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Hydraulic Summary & Recommendations

PROJECT NAME

City of Englewood – Acoma St. Area Drainage Study

ULTEIG PROJECT NUMBER

20.00660

DEPARTMENT

Civil and Field Services – Municipal Civil

PREPARED FOR

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PREPARED BY

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ENGINEER OF RECORD

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REVISION HISTORY

Revision	Date	Description
A	07/24/2020	Summary of Hydraulic Analysis and Recommendations
B	07/31/2020	Edits to incorporate feedback from City
C	08/07/2020	Final edits

Project Background

Ulteig was hired by the City of Englewood to perform a drainage feasibility study for the Acoma Area Drainage Basin. This study was initiated by the City to identify changes to the existing system that will improve the stormwater conveyance during significant rainfall events.

Ulteig began by reviewing the results of previous studies including the 1998 SWIMM model and the more recent study completed by Calibre. The Calibre model worked well for the purpose of the previous study but was not detailed enough for evaluating the inlet needs in the system. The previous studies were skeletonized models of the existing system with only key junctions included. These models did not need to account for every inlet location and local changes in pipe slopes that affect the performance of individual inlets. The previous work also only used the overall surface elevations to determine drainage areas and did not account for the runoff direction changes from roadways, ditches, and cross-gutters. Therefore, Ulteig created a new, more detailed model using the City's GIS resources and the Calibre study as references and supplemented with field verification of all inlets and key manholes in the system. This detail allowed Ulteig to have the detail needed to make recommendations that optimize the current system's capacity. The storm data used in this study is the most recent data available from ATLAS 14. For the two previous studies an older data set was used which had higher flows than the current ATLAS 14 data. Both Ulteig and city representatives agreed that the most up-to-date data available should be used during this analysis. Due to a lack of details in the Cherry Hills Village area, Ulteig used conservative values when considering the runoff contributions from this area. In future studies, Ulteig recommends doing a more detailed analysis of the Cherry Hills Village area to get a clearer understanding of how the runoff affects the system.

Analysis and Recommendations

Throughout the analysis several problematic areas were identified. These areas were ones that were experiencing gutter depths of 8" or more during the 25-yr storm and had significant gutter spreads. Problem areas were also identified by running the existing model with the 100-yr storm and taking note of where significant flooding occurred with gutter flow depths over 1'. The overall system was able to effectively convey the flow during the 25-yr event except for a few key areas. The identified areas of concern are outlined in the tables below. Table 1 contains a list of projects sorted by the priority that Ulteig recommends. It is important to note that Ulteig recommends making all the outlined modifications to be able to convey the 25-yr storm effectively but understands that funds may not always be immediately available. Table 2 contains modifications that are lowest on the priority list but should still be completed soon to improve the system's efficiency. Organizing the projects in this way serves to aid the City in making decisions on where to allocate funds as they become available. Table 3 shows the maximum gutter inlet depths during the 25 and 100-yr storms under the proposed and existing conditions. Exhibits showing recommended improvements can be found in the Appendix.

Table 1: Immediate Modifications

Priority	Projects	Issue	Recommended Improvement
1	Acoma St Low Point	The inlets at the low point on Acoma St are not large enough to accept the runoff that's coming into this area, causing flooding.	Beginning with the inlets on Acoma St, replace the eastern inlet with a Type R inlet with a length of 120". Replace the western inlet with a Type R inlet with a length of 180". Increase the pipe size to 48" beginning at the inlets at the low point to Tufts Ave. The existing 48" pipe will remain in place. Reinforced concrete pipe (RCP) is to be used.
	Alley between Acoma St. and Bannock St.	The inlet in this alley is not large enough to accept the runoff that is coming into it causing the flow to backup and flood the area.	Replace the existing inlet with a grate inlet. Increase the grate length from 36" to 72".
	Alley between Acoma St. and Broadway	The inlet in this alley is not large enough to accept the runoff that is coming into it causing the flow to backup and flood the area.	Replace the existing inlet with a grate inlet. Increase the grate length from 36" to 72".
2	Broadway Low Point	The inlets on the low point are not able to convey the flow that is coming into it and is causing flooding. This is the case for both the east and west sides of Broadway.	Replace the existing combination inlets with Type R inlets. The southern-most replacement inlet should have a length of 72" and the center inlet should have a length of 120". This will allow the runoff to enter the system instead of flooding the area. This will be the case on both sides of Broadway. The northern-most inlet on the west side will also be replaced with a 120" Type R inlet.
	Tufts Ave and Lincoln St	Much of the runoff is bypassing the inlet at this intersection and continuing to flow down to Broadway causing flooding.	Install 1 double combination inlet to the 20' west of the existing inlet. This inlet will connect to the existing inlet through a pipe. This inlet will serve to catch the bypass flow and route it into the system instead of it continuing to flow down Broadway.
	Alley between Sherman St and Grant St, South of Tufts Ave	The inlet at this low point is not large enough to accept the runoff that's coming into this area causing flooding.	Install an additional grate inlet adjacent to the existing. This will increase the capacity of the inlets and allow for more flow.
3	Broadway and Union Ave	All of the flow along the eastern side of Broadway from Union Ave to Belleview Ave is being routed to the inlet on the southeastern side of this intersection. Much of the flow is bypassing this inlet and continuing along to the low point on Broadway causing flooding.	Add one Type R inlet to the east of the intersection on the south side of Union Ave. This inlet will be placed west of the alley to capture the flow from this block. It will be connected to the system via a new connection to the pipe along Union Ave. Add one Type R inlet on the west side of Broadway, immediately south of the intersection. New pipe will connect this inlet to a new combination inlet west of the alley half a block west of Broadway. The new pipe will continue and connect to the overall system at the intersection of Union Ave. and Acoma St. This will draw the runoff away from Broadway and give the system more time to process and manage the flow.
	Acoma St, Union Ave to Low Point	The pipes along Acoma are surcharging during the 25-yr storm and this issue gets worse as the storm intensity increases. This issue will only worsen as more runoff is routed through this area with the additions of inlets at Union Ave.	Increase the pipe size from Union Ave to the low point to 36". Reinforced concrete pipe (RCP) is to be used. This allows for more flow and significantly reduces the surcharging.

4	Tufts Ave, Acoma St to Bannock	The pipes in this stretch are undersized and the transition from the circular to elliptical pipe is causing the pipes to surcharge and pop off manholes during large storms.	Remove the 76" pipe from Acoma St to Bannock St and replace with an 86"x30" elliptical RCP. This will correct the bottlenecking that is currently happening. It will reduce the depth of water in the pipes despite the additional flow from other proposed inlets.
5	Broadway and Layton Ave	The southeastern inlet at Union Ave and Broadway is accepting all of the runoff from Union Ave to Belleview Ave and is not able to capture the majority of the flow. The inlets on the western side of Broadway half a block north is experiencing the same issue.	Add one Type R inlet on the southeast and southwest side of the intersection, along Broadway. The new pipes will flow west to east and will connect to the existing system at the intersection of Layton Ave and Lincoln St. This serves to break up the drainage areas and allow the system time to capture and process the flow.
	Lincoln St, Layton Ave to Union Ave	The current pipes are surcharging during the 25-yr storm and this surcharging will increase with the addition of inlets at Broadway and Layton Ave.	Replace the existing 42" pipe along Lincoln St with a 48" RCP beginning at the intersection Layton Ave and stopping at the intersection with Union Ave.
6	Layton Ave and Sherman St	The existing pipes are surcharging during the 25-yr storm and are keeping the inlets on Sherman St from efficiently collecting the runoff, causing flooding.	Replace the existing 36" pipe beginning at the inlets on Sherman St with 48" RCP. This pipe replacement will stop at the intersection of Lincoln St and Layton Ave.
7	Grant St and Chenango Ave	The inlets just north of this intersection are experiencing depths over 8" during the 25-year storm. The cause of this flooding was determined to be both pipe size and inlet capacity.	Ulteig recommends both increasing pipe sizes and adding new inlets. The western inlet will be replaced with a 15' Type R inlet. The eastern inlet will be replaced with a 10' Type R inlet. The pipe connection from the western inlet will be increased to 30". The pipe underneath Grant St will be upsized to 36". The pipes along Chenango Ave up to the inlets on Sherman St will be upsized to 48".
8	Fox St and Stanford Ave	The inlets at this intersection are not able to capture the runoff that is coming from the contributing drainage areas and is flooding.	Install 2 sets of combination inlets on the north and south side of Stanford Ave. to the east of the intersection. They will be placed directly across from each other with the north inlet just west of the alley. They will be connected by a pipe that will outlet in the drainage ditch to the south. To further prevent significant ponding, construct a valley gutter that connects to the inlet on the SE corner of the intersection. This valley gutter will convey the flow that isn't captured by the inlet directly to the greenway.
9	Delaware St, Layton Ave to Greenway	The pipes along this street are not large enough to effectively convey the runoff through this area causing the inlets to backflow and flood.	Increase the pipe size from 18" to 24" from Layton Ave. to Union Ave. Increase the pipe size to 30" from Union Ave. to Tufts Ave. Increase the pipe size to 36" from Tufts Ave. to the greenway. This will increase the capacity of the system and allow the inlets to work more efficiently. Reinforced concrete pipe (RCP) is to be used.

Table 2: Future Modifications

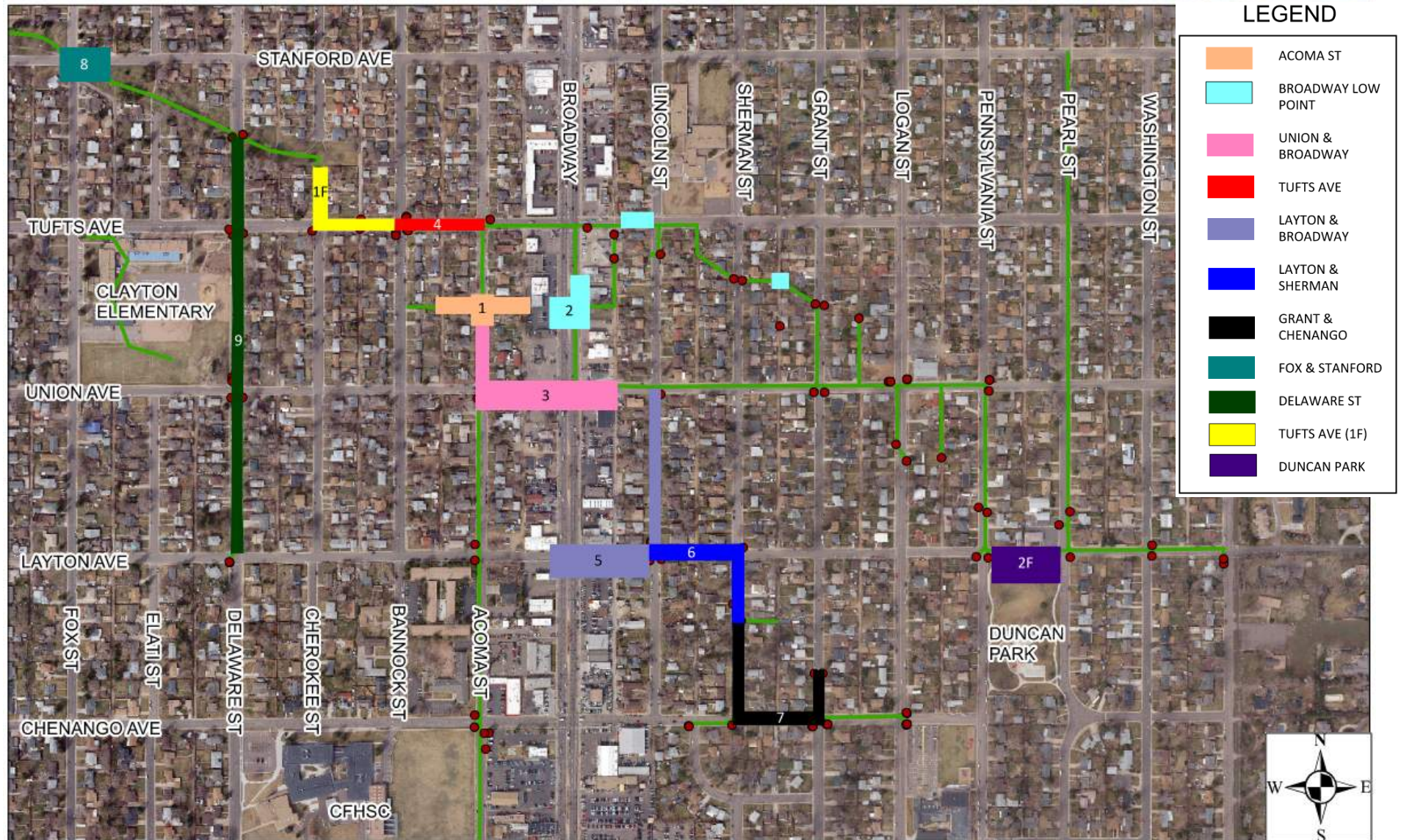
Priority	Project	Issue	Recommended Improvement
1F	Tufts Ave, Bannock St to Greenway	The current pipe configuration is causing the manholes in the area to surcharge during the 25-yr storm, particularly the manhole at Tufts Ave and Bannock St. The transition to the elliptical pipe is what is causing the system to backup.	In addition to the pipe size increases mentioned above, a spray-on lining should be applied to the pipes starting at Bannock St. and continuing to the outlet in the greenway. This will reduce the friction in the pipes as the water flows through and will work to lower the depth of water in the pipes. This will mean less surcharging in the area.
2F	Duncan Park	This area is seeing surcharging during the 25-yr event. There is significant runoff coming from the Cherry Hills Village community that gets routed through this system that could cause issues during large storms.	Construct an underground water storage structure that would flatten the curve as the runoff is carried downstream. This structure has the benefit of lowering the depth of water in the pipes downstream. This means that there is less surcharging and allows the system to be more efficient. The storage structure used during modeling was the MC-4500 StormTech Chamber.

Table 4: Maximum Inlet Depths (FEET)

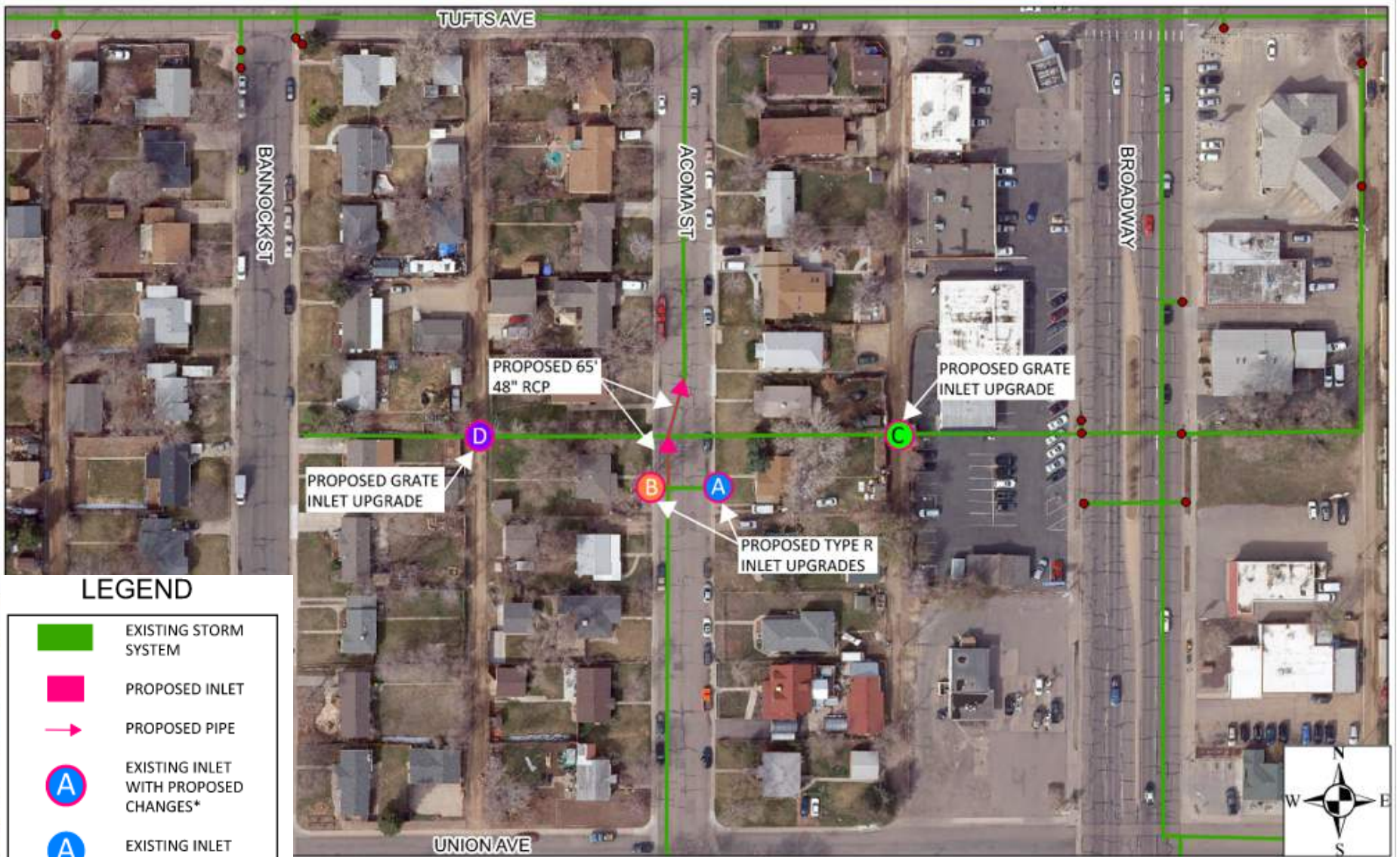
Location	Inlet ID	Model ID	25-Year EXISTING	25-Year PROPOSED	100-Year EXISTING	100-Year PROPOSED
Acoma St. Low Point	A	102j	0.53	0.42	0.66	0.5
	B	102k	1.03	0.61	5.07	0.88
	C	102h	0.65	0.55	0.77	0.66
	D	102l	0.30	0.3	0.36	0.36
Fox St. and Stanford Ave	E	88d	0.81	0.44	0.96	0.52
	F	88n	0.47	0.41	0.57	0.48
	G	88p	0.69	0.57	1.07	0.69
	H	88g	0.27	0.24	0.69	0.28
Tufts Ave, Lincoln St and Sherman St	I	90a	0.72	0.49	2.74	0.59
	J	91d	0.72	0.65	1.42	0.80
Broadway, Low Point	K	90d	1.10	0.56	3.56	0.85
	L	90e	0.61	0.51	1.95	0.64
	M	102i	0.23	0.23	0.27	0.27
	N	102m	0.82	0.09	0.98	0.32
	O	103c	0.86	0.58	0.99	0.74
Grant St. and Chenango Ave.	P	106e	0.95	0.64	1.34	0.81
	Q	105d	1.99	0.72	6.52	1.07

Appendix

Project Overview



Acoma Street - Priority 1



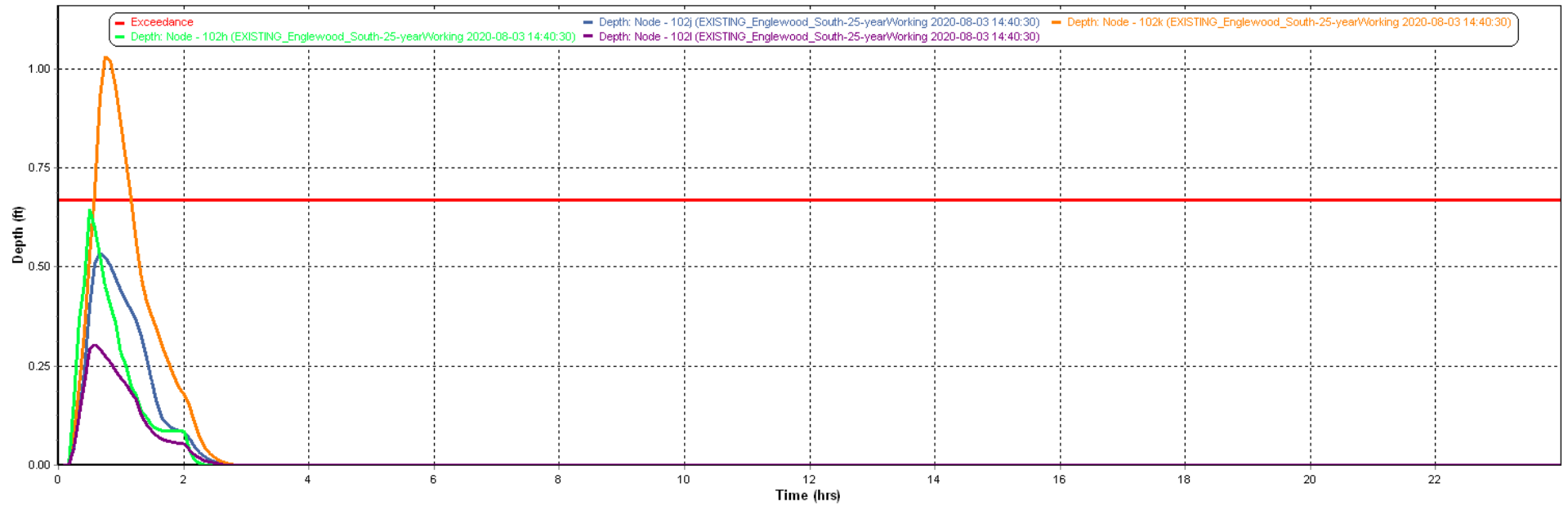
LEGEND

- EXISTING STORM SYSTEM
- PROPOSED INLET
- PROPOSED PIPE
- A EXISTING INLET WITH PROPOSED CHANGES*
- A EXISTING INLET WITH NO CHANGES*
- EXISTING INLET WITH NO DEPTHS SHOWN

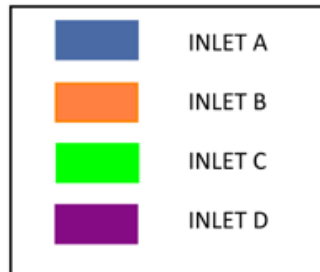
*NOTE: The fill color of the inlet label corresponds to the depth data line color.

Inlet ID	EXISTING Structure	PROPOSED Structure
A	Type 16	Type R (10')
B	Type 16	Type R (15')
C	Grate (36")	Grate (72")
D	Grate (36")	Grate (72")

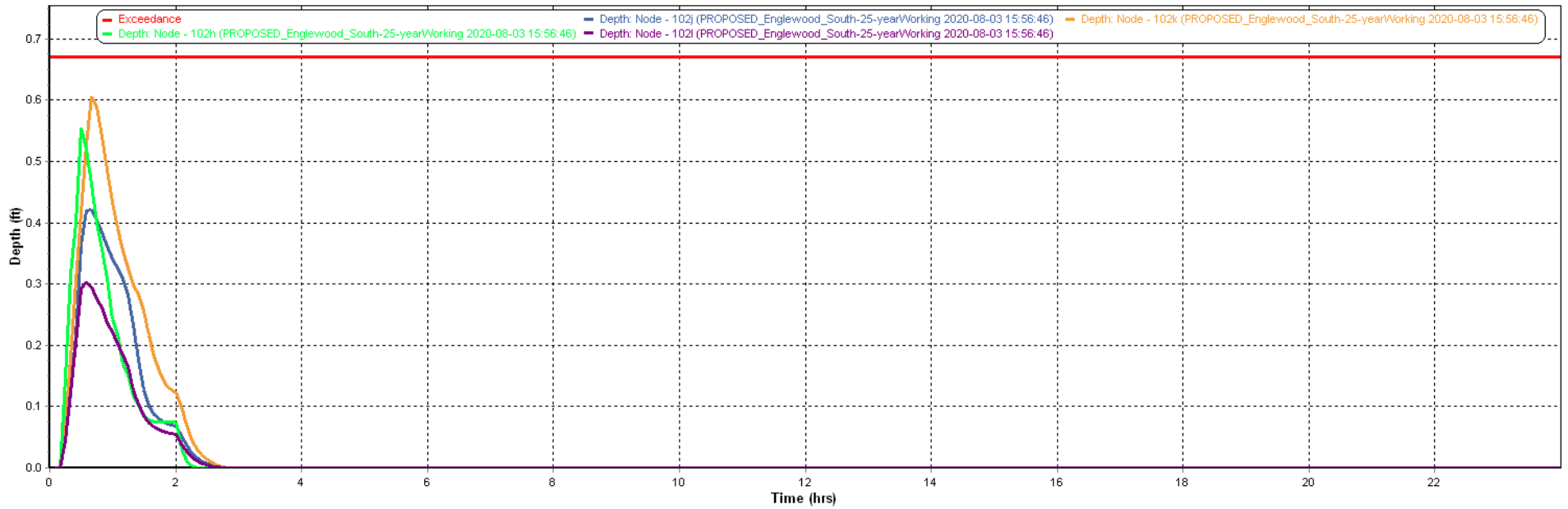
Acoma St. - 25 Year EXISTING



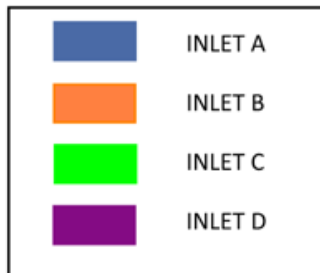
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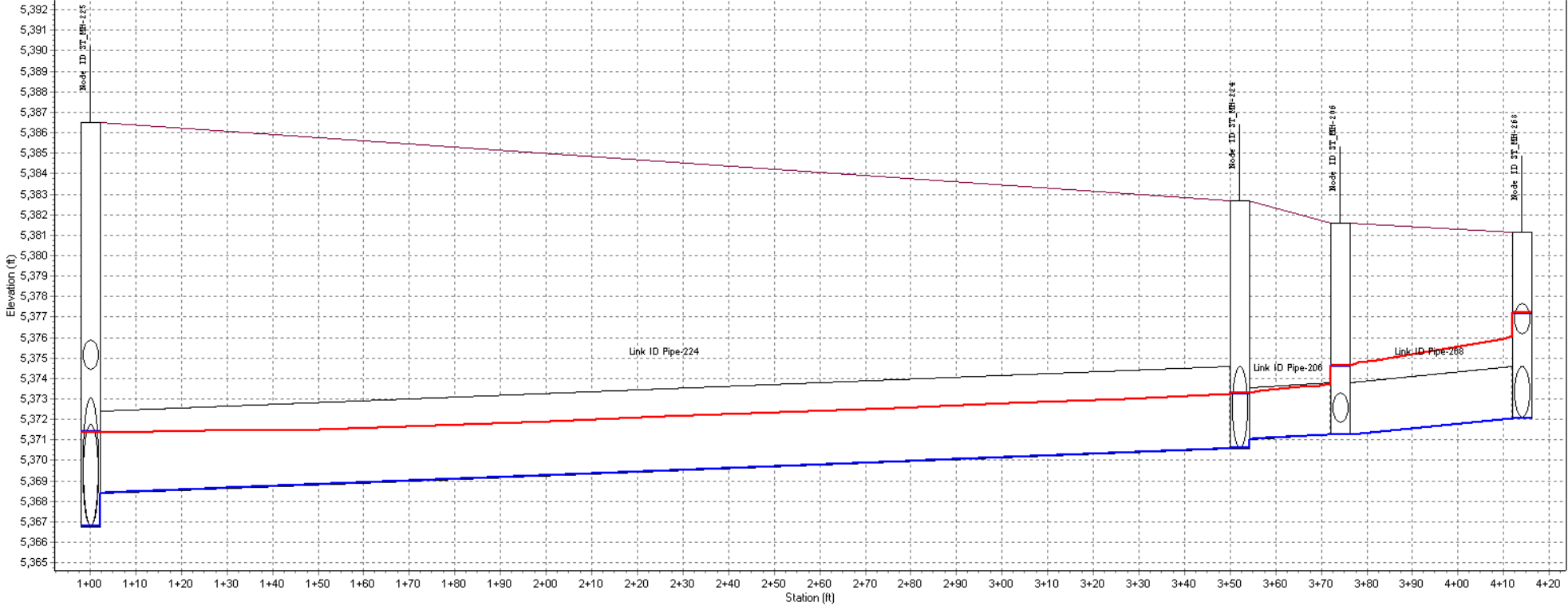
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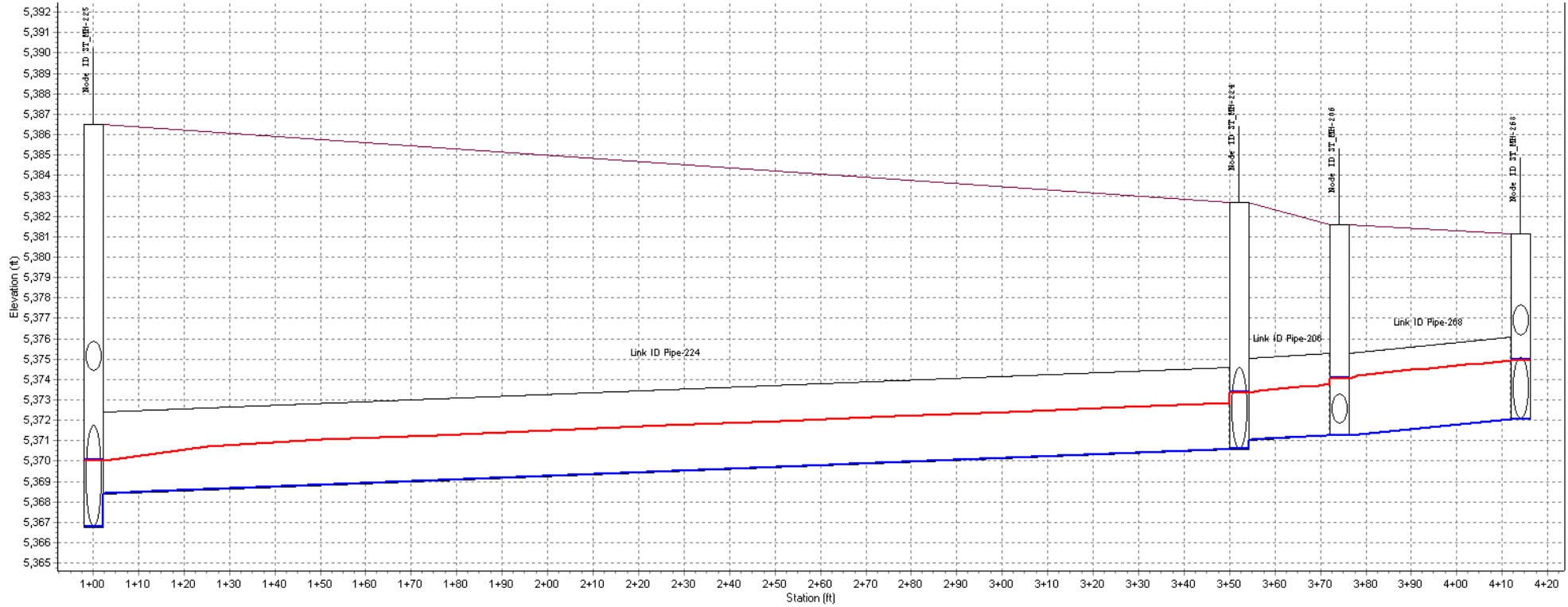


Acoma Area Drainage Study - 25 Year EXISTING
Acoma St, Inlets to Tufts Ave



Node ID:	ST_MH-225		ST_MH-224	ST_MH-206	ST_MH-268
Rim (ft):	5386.52		5382.69	5381.57	5381.15
Invert (ft):	5366.74		5370.58	5371.27	5372.07
Min Pipe Cover (ft):	10.65		8.11	7.80	3.50
Max HGL (ft):	5371.39		5373.29	5374.70	5377.20
Link ID:		Pipe-224		Pipe-206	Pipe-268
Length (ft):		252.00		22.00	40.00
Dia (ft):		4.00		2.50	2.50
Slope (ft/ft):		0.0087		0.0109	0.0200
Up Invert (ft):		5370.58		5371.27	5372.07
Dn Invert (ft):		5368.38		5371.03	5371.27
Max Q (cfs):		50.55		34.43	33.96
Max Vel (ft/s):		6.33		7.23	6.92
Max Depth (ft):		2.74		2.38	2.50

Acoma Area Drainage Study - 25 Year PROPOSED
Acoma St, Inlets to Tufts Ave



Node ID:	ST_MH-225		ST_MH-224	ST_MH-206	ST_MH-268
Rim (ft):	5386.52		5382.69	5381.57	5381.15
Invert (ft):	5366.74		5370.58	5371.27	5372.07
Min Pipe Cover (ft):	10.65		7.66	6.30	3.50
Max HGL (ft):	5370.04		5373.36	5374.08	5374.95
Link ID:		Pipe-224		Pipe-206	Pipe-268
Length (ft):		252.00		22.00	40.00
Dia (ft):		4.00		4.00	4.00
Slope (ft/ft):		0.0087		0.0109	0.0200
Up Invert (ft):		5370.58		5371.27	5372.07
Dn Invert (ft):		5368.38		5371.03	5371.27
Max Q (cfs):		51.88		47.78	47.31
Max Vel (ft/s):		6.38		6.01	5.46
Max Depth (ft):		2.47		2.56	2.82

Broadway, Low Point - Priority 2



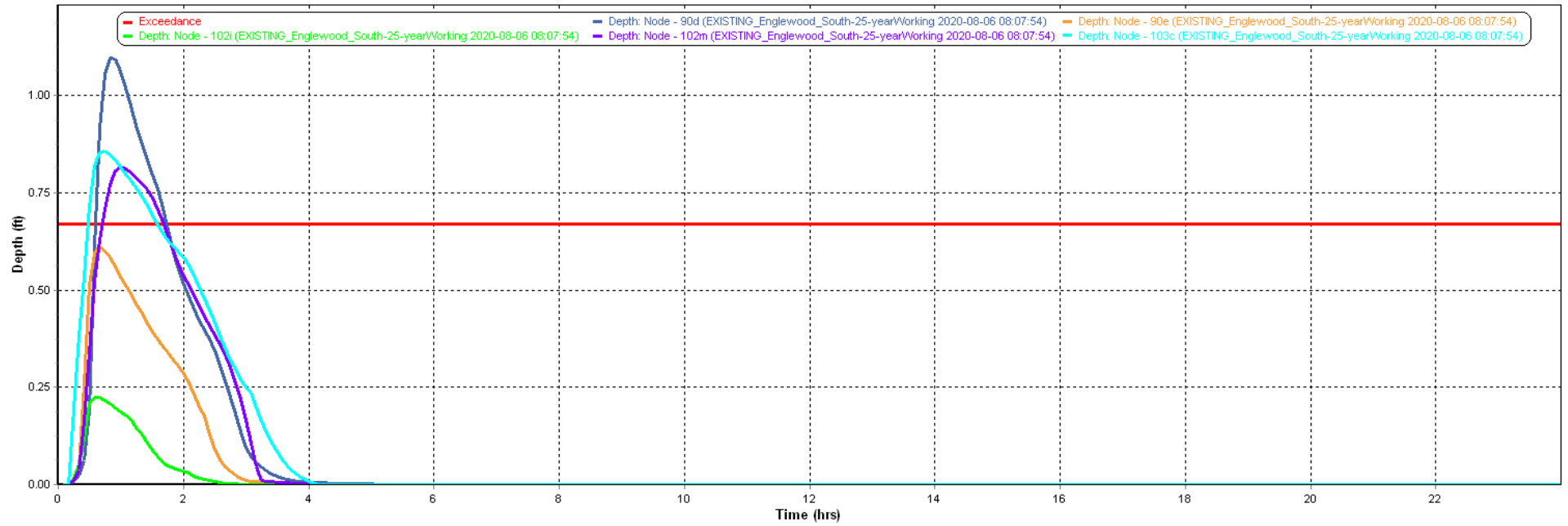
LEGEND

- EXISTING STORM SYSTEM
- PROPOSED INLET
- PROPOSED PIPE
- A EXISTING INLET WITH PROPOSED CHANGES*
- A EXISTING INLET WITH NO CHANGES*
- EXISTING INLET WITH NO DEPTHS SHOWN

*NOTE: The fill color of the inlet label corresponds to the depth data line color.

Inlet ID	EXISTING Structure	PROPOSED Structure
K	Combination	Type R (10')
L	Combination	Type R (5')
M	Combination	Type R (10')
N	Combination	Type R (10')
O	Combination	Type R (5')

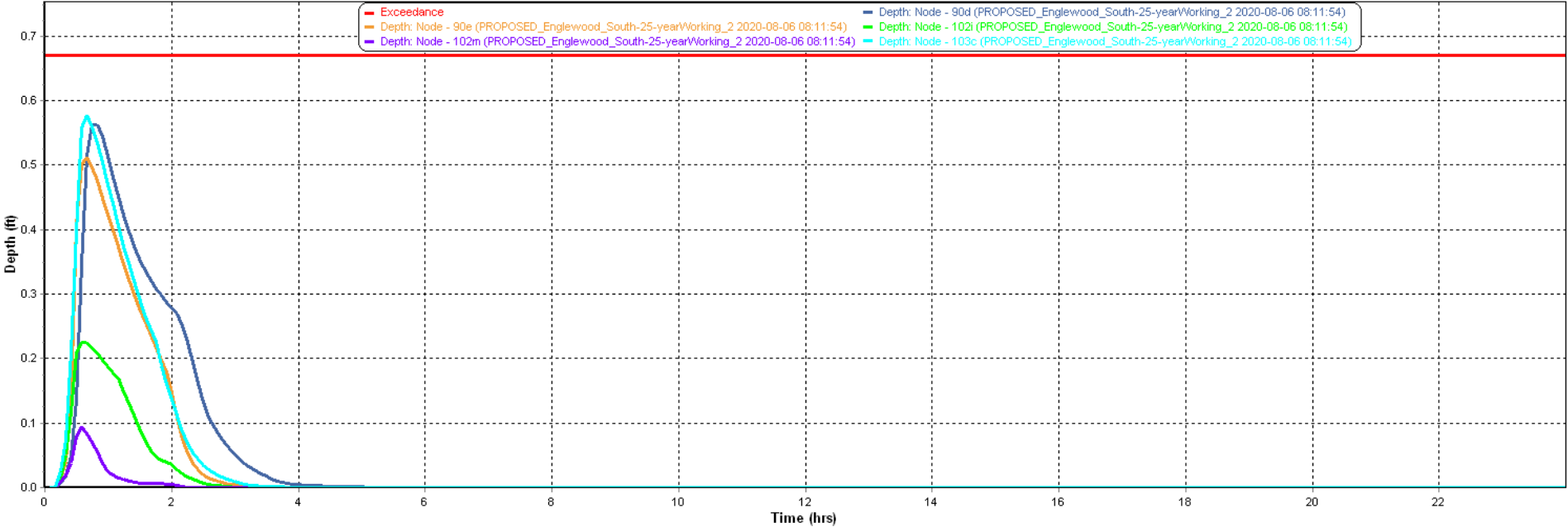
Broadway, Low Point - 25 Year EXISTING



LEGEND

■	INLET K
■	INLET L
■	INLET M
■	INLET N
■	INLET O

Broadway, Low Point - 25 Year PROPOSED









LEGEND

INLET K	Blue
INLET L	Orange
INLET M	Green
INLET N	Purple
INLET O	Cyan

Tufts Ave, Lincoln St & Sherman St - Priority 2



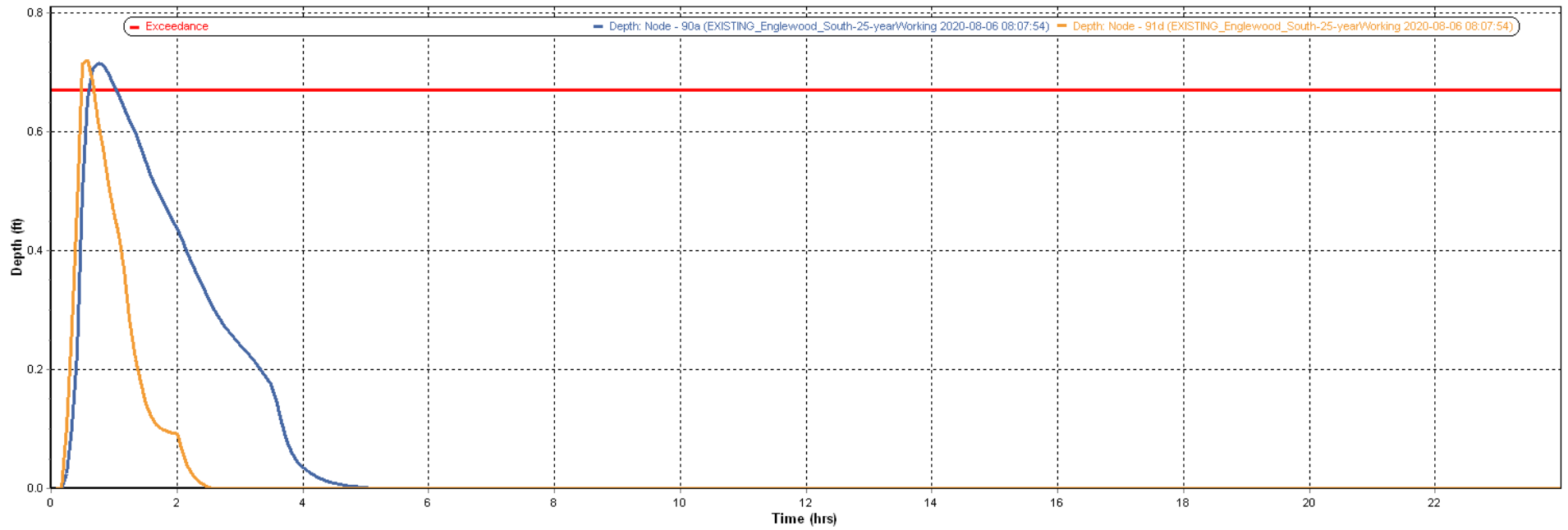
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	EXISTING STORM SYSTEM
	PROPOSED INLET
	PROPOSED PIPE
	EXISTING INLET WITH PROPOSED CHANGES*
	EXISTING INLET WITH NO CHANGES*
	EXISTING INLET WITH NO DEPTHS SHOWN

Inlet ID	EXISTING Structure	PROPOSED Structure
I	Combination	N/A
J	Grate (36")	Grate (72")

*NOTE: The fill color of the inlet label corresponds to the depth data line color.

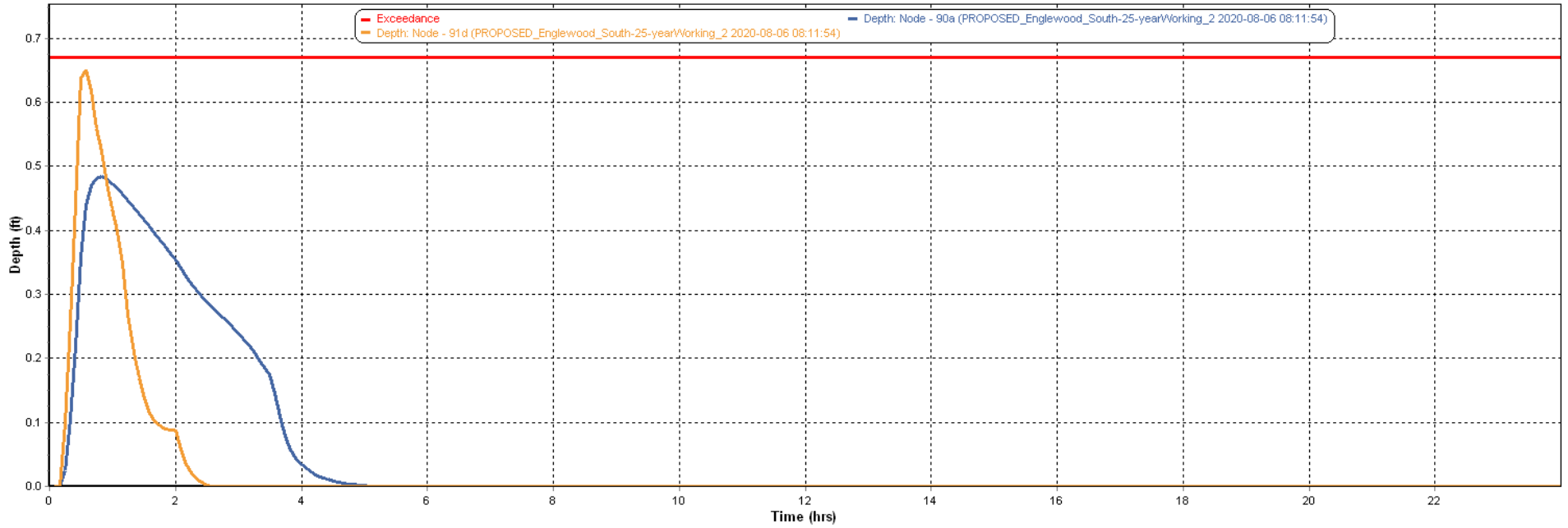
Tufts Ave, Lincoln St & Sherman St - 25 Year EXISTING



LEGEND



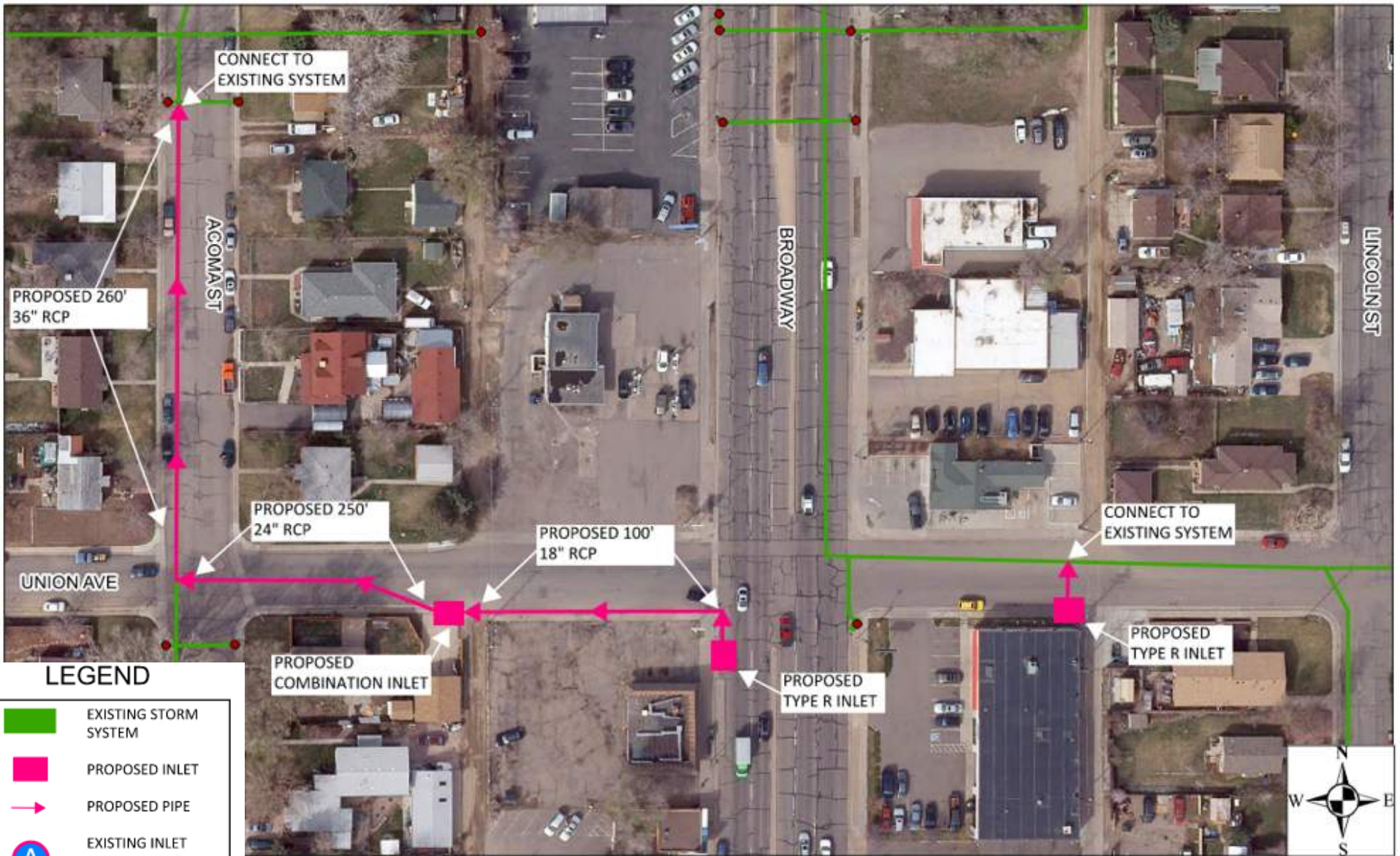
Tufts Ave, Lincoln St & Sherman St - 25 Year PROPOSED



LEGEND



Broadway & Union Ave - Priority 3



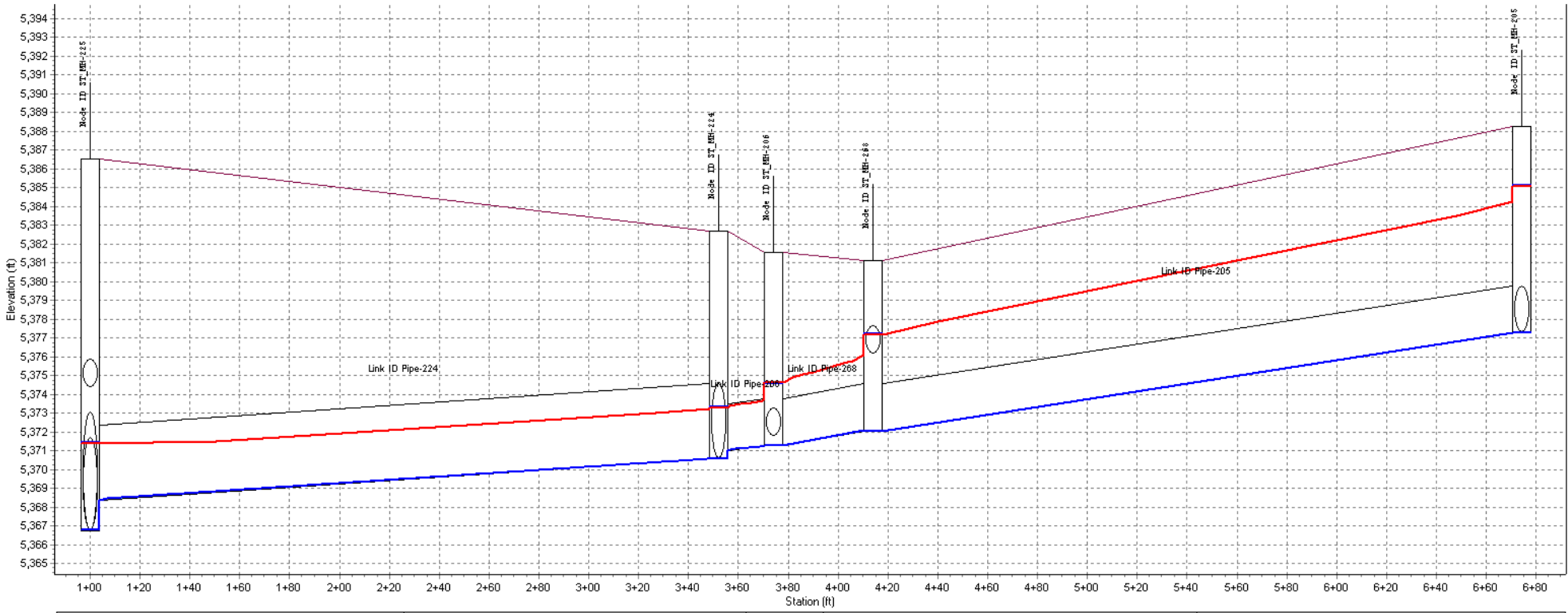
LEGEND

- EXISTING STORM SYSTEM
- PROPOSED INLET
- PROPOSED PIPE
- A EXISTING INLET WITH PROPOSED CHANGES*
- A EXISTING INLET WITH NO CHANGES*
- EXISTING INLET WITH NO DEPTHS SHOWN

EXISTING Pipe Size	PROPOSED Pipe Size	Length
30"	36"	260'

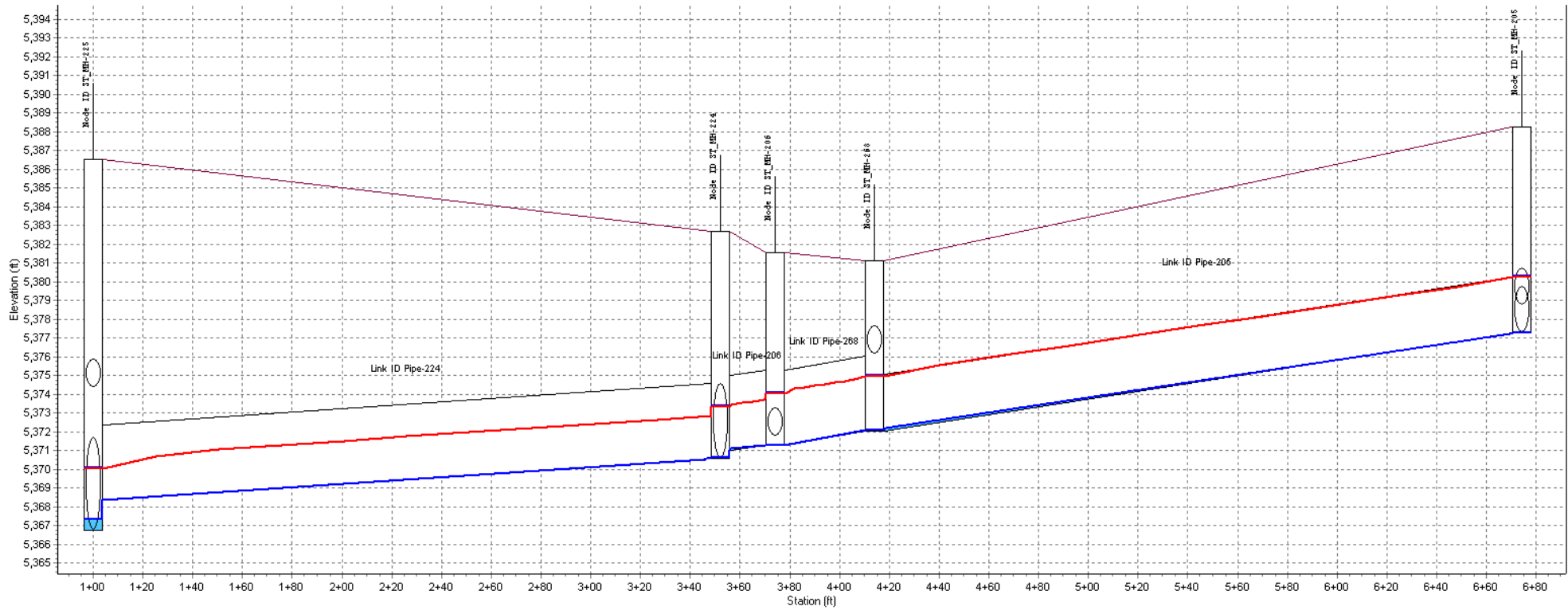
*NOTE: The fill color of the inlet label corresponds to the depth data line color.

Acoma Area Drainage Study - 25 Year EXISTING
Acoma St, Union Ave to Tufts Ave



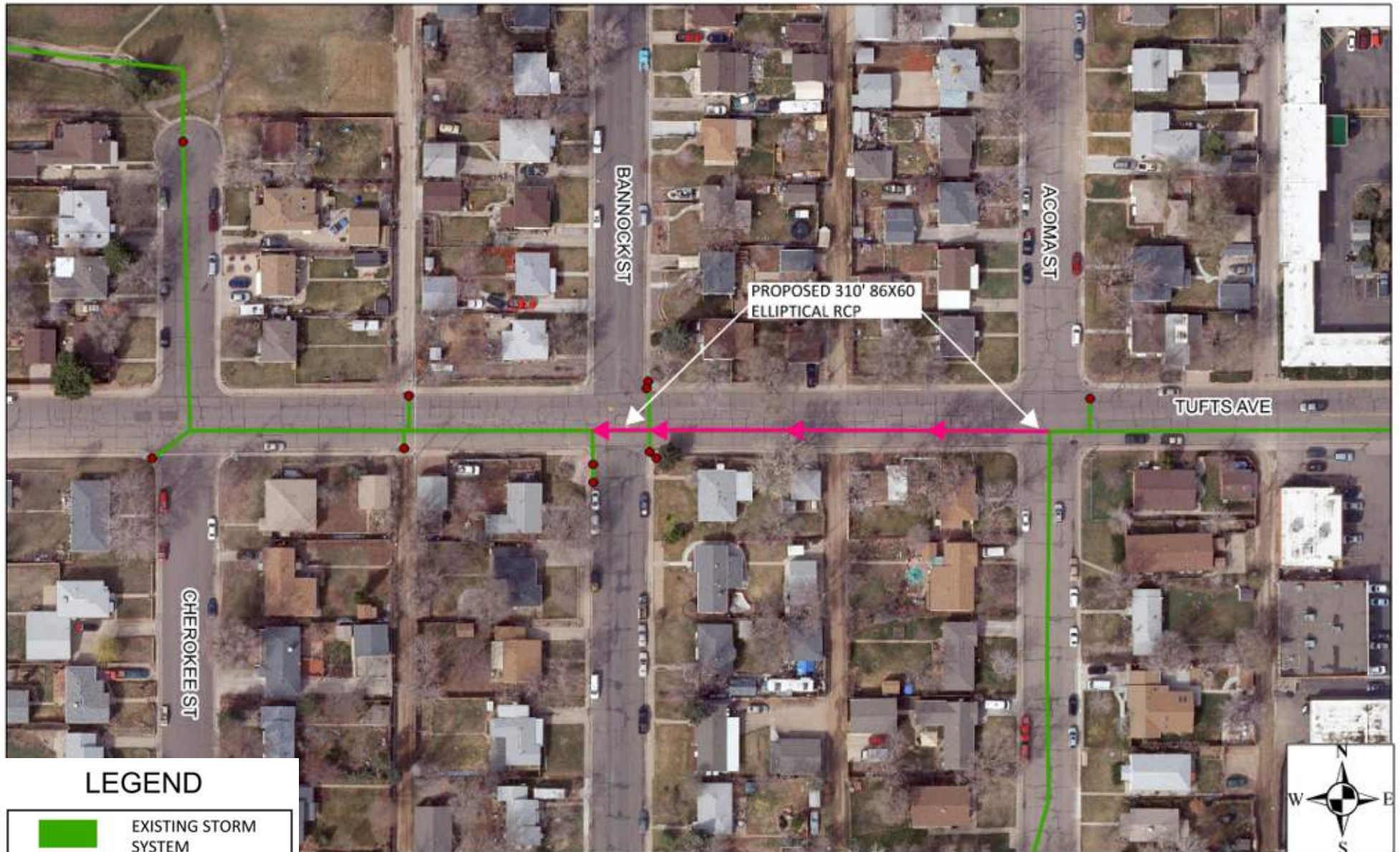
Node ID:	ST_MH-225		ST_MH-224	ST_MH-206	ST_MH-268		ST_MH-205
Rim (ft):	5386.52		5382.69	5381.57	5381.15		5388.28
Invert (ft):	5366.74		5370.58	5371.27	5372.07		5377.27
Min Pipe Cover (ft):	10.65		8.11	7.80	3.50		8.51
Max HGL (ft):	5371.39		5373.29	5374.70	5377.20		5385.13
Link ID:		Pipe-224		Pipe-206	Pipe-268		Pipe-205
Length (ft):		252.00		22.00	40.00		260.00
Dia (ft):		4.00		2.50	2.50		2.50
Slope (ft/ft):		0.0087		0.0109	0.0200		0.0200
Up Invert (ft):		5370.58		5371.27	5372.07		5377.27
Dn Invert (ft):		5368.38		5371.03	5371.27		5372.07
Max Q (cfs):		50.55		34.43	33.96		29.41
Max Vel (ft/s):		6.33		7.23	6.92		5.99
Max Depth (ft):		2.74		2.38	2.50		2.50

Acoma Area Drainage Study - 25 Year PROPOSED
Acoma St, Union Ave to Tufts Ave







Node ID:	ST_MH-225		ST_MH-224	ST_MH-206	ST_MH-268		ST_MH-205
Rim (ft):	5386.52		5382.69	5381.57	5381.15		5388.28
Invert (ft):	5366.74		5370.58	5371.27	5372.07		5377.27
Min Pipe Cover (ft):	10.65		7.66	6.30	3.50		7.51
Max HGL (ft):	5370.04		5373.36	5374.08	5374.95		5380.27
Link ID:		Pipe-224		Pipe-206	Pipe-268		Pipe-205
Length (ft):		252.00		22.00	40.00		260.00
Dia (ft):		4.00		4.00	4.00		3.00
Slope (ft/ft):		0.0087		0.0109	0.0200		0.0200
Up Invert (ft):		5370.58		5371.27	5372.07		5377.27
Dn Invert (ft):		5368.38		5371.03	5371.27		5372.07
Max Q (cfs):		51.88		47.78	47.31		40.76
Max Vel (ft/s):		6.38		6.01	5.46		5.93
Max Depth (ft):		2.47		2.56	2.82		2.91

Tufts Avenue - Priority 4

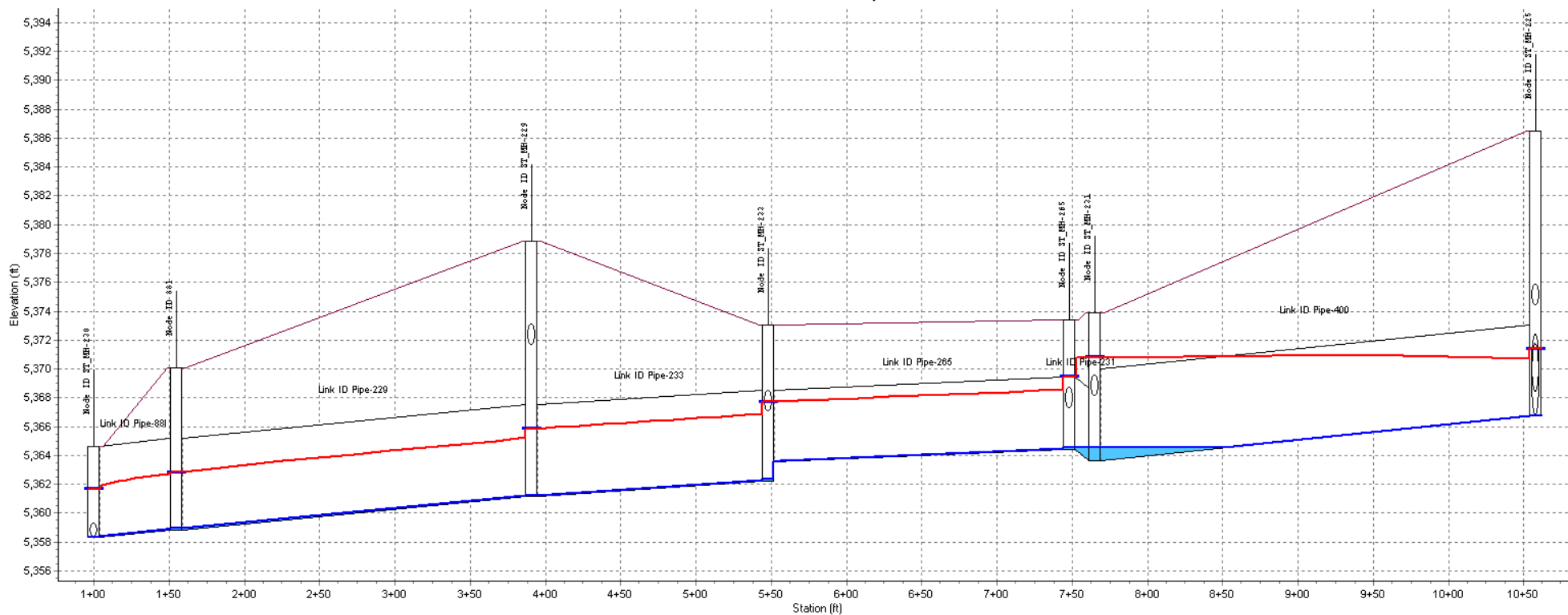


LEGEND

-  EXISTING STORM SYSTEM
-  PROPOSED PIPE LINING
-  PROPOSED PIPE
-  EXISTING INLET

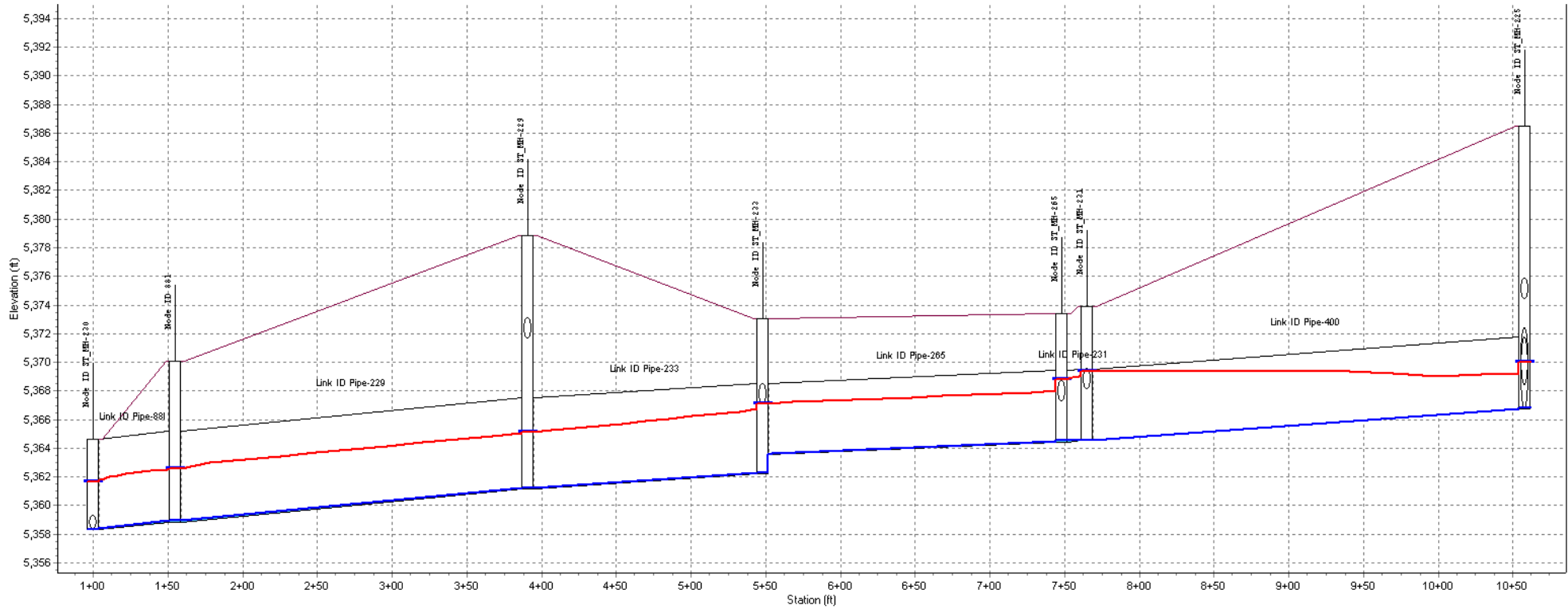
EXISTING Pipe Size	PROPOSED Pipe Size	Length
76"	86"x60" Elliptical	310'

Acoma Area Drainage Study - 25 Year EXISTING
Tufts Ave, Acoma St to Greenway



Node ID:	ST_MH-230	881	ST_MH-229	ST_MH-233	ST_MH-231	ST_MH-225
Rim (ft):	5359.00	5370.07	5378.83	5373.02	5373.89	5386.52
Invert (ft):	5358.32	5358.85	5361.17	5362.22	5363.65	5366.74
Min Pipe Cover (ft):	0.00		5.70	4.47	4.00	3.91
Max HGL (ft):	5361.67	5362.83	5365.85	5367.72	5369.76	5371.39
Link ID:	Pipe-881	Pipe-229	Pipe-233	Pipe-265	Pipe-231	Pipe-400
Length (ft):	54.63	236.37	157.00	200.00	17.00	293.00
Dia (ft):	6.33	6.33	6.33	5.00	5.00	6.33
Slope (ft/ft):	0.0097	0.0098	0.0067	0.0043	-0.0447	0.0105
Up Invert (ft):	5358.85	5361.17	5362.22	5364.41	5363.65	5366.74
Dn Invert (ft):	5358.32	5358.85	5361.17	5363.55	5364.41	5363.65
Max Q (cfs):	172.06	164.10	162.25	160.63	157.93	156.11
Max Vel (ft/s):	15.17	7.57	5.98	5.29	8.04	5.63
Max Depth (ft):	3.64	4.24	5.09	4.58	5.00	5.49

Acoma Area Drainage Study - 25 Year PROPOSED
Tufts Ave, Acoma St to Greenway









Node ID:	ST_MH-230	881		ST_MH-229		ST_MH-233		ST_MH-265	ST_MH-231		ST_MH-225
Rim (ft):	5359.00	5370.07		5378.83		5373.02		5373.89	5373.89		5386.52
Invert (ft):	5358.32	5358.85		5361.17		5362.22		5364.41	5364.54		5366.74
Min Pipe Cover (ft):	0.00			5.70		4.47		4.00	4.28		10.65
Max HGL (ft):	5361.67	5362.57		5365.11		5367.13		5368.37	5369.37		5370.04
Link ID:	Pipe-881		Pipe-229		Pipe-233		Pipe-265		Pipe-231		Pipe-400
Length (ft):	54.63		236.37		157.00		200.00		17.00		293.00
Dia (ft):	6.33		6.33		6.33		5.00		5.00		5.00
Slope (ft/ft):	0.0097		0.0098		0.0067		0.0043		0.0076		0.0075
Up Invert (ft):	5358.85		5361.17		5362.22		5364.41		5364.54		5366.74
Dn Invert (ft):	5358.32		5358.85		5361.17		5363.55		5364.41		5364.54
Max Q (cfs):	176.09		174.86		173.06		171.16		168.70		167.16
Max Vel (ft/s):	15.34		9.24		7.36		6.22		5.54		6.35
Max Depth (ft):	3.49		3.76		4.43		3.99		4.62		4.06

Broadway & Layton Ave - Priority 5



EXISTING Pipe Size	PROPOSED Pipe Size	Length
42"	48"	660'

LEGEND

-  EXISTING STORM SYSTEM
-  PROPOSED INLET
-  PROPOSED PIPE
-  EXISTING INLET WITH PROPOSED CHANGES*
-  EXISTING INLET WITH NO CHANGES*
-  EXISTING INLET WITH NO DEPTHS SHOWN

*NOTE: The fill color of the inlet label corresponds to the depth data line color.

Sherman St & Layton Ave - Priority 6



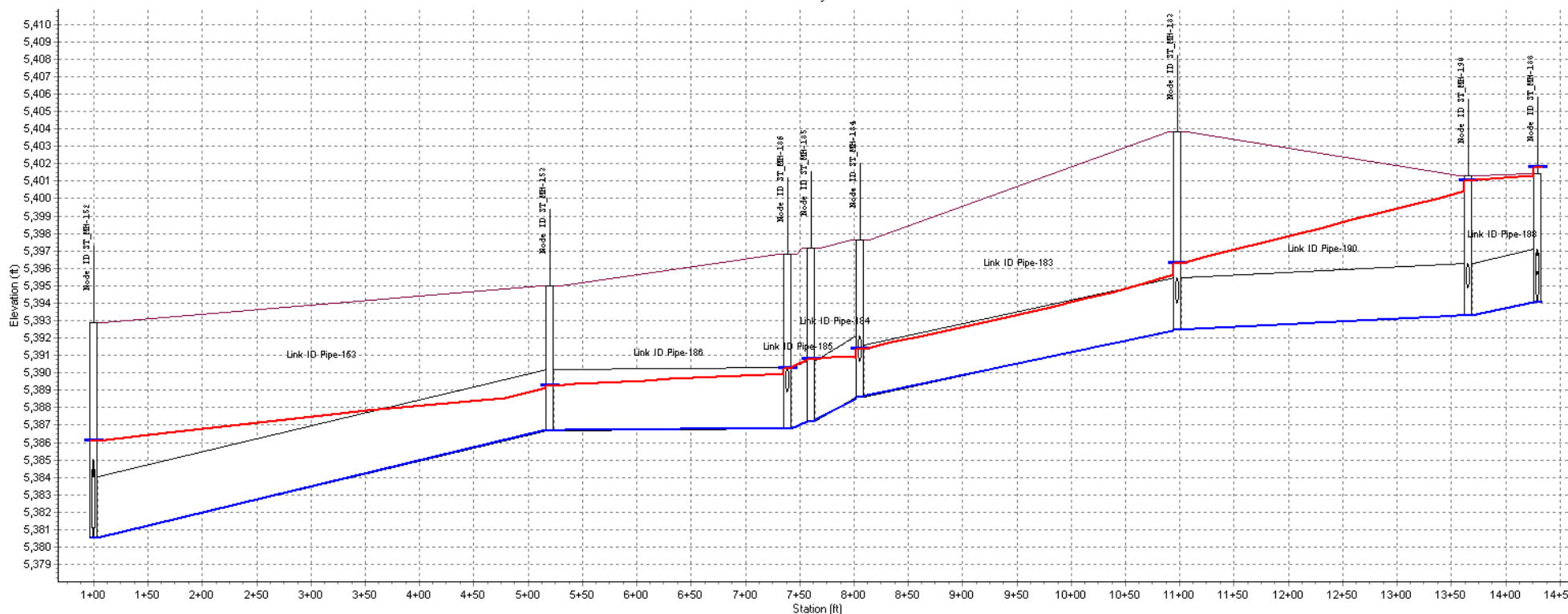
LEGEND

- EXISTING STORM SYSTEM
- PROPOSED INLET
- PROPOSED PIPE
- A EXISTING INLET WITH PROPOSED CHANGES*
- A EXISTING INLET WITH NO CHANGES*
- EXISTING INLET WITH NO DEPTHS SHOWN

EXISTING Pipe Size	PROPOSED Pipe Size	Length
36"	48"	610'

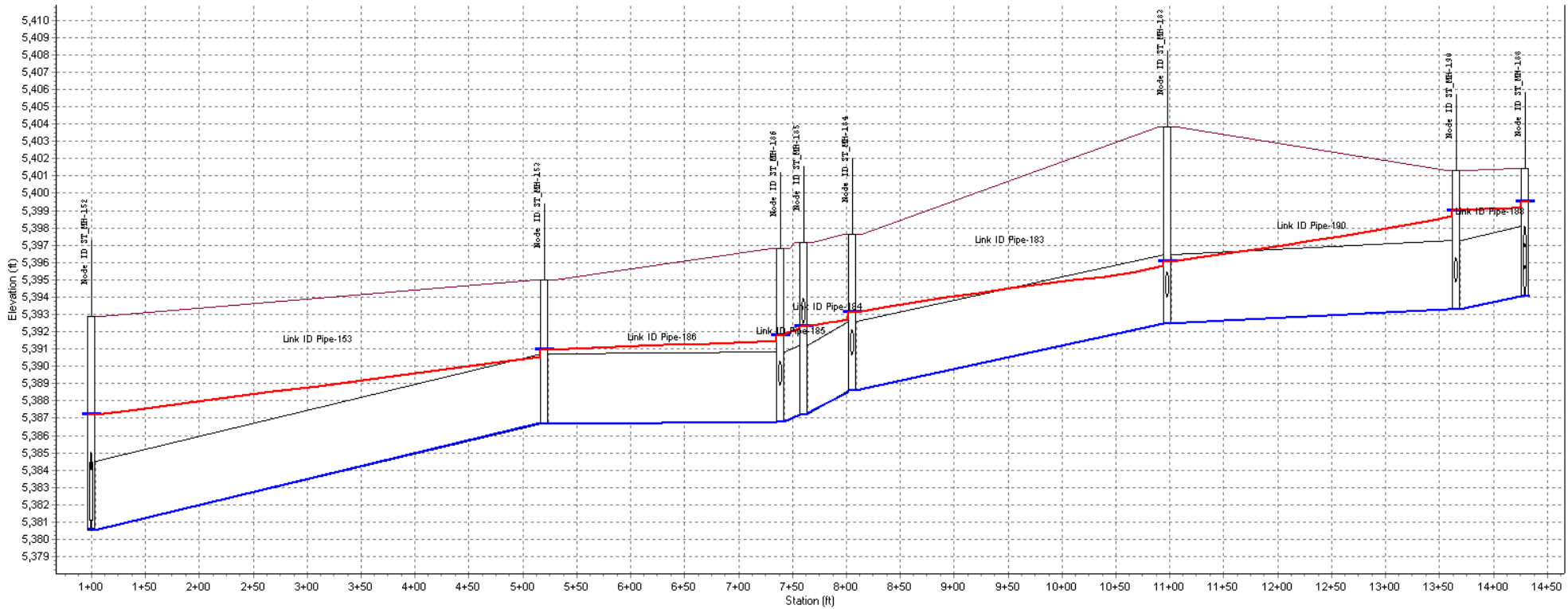
*NOTE: The fill color of the inlet label corresponds to the depth data line color.

Acoma Area Drainage Study - 25 Year EXISTING
 Sherman St and Layton Ave



Node ID:	ST_MH-152		ST_MH-153		ST_MH-185	ST_MH-186	ST_MH-187	MH-184		ST_MH-183		ST_MH-190	ST_MH-188
Rim (ft):	5392.90		5395.00		5396.87	5397.18	5397.62			5403.86		5401.30	5401.43
Invert (ft):	5380.52		5386.70		5386.87	5387.18	5388.62			5392.46		5393.30	5394.08
Min Pipe Cover (ft):	7.88		4.80		6.50	6.50	5.50			8.40		5.00	4.35
Max HGL (ft):	5386.61		5389.25		5390.77	5390.77	5391.36			5397.04		5401.30	5401.81
Link ID:		Pipe-153			Pipe-186	Pipe-185	Pipe-184			Pipe-183		Pipe-190	Pipe-188
Length (ft):		420.45			218.50	21.39	45.19			292.73		267.72	63.35
Dia (ft):		3.50			3.50	3.50	3.50			3.00		3.00	3.00
Slope (ft/ft):		0.0147			0.0005	0.0168	0.0319			0.0131		0.0031	0.0123
Up Invert (ft):		5386.70			5386.82	5387.18	5388.62			5392.46		5393.30	5394.08
Dn Invert (ft):		5380.52			5386.70	5386.87	5387.18			5388.62		5392.46	5393.30
Max Q (cfs):		42.65			42.38	40.68	43.12			37.57		40.20	39.57
Max Vel (ft/s):		6.10			4.90	4.36	5.76			5.83		5.72	5.60
Max Depth (ft):		2.93			3.00	3.48	3.12			2.87		3.00	3.00

Acoma Area Drainage Study - 25 Year PROPOSED
 Sherman St and Layton Ave









Node ID:	ST_MH-152	ST_MH-153	ST_MH-183	ST_MH-184	ST_MH-188	ST_MH-190	ST_MH-188
Rim (ft):	5392.90	5395.00	5397.18	5397.62	5403.86	5401.30	5401.43
Invert (ft):	5380.52	5386.70	5386.82	5388.62	5392.46	5393.30	5394.08
Min Pipe Cover (ft):	7.88	4.30	6.00	5.00	7.40	4.00	3.35
Max HGL (ft):	5387.22	5391.13	5391.32	5393.28	5396.05	5399.04	5399.63
Link ID:	Pipe-153	Pipe-186	Pipe-185	Pipe-184	Pipe-183	Pipe-190	Pipe-188
Length (ft):	420.45	218.50	21.39	45.19	292.73	267.72	63.35
Dia (ft):	4.00	4.00	4.00	4.00	4.00	4.00	4.00
Slope (ft/ft):	0.0147	0.0005	0.0168	0.0319	0.0131	0.0031	0.0123
Up Invert (ft):	5386.70	5386.82	5387.18	5388.62	5392.46	5393.30	5394.08
Dn Invert (ft):	5380.52	5386.70	5386.82	5387.18	5388.62	5392.46	5393.30
Max Q (cfs):	74.35	72.95	71.22	62.85	65.91	64.28	61.72
Max Vel (ft/s):	6.66	6.00	5.67	5.09	6.14	5.52	5.08
Max Depth (ft):	4.00	4.00	4.00	4.00	3.79	3.79	4.00

Grant St & Chenango Ave - Priority 7



LEGEND

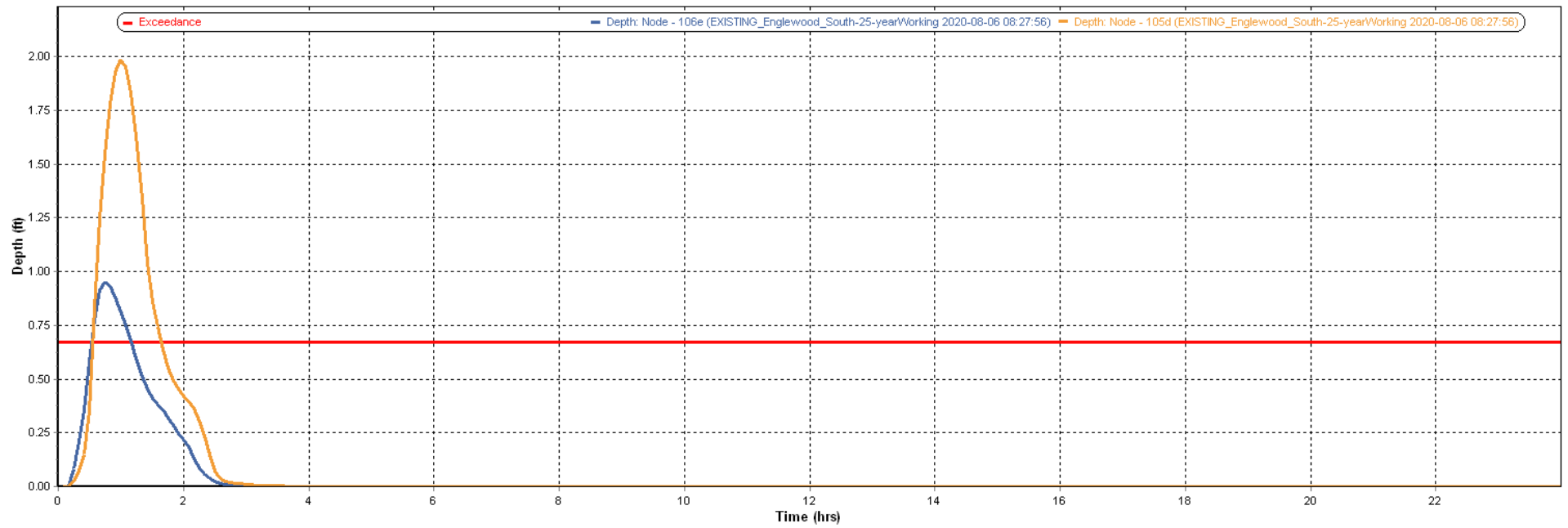
	EXISTING STORM SYSTEM
	PROPOSED INLET
	PROPOSED PIPE
	EXISTING INLET WITH PROPOSED CHANGES*
	EXISTING INLET WITH NO CHANGES*
	EXISTING INLET WITH NO DEPTHS SHOWN

*NOTE: The fill color of the inlet label corresponds to the depth data line color.

EXISTING Pipe Size	PROPOSED Pipe Size	Length
18"	30"	10'
24"	36"	175'
36"	48"	700'

Inlet ID	EXISTING Structure	PROPOSED Structure
P	Combination	Type R (10')
Q	Combination	Type R (15')

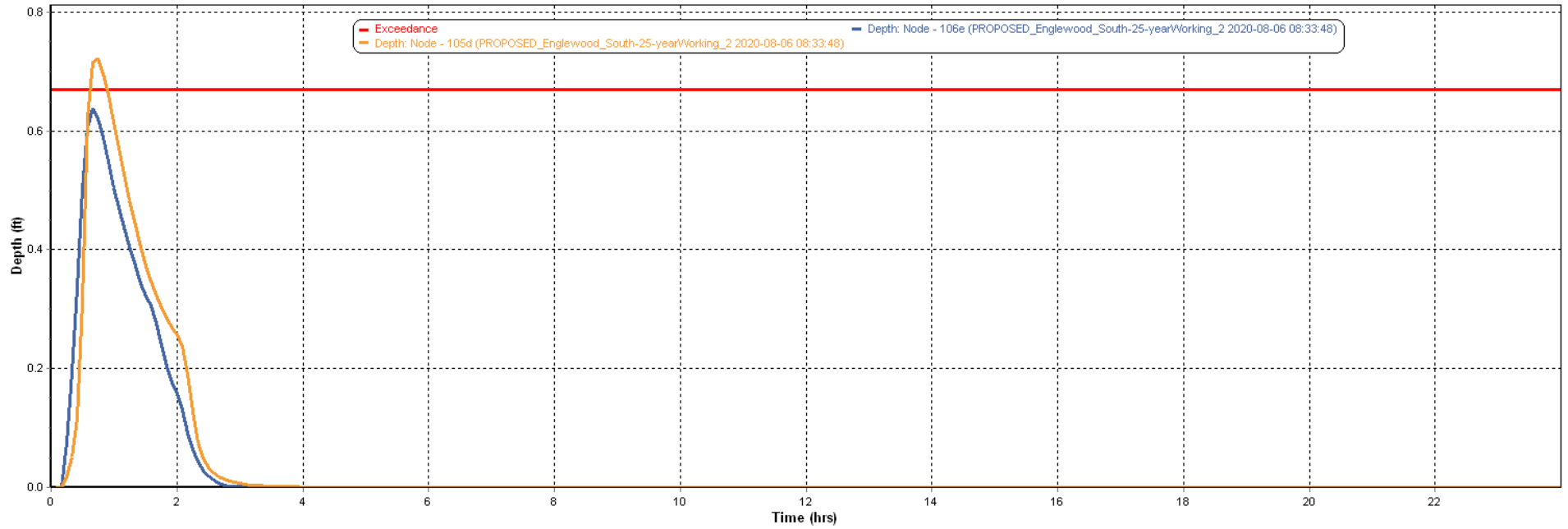
Grant St & Chenango Ave - 25 Year EXISTING



LEGEND



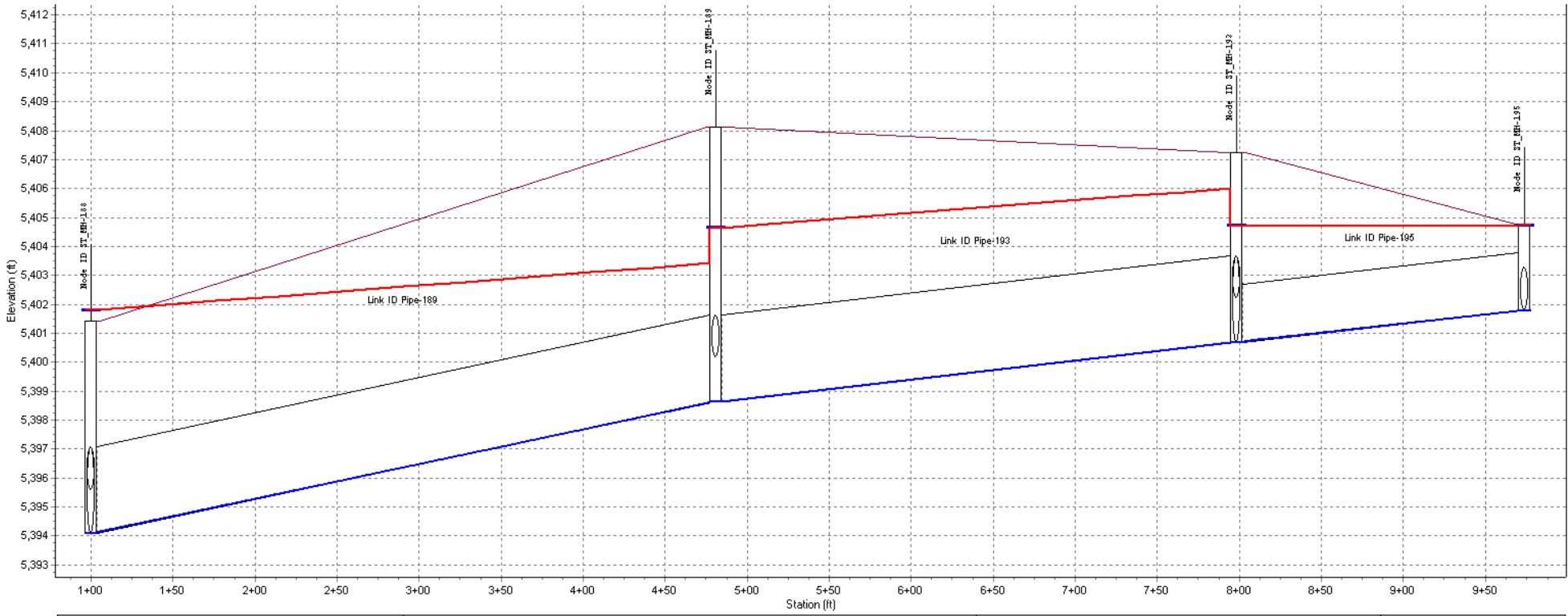
Grant St & Chenango Ave - 25 Year PROPOSED



LEGEND

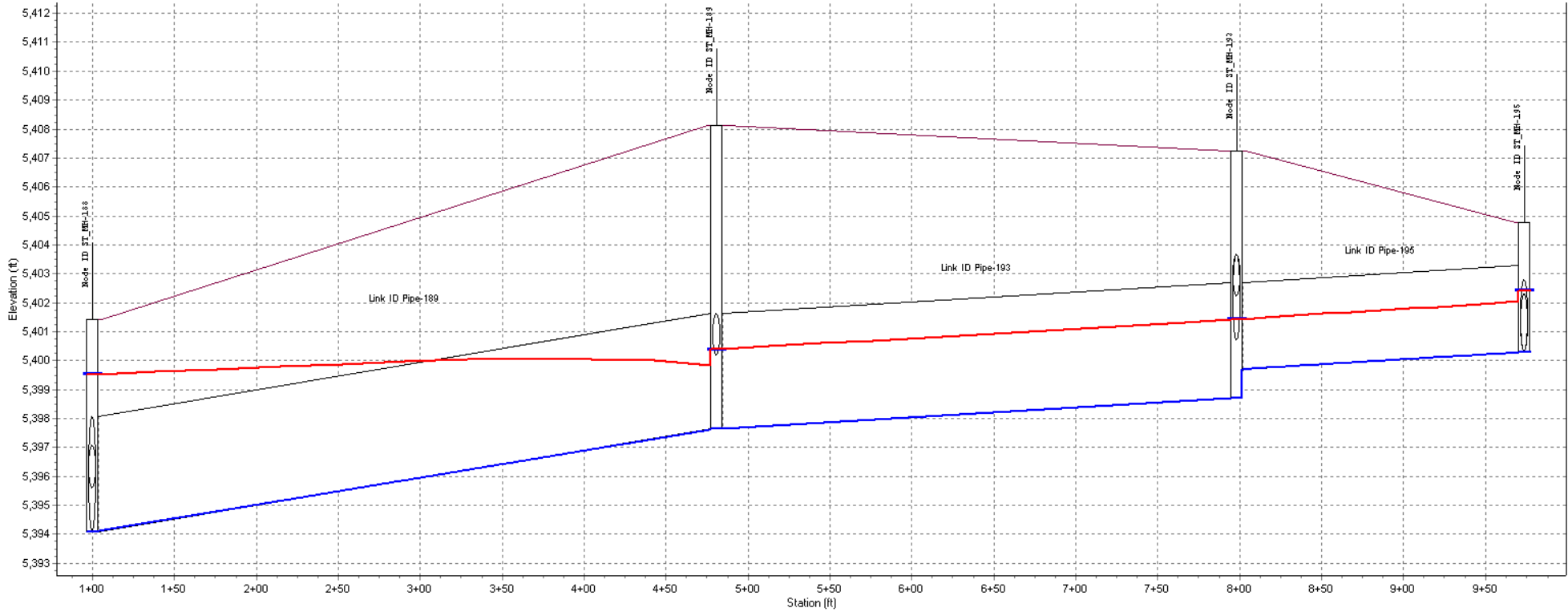


Acoma Area Drainage Study - 25 Year EXISTING
Grant St and Chenango Ave



Node ID:	ST_MH-188		ST_MH-189		ST_MH-193		ST_MH-195
Rim (ft):	5401.43		5408.14		5407.24		5404.79
Invert (ft):	5394.08		5398.64		5400.69		5401.79
Min Pipe Cover (ft):	4.35		6.50		3.55		1.00
Max HGL (ft):	5401.81		5406.88		5407.24		5404.88
Link ID:		Pipe-188		Pipe-193		Pipe-195	
Length (ft):		380.75		317.33		175.43	
Dia (ft):		3.00		3.00		2.00	
Slope (ft/ft):		0.0120		0.0065		0.0063	
Up Invert (ft):		5398.64		5400.69		5401.79	
Dn Invert (ft):		5394.08		5398.64		5400.69	
Max Q (cfs):		44.78		44.57		14.42	
Max Vel (ft/s):		7.33		7.26		4.59	
Max Depth (ft):		3.00		3.00		2.00	

Acoma Area Drainage Study - 25 Year PROPOSED
Grant St and Chenango Ave



	ST_MH-188	ST_MH-189	ST_MH-193	ST_MH-195
Node ID:	ST_MH-188	ST_MH-189	ST_MH-193	ST_MH-195
Rim (ft):	5401.43	5408.14	5407.24	5404.79
Invert (ft):	5394.08	5397.64	5398.69	5400.29
Min Pipe Cover (ft):	3.35	6.50	3.55	1.50
Max HGL (ft):	5399.63	5400.39	5401.44	5402.43
Link ID:	Pipe-188	Pipe-193	Pipe-195	
Length (ft):	380.75	317.33	175.43	
Dia (ft):	4.00	4.00	3.00	
Slope (ft/ft):	0.0093	0.0033	0.0034	
Up Invert (ft):	5397.64	5398.69	5400.29	
Dn Invert (ft):	5394.08	5397.64	5398.69	
Max Q (cfs):	66.93	57.52	23.74	
Max Vel (ft/s):	7.08	7.20	4.97	
Max Depth (ft):	3.37	2.73	1.94	

Fox St & Stanford Ave - Priority 8



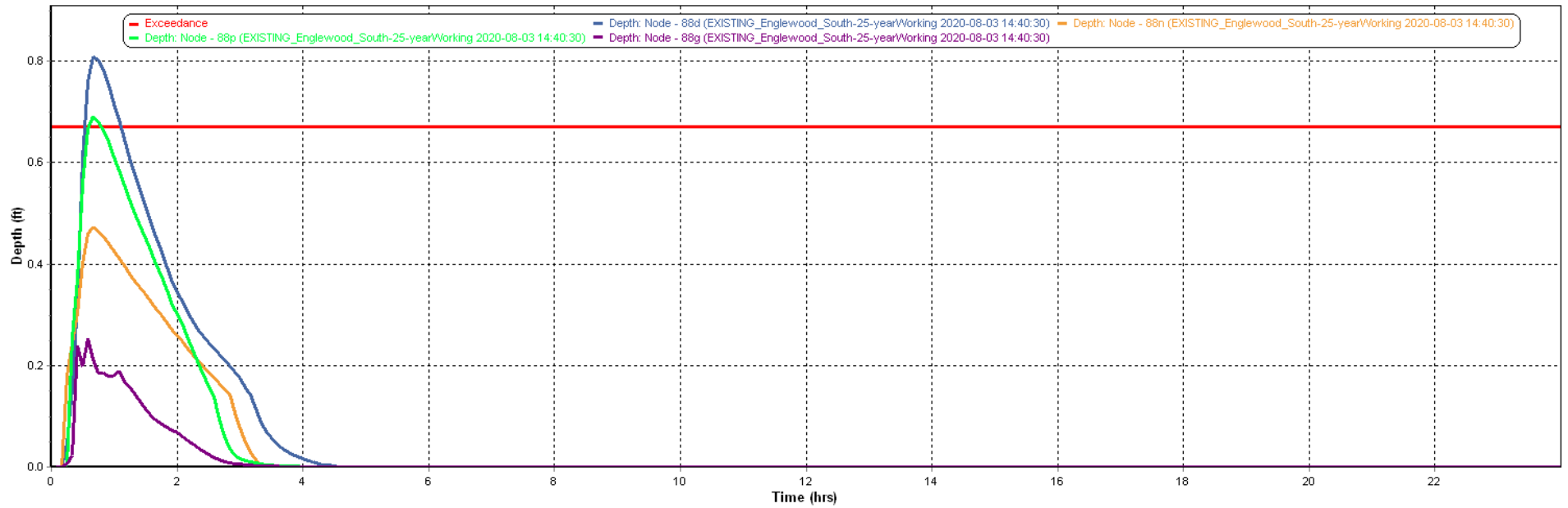
LEGEND

- EXISTING STORM SYSTEM
- PROPOSED INLET
- PROPOSED PIPE
- A EXISTING INLET WITH PROPOSED CHANGES*
- A EXISTING INLET WITH NO CHANGES*
- EXISTING INLET WITH NO DEPTHS SHOWN

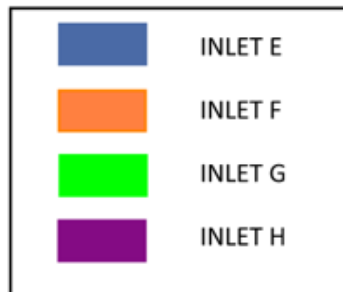
*NOTE: The fill color of the inlet label corresponds to the depth data line color.

Inlet ID	EXISTING Structure	PROPOSED Structure
E	Combination	N/A
F	Combination	N/A
G	Combination	N/A
H	Combination	N/A

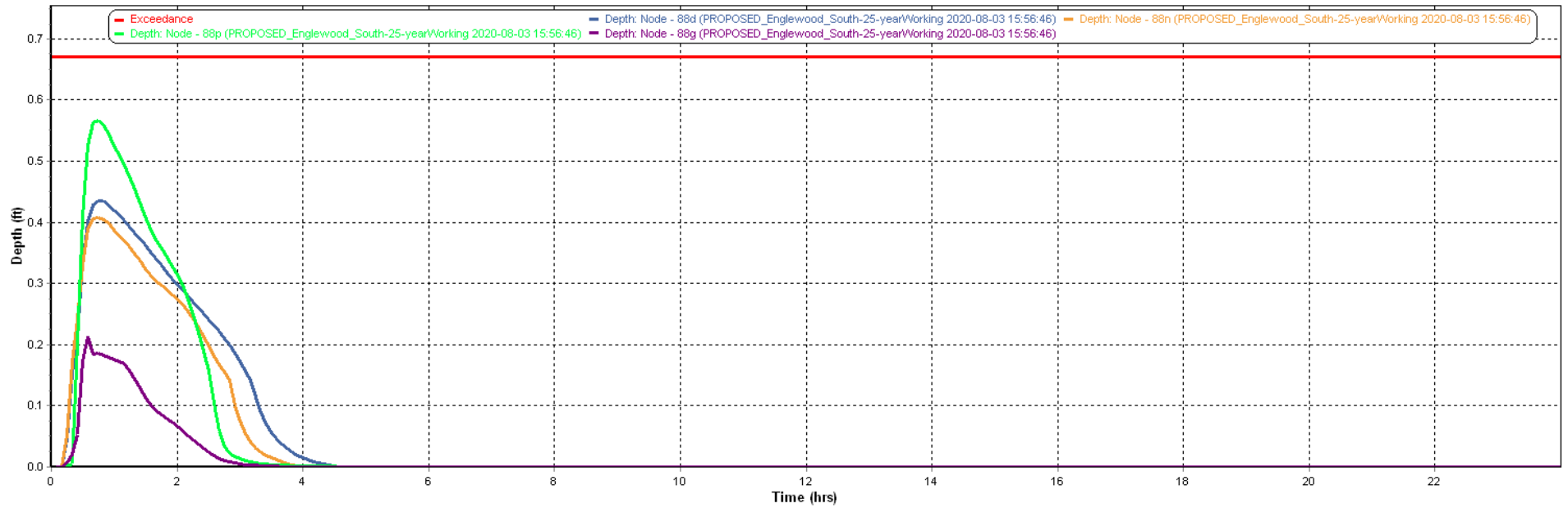
Fox St. & Stanford Ave. - 25 Year EXISTING



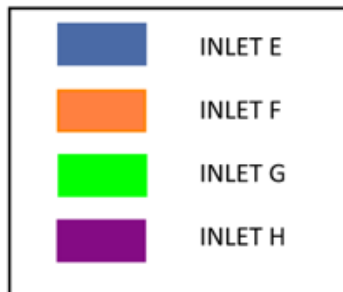
LEGEND



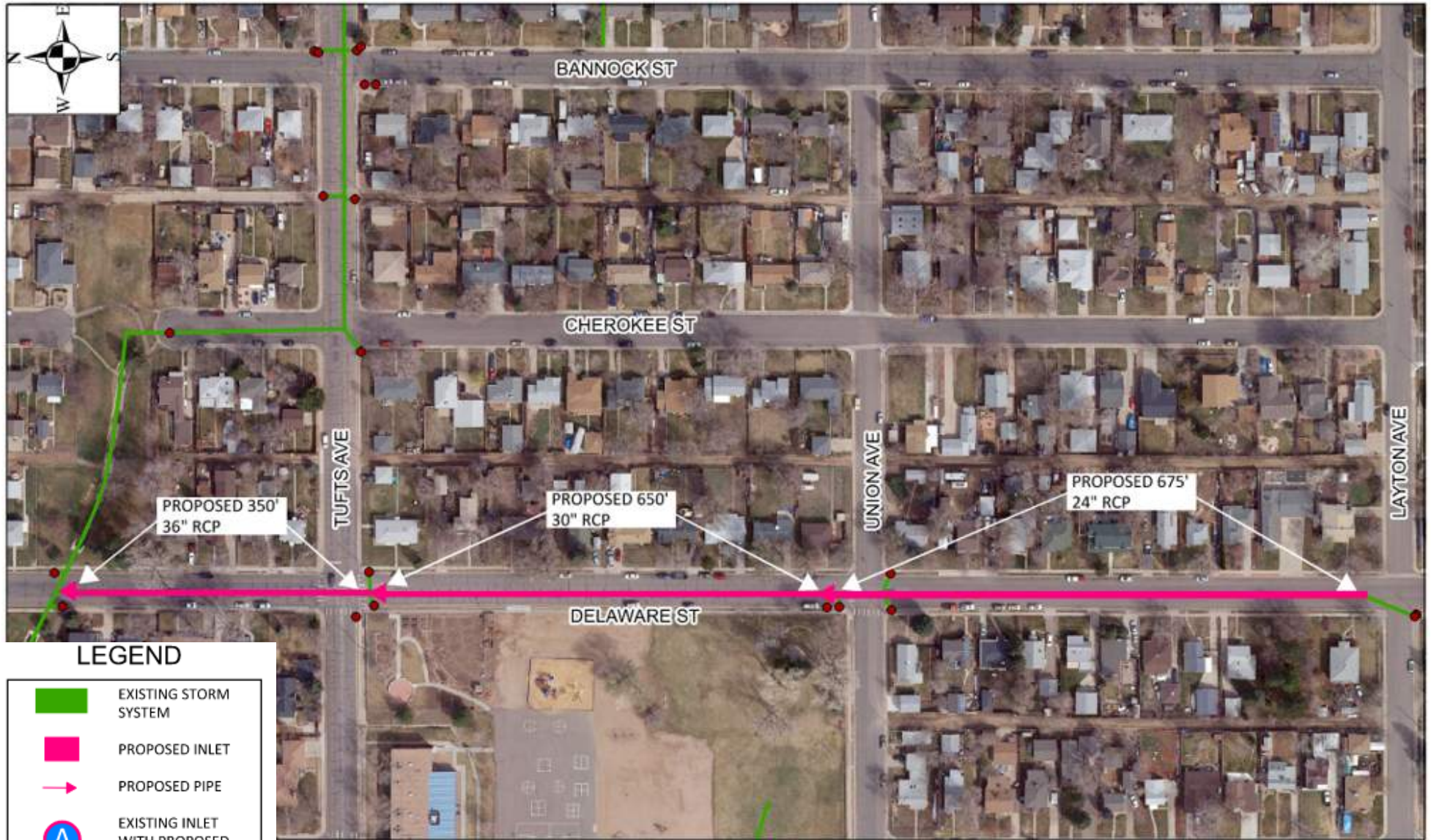
Fox St & Stanford Ave - 25 Year PROPOSED



LEGEND



Delaware St - Priority 9



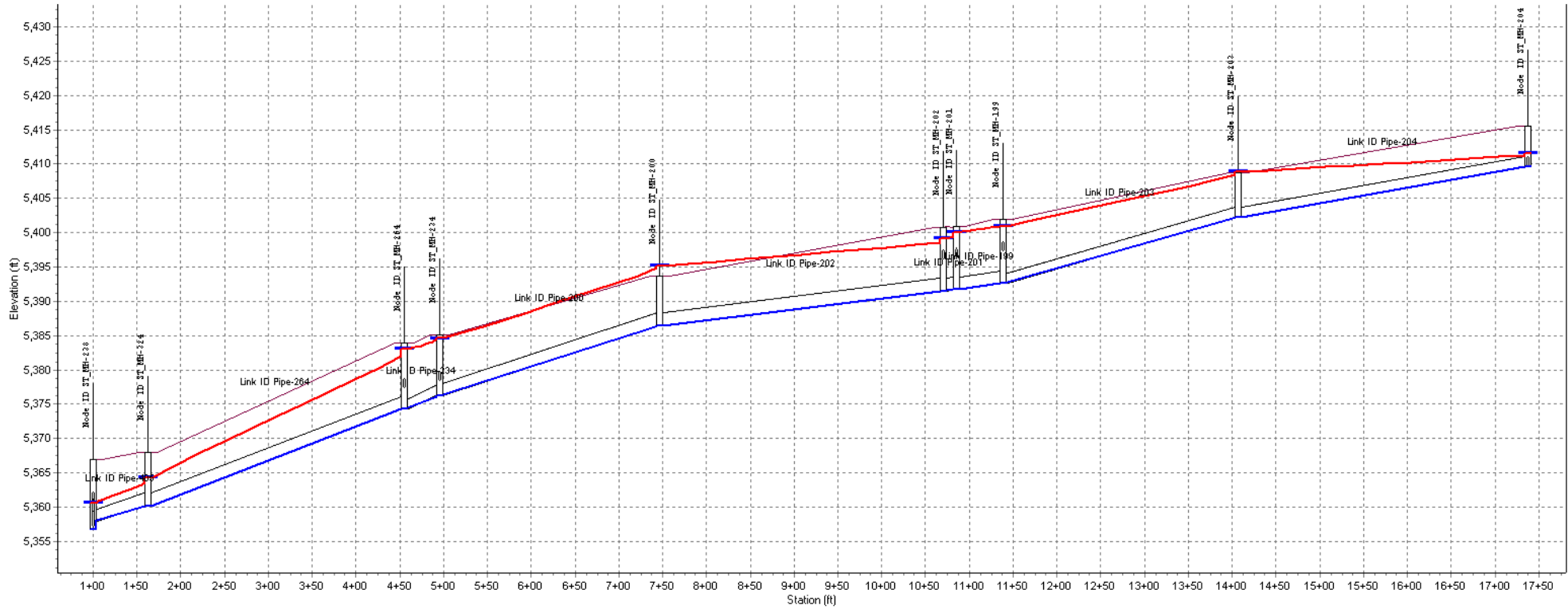
LEGEND

- EXISTING STORM SYSTEM
- PROPOSED INLET
- PROPOSED PIPE
- A EXISTING INLET WITH PROPOSED CHANGES*
- A EXISTING INLET WITH NO CHANGES*
- EXISTING INLET WITH NO DEPTHS SHOWN

EXISTING Pipe Size	PROPOSED Pipe Size	Length
18"	24"	675'
22"	30"	650'
22"	36"	350'

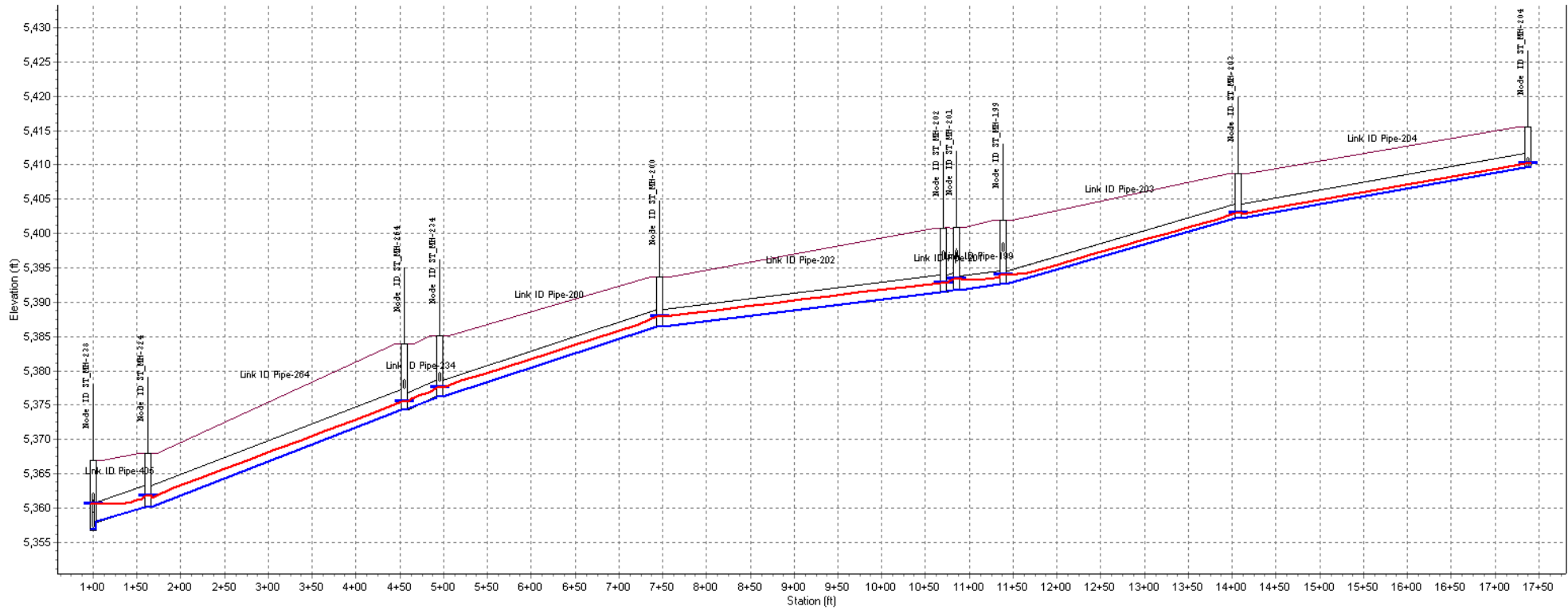
*NOTE: The fill color of the inlet label corresponds to the depth data line color.

Acoma Area Drainage Study - 25 Year EXISTING
 Delaware St, Layton Ave to Greenway



Node ID:	ST_MH-238	ST_MH-244	ST_MH-244	ST_MH-234	ST_MH-200	ST_MH-202	ST_MH-201	ST_MH-199	ST_MH-203	ST_MH-204
Rim (ft):	5366.96	5368.00	5383.96	5385.05	5393.74	5400.97	5401.95	5408.77	5415.60	
Invert (ft):	5356.74	5360.21	5374.28	5376.19	5386.47	5391.76	5392.59	5402.27	5409.66	
Min Pipe Cover (ft):	4.71	5.96	5.10	5.25	5.44	3.22	3.20	5.00	4.44	
Max HGL (ft):	5360.64	5364.86	5383.93	5385.05	5395.14	5398.18	5401.10	5408.85	5411.65	
Link ID:	Pipe-405	Pipe-264	Pipe-234	Pipe-200	Pipe-202	Pipe-201	Pipe-199	Pipe-203	Pipe-204	
Length (ft):	62.00	293.00	40.00	252.00	323.08	15.34	53.58	268.00	330.00	
Dia (ft):	1.83	1.83	1.50	1.83	1.83	1.83	1.83	1.50	1.50	
Slope (ft/ft):	0.0373	0.0480	0.0477	0.0408	0.0156	0.0156	0.0155	0.0361	0.0224	
Up Invert (ft):	5360.21	5374.28	5376.19	5386.47	5391.52	5391.76	5392.59	5402.27	5409.66	
Dn Invert (ft):	5357.90	5360.21	5374.28	5376.19	5386.47	5391.76	5391.76	5392.59	5402.27	
Max Q (cfs):	19.52	19.52	17.96	16.15	19.26	21.41	17.89	8.76	9.40	
Max Vel (ft/s):	7.61	8.09	10.16	6.12	7.92	8.11	6.78	4.95	7.03	
Max Depth (ft):	1.83	1.83	1.50	1.83	1.83	1.83	1.83	1.50	1.50	

Acoma Area Drainage Study - 25 Year PROPOSED
 Delaware St, Layton Ave to Greenway







	ST_MH-238	ST_MH-244	ST_MH-244	ST_MH-234	ST_MH-200	ST_MH-202	ST_MH-201	ST_MH-199	ST_MH-203	ST_MH-204
Node ID:	ST_MH-238	ST_MH-244	ST_MH-244	ST_MH-234	ST_MH-200	ST_MH-202	ST_MH-201	ST_MH-199	ST_MH-203	ST_MH-204
Rim (ft):	5366.96	5368.00	5383.96	5385.05	5393.74	5400.97	5401.95	5408.77	5415.60	
Invert (ft):	5356.74	5360.21	5374.28	5376.19	5386.47	5392.76	5392.59	5402.27	5409.66	
Min Pipe Cover (ft):	4.71	4.79	5.10	5.25	4.77	3.22	3.20	4.50	3.94	
Max HGL (ft):	5360.59	5361.76	5375.68	5377.53	5387.86	5393.36	5394.04	5402.97	5410.22	
Link ID:	Pipe-405	Pipe-264	Pipe-234	Pipe-200	Pipe-202	Pipe-201	Pipe-199	Pipe-203	Pipe-204	
Length (ft):	62.00	293.00	40.00	252.00	323.08	15.34	53.58	268.00	330.00	
Dia (ft):	3.00	3.00	2.50	2.50	2.50	2.00	2.00	2.00	2.00	
Slope (ft/ft):	0.0373	0.0480	0.0477	0.0408	0.0156	0.0156	0.0155	0.0361	0.0224	
Up Invert (ft):	5360.21	5374.28	5376.19	5386.47	5391.52	5391.52	5392.59	5402.27	5409.66	
Dn Invert (ft):	5357.90	5360.21	5374.28	5376.19	5386.47	5391.52	5391.76	5392.59	5402.27	
Max Q (cfs):	23.87	24.62	23.84	19.72	19.88	17.42	13.22	4.88	5.04	
Max Vel (ft/s):	6.99	8.29	9.22	7.36	7.72	6.11	5.18	2.97	6.11	
Max Depth (ft):	1.69	1.41	1.30	1.34	1.31	1.42	1.52	1.07	0.62	

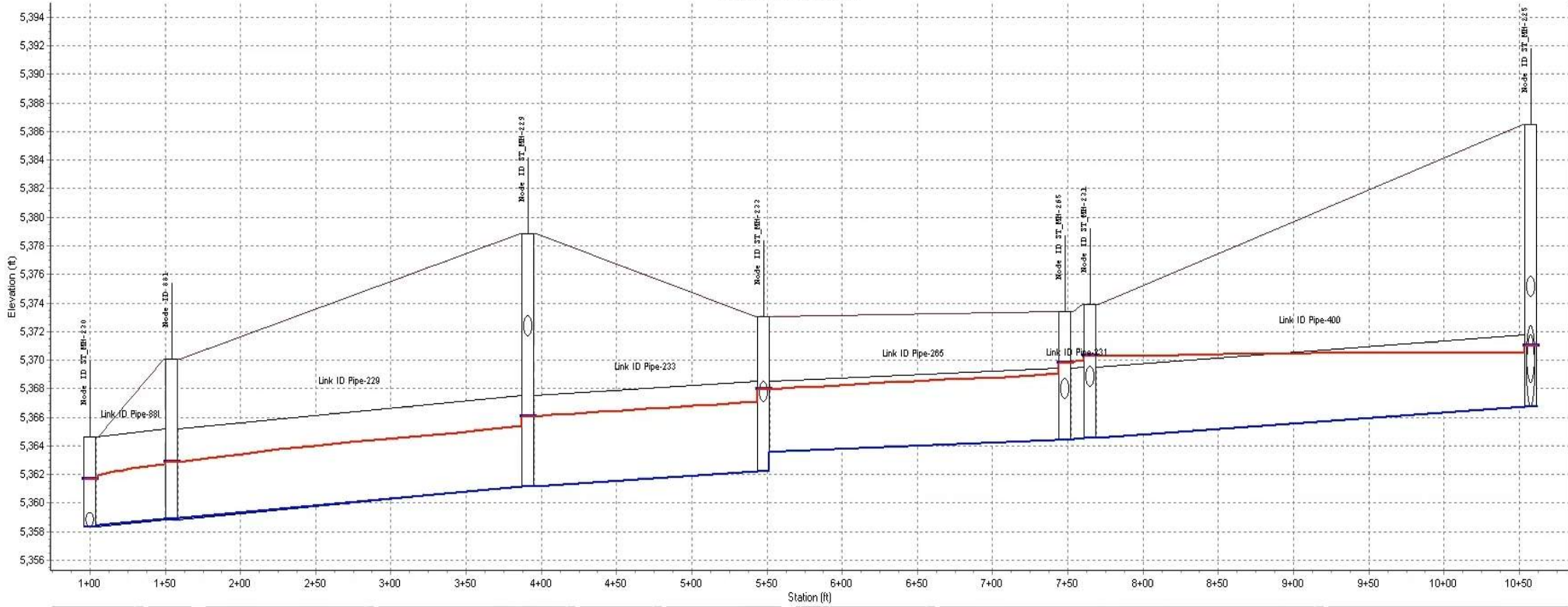
Tufts Ave - Priority 1F



LEGEND

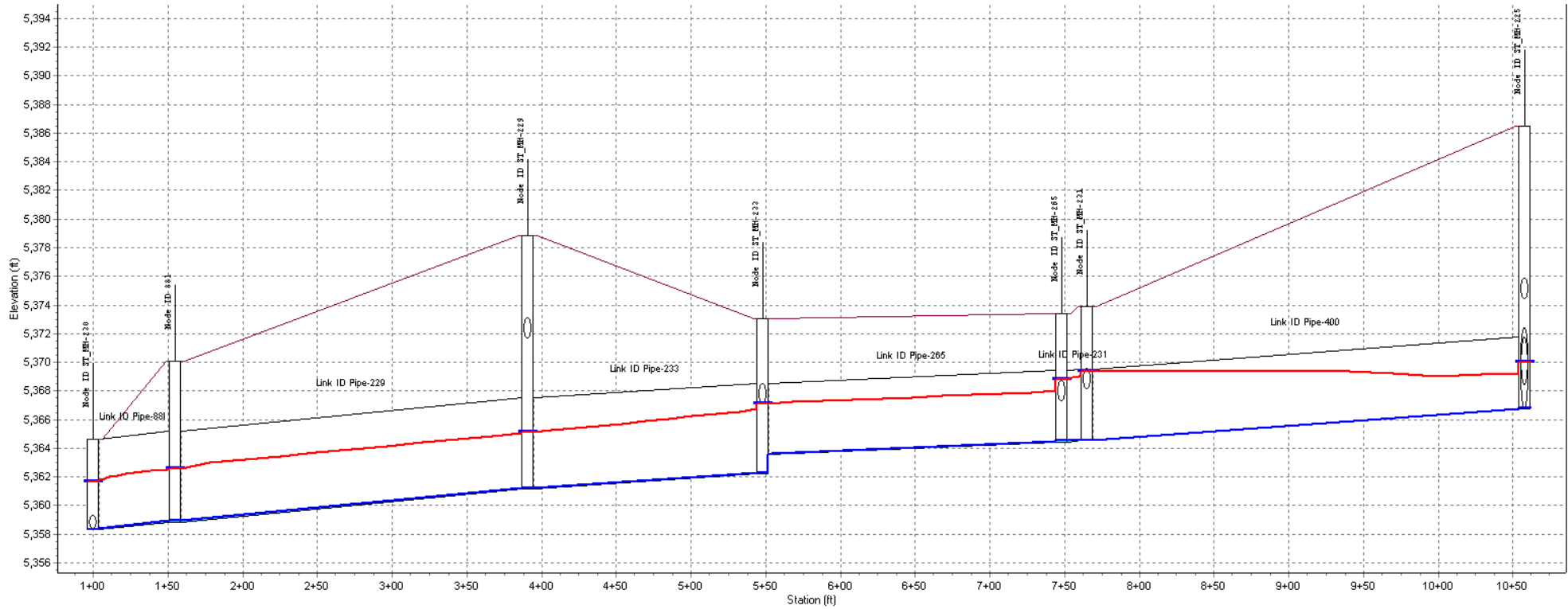
-  EXISTING STORM SYSTEM
-  PROPOSED PIPE LINING
-  PROPOSED PIPE
-  EXISTING INLET

Acoma Area Drainage Study - 25 Year EXISTING
 Tufts Ave. Acoma St to Greenway



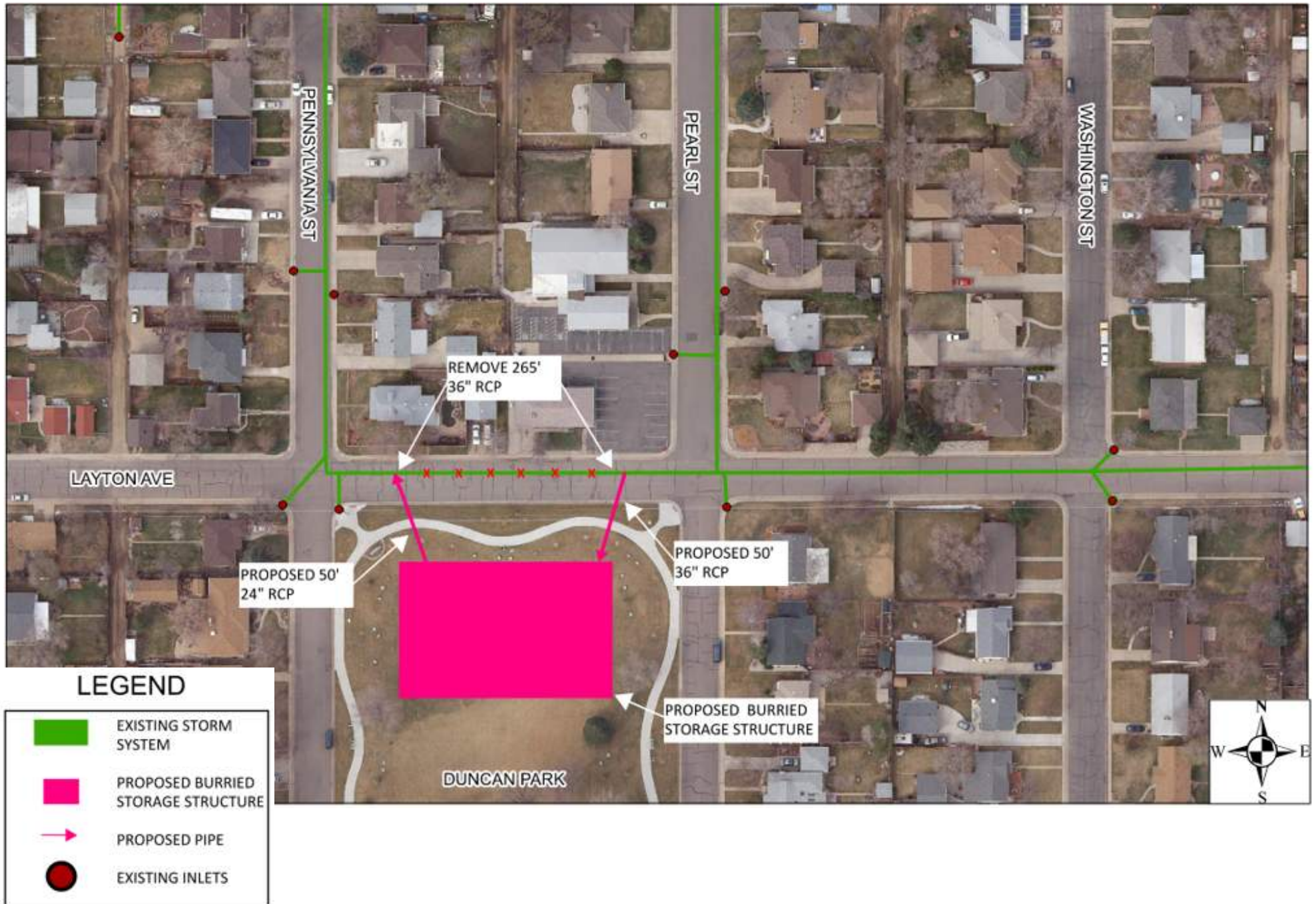
Node ID:	ST_MH-230	881	ST_MH-229	ST_MH-233	ST_MH-265	ST_MH-231	ST_MH-225
Rim (ft):	5359.00	5370.07	5378.83	5373.02	5373.89	5373.89	5386.52
Invert (ft):	5358.32	5358.85	5361.17	5362.22	5364.54	5364.54	5366.74
Min Pipe Cover (ft):	0.00		5.70	4.47	4.00	4.28	10.65
Max HGL (ft):	5361.65	5362.86	5366.06	5367.97	5369.29	5370.29	5371.04
Link ID:	Pipe-981	Pipe-229	Pipe-233	Pipe-265	Pipe-231	Pipe-400	
Length (ft):	54.63	236.37	157.00	200.00	17.00	293.00	
Dia (ft):	6.33	6.33	6.33	5.00	5.00	5.00	
Slope (ft/ft):	0.0097	0.0098	0.0067	0.0043	0.0076	0.0075	
Up Invert (ft):	5358.85	5361.17	5362.22	5364.41	5364.54	5366.74	
Dn Invert (ft):	5358.32	5358.85	5361.17	5363.55	5364.41	5364.54	
Max Q (cfs):	174.98	173.72	171.95	170.33	167.64	165.55	
Max Vel (ft/s):	15.19	7.69	6.10	5.52	5.28	6.20	
Max Depth (ft):	3.64	4.34	5.32	4.71	5.00	4.64	

Acoma Area Drainage Study - 25 Year PROPOSED
Tufts Ave, Acoma St to Greenway

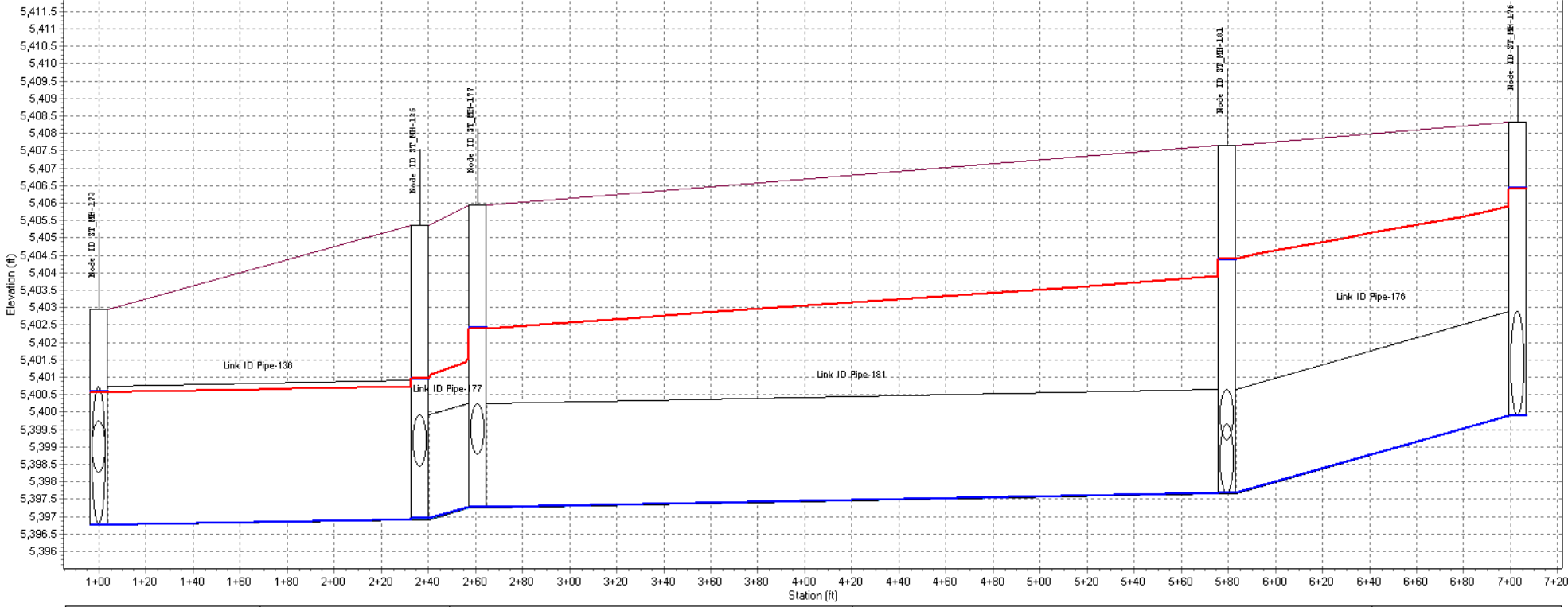


Node ID:	ST_MH-230	881		ST_MH-229		ST_MH-233		ST_MH-265	ST_MH-231		ST_MH-225
Rim (ft):	5359.00	5370.07		5378.83		5373.02		5373.89	5373.89		5386.52
Invert (ft):	5358.32	5358.85		5361.17		5362.22		5364.41	5364.54		5366.74
Min Pipe Cover (ft):	0.00			5.70		4.47		4.00	4.28		10.65
Max HGL (ft):	5361.67	5362.57		5365.11		5367.13		5368.37	5369.37		5370.04
Link ID:	Pipe-881		Pipe-229		Pipe-233		Pipe-265		Pipe-231		Pipe-400
Length (ft):	54.63		236.37		157.00		200.00		17.00		293.00
Dia (ft):	6.33		6.33		6.33		5.00		5.00		5.00
Slope (ft/ft):	0.0097		0.0098		0.0067		0.0043		0.0076		0.0075
Up Invert (ft):	5358.85		5361.17		5362.22		5364.41		5364.54		5366.74
Dn Invert (ft):	5358.32		5358.85		5361.17		5363.55		5364.41		5364.54
Max Q (cfs):	176.09		174.86		173.06		171.16		168.70		167.16
Max Vel (ft/s):	15.34		9.24		7.36		6.22		5.54		6.35
Max Depth (ft):	3.49		3.76		4.43		3.99		4.62		4.06

Duncan Park - Priority 2F

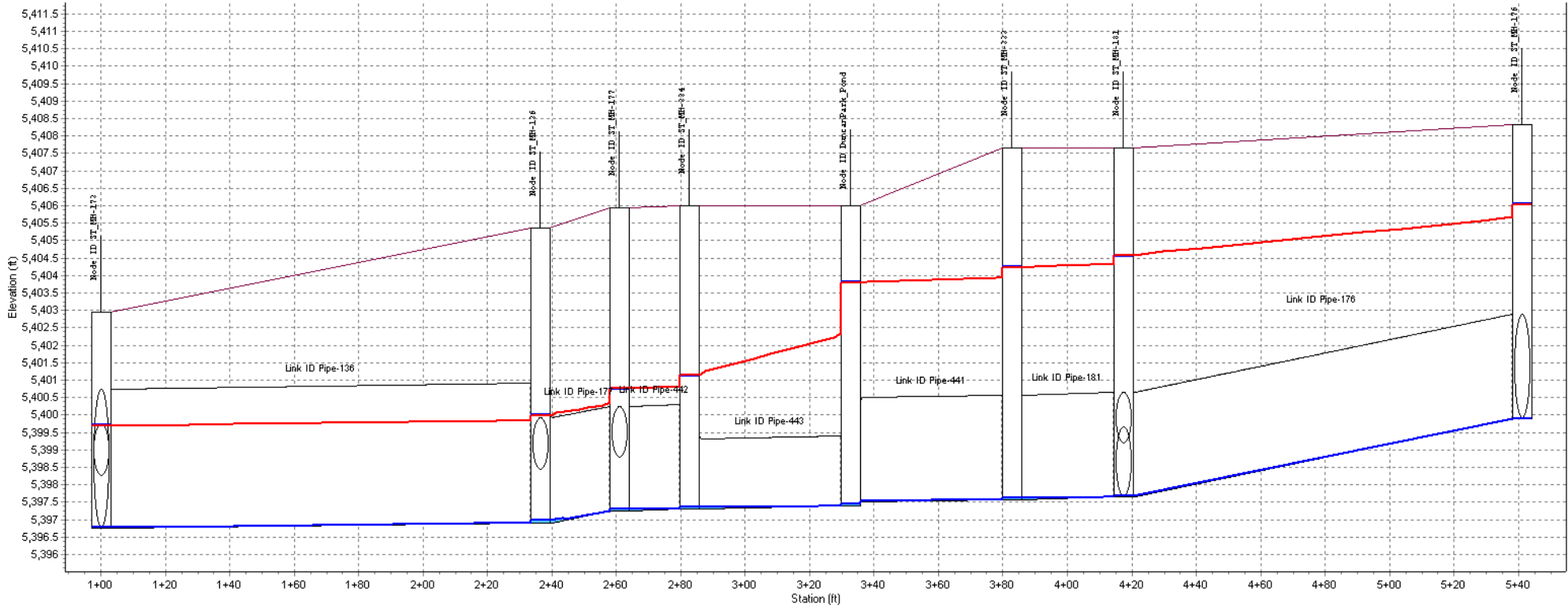


Acoma Area Drainage Study - 25 Year EXISTING
 Duncan Park Pond



Node ID:	ST_MH-173	ST_MH-136	ST_MH-177		ST_MH-181	ST_MH-176
Rim (ft):	5402.94	5405.36	5405.94		5407.66	5408.34
Invert (ft):	5396.75	5396.91	5397.25		5397.66	5399.89
Min Pipe Cover (ft):	2.19	4.45	5.69		7.00	5.45
Max HGL (ft):	5400.59	5401.01	5402.47		5404.49	5406.56
Link ID:	Pipe-136	Pipe-77		Pipe-181		Pipe-176
Length (ft):	136.40	24.43		318.61		123.63
Dia (ft):	4.00	3.00		3.00		3.00
Slope (ft/ft):	0.0012	0.0139		0.0013		0.0180
Up Invert (ft):	5396.91	5397.25		5397.66		5399.89
Dn Invert (ft):	5396.75	5396.91		5397.25		5397.66
Max Q (cfs):	47.16	45.81		39.77		32.72
Max Vel (ft/s):	3.91	6.48		5.63		4.63
Max Depth (ft):	3.91	3.00		3.00		3.00

Acoma Area Drainage Study - 25 Year PROPOSED
Duncan Park Pond



Node ID:	ST_MH-173	ST_MH-136	ST_MH-177	ST_MH-334	DuncanPark_Pond	ST_MH-333	ST_MH-181	ST_MH-176
Rim (ft):	5402.94	5405.36	5405.94	5406.00	5406.00	5407.66	5407.66	5408.34
Invert (ft):	5396.75	5396.91	5397.25	5397.30	5397.40	5397.56	5397.66	5399.89
Min Pipe Cover (ft):	2.19	4.45	5.69	5.70		7.10	7.00	5.45
Max HGL (ft):	5399.69	5400.00	5400.78	5401.15	5403.81	5404.26	5404.62	5406.10
Link ID:	Pipe-136	Pipe-177	Pipe-442	Pipe-443	Pipe-441	Pipe-181	Pipe-176	
Length (ft):	136.40	24.43	21.88	50.00	50.00	34.59	123.63	
Dia (ft):	4.00	3.00	3.00	2.00	3.00	3.00	3.00	
Slope (ft/ft):	0.0012	0.0139	0.0023	0.0020	0.0012	0.0029	0.0180	
Up Invert (ft):	5396.91	5397.25	5397.30	5397.40	5397.56	5397.66	5399.89	
Dn Invert (ft):	5396.75	5396.91	5397.25	5397.30	5397.50	5397.56	5397.66	
Max Q (cfs):	33.77	33.30	30.61	30.61	42.74	42.64	32.23	
Max Vel (ft/s):	3.33	4.71	4.33	9.74	6.51	6.03	4.56	
Max Depth (ft):	3.01	3.00	3.00	2.00	3.00	3.00	3.00	