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M E M O

TO:	Michael Fabbre, District Manager	DATE:	November 13, 2020
FIRM:	Mt. Crested Butte Water & Sanitation District	JOB NO.	1028.2e
ADDRESS:	100 Gothic Road	PROJECT:	Hunter Ridge Development - Sanitary Sewer Analysis
	Mt. Crested Butte, CO 81225	SUBJECT:	Capacity Analysis & Results

JVA has completed its preliminary analysis of Hunter Ridge Development's sanitary sewer proposed gravity sewer alignment for Mt. Crested Butte Water & Sanitation District (MCBWSD or District). The analysis included modeling the existing sewer system and the proposed Hunter Ridge development alignment. Hunter Ridge development is located on the south side of Hunter Hill Road and the existing sewer system the runs through the proposed development. The sewer system main traverses a steep hillside and runs adjacent to the Avalanche Zone mapped by the Town of Mt. Crested Butte. The existing manholes are difficult for the District to access or completely inaccessible year-round and portions of the sewer main are very close to the Avalanche Zone.

Background and Research

The District provided JVA with their Geographic Information System (GIS) sanitary sewer database and the Hunter Ridge Development plans. There was no elevation data available from MCBWSD and the elevation data on the Hunter Ridge plans did not encompass the entirety of the sewer system that is required to be analyzed. JVA acquired State of Colorado LiDAR data that was used to create a contour surface of the project area. The District was able to provide depth elevations for the existing system and the Hunter Ridge plans included profiles with manhole depths that were used to create the model. Confirmation of the ground surface and invert depths were required as there are flat spots in the system using the provided data and the LiDAR surface. There were two manholes MH4.12 and MH4.5 whose depth measurements provided by the District resulted in negative slopes using the LiDAR surface data. The pipe inverts for these manholes were instead calculated assuming a straight pipe between the upstream and downstream inverts. The profile data provided by the Hunter Ridge development was also used to determine the pipe invert elevations as the collected data from the District only provided invert and rim of the manholes.

Sanitary Sewer Analysis

JVA used the EPA Stormwater Management Model (SWMM) to create sewer models of the existing and proposed development sewer systems. While SWMM was created for stormwater modeling, it is a dynamic hydraulic routing simulation model that can be used for sanitary system modeling through the use of external inflows into the pipe and junction network. The existing system model includes the sanitary system upstream and downstream of the Hunter Ridge Development property. MCBWSD completed flow monitoring of portions of their system as part of a recent inflow and infiltration study and the Hunter Ridge development was within one of the flow meter sewersheds. The measured flows were inputted into the existing system model at manhole MH4.15 to evaluate current capacity of the system. Figure 1 shows the existing system that was included into the model and the location of the flow meter that collected the data used in the model. Figure 2 is the profile of the existing sanitary system modeled. Attached are summary tables of the existing model manhole and pipe inputs.

Buildout flows for the vacant single family lots were estimated using the June water use acquired from the District for lots of similar size. The flow for a single lot was identified to be 0.833 gpm. While normally a portion of the water use would be assumed to not reach the sewer system, the entire water use amount was utilized to be conservative. There are currently 12 lots not developed upstream of the modeled system equating to approximately 10.0 gpm. The buildout flow was added to the starting node in the model, manhole MH4.15, to account for buildout conditions. The buildout lots are shown in Figure 1.

The District provided a preliminary alignment for the sewer system that was designed by NCW Associates, Inc. that would move the sewer main further east outside of the Avalanche Zone and within the proposed roadway and access road. The sewer will remain an 8-inch pipe. The development has 8 lots that will be connected to the system, 4 single family lots and 4 multiunit 3-plex lots. The single family lots were estimated to have a loading value of 0.833 gpm while the multiunit lots were estimated to have a loading of 0.972 gpm based on water use of similar units within the area. Figure 3 shows the location of the proposed sewer main and assumed location of the lot connections. Figure 4 is the profile of the Hunter Ridge sanitary system modeled. Attached are summary tables of the Hunter Ridge model manhole and pipe inputs.

The sewer system analysis included the current condition and full buildout condition for both the existing system and the Hunter Ridge development. The results were evaluated using the proportional depth of flow, a measure of the maximum depth of flow divided by the diameter of the pipe (d/D). Table 1 provides the model d/D results.

Table 1. Model Scenario Maximum d/D Results

Link	Upstream Manhole	Downstream Manhole	Existing d/D	Existing Buildout d/D	Hunter Ridge d/D	Hunter Ridge Buildout d/D
P369	MH4.2	MH4.1	0.30	0.31	0.30	0.31
P370	MH4.3	MH4.2	0.27	0.28	0.27	0.28
P371	MH4.4	MH4.3	0.43	0.45	0.44	0.46
P372	MH4.5	MH4.4	0.59	0.61	0.6	0.62
P373	MH4.6	MH4.5	0.55	0.58	0.56	0.58
P374	MH4.7	MH4.6	0.49	0.51	0.49	0.51
P375	MH4.8	MH4.7	0.39	0.41		
P376	MH4.9	MH4.8	0.3	0.31		
P377	MH4.10	MH4.9	0.31	0.32		
P378	MH4.11	MH4.10	0.34	0.35		
P379	MH4.12	MH4.11	0.53	0.56	0.53	0.55
P380	MH4.13	MH4.12	0.65	0.68	0.66	0.68
P413	MH4.14	MH4.13	0.44	0.45	0.43	0.46
P677	MH4.15	MH4.14	0.25	0.26	0.25	0.26
MH410A1_DEFLEC-MH4.7	MH4.10A1_DEFLEC	MH4.7			0.28	0.29
MH4.10A1-MH4.10A1_DEFLEC	MH4.10A1	MH4.10A1_DEFLEC			0.38	0.4
MH4.11-MH4.10A1	MH4.11	MH4.10A1			0.35	0.36

The results of the model indicate that the addition of the Hunter Ridge Development as proposed will not adversely affect the sanitary sewer system for both existing and buildout conditions. The results are based upon the previously outlined information and assumptions. The maximum d/D values show little change between the existing, existing buildout, Hunter Ridge and Hunter Ridge buildout scenarios. Generally, the maximum d/D value for sanitary sewer mains is 0.6. There are three pipe sections showing a d/D values greater than 0.60, P372 and P380. The slope of pipe P380 is shallower than the upstream pipe which results in a larger depth of flow through the pipe. The same is occurring for pipe P372. A d/D greater than 0.60 is usually an indicator that the pipe should be reviewed for upsizing.

However, the d/D for the buildout conditions is not much higher than 0.60. Also, no other flows are anticipated to be added to the sewer system in this area therefore there is no reason to require upsizing the diameter of these pipes. Furthermore, both pipe sections have a manhole whose invert was calculated rather than a measured depth. It is important to obtain field data on the two manholes to ensure the assumptions in the sewer model are accurate. Confirmation of the ground surface and invert elevations of the manholes within the system will be needed to confirm the assumptions and results. The measured flow data shows there is a significant amount of inflow and infiltration (I/I) within the system especially during the spring snow melt. Therefore, if I/I is reduced in the system the maximum d/D values within the system will also be reduced.

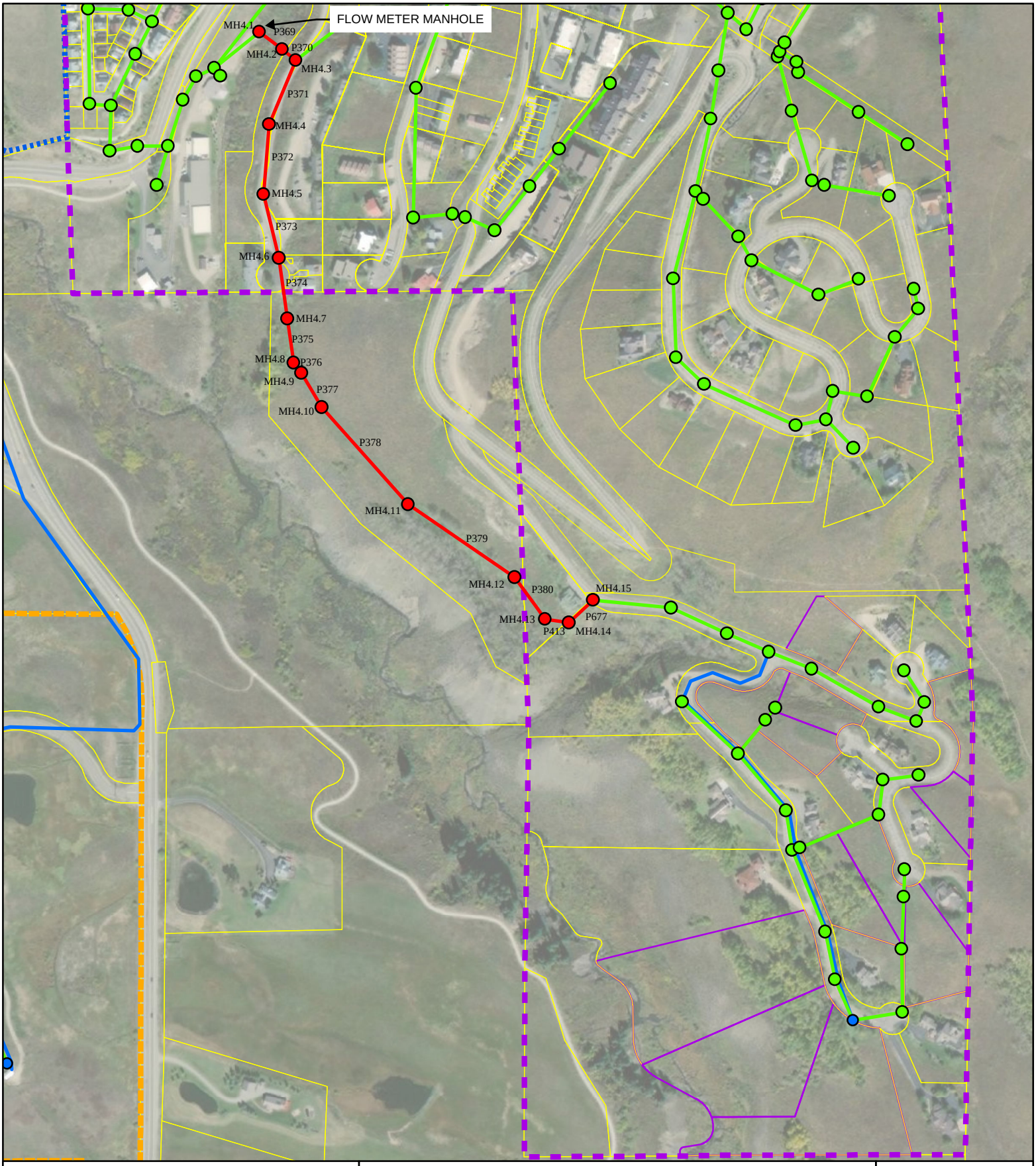
JVA looks forward to discussing the results of this capacity analysis for the proposed Hunter Ridge Development.

Signed: _____

Cooper D. Best, P.E.
Regional Project Manager

Copies to:

Attachments:
Figure 1 - Existing System and Buildout Map
Figure 2 - Existing System Profile
Figure 3 - Hunter Ridge System Map
Figure 4 - Hunter Ridge System Profile
Model Tables



MANHOLE
MODEL MANHOLE
LIFT STATION
GRAVITY MODEL
GRAVITY
FORCEMAIN

WATER AND SEWER
SEWER ONLY
WATER ONLY
PARCEL
BUILDOUT PARCEL

0 250 500 1,000 FEET

1 INCH = 500 FEET

FIGURE 1 - EXISTING SYSTEM MODEL

MCBWSD HUNTER RIDGE SANITARY SEWER ANALYSIS
MT CRESTED BUTTE, COLORADO
JOB 1028.2e
JULY 2020

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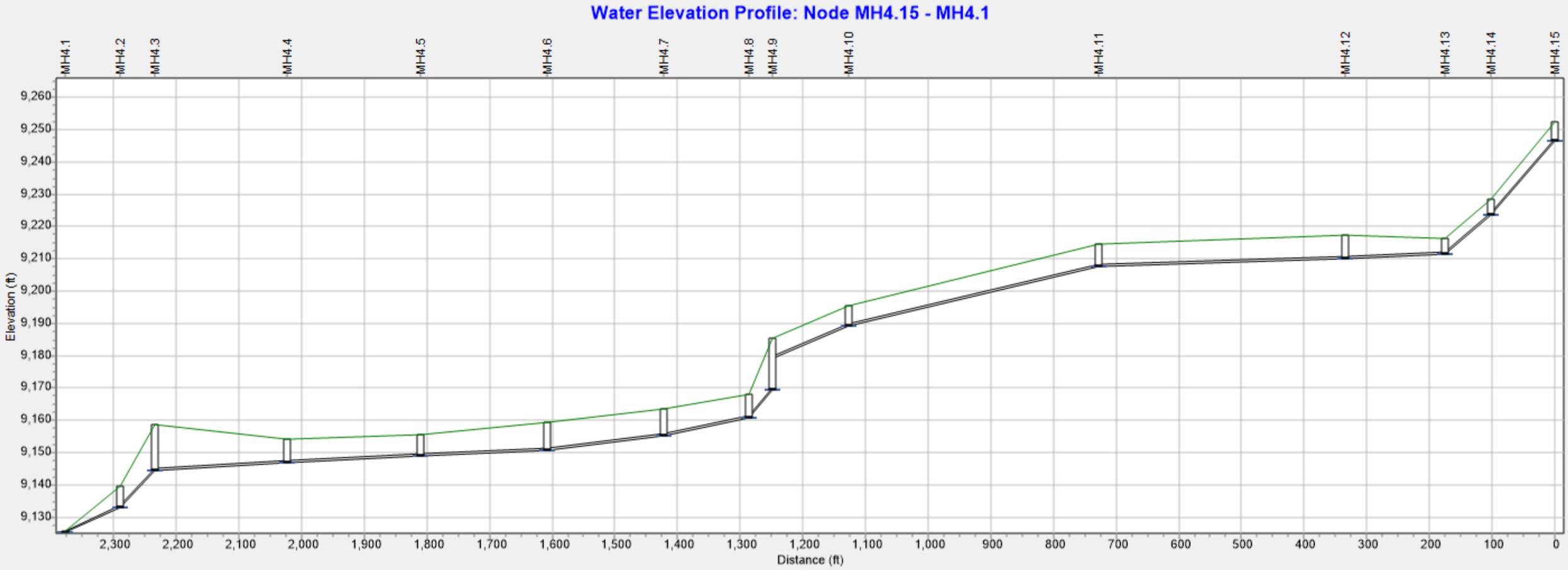
Water Elevation Profile: Node MH4.15 - MH4.1
MH4.1
MH4.2
MH4.3
MH4.4
MH4.5
MH4.6
MH4.7
MH4.8
MH4.9
MH4.10
MH4.11
MH4.12
MH4.13
MH4.14
MH4.15
Elevation (ft)
9,260
9,250
9,240
9,230
9,220
9,210
9,200
9,190
9,180
9,170
9,160
9,150
9,140
9,130
2,300
2,200
2,100
2,000
1,900
1,800
1,700
1,600
1,500
1,400
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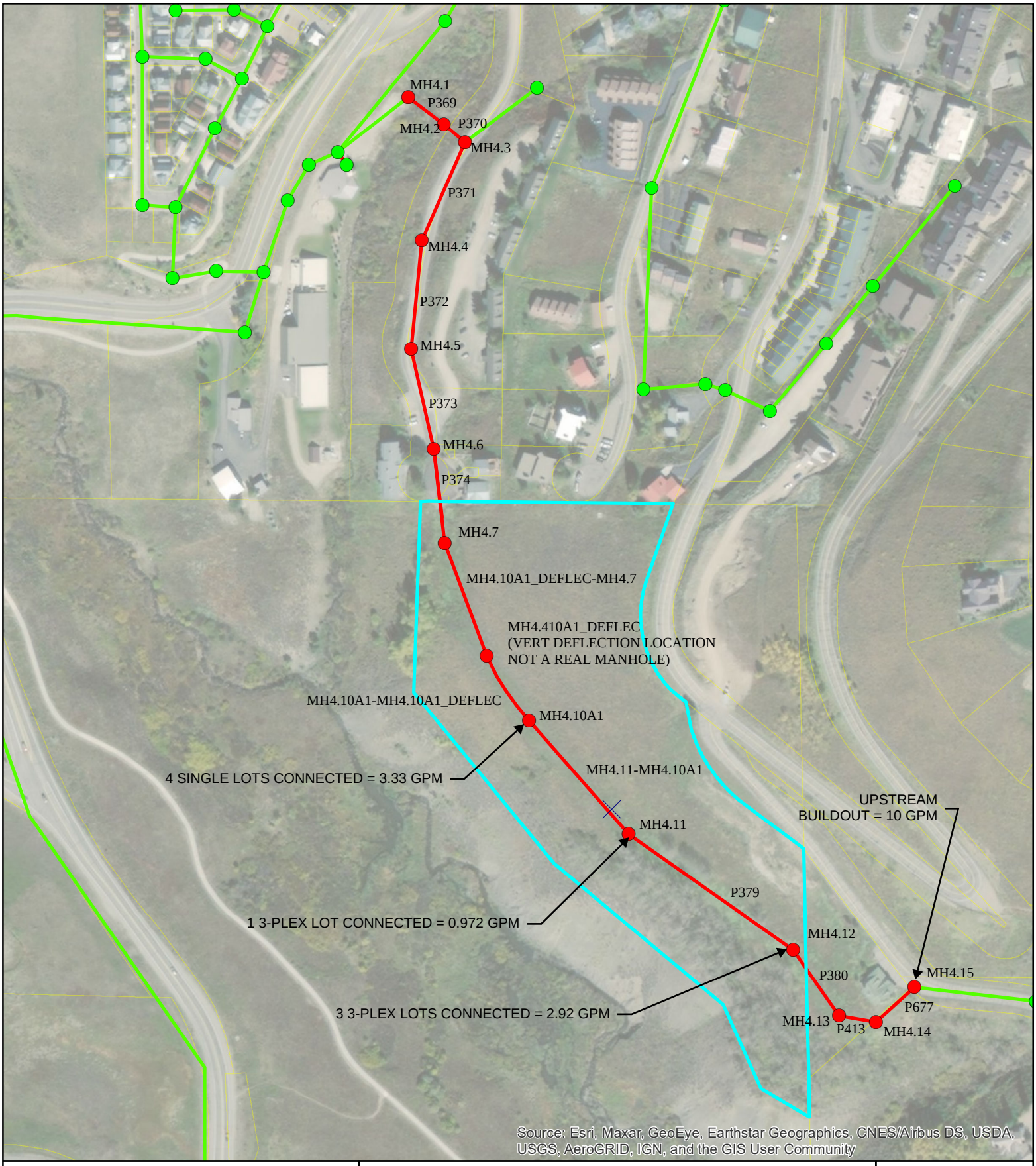
700
600
500
400
300
200
100
0
Distance (ft)



MANHOLE
MODEL MANHOLE
GRAVITY
GRAVITY MODEL
HUNTER RIDGE

0 125 250 500 FEET

1 INCH = 250 FEET

FIGURE 3 - HUNTER RIDGE SYSTEM MODEL

MCBWSD SAHUNTER RIDGE SANITARY SEWER ANALYSIS
MT CRESTED BUTTE, COLORADO
JOB 1028.2e NOVEMBER 2020

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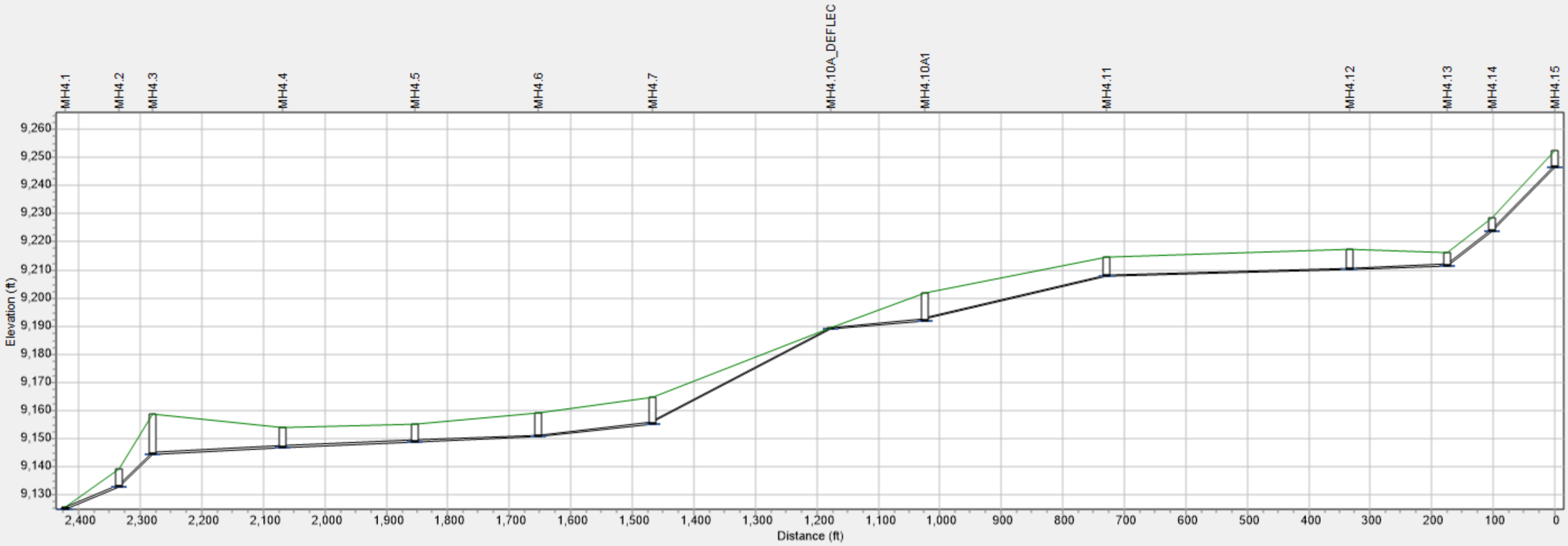
Water Elevation Profile: Node MH4.15 - MH4.1



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Job Name: Hunter Ridge Sanitary Sewer Analysis
Job Number:1028.2e
Date: 11/12/2020
By: LAL

EXISTING SYSTEM MODEL DATA

MHID	Est. Ground Elevation of Existing System LiDAR(ft)	Measured Depth to Invert (ft)	Invert Elevation (ft)	X	Y	Inlet pipe offset	Influent Flow	Additional Buildout Influent Flow
MH4.1	9134.44	9.25	9125.19	2581621.044	1389565.34			
MH4.2	9139.49	6.50	9132.99	2581691.065	1389511.454			
MH4.3	9158.71	14.17	9144.54	2581732.562	1389476.949			
MH4.4	9154.17	7.33	9146.84	2581647.608	1389283.061			
MH4.5	9157.46	6.58	9148.88[a]	2581626.75	1389070.178			
MH4.6	9159.22	8.42	9150.80	2581670.805	1388874.553			
MH4.7	9163.54	8.25	9155.29	2581692.801	1388689.156			
MH4.8	9168.21	7.58	9160.63[b]	2581710.962	1388555.218			
MH4.9	9185.32	15.75	9169.57[b]	2581733.093	1388522.951	9.55 ft		
MH4.10	9195.46	6.33	9189.13[b]	2581793.586	1388417.806			
MH4.11	9214.48	6.83	9207.65[b]	2582054.418	1388117.165			
MH4.12	9217.23	7.08	9210.15[a]	2582377.257	1387889.628			
MH4.13	9216.37	4.92	9211.45	2582467.926	1387759.793			
MH4.14	9228.47	4.67	9223.80	2582540.376	1387747.902			
MH4.15	9252.48	5.83	9246.65	2582616.358	1387815.729		Flow Meter Data	10.0 gpm

a. Measured depth causes bust in system, Assumed straight pipe between up and down manhole.
b. Invert elevations adjusted based on Hunter Ridge exist system data. Measured depth from District held except MH4.9, rim elevation adjustec

PIPE ID	Length	Slope	Upstream MH	Downstream MH	Entry Loss	Exit Loss
P369	88.36	8.83%	MH4.2	MH4.1	0.15	0
P370	53.97	21.41%	MH4.3	MH4.2	1	0.15
P371	211.68	1.08%	MH4.4	MH4.3	0.5	1
P372	213.9	1.48%	MH4.5	MH4.4	0.5	0.5
P373	200.52	0.96%	MH4.6	MH4.5	0.15	0.5
P374	186.7	2.41%	MH4.7	MH4.6	0.15	0.15
P375	135.16	3.95%	MH4.8	MH4.7	0.5	0.15
P376	39.13	22.84%	MH4.9	MH4.8	0.15	0.5
P377	121.3	8.25%	MH4.10	MH4.9	0.15	0.15
P378	398.02	4.65%	MH4.11	MH4.10	0.15	0.15
P379	394.97	0.63%	MH4.12	MH4.11	0.5	0.15
P380	158.36	0.82%	MH4.13	MH4.12	0.9	0.5
P413	73.42	16.82%	MH4.14	MH4.13	0.9	0.9
P677	101.85	22.43%	MH4.15	MH4.14	0	0.9

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Job Name: Hunter Ridge Sanitary Sewer Analysis
Job Number:1028.2e
Date: 11/12/2020
By: LAL

HUNTER RIDGE SYSTEM MODEL DATA

MHID	Est. Ground Elevation of Existing System LiDAR(ft)	Measured Depth to Invert (ft)	Invert Elevation (ft)	X	Y	Inlet pipe offset	Influent Flow	Additional Buildout Influent Flow	Note
MH4.1	9134.44	9.25	9125.19	2581621.044	1389565.34				
MH4.2	9139.49	6.50	9132.99	2581691.065	1389511.454				
MH4.3	9158.71	14.17	9144.54	2581732.562	1389476.949				
MH4.4	9154.17	7.33	9146.84	2581647.608	1389283.061				
MH4.5	9157.46	6.58	9148.88[a]	2581626.75	1389070.178				
MH4.6	9159.22	8.42	9150.80	2581670.805	1388874.553				
MH4.7	9163.54	8.25	9155.29	2581686.943	1388739.292	0.7 ft			
MH4.10A1_DEFLEC	-	0.67	9188.94	2581784.322	1388737.927				not real manhole
MH4.10A	9202.07	10.00	9192.07[b]	2581789.598	1388508.397	0.5 ft	3.33 gpm		
MH4.11	9213.74	6.83	9207.65[b]	2582054.418	1388117.165		0.972 gpm		
MH4.12	9219.09	7.08	9210.15[a]	2582377.257	1387889.628		2.92 gpm		
MH4.13	9216.37	4.92	9211.45	2582467.926	1387759.793				
MH4.14	9228.47	4.67	9223.80	2582540.376	1387747.902				
MH4.15	9252.48	5.83	9246.65	2582616.358	1387815.729		Flow Meter Data	10.0 gpm	

a. Measured depth causes bust in system, Assumed straight pipe between up and down manhole.
b. Invert elevations adjusted based on Hunter Ridge exist system data. Measured depth from District held, rim elevation adjustec

PIPE ID	Length	Slope	Upstream MH	Downstream MH	Entry Loss	Exit Loss
P369	88.36	8.83%	MH4.2	MH4.1	0.15	0
P370	53.97	21.41%	MH4.3	MH4.2	1	0.15
P371	211.68	1.08%	MH4.4	MH4.3	0.5	1
P372	213.9	1.48%	MH4.5	MH4.4	0.5	0.5
P373	200.52	0.96%	MH4.6	MH4.5	0.15	0.5
P374	136.22	2.41%	MH4.7	MH4.6	1	0.15
MH410A1_DEFLEC-MH4.7	289.32	11.38%	MH4.10A1_DEFLEC	MH4.7	1	1
MH4.10A1-MH4.10A1_DEFLEC	152.82	2.05%	MH4.10A1	MH4.10A1_DEFLEC	0.9	1
MH4.11-MH4.10A1	296.59	5.08%	MH4.11	MH4.10A1	0.5	0.9
P379	394.97	0.63%	MH4.12	MH4.11	0.5	0.5
P380	158.36	0.82%	MH4.13	MH4.12	0.9	0.5
P413	73.42	16.82%	MH4.14	MH4.13	0.9	0.9
P677	101.85	22.43%	MH4.15	MH4.14	0	0.9