe slope. Both scenarios are calculated. The Zone 1 flow depth of the described pipe at 1.0% is 0.32 feet and at 1.32% is 0.29 feet, between 3 and 4 inches deep. See Appendix B for the Hydraflow calculation.

In the preliminary design of the sewer vertical alignment one segment of pipe is sloped at 0.60%. This segment located at the intersection of Local F and Local C is evaluated as an 8" PVC

pipe at 0.60% for a Zone 1 flow depth of 0.37 feet. The flow rate in this location is anticipated to be a fraction of the 0.794 cfs.

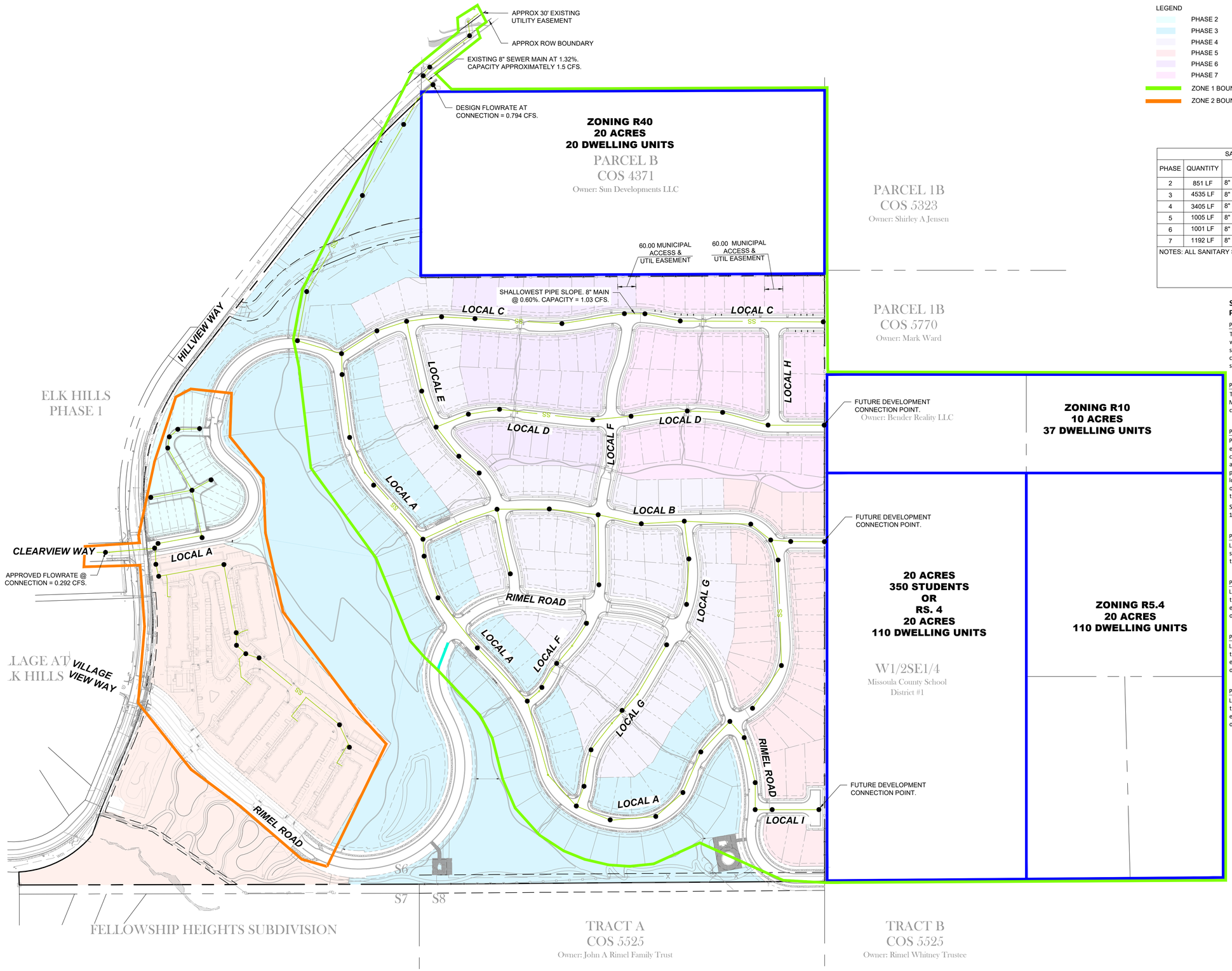
The project is phased into seven phases. Exhibits in Appendix A show the sewer build-out phase by phase. In various locations sewer main construction will extend beyond the pavement edge of the phase. In these instances the termination manhole will be constructed with a removeable cone to meet the interim requirement of 18" above surrounding landscape grade. When the subsequent phase is constructed the manhole will be completed flush with finished grade.

3.0 CONCLUSION

In conclusion, the proposed sewer design for the subdivision development meets the requirements of the MCPWSS and DEQ2. It will provide the necessary sewer conveyance to serve the 226 single-family Wildroot lots and future adjacent developments up to 277 single-family lots.

Cushing Terrell

Appendix A: Sewer Exhibits



LEGEND

- PHASE 2
- PHASE 3
- PHASE 4
- PHASE 5
- PHASE 6
- PHASE 7
- ZONE 1 BOUNDARY
- ZONE 2 BOUNDARY

SANITARY SEWER REQUIREMENTS		
PHASE	QUANTITY	DESCRIPTION
2	851 LF	8" SANITARY SEWER LINE (WITH MANHOLES)
3	4535 LF	8" SANITARY SEWER LINE (WITH MANHOLES)
4	3405 LF	8" SANITARY SEWER LINE (WITH MANHOLES)
5	1005 LF	8" SANITARY SEWER LINE (WITH MANHOLES)
6	1001 LF	8" SANITARY SEWER LINE (WITH MANHOLES)
7	1192 LF	8" SANITARY SEWER LINE (WITH MANHOLES)
NOTES: ALL SANITARY SEWER LINES ARE TO BE 8" PVC SDR 35		

SANITARY SEWER SYSTEM REQUIREMENTS PER PHASE

Phase 1:
The Multi-Family development has been designed to sanitary wastewater from the Multi-Family to an existing sanitary sewer system on the west side of Hillview Way at Clearview. This connection will be utilized for Phase 1 and Phase 2. The new sanitary sewer line will be 8" PVC and will be set at a minimum slope of 0.40%.

Phase 2:
This phase contains 21 Townhouses. A stub out from the Multi-Family was provided to allow this portion of the subdivision to connect to and utilize the sanitary sewer line constructed in Phase 1.

Phase 3:
Phase 3 will require construction of a sanitary sewer main line extension north along Hillview Way connecting to the current top of current sanitary sewer system manhole. This connection is approximately 300' north of the northernmost corner of the project parcel, and approximately 1200' north of the Sanitary Sewer Line located in Local A. The line will convey wastewater from the entirety of the single family residential and sub outs for future development to the east.

Sanitary sewer services will be installed to each lot at approximately 10' from the property line on the low side of the site.

Phase 4:
Lots within Phase 4 will drain to the main line in Phase 3. Sanitary sewer services will be installed to each lot at approximately 10' from the property line on the low side of the site.

Phase 5:
Lots within Phase 4 (as well as stub out for future phases) will drain to the main line in Phase 3. Sanitary sewer services will be installed to each lot at approximately 10' from the property line on the low side of the site.

Phase 6:
Lots within Phase 6 (as well as stub out for future phases) will drain to the main line in Phase 3. Sanitary sewer services will be installed to each lot at approximately 10' from the property line on the low side of the site.

Phase 7:
Lots within Phase 7 (as well as stub out for future phases) will drain to the main line in Phase 6. Sanitary sewer services will be installed to each lot at approximately 10' from the property line on the low side of the site.

Cushing Terrell.
cushingterrell.com
800.757.9522

MISSOULA, MONTANA
WILDROOT

EXHIBIT

12.05.2023
DRAWN BY | MASCIA
CHECKED BY |
REVISIONS

NOT FOR CONSTRUCTION - EXHIBIT

OVERALL SANITARY SEWER PLAN

X300

Cushing Terrell.

cushingterrell.com
800.757.9522

PARCEL B
COS 4371
Owner: Sun Developments LLC

PARCEL 1B
COS 5323
Owner: Shirley A Jensen

PARCEL 1B
COS 5770
Owner: Mark Ward

Owner: Bender Reality LLC

ELK HILLS
PHASE 1

VILLAGE AT
ELK HILLS

W1/2SE1/4
Missoula County School
District #1

PLAT H12
Missoula County School
District #1

FELLOWSHIP HEIGHTS SUBDIVISION

TRACT A
COS 5525
Owner: John A Rimel Family Trust

TRACT B
COS 5525
Owner: Rimel Whitney Trustee

HILLVIEW WAY

CLEARVIEW WAY

VILLAGE VIEW WAY

RIMEL ROAD

60.00 MUNICIPAL ACCESS & UTIL EASEMENT

60.00 MUNICIPAL ACCESS & UTIL EASEMENT

LOCAL A

LOCAL B

LOCAL C

LOCAL C

LOCAL D

LOCAL D

LOCAL E

LOCAL F

LOCAL F

LOCAL G

LOCAL G

LOCAL H

LOCAL I

S6

S7

S8

NORTH

1
X301
OVERALL UTILITY PLAN - SANITARY SEWER

0 75 150 300
SCALE: 1" = 150'

11/28/2023 4:31 PM | L:\HILLVIEW_SUBDIV\BIMCAD\Civil\Exhibit DWGs\PRELIM PLAT SUFFICIENCY EXHIBITS\WILDROOT_X300_OVERALL SEWER.dwg

MISSOULA, MONTANA
WILDROOT

NOT FOR CONSTRUCTION - EXHIBIT

EXHIBIT

12.05.2023
DRAWN BY | MASCIA
CHECKED BY |
REVISIONS

OVERALL UTILITY PLAN - SANITARY SEWER

X301

Cushing Terrell.

cushingterrell.com
800.757.9522

NORTH

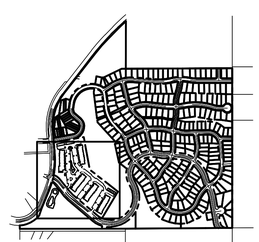
1 / X302 PHASE 1 SANITARY SEWER EXHIBIT

0 25 50 100
SCALE: 1" = 50'

MISSOULA, MONTANA
WILDROOT

EXHIBIT

12.05.2023
DRAWN BY | MASCIA
CHECKED BY |
REVISIONS



KEY PLAN

NOT FOR CONSTRUCTION - EXHIBIT

PHASE 1 SANITARY SEWER EXHIBIT

X302

1 X303 PHASE 2 SANITARY SEWER EXHIBIT

NORTH

0 15 30 60

SCALE: 1" = 30'

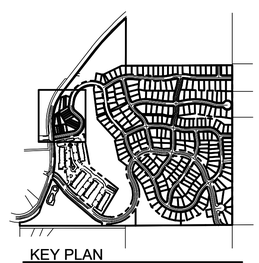
Cushing Terrell.

cushingterrell.com
800.757.9522

MISSOULA, MONTANA
WILDROOT

EXHIBIT

12.05.2023
DRAWN BY | MASCIA
CHECKED BY |
REVISIONS



KEY PLAN

NOT FOR CONSTRUCTION - EXHIBIT

PHASE 2 SANITARY SEWER EXHIBIT

X303

Cushing Terrell.
cushingterrell.com
800.757.9522

PHASE 3 SANITARY SEWER MAIN CONNECTION TO EXISTING SANITARY SEWER MAIN.

PHASE 3 SANITARY SEWER MAIN TERMINATION.

PHASE 3 SANITARY SEWER MAIN TERMINATION.

PHASE 3 SANITARY SEWER MAIN TERMINATION.

PHASE 7

PHASE 6

PHASE 5

PHASE 4

PHASE 3

PHASE 2

HILLVIEW WAY

LOCAL A

LOCAL B

LOCAL C

LOCAL F

LOCAL G

LOCAL I

RIMEL ROAD

SS

NORTH

1 / X304 PHASE 3 SANITARY SEWER EXHIBIT

SCALE: 1" = 100'

0 50 100 200

KEY PLAN

MISSOULA, MONTANA
WILDROOT

EXHIBIT

12.05.2023
DRAWN BY | MASCIA
CHECKED BY |
REVISIONS

NOT FOR CONSTRUCTION - EXHIBIT

PHASE 3 SANITARY SEWER EXHIBIT

X304

PHASE 7

PHASE 6

PHASE 5

PHASE 4

PHASE 3

PHASE 4 SANITARY SEWER MAIN TERMINATION.

PHASE 4 SANITARY SEWER MAIN TERMINATION.

PHASE 4 SANITARY SEWER MAIN TERMINATION.

PHASE 3 SANITARY SEWER MAIN TERMINATION. PHASE 4 SANITARY SEWER MAIN CONNECTION.

PHASE 3 SANITARY SEWER MAIN TERMINATION. PHASE 4 SANITARY SEWER MAIN CONNECTION.

PHASE 3 SANITARY SEWER MAIN TERMINATION. PHASE 4 SANITARY SEWER MAIN CONNECTION.

LOCAL C

LOCAL D

LOCAL E

LOCAL F

LOCAL B

LOCAL G

RIMEL ROAD

SS

C315

C314

C358

C357

C356

C355

NORTH

1
X305

PHASE 4 SANITARY SEWER EXHIBIT

0 30 60 120

SCALE: 1" = 60'

KEY PLAN

Cushing Terrell.

cushingterrell.com
800.757.9522

MISSOULA, MONTANA
WILDROOT

EXHIBIT

12.05.2023
DRAWN BY | MASCIA
CHECKED BY |
REVISIONS

NOT FOR CONSTRUCTION - EXHIBIT

PHASE 4 SANITARY SEWER EXHIBIT

X305

Cushing Terrell.

cushingterrell.com
800.757.9522

PHASE 7

PHASE 4 SANITARY SEWER MAIN TERMINATION. PHASE 5 SANITARY SEWER MAIN CONNECTION.

PHASE 5

PHASE 4

PHASE 3 SANITARY SEWER MAIN TERMINATION. PHASE 5 SANITARY SEWER MAIN CONNECTION.

PHASE 3

LOCAL A

LOCAL B

LOCAL F

LOCAL G

LOCAL I

RIMEL ROAD

C375 C376 C377 C370

SS

NORTH

1 / X306 PHASE 5 SANITARY SEWER EXHIBIT

0 25 50 100

SCALE: 1" = 50'

KEY PLAN

MISSOULA, MONTANA
WILDROOT

NOT FOR CONSTRUCTION - EXHIBIT

EXHIBIT

12.05.2023
DRAWN BY | MASCIA
CHECKED BY |
REVISIONS

PHASE 5 SANITARY SEWER EXHIBIT

X306

Cushing Terrell.
cushingterrell.com
800.757.9522

PHASE 4 SANITARY SEWER MAIN TERMINATION. PHASE 6 SANITARY SEWER MAIN CONNECTION.

PHASE 6 SANITARY SEWER MAIN TERMINATION.

PHASE 4 SANITARY SEWER MAIN TERMINATION. PHASE 6 SANITARY SEWER MAIN CONNECTION.

PHASE 6 SANITARY SEWER MAIN TERMINATION.

LOCAL C

LOCAL D

LOCAL E

LOCAL F

LOCAL A

LOCAL B

PHASE 6

PHASE 7

PHASE 3

PHASE 4

SS

CW12

1 X307 PHASE 6 SANITARY SEWER EXHIBIT

NORTH

0 20 40 80

SCALE: 1" = 40'

KEY PLAN

MISSOULA, MONTANA
WILDROOT

EXHIBIT

12.05.2023
DRAWN BY | MASCIA
CHECKED BY |
REVISIONS

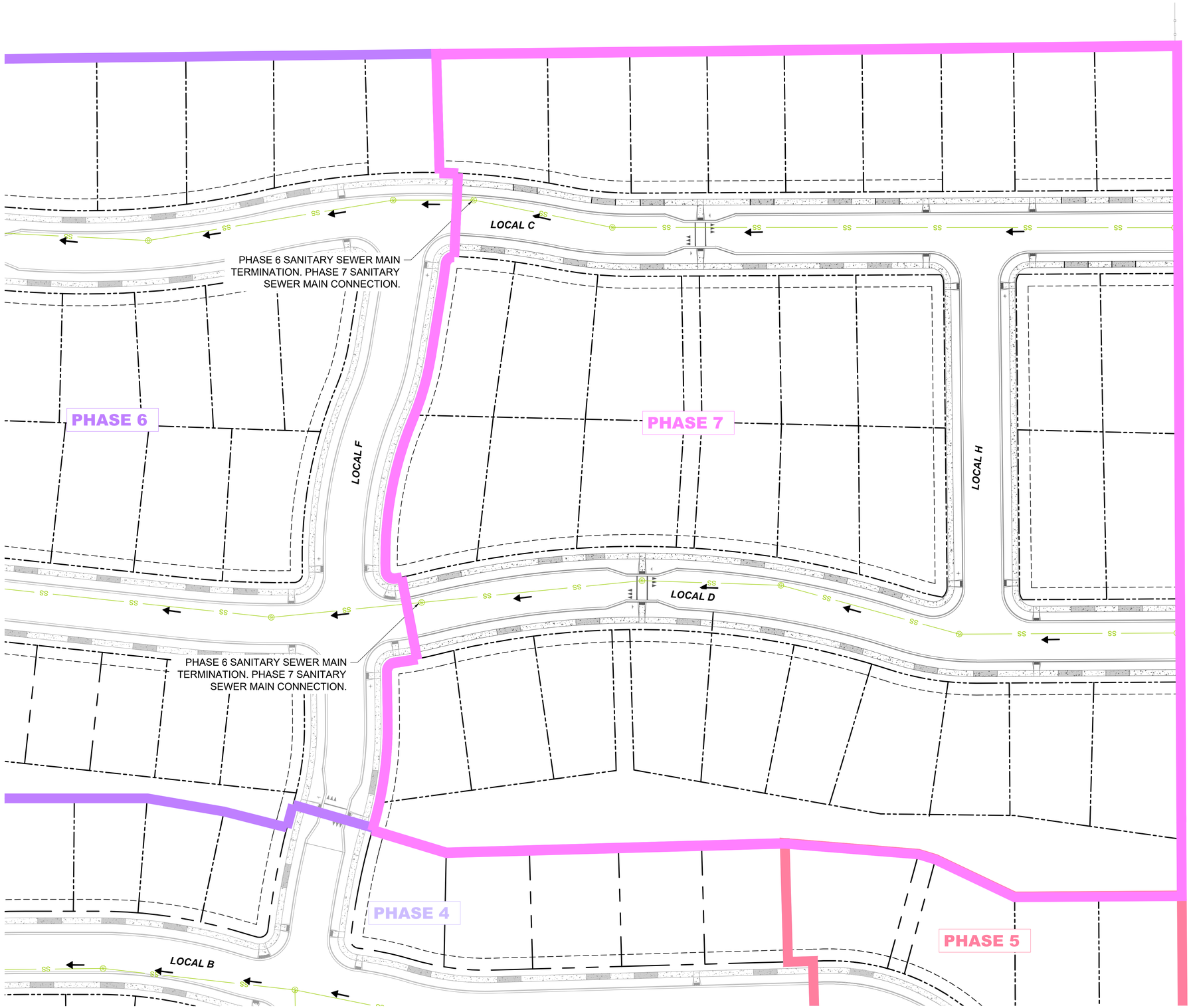
NOT FOR CONSTRUCTION - EXHIBIT

PHASE 6 SANITARY SEWER EXHIBIT

X307

Cushing Terrell.

cushingterrell.com
800.757.9522



NORTH

1 / X308 PHASE 7 SANITARY SEWER EXHIBIT

0 20 40 80

SCALE: 1" = 40'

MISSOULA, MONTANA
WILDROOT

EXHIBIT

12.05.2023
DRAWN BY | MASCIA
CHECKED BY |
REVISIONS

KEY PLAN

NOT FOR CONSTRUCTION - EXHIBIT

PHASE 7 SANITARY SEWER EXHIBIT

X308

Cushing Terrell

Appendix B: Sewer Calculations

Channel Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Wednesday, Nov 29 2023

0.6% 8 IN PVC

Circular

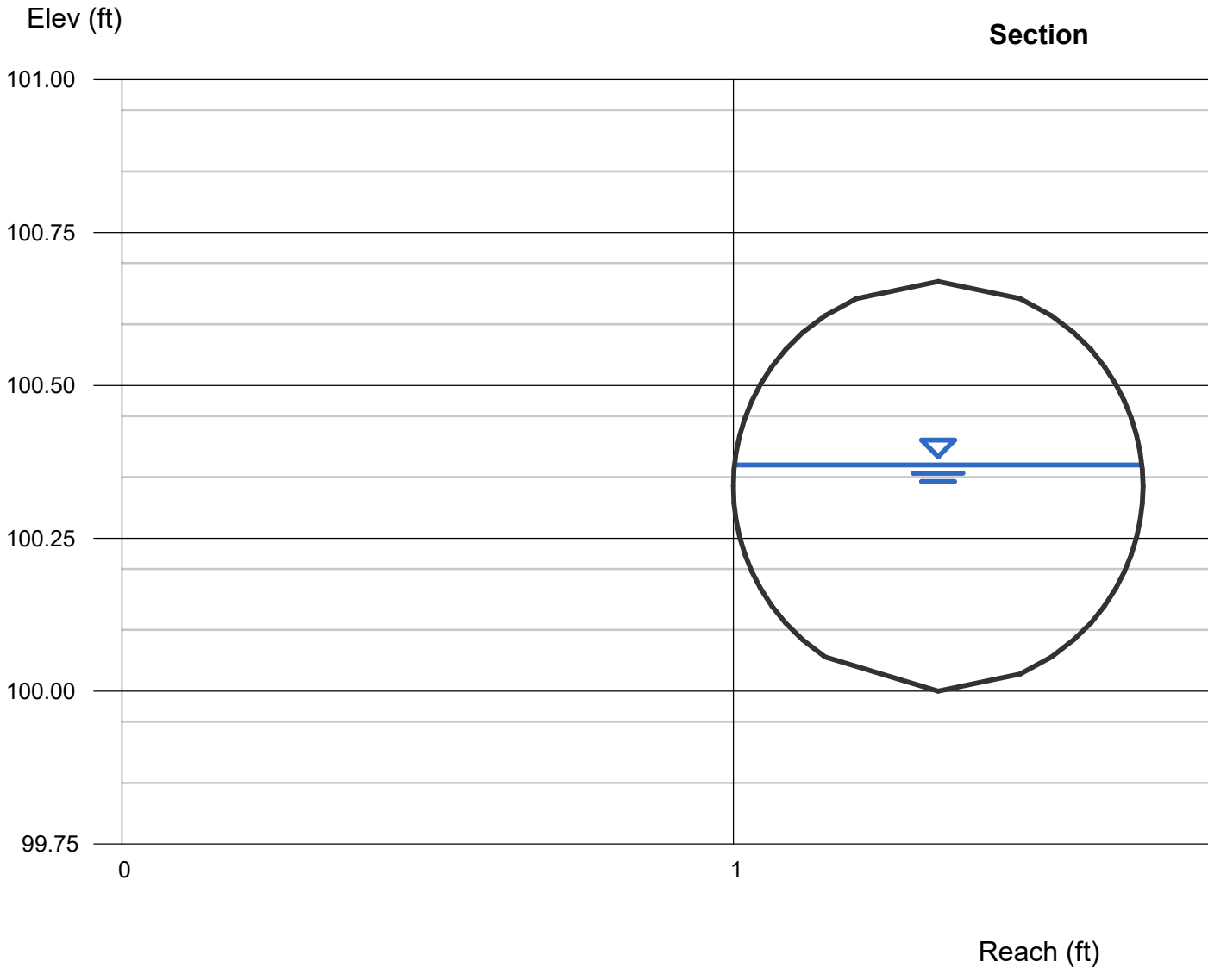
Diameter (ft)	= 0.67
Invert Elev (ft)	= 100.00
Slope (%)	= 0.60
N-Value	= 0.009

Calculations

Compute by:	Known Q
Known Q (cfs)	= 0.79

Highlighted

Depth (ft)	= 0.37
Q (cfs)	= 0.794
Area (sqft)	= 0.20
Velocity (ft/s)	= 3.96
Wetted Perim (ft)	= 1.13
Crit Depth, Yc (ft)	= 0.43
Top Width (ft)	= 0.67
EGL (ft)	= 0.61



Channel Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Wednesday, Nov 29 2023

1.0% 8 IN PVC

Circular

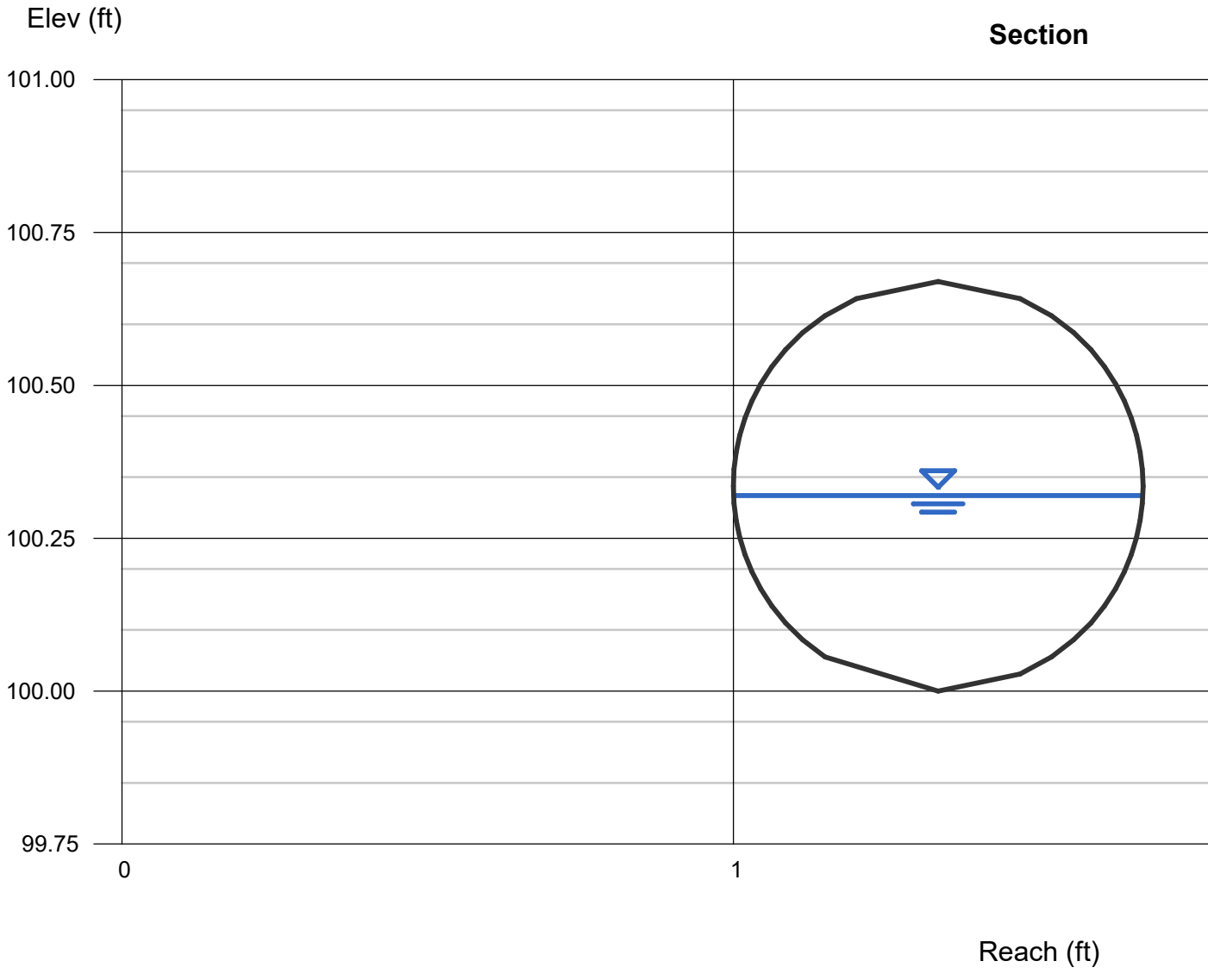
Diameter (ft)	= 0.67
Invert Elev (ft)	= 100.00
Slope (%)	= 1.00
N-Value	= 0.009

Calculations

Compute by:	Known Q
Known Q (cfs)	= 0.79

Highlighted

Depth (ft)	= 0.32
Q (cfs)	= 0.794
Area (sqft)	= 0.17
Velocity (ft/s)	= 4.75
Wetted Perim (ft)	= 1.03
Crit Depth, Yc (ft)	= 0.43
Top Width (ft)	= 0.67
EGL (ft)	= 0.67



Channel Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Wednesday, Nov 29 2023

1.32% 8 IN PVC

Circular

Diameter (ft)	= 0.67
Invert Elev (ft)	= 100.00
Slope (%)	= 1.32
N-Value	= 0.009

Calculations

Compute by:	Known Q
Known Q (cfs)	= 0.79

Highlighted

Depth (ft)	= 0.29
Q (cfs)	= 0.794
Area (sqft)	= 0.15
Velocity (ft/s)	= 5.40
Wetted Perim (ft)	= 0.96
Crit Depth, Yc (ft)	= 0.43
Top Width (ft)	= 0.66
EGL (ft)	= 0.74