Appendix L: Hydrology Report

Appendices

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Preliminary Hydrology Study

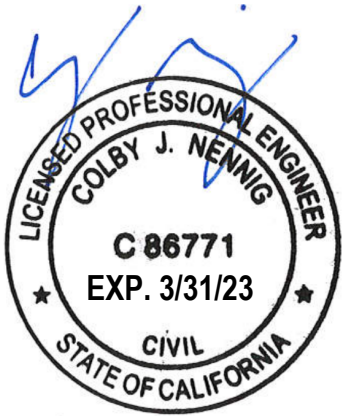
DATE: June 9, 2022

TO: City of Brea

FR: R.A. Smith

CC:

RE: Brea Mall Expansion Preliminary H & H Report



Section 1 – Project Description

The proposed redevelopment is located at 1065 Brea Mall, in Brea California. The property is bound by Randolph Avenue to the west, E Birch Street to the north, State College Boulevard to the East, and Imperial Highway to the south. The existing site was previously developed and the project is proposing demolition of the existing Sears Building and associated pedestrian access. Additionally, the existing A.C. Parking lot is proposed to be demolished. The existing utilities servicing the Sears Building are proposed to be removed, and utilities that are passing through the existing parking lot are proposed to be re-routed adjacent to the proposed redevelopment.

The proposed redevelopment has both a residential and retail component. The Westernmost building is a proposed Fitness Center, which includes outdoor pool area(s). The Fitness Center is serviced by a new at-grade loading area with access from the proposed ring road via service road. The service road also provides access to the trash enclosure for waste management. On the westerly side of the Fitness center, adjacent to Randolph Avenue, there is an existing landscape area that drains onto the project site. To mitigate this area a new v-ditch is provided to capture this run-on and discharge it to the existing public storm drain within Randolph via the existing drain inlet to remain. This existing inlet to remain is located within the existing parking lot to be demolished. The area draining to this v-ditch is entirely pervious landscaping within the landscape setback. See Exhibit within Attachment 3 for reference.

The southernmost building is a multi-level building with 383 proposed residential dwelling units and three parking levels. There is access to the subterranean parking level (residents only) from the Southwest, from to the middle parking level from the North (retail only), and to the upper parking level (residents only) from the East. All ingress/egress to the parking levels will be accessible from the proposed ring road.

The proposed buildings on the Northeasterly side of the redevelopment (within the exiting Sears footprint) consist of a Sporting Goods Store on the upper level, and a series of retail/restaurants on the lower level. Each of the proposed buildings will have their own respective at-grade loading docks. All loading/service areas will be at-grade. Note that Retail B/C and Sporting Goods will abut and connect to the existing mall.

The existing ring road will be reconfigured with a new A.C. Pavement ring road that provides vehicular access to the proposed Fitness Center, Restaurants/Retail Shops, Sporting Goods Store and Residential Complex. It is anticipated that the existing ring road to the south of the redevelopment will be utilized for new utilities and/or utility re-routing. As such, there will be new A.C. Pavement within these trenching locations and it is assumed that the entirety of the existing ring road will be removed and replaced in this location. This new ring road will maintain the existing grades along the southerly side and will drain towards the curb and gutter adjacent to the residential building.

There is a proposed paseo containing hardscape, softscape, and landscaping between Retail Buildings A-D. This area will provide a place for pedestrians to lounge, walk and provides access between the different uses.

There is a new ADS chamber system proposed for infiltration of the Design Capture Volume for water quality. The disturbed area of the ADS Chamber system will not be captured as this area will generally follow existing drainage patterns at full buildout of the project. To capture a sufficient area for mitigation of the chamber footprint, a small portion of the upper level will be reconfigured with new valley gutters and a new inlet and capture existing runoff for a greater area than the chamber system footprint. The ADS Chamber system is provided for both water quality treatment/infiltration and hydromodification. See separate WQMP including water quality and hydromodification design information.

The disturbed area of the project site is approximately 638,312sf (14.65ac). As discussed above, there is a portion of the disturbed area (23,415sf) that will not be treated in lieu of treating a larger portion of the existing parking lot run-on (27,405sf). The hydrologic area for the WQMP and Hydrology report is 642,302sf (14.75ac) as denoted in the subsequent Exhibits and Calculations.

There will be proposed landscaping on the project site within the parking lot areas, the paseo, and adjacent to the proposed buildings. However, at this time the quantity of landscaping/pervious areas has not been finalized. For the purposes of this report, it is conservatively assumed that the entirety of the proposed redevelopment is 100% impervious.

See Existing Hydrology Map (HYD-01) in Attachment 2 and Proposed Hydrology Map (HYD-02) in Attachment 3. Exhibits HYD-03 through HYD-04 in Attachment 3 provide Details of the proposed Chamber System along with the proposed trash full capture filters for the new catch basins.

A summary of the Hydrologic Areas are provided below:

Existing Summary	Hydrologic Area (sf)	Hydrologic Area (ac)	Impervious (sf)	Impervious (ac)	Pervious (sf)	Pervious (ac)
Existing	642,302	14.75	606,975	13.93	35,327	0.81
Area 1 (West)	486,917	11.18	460,137	10.56	26,780	0.61
Area 2 (East)	104,200	2.39	98,469	2.26	5,731	0.13
Area 3 (Central)	51,185	1.18	51,185	1.18	-	0.00

As shown in the Existing Hydrology Map (HYD-01) there are three existing drainage areas that fall within the project footprint. Per the City of Brea Master Plan of Drainage (see Attachment 6) the entirety of the project footprint (including these three drainage areas) falls within the Fullerton Creek Watershed.

Existing Area 1 (West) is conveyed westerly to the public storm drain system within Randolph Avenue, which conveys the runoff southerly towards the downstream Concentration Point identified as “304XG” in the City’s Master Plan of Drainage. Concentration Point “304XG” is located at the intersections of Randolph Avenue and Imperial Highway. Similarly, Existing Area 2 (East) is conveyed southerly towards the storm drain system within the ring road, which runs southwesterly towards the public storm drain line within Imperial Highway. From there the runoff is conveyed westerly to the same downstream Concentration Point identified as “304XG” in the City’s Master Plan of Drainage. From this Concentration Point the runoff is conveyed southerly via public storm drain to an existing vegetated channel south of Imperial Highway and just south of the cul-de-sac on Randolph Avenue. This channel conveys the flow southeasterly under State College Boulevard and ultimately to Fullerton Creek.

Existing Area 3 (Central) consists of the easterly portion of the Sears roof runoff, which drains easterly via roof drain towards the existing public storm drain line (within easement) that runs southerly through the existing mall parking lot and across State College Boulevard. The downstream Point of Concentration of this line is “334K”. From this Point of Concentration the runoff is conveyed southerly and discharges to a vegetated channel south of Imperial Highway. This channel drains to a point of confluence with the aforementioned channel of Areas 1 & 2, just upstream of Concentration Point “348XK”, and ultimately to Fullerton Creek.

See Existing Hydrology Map (HYD-01) in Attachment 2. See also Attachment 5 for the Orange County Drainage Facilities Map, Attachment 6 for applicable sheets from City of Brea Master Plan of Drainage, and Attachment 7 for applicable As-Builts from the City of Brea, Brea Mall, and C-Below.

The proposed hydrologic areas are assumed to be 100% impervious for this purposes of this preliminary drainage study. See Summary below:

Proposed	Hydrologic Area (sf)	Hydrologic Area (ac)	Impervious (sf)	Impervious (ac)	Pervious (sf)	Pervious (ac)
DA #1A	10,550	0.24	10,550	0.24	-	0.00
DA #1B	26,195	0.60	26,195	0.60	-	0.00
DA #1C	87,805	2.02	87,805	2.02	-	0.00
DA #1D	15,920	0.37	15,920	0.37	-	0.00
DA #1E	94,956	2.18	94,956	2.18	-	0.00
DA #1F	46,830	1.08	46,830	1.08	-	0.00
DA #1G	59,930	1.38	59,930	1.38	-	0.00
DA #1H	10,740	0.25	10,740	0.25	-	0.00
DA #1I	64,095	1.47	64,095	1.47	-	0.00
DA #2A	61,900	1.42	61,900	1.42	-	0.00
DA #2B	17,665	0.41	17,665	0.41	-	0.00
DA #2C	135,065	3.10	135,065	3.10	-	0.00
DA #2D	10,651	0.24	10,651	0.24	-	0.00

Proposed DMA #1 (upper and lower hydrologic areas) drains via sheet flow and storm drain pipe to the proposed Infiltration Chamber for treatment and full infiltration of the required Design Capture Volume. See separate WQMP Report for design calculations. In storm events greater than the design storm, the Chamber system will overflow westerly towards the public storm drain system in Randolph Avenue. From there the overflow runoff will follow the existing drainage patterns outlined above to Point of Concentration "304XG" as outlined in the City's Master Plan of Drainage. From there the overflow will ultimately drain to Fullerton Creek. This drainage pattern is consistent with the Existing Area 1 (west) and Existing Area 2 (east) drainage pattern.

The existing Sears roof drain runoff is identified as Existing Area 3 (Central). This roof drain has been removed with the demolition of the Sears Building. As such, there are no proposed flows from the redevelopment that drain to Concentration Point "348XK". However, there is an existing 8" roof drain (near the existing mall service court) that is to be re-routed (as needed) to avoid conflict with the new building.

In addition to the redeveloped area as discussed above, there are three existing pipes containing runoff from existing upstream developments that are to be re-routed, bypass the project site, and discharge directly to the public storm drain system on Randolph Avenue. These pipes are identified in Attachment 3, but are not included in table above as the flows did not originate from the hydrologic area that is being analyzed.

See Proposed Hydrology Map (HYD-02) in Attachment 3.

Section 2 – Hydrology Requirements

This H & H Report is provided to show that the project will satisfy the following hydrology requirements outlined by the Orange County Hydrology Manual and City of Brea Master Plan of Drainage. The methodology discussed in the Orange County Hydrology Manual, and latest addendum, was used to satisfy the requirements below:

1. Rational Methodology Hydrology Analysis of existing and post-development peak 10yr, 25yr, and 100yr storm flow rates, including mitigation measures to reduce peak flows to existing conditions if necessary.

2. Hydraulic Grade Line Analysis for 10yr, 25yr, and 100yr peak flows to ensure Hydraulic Grade Line is below the ground surface to prevent ponding.

Section 3 – Hydrology/Hydraulic Analysis of pre vs. post 100-year Peak Flows

The hydrologic analysis was performed in accordance with the Orange County Rational Methodology outlined in the Orange County Hydrology Manual and its latest addendum. The addendum limits the initial drainage area to 300ft. The rainfall intensity was determined from the appropriate intensity-duration-frequency (IDF) curve for the particular area of study. Orange County uses different IDF curves depending on whether the location is a mountainous or non-mountaneous region. Since this site is below 2,000 in elevation the main precipitation intensities for non-mountainous areas was used. Figure B-3 from the Orange County Hydrology Manual was used for finding the intensities. The Fp used is 0.25 for Soil Group C soils. See applicable Sections from the Hydrology Manual in Attachment 1 of this Report.

As described in Section 1 above and shown in the Proposed Hydrology Exhibit (HYD-02 in Attachment 3) the proposed site contains a series of new storm drain infrastructure. Each pipe run corresponds to a travel time (Tt) which results in a higher time of concentration and a lower intensity. The Manning's Equation was used to calculate the velocity within each pipe. (Note that at this time the full hydrology/hydraulic analysis of each roof drain is not included in this Report as this is a Preliminary Study, and roof drain locations have not been finalized).

Manning Equation:

$$Q = VA \qquad V = \frac{k}{n}\left(\frac{A}{P}\right)^{2/3} S^{1/2}$$

Where k = 1.49
A = Flow Area of the Pipe (sf)
P = Wetted Perimeter (ft)
Q = Discharge Flow Rate (cfs)
S = Slope (ft/ft)
V = Velocity (ft/s)

The travel time can be found by dividing the pipe length by the velocity and multiplying the value by by 60 to get the travel time in minutes:

Tt (min) = [pipe length (ft)] / [velocity (ft/s) * 60 (sec/min)]

In addition to reducing the peak flows another important aspect of the design is to size the storm drain pipes to accommodate the runoff from the 10yr, 25yr, and 100yr peak flows. Using the Manning's Equation above, the peak flows (Q) for the 10yr, 25yr, and 100yr storm were calculated for each proposed drainage area. The pipes were sized for a capacity to bypass peak flows from all three storm events whilst maintaining a minimum velocity of 2.0 ft/s.

Note that all existing pipes onsite are RCP, which correspond to a Manning's n Value of 0.013. The proposed private onsite storm drain lines are HDPE (0.012), and the proposed public bypass line is RCP (0.013).

Drainage Area #1 consists of the “lower” level drainage from the Fitness Center, Retail A-D, as well as the adjacent pavement/hardscape/softscape areas. Drainage Area #1 has been broken into a series of subareas with the upstream area identified as Node 1 on the Proposed Hydrology Exhibit. All flows from Drainage Area #1 drain to the proposed ADS Chamber System for infiltration. The convergence of flows from DA #1 and DA #2 is at Node 10 on the Proposed Hydrology Exhibit.

Drainage Area #2 consists of the “upper” level drainage from the Residential Building, Sporting Goods Building, and adjacent pavement/hardscape/softscape areas. Drainage Area #2 has been broken into a series of subareas with the usptream area identified as Node 11. All flows from Drainage Area #2 drain to the proposed ADS Chamber System for infiltration. The convergence of flows from DA #1 and DA #2 is at Node 10 on the Proposed Hydrology Exhibit.

There is an overflow pipe discharging from the basin that contains the combined flows from Drainage Areas 1 and 2. This overflow pipe drains to the public storm drain line within Randolph Avenue at Node 15 as shown on the Proposed Hydrology Map.

Hydrology Calculations for these drainage areas and subareas were performed using a spreadsheet based on the Hydrology Manual and Methodology as discussed above. The results are depicted in (Attachment 4) and as summarized below:

10yr Peak Hydrology Analysis

10yr Pre-Development					
Rational Analysis	Coefficient, C	Intensity (in/hr)	Area (ac)	Downstream Concentration Point	Q10 (cfs)
Area 1 - West	0.90	3.53	11.18	304XG	40.70
Area 2 -East	0.90	4.06	2.39	304XG	8.71
Area 3 - Central	0.90	4.06	1.18	334K	4.29
Existing Combined Flows to Downstream Concentration Point 304XG					49.41
Existing Combined Flows to Downstream Concentration Point 334K					4.29
10yr Post-Development					
Rational Analysis	Coefficient, C	Intensity (in/hr)	Area (ac)	Downstream Concentration Point	Q10 (cfs)
DA #1 (part of DMA #1)	0.90	2.72	9.57	304XG	31.66
DA #2 (part of DMA #1)	0.90	3.30	5.17	304XG	16.19
Proposed Combined Flows to Downstream Concentration Point 304XG					47.85
Proposed Combined Flows to Downstream Concentration Point 334K					0.00

25yr Peak Hydrology Analysis

25yr Pre-Development					
Rational Analysis	Coefficient, C	Intensity (in/hr)	Area (ac)	Downstream Concentration Point	Q25 (cfs)
Area 1 - West	0.90	4.20	11.18	304XG	48.39
Area 2 -East	0.90	4.82	2.39	304XG	10.36
Area 3 - Central	0.90	4.82	1.18	334K	5.10
Existing Combined Flows to Downstream Concentration Point 304XG					58.75
Existing Combined Flows to Downstream Concentration Point 334K					5.10
25yr Post-Development					
Rational Analysis	Coefficient, C	Intensity (in/hr)	Area (ac)	Downstream Concentration Point	Q25 (cfs)
DA #1 (part of DMA #1)	0.90	3.25	9.57	304XG	37.66
DA #2 (part of DMA #1)	0.90	3.93	5.17	304XG	19.28
Proposed Combined Flows to Downstream Concentration Point 304XG					56.94
Proposed Combined Flows to Downstream Concentration Point 334K					0.00

100yr Peak Hydrology Analysis

100yr Pre-Development					
Rational Analysis	Coefficient, C	Intensity (in/hr)	Area (ac)	Downstream Concentration Point	Q100 (cfs)
Area 1 - West	0.90	5.38	11.18	304XG	62.11
Area 2 -East	0.90	6.19	2.39	304XG	13.29
Area 3 - Central	0.90	6.19	1.18	334K	6.54
Existing Combined Flows to Downstream Concentration Point 304XG					75.40
Existing Combined Flows to Downstream Concentration Point 334K					6.54
100yr Post-Development					
Rational Analysis	Coefficient, C	Intensity (in/hr)	Area (ac)	Downstream Concentration Point	Q100 (cfs)
DA #1 (part of DMA #1)	0.90	4.15	9.57	304XG	48.26
DA #2 (part of DMA #1)	0.90	5.02	5.17	304XG	24.68
Proposed Combined Flows to Downstream Concentration Point 304XG					72.94
Proposed Combined Flows to Downstream Concentration Point 334K					0.00

As depicted above and in Attachment 4 (Orange County Rational Methodology Spreadsheet) the flows to the storm drain system are less in the redeveloped condition than the existing. Note that the redeveloped condition is also assuming 100% impervious area, and has not taken into account the additional storage volume provided by the proposed Chamber System. These calculations will be updated during the Construction Document phase for the Final Hydrology Report accordingly.

Furthermore, the flows ultimately draining to downstream Point of Concentration identified as "304XG" (in the City's Master Plan of Drainage (See Attachments 2, 3, and 5 for location) have been reduced by the following:

- 10yr flows reduced by 1.56cfs at 304XG
    - The City of Brea Master Plan of Drainage identifies a Q10 flow of 521.4cfs at the confluence of Node 304XG which includes Q10 flows from the upstream pipes (Nodes 297X, 303G, Randolph Drain) and the associated sheet flow from Randolph identified as Q10=31.6cfs. Based on the Rational Analysis provided, the flow at this confluence will be reduced to 519.84cfs for the 10 year peak storm.
- 25yr flows reduced by 1.81cfs at 304XG
- 100yr flows reduced by 2.46cfs at 304XG

As the entirety of the redevelopment drains toward Concentration point 304XG, the existing flows draining towards 334K have been removed entirely:

- 10yr flows reduced by 4.29cfs at 334K
- 25yr flows reduced by 5.10cfs at 334K
- 100yr flows reduced by 6.54cfs at 334K

As such, the downstream receiving storm drain systems will not be adversely impacted by the redevelopment. In fact, the proposed redevelopment will reduce flows in the Fullerton Creek Watershed by a total of:

- 10yr flows reduced by 5.85cfs
- 25yr flows reduced by 6.91cfs
- 100yr flows reduced by 9.00cfs

Note that, in reality, the actual reduction of flows will be greater than this after the proposed landscaping is included in the calculations. Furthermore, this study does not include the additional reduction of flows for the volume that will be infiltrated by the proposed ADS Chamber System.

The reduction in flows not only has a positive impact on the downsteam system, but the Fullerton Creek Watershed as a whole. Since flows from the project are being reduced, the net outcomes on the upstream storm drain system is a greater capacity for current tenants and any future development upstream of the project.

Section 4 – Bypass Flows

As shown in the Existing Hydrology Exhibit (Attachment 2), and Proposed Hydrology Exhibit (Attachment 3), there are three existing public storm drain pipes that run through the project site and discharge near the Randolph Avenue Driveway as discussed below. The flows from these three pipes are to be picked up and bypassed, via a public storm drain pipe, around the development to the public storm drain in Randolph Avenue. The manning's equation was used to determine the maximum flows that can be associated with each of the three pipes.

Manning Equation:

$$Q = VA \qquad V = \frac{k}{n}\left(\frac{A}{P}\right)^{2/3} S^{1/2}$$

Where k = 1.49
A = Flow Area of the Pipe (sf)
P = Wetted Perimeter (ft)
Q = Discharge Flow Rate (cfs)
S = Slope (ft/ft)
V = Velocity (ft/s)

Node 20
There is an existing 12" RCP pipe at a slope of 0.45% that is discharging from the service area between the existing Sears and Nordstrom. This discharge pipe is proposed to be re-routed westerly along the north side of Retail A. This connection is identified as Node 20 in Attachments 2 and 3 and has a maximum capacity (Q value) of the following:

Q = (1.49/0.013) * (0.79sf) * (0.25ft^(2/3) * (0.0045ft/ft)^(1/2) = 2.40cfs maximum

The proposed pipe used to re-route these flows from Node 20 is a public 12" RCP pipe with a slope of 0.5%. This proposed pipe has the capacity to bypass the following flow:

Q = (1.49/0.013) * (0.79sf) * (0.25ft^(2/3) * (0.005ft/ft)^(1/2) = 2.53cfs maximum

The bypass pipe has a greater capacity than the maximum flows from Node 20 (2.53cfs > 2.40cfs)

Node 21
There is an existing 24" RCP pipe at a slope of 0.25% that is discharging from the ring road between Nordstrom and the westerly parking structure. This pipe is proposed to be re-routed westerly along the north side of the Fitness Center where it combines with the flows from Node 20. This pipe is identified as Node 21 in Attachments 2 and 3, and has a maximum capacity (Q value) of the following:

Q = (1.49/0.013) * (3.14sf) * (0.5ft^(2/3) * (0.0025ft/ft)^(1/2) = 11.34cfs maximum

If this maximum flow is combined with the maximum flow from node 20, the maximum flow at this location for the bypass pipe is 13.74cfs.

The proposed pipe downstream of this location is a public 30” RCP pipe at 0.5% slope, which has the following capacity:

Q = (1.49/0.013) * (4.91sf) * (0.625ft^(2/3) * (0.005ft/ft)^(1/2) = 29.08cfs maximum

The bypass pipe has a greater capacity than the maximum flows from Node 20+21 (29.08cfs > 13.74cfs)

Node 22

There is an existing 18” RCP pipe at a slope of 2.00% that is discharging from the westerly side of the parking structure adjacent to Randolph Avenue. This pipe is proposed to be re-routed along the westerly side of the Fitness Center where it combines with the flows from Node 20/21. This pipe is identified as Node 22 in Attachments 2 and 3, and has a maximum capacity (Q value) of the following:

Q = (1.49/0.013) * (1.77sf) * (0.375ft^(2/3) * (0.02ft/ft)^(1/2) = 14.90cfs maximum

The proposed pipe downstream of this location is a public 30” RCP pipe at 0.5% slope, which has the following capacity:

Q = (1.49/0.013) * (4.91sf) * (0.625ft^(2/3) * (0.005ft/ft)^(1/2) = 29.08cfs maximum

The bypass pipe has a greater capacity than the maximum flows from Node 20+21+22 (29.08cfs > 28.64cfs)

As such, the proposed bypass pipe has sufficient capacity to bypass the maximum flows from the upstream developments.

Section 5 – Hydraulic Grade Line Analysis

Using the Hydrology Analysis provided in Sections 3 and 4 above, a Hydraulic Grade Line (HGL) Analysis was prepared using the Hydraflow Storm Sewer Extension for Autodesk Civil3D. The hydrology analysis above shows that the proposed pipes have the capacity to bypass the 10yr, 25yr, and 100yr events so it is not expected that the HGL would be above the pipe. However, the HGL Analysis is provided to ensure that the hydraulic grade line is contained beneath the ground surface, and thus to prevent ponding/flooding on the project site.

Attachments 8, 9, and 10 show the HGL Analysis for the 10yr, 25yr, and 100yr events for the proposed pipes discharging to the proposed Chamber System, respectively. The Q values shown at each node correspond to the flows calculated in Attachment 4 based on the Orange County Hydrology Manual. The Plan View, Computations, and Profile depicting the HGL is provided for each. The downstream HGL was set at the crown of the pipe discharging into the proposed chamber system to analyze the worst case scenario. As shown in the Attachments, the HGL does not exceed the ground surface at any location.

Attachments 11, 12, and 13 show the HGL Analysis for the 10yr, 25yr, and 100yr events for the overflow pipe discharging from the Chamber System to the 36” public line in Randolph Avenue. The Q value provided for the overflow is set equal to the combined flows from Drainage Areas #1 and #2. This analysis assumes that the peak flow in to the chamber system is the same as the peak flow out of the chamber and does not account for infiltration or volume storage. The Plan View, Computations, and Profile depicting the HGL is provided for each. The downstream HGL was set at the crown of the pipe discharging into the existing storm drain in Randolph. As shown in the Attachments, the HGL does not exceed the ground surface at any location.

Attachments 14, 15, and 16 show the HGL Analysis for the 10yr, 25yr, and 100yr events for the public bypass pipe connecting to the three existing pipes upstream of the redevelopment. The Q values for the existing upstream pipes were set at the maximum flows calculated in Section 4, and the Q value for the overflow pipe was set at the peak 10yr, 25yr, and 100yr flows, respectively with the downstream HGL set at the crown of the downstream pipe. As shown in the Attachments, the HGL does not exceed the ground surface at any location.

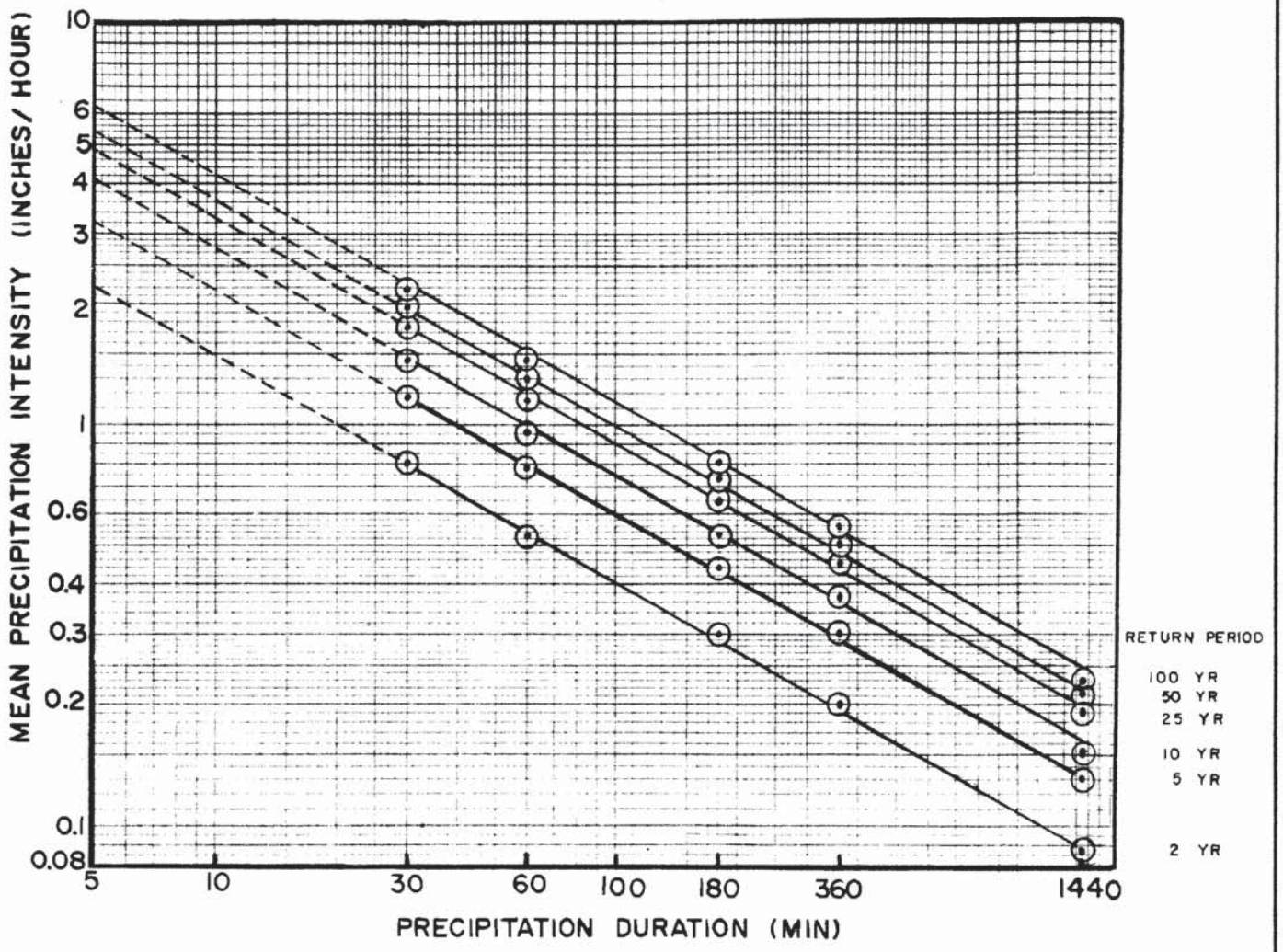
Please reference Attachment 7 for the existing as-built elevations and slopes.

Attachment 1 – Orange County Hydrology Manual Exhibits

Regression Equations: $I(t) = at^b$

(I= Intensity in inches/hour, t= duration in minutes)

Return Frequency (years)	a	b
2	5.702	-0.574
5	7.870	-0.562
10	10.209	-0.573
25	11.995	-0.566
50	13.521	-0.566
100	15.560	-0.573



ORANGE COUNTY

HYDROLOGY MANUAL

MEAN PRECIPITATION INTENSITIES FOR NONMOUNTAINOUS AREAS

Figure B-3

C.6.4. Estimation of Maximum Loss Rates for Pervious Areas, F_p

Table C.2 lists the maximum loss rates (inch/hour), F_p, for pervious area as a function of soil group.

TABLE C.2.

MAXIMUM EFFECTIVE PERVIOUS AREA LOSS RATES (inch/hour), F_p

SOIL GROUP:	A	B	C	D
F_p:	0.40	0.30	0.25	0.20

Table C.2 reflects the model calibration assuming an F_p of 0.30 in/hr. for all the considered catchments and storm return frequencies. This mean value of F_p of 0.30 in/hr. was assigned to Hydrologic Soil Group B due to the actual average soil conditions in the reconstitution study areas. The F_p values for Hydrologic Soil Groups A, C, and D, were assigned to account for the different soil types that may be found in Orange County.

C.6.5. Estimation of Catchment Maximum Loss Rates, F_m

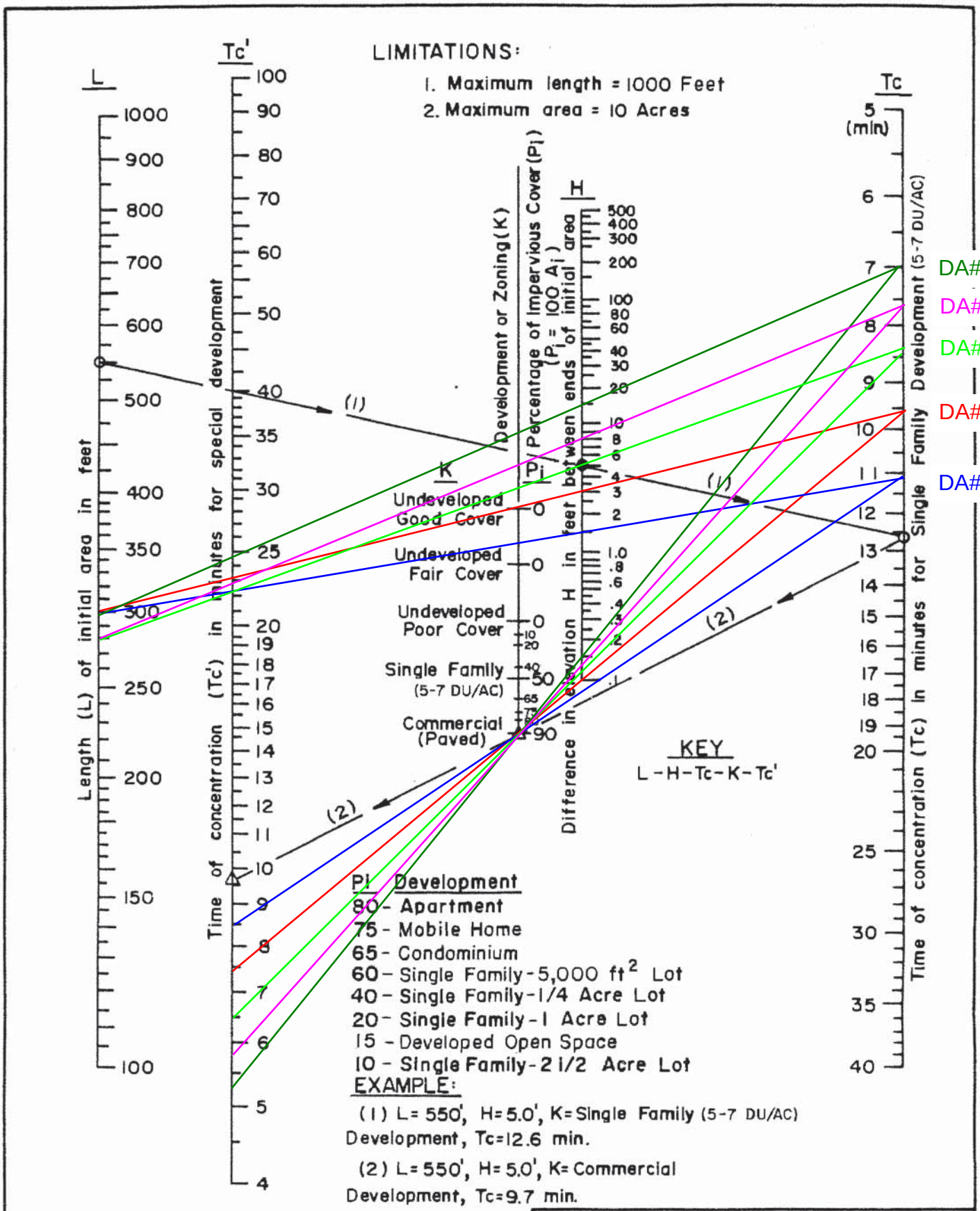
The maximum loss rate selected from Table C.2 applies to the pervious area fraction of the watershed. The loss rate assumed for an impervious surface is 0.0 inch/hour. The maximum loss rate, F_m, for a catchment is therefore given by

$$F_m = a_p F_p \qquad (C.7)$$

where a_p is the pervious area fraction and F_p is the maximum loss rate for the pervious area (Section C.6.4).

Should a catchment contain several F_m values, the composite F_m value is determined as a simple area average of the several F_m values.

Initial Drainage Area limited to 300 ft per Orange County Hydrology Manual Addendum



ORANGE COUNTY
HYDROLOGY MANUAL

TIME OF CONCENTRATION NOMOGRAPH FOR INITIAL SUBAREA

Figure D-1

It is noted that the Tc computation procedure is based upon the summation of an initial subarea time of concentration with the several travel times estimated by normal depth flow-velocities through subsequent subareas.

D.4. INTENSITY-DURATION CURVES

The precipitation intensity-duration curves presented in Section B.3 (Figures B-3 and B-4) are appropriate for the rational method.

D.5. RUNOFF COEFFICIENT

The runoff coefficient (C) is the ratio of rate of runoff to the rate of rainfall at an average intensity (I) when the total drainage area is contributing. The selection of the runoff coefficient depends on rainfall intensity, soil infiltration rate (F_p), and impervious and pervious area fractions (a_i and a_p).

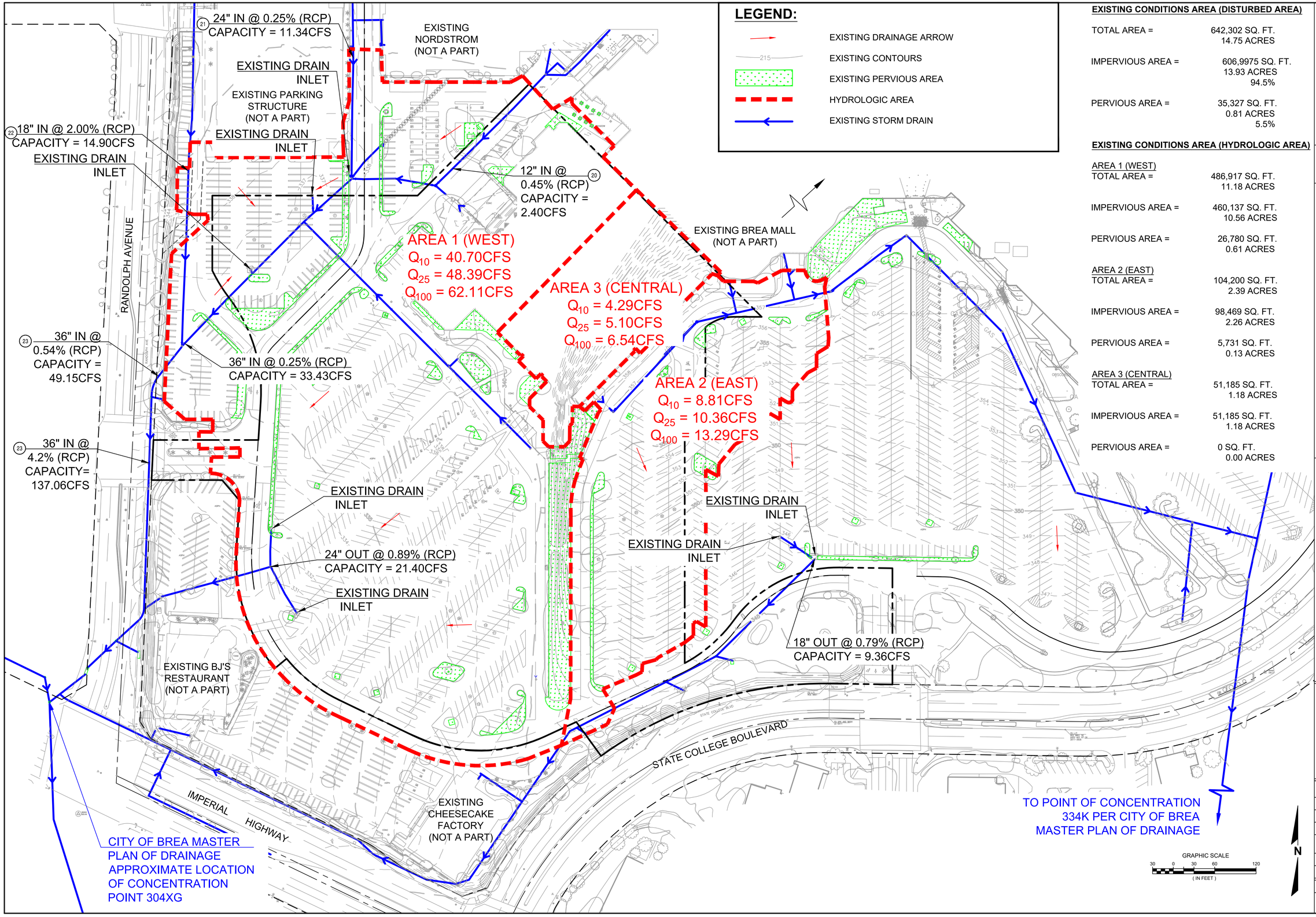
Since one acre-inch/hour is equal to 1.008 cfs, the rational formula is generally assumed to estimate a peak flowrate in cfs. Runoff coefficient curves are developed using the relationship:

$$C = \begin{cases} 0.90\ (a_i + \dfrac{(I - F_p)a_p}{I}), & \text{for I greater than } F_p; \\ 0.90\ a_i, & \text{for I less than or equal to } F_p \end{cases} \qquad (D.3)$$

where the proportion factor of 0.90 is a calibration constant determined by an average fit between the rational method and design storm unit hydrograph (see Section E) peak flow rate estimates, and where

C	=	runoff coefficient
I	=	rainfall intensity (inches/hour)
F_p	=	infiltration rate for pervious areas (inches/hour) (see Section C.6.4)
a_i	=	ratio of impervious area to total area (decimal fraction)
a_p	=	ratio of pervious area to total area (decimal fraction), ($a_p = 1 - a_i$)

Attachment 2 – Existing Hydrology Exhibit



LEGEND:

- EXISTING DRAINAGE ARROW
- EXISTING CONTOURS
- EXISTING PERVIOUS AREA
- HYDROLOGIC AREA
- EXISTING STORM DRAIN

EXISTING CONDITIONS AREA (DISTURBED AREA)

TOTAL AREA =	642,302 SQ. FT. 14.75 ACRES
IMPERVIOUS AREA =	606,9975 SQ. FT. 13.93 ACRES 94.5%
PERVIOUS AREA =	35,327 SQ. FT. 0.81 ACRES 5.5%

EXISTING CONDITIONS AREA (HYDROLOGIC AREA)

AREA 1 (WEST)

TOTAL AREA =	486,917 SQ. FT. 11.18 ACRES
IMPERVIOUS AREA =	460,137 SQ. FT. 10.56 ACRES
PERVIOUS AREA =	26,780 SQ. FT. 0.61 ACRES

AREA 2 (EAST)

TOTAL AREA =	104,200 SQ. FT. 2.39 ACRES
IMPERVIOUS AREA =	98,469 SQ. FT. 2.26 ACRES
PERVIOUS AREA =	5,731 SQ. FT. 0.13 ACRES

AREA 3 (CENTRAL)

TOTAL AREA =	51,185 SQ. FT. 1.18 ACRES
IMPERVIOUS AREA =	51,185 SQ. FT. 1.18 ACRES
PERVIOUS AREA =	0 SQ. FT. 0.00 ACRES

DESCRIPTION

DATE

raSmith
CREATIVITY BEYOND ENGINEERING
8881 Research Drive
Irvine, CA 92618-4236
(949) 872-2378
rasmith.com

BREA MALL EXPANSION
1065 BREA MALL, BREA, CA 92821

EXISTING HYDROLOGY EXHIBIT

NOT FOR CONSTRUCTION

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R.A. Smith, Inc.

DATE: 6/9/22
SCALE: 1" = 60'
JOB NO. 3180011
PROJECT MANAGER: CHRIS T. BRATTY
DESIGNED BY: CJN
CHECKED BY: RMK

SHEET NUMBER
HYD-01

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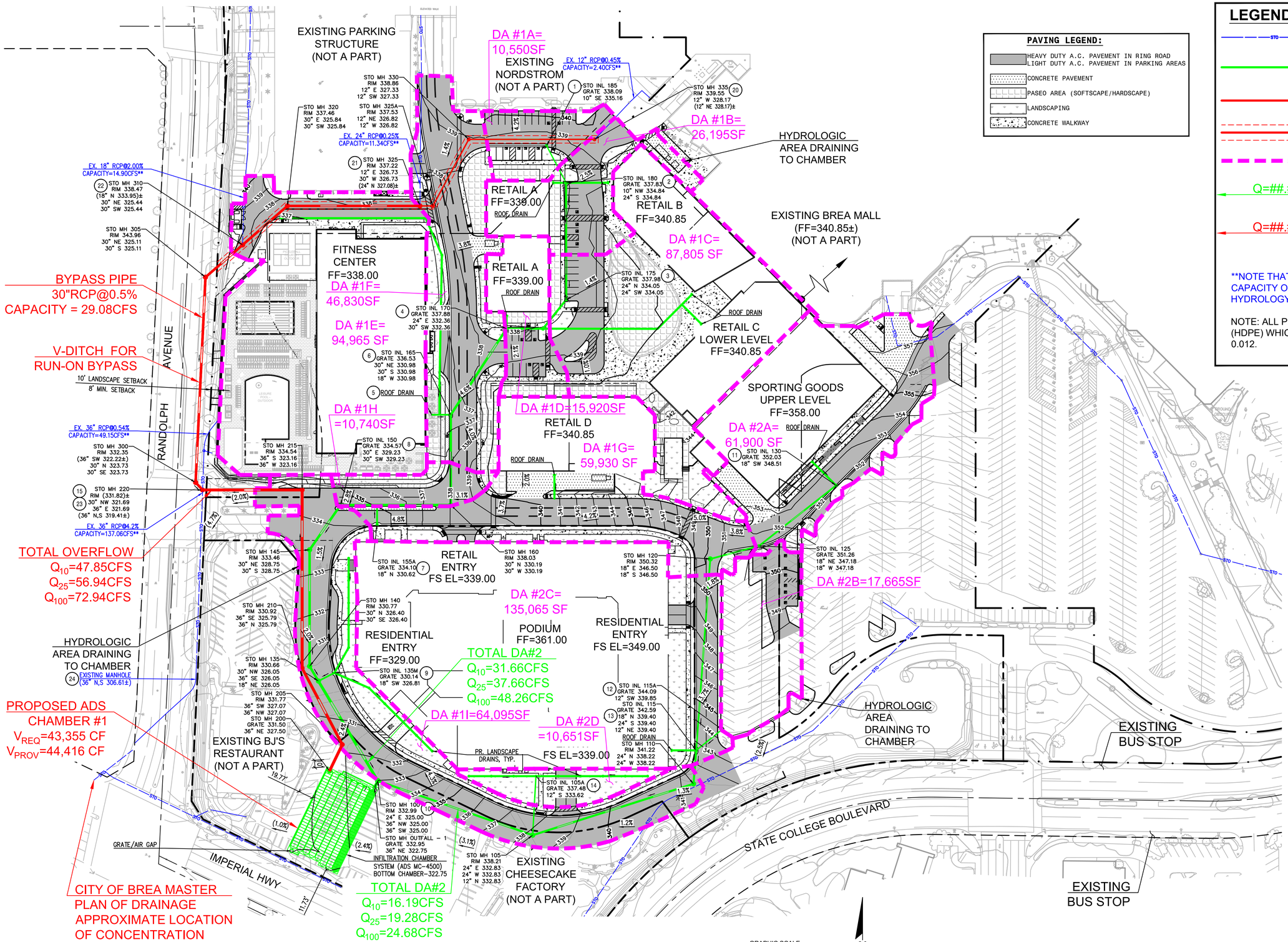
Attachment 3 – Proposed Hydrology Exhibit



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RAS JOB NO. 3180011.03

PROJECT MANAGER: CHRIS T. BRATTY

DESIGNED BY: CJN

CHECKED BY: RMK

BREA MALL AND RESIDENCES AT BREA

1065 Brea Mall, Brea, CA 92821

PROPOSED HYDROLOGY EXHIBIT

raSmith
CREATIVITY BEYOND ENGINEERING
8911 Research Drive
Irvine, CA 92618-4237
(949) 872-2378
rasmith.com

HYD-02

Scale 1" = 60'
Job No. 2018-170
Date 6/9/22

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PROJECT INFORMATION	
ENGINEERED PRODUCT MANAGER	
ADS SALES REP	
PROJECT NO.	

ADS Advanced Drainage Systems, Inc.

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BREA MALL

BREA, CA

MC-4500 STORMTECH CHAMBER SPECIFICATIONS

1. CHAMBERS SHALL BE STORMTECH MC-4500.
2. CHAMBERS SHALL BE ARCH-SHAPED AND SHALL BE MANUFACTURED FROM VIRGIN, IMPACT-MODIFIED POLYPROPYLENE COPOLYMERS.
3. CHAMBERS SHALL MEET THE REQUIREMENTS OF ASTM F2418-16a, "STANDARD SPECIFICATION FOR POLYPROPYLENE (PP) CORRUGATED WALL STORMWATER COLLECTION CHAMBERS" CHAMBER CLASSIFICATION 60x101.
4. CHAMBER ROWS SHALL PROVIDE CONTINUOUS, UNOBSTRUCTED INTERNAL SPACE WITH NO INTERNAL SUPPORTS THAT WOULD IMPEDE FLOW OR LIMIT ACCESS FOR INSPECTION.
5. THE STRUCTURAL DESIGN OF THE CHAMBERS, THE STRUCTURAL BACKFILL, AND THE INSTALLATION REQUIREMENTS SHALL ENSURE THAT THE LOAD FACTORS SPECIFIED IN THE AASHTO LRFD BRIDGE DESIGN SPECIFICATIONS, SECTION 12.12, ARE MET FOR: 1) LONG-DURATION DEAD LOADS AND 2) SHORT-DURATION LIVE LOADS, BASED ON THE AASHTO DESIGN TRUCK WITH CONSIDERATION FOR IMPACT AND MULTIPLE VEHICLE PRESENCES.
6. CHAMBERS SHALL BE DESIGNED, TESTED AND ALLOWABLE LOAD CONFIGURATIONS DETERMINED IN ACCORDANCE WITH ASTM F2787, "STANDARD PRACTICE FOR STRUCTURAL DESIGN OF THERMOPLASTIC CORRUGATED WALL STORMWATER COLLECTION CHAMBERS". LOAD CONFIGURATIONS SHALL INCLUDE: 1) INSTANTANEOUS (<1 MIN) AASHTO DESIGN TRUCK LIVE LOAD ON MINIMUM COVER 2) MAXIMUM PERMANENT (75-YR) COVER LOAD AND 3) ALLOWABLE COVER WITH PARKED (1-WEEK) AASHTO DESIGN TRUCK.
7. REQUIREMENTS FOR HANDLING AND INSTALLATION:
   - TO MAINTAIN THE WIDTH OF CHAMBERS DURING SHIPPING AND HANDLING, CHAMBERS SHALL HAVE INTEGRAL, INTERLOCKING STACKING LUGS.
   - TO ENSURE A SECURE JOINT DURING INSTALLATION AND BACKFILL, THE HEIGHT OF THE CHAMBER JOINT SHALL NOT BE LESS THAN 3".
   - TO ENSURE THE INTEGRITY OF THE ARCH SHAPE DURING INSTALLATION, a) THE ARCH STIFFNESS CONSTANT AS DEFINED IN SECTION 6.2.8 OF ASTM F2418 SHALL BE GREATER THAN OR EQUAL TO 500 LBS/IN/IN. AND b) TO RESIST CHAMBER DEFORMATION DURING INSTALLATION AT ELEVATED TEMPERATURES (ABOVE 73° F / 23° C), CHAMBERS SHALL BE PRODUCED FROM REFLECTIVE GOLD OR YELLOW COLORS.
8. ONLY CHAMBERS THAT ARE APPROVED BY THE SITE DESIGN ENGINEER WILL BE ALLOWED. UPON REQUEST BY THE SITE DESIGN ENGINEER OR OWNER, THE CHAMBER MANUFACTURER SHALL SUBMIT A STRUCTURAL EVALUATION FOR APPROVAL BEFORE DELIVERING CHAMBERS TO THE PROJECT SITE AS FOLLOWS:
   - THE STRUCTURAL EVALUATION SHALL BE SEALED BY A REGISTERED PROFESSIONAL ENGINEER.
   - THE STRUCTURAL EVALUATION SHALL DEMONSTRATE THAT THE SAFETY FACTORS ARE GREATER THAN OR EQUAL TO 1.95 FOR DEAD LOAD AND 1.75 FOR LIVE LOAD, THE MINIMUM REQUIRED BY ASTM F2787 AND BY SECTIONS 3 AND 12.12 OF THE AASHTO LRFD BRIDGE DESIGN SPECIFICATIONS FOR THERMOPLASTIC PIPE.
   - THE TEST DERIVED CREEP MODULUS AS SPECIFIED IN ASTM F2418 SHALL BE USED FOR PERMANENT DEAD LOAD DESIGN EXCEPT THAT IT SHALL BE THE 75-YEAR MODULUS USED FOR DESIGN.
9. CHAMBERS AND END CAPS SHALL BE PRODUCED AT AN ISO 9001 CERTIFIED MANUFACTURING FACILITY.

IMPORTANT - NOTES FOR THE BIDDING AND INSTALLATION OF MC-4500 CHAMBER SYSTEM

1. STORMTECH MC-4500 CHAMBERS SHALL NOT BE INSTALLED UNTIL THE MANUFACTURER'S REPRESENTATIVE HAS COMPLETED A PRE-CONSTRUCTION MEETING WITH THE INSTALLERS.
2. STORMTECH MC-4500 CHAMBERS SHALL BE INSTALLED IN ACCORDANCE WITH THE "STORMTECH MC-3500/MC-4500 CONSTRUCTION GUIDE".
3. CHAMBERS ARE NOT TO BE BACKFILLED WITH A DOZER OR EXCAVATOR SITUATED OVER THE CHAMBERS. STORMTECH RECOMMENDS 3 BACKFILL METHODS:
   - STONESHOOTER LOCATED OFF THE CHAMBER BED.
   - BACKFILL AS ROWS ARE BUILT USING AN EXCAVATOR ON THE FOUNDATION STONE OR SUBGRADE.
   - BACKFILL FROM OUTSIDE THE EXCAVATION USING A LONG BOOM HOE OR EXCAVATOR.
4. THE FOUNDATION STONE SHALL BE LEVELED AND COMPACTED PRIOR TO PLACING CHAMBERS.
5. JOINTS BETWEEN CHAMBERS SHALL BE PROPERLY SEATED PRIOR TO PLACING STONE.
6. MAINTAIN MINIMUM 9" (230 mm) SPACING BETWEEN THE CHAMBER ROWS.
7. INLET AND OUTLET MANIFOLDS MUST BE INSERTED A MINIMUM OF 12" (300 mm) INTO CHAMBER END CAPS.
8. EMBEDMENT STONE SURROUNDING CHAMBERS MUST BE A CLEAN, CRUSHED, ANGULAR STONE MEETING THE AASHTO M43 DESIGNATION OF #3 OR #4.
9. STONE SHALL BE BROUGHT UP EVENLY AROUND CHAMBERS SO AS NOT TO DISTORT THE CHAMBER SHAPE. STONE DEPTHS SHOULD NEVER DIFFER BY MORE THAN 12" (300 mm) BETWEEN ADJACENT CHAMBER ROWS.
10. STONE MUST BE PLACED ON THE TOP CENTER OF THE CHAMBER TO ANCHOR THE CHAMBERS IN PLACE AND PRESERVE ROW SPACING.
11. THE CONTRACTOR MUST REPORT ANY DISCREPANCIES WITH CHAMBER FOUNDATION MATERIAL BEARING CAPACITIES TO THE SITE DESIGN ENGINEER.
12. ADS RECOMMENDS THE USE OF "FLEXSTORM CATCH IT" INSERTS DURING CONSTRUCTION FOR ALL INLETS TO PROTECT THE SUBSURFACE STORMWATER MANAGEMENT SYSTEM FROM CONSTRUCTION SITE RUNOFF.

NOTES FOR CONSTRUCTION EQUIPMENT

1. STORMTECH MC-4500 CHAMBERS SHALL BE INSTALLED IN ACCORDANCE WITH THE "STORMTECH MC-3500/MC-4500 CONSTRUCTION GUIDE".
2. THE USE OF EQUIPMENT OVER MC-4500 CHAMBERS IS LIMITED:
   - NO EQUIPMENT IS ALLOWED ON BARE CHAMBERS.
   - NO RUBBER TIRED LOADER, DUMP TRUCK, OR EXCAVATORS ARE ALLOWED UNTIL PROPER FILL DEPTHS ARE REACHED IN ACCORDANCE WITH THE "STORMTECH MC-3500/MC-4500 CONSTRUCTION GUIDE".
   - WEIGHT LIMITS FOR CONSTRUCTION EQUIPMENT CAN BE FOUND IN THE "STORMTECH MC-3500/MC-4500 CONSTRUCTION GUIDE".
3. FULL 36" (900 mm) OF STABILIZED COVER MATERIALS OVER THE CHAMBERS IS REQUIRED FOR DUMP TRUCK TRAVEL OR DUMPING.

USE OF A DOZER TO PUSH EMBEDMENT STONE BETWEEN THE ROWS OF CHAMBERS MAY CAUSE DAMAGE TO CHAMBERS AND IS NOT AN ACCEPTABLE BACKFILL METHOD. ANY CHAMBERS DAMAGED BY USING THE "DUMP AND PUSH" METHOD ARE NOT COVERED UNDER THE STORMTECH STANDARD WARRANTY.

CONTACT STORMTECH AT 1-888-892-2694 WITH ANY QUESTIONS ON INSTALLATION REQUIREMENTS OR WEIGHT LIMITS FOR CONSTRUCTION EQUIPMENT.

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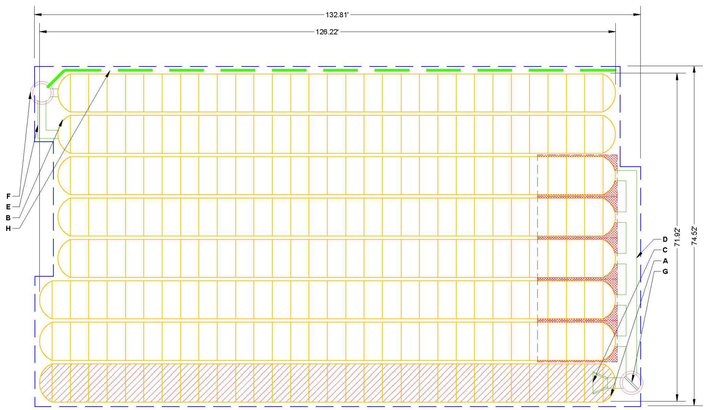
PROPOSED LAYOUT		CONCEPTUAL ELEVATIONS	
235	STORMTECH MC-4500 CHAMBERS	MAXIMUM ALLOWABLE GRADE (TOP OF PAVEMENT/UNPAVED):	13.00
16	STORMTECH MC-4500 END CAPS	MINIMUM ALLOWABLE GRADE (UNPAVED WITH TRAFFIC):	8.50
18	STONE ABOVE (in)	MINIMUM ALLOWABLE GRADE (UNPAVED NO TRAFFIC):	8.00
12	STONE BELOW (in)	MINIMUM ALLOWABLE GRADE (TOP OF RIGID CONCRETE PAVEMENT):	8.00
40	STONE VOID	MINIMUM ALLOWABLE GRADE (BASE OF FLEXIBLE PAVEMENT):	8.00
44416	INSTALLED SYSTEM VOLUME (CF) (PERIMETER STONE INCLUDED) (COVER STONE INCLUDED) (BASE STONE INCLUDED)	TOP OF STONE:	7.50
		TOP OF MC-4500 CHAMBER:	6.00
		24" x 24" BOTTOM MANIFOLD INVERT:	1.19
		24" ISOLATOR ROW PLUS INVERT:	1.19
9873	SYSTEM AREA (SF)	18" x 18" BOTTOM MANIFOLD INVERT:	1.16
422.7	SYSTEM PERIMETER (ft)	18" BOTTOM CONNECTION INVERT:	1.16
		BOTTOM OF MC-4500 CHAMBER:	1.00
		UNDERDRAIN INVERT:	0.00
		BOTTOM OF STONE:	0.00

PART TYPE	ITEM ON LAYOUT	DESCRIPTION	*INVERT ABOVE BASE OF CHAMBER INVERT*	MAX FLOW
PREFABRICATED END CAP	A	24" BOTTOM PARTIAL CUT END CAP, PART#: MC4500IEPP24B / TYP OF ALL 24" BOTTOM CONNECTIONS AND ISOLATOR PLUS ROWS.	2.26"	
PREFABRICATED END CAP	B	18" BOTTOM PARTIAL CUT END CAP, PART#: MC4500IEPP18B / TYP OF ALL 18" BOTTOM CONNECTIONS	1.97"	
	C	INSTALL FLAMP ON 24" ACCESS PIPE / PART#: MC450024RAMP		
	D	MANIFOLD	2.26"	
	E	MANIFOLD	1.97"	
	F	CONCRETE STRUCTURE		8.0 CFS OUT
	G	CONCRETE STRUCTURE (DESIGN BY ENGINEER / PROVIDED BY OTHERS)		41.5 CFS IN
	H	WIWEIR		
UNDERDRAIN		6" ADS N-12 DUAL WALL PERFORATED HDPE UNDERDRAIN		



ISOLATOR ROW PLUS (SEE DETAIL)

PLACE MINIMUM 17.50' OF ADSPLUS175 WOVEN GEOTEXTILE OVER BEDDING STONE AND UNDERNEATH CHAMBER FEET FOR SCOUR PROTECTION AT ALL CHAMBER INLET ROWS

BED LIMITS

NOTES

- MANIFOLD SIZE TO BE DETERMINED BY SITE DESIGN ENGINEER. SEE TECH NOTE #8.32 FOR MANIFOLD SIZING GUIDANCE.
- DUE TO THE ADAPTATION OF THIS CHAMBER SYSTEM TO SPECIFIC SITE AND DESIGN CONSTRAINTS, IT MAY BE NECESSARY TO CUT AND COUPLE ADDITIONAL PIPE TO STANDARD MANIFOLD COMPONENTS IN THE FIELD.
- THE SITE DESIGN ENGINEER MUST REVIEW ELEVATIONS AND IF NECESSARY ADJUST GRADING TO ENSURE THE CHAMBER COVER REQUIREMENTS ARE MET.
- THIS CHAMBER SYSTEM WAS DESIGNED WITHOUT SITE-SPECIFIC INFORMATION ON SOIL CONDITIONS OR BEARING CAPACITY. THE SITE DESIGN ENGINEER IS RESPONSIBLE FOR DETERMINING THE SUITABILITY OF THE SOIL AND PROVIDING THE BEARING CAPACITY OF THE INSITU SOILS. THE BASE STONE DEPTH MAY BE INCREASED OR DECREASED ONCE THIS INFORMATION IS PROVIDED.
- **NOT FOR CONSTRUCTION:** THIS LAYOUT IS FOR DIMENSIONAL PURPOSES ONLY TO PROVE CONCEPT & THE REQUIRED STORAGE VOLUME CAN BE ACHIEVED ON SITE.

BREA MALL
BREA, CA
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PROJECT #:
DRAWN: CN
CHECKED: N/A

REV	DRW	CHK	DESCRIPTION

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1-800-733-7473

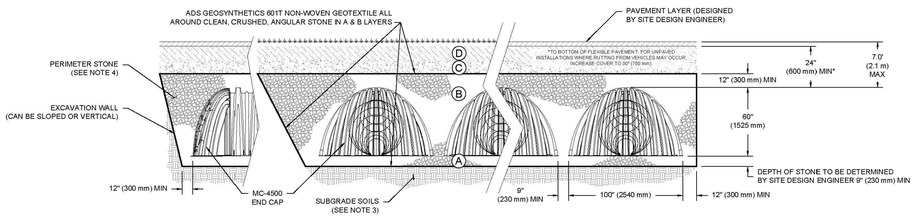
0 15' 30'

SHEET
2 OF 5

ACCEPTABLE FILL MATERIALS: STORMTECH MC-4500 CHAMBER SYSTEMS

	MATERIAL LOCATION	DESCRIPTION	AASHTO MATERIAL CLASSIFICATIONS	COMPACTION / DENSITY REQUIREMENT
D	**FINAL FILL:** FILL MATERIAL FOR LAYER 'D' STARTS FROM THE TOP OF THE 'C' LAYER TO THE BOTTOM OF FLEXIBLE PAVEMENT OR UNPAVED FINISHED GRADE ABOVE. NOTE THAT PAVEMENT SUBBASE MAY BE PART OF THE 'D' LAYER.	ANY SOIL/ROCK MATERIALS, NATIVE SOILS, OR PER ENGINEER'S PLANS. CHECK PLANS FOR PAVEMENT SUBGRADE REQUIREMENTS.	N/A	PREPARE PER SITE DESIGN ENGINEER'S PLANS. PAVED INSTALLATIONS MAY HAVE STRINGENT MATERIAL AND PREPARATION REQUIREMENTS.
C	**INITIAL FILL:** FILL MATERIAL FOR LAYER 'C' STARTS FROM THE TOP OF THE EMBEDMENT STONE ('B' LAYER) TO 24" (600 mm) ABOVE THE TOP OF THE CHAMBER. NOTE THAT PAVEMENT SUBBASE MAY BE A PART OF THE 'C' LAYER.	GRANULAR WELL-GRADED SOIL/AGGREGATE MIXTURES, <35% FINES OR PROCESSED AGGREGATE. MOST PAVEMENT SUBBASE MATERIALS CAN BE USED IN LIEU OF THIS LAYER.	AASHTO M145[4] A-1, A-2-4, A-3 OR AASHTO M43[4] 3, 357, 4, 467, 5, 56, 57, 6, 67, 68, 7, 78, 8, 89, 9, 10	BEGIN COMPACTIONS AFTER 24" (600 mm) OF MATERIAL OVER THE CHAMBERS IS REACHED. COMPACT ADDITIONAL LAYERS IN 12" (300 mm) MAX LIFTS TO A MIN. 95% PROCTOR DENSITY FOR WELL GRADED MATERIAL AND 95% RELATIVE DENSITY FOR PROCESSED AGGREGATE MATERIALS.
B	**EMBEDMENT STONE:** FILL SURROUNDING THE CHAMBERS FROM THE FOUNDATION STONE ('A' LAYER) TO THE 'C' LAYER ABOVE.	CLEAN, CRUSHED, ANGULAR STONE	AASHTO M43[4] 3, 4	NO COMPACTION REQUIRED.
A	**FOUNDATION STONE:** FILL BELOW CHAMBERS FROM THE SUBGRADE UP TO THE FOOT (BOTTOM) OF THE CHAMBER.	CLEAN, CRUSHED, ANGULAR STONE	AASHTO M43[4] 3, 4	PLATE COMPACT OR ROLL TO ACHIEVE A FLAT SURFACE.[2,3]

PLEASE NOTE:
1. THE LISTED AASHTO DESIGNATIONS ARE FOR GRADATIONS ONLY. THE STONE MUST ALSO BE CLEAN, CRUSHED, ANGULAR. FOR EXAMPLE, A SPECIFICATION FOR #4 STONE WOULD STATE: "CLEAN, CRUSHED, ANGULAR NO. 4 (AASHTO M43) STONE".
2. STORMTECH COMPACTION REQUIREMENTS ARE MET FOR 'A' LOCATION MATERIALS WHEN PLACED AND COMPACTED IN 9" (230 mm) (MAX) LIFTS USING TWO FULL COVERAGES WITH A VIBRATORY COMPACTOR.
3. WHERE INFILTRATION SURFACES MAY BE COMPROMISED BY COMPACTION, FOR STANDARD DESIGN LOAD CONDITIONS, A FLAT SURFACE MAY BE ACHIEVED BY RAKING OR DRAGGING WITHOUT COMPACTION EQUIPMENT. FOR SPECIAL LOAD DESIGNS, CONTACT STORMTECH FOR COMPACTION REQUIREMENTS.
4. ONCE LAYER 'C' IS PLACED, ANY SOIL/MATERIAL CAN BE PLACED IN LAYER 'D' UP TO THE FINISHED GRADE. MOST PAVEMENT SUBBASE SOILS CAN BE USED TO REPLACE THE MATERIAL REQUIREMENTS OF LAYER 'C' OR 'D' AT THE SITE DESIGN ENGINEER'S DISCRETION.



NOTES:

1. CHAMBERS SHALL MEET THE REQUIREMENTS OF ASTM F2418-16a "STANDARD SPECIFICATION FOR POLYPROPYLENE (PP) CORRUGATED WALL STORMWATER COLLECTION CHAMBERS" CHAMBER CLASSIFICATION 60x101
2. MC-4500 CHAMBERS SHALL BE DESIGNED IN ACCORDANCE WITH ASTM F2787 "STANDARD PRACTICE FOR STRUCTURAL DESIGN OF THERMOPLASTIC CORRUGATED WALL STORMWATER COLLECTION CHAMBERS".
3. THE SITE DESIGN ENGINEER IS RESPONSIBLE FOR ASSESSING THE BEARING RESISTANCE (ALLOWABLE BEARING CAPACITY) OF THE SUBGRADE SOILS AND THE DEPTH OF FOUNDATION STONE WITH CONSIDERATION FOR THE RANGE OF EXPECTED SOIL MOISTURE CONDITIONS.
4. PERIMETER STONE MUST BE EXTENDED HORIZONTALLY TO THE EXCAVATION WALL FOR BOTH VERTICAL AND SLOPED EXCAVATION WALLS.
5. REQUIREMENTS FOR HANDLING AND INSTALLATION:
   - TO MAINTAIN THE WIDTH OF CHAMBERS DURING SHIPPING AND HANDLING, CHAMBERS SHALL HAVE INTEGRAL, INTERLOCKING STACKING LUGS.
   - TO ENSURE A SECURE JOINT DURING INSTALLATION AND BACKFILL, THE HEIGHT OF THE CHAMBER JOINT SHALL NOT BE LESS THAN 3".
   - TO ENSURE THE INTEGRITY OF THE ARCH SHAPE DURING INSTALLATION, a) THE ARCH STIFFNESS CONSTANT AS DEFINED IN SECTION 6.2.8 OF ASTM F2418 SHALL BE GREATER THAN OR EQUAL TO 500 LBS/IN/IN. AND b) TO RESIST CHAMBER DEFORMATION DURING INSTALLATION AT ELEVATED TEMPERATURES (ABOVE 73° F / 23° C), CHAMBERS SHALL BE PRODUCED FROM REFLECTIVE GOLD OR YELLOW COLORS.

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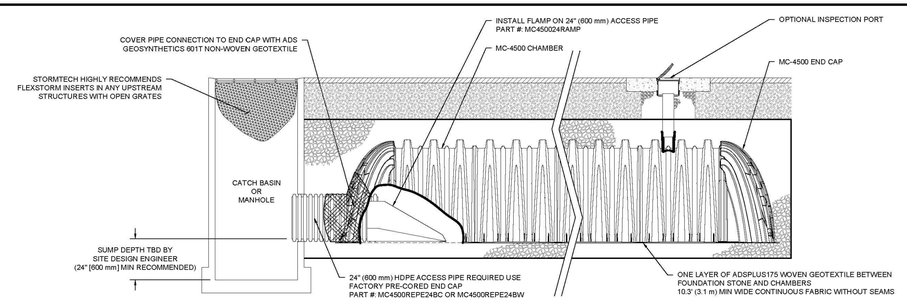

MC-4500 ISOLATOR ROW PLUS DETAIL
NTS

INSPECTION & MAINTENANCE

STEP 1) INSPECT ISOLATOR ROW PLUS FOR SEDIMENT
- A. INSPECTION PORTS (IF PRESENT)
  - A.1. REMOVE/OPEN LID ON NYLOPLAST INLINE DRAIN
  - A.2. REMOVE AND CLEAN FLEXSTORM FILTER IF INSTALLED
  - A.3. USING A FLASHLIGHT AND STADIA ROD, MEASURE DEPTH OF SEDIMENT AND RECORD ON MAINTENANCE LOG
  - A.4. LOWER A CAMERA INTO ISOLATOR ROW PLUS FOR VISUAL INSPECTION OF SEDIMENT LEVELS (OPTIONAL)
  - A.5. IF SEDIMENT IS AT, OR ABOVE, 3" (80 mm) PROCEED TO STEP 2. IF NOT, PROCEED TO STEP 3.
- B. ALL ISOLATOR PLUS ROWS
  - B.1. REMOVE COVER FROM STRUCTURE AT UPSTREAM END OF ISOLATOR ROW PLUS
  - B.2. USING A FLASHLIGHT, INSPECT DOWN THE ISOLATOR ROW PLUS THROUGH OUTLET PIPE
    - i) MIRRORS ON POLES OR CAMERAS MAY BE USED TO AVOID A CONFINED SPACE ENTRY
    - ii) FOLLOW OSHA REGULATIONS FOR CONFINED SPACE ENTRY IF ENTERING MANHOLE
  - B.3. IF SEDIMENT IS AT, OR ABOVE, 3" (80 mm) PROCEED TO STEP 2. IF NOT, PROCEED TO STEP 3.

STEP 2) CLEAN OUT ISOLATOR ROW PLUS USING THE JETVAC PROCESS
- A. A FIXED CULVERT CLEANING NOZZLE WITH REAR FACING SPREAD OF 45° (1.1 m) OR MORE IS PREFERRED
- B. APPLY MULTIPLE PASSES OF JETVAC UNTIL BACKFLUSH WATER IS CLEAN
- C. VACUUM STRUCTURE SUMP AS REQUIRED

STEP 3) REPLACE ALL COVERS, GRATES, FILTERS, AND LIDS; RECORD OBSERVATIONS AND ACTIONS.

STEP 4) INSPECT AND CLEAN BASINS AND MANHOLES UPSTREAM OF THE STORMTECH SYSTEM.

NOTES

1. INSPECT EVERY 6 MONTHS DURING THE FIRST YEAR OF OPERATION. ADJUST THE INSPECTION INTERVAL BASED ON PREVIOUS OBSERVATIONS OF SEDIMENT ACCUMULATION AND HIGH WATER ELEVATIONS.
2. CONDUCT JETTING AND VACTORING ANNUALLY OR WHEN INSPECTION SHOWS THAT MAINTENANCE IS NECESSARY.

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REV	DRW	CHK	DESCRIPTION

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StormTech® Chamber System
888-892-2694 | WWW.STORMTECH.COM

4640 TRUEMAN BLVD
HILLIARD, OHIO 43026
1-800-733-7473

SHEET
4 OF 5

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RAS JOB NO. 3180011.03

PROJECT MANAGER: CHRIS T. BRATTY

DESIGNED BY: CJN

CHECKED BY: RMK

BREA MALL AND RESIDENCES AT BREA

1065 Brea Mall, Brea, CA 92821

HYDROLOGY DETAILS

raSmith
CREATIVITY BEYOND ENGINEERING
8911 Research Drive
Irvine, CA 92618-4237
(949) 872-2378
rasmith.com

HYD-03

Scale AS SHOWN
Job No. 2018-170
Date 6/9/22

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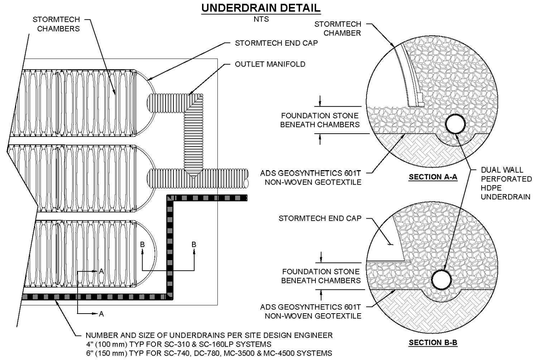
UNDERDRAIN DETAIL

NTS



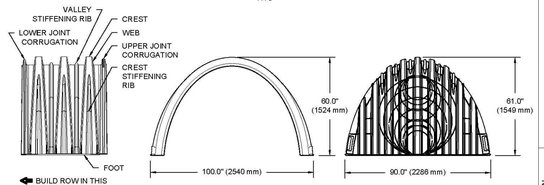
SECTION A-A

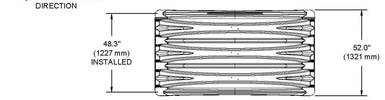
SECTION B-B

NUMBER AND SIZE OF UNDERDRAINS PER SITE DESIGN ENGINEER
4" (100 mm) TYP FOR SC-310 & SC-160LP SYSTEMS
6" (150 mm) TYP FOR SC-740, DC-780, MC-3500 & MC-4500 SYSTEMS

MC-4500 TECHNICAL SPECIFICATION

NTS





NOMINAL CHAMBER SPECIFICATIONS

SIZE (W X H X INSTALLED LENGTH)	100.0" X 60.0" X 48.3"	(2540 mm X 1524 mm X 1227 mm)
CHAMBER STORAGE	106.5 CUBIC FEET	(3.01 m³)
MINIMUM INSTALLED STORAGE*	162.6 CUBIC FEET	(4.60 m³)
WEIGHT (NOMINAL)	125.0 lbs.	(56.7 kg)

NOMINAL END CAP SPECIFICATIONS

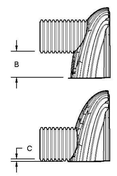
SIZE (W X H X INSTALLED LENGTH)	90.0" X 61.0" X 32.8"	(2286 mm X 1549 mm X 833 mm)
END CAP STORAGE	39.5 CUBIC FEET	(1.12 m³)
MINIMUM INSTALLED STORAGE*	115.3 CUBIC FEET	(3.26 m³)
WEIGHT (NOMINAL)	90 lbs.	(40.8 kg)

*ASSUMES 12" (305 mm) STONE ABOVE, 9" (229 mm) STONE FOUNDATION AND BETWEEN CHAMBERS, 12" (305 mm) STONE PERIMETER IN FRONT OF END CAPS AND 40% STONE POROSITY.

PARTIAL CUT HOLES AT BOTTOM OF END CAP FOR PART NUMBERS ENDING WITH "B"
PARTIAL CUT HOLES AT TOP OF END CAP FOR PART NUMBERS ENDING WITH "T"
END CAPS WITH A PREFABRICATED WELDED STUB END WITH "W"

PART #	STUB	B	C
MC4500IEPP06T	6" (150 mm)	42.54" (1081 mm)	---
MC4500IEPP06B		---	0.86" (22 mm)
MC4500IEPP08T	8" (200 mm)	40.50" (1029 mm)	---
MC4500IEPP08B		---	1.01" (26 mm)
MC4500IEPP10T	10" (250 mm)	38.37" (975 mm)	---
MC4500IEPP10B		---	1.33" (34 mm)
MC4500IEPP12T	12" (300 mm)	35.69" (907 mm)	---
MC4500IEPP12B		---	1.55" (39 mm)
MC4500IEPP15T	15" (375 mm)	32.72" (831 mm)	---
MC4500IEPP15B		---	1.70" (43 mm)
MC4500IEPP18T	18" (450 mm)	29.36" (746 mm)	---
MC4500IEPP18TW			
MC4500IEPP18B		---	1.97" (50 mm)
MC4500IEPP18BW			
MC4500IEPP24T	24" (600 mm)	23.05" (585 mm)	---
MC4500IEPP24TW			
MC4500IEPP24B		---	2.26" (57 mm)
MC4500IEPP24BW			
MC4500IEPP30BW	30" (750 mm)	---	2.95" (75 mm)
MC4500IEPP36BW	36" (900 mm)	---	3.25" (83 mm)
MC4500IEPP42BW	42" (1050 mm)	---	3.55" (90 mm)

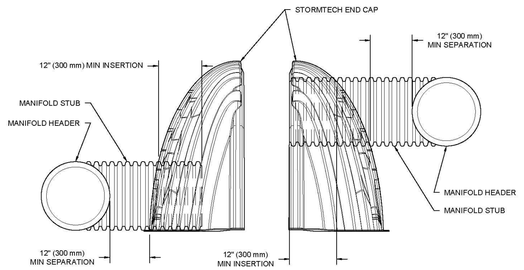
NOTE: ALL DIMENSIONS ARE NOMINAL



CUSTOM PARTIAL CUT INVERTS ARE AVAILABLE UPON REQUEST. INVENTORIED MANIFOLDS INCLUDE 12-24" (300-600 mm) SIZE ON SIZE AND 15-48" (375-1200 mm) ECCENTRIC MANIFOLDS. CUSTOM INVERT LOCATIONS ON THE MC-4500 END CAP CUT IN THE FIELD ARE NOT RECOMMENDED FOR PIPE SIZES GREATER THAN 10" (250 mm). THE INVERT LOCATION IN COLUMN 'B' ARE THE HIGHEST POSSIBLE FOR THE PIPE SIZE.

MC-SERIES END CAP INSERTION DETAIL

NTS



NOTE: MANIFOLD STUB MUST BE LAID HORIZONTAL FOR A PROPER FIT IN END CAP OPENING.

BREA MALL
BREA, CA

DATE: | DRAWN: CN | PROJECT #: | CHECKED: IVA

REV.	DRW.	CHK	DESCRIPTION

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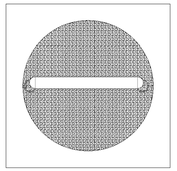
SHEET 5 OF 5

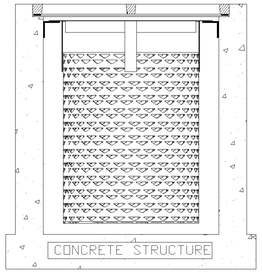
THIS DRAWING HAS BEEN PREPARED BASED ON INFORMATION PROVIDED TO ADS UNDER THE DIRECTION OF THE SITE DESIGN ENGINEER OF RECORD PROJECT REPRESENTATIVE. THE SITE DESIGN ENGINEER SHALL REVIEW THIS DRAWING PRIOR TO CONSTRUCTION. IT IS THE ULTIMATE RESPONSIBILITY OF THE SITE DESIGN ENGINEER TO ENSURE THAT THE SYSTEM LAYOUT MEETS ALL APPLICABLE REGULATIONS AND PROJECT REQUIREMENTS.

BIO CLEAN FULL CAPTURE FILTER

FOR USE IN GRATE INLETS

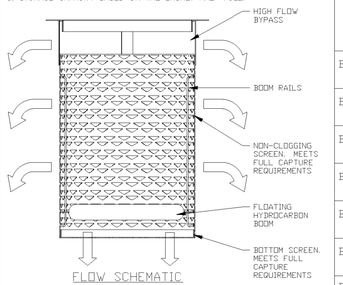


TOP VIEW



NOTES:

1. ALL HARDWARE, FLANGE, FRAME, SCREENS SHALL BE STAINLESS STEEL
2. HYDROCARBON BOOM SHALL BE 2" DIAMETER AND CONNECTED, MECHANICALLY TO THE FILTER FRAME WITH RAILS ALLOWING IT TO FLOAT ON THE WATER SURFACE REGARDLESS OF HEIGHT
3. SEE PERFORMANCE REPORTS IN MANUFACTURES SPECIFICATIONS.
4. OTHER STANDARD AND CUSTOM MODEL SIZES AVAILABLE – CONTACT BIO CLEAN FOR MORE INFORMATION.
5. BASED ON 37% OPEN AREA.
6. CONSIDERS A SAFETY FACTOR OF 2.0.
7. CONSIDERS A LOCAL DEPRESSION PONDING DEPTH OF 6 INCHES.
8. STORAGE CAPACITY BASED ON THE BASKET HALF FULL.



FLOW SCHEMATIC

MODEL #	TREATMENT FLOW (CFS)	BYPASS FLOW (CFS)	SOLIDS STORAGE CAPACITY (CF)
BC-GRATE-FC 12-12-12	1.55	1.55	0.27
BC-GRATE-FC 18-18-18	4.32	3.68	1.05
BC-GRATE-FC 24-24-24	7.67	4.83	2.41
BC-GRATE-FC 30-30-24	12.97	6.21	3.98
BC-GRATE-FC 25-38-24	13.53	6.59	4.16
BC-GRATE-FC 36-36-24	19.64	7.60	5.94
BC-GRATE-FC 48-48-18	25.59	10.13	7.92

DRAWING: BIO CLEAN GRATE INLET FILTER DETAILS | MEETS FULL CAPTURE REQUIREMENTS
TYPICAL MODEL DETAIL
WARRANTY: 5 YEAR MANUFACTURERS | PROJECT:

BIO CLEAN ENVIRONMENTAL SERVICES, INC.
398 VIA EL CENTRO, OCEANSIDE CA 92058
PHONE: 760-433-7640 FAX: 760-433-3176

DATE: 10/10/17 | SCALE: 0" = 1'S
DRAFTER: M.C.P. | UNITS = INCHES

REVISIONS: | DATE:
REVISIONS: | DATE:
REVISIONS: | DATE:
REVISIONS: | DATE:

Bio Clean
A Forterra Company

PAGE 1

NOTE:

ALL DRAIN INLETS THAT DISCHARGE INTO AN EXISTING OR PROPOSED STORM DRAIN MUST BE LABELED TO DISCOURAGE ILLEGAL DUMPING OF POLLUTANTS WITH THE STENCIL ABOVE IN A VISIBLE AREA. 2 COATS MINIMUM.

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BREA MALL AND RESIDENCES AT BREA

1065 Brea Mall, Brea, CA 92821

HYDROLOGY DETAILS

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RAS JOB NO. 3180011.03

PROJECT MANAGER:
CHRIS T. BRATTY

DESIGNED BY: CJN

CHECKED BY: RMK

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CREATIVITY BEYOND ENGINEERING
8911 Research Drive
Irvine, CA 92618-4237
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rasmith.com

HYD-04

Scale AS SHOWN
Job No. 2018-170
Date 6/9/22

Attachment 4 – Rational Methodology Calculation Spreadsheet

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CREATIVITY BEYOND ENGINEERING
8881 Research Drive
Irvine, CA 92618-4236
(949) 872-2378
rasmith.com

8881 Research Drive
Irvine, CA 92618
Phone: (949)-872-2378
Fax: (949)-387-3915

JOB NAME: Brea Mall Expansion

JOB NO: 3180011

10-YEAR HYDROLOGIC CALCULATIONS

ADAPTED FROM ORANGE COUNTY HYDROLOGY MANUAL																		CJN		3/5/2022		
CITY OF BREA																		PAGE	1	OF 1		
HYDROLOGY MANUAL			10 - Year Rainfall Analysis											SHEET FLOW			PIPE HYDRAULICS				
NODE/CONTROLING	DRAINAGE AREA NAME	AREA	AREA (ACRES)		SOIL	DEV.	Tt	Ai	TC	I	C	Fp	Q(TOTAL)	FLOW PATH	SLOPE	HYDRAULICS AND	PIPE	LENGTH	SLOPE	n	VEL.
PATH		SF	SUBAREA	TOTAL	TYPE	TYPE	MIN	%	MIN	IN/HR	Page D-3	C.6.4		LENGTH (FT)	FT/FT	NOTES	DIA (IN)		FT/FT		FPS
Sheet Flow	Existing Area 1	486,917	11.18	11.18	C	MIX		94.5%	5.00	4.06	0.90	0.25	40.70	277	0.01	Q=40.7CAP=33.44					
							1.374									BAD	36	390	0.0025	0.013	4.731
To Public Storm Drain	Existing Area 1	-	-	11.18	C	MIX		94.5%	6.37	3.53	0.90	0.25	40.70	-	-						
																	-	-			
Sheet Flow	Existing Area 2	104,200	2.39	2.39	C	MIX		94.5%	5.00	4.06	0.90	0.25	8.71	600	0.02						
																	-	-			
Sheet Flow	Existing Area 3	51,185	1.18	1.18	C	MIX		100.0%	5.00	4.06	0.90	0.25	4.29	200	0.02						
																	-	-			
Sheet Flow to Node 1	DA #1A	10,550	0.24	0.24	C	MIX		100.0%	5.00	4.06	0.90	0.25	0.88	125	0.04	Q=0.88CAP=1.68					
							0.351									OK	10	65	0.005	0.012	3.086
Sheet + Pipe at Node 2	DA #1B	26,195	0.60	0.84	C	MIX		100.0%	5.35	3.90	0.90	0.25	3.00	160	0.02	Q=3CAP=17.38					
							0.500									OK	24	166	0.005	0.012	5.531
Sheet + Pipe at Node 3	DA #1C	87,805	2.02	2.86	C	MIX		100.0%	7.50	3.22	0.90	0.25	8.84	300	0.01	Q=8.84CAP=17.38					
							0.259									OK	24	86	0.005	0.012	5.531
Sheet + Pipe at Node 4	DA #1D	15,920	0.37	3.22	C	MIX		100.0%	7.76	3.16	0.90	0.25	9.87	100	0.02	Q=9.87CAP=17.38					
							0.416									OK	24	138	0.005	0.012	5.531
Sheet + Pipe at Node 5	DA #1E	94,956	2.18	2.18	C	MIX		100.0%	5.00	4.06	0.90	0.25	7.96	-	-	Q=7.96CAP=13.97					
							0.048									OK	18	23	0.015	0.012	7.908
Sheet + Pipe at Node 6	DA #1F	46,830	1.08	6.48	C	MIX		100.0%	8.50	3.00	0.90	0.25	20.74	300	0.005	Q=20.74CAP=35.92					
							0.569									OK	30	250	0.0065	0.012	7.318
Sheet Flow at Node 7	DA #1G	59,930	1.38	1.38	C	MIX		100.0%	5.25	3.95	0.90	0.25	4.89	300	0.05	Q=4.89CAP=8.84					
							0.087									OK	18	26	0.006	0.012	5.002
Sheet + Pipe at Node 8	DA #1H	10,740	0.25	8.10	C	MIX		100.0%	8.59	2.98	0.90	0.25	26.29	125	0.036	Q=26.29CAP=54.57					
							0.039									OK	30	26	0.015	0.012	11.117
Sheet + Pipe at Node 9	DA #1I	64,095	1.47	1.47	C	MIX		100.0%	5.00	4.06	0.90	0.25	5.38	100	0.05	Q=5.38CAP=15.81					
							0.061									OK	18	33	0.0192	0.012	8.947
Total to Chamber at Node 10	Total DA#1 (lower)	-	-	9.57	C	MIX		100.0%	10.06	2.72	0.90	0.25	31.66	-	-	Q=31.66CAP=58.41					
																OK	36	168	0.0065	0.012	8.264
Sheet + Pipe at Node 11	DA #2A	61,900	1.42	1.42	C	MIX		100.0%	6.50	3.49	0.90	0.25	4.47	280	0.018	Q=4.47CAP=11.41					
							0.343									OK	18	133	0.01	0.012	6.457
Sheet Flow at Node 12	DA #2B	17,665	0.41	0.41	C	MIX		100.0%	5.75	3.75	0.90	0.25	1.37	275	0.029091	Q=1.37CAP=3.87					
							0.152									OK	12	45	0.01	0.012	4.928
Sheet + Pipe at Node 13	DA #2C	135,065	3.10	4.93	C	MIX		100.0%	6.84	3.39	0.90	0.25	15.30	200	0.045	Q=15.3CAP=39.78					
							0.353									OK	24	268	0.0262	0.012	12.661
Sheet Flow at Node 14	DA #2D	10,651	0.24	0.24	C	MIX		100.0%	5.00	4.06	0.90	0.25	0.89	100	0.05	Q=0.89CAP=2.38					
							0.302									OK	10	79	0.01	0.012	4.364
Total to Chamber at Node 10	Total DA #2 (upper)	-	-	5.17	C	MIX		100.0%	7.20	3.30	0.90	0.25	16.19	-	-	Q=16.19CAP=30.1					
																OK	24	237	0.015	0.012	9.580
Overflow to Public Drain at Node 15	Total DA#1 & DA#2	-	-	14.75	C	MIX		100.0%	10.06	2.72	0.90	0.25	47.85	-	-	Q=47.85CAP=75.99					
																OK	36	394	0.011	0.012	10.750

raSmith
CREATIVITY BEYOND ENGINEERING
8881 Research Drive
Irvine, CA 92618-4236
(949) 872-2378
rasmith.com

8881 Research Drive
Irvine, CA 92618
Phone: (949)-872-2378
Fax: (949)-387-3915

JOB NAME: Brea Mall Expansion

JOB NO: 3180011

25-YEAR HYDROLOGIC CALCULATIONS

ADAPTED FROM ORANGE COUNTY HYDROLOGY MANUAL | CJN | 3/5/2022

CITY OF BREA | PAGE 1 OF 1

HYDROLOGY MANUAL | 25 - Year Rainfall Analysis

NODE/CONTROLING PATH	DRAINAGE AREA NAME	AREA SF	AREA (ACRES) SUBAREA	AREA (ACRES) TOTAL	SOIL TYPE	DEV. TYPE	Tt MIN	Ai %	TC MIN	I IN/HR	C Page D-3	Fp C.6.4	Q(TOTAL)	SHEET FLOW FLOW PATH LENGTH (FT)	SHEET FLOW SLOPE FT/FT	HYDRAULICS AND NOTES	PIPE HYDRAULICS PIPE DIA (IN)	PIPE HYDRAULICS LENGTH	PIPE HYDRAULICS SLOPE FT/FT	PIPE HYDRAULICS n	PIPE HYDRAULICS VEL. FPS
Sheet Flow	Existing Area 1	486,917	11.18	11.18	C	MIX		94.5%	5.00	4.82	0.90	0.25	48.39	277	0.01	Q=48.39CAP=33.44					
							1.374									BAD	36	390	0.0025	0.013	4.731
To Public Storm Drain	Existing Area 1	-	-	11.18	C	MIX		94.5%	6.37	4.20	0.90	0.25	48.39	-	-						
																	-	-			
Sheet Flow	Existing Area 2	104,200	2.39	2.39	C	MIX		94.5%	5.00	4.82	0.90	0.25	10.36	600	0.02						
																	-	-			
Sheet Flow	Existing Area 3	51,185	1.18	1.18	C	MIX		100.0%	5.00	4.82	0.90	0.25	5.10	200	0.02						
																	-	-			
Sheet Flow to Node 1	DA #1A	10,550	0.24	0.24	C	MIX		100.0%	5.00	4.82	0.90	0.25	1.05	125	0.04	Q=1.05CAP=1.68					
							0.351									OK	10	65	0.005	0.012	3.086
Sheet + Pipe at Node 2	DA #1B	26,195	0.60	0.84	C	MIX		100.0%	5.35	4.64	0.90	0.25	3.56	160	0.02	Q=3.56CAP=17.38					
							0.500									OK	24	166	0.005	0.012	5.531
Sheet + Pipe at Node 3	DA #1C	87,805	2.02	2.86	C	MIX		100.0%	7.50	3.83	0.90	0.25	10.52	300	0.01	Q=10.52CAP=17.38					
							0.259									OK	24	86	0.005	0.012	5.531
Sheet + Pipe at Node 4	DA #1D	15,920	0.37	3.22	C	MIX		100.0%	7.76	3.76	0.90	0.25	11.76	100	0.02	Q=11.76CAP=31.51					
							0.358									OK	30	138	0.005	0.012	6.418
Sheet + Pipe at Node 5	DA #1E	94,956	2.18	2.18	C	MIX		100.0%	5.00	4.82	0.90	0.25	9.46	-	-	Q=9.46CAP=13.97					
							0.048									OK	18	23	0.015	0.012	7.908
Sheet + Pipe at Node 6	DA #1F	46,830	1.08	6.48	C	MIX		100.0%	8.50	3.57	0.90	0.25	24.68	300	0.005	Q=24.68CAP=35.92					
							0.569									OK	30	250	0.0065	0.012	7.318
Sheet Flow at Node 7	DA #1G	59,930	1.38	1.38	C	MIX		100.0%	5.25	4.69	0.90	0.25	5.81	300	0.05	Q=5.81CAP=8.84					
							0.087									OK	18	26	0.006	0.012	5.002
Sheet + Pipe at Node 8	DA #1H	10,740	0.25	8.10	C	MIX		100.0%	8.59	3.55	0.90	0.25	31.28	125	0.036	Q=31.28CAP=54.57					
							0.039									OK	30	26	0.015	0.012	11.117
Sheet + Pipe at Node 9	DA #1I	64,095	1.47	1.47	C	MIX		100.0%	5.00	4.82	0.90	0.25	6.39	100	0.05	Q=6.39CAP=15.81					
							0.061									OK	18	33	0.0192	0.012	8.947
Total to Chamber at Node 10	Total DA#1 (lower)	-	-	9.57	C	MIX		100.0%	10.06	3.25	0.90	0.25	37.66	-	-	Q=37.66CAP=58.41					
																OK	36	168	0.0065	0.012	8.264
Sheet + Pipe at Node 11	DA #2A	61,900	1.42	1.42	C	MIX		100.0%	6.50	4.16	0.90	0.25	5.32	280	0.018	Q=5.32CAP=11.41					
							0.343									OK	18	133	0.01	0.012	6.457
Sheet Flow at Node 12	DA #2B	17,665	0.41	0.41	C	MIX		100.0%	5.75	4.46	0.90	0.25	1.63	275	0.029091	Q=1.63CAP=3.87					
							0.152									OK	12	45	0.01	0.012	4.928
Sheet + Pipe at Node 13	DA #2C	135,065	3.10	4.93	C	MIX		100.0%	6.84	4.04	0.90	0.25	18.21	200	0.045	Q=18.21CAP=39.78					
							0.353									OK	24	268	0.0262	0.012	12.661
Sheet Flow at Node 14	DA #2D	10,651	0.24	0.24	C	MIX		100.0%	5.00	4.82	0.90	0.25	1.06	100	0.05	Q=1.06CAP=2.38					
							0.302									OK	10	79	0.01	0.012	4.364
Total to Chamber at Node 10	Total DA #2 (upper)	-	-	5.17	C	MIX		100.0%	7.20	3.93	0.90	0.25	19.28	-	-	Q=19.28CAP=30.1					
																OK	24	237	0.015	0.012	9.580
Overflow to Public Drain at Node 15	Total DA#1 & DA#2	-	-	14.75	C	MIX		100.0%	10.06	3.25	0.90	0.25	56.94	-	-	Q=56.94CAP=75.99					
																OK	36	394	0.011	0.012	10.750

raSmith
CREATIVITY BEYOND ENGINEERING
8881 Research Drive
Irvine, CA 92618-4236
(949) 872-2378
rasmith.com

8881 Research Drive
Irvine, CA 92618
Phone: (949)-872-2378
Fax: (949)-387-3915

JOB NAME: Brea Mall Expansion

JOB NO: 3180011

100-YEAR HYDROLOGIC CALCULATIONS

ADAPTED FROM ORANGE COUNTY HYDROLOGY MANUAL | CJN | 3/5/2022

CITY OF BREA | PAGE 1 OF 1

HYDROLOGY MANUAL | 100 - Year Rainfall Analysis

NODE/CONTROLING PATH	DRAINAGE AREA NAME	AREA SF	AREA (ACRES) SUBAREA	AREA (ACRES) TOTAL	SOIL TYPE	DEV. TYPE	Tt MIN	Ai %	TC MIN	I IN/HR	C Page D-3	Fp C.6.4	Q(TOTAL)	SHEET FLOW FLOW PATH LENGTH (FT)	SHEET FLOW SLOPE FT/FT	HYDRAULICS AND NOTES	PIPE HYDRAULICS PIPE DIA (IN)	PIPE HYDRAULICS LENGTH	PIPE HYDRAULICS SLOPE FT/FT	PIPE HYDRAULICS n	PIPE HYDRAULICS VEL. FPS
Sheet Flow	Existing Area 1	486,917	11.18	11.18	C	MIX		94.5%	5.00	6.19	0.90	0.25	62.11	277	0.01	Q=62.11CAP=33.44					
							1.374									BAD	36	390	0.0025	0.013	4.731
To Public Storm Drain	Existing Area 1	-	-	11.18	C	MIX		94.5%	6.37	5.38	0.90	0.25	62.11	-	-						
																	-	-			
Sheet Flow	Existing Area 2	104,200	2.39	2.39	C	MIX		94.5%	5.00	6.19	0.90	0.25	13.29	600	0.02						
																	-	-			
Sheet Flow	Existing Area 3	51,185	1.18	1.18	C	MIX		100.0%	5.00	6.19	0.90	0.25	6.54	200	0.02						
																	-	-			
Sheet Flow to Node 1	DA #1A	10,550	0.24	0.24	C	MIX		100.0%	5.00	6.19	0.90	0.25	1.35	125	0.04	Q=1.35CAP=1.68					
							0.351									OK	10	65	0.005	0.012	3.086
Sheet + Pipe at Node 2	DA #1B	26,195	0.60	0.84	C	MIX		100.0%	5.35	5.95	0.90	0.25	4.57	160	0.02	Q=4.57CAP=17.38					
							0.500									OK	24	166	0.005	0.012	5.531
Sheet + Pipe at Node 3	DA #1C	87,805	2.02	2.86	C	MIX		100.0%	7.50	4.90	0.90	0.25	13.47	300	0.01	Q=13.47CAP=17.38					
							0.259									OK	24	86	0.005	0.012	5.531
Sheet + Pipe at Node 4	DA #1D	15,920	0.37	3.22	C	MIX		100.0%	7.76	4.81	0.90	0.25	15.05	100	0.02	Q=15.05CAP=31.51					
							0.358									OK	30	138	0.005	0.012	6.418
Sheet + Pipe at Node 5	DA #1E	94,956	2.18	2.18	C	MIX		100.0%	5.00	6.19	0.90	0.25	12.14	-	-	Q=12.14CAP=13.97					
							0.048									OK	18	23	0.015	0.012	7.908
Sheet + Pipe at Node 6	DA #1F	46,830	1.08	6.48	C	MIX		100.0%	8.50	4.57	0.90	0.25	31.61	300	0.005	Q=31.61CAP=35.92					
							0.569									OK	30	250	0.0065	0.012	7.318
Sheet Flow at Node 7	DA #1G	59,930	1.38	1.38	C	MIX		100.0%	5.25	6.02	0.90	0.25	7.45	300	0.05	Q=7.45CAP=8.84					
							0.087									OK	18	26	0.006	0.012	5.002
Sheet + Pipe at Node 8	DA #1H	10,740	0.25	8.10	C	MIX		100.0%	8.59	4.54	0.90	0.25	40.06	125	0.036	Q=40.06CAP=54.57					
							0.039									OK	30	26	0.015	0.012	11.117
Sheet + Pipe at Node 9	DA #1I	64,095	1.47	1.47	C	MIX		100.0%	5.00	6.19	0.90	0.25	8.19	100	0.05	Q=8.19CAP=15.81					
							0.061									OK	18	33	0.0192	0.012	8.947
Total to Chamber at Node 10	Total DA#1 (lower)	-	-	9.57	C	MIX		100.0%	10.06	4.15	0.90	0.25	48.26	-	-	Q=48.26CAP=58.41					
																OK	36	168	0.0065	0.012	8.264
Sheet + Pipe at Node 11	DA #2A	61,900	1.42	1.42	C	MIX		100.0%	6.50	5.32	0.90	0.25	6.81	280	0.018	Q=6.81CAP=11.41					
							0.343									OK	18	133	0.01	0.012	6.457
Sheet Flow at Node 12	DA #2B	17,665	0.41	0.41	C	MIX		100.0%	5.75	5.71	0.90	0.25	2.08	275	0.029091	Q=2.08CAP=3.87					
							0.152									OK	12	45	0.01	0.012	4.928
Sheet + Pipe at Node 13	DA #2C	135,065	3.10	4.93	C	MIX		100.0%	6.84	5.17	0.90	0.25	23.32	200	0.045	Q=23.32CAP=39.78					
							0.353									OK	24	268	0.0262	0.012	12.661
Sheet Flow at Node 14	DA #2D	10,651	0.24	0.24	C	MIX		100.0%	5.00	6.19	0.90	0.25	1.36	100	0.05	Q=1.36CAP=2.38					
							0.302									OK	10	79	0.01	0.012	4.364
Total to Chamber at Node 10	Total DA #2 (upper)	-	-	5.17	C	MIX		100.0%	7.20	5.02	0.90	0.25	24.68	-	-	Q=24.68CAP=30.1					
																OK	24	237	0.015	0.012	9.580
Overflow to Public Drain at Node 15	Total DA#1 & DA#2	-	-	14.75	C	MIX		100.0%	10.06	4.15	0.90	0.25	72.94	-	-	Q=72.94CAP=75.99					
																OK	36	394	0.011	0.012	10.750

Attachment 5 – Orange County Drainage Facilities Map

E 6057906.734
N 2292345.575
E 6079406.982
N 2292345.484

LOS ANGELES COUNTY

BREA

FULLERTON

PLACENTIA

OLINDA ALPHA COUNTY LANDFILL

PROJECT SITE

CRAIG REGIONAL PARK

CARBON CANYON REGIONAL PARK

U.S. ARMY CORPS OF ENGINEERS

COUNTY OF ORANGE
CITY OF BREA

CITY OF FULLERTON

DETENTION BASIN

N 2276545.419
E 6057906.870
N 2276545.349
E 6079407.095

NOTICE

The drainage information has been prepared for information purposes only. The location, ownership, facility information and limits have been determined from available information provided by public agencies, but may not be exact, accurate, or up-to-date. The user of this information is responsible for verifying exact location, ownership, accuracy, and the regional versus local character of drainage facilities.

Additional information may be obtained from public plans and recorded deeds. Facility designations included with this information are for convenience only and are not controlling or intended to imply ownership by the County or the Orange County Flood Control District (OCFCD). The information is being provided as a courtesy and neither the County of Orange nor OCFCD assume any liabilities for inaccuracy of the information.

To notify OC Public Works Flood Control Section of additions or corrections, please contact Sal Gutierrez at (714) 834-5396 or by email at sal.gutierrez@ocpw.ocgov.com

N

0 200 400 600 800
FEET

ORANGE COUNTY FLOOD CONTROL DISTRICT

BASE MAP
OF DRAINAGE FACILITIES
IN ORANGE COUNTY

REVISION	DATE	SHEET NO.	DWG. NO.
S. GUTIERREZ	DEC. 22,2010	2	MAPS-113-3

- Channel Drainage Area Boundary
- Major Sub-Area Drainage Boundary
- Minor Sub-Area Drainage Boundary
- Existing O.C.F.C.D. Facility
- Existing Local Facility
- Existing Retarding Basin or Reservoir
- Natural Watercourse
- City Limits
- G Greenbelt
- P.S. Pump Station
- Catch Basin (length in feet)
- Drop Inlet or Other Entry
- OCFCD Basins or Reservoirs

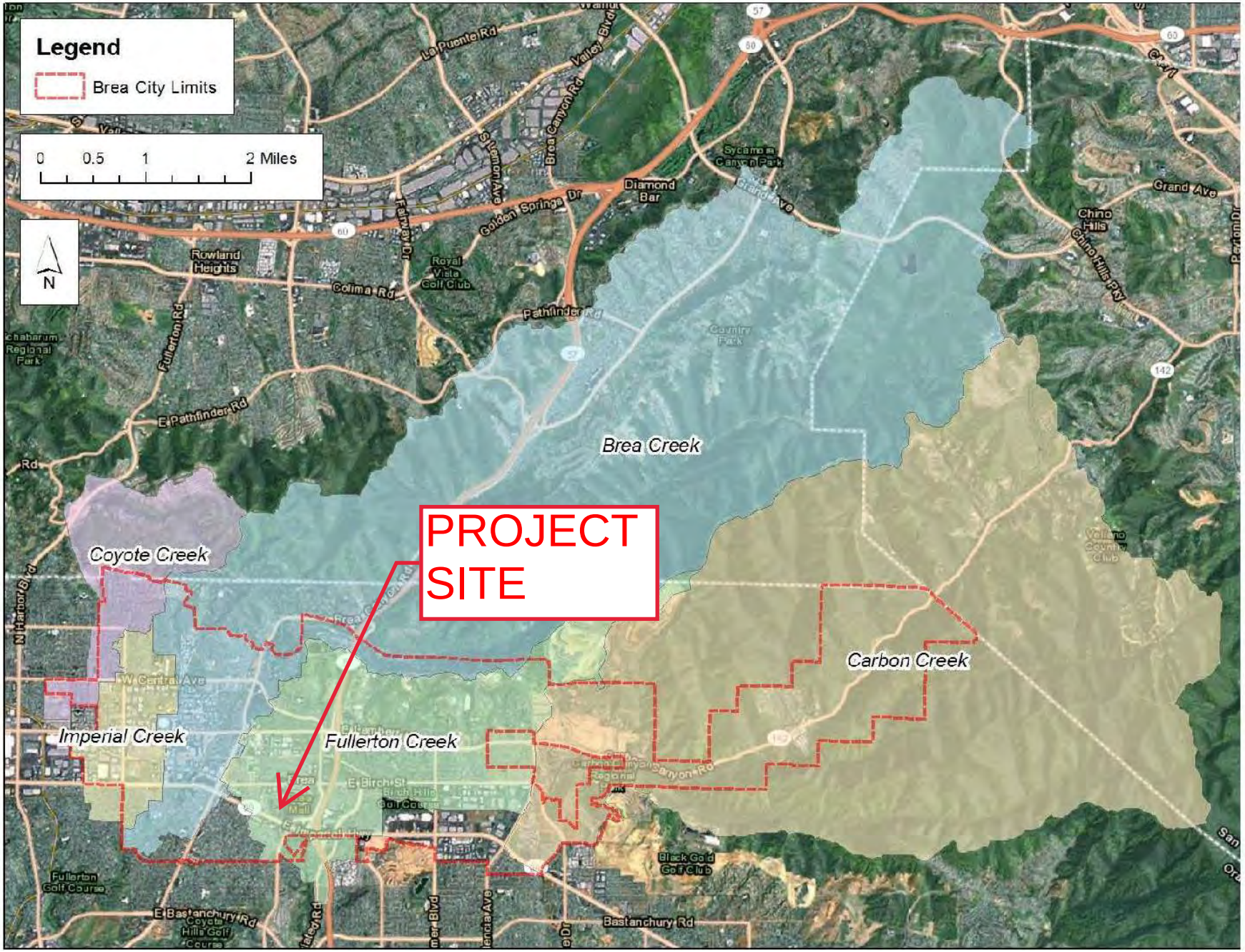
Ownership (If other than City or County): Private = P State = S Federal = F

EXISTING FACILITIES

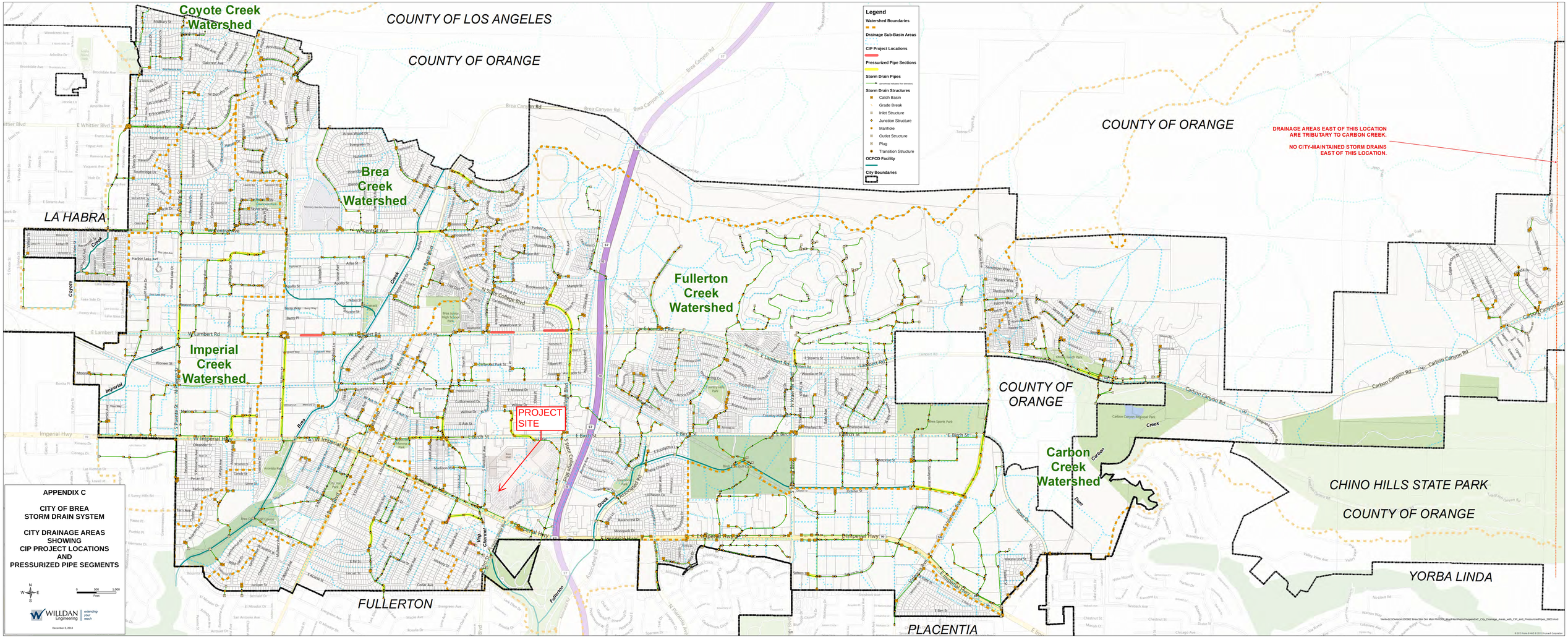
O.C.F.C.D.	LOCAL	
		Earth Trapezoidal Channel (base width by height in feet)
		Reinforced Concrete Trapezoidal Channel (base width by height in feet)
		Reinforced Concrete Rectangular Channel (base width by height in feet)
		Reinforced Concrete Box (RCB) (number of barrels-span by height in feet)
		Reinforced Concrete Pipe (RCP) (diameter in inches)
		Metal Sheet Channel (MSC) (Base width by pile height in feet /Sheet pile total length)
		Corrugated Metal Pipe (CMP) (diameter in inches)
		Concrete Pipe (diameter in inches)
		Concrete Oval Pipe (width by height in inches)
		Steel Pipe (diameter in inches)
		Reinforced Concrete Arch (base span by height in inches)
		Corrugated Metal Arch (base span by height in inches)

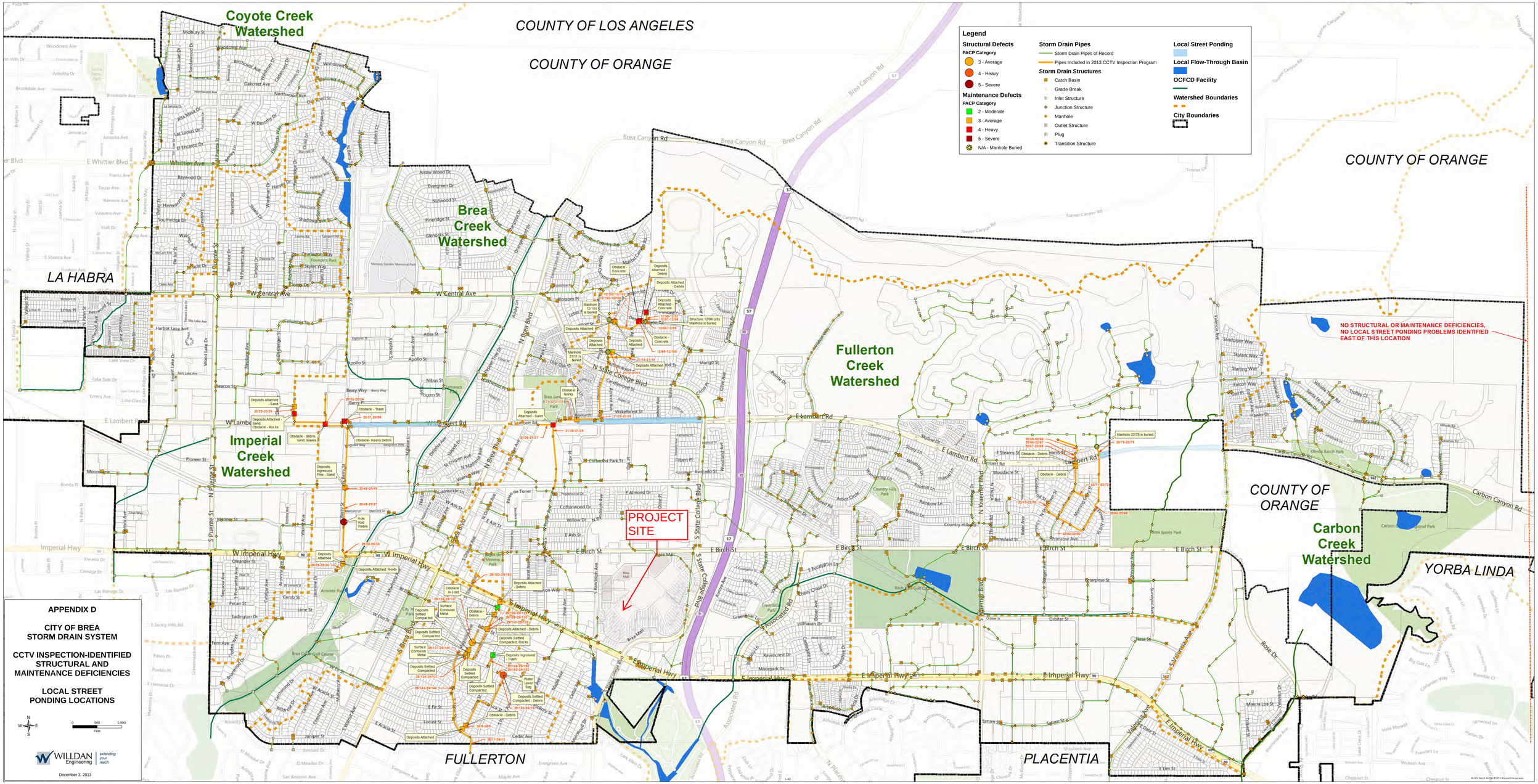
2

Attachment 6 – City of Brea Master Plan of Drainage (applicable pages)



Appendix B: *Major watersheds crossing Brea City limits*


Coyote Creek Watershed
COUNTY OF LOS ANGELES
COUNTY OF ORANGE
Brea Creek Watershed
LA HABRA
Fullerton Creek Watershed
Imperial Creek Watershed
PROJECT SITE
COUNTY OF ORANGE
DRAINAGE AREAS EAST OF THIS LOCATION ARE TRIBUTARY TO CARBON CREEK.
NO CITY-MAINTAINED STORM DRAINS EAST OF THIS LOCATION.
Carbon Creek Watershed
CHINO HILLS STATE PARK
COUNTY OF ORANGE
YORBA LINDA
FULLERTON
PLACENTIA
Legend
Watershed Boundaries
Drainage Sub-Basin Areas
CIP Project Locations
Pressurized Pipe Sections
Storm Drain Pipes
(arrowhead indicates flow direction)
Storm Drain Structures
Catch Basin
Grade Break
Inlet Structure
Junction Structure
Manhole
Outlet Structure
Plug
Transition Structure
OCFCD Facility
City Boundaries
APPENDIX C
CITY OF BREA
STORM DRAIN SYSTEM
CITY DRAINAGE AREAS SHOWING CIP PROJECT LOCATIONS AND PRESSURIZED PIPE SEGMENTS
N
W
E
S
0
500
1,000
Feet
WILLDAN Engineering
extending your reach
December 3, 2013



APPENDIX D

CITY OF BREA STORM DRAIN SYSTEM

CCTV INSPECTION-IDENTIFIED STRUCTURAL AND MAINTENANCE DEFICIENCIES

LOCAL STREET PONDING LOCATIONS

N W E S

0 500 1,000 Feet

WILLDAN Engineering | extending your reach

December 3, 2013

APPENDIX D: CITY OF BREA STORM DRAIN SYSTEM - CCTV INSPECTION IDENTIFIED STRUCTURAL AND MAINTENANCE DEFECTS - LOCAL STREET PONDING LOCATIONS

©2012 Zenrin ©ATID ©2013 Wildwell Corporation

Fullerton Creek Watershed

Collection Points

Flow Paths

Subbasin Boundaries

0 0.125 0.25 0.5 Miles

N

EX. AREA #1 (WEST)
EX. AREA #2 (EAST)
PR. DA #1 (WEST)
PR. DA #2 (EAST)

PROJECT SITE

EX. AREA #3 (CENTRAL)

DOWNSTREAM CONVERGENCE OF EXISTING FLOWS

1 2 Fullerton Creek

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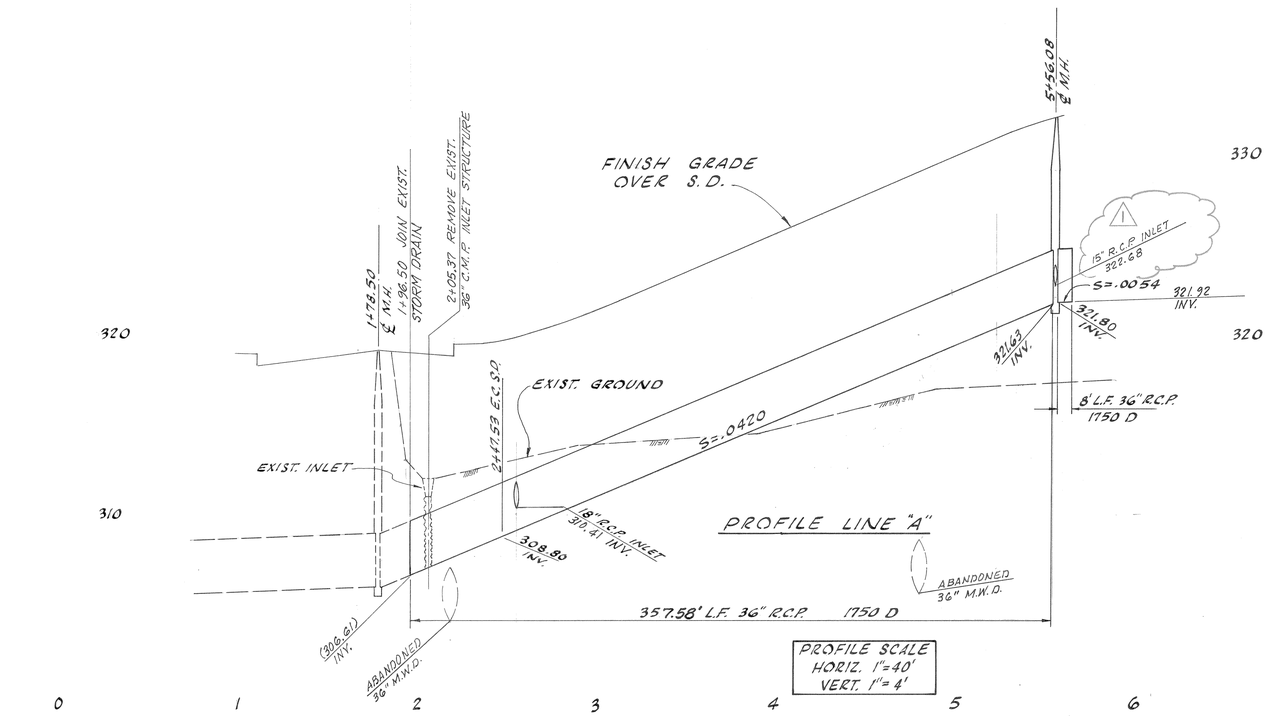
Fullerton Creek 10-year Storm Rational Method Study

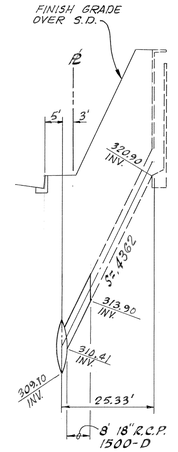
Concentration Point / Outlet	Subarea / Basin Area (ac)	Effective Area (ac)	Total area (ac)	Fp	Ap	Tt (min)	Tc (min)	I (in/hr)	Fm	Fm avg.	Q Total (cfs)	Flow Path Length (ft)	Slope (ft/ft)	Velocity (fps)	Depth of Flow (ft)	Comments
350O	2.2	2.2	2.2	0.3	0.35		14.8	1.73	0.11	0.11	3.3	303.9	0.09239			
352O	24.2	26.4	26.4	0.3	0.47	2.5	17.3	1.58	0.14	0.14	34.7	1067.1	0.02936	7.1(PUG)	0.41(PUG)	
354AX		26.4		0.3	0.46	1.43	18.7	1.52		0.14	34.7	494.5	0.00335	5.8(AG)	1.82(AG)	Warning: Trapezoidal channel OVERFLOW
343N	1.2	1.2	1.2	0.3	0.45		11.5	1.99	0.14	0.14	2	328	0.00424			
345N	13.7	14.9	14.9	0.3	0.41	10.7	22.2	1.38	0.12	0.12	17	1806.6	0.01034	3.5(AG)	0.45(AG)	Warning: Local street (< 500 ADT) OVERFLOW (crown)
348XK		14.9		0.3	0.42	8.22	30.5	1.15		0.12	17	1751.3	0.01027	3.6(AG)	0.79(AG)	
312I	1.4	1.4	1.4	0.3	0.45		11.8	1.97	0.14	0.14	2.3	284.9	0.00284			
314I	12.9	14.3	14.3	0.3	0.45	11.37	23.2	1.35	0.14	0.14	15.7	1543.7	0.00657	2.8(AG)	0.46(AG)	Warning: Local street (< 500 ADT) OVERFLOW (crown)
320XI		14.3		0.3	0.45	0.81	24	1.32		0.14	15.7	773.8	0.109	15.9(PUG)	0.82(PUG)	Warning: Pipe OVERFLOW
306H	1.4	1.4	1.4	0.3	0.45		6.1	2.84	0.14	0.14	3.5	201.2	0.03719			
308H	13.9	15.3	15.3	0.3	0.24	2.01	8.2	2.42	0.07	0.08	32.6	404.1	0.01015	3.8(AG)	0.57(AG)	Warning: Local street (< 500 ADT) OVERFLOW (crown)
309XH		15.3		0.3	0.26	2.11	10.3	2.13		0.08	32.6	1149.2	0.02079	9.1(PUG)	1.23(PUG)	Warning: Pipe OVERFLOW
299G	0.8	0.8	0.8	0.3	0.45		6	2.89	0.14	0.14	2	133.9	0.01935			
301G	10.3	11.1	11.1	0.3	0.34	9.02	15	1.72	0.1	0.11	16.3	834.6	0.00159	1.7(AG)	0.64(AG)	Warning: Local street (< 500 ADT) OVERFLOW (crown)
303G	11.7	22.8	22.8	0.3	0.29	1.65	16.6	1.62	0.09	0.1	31.6	723.2	0.00943	7.3(PUG)	1.16(PUG)	
304XG		22.8		0.3	0.32	0.76	17.4	1.58		0.1	31.6	650.9	0.03626	14.3(PUG)	1.15(PUG)	
290F	0.6	0.6	0.6	0.3	0.27		7	2.63	0.08	0.08	1.4	155.1	0.00645			
293F	22.2	22.8	22.8			6.86	13.9	1.79		0.1	35.1	1143.5	0.00758	3.3(AG)	0.55(AG)	Warning: Local street (< 500 ADT) OVERFLOW (crown)
295XF	15.9	38.7	38.7	0.3	0.4	1.53	15.4	1.69	0.12	0.11	55.7	1057.9	0.0228	11.5(PUG)	1.64(PUG)	Warning: Pipe OVERFLOW
285E	0.8	0.8	0.8	0.3	0.45		5.3	3.08	0.14	0.14	2.2	154.1	0.04509			
288XD	14.7	15.5	15.5	0.3	0.17	8.55	13.9	1.8	0.05	0.05	24.5	1624.2	0.01621	3.6(AG)	0.46(AG)	
279D	1.2	1.2	1.2	0.3	0.32		6.1	2.86	0.1	0.1	3	163.3	0.01788			
281D	4.8	6.1	6.1	0.3	0.24	3.48	9.5	2.22	0.07	0.08	11.8	336.2	0.01899	1.8(AG)	0.33(AG)	
283D	16.5	22.6	22.6	0.3	0.23	2.6	12.1	1.94	0.07	0.07	38.2	1337	0.01805	8.6(PUG)	0.90(PUG)	
288XD		22.6		0.3	0.24	1.61	13.7	1.8		0.07	38.2	661.5	0.00597	6.8(PUG)	2.05(PUG)	Warning: Pipe OVERFLOW
271C	1.8	1.8	1.8	0.3	0.2		7.3	2.58	0.06	0.06	4.1	226.1	0.00884			

Fullerton Creek 10-year Storm Rational Method Study

Concentration Point / Outlet	Subarea / Basin Area (ac)	Effective Area (ac)	Total area (ac)	Fp	Ap	Tt (min)	Tc (min)	I (in/hr)	Fm	Fm avg.	Q Total (cfs)	Flow Path Length (ft)	Slope (ft/ft)	Velocity (fps)	Depth of Flow (ft)	Comments
Head Node - 274C		218.9		0.31	0.32	0	15.2	1.71		0.1	321.5					Confluence Details
Head Node - 283D		225.5		0.31	0.31	0	13.7	1.8		0.1	353					Confluence Details
Head Node - 285E		225.1		0.31	0.31	0	13.9	1.8		0.1	350.5					Confluence Details
288XD - Confluence		261.5	274.6	0.31	0.31	0	15.5	1.69		0.1	379.5					Confluence Results
Head Node - 293F		273.4		0.31	0.32	0	15.4	1.69		0.1	398.6					Confluence Details
Head Node - 268B		259.9		0.31	0.32	0	13.1	1.85		0.1	418.5					Confluence Details
Head Node - 263Z		313.4		0.31	0.3	0	27.4	1.22		0.09	323.8					Confluence Details
Head Node - 245X		300.8		0.31	0.32	0	15.9	1.67		0.1	432					Confluence Details
Head Node - 250Y		300.3		0.31	0.32	0	15.6	1.68		0.1	434.8					Confluence Details
Head Node - 274C		257.3		0.31	0.33	0	15.3	1.7		0.1	377					Confluence Details
Head Node - 283D		260.3		0.31	0.31	0	13.9	1.8		0.1	406.4					Confluence Details
Head Node - 285E		260.2		0.31	0.31	0	14	1.79		0.1	404					Confluence Details
295XF - Confluence		300.3	313.4	0.31	0.32	0	15.6	1.68		0.1	434.8					Confluence Results
Head Node - 293F		282.1		0.31	0.31	1.01	16.4	1.63		0.1	398.6					Confluence Details
Head Node - 268B		268.6		0.31	0.31	1	14.1	1.78		0.1	418.5					Confluence Details
Head Node - 263Z		322.1		0.31	0.3	1.05	28.5	1.2		0.09	323.8					Confluence Details
Head Node - 245X		309.5		0.31	0.31	1	16.9	1.61		0.1	432					Confluence Details
Head Node - 250Y		309		0.31	0.31	0.99	16.6	1.62		0.1	434.8					Confluence Details
Head Node - 274C		266		0.31	0.33	1.02	16.3	1.64		0.1	377					Confluence Details
Head Node - 283D		269		0.31	0.31	1.01	14.9	1.73		0.1	406.4					Confluence Details
Head Node - 285E		268.9		0.31	0.31	1.01	15	1.72		0.1	404					Confluence Details
297X	8.7	309	322.1	0.3	0.2	0.99	16.6	1.62	0.06	0.1	434.8	751	0.00477	12.6(PUG)	5.47(PUG)	
Head Node - 303G		353		0.31	0.27	0	17.4	1.58		0.08	479.7					Confluence Details
Head Node - 293F		367.9		0.31	0.27	0	18	1.55		0.08	489.1					Confluence Details
Head Node - 268B		352.2		0.31	0.27	0	15.7	1.67		0.08	508.4					Confluence Details
Head Node - 263Z		407.8		0.31	0.27	0	30.2	1.16		0.08	398.7					Confluence Details
Head Node - 245X		395.2		0.31	0.27	0	18.4	1.53		0.09	518.4					Confluence Details
Head Node - 250Y		394.7		0.31	0.27	0	18.2	1.54		0.09	521.4					Confluence Details
Head Node - 274C		351.8		0.31	0.28	0	17.9	1.55		0.09	468.3					Confluence Details
Head Node - 283D		353.6		0.31	0.27	0	16.5	1.63		0.08	496.5					Confluence Details
Head Node - 285E		353.6		0.31	0.27	0	16.6	1.62		0.08	494.2					Confluence Details
304XG - Confluence		394.7	407.8	0.31	0.27	0	18.2	1.54		0.09	521.4					Confluence Results
Head Node - 308H		249.2		0.31	0.26	0	10.3	2.13		0.08	466.5					Confluence Details
Head Node - 303G		383.8		0.31	0.26	0	17.8	1.56		0.08	517.7					Confluence Details
Head Node - 293F		398.7		0.31	0.26	0	18.5	1.53		0.08	526.3					Confluence Details
Head Node - 268B		383		0.31	0.26	0	16.1	1.65		0.08	548					Confluence Details
Head Node - 263Z		438.7		0.31	0.26	0	30.6	1.15		0.08	427.8					Confluence Details
Head Node - 245X		426.1		0.31	0.27	0	18.9	1.51		0.08	554.9					Confluence Details
Head Node - 250Y		425.6		0.31	0.27	0	18.6	1.52		0.08	558.1					Confluence Details
Head Node - 274C		382.7		0.31	0.27	0	18.4	1.53		0.08	505.7					Confluence Details
Head Node - 283D		384.4		0.31	0.26	0	16.9	1.61		0.08	535.3					Confluence Details
Head Node - 285E		384.5		0.31	0.26	0	17	1.6		0.08	532.9					Confluence Details
309XH - Confluence		425.6	438.7	0.31	0.27	0	18.6	1.52		0.08	558.1					Confluence Results

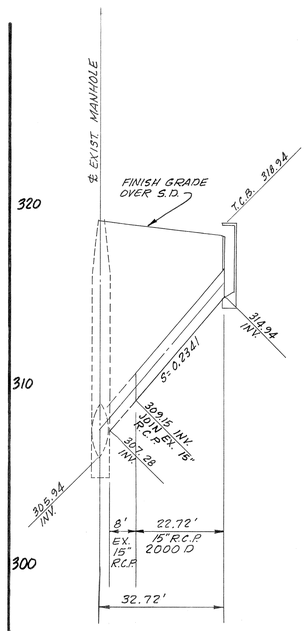
Attachment 7 – As-Built Information from City of Brea, Onsite storm drain, and C-Below Survey





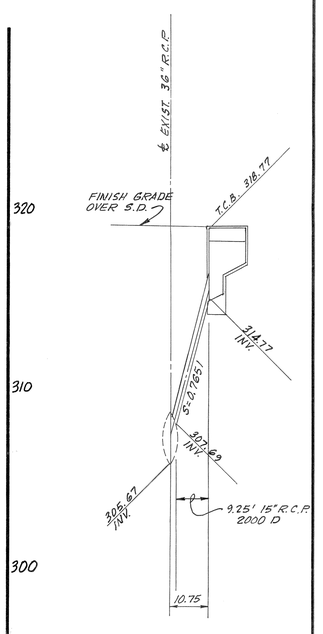
PROFILE LINE "B"

PROFILE SCALE HORIZ. 1"=20' VERT. 1"=4'



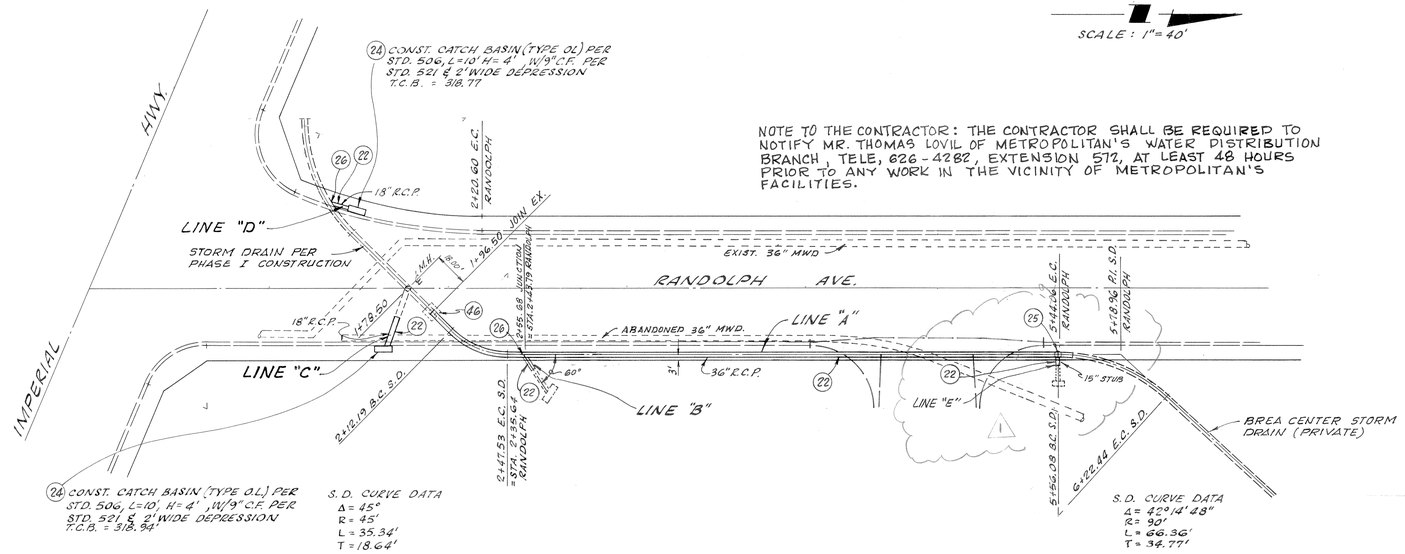
PROFILE LINE "C"

PROFILE SCALE HORIZ. 1"=20' VERT. 1"=4'



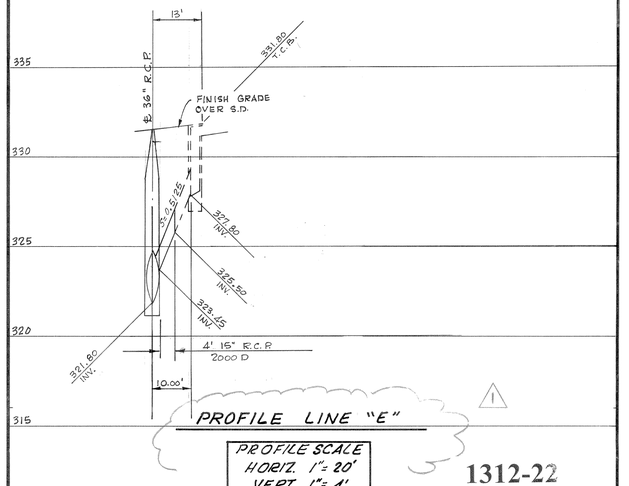
PROFILE LINE "D"

PROFILE SCALE HORIZ. 1"=20' VERT. 1"=4'



NOTE TO THE CONTRACTOR: THE CONTRACTOR SHALL BE REQUIRED TO NOTIFY MR. THOMAS LOVIL OF METROPOLITAN'S WATER DISTRIBUTION BRANCH, TELE, 626-4282, EXTENSION 572, AT LEAST 48 HOURS PRIOR TO ANY WORK IN THE VICINITY OF METROPOLITAN'S FACILITIES.

SCALE : 1"=40'



PROFILE LINE "E"

PROFILE SCALE HORIZ. 1"=20' VERT. 1"=4'

1312-22

"AS BUILT"

9/23/77

NOTES :

1. FOR CONSTRUCTION NOTES SEE SHEET NO. 2.

REVISIONS

DATE	INITIAL	DESCRIPTION	APP'D.
6/9/76	G.T.	⚠ CHANGED LOCATION & LENGTH OF LINE "E"	S.W.R.

ENGINEERING DEPARTMENT
CITY OF BREA CALIFORNIA

RANDOLPH AVENUE STORM DRAIN PLAN PHASE II

DRAWN BY: E.F.W.
CHECKED BY: C.R.A.
DATE: MAY 3, 1976

Malo R. Reich
CITY ENGINEER

SCALE: 1"=40'

SHEET 20 OF 44

E. 11,250 E. 11,500 E. 11,750 E. 12,000 E. 12,250 E. 12,500 E. 12,750

BIRCH STREET

N. 10,750 N. 10,500 N. 10,250 N. 10,000 N. 9,750 N. 9,500

CITY OF BREA PARCEL

RANDOLPH AVE.

SEARS

BREA MALL CENTRAL TENANT BLDG.

MAY CO.

BROADWAY

FUTURE EXPANSION

TRUCK COURT NO. 1

TRUCK COURT NO. 2

TRUCK COURT NO. 3

TRUCK COURT NO. 4

TRUCK COURT NO. 5

RETAINING WALL

RELOCATE EXIST. 36" RCP S.D. PER CITY OF BREA DWG. NO. SW-20

EXIST. 36" R.C.P.

SEE SHEET SW-7

SEE SHEET SW-6

NOTE: SITEWORK CONTRACTOR SHALL COORDINATE HIS WORK & CURB, AROUND EACH BLDG., WITH THE RESPECTIVE CONTRACTOR.

AS BUILT

NO.	DATE	REVISION	BY
6	7-13	REVISION NO. 5	C.K.
5	3-13	REVISED CITY PARCEL LOCATION, GRADES & S.D.	C.K.
4	8-11	MISC. REVISED ISLAND REVISIONS	C.K.
3	8-11	REV. BROADWAY ALIGN.	C.K.
2	8-11	ADDED 8" & 12" RCP & 12" RINK	C.K.
1	7-11	ADDED A.C. RAMPS	C.K.

PLANS PREPARED UNDER THE SUPERVISION OF:

Timothy Norman

R.C.E. 71423

PSOMAS & ASSOCIATES
CIVIL ENGINEERS · LAND SURVEYORS
1617 PONTIUS AVENUE · LOS ANGELES, CALIFORNIA 90025 · (213) 478-3081

SITE GRADING & DRAINAGE PLAN

BREA MALL

IMPERIAL HIGHWAY AT ORANGE FREEWAY
BREA, CALIFORNIA

HOMART DEVELOPMENT CO.

NORTH 1" = 50'

PROJECT NO. 79178

DRAWN APPROVED

SW-5

DATE 5-17-10

AS BUILT

NO.	DATE	REVISION	BY	CHK	APP'D
1	10/7/76	"AS BUILT"			
2	10/7/76	REVISED S.D. LINES NO. 17, 17A, 18 & 22	BJH	C.C.	

I HEREBY CERTIFY THAT THE ABOVE PLAN WAS PREPARED UNDER MY SUPERVISION OR BY ME AND THAT I AM A DULY LICENSED CIVIL ENGINEER UNDER THE LAWS OF THE STATE OF CALIFORNIA.

Timothy Comas

R.C.E. 24543

DATE 7/4/73

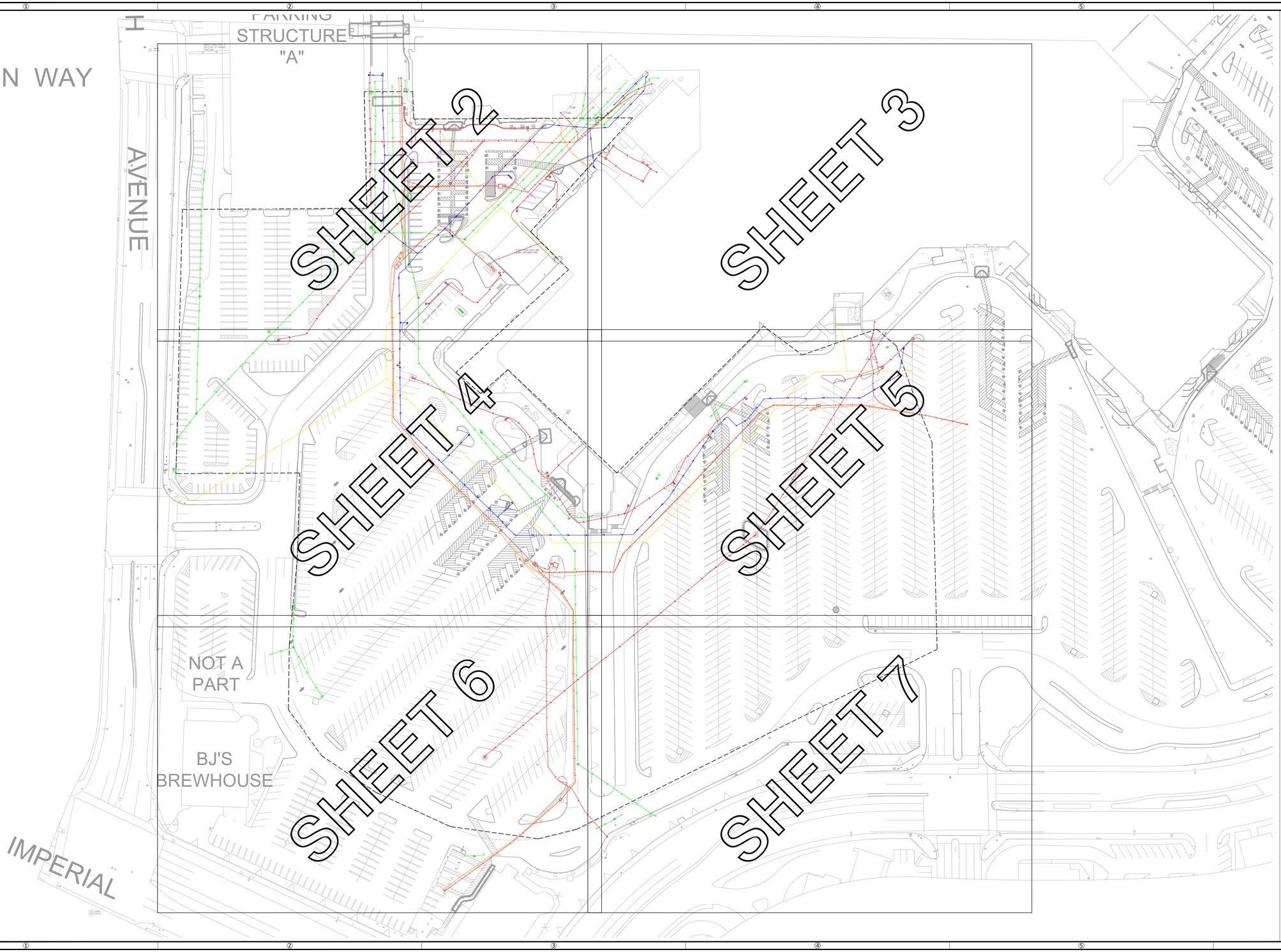
PSOMAS & ASSOCIATES
CIVIL ENGINEERS · LAND SURVEYORS
1617 PONTIUS AVENUE · LOS ANGELES, CALIFORNIA · 90025 · (213) 478-3091

STORM DRAIN PROFILES

BREA MALL
IMPERIAL HIGHWAY AT ORANGE FREEWAY
BREA, CALIFORNIA
HOMART DEVELOPMENT CO.

PROJECT NO.	75-278
DRAWN	APPROVED
C.K.	
SW-12	
DATE	5-17-76

SCALES: HORIZ. 1" = 50'
VERT. 1" = 5'



UTILITY NOTES

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6. IN THE EVENT THE INFORMATION SHOWN IN THIS PLAN VARIES FROM THE ACTUAL SITE CONDITIONS, C BELOW SHALL BE NOTIFIED WITHIN 24 HOURS AFTER DISCOVERY OF THE CONFLICT.

LEGEND

ELECTRICAL	E
GAS	G
COMMUNICATION	C
WATER	W
SANITARY SEWER	SS
STORM DRAIN	SD
POSSIBLE LINE LOCATION	U
STREET LIGHT	SL
AIR	AIR
TRAFFIC SIGNAL	TS
FIRE WATER	FW
CHILLED WATER	CHW
DOMESTIC WATER	DW
HOT WATER	HW

N

C BELOW SUBSURFACE IMAGING
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GROUND PENETRATING RADAR (GPR)
UTILITY LOCATING
RADIOGRAPHY
POTHOLING
MAPPING

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PROJECT:
PARTIAL UNDERGROUND UTILITY MAP FOR:
BREA MALL
1065 BREA MALL
BREA, CA 92821

CLIENT:
RA SMITH NATIONAL, LLC
8881 RESEARCH DR.
IRVINE, CA 92618

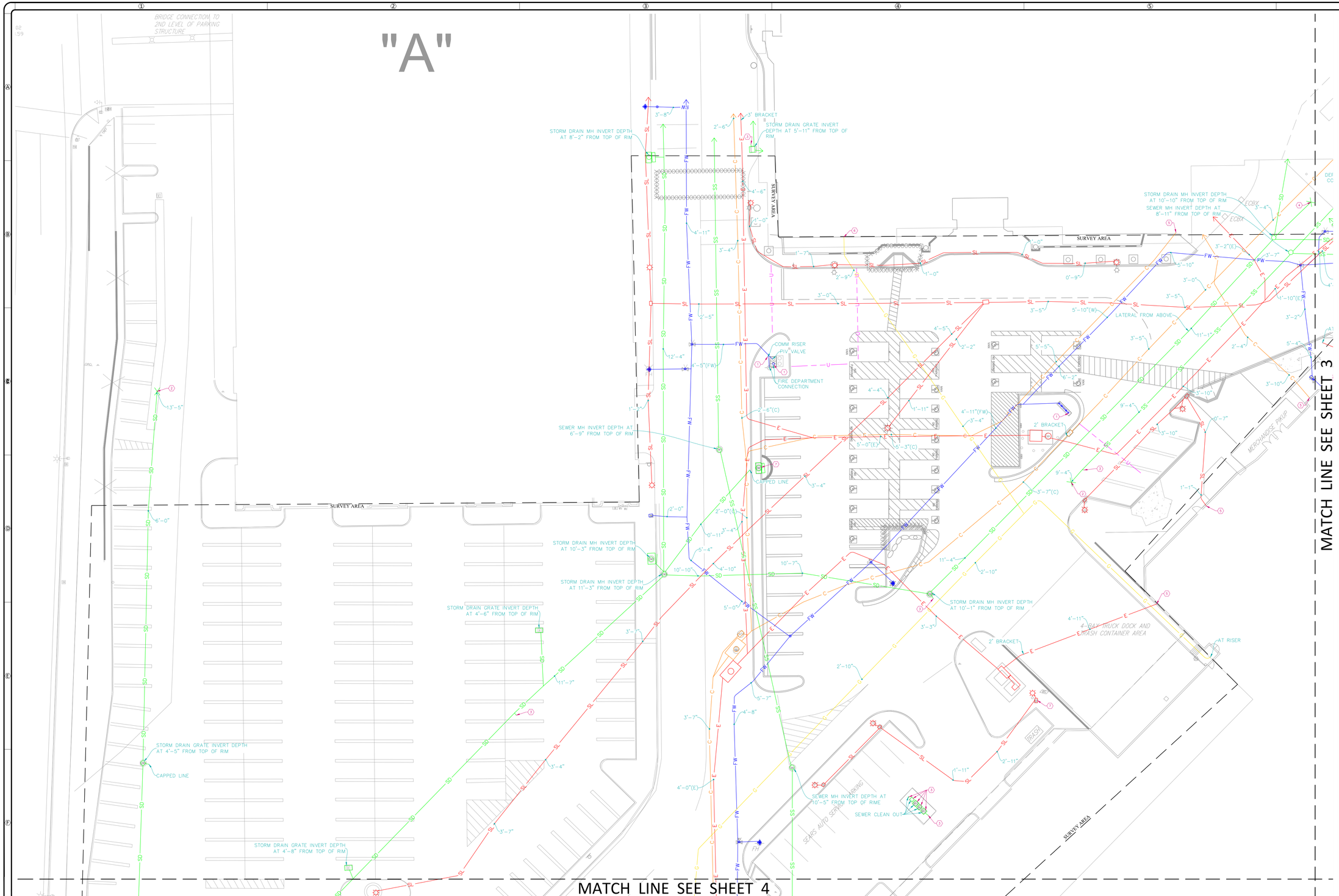
REVISIONS

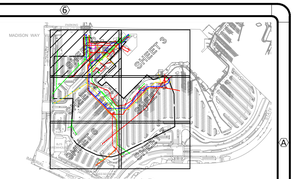
NO	DATE	BY	DESCRIPTION

DATE LOCATED: 02/2018
DRAWN BY/DATE: JP 02/20/2018
TECHNICIAN CHECK BY/DATE: B. TRAHAN
QC CHECKED BY/DATE: OG 02/23/2018
SCALE: N.T.S
PROJECT NO: 17-1578

SHEET 1 OF 7

"A"





VICINITY MAP

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LEGEND

ELECTRICAL	E
GAS	G
COMMUNICATION	C
WATER	W
SANITARY SEWER	SS
STORM DRAIN	SD
POSSIBLE LINE LOCATION	U
STREET LIGHT	SL
AIR	AIR
TRAFFIC SIGNAL	TS
FIRE WATER	FW
CHILLED WATER	CHW
DOMESTIC WATER	DW
HOT WATER	HW
OFFSET FROM REFERENCE	10'-8"
DEPTH FROM SURFACE	1'-6"

KEY NOTES

1. NON-CONDUCTIVE, UNABLE TO LOCATE PAST THIS POINT.
2. BLOCKED
3. NO ACCESS, UNABLE TO LOCATE PAST THIS POINT.
4. CANNOT PUSH FURTHER PAST THIS POINT.
5. AT BUILDING
6. AT DROP
7. CANNOT OPEN, UNABLE TO LOCATE PAST THIS POINT.

N

20 10 0 20 40

SCALE IN FEET
1 inch =20 ft.

C BELOW SUBSURFACE IMAGING
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PROJECT:

PARTIAL UNDERGROUND UTILITY MAP FOR:
BREA MALL
1065 BREA MALL
BREA, CA 92821

CLIENT:

RA SMITH NATIONAL, LLC
8881 RESEARCH DR.
IRVINE, CA 92618

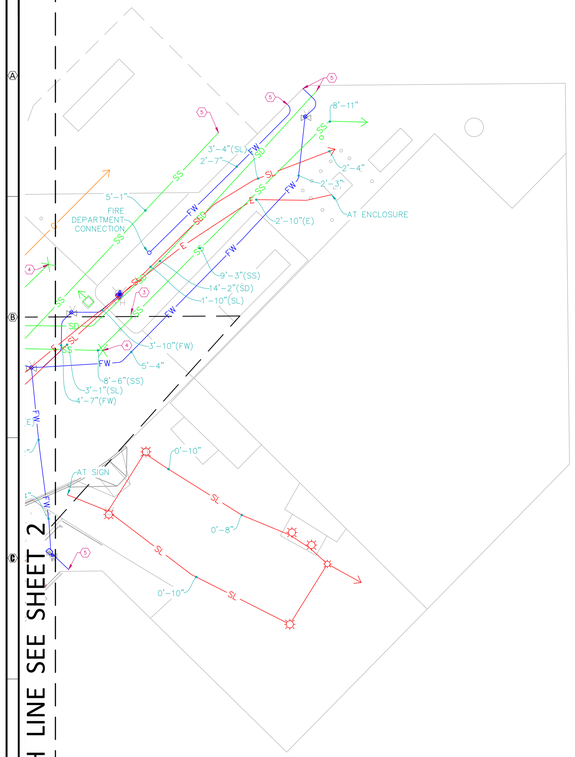
REVISIONS

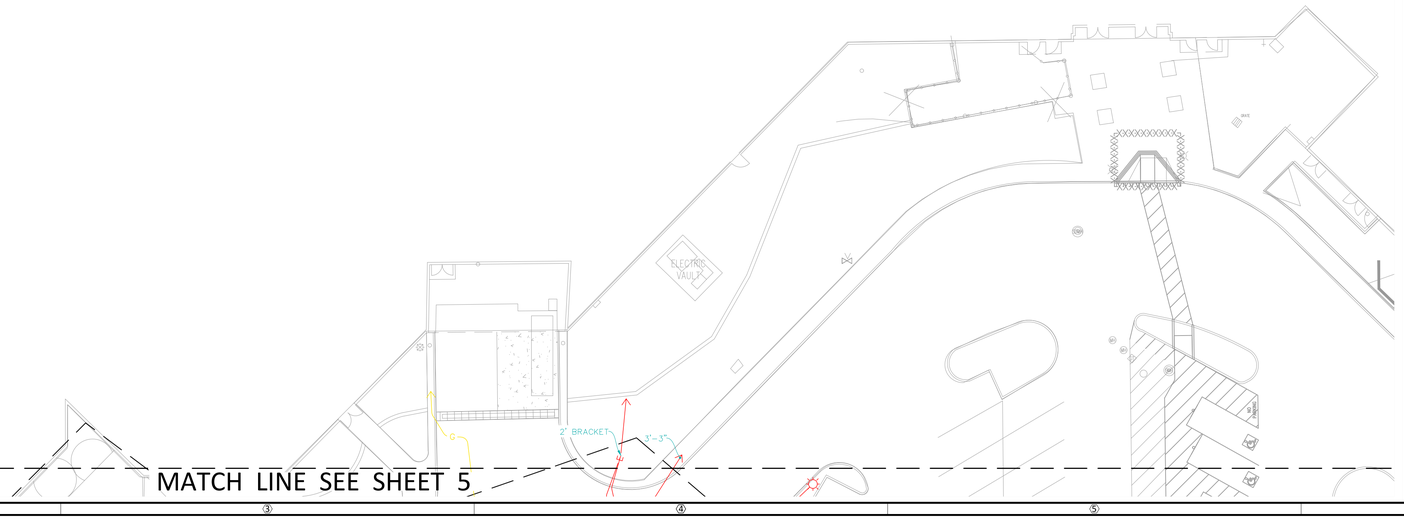
NO	DATE	BY	DESCRIPTION

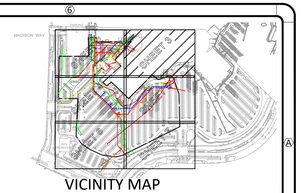
DATE LOCATED: 02/2018
DRAWN BY/DATE: JP 02/20/2018
TECHNICIAN CHECK BY/DATE: B. TRAHAN
QC CHECKED BY/DATE: OG 02/23/2018
SCALE: 1" = 20'
PROJECT NO: 17-1578

SHEET 2 OF 7

L-42







VICINITY MAP

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LEGEND

- ELECTRICAL — E
- GAS — G
- COMMUNICATION — C
- WATER — W
- SANITARY SEWER — SS
- STORM DRAIN — SD
- POSSIBLE LINE LOCATION — U
- STREET LIGHT — SL
- AIR — AIR
- TRAFFIC SIGNAL — TS
- FIRE WATER — FW
- CHILLED WATER — CHW
- DOMESTIC WATER — DW
- HOT WATER — HW
- OFFSET FROM REFERENCE — 10'-8"
- DEPTH FROM SURFACE — 1'-6"

KEY NOTES

1. NON-CONDUCTIVE, UNABLE TO LOCATE PAST THIS POINT.
2. BLOCKED
3. NO ACCESS, UNABLE TO LOCATE PAST THIS POINT.
4. CANNOT PUSH FURTHER PAST THIS POINT.
5. AT BUILDING
6. AT DROP
7. CANNOT OPEN, UNABLE TO LOCATE PAST THIS POINT.

N

20 10 0 20 40

SCALE IN FEET
1 inch =20 ft.

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PROJECT:

PARTIAL UNDERGROUND UTILITY MAP FOR:
BREA MALL
1065 BREA MALL
BREA, CA 92821

CLIENT:

RA SMITH NATIONAL, LLC
8881 RESEARCH DR.
IRVINE, CA 92618

REVISIONS

NO	DATE	BY	DESCRIPTION

DATE LOCATED: 02/2018
DRAWN BY/DATE: JP 02/20/2018
TECHNICIAN CHECK BY/DATE: B. TRAHAN
QC CHECKED BY/DATE: OG 02/23/2018
SCALE: 1" = 20'
PROJECT NO: 17-1578

SHEET 3 OF 7

L-43

MATCH LINE SEE SHEET 2

STORM DRAIN GRATE INVERT DEPTH AT 10'-8" FROM TOP OF RIM

CATCH BASIN

SURVEY AREA

ELECTRIC RISER AT SIGN DOES NOT ENTER SCOPE OF WORK

SEWER MH INVERT DEPTH AT 10'-11" FROM TOP OF RIME

STORM DRAIN MH INVERT DEPTH AT 7'-3" FROM TOP OF RIM

BIKE RACK

HOSE BIB

STOP

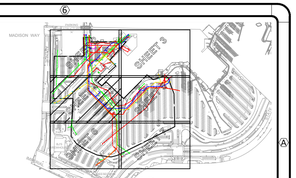
AT CURB OUTLET

STORM DRAIN MH INVERT DEPTH AT 4'-2" FROM TOP OF RIM

SEWER MH INVERT DEPTH AT 12'-3" FROM TOP OF RIM

MATCH LINE SEE SHEET 5

MATCH LINE SEE SHEET 6



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LEGEND

ELECTRICAL	E
GAS	G
COMMUNICATION	C
WATER	W
SANITARY SEWER	SS
STORM DRAIN	SD
POSSIBLE LINE LOCATION	U
STREET LIGHT	SL
AIR	AIR
TRAFFIC SIGNAL	TS
FIRE WATER	FW
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HOT WATER	HW
OFFSET FROM REFERENCE	10'-8"
DEPTH FROM SURFACE	1'-6"

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N

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1065 BREA MALL
BREA, CA 92821

CLIENT:

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REVISIONS

NO	DATE	BY	DESCRIPTION

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QC CHECKED BY/DATE: OG 02/23/2018
SCALE: 1" = 20'
PROJECT NO: 17-1578

SHEET 4 OF 7

L-44

MATCH LINE SEE SHEET 3

MATCH LINE SEE SHEET 4

MATCH LINE SEE SHEET 7

SURVEY AREA

SURVEY AREA

STORM DRAIN MH INVERT DEPTH AT 5'-6" FROM TOP OF RIM

STORM DRAIN MH INVERT DEPTH AT 5'-3" FROM TOP OF RIM

STORM DRAIN MH INVERT DEPTH AT 7'-2" FROM TOP OF RIM

AT CHARGING STATION

AT CHARGING STATION

COMM PULL BOX

2'(E) BRACKET

4'-0"(E)

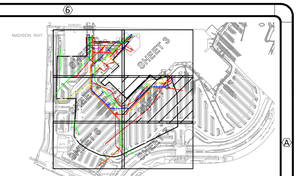
3'-10"(C)

4'-1"(C)

4'-6"(E)

NVERT DEPTH P OF RIM

12"x12" DI



VICINITY MAP

UTILITY NOTES

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6. IN THE EVENT THE INFORMATION SHOWN IN THIS PLAN VARIES FROM THE ACTUAL SITE CONDITIONS, C BELOW SHALL BE NOTIFIED WITHIN 24 HOURS AFTER DISCOVERY OF THE CONFLICT.

LEGEND

ELECTRICAL	E
GAS	G
COMMUNICATION	C
WATER	W
SANITARY SEWER	SS
STORM DRAIN	SD
POSSIBLE LINE LOCATION	U
STREET LIGHT	SL
AIR	AIR
TRAFFIC SIGNAL	TS
FIRE WATER	FW
CHILLED WATER	CHW
DOMESTIC WATER	DW
HOT WATER	HW
OFFSET FROM REFERENCE	10'-8"
DEPTH FROM SURFACE	1'-6"

KEY NOTES

1. NON-CONDUCTIVE, UNABLE TO LOCATE PAST THIS POINT.
2. BLOCKED
3. NO ACCESS, UNABLE TO LOCATE PAST THIS POINT.
4. CANNOT PUSH FURTHER PAST THIS POINT.
5. AT BUILDING
6. AT DROP
7. CANNOT OPEN, UNABLE TO LOCATE PAST THIS POINT.

N

20 10 0 20 40

SCALE IN FEET
1 inch =20 ft.

C BELOW SUBSURFACE IMAGING
14280 EUCLID AVE
CHINO, CA 91710
P: 888-902-3569
F: 909-606-6555
www.cbelow.com

GROUND PENETRATING RADAR (GPR)
UTILITY LOCATING
RADIOGRAPHY
POTHOLING
MAPPING

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PROJECT:

PARTIAL UNDERGROUND UTILITY MAP FOR:
BREA MALL
1065 BREA MALL
BREA, CA 92821

CLIENT:

RA SMITH NATIONAL, LLC
8881 RESEARCH DR.
IRVINE, CA 92618

REVISIONS

NO	DATE	BY	DESCRIPTION

DATE LOCATED:	02/2018
DRAWN BY/DATE:	JP 02/20/2018
TECHNICIAN CHECK BY/DATE:	B. TRAHAN
QC CHECKED BY/DATE:	OG 02/23/2018
SCALE:	1" = 20'
PROJECT NO:	17-1578

SHEET 5 OF 7

L-45

MATCH LINE SEE SHEET 4

NOT A PART

BJ'S BREWHOUSE

STORM DRAIN MH INVERT DEPTH AT 6'-0" FROM TOP OF RIM

6'-5"

7'-4"

5'-10"

STORM DRAIN GRATE INVERT DEPTH AT 4'-2" FROM TOP OF RIM

SURVEY AREA

5'-7"

3'-7"

3'-2"

3'-1"(E)

3'-6"

14'-7"

3'-0"

SEWER MH INVERT DEPTH AT 14'-9" FROM TOP OF RIM

3'-3"

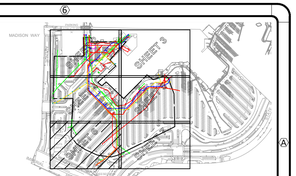
3'-6"

SEWER MH INVERT DEPTH AT 9'-5" FROM TOP OF RIM

3'-3"

3'-5"

MATCH LINE SEE SHEET 7



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LEGEND

ELECTRICAL	E
GAS	G
COMMUNICATION	C
WATER	W
SANITARY SEWER	SS
STORM DRAIN	SD
POSSIBLE LINE LOCATION	U
STREET LIGHT	SL
AIR	AIR
TRAFFIC SIGNAL	TS
FIRE WATER	FW
CHILLED WATER	CHW
DOMESTIC WATER	DW
HOT WATER	HW
OFFSET FROM REFERENCE	10'-8"
DEPTH FROM SURFACE	1'-6"

KEY NOTES

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N

20 10 0 20 40

SCALE IN FEET
1 inch =20 ft.

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PROJECT:

PARTIAL UNDERGROUND UTILITY MAP FOR:
BREA MALL
1065 BREA MALL
BREA, CA 92821

CLIENT:

RA SMITH NATIONAL, LLC
8881 RESEARCH DR.
IRVINE, CA 92618

REVISIONS

NO	DATE	BY	DESCRIPTION

DATE LOCATED: 02/2018
DRAWN BY/DATE: JP 02/20/2018
TECHNICIAN CHECK BY/DATE: B. TRAHAN
QC CHECKED BY/DATE: OG 02/23/2018
SCALE: 1" = 20'
PROJECT NO: 17-1578

SHEET 6 OF 7

L-46

MATCH LINE SEE SHEET 5

MATCH LINE SEE SHEET 6

SURVEY AREA

SL

2'-6"

SS

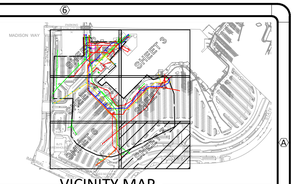
16'-1"

CAPPED LINE

SD

STORM DRAIN MH

3' BRACKET



VICINITY MAP

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GAS	G
COMMUNICATION	C
WATER	W
SANITARY SEWER	SS
STORM DRAIN	SD
POSSIBLE LINE LOCATION	U
STREET LIGHT	SL
AIR	AIR
TRAFFIC SIGNAL	TS
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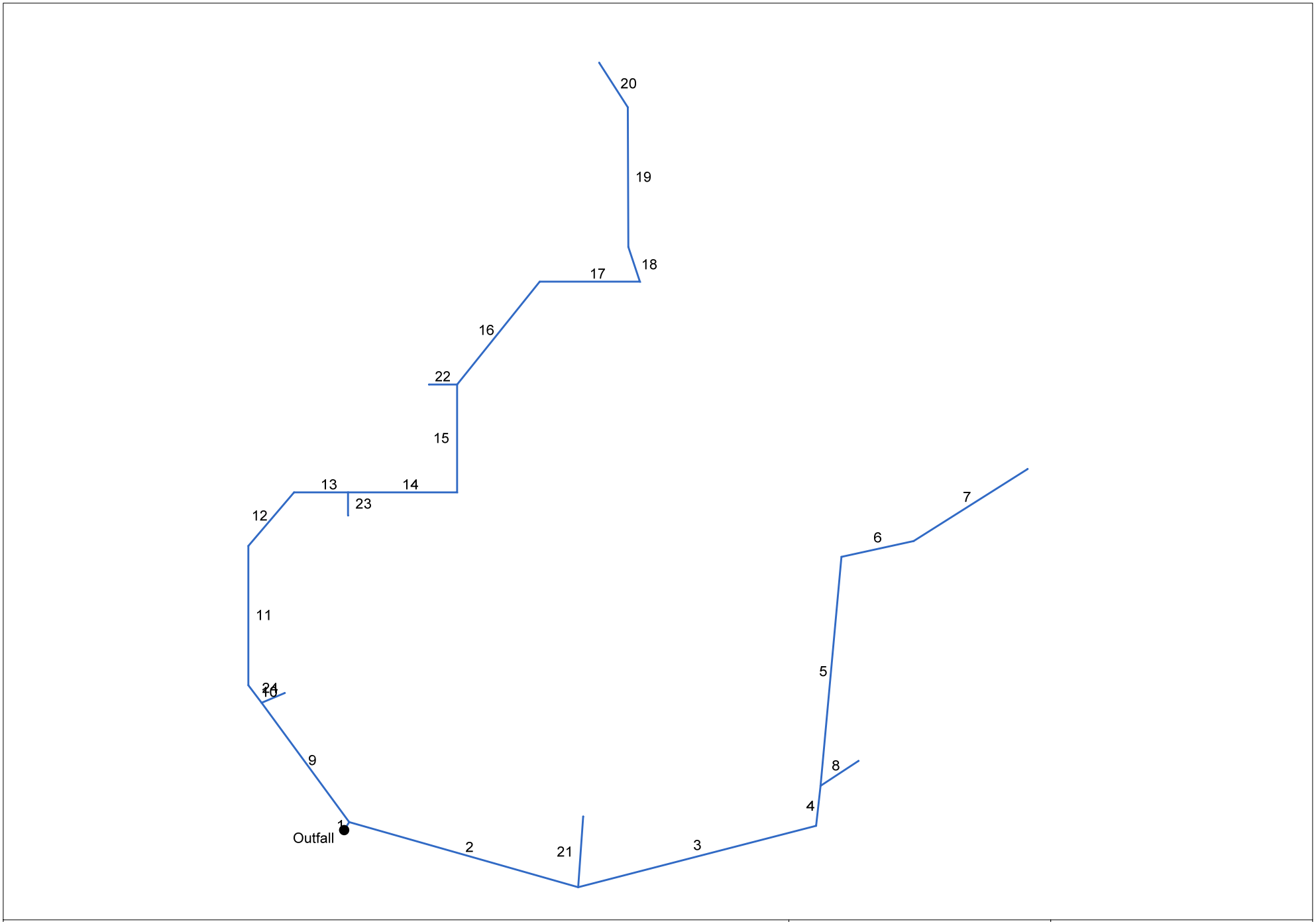
SCALE: 1" = 20'
PROJECT NO: 17-1578

SHEET 7 OF 7

L-47

Attachment 8 – 10yr HGL Analysis for Drainage Areas 1 & 2 to Chamber System

Hydraflow Storm Sewers Extension for Autodesk® Civil 3D® Plan



Project File: STO 100 - 10yr.stm	Number of lines: 24	Date: 3/5/2022

Hydraulic Grade Line Computations

Line	Size	Q	Downstream								Len	Upstream								Check		JL coeff	Minor loss
			Invert elev (ft)	HGL elev (ft)	Depth (ft)	Area (sqft)	Vel (ft/s)	Vel head (ft)	EGL elev (ft)	Sf (%)		Invert elev (ft)	HGL elev (ft)	Depth (ft)	Area (sqft)	Vel (ft/s)	Vel head (ft)	EGL elev (ft)	Sf (%)	Ave Sf (%)	Enrgy loss (ft)		
(1)	(in) (2)	(cfs) (3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(ft) (12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(K) (23)	(ft) (24)
1	36	47.85	322.75	325.00	2.25	5.69	8.41	1.10	326.10	0.000	10.000	325.00	327.25	2.25**	5.69	8.41	1.10	328.35	0.000	0.000	n/a	0.99	n/a
2	24	16.19	325.00	327.25	2.00	2.44	5.15	0.41	327.66	0.437	220.581	332.83	334.28 j	1.45**	2.44	6.64	0.69	334.96	0.570	0.503	n/a	1.00	0.69
3	24	15.30	332.83	334.28	1.45	2.37	6.27	0.65	334.93	0.000	226.794	338.22	339.63 j	1.41**	2.37	6.47	0.65	340.28	0.000	0.000	n/a	0.94	0.61
4	24	15.30	338.22	339.63	1.41*	2.37	6.47	0.65	340.28	0.000	45.131	339.40	340.81	1.41**	2.37	6.47	0.65	341.46	0.000	0.000	n/a	0.77	0.50
5	18	4.47	339.40	340.81	1.41	0.97	2.59	0.33	341.14	0.000	257.835	346.50	347.31 j	0.81**	0.97	4.59	0.33	347.64	0.000	0.000	n/a	0.95	0.31
6	18	4.47	346.50	347.31	0.81*	0.97	4.59	0.33	347.64	0.000	67.990	347.18	347.99	0.81**	0.97	4.59	0.33	348.32	0.000	0.000	n/a	0.45	0.15
7	18	4.47	347.18	347.99	0.81*	0.97	4.59	0.33	348.32	0.000	131.407	348.51	349.32	0.81**	0.97	4.59	0.33	349.65	0.000	0.000	n/a	1.00	0.33
8	12	1.37	339.40	340.81	1.00	0.79	1.74	0.05	340.86	0.126	44.656	339.85	340.85	1.00	0.79	1.74	0.05	340.90	0.124	0.125	0.056	1.00	0.05
9	36	31.66	325.00	327.25	2.25	4.50	5.57	0.77	328.02	0.000	155.927	326.05	327.87 j	1.82**	4.50	7.04	0.77	328.64	0.000	0.000	n/a	1.00	n/a
10	30	26.28	326.05	327.87	1.82	3.66	6.85	0.80	328.67	0.000	23.122	326.40	328.15 j	1.75**	3.66	7.18	0.80	328.95	0.000	0.000	n/a	0.57	0.46
11	30	26.28	326.40	328.15	1.75*	3.66	7.18	0.80	328.95	0.000	156.495	328.75	330.50	1.75**	3.66	7.18	0.80	331.30	0.000	0.000	n/a	0.62	0.50
12	30	26.28	328.75	330.50	1.75*	3.66	7.18	0.80	331.30	0.000	73.206	329.23	330.98	1.75**	3.66	7.18	0.80	331.78	0.000	0.000	n/a	0.85	0.68
13	30	25.62	329.23	330.98	1.75	3.61	7.00	0.78	331.76	0.000	49.040	329.55	331.27 j	1.72**	3.61	7.10	0.78	332.06	0.000	0.000	n/a	1.00	n/a
14	30	20.73	329.55	331.27	1.72	3.19	5.74	0.66	331.93	0.000	99.004	330.19	331.74 j	1.55**	3.19	6.51	0.66	332.39	0.000	0.000	n/a	1.00	n/a
15	30	20.73	330.19	331.74	1.55*	3.19	6.51	0.66	332.39	0.000	121.184	330.98	332.53	1.55**	3.19	6.51	0.66	333.18	0.000	0.000	n/a	1.00	n/a
16	30	9.87	330.98	332.53	1.55	1.95	3.10	0.40	332.92	0.000	137.819	332.36	333.41 j	1.05**	1.95	5.05	0.40	333.81	0.000	0.000	n/a	0.87	n/a
17	24	9.87	332.36	333.41	1.05	1.67	5.92	0.46	333.87	0.000	91.054	333.53	334.65	1.12**	1.82	5.44	0.46	335.11	0.000	0.000	n/a	1.00	0.46
18	24	8.83	333.53	334.65	1.12	1.69	4.86	0.42	335.08	0.000	40.449	334.05	335.11 j	1.06**	1.69	5.23	0.42	335.53	0.000	0.000	n/a	0.31	0.13
19	24	2.99	334.06	335.11	1.05	0.80	1.79	0.22	335.33	0.000	157.000	334.84	335.44 j	0.60**	0.80	3.75	0.22	335.66	0.000	0.000	n/a	0.52	0.11
20	10	0.88	334.84	335.44	0.60	0.27	2.08	0.16	335.61	0.000	56.246	335.16	335.58 j	0.42**	0.27	3.24	0.16	335.74	0.000	0.000	n/a	1.00	n/a
21	12	0.89	332.83	334.28	1.00	0.79	1.13	0.02	334.30	0.053	79.422	333.62	334.31	0.69	0.58	1.53	0.04	334.35	0.078	0.065	0.052	1.00	0.04

Project File: STO 100 - 10yr.stm | Number of lines: 24 | Run Date: 3/5/2022

Notes: * depth assumed; ** Critical depth.; j-Line contains hyd. jump ; c = cir e = ellip b = box

Hydraulic Grade Line Computations

Line	Size	Q	Downstream								Len	Upstream								Check		JL coeff	Minor loss
			Invert elev (ft)	HGL elev (ft)	Depth (ft)	Area (sqft)	Vel (ft/s)	Vel head (ft)	EGL elev (ft)	Sf (%)		Invert elev (ft)	HGL elev (ft)	Depth (ft)	Area (sqft)	Vel (ft/s)	Vel head (ft)	EGL elev (ft)	Sf (%)	Ave Sf (%)	Enrgy loss (ft)		
(1)	(in) (2)	(cfs) (3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(ft) (12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(K) (23)	(ft) (24)
22	18	7.96	330.98	332.53	1.50	1.77	4.51	0.32	332.84	0.490	25.723	331.37	332.49	1.12	1.41	5.65	0.50	332.98	0.601	0.545	0.140	1.00	0.50
23	18	4.89	329.55	331.27	1.50	1.03	2.77	0.12	331.39	0.185	26.044	331.12	331.97 j	0.85**	1.03	4.74	0.35	332.32	0.490	0.337	n/a	1.00	n/a
24	18	5.38	326.05	327.87	1.50	1.10	3.05	0.14	328.02	0.224	24.166	328.61	329.50 j	0.89**	1.10	4.90	0.37	329.88	0.507	0.365	n/a	1.00	0.37

Project File: STO 100 - 10yr.stm | Number of lines: 24 | Run Date: 3/5/2022

Notes: * depth assumed; ** Critical depth.; j-Line contains hyd. jump ; c = cir e = ellip b = box

Hydraflow HGL Computation Procedure

General Procedure:

Hydraflow computes the HGL using the Bernoulli energy equation. Manning's equation is used to determine energy losses due to pipe friction. In a standard step, iterative procedure, Hydraflow assumes upstream HGLs until the energy equation balances. If the energy equation cannot balance, supercritical flow exists and critical depth is temporarily assumed at the upstream end. A supercritical flow Profile is then computed using the same procedure in a downstream direction using momentum principles.

Col. 1 The line number being computed. Calculations begin at Line 1 and proceed upstream.

Col. 2 The line size. In the case of non-circular pipes, the line rise is printed above the span.

Col. 3 Total flow rate in the line.

Col. 4 The elevation of the downstream invert.

Col. 5 Elevation of the hydraulic grade line at the downstream end. This is computed as the upstream HGL + Minor loss of this line's downstream line.

Col. 6 The downstream depth of flow inside the pipe (HGL - Invert elevation) but not greater than the line size.

Col. 7 Cross-sectional area of the flow at the downstream end.

Col. 8 The velocity of the flow at the downstream end, (Col. 3 / Col. 7).

Col. 9 Velocity head (Velocity squared / 2g).

Col. 10 The elevation of the energy grade line at the downstream end, HGL + Velocity head, (Col. 5 + Col. 9).

Col. 11 The friction slope at the downstream end (the S or Slope term in Manning's equation).

Col. 12 The line length.

Col. 13 The elevation of the upstream invert.

Col. 14 Elevation of the hydraulic grade line at the upstream end.

Col. 15 The upstream depth of flow inside the pipe (HGL - Invert elevation) but not greater than the line size.

Col. 16 Cross-sectional area of the flow at the upstream end.

Col. 17 The velocity of the flow at the upstream end, (Col. 3 / Col. 16).

Col. 18 Velocity head (Velocity squared / 2g).

Col. 19 The elevation of the energy grade line at the upstream end, HGL + Velocity head, (Col. 14 + Col. 18) .

Col. 20 The friction slope at the upstream end (the S or Slope term in Manning's equation).

Col. 21 The average of the downstream and upstream friction slopes.

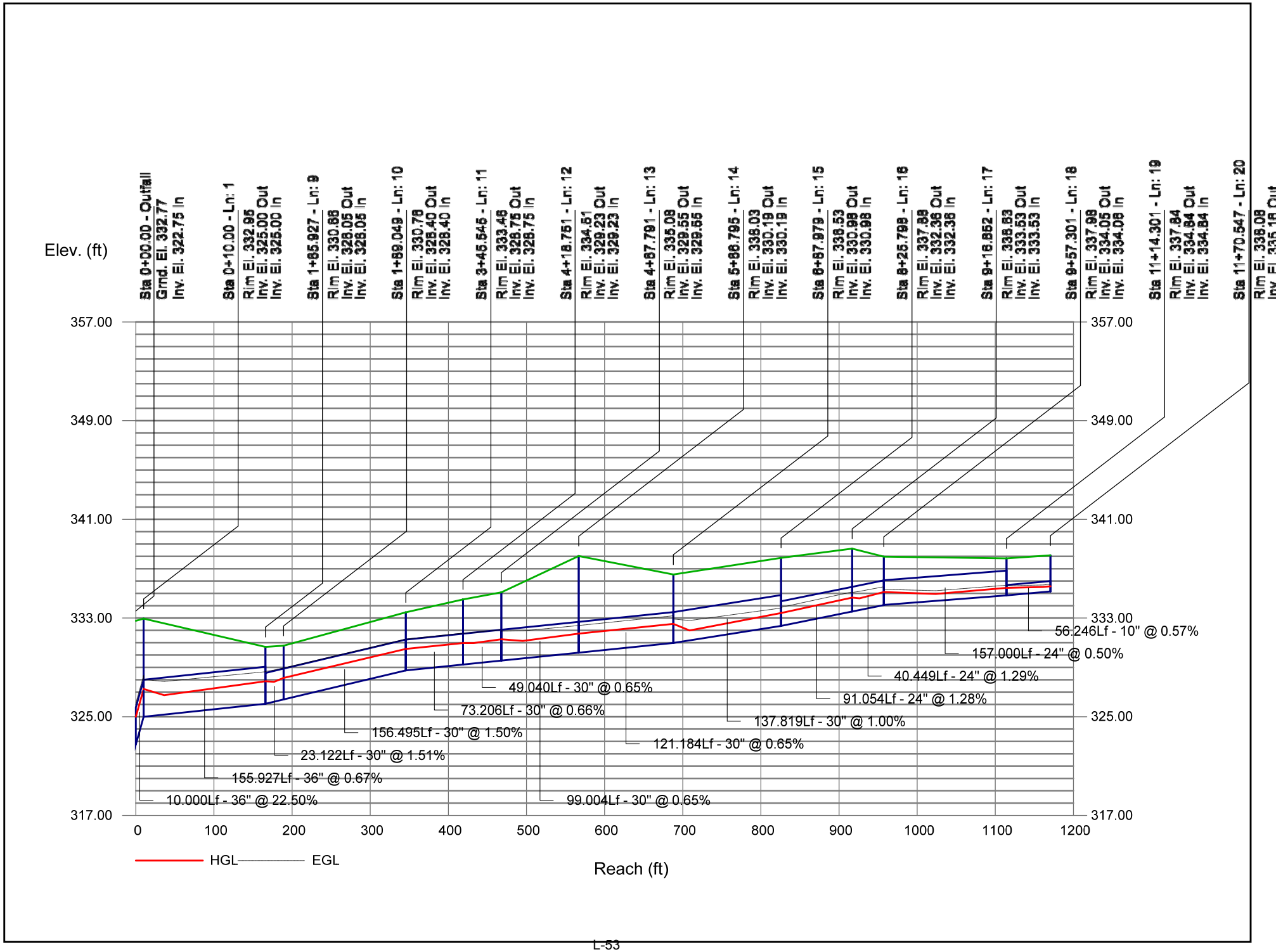
Col. 22 Energy loss. Average Sf/100 x Line Length (Col. 21/100 x Col. 12). Equals (EGL upstream - EGL downstream) +/- tolerance.

Col. 23 The junction loss coefficient (K).

Col. 24 Minor loss. (Col. 23 x Col. 18). Is added to upstream HGL and used as the starting HGL for the next upstream line(s).

Storm Sewer Profile

Proj. file: STO 100 - 10yr.stm



Storm Sewer Profile

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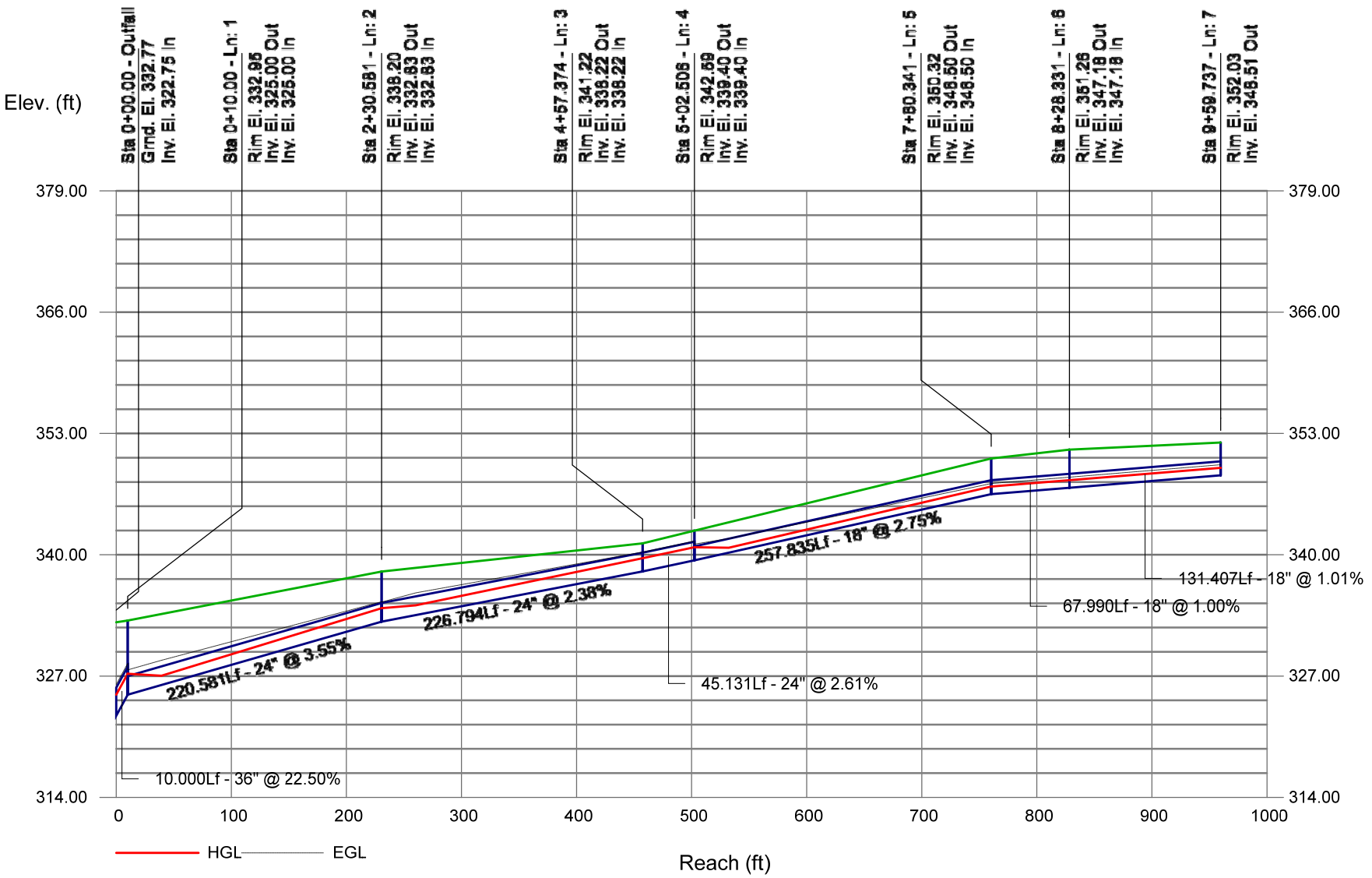
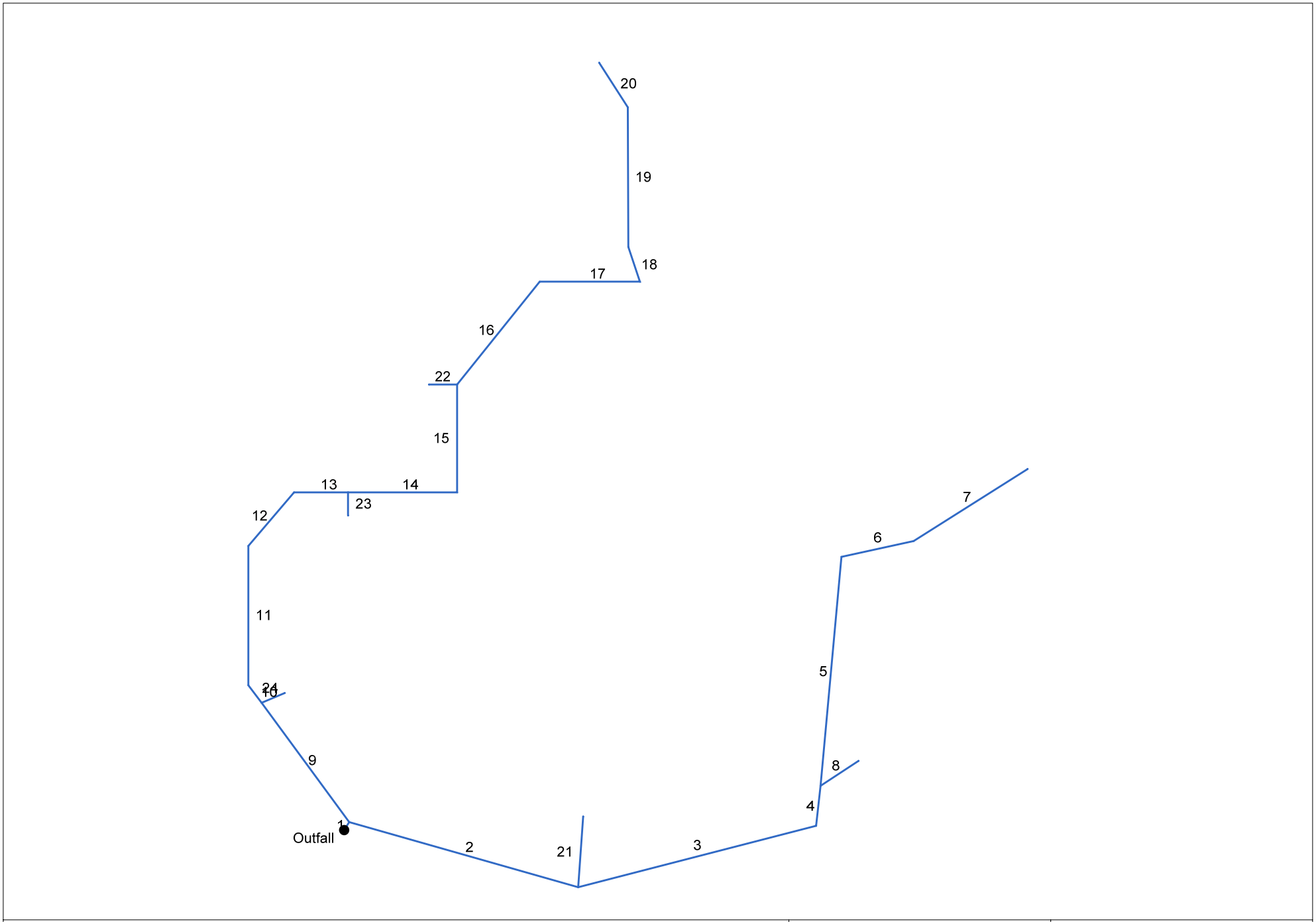


Attachment 9 – 25yr HGL Analysis for Drainage Areas 1 & 2 to Chamber System

Hydraflow Storm Sewers Extension for Autodesk® Civil 3D® Plan



Project File: STO 100 - 25yr.stm	Number of lines: 24	Date: 3/5/2022

Hydraulic Grade Line Computations

Line	Size	Q	Downstream								Len	Upstream								Check		JL coeff	Minor loss
			Invert elev (ft)	HGL elev (ft)	Depth (ft)	Area (sqft)	Vel (ft/s)	Vel head (ft)	EGL elev (ft)	Sf (%)		Invert elev (ft)	HGL elev (ft)	Depth (ft)	Area (sqft)	Vel (ft/s)	Vel head (ft)	EGL elev (ft)	Sf (%)	Ave Sf (%)	Enrgy loss (ft)		
(1)	(in) (2)	(cfs) (3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(ft) (12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(K) (23)	(ft) (24)
1	36	56.95	322.75	325.19	2.44	6.16	9.24	1.33	326.52	0.000	10.000	325.00	327.44	2.44**	6.16	9.24	1.33	328.77	0.000	0.000	n/a	0.99	n/a
2	24	19.28	325.00	327.44	2.00	2.66	6.14	0.59	328.03	0.619	220.581	332.83	334.41 j	1.58**	2.66	7.25	0.82	335.23	0.666	0.643	n/a	1.00	n/a
3	24	18.22	332.83	334.41	1.58	2.59	6.85	0.77	335.18	0.000	226.794	338.22	339.76 j	1.54**	2.59	7.04	0.77	340.53	0.000	0.000	n/a	0.94	n/a
4	24	18.22	338.22	339.76	1.54*	2.59	7.04	0.77	340.53	0.000	45.131	339.40	340.94	1.54**	2.59	7.04	0.77	341.71	0.000	0.000	n/a	0.77	n/a
5	18	5.32	339.40	340.94	1.50	1.09	3.01	0.14	341.08	0.219	257.835	346.50	347.39 j	0.89**	1.09	4.89	0.37	347.76	0.505	0.362	n/a	0.95	0.35
6	18	5.32	346.50	347.39	0.89*	1.09	4.89	0.37	347.76	0.000	67.990	347.18	348.07	0.89**	1.09	4.89	0.37	348.44	0.000	0.000	n/a	0.45	0.17
7	18	5.32	347.18	348.07	0.89*	1.09	4.89	0.37	348.44	0.000	131.407	348.51	349.40	0.89**	1.09	4.89	0.37	349.77	0.000	0.000	n/a	1.00	0.37
8	12	1.63	339.40	340.94	1.00	0.79	2.08	0.07	341.00	0.179	44.656	339.85	341.02	1.00	0.79	2.08	0.07	341.08	0.179	0.179	0.080	1.00	0.07
9	36	37.67	325.00	327.44	2.44	4.99	6.11	0.89	328.33	0.000	155.927	326.05	328.04 j	1.99**	4.99	7.55	0.89	328.93	0.000	0.000	n/a	1.00	n/a
10	30	31.28	326.05	328.04	1.99	4.01	7.45	0.95	328.99	0.000	23.122	326.40	328.30 j	1.90**	4.01	7.80	0.95	329.25	0.000	0.000	n/a	0.57	0.54
11	30	31.28	326.40	328.30	1.90*	4.01	7.80	0.95	329.25	0.000	156.495	328.75	330.65	1.90**	4.01	7.80	0.95	331.60	0.000	0.000	n/a	0.62	0.59
12	30	31.28	328.75	330.65	1.90*	4.01	7.80	0.95	331.60	0.000	73.206	329.23	331.13	1.90**	4.01	7.80	0.95	332.08	0.000	0.000	n/a	0.85	0.80
13	30	30.49	329.23	331.13	1.90	3.96	7.60	0.92	332.06	0.000	49.040	329.55	331.43 j	1.88**	3.96	7.70	0.92	332.35	0.000	0.000	n/a	1.00	0.92
14	30	24.68	329.55	331.43	1.88	3.53	6.23	0.76	332.19	0.000	99.004	330.19	331.88 j	1.69**	3.53	6.98	0.76	332.64	0.000	0.000	n/a	1.00	n/a
15	30	24.68	330.19	331.88	1.69*	3.53	6.98	0.76	332.64	0.000	121.184	330.98	332.67	1.69**	3.53	6.98	0.76	333.43	0.000	0.000	n/a	1.00	n/a
16	30	11.76	330.98	332.67	1.69	2.20	3.33	0.44	333.11	0.000	137.819	332.36	333.51 j	1.15**	2.20	5.34	0.44	333.95	0.000	0.000	n/a	0.87	n/a
17	24	11.76	332.36	333.51	1.15	1.87	6.30	0.52	334.03	0.000	91.054	333.53	334.76	1.23**	2.03	5.80	0.52	335.28	0.000	0.000	n/a	1.00	n/a
18	24	10.52	333.53	334.76	1.23	1.89	5.19	0.48	335.24	0.000	40.449	334.05	335.21 j	1.16**	1.89	5.56	0.48	335.69	0.000	0.000	n/a	0.31	0.15
19	24	3.56	334.06	335.21	1.15	0.90	1.90	0.24	335.45	0.000	157.000	334.84	335.50 j	0.66**	0.90	3.94	0.24	335.74	0.000	0.000	n/a	0.52	n/a
20	10	1.05	334.84	335.50	0.66	0.30	2.27	0.08	335.58	0.209	56.246	335.16	335.62 j	0.46**	0.31	3.43	0.18	335.80	0.575	0.392	0.221	1.00	0.18
21	12	1.06	332.83	334.41	1.00	0.79	1.35	0.03	334.44	0.076	79.422	333.62	334.46	0.84	0.70	1.51	0.04	334.49	0.073	0.074	0.059	1.00	0.04

Project File: STO 100 - 25yr.stm | Number of lines: 24 | Run Date: 3/5/2022

Notes: * depth assumed; ** Critical depth.; j-Line contains hyd. jump ; c = cir e = ellip b = box

Hydraulic Grade Line Computations

Line	Size	Q	Downstream								Len	Upstream								Check		JL coeff	Minor loss
			Invert elev (ft)	HGL elev (ft)	Depth (ft)	Area (sqft)	Vel (ft/s)	Vel head (ft)	EGL elev (ft)	Sf (%)		Invert elev (ft)	HGL elev (ft)	Depth (ft)	Area (sqft)	Vel (ft/s)	Vel head (ft)	EGL elev (ft)	Sf (%)	Ave Sf (%)	Enrgy loss (ft)		
(1)	(in) (2)	(cfs) (3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(ft) (12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(K) (23)	(ft) (24)
22	18	9.46	330.98	332.67	1.50	1.77	5.35	0.45	333.12	0.692	25.723	331.37	332.83	1.46	1.76	5.39	0.45	333.28	0.614	0.653	0.168	1.00	0.45
23	18	5.81	329.55	331.43	1.50	1.15	3.29	0.17	331.60	0.261	26.044	331.12	332.05 j	0.93**	1.15	5.05	0.40	332.45	0.524	0.393	n/a	1.00	n/a
24	18	6.39	326.05	328.04	1.50	1.22	3.62	0.20	328.25	0.316	24.166	328.61	329.59 j	0.98**	1.22	5.25	0.43	330.01	0.549	0.432	n/a	1.00	0.43

Project File: STO 100 - 25yr.stm | Number of lines: 24 | Run Date: 3/5/2022

Notes: * depth assumed; ** Critical depth.; j-Line contains hyd. jump ; c = cir e = ellip b = box

Hydraflow HGL Computation Procedure

General Procedure:

Hydraflow computes the HGL using the Bernoulli energy equation. Manning's equation is used to determine energy losses due to pipe friction. In a standard step, iterative procedure, Hydraflow assumes upstream HGLs until the energy equation balances. If the energy equation cannot balance, supercritical flow exists and critical depth is temporarily assumed at the upstream end. A supercritical flow Profile is then computed using the same procedure in a downstream direction using momentum principles.

Col. 1 The line number being computed. Calculations begin at Line 1 and proceed upstream.

Col. 2 The line size. In the case of non-circular pipes, the line rise is printed above the span.

Col. 3 Total flow rate in the line.

Col. 4 The elevation of the downstream invert.

Col. 5 Elevation of the hydraulic grade line at the downstream end. This is computed as the upstream HGL + Minor loss of this line's downstream line.

Col. 6 The downstream depth of flow inside the pipe (HGL - Invert elevation) but not greater than the line size.

Col. 7 Cross-sectional area of the flow at the downstream end.

Col. 8 The velocity of the flow at the downstream end, (Col. 3 / Col. 7).

Col. 9 Velocity head (Velocity squared / 2g).

Col. 10 The elevation of the energy grade line at the downstream end, HGL + Velocity head, (Col. 5 + Col. 9).

Col. 11 The friction slope at the downstream end (the S or Slope term in Manning's equation).

Col. 12 The line length.

Col. 13 The elevation of the upstream invert.

Col. 14 Elevation of the hydraulic grade line at the upstream end.

Col. 15 The upstream depth of flow inside the pipe (HGL - Invert elevation) but not greater than the line size.

Col. 16 Cross-sectional area of the flow at the upstream end.

Col. 17 The velocity of the flow at the upstream end, (Col. 3 / Col. 16).

Col. 18 Velocity head (Velocity squared / 2g).

Col. 19 The elevation of the energy grade line at the upstream end, HGL + Velocity head, (Col. 14 + Col. 18) .

Col. 20 The friction slope at the upstream end (the S or Slope term in Manning's equation).

Col. 21 The average of the downstream and upstream friction slopes.

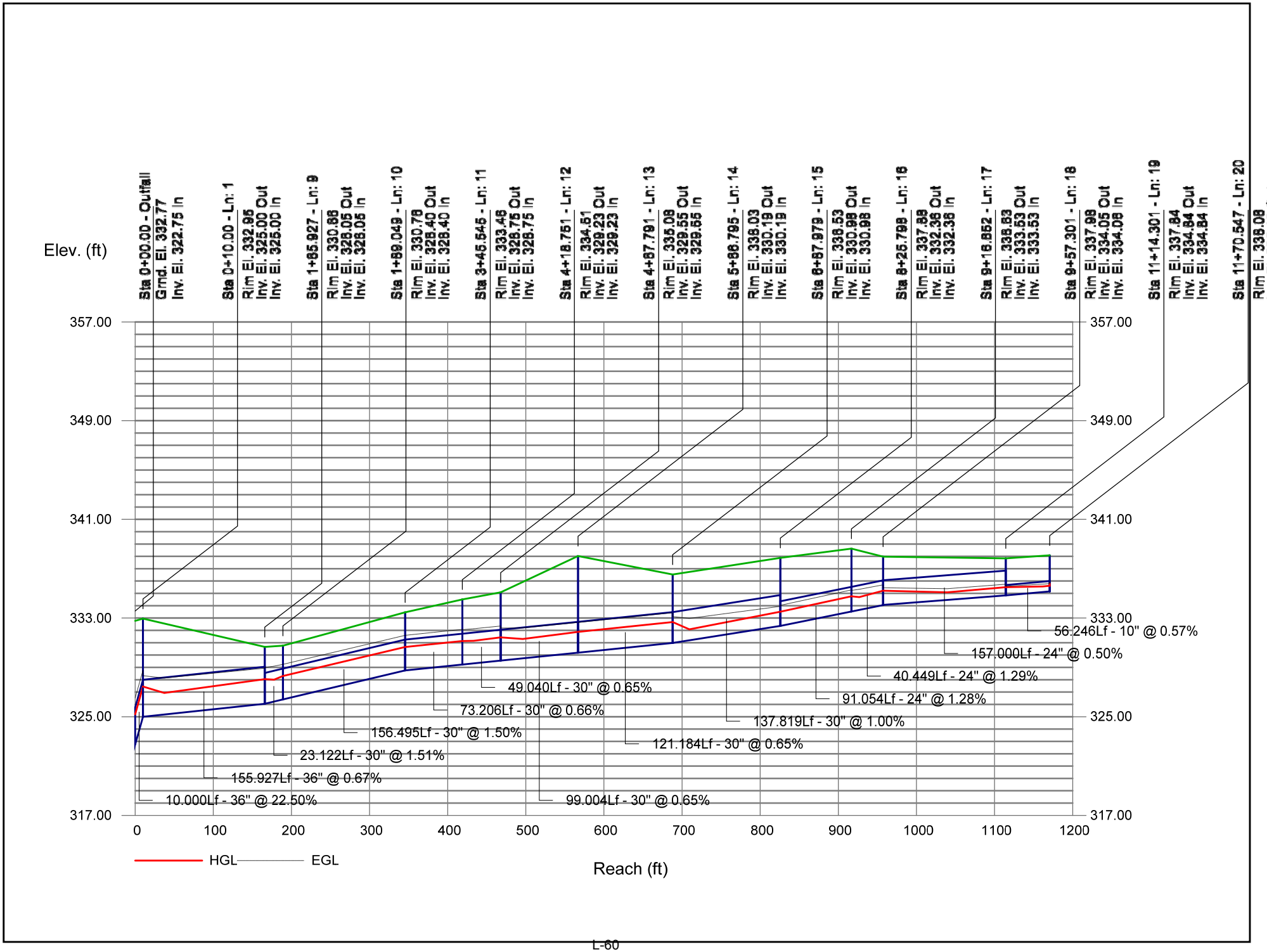
Col. 22 Energy loss. Average Sf/100 x Line Length (Col. 21/100 x Col. 12). Equals (EGL upstream - EGL downstream) +/- tolerance.

Col. 23 The junction loss coefficient (K).

Col. 24 Minor loss. (Col. 23 x Col. 18). Is added to upstream HGL and used as the starting HGL for the next upstream line(s).

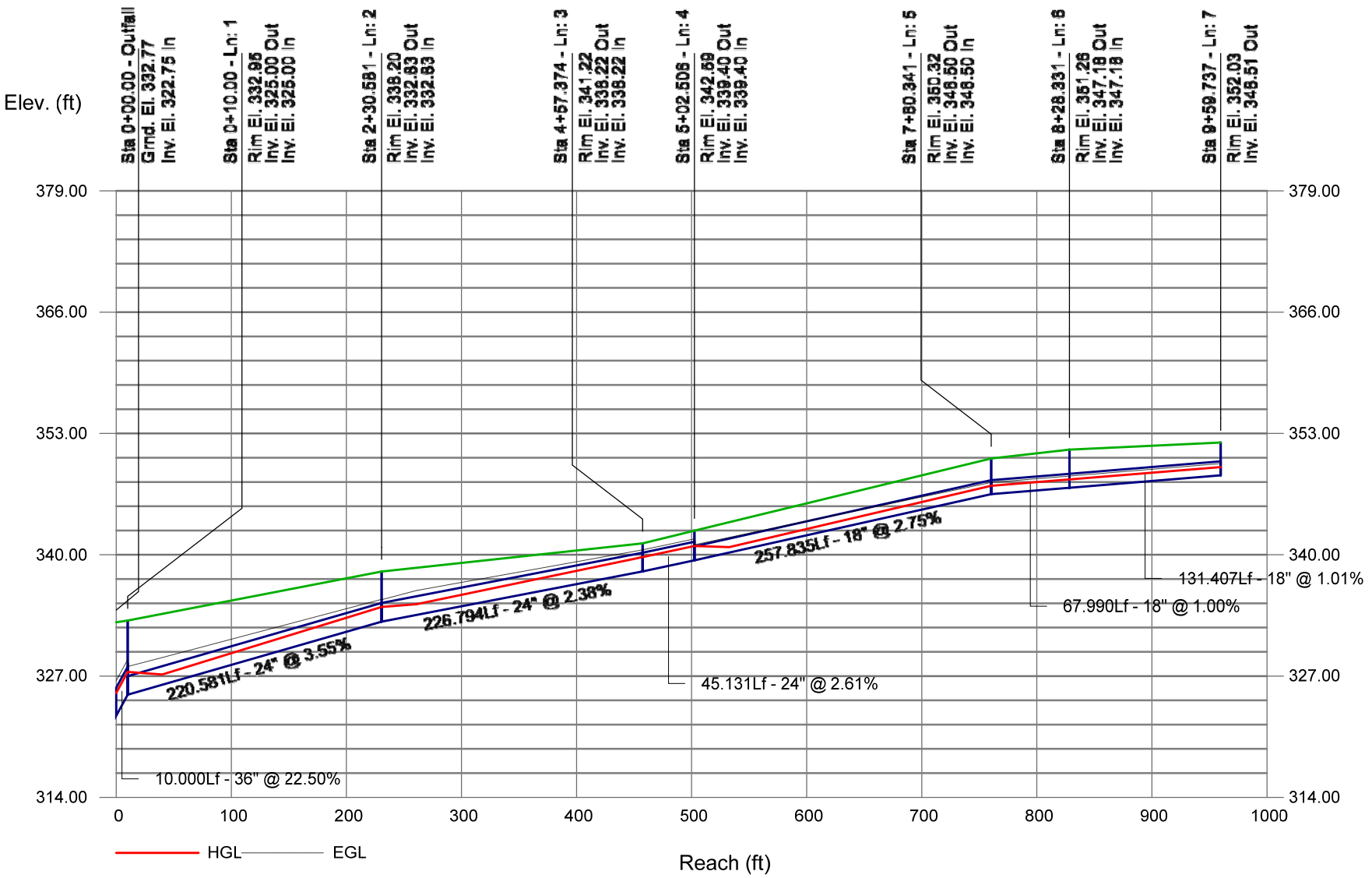
Storm Sewer Profile

Proj. file: STO 100 - 25yr.stm



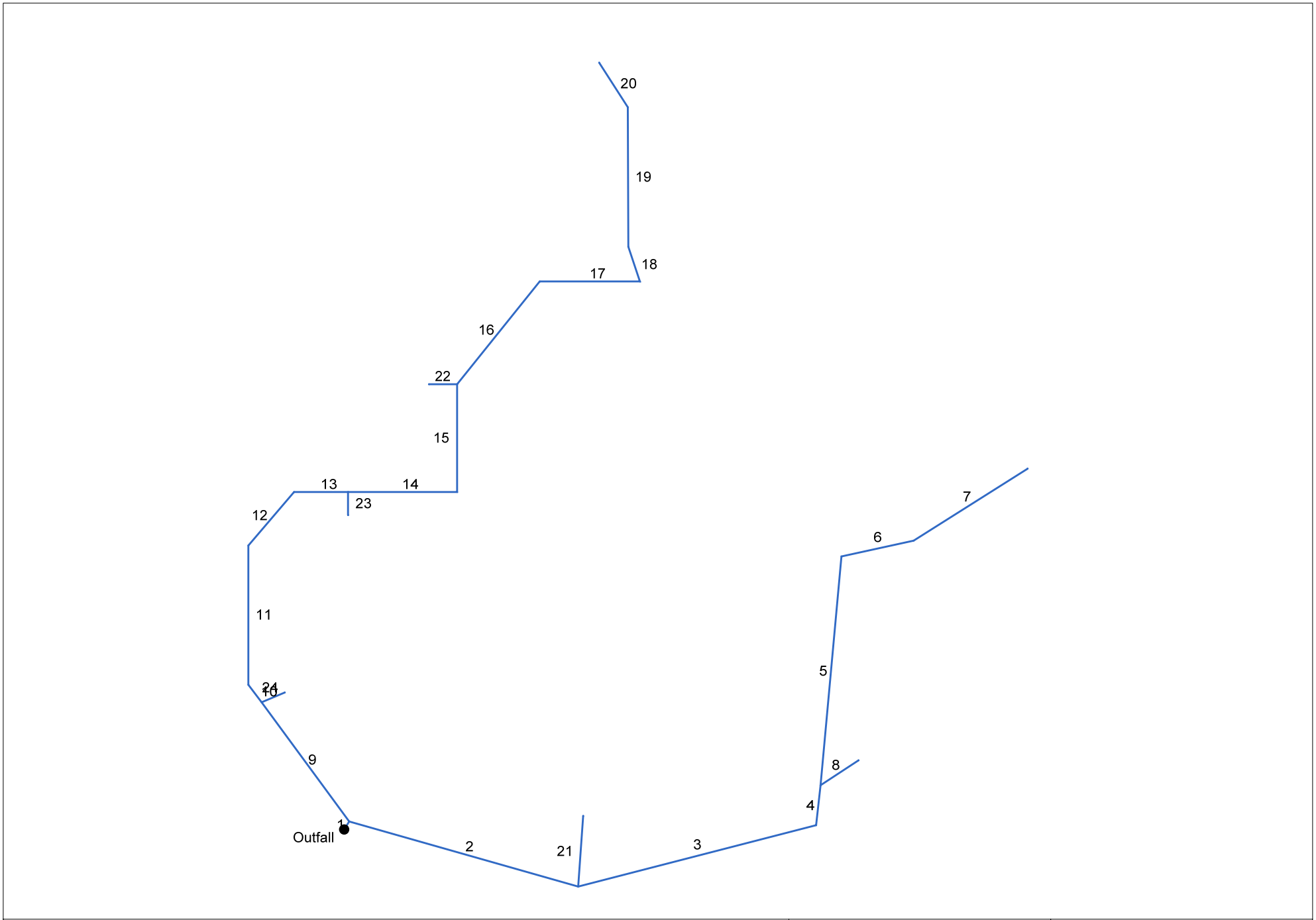
Storm Sewer Profile

Proj. file: STO 100 - 25yr.stm



Attachment 10 – 100yr HGL Analysis for Drainage Areas 1 & 2 to Chamber System

Hydraflow Storm Sewers Extension for Autodesk® Civil 3D® Plan



Project File: New.stm	Number of lines: 24	Date: 3/5/2022

Hydraulic Grade Line Computations

Line	Size	Q	Downstream								Len	Upstream								Check		JL coeff	Minor loss
			Invert elev (ft)	HGL elev (ft)	Depth (ft)	Area (sqft)	Vel (ft/s)	Vel head (ft)	EGL elev (ft)	Sf (%)		Invert elev (ft)	HGL elev (ft)	Depth (ft)	Area (sqft)	Vel (ft/s)	Vel head (ft)	EGL elev (ft)	Sf (%)	Ave Sf (%)	Enrgy loss (ft)		
(1)	(in) (2)	(cfs) (3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(ft) (12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(K) (23)	(ft) (24)
1	36	72.93	322.75	325.44	2.69	6.69	10.90	1.85	327.29	0.000	10.000	325.00	327.69	2.69**	6.69	10.90	1.85	329.54	0.000	0.000	n/a	0.99	1.83
2	24	24.67	325.00	327.69	2.00	2.92	7.85	0.96	328.65	1.014	220.581	332.83	334.58 j	1.75**	2.92	8.46	1.11	335.69	0.917	0.966	n/a	1.00	n/a
3	24	23.31	332.83	334.58	1.75	2.87	7.99	1.03	335.61	0.000	226.794	338.22	339.93 j	1.71**	2.87	8.13	1.03	340.96	0.000	0.000	n/a	0.94	n/a
4	24	23.31	338.22	339.93	1.71*	2.87	8.13	1.03	340.96	0.000	45.131	339.40	341.11	1.71**	2.87	8.13	1.03	342.14	0.000	0.000	n/a	0.77	n/a
5	18	6.81	339.40	341.11	1.50	1.26	3.85	0.23	341.35	0.358	257.835	346.50	347.51 j	1.01**	1.26	5.39	0.45	347.96	0.569	0.464	n/a	0.95	n/a
6	18	6.81	346.50	347.51	1.01*	1.26	5.39	0.45	347.96	0.000	67.990	347.18	348.19	1.01**	1.26	5.39	0.45	348.64	0.000	0.000	n/a	0.45	n/a
7	18	6.81	347.18	348.19	1.01*	1.26	5.39	0.45	348.64	0.000	131.407	348.51	349.52	1.01**	1.26	5.39	0.45	349.97	0.000	0.000	n/a	1.00	n/a
8	12	2.08	339.40	341.11	1.00	0.79	2.65	0.11	341.22	0.291	44.656	339.85	341.24	1.00	0.79	2.65	0.11	341.35	0.291	0.291	0.130	1.00	0.11
9	36	48.26	325.00	327.69	2.69	5.71	7.21	1.11	328.80	0.000	155.927	326.05	328.31	2.26**	5.71	8.45	1.11	329.42	0.000	0.000	n/a	1.00	1.11
10	30	40.07	326.05	328.31	2.26	4.45	8.58	1.26	329.57	0.000	23.122	326.40	328.53 j	2.13**	4.45	9.00	1.26	329.79	0.000	0.000	n/a	0.57	n/a
11	30	40.07	326.40	328.53	2.13*	4.45	9.00	1.26	329.79	0.000	156.495	328.75	330.88	2.13**	4.45	9.00	1.26	332.14	0.000	0.000	n/a	0.62	n/a
12	30	40.07	328.75	331.25	2.50*	4.91	8.16	1.04	332.29	0.814	73.206	329.23	331.85	2.50	4.91	8.16	1.04	332.88	0.813	0.814	0.596	0.85	0.88
13	30	39.06	329.23	332.73	2.50	4.91	7.96	0.98	333.71	0.773	49.040	329.55	333.11	2.50	4.91	7.96	0.98	334.09	0.773	0.773	0.379	1.00	0.98
14	30	31.61	329.55	334.09	2.50	4.91	6.44	0.64	334.74	0.506	99.004	330.19	334.59	2.50	4.91	6.44	0.64	335.24	0.506	0.506	0.501	1.00	0.64
15	30	31.61	330.19	335.24	2.50	4.91	6.44	0.64	335.88	0.506	121.184	330.98	335.85	2.50	4.91	6.44	0.64	336.50	0.506	0.506	0.614	1.00	0.64
16	30	15.05	330.98	336.50	2.50	4.91	3.07	0.15	336.64	0.115	137.819	332.36	336.65	2.50	4.91	3.07	0.15	336.80	0.115	0.115	0.158	0.87	0.13
17	24	15.05	332.36	336.78	2.00	3.14	4.79	0.36	337.14	0.377	91.054	333.53	337.12	2.00	3.14	4.79	0.36	337.48	0.377	0.377	0.344	1.00	0.36
18	24	13.47	333.53	337.48	2.00	3.14	4.29	0.29	337.77	0.302	40.449	334.05	337.60	2.00	3.14	4.29	0.29	337.89	0.302	0.302	0.122	0.31	0.09
19	24	4.57	334.06	337.69	2.00	3.14	1.45	0.03	337.73	0.035	157.000	334.84	337.75	2.00	3.14	1.45	0.03	337.78	0.035	0.035	0.055	0.52	0.02
20	10	1.35	334.84	337.76	0.83	0.55	2.48	0.10	337.86	0.324	56.246	335.16	337.95	0.83	0.55	2.48	0.10	338.04	0.324	0.324	0.182	1.00	0.10
21	12	1.36	332.83	334.58	1.00	0.79	1.73	0.05	334.63	0.124	79.422	333.62	334.68	1.00	0.79	1.73	0.05	334.73	0.124	0.124	0.099	1.00	0.05

Project File: New.stm | Number of lines: 24 | Run Date: 3/5/2022

Notes: * depth assumed; ** Critical depth.; j-Line contains hyd. jump ; c = cir e = ellip b = box

Hydraulic Grade Line Computations

Line	Size	Q	Downstream								Len	Upstream								Check		JL coeff	Minor loss
			Invert elev (ft)	HGL elev (ft)	Depth (ft)	Area (sqft)	Vel (ft/s)	Vel head (ft)	EGL elev (ft)	Sf (%)		Invert elev (ft)	HGL elev (ft)	Depth (ft)	Area (sqft)	Vel (ft/s)	Vel head (ft)	EGL elev (ft)	Sf (%)	Ave Sf (%)	Enrgy loss (ft)		
(1)	(in) (2)	(cfs) (3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(ft) (12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(K) (23)	(ft) (24)
22	18	12.14	330.98	336.50	1.50	1.77	6.87	0.73	337.23	1.139	25.723	331.37	336.79	1.50	1.77	6.87	0.73	337.52	1.139	1.139	0.293	1.00	0.73
23	18	7.45	329.55	334.09	1.50	1.77	4.22	0.28	334.37	0.429	26.044	331.12	334.20	1.50	1.77	4.22	0.28	334.48	0.429	0.429	0.112	1.00	0.28
24	18	8.19	326.05	328.31	1.50	1.40	4.64	0.33	328.64	0.519	24.166	328.61	329.72 j	1.11**	1.40	5.85	0.53	330.25	0.646	0.582	n/a	1.00	0.53

Project File: New.stm | Number of lines: 24 | Run Date: 3/5/2022

Notes: * depth assumed; ** Critical depth.; j-Line contains hyd. jump ; c = cir e = ellip b = box

Hydraflow HGL Computation Procedure

General Procedure:

Hydraflow computes the HGL using the Bernoulli energy equation. Manning's equation is used to determine energy losses due to pipe friction. In a standard step, iterative procedure, Hydraflow assumes upstream HGLs until the energy equation balances. If the energy equation cannot balance, supercritical flow exists and critical depth is temporarily assumed at the upstream end. A supercritical flow Profile is then computed using the same procedure in a downstream direction using momentum principles.

Col. 1 The line number being computed. Calculations begin at Line 1 and proceed upstream.

Col. 2 The line size. In the case of non-circular pipes, the line rise is printed above the span.

Col. 3 Total flow rate in the line.

Col. 4 The elevation of the downstream invert.

Col. 5 Elevation of the hydraulic grade line at the downstream end. This is computed as the upstream HGL + Minor loss of this line's downstream line.

Col. 6 The downstream depth of flow inside the pipe (HGL - Invert elevation) but not greater than the line size.

Col. 7 Cross-sectional area of the flow at the downstream end.

Col. 8 The velocity of the flow at the downstream end, (Col. 3 / Col. 7).

Col. 9 Velocity head (Velocity squared / 2g).

Col. 10 The elevation of the energy grade line at the downstream end, HGL + Velocity head, (Col. 5 + Col. 9).

Col. 11 The friction slope at the downstream end (the S or Slope term in Manning's equation).

Col. 12 The line length.

Col. 13 The elevation of the upstream invert.

Col. 14 Elevation of the hydraulic grade line at the upstream end.

Col. 15 The upstream depth of flow inside the pipe (HGL - Invert elevation) but not greater than the line size.

Col. 16 Cross-sectional area of the flow at the upstream end.

Col. 17 The velocity of the flow at the upstream end, (Col. 3 / Col. 16).

Col. 18 Velocity head (Velocity squared / 2g).

Col. 19 The elevation of the energy grade line at the upstream end, HGL + Velocity head, (Col. 14 + Col. 18) .

Col. 20 The friction slope at the upstream end (the S or Slope term in Manning's equation).

Col. 21 The average of the downstream and upstream friction slopes.

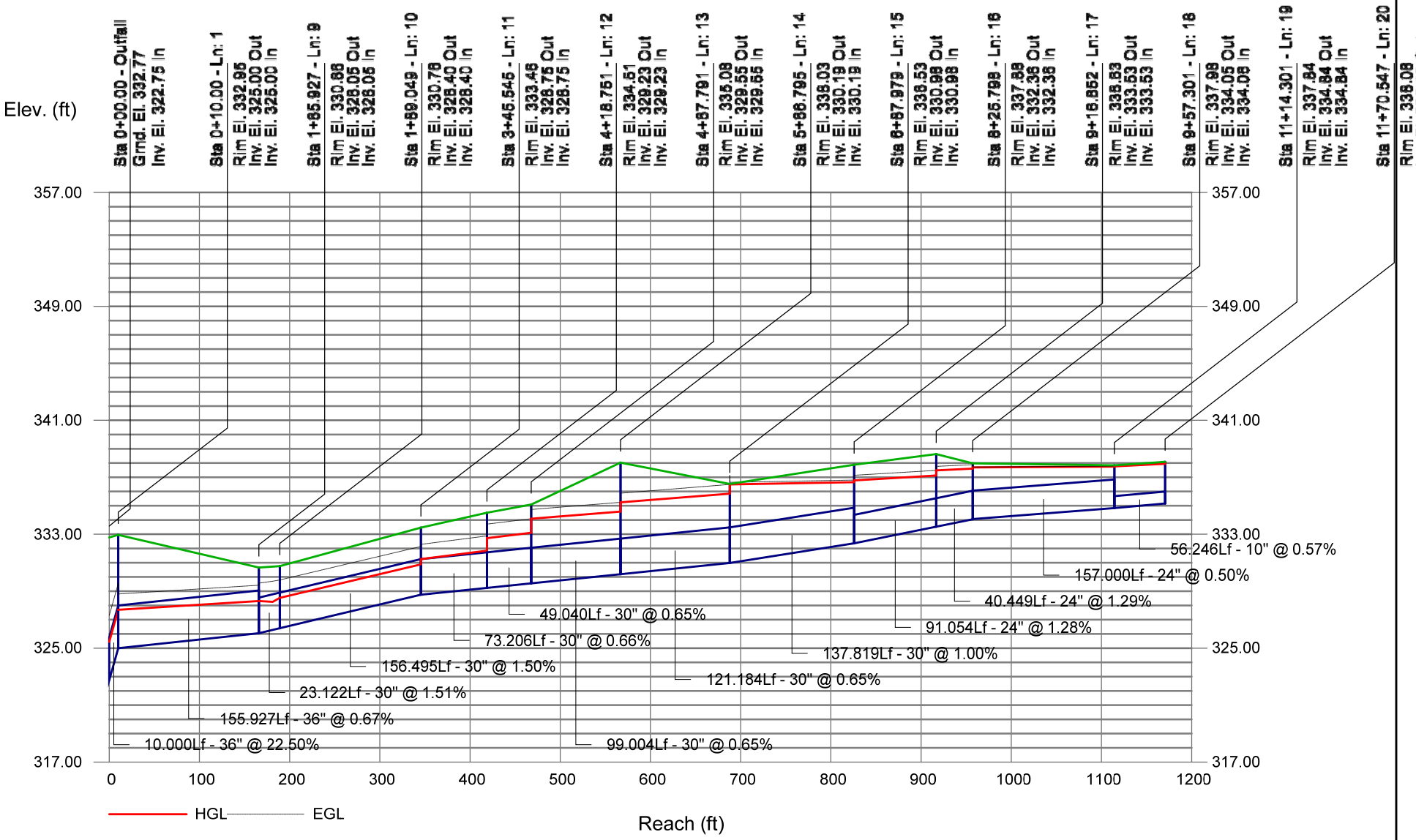
Col. 22 Energy loss. Average Sf/100 x Line Length (Col. 21/100 x Col. 12). Equals (EGL upstream - EGL downstream) +/- tolerance.

Col. 23 The junction loss coefficient (K).

Col. 24 Minor loss. (Col. 23 x Col. 18). Is added to upstream HGL and used as the starting HGL for the next upstream line(s).

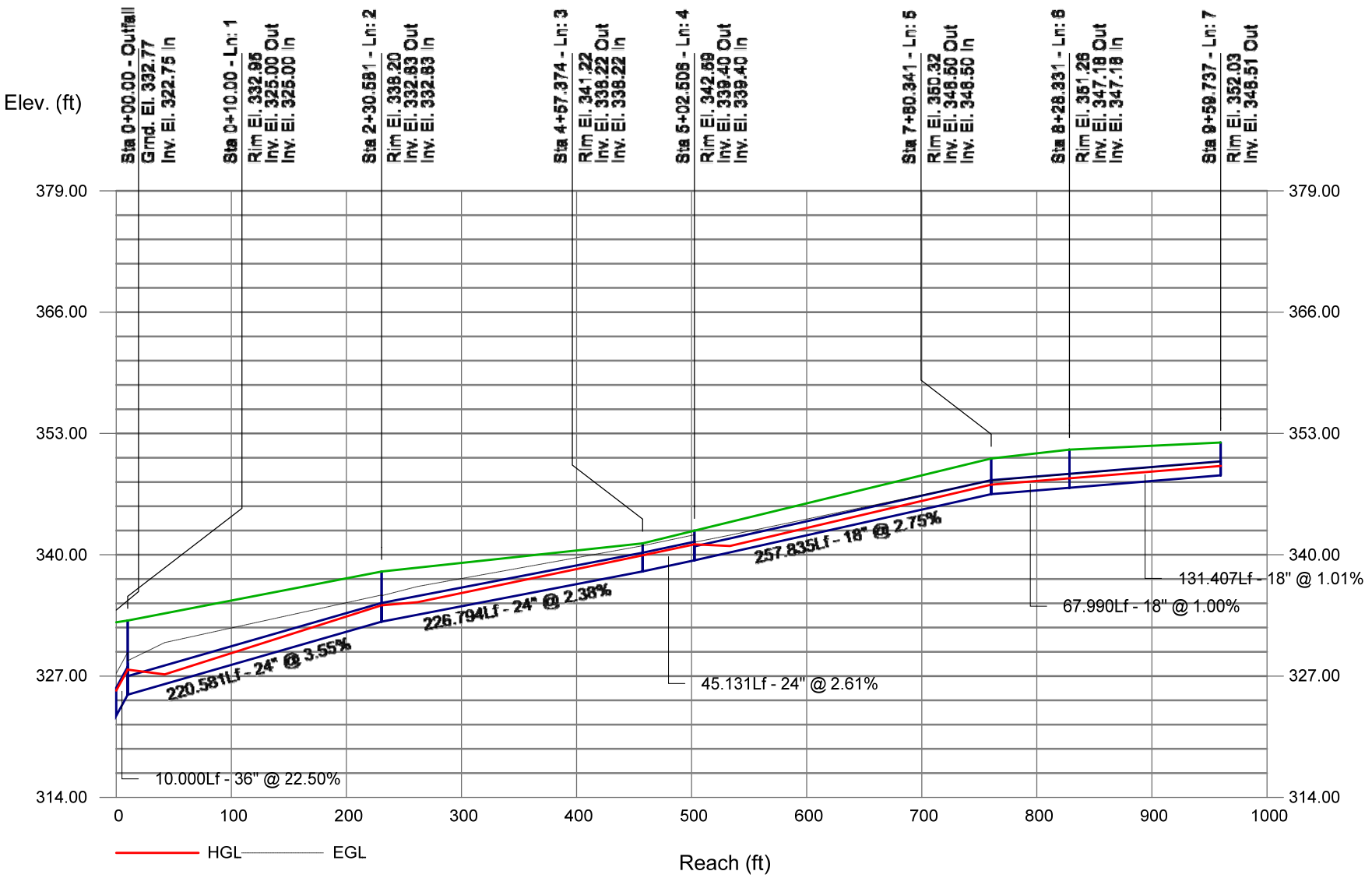
Storm Sewer Profile

Proj. file: New.stm



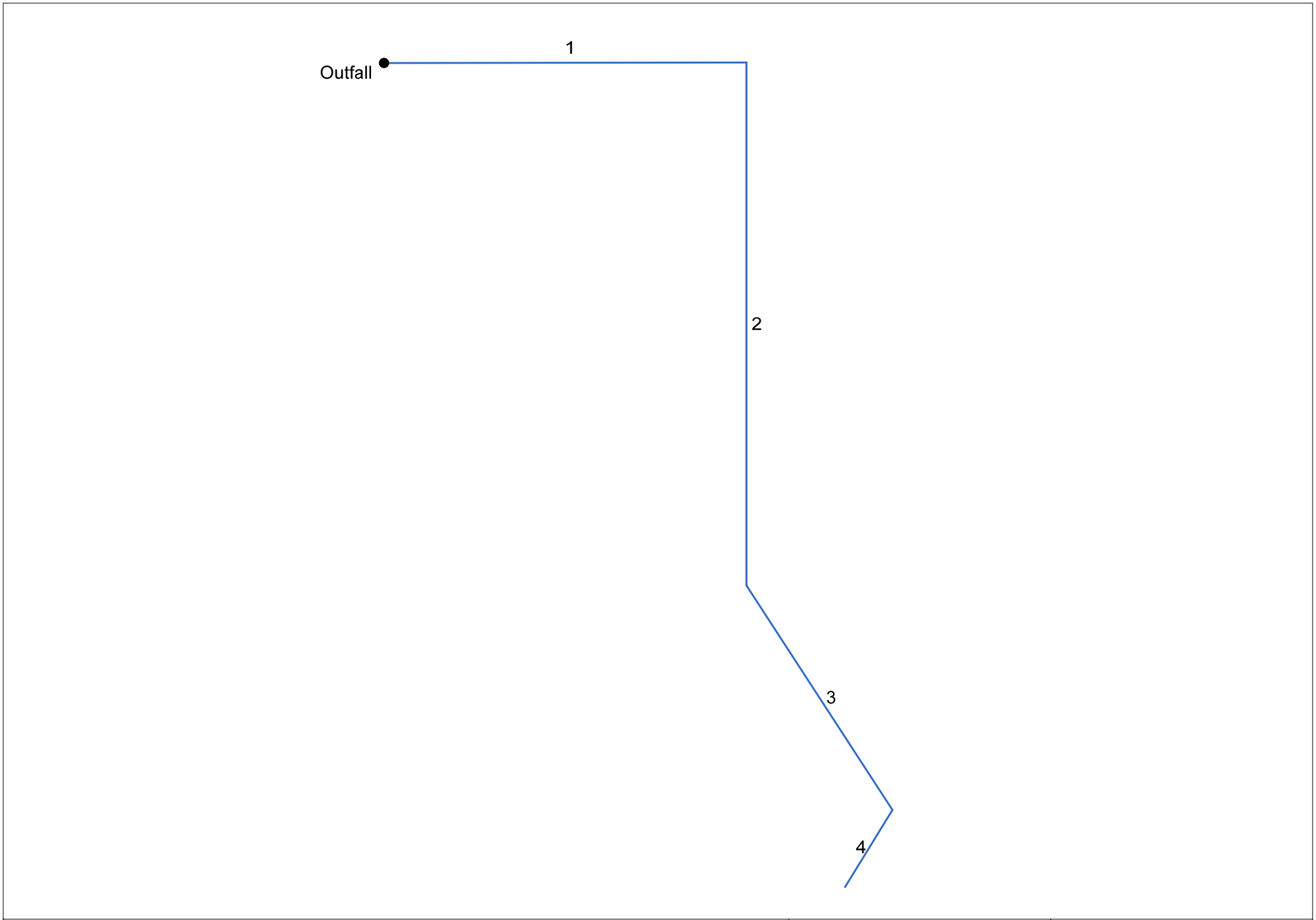
Storm Sewer Profile

Proj. file: New.stm



Attachment 11 – 10yr HGL Analysis for Chamber System Overflow to Public Storm Drain

Hydraflow Storm Sewers Extension for Autodesk® Civil 3D® Plan



Project File: New.stm	Number of lines: 4	Date: 3/5/2022

Hydraulic Grade Line Computations

Line	Size	Q	Downstream								Len	Upstream								Check		JL coeff	Minor loss
			Invert elev (ft)	HGL elev (ft)	Depth (ft)	Area (sqft)	Vel (ft/s)	Vel head (ft)	EGL elev (ft)	Sf (%)		Invert elev (ft)	HGL elev (ft)	Depth (ft)	Area (sqft)	Vel (ft/s)	Vel head (ft)	EGL elev (ft)	Sf (%)	Ave Sf (%)	Enrgy loss (ft)		
(1)	(in) (2)	(cfs) (3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(ft) (12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(K) (23)	(ft) (24)
1	36	47.85	321.69	324.69	3.00	5.69	6.77	0.71	325.40	0.439	133.973	323.16	325.41	2.25**	5.69	8.41	1.10	326.51	0.527	0.483	n/a	1.00	n/a
2	36	47.85	323.16	325.41	2.25*	5.69	8.41	1.10	326.51	0.000	239.397	325.79	328.04	2.25**	5.69	8.41	1.10	329.14	0.000	0.000	n/a	0.52	n/a
3	36	47.85	325.79	328.04	2.25*	5.69	8.41	1.10	329.14	0.000	116.018	327.07	329.32	2.25**	5.69	8.41	1.10	330.42	0.000	0.000	n/a	0.84	n/a
4	36	47.85	327.07	329.32	2.25*	5.69	8.41	1.10	330.42	0.000	39.330	327.50	329.75	2.25**	5.69	8.41	1.10	330.85	0.000	0.000	n/a	1.00	n/a

Project File: New.stm | Number of lines: 4 | Run Date: 3/5/2022

Notes: * depth assumed; ** Critical depth. ; c = cir e = ellip b = box

Hydraflow HGL Computation Procedure

General Procedure:

Hydraflow computes the HGL using the Bernoulli energy equation. Manning's equation is used to determine energy losses due to pipe friction. In a standard step, iterative procedure, Hydraflow assumes upstream HGLs until the energy equation balances. If the energy equation cannot balance, supercritical flow exists and critical depth is temporarily assumed at the upstream end. A supercritical flow Profile is then computed using the same procedure in a downstream direction using momentum principles.

Col. 1 The line number being computed. Calculations begin at Line 1 and proceed upstream.

Col. 2 The line size. In the case of non-circular pipes, the line rise is printed above the span.

Col. 3 Total flow rate in the line.

Col. 4 The elevation of the downstream invert.

Col. 5 Elevation of the hydraulic grade line at the downstream end. This is computed as the upstream HGL + Minor loss of this line's downstream line.

Col. 6 The downstream depth of flow inside the pipe (HGL - Invert elevation) but not greater than the line size.

Col. 7 Cross-sectional area of the flow at the downstream end.

Col. 8 The velocity of the flow at the downstream end, (Col. 3 / Col. 7).

Col. 9 Velocity head (Velocity squared / 2g).

Col. 10 The elevation of the energy grade line at the downstream end, HGL + Velocity head, (Col. 5 + Col. 9).

Col. 11 The friction slope at the downstream end (the S or Slope term in Manning's equation).

Col. 12 The line length.

Col. 13 The elevation of the upstream invert.

Col. 14 Elevation of the hydraulic grade line at the upstream end.

Col. 15 The upstream depth of flow inside the pipe (HGL - Invert elevation) but not greater than the line size.

Col. 16 Cross-sectional area of the flow at the upstream end.

Col. 17 The velocity of the flow at the upstream end, (Col. 3 / Col. 16).

Col. 18 Velocity head (Velocity squared / 2g).

Col. 19 The elevation of the energy grade line at the upstream end, HGL + Velocity head, (Col. 14 + Col. 18) .

Col. 20 The friction slope at the upstream end (the S or Slope term in Manning's equation).

Col. 21 The average of the downstream and upstream friction slopes.

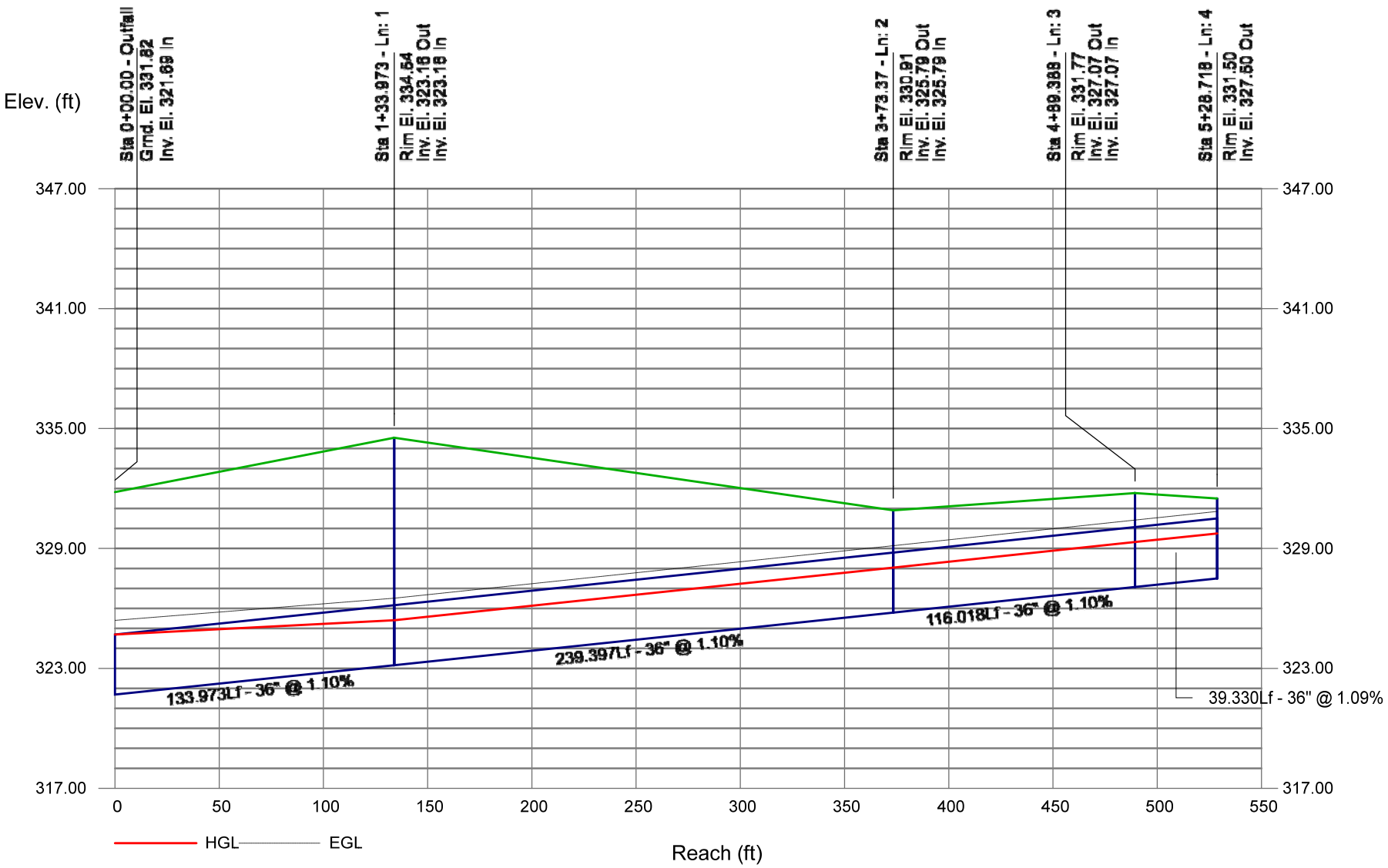
Col. 22 Energy loss. Average Sf/100 x Line Length (Col. 21/100 x Col. 12). Equals (EGL upstream - EGL downstream) +/- tolerance.

Col. 23 The junction loss coefficient (K).

Col. 24 Minor loss. (Col. 23 x Col. 18). Is added to upstream HGL and used as the starting HGL for the next upstream line(s).

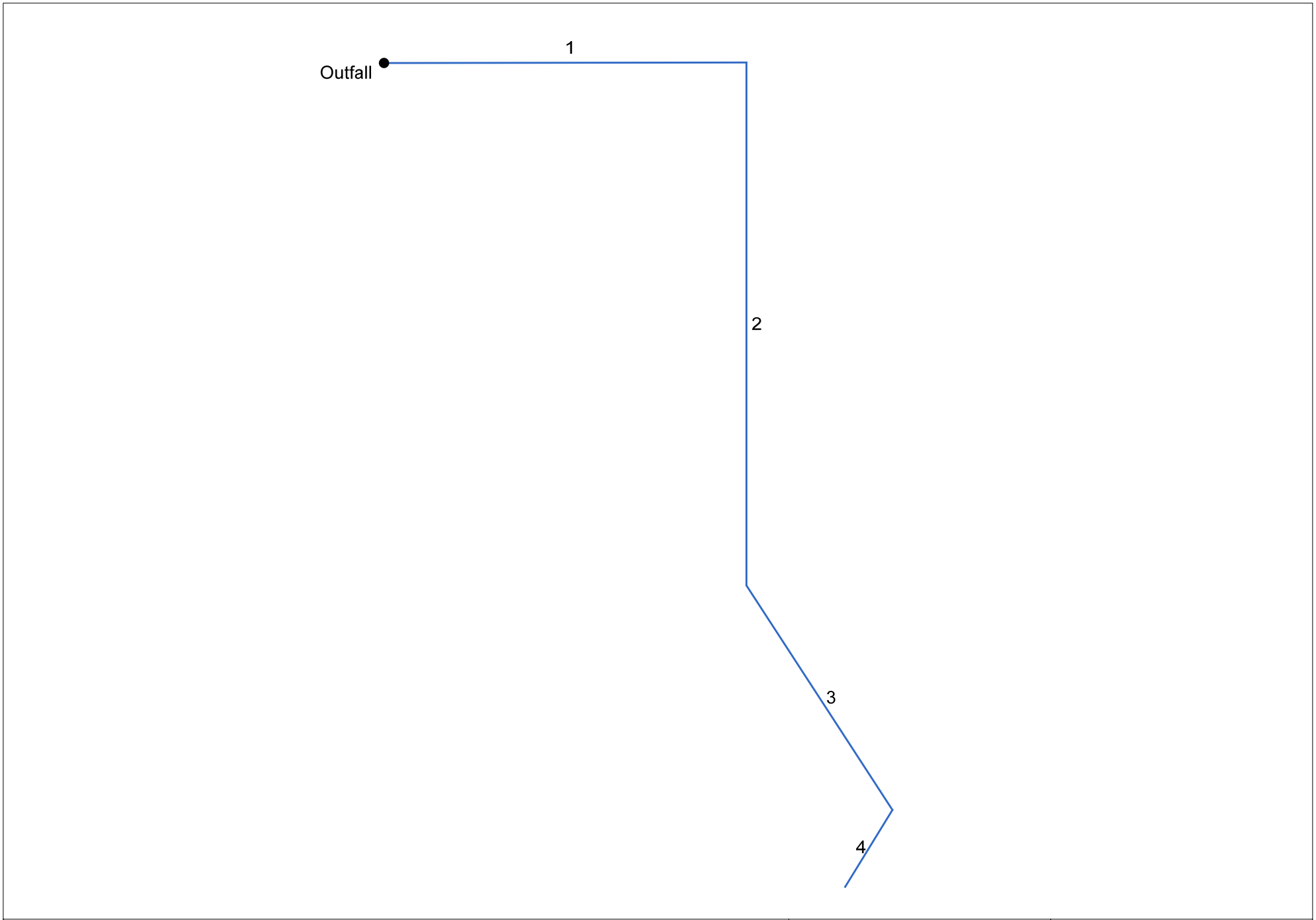
Storm Sewer Profile

Proj. file: New.stm



Attachment 12 – 25yr HGL Analysis for Chamber System Overflow to Public Storm Drain

Hydraflow Storm Sewers Extension for Autodesk® Civil 3D® Plan



Project File: New.stm	Number of lines: 4	Date: 3/5/2022

Hydraulic Grade Line Computations

Line	Size	Q	Downstream								Len	Upstream								Check		JL coeff	Minor loss
			Invert elev (ft)	HGL elev (ft)	Depth (ft)	Area (sqft)	Vel (ft/s)	Vel head (ft)	EGL elev (ft)	Sf (%)		Invert elev (ft)	HGL elev (ft)	Depth (ft)	Area (sqft)	Vel (ft/s)	Vel head (ft)	EGL elev (ft)	Sf (%)	Ave Sf (%)	Enrgy loss (ft)		
(1)	(in) (2)	(cfs) (3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(ft) (12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(K) (23)	(ft) (24)
1	36	56.94	321.69	324.69	3.00	6.16	8.06	1.01	325.70	0.621	133.973	323.16	325.60	2.44**	6.16	9.24	1.33	326.93	0.628	0.625	n/a	1.00	n/a
2	36	56.94	323.16	325.60	2.44*	6.16	9.24	1.33	326.93	0.000	239.397	325.79	328.23	2.44**	6.16	9.24	1.33	329.56	0.000	0.000	n/a	0.52	n/a
3	36	56.94	325.79	328.23	2.44*	6.16	9.24	1.33	329.56	0.000	116.018	327.07	329.51	2.44**	6.16	9.24	1.33	330.84	0.000	0.000	n/a	0.84	n/a
4	36	56.94	327.07	329.51	2.44*	6.16	9.24	1.33	330.84	0.000	39.330	327.50	329.94	2.44**	6.16	9.24	1.33	331.27	0.000	0.000	n/a	1.00	n/a

Project File: New.stm | Number of lines: 4 | Run Date: 3/5/2022

Notes: * depth assumed; ** Critical depth. ; c = cir e = ellip b = box

Hydraflow HGL Computation Procedure

General Procedure:

Hydraflow computes the HGL using the Bernoulli energy equation. Manning's equation is used to determine energy losses due to pipe friction. In a standard step, iterative procedure, Hydraflow assumes upstream HGLs until the energy equation balances. If the energy equation cannot balance, supercritical flow exists and critical depth is temporarily assumed at the upstream end. A supercritical flow Profile is then computed using the same procedure in a downstream direction using momentum principles.

Col. 1 The line number being computed. Calculations begin at Line 1 and proceed upstream.

Col. 2 The line size. In the case of non-circular pipes, the line rise is printed above the span.

Col. 3 Total flow rate in the line.

Col. 4 The elevation of the downstream invert.

Col. 5 Elevation of the hydraulic grade line at the downstream end. This is computed as the upstream HGL + Minor loss of this line's downstream line.

Col. 6 The downstream depth of flow inside the pipe (HGL - Invert elevation) but not greater than the line size.

Col. 7 Cross-sectional area of the flow at the downstream end.

Col. 8 The velocity of the flow at the downstream end, (Col. 3 / Col. 7).

Col. 9 Velocity head (Velocity squared / 2g).

Col. 10 The elevation of the energy grade line at the downstream end, HGL + Velocity head, (Col. 5 + Col. 9).

Col. 11 The friction slope at the downstream end (the S or Slope term in Manning's equation).

Col. 12 The line length.

Col. 13 The elevation of the upstream invert.

Col. 14 Elevation of the hydraulic grade line at the upstream end.

Col. 15 The upstream depth of flow inside the pipe (HGL - Invert elevation) but not greater than the line size.

Col. 16 Cross-sectional area of the flow at the upstream end.

Col. 17 The velocity of the flow at the upstream end, (Col. 3 / Col. 16).

Col. 18 Velocity head (Velocity squared / 2g).

Col. 19 The elevation of the energy grade line at the upstream end, HGL + Velocity head, (Col. 14 + Col. 18) .

Col. 20 The friction slope at the upstream end (the S or Slope term in Manning's equation).

Col. 21 The average of the downstream and upstream friction slopes.

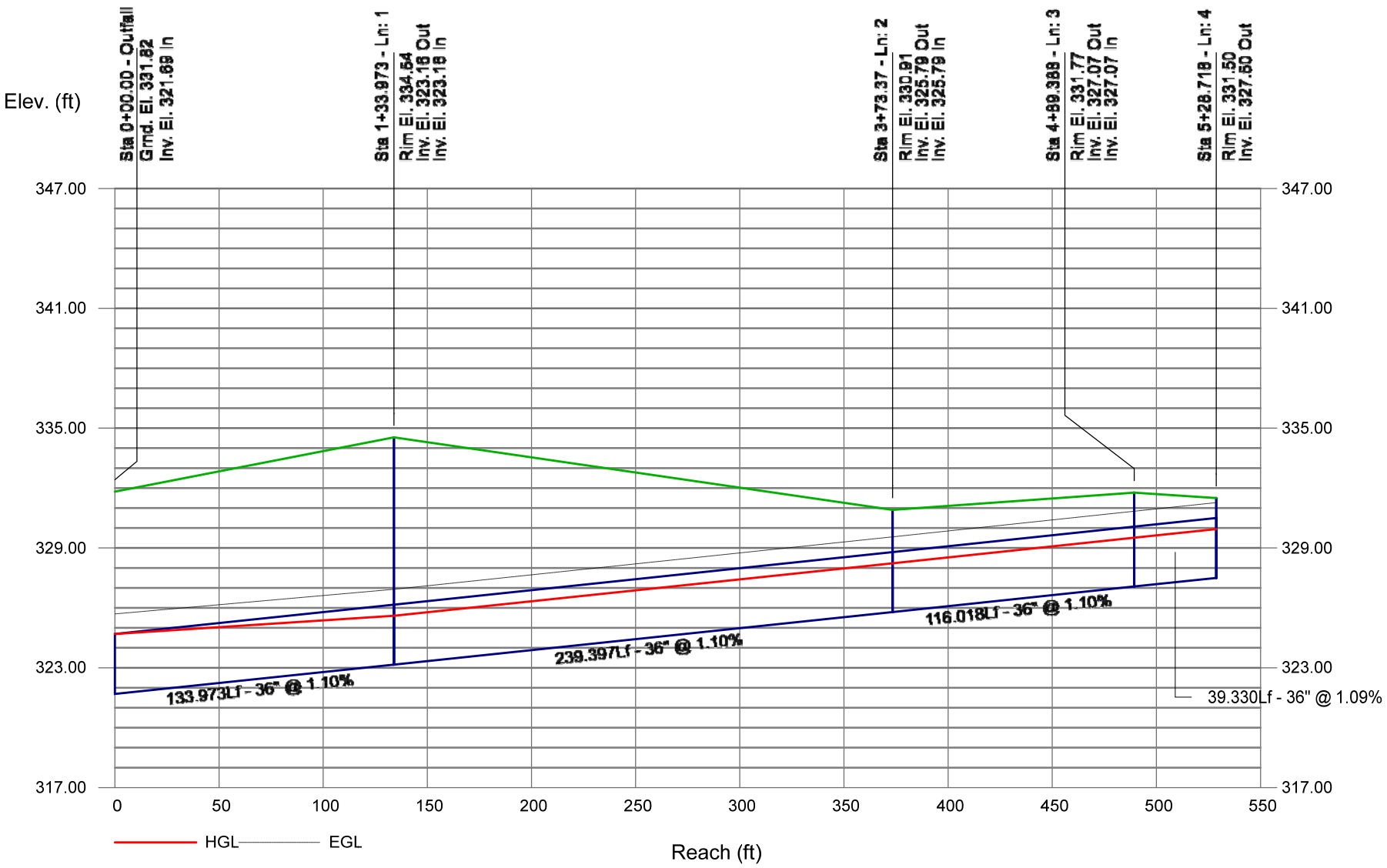
Col. 22 Energy loss. Average Sf/100 x Line Length (Col. 21/100 x Col. 12). Equals (EGL upstream - EGL downstream) +/- tolerance.

Col. 23 The junction loss coefficient (K).

Col. 24 Minor loss. (Col. 23 x Col. 18). Is added to upstream HGL and used as the starting HGL for the next upstream line(s).

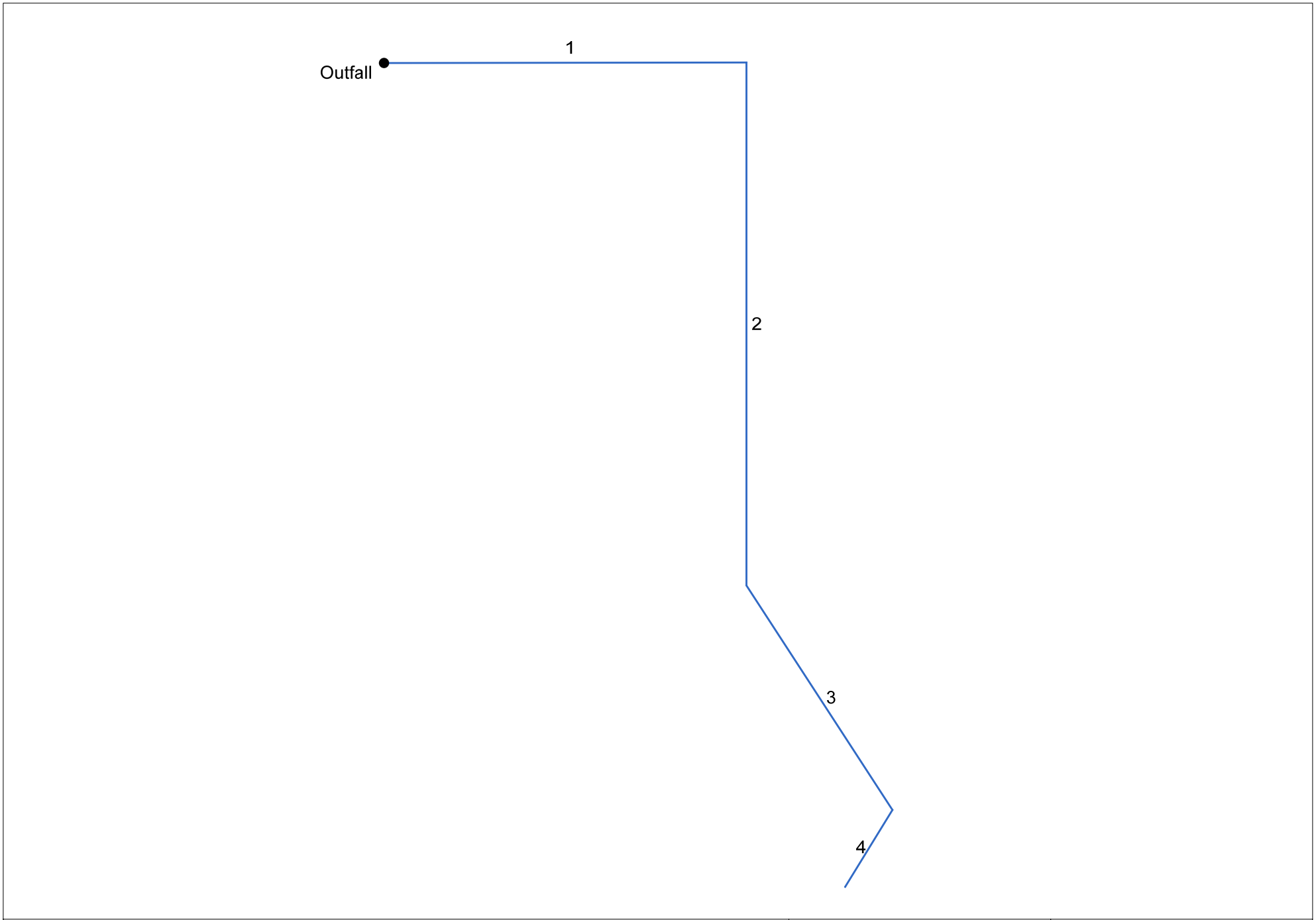
Storm Sewer Profile

Proj. file: New.stm



Attachment 13 – 100yr HGL Analysis for Chamber System Overflow to Public Storm Drain

Hydraflow Storm Sewers Extension for Autodesk® Civil 3D® Plan



Project File: New.stm	Number of lines: 4	Date: 3/5/2022

Hydraulic Grade Line Computations

Line	Size	Q	Downstream								Len	Upstream								Check		JL coeff	Minor loss
			Invert elev (ft)	HGL elev (ft)	Depth (ft)	Area (sqft)	Vel (ft/s)	Vel head (ft)	EGL elev (ft)	Sf (%)		Invert elev (ft)	HGL elev (ft)	Depth (ft)	Area (sqft)	Vel (ft/s)	Vel head (ft)	EGL elev (ft)	Sf (%)	Ave Sf (%)	Enrgy loss (ft)		
(1)	(in) (2)	(cfs) (3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(ft) (12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(K) (23)	(ft) (24)
1	36	72.94	321.69	324.69	3.00	6.69	10.32	1.66	326.35	1.020	133.973	323.16	325.85	2.69**	6.69	10.90	1.85	327.70	0.899	0.959	n/a	1.00	1.85
2	36	72.94	323.16	325.85	2.69*	6.69	10.90	1.85	327.70	0.000	239.397	325.79	328.48	2.69**	6.69	10.90	1.85	330.33	0.000	0.000	n/a	0.52	0.96
3	36	72.94	325.79	328.48	2.69*	6.69	10.90	1.85	330.33	0.000	116.018	327.07	329.76	2.69**	6.69	10.90	1.85	331.61	0.000	0.000	n/a	0.84	1.55
4	36	72.94	327.07	329.76	2.69*	6.69	10.90	1.85	331.61	0.000	39.330	327.50	330.19	2.69**	6.69	10.90	1.85	332.04	0.000	0.000	n/a	1.00	1.85

Project File: New.stm | Number of lines: 4 | Run Date: 3/5/2022

Notes: * depth assumed; ** Critical depth. ; c = cir e = ellip b = box

Hydraflow HGL Computation Procedure

General Procedure:

Hydraflow computes the HGL using the Bernoulli energy equation. Manning's equation is used to determine energy losses due to pipe friction. In a standard step, iterative procedure, Hydraflow assumes upstream HGLs until the energy equation balances. If the energy equation cannot balance, supercritical flow exists and critical depth is temporarily assumed at the upstream end. A supercritical flow Profile is then computed using the same procedure in a downstream direction using momentum principles.

Col. 1 The line number being computed. Calculations begin at Line 1 and proceed upstream.

Col. 2 The line size. In the case of non-circular pipes, the line rise is printed above the span.

Col. 3 Total flow rate in the line.

Col. 4 The elevation of the downstream invert.

Col. 5 Elevation of the hydraulic grade line at the downstream end. This is computed as the upstream HGL + Minor loss of this line's downstream line.

Col. 6 The downstream depth of flow inside the pipe (HGL - Invert elevation) but not greater than the line size.

Col. 7 Cross-sectional area of the flow at the downstream end.

Col. 8 The velocity of the flow at the downstream end, (Col. 3 / Col. 7).

Col. 9 Velocity head (Velocity squared / 2g).

Col. 10 The elevation of the energy grade line at the downstream end, HGL + Velocity head, (Col. 5 + Col. 9).

Col. 11 The friction slope at the downstream end (the S or Slope term in Manning's equation).

Col. 12 The line length.

Col. 13 The elevation of the upstream invert.

Col. 14 Elevation of the hydraulic grade line at the upstream end.

Col. 15 The upstream depth of flow inside the pipe (HGL - Invert elevation) but not greater than the line size.

Col. 16 Cross-sectional area of the flow at the upstream end.

Col. 17 The velocity of the flow at the upstream end, (Col. 3 / Col. 16).

Col. 18 Velocity head (Velocity squared / 2g).

Col. 19 The elevation of the energy grade line at the upstream end, HGL + Velocity head, (Col. 14 + Col. 18) .

Col. 20 The friction slope at the upstream end (the S or Slope term in Manning's equation).

Col. 21 The average of the downstream and upstream friction slopes.

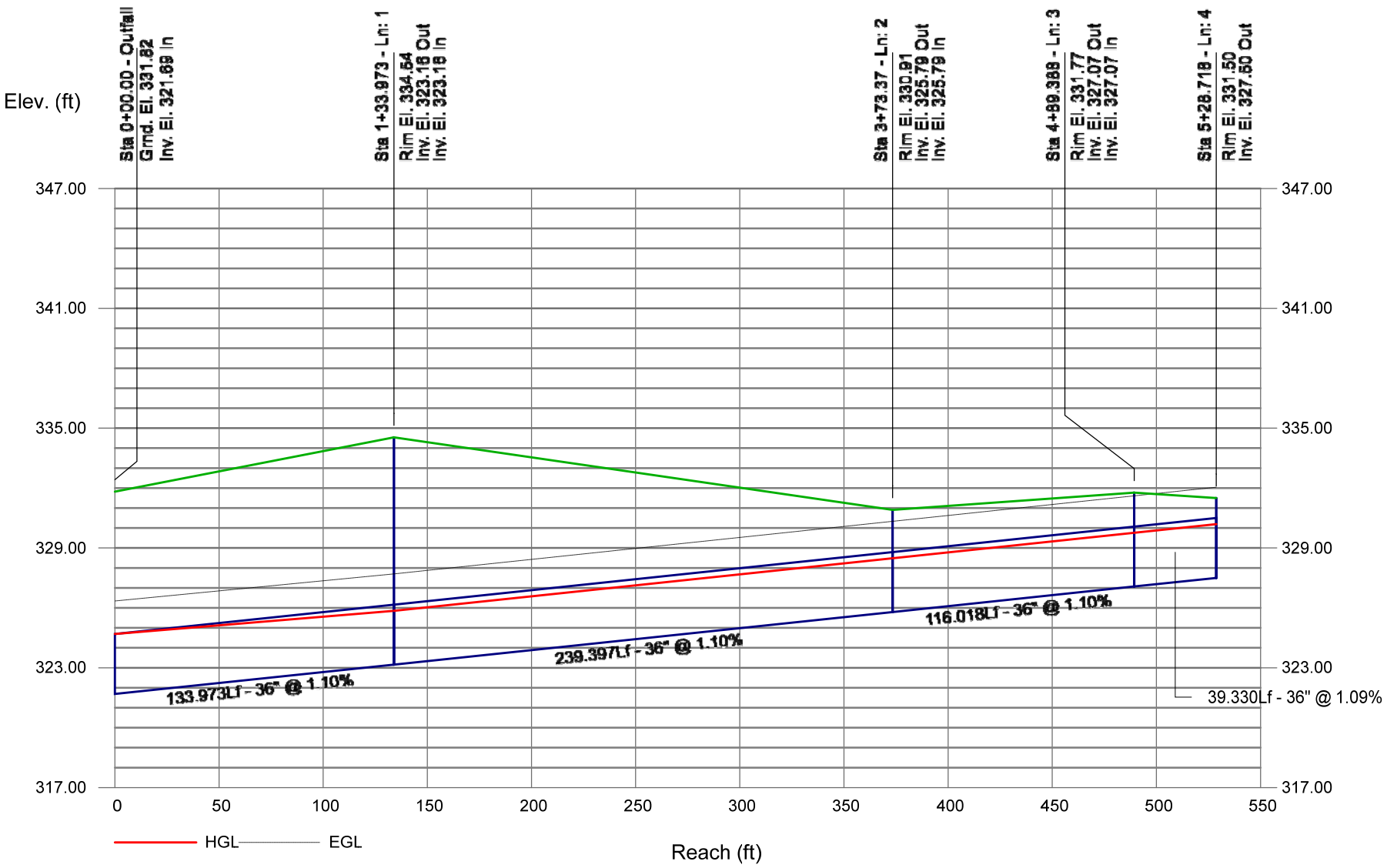
Col. 22 Energy loss. Average Sf/100 x Line Length (Col. 21/100 x Col. 12). Equals (EGL upstream - EGL downstream) +/- tolerance.

Col. 23 The junction loss coefficient (K).

Col. 24 Minor loss. (Col. 23 x Col. 18). Is added to upstream HGL and used as the starting HGL for the next upstream line(s).

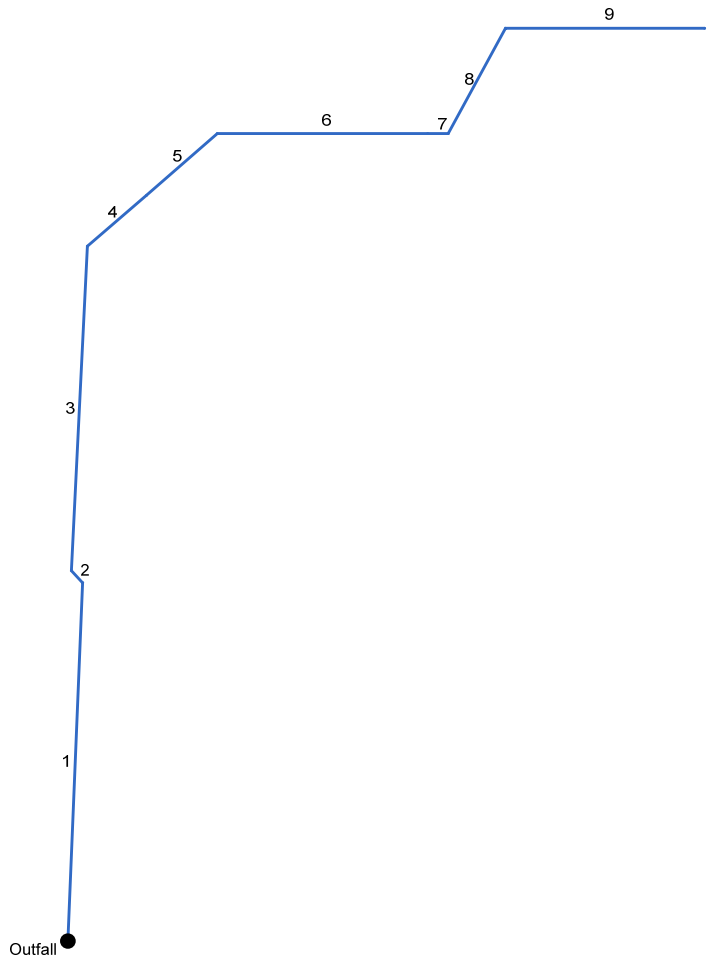
Storm Sewer Profile

Proj. file: New.stm



Attachment 14 – 10yr HGL Analysis for Bypass Pipe including Maximum Existing Upstream Flows & 10yr Peak Flows

Hydraflow Storm Sewers Extension for Autodesk® Civil 3D® Plan



Project File: STO 300.stm	Number of lines: 9	Date: 6/9/2022

Hydraulic Grade Line Computations

Line	Size	Q	Downstream								Len	Upstream								Check		JL coeff	Minor loss
			Invert elev (ft)	HGL elev (ft)	Depth (ft)	Area (sqft)	Vel (ft/s)	Vel head (ft)	EGL elev (ft)	Sf (%)		Invert elev (ft)	HGL elev (ft)	Depth (ft)	Area (sqft)	Vel (ft/s)	Vel head (ft)	EGL elev (ft)	Sf (%)	Ave Sf (%)	Enrgy loss (ft)		
(1)	(in) (2)	(cfs) (3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(ft) (12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(K) (23)	(ft) (24)
1	36	76.49	306.61	309.61	3.00	6.76	10.82	1.82	311.43	1.316	304.765	319.41	322.14	2.73**	6.76	11.31	1.99	324.13	1.148	1.232	n/a	0.75	n/a
2	30	28.64	319.66	322.14	2.48	3.83	5.84	0.87	323.01	0.000	13.827	323.73	325.55 j	1.82**	3.83	7.47	0.87	326.42	0.000	0.000	n/a	0.76	n/a
3	30	28.64	323.73	325.75	2.02*	4.25	6.73	0.70	326.46	0.500	276.043	325.11	327.13	2.02	4.25	6.73	0.70	327.84	0.500	0.500	1.379	0.76	0.54
4	30	28.64	325.11	327.67	2.50	4.91	5.84	0.53	328.20	0.488	66.081	325.44	327.94	2.50	4.91	5.83	0.53	328.47	0.476	0.482	0.319	0.15	0.08
5	30	13.74	325.44	328.02	2.50	4.91	2.80	0.12	328.14	0.112	79.823	325.84	328.09	2.25	4.65	2.96	0.14	328.22	0.099	0.106	0.084	0.70	0.10
6	30	13.74	325.84	328.18	2.34	2.45	2.88	0.49	328.67	0.000	178.044	326.73	327.98	1.25**	2.45	5.62	0.49	328.47	0.000	0.000	n/a	0.15	0.07
7	12	2.40	326.73	327.98	1.00	0.79	3.06	0.15	328.12	0.454	17.440	326.82	328.06	1.00	0.79	3.06	0.15	328.20	0.454	0.454	0.079	0.90	0.13
8	12	2.40	326.82	328.19	1.00	0.79	3.06	0.15	328.33	0.454	101.578	327.33	328.65	1.00	0.79	3.06	0.15	328.79	0.454	0.454	0.461	0.90	0.13
9	12	2.40	327.33	328.78	1.00	0.79	3.06	0.15	328.92	0.454	168.945	328.17	329.55	1.00	0.79	3.06	0.15	329.69	0.454	0.454	0.767	1.00	0.15

Project File: STO 300.stm | Number of lines: 9 | Run Date: 6/9/2022

Notes: * depth assumed; ** Critical depth.; j-Line contains hyd. jump ; c = cir e = ellip b = box

Hydraflow HGL Computation Procedure

General Procedure:

Hydraflow computes the HGL using the Bernoulli energy equation. Manning's equation is used to determine energy losses due to pipe friction. In a standard step, iterative procedure, Hydraflow assumes upstream HGLs until the energy equation balances. If the energy equation cannot balance, supercritical flow exists and critical depth is temporarily assumed at the upstream end. A supercritical flow Profile is then computed using the same procedure in a downstream direction using momentum principles.

Col. 1 The line number being computed. Calculations begin at Line 1 and proceed upstream.

Col. 2 The line size. In the case of non-circular pipes, the line rise is printed above the span.

Col. 3 Total flow rate in the line.

Col. 4 The elevation of the downstream invert.

Col. 5 Elevation of the hydraulic grade line at the downstream end. This is computed as the upstream HGL + Minor loss of this line's downstream line.

Col. 6 The downstream depth of flow inside the pipe (HGL - Invert elevation) but not greater than the line size.

Col. 7 Cross-sectional area of the flow at the downstream end.

Col. 8 The velocity of the flow at the downstream end, (Col. 3 / Col. 7).

Col. 9 Velocity head (Velocity squared / 2g).

Col. 10 The elevation of the energy grade line at the downstream end, HGL + Velocity head, (Col. 5 + Col. 9).

Col. 11 The friction slope at the downstream end (the S or Slope term in Manning's equation).

Col. 12 The line length.

Col. 13 The elevation of the upstream invert.

Col. 14 Elevation of the hydraulic grade line at the upstream end.

Col. 15 The upstream depth of flow inside the pipe (HGL - Invert elevation) but not greater than the line size.

Col. 16 Cross-sectional area of the flow at the upstream end.

Col. 17 The velocity of the flow at the upstream end, (Col. 3 / Col. 16).

Col. 18 Velocity head (Velocity squared / 2g).

Col. 19 The elevation of the energy grade line at the upstream end, HGL + Velocity head, (Col. 14 + Col. 18) .

Col. 20 The friction slope at the upstream end (the S or Slope term in Manning's equation).

Col. 21 The average of the downstream and upstream friction slopes.

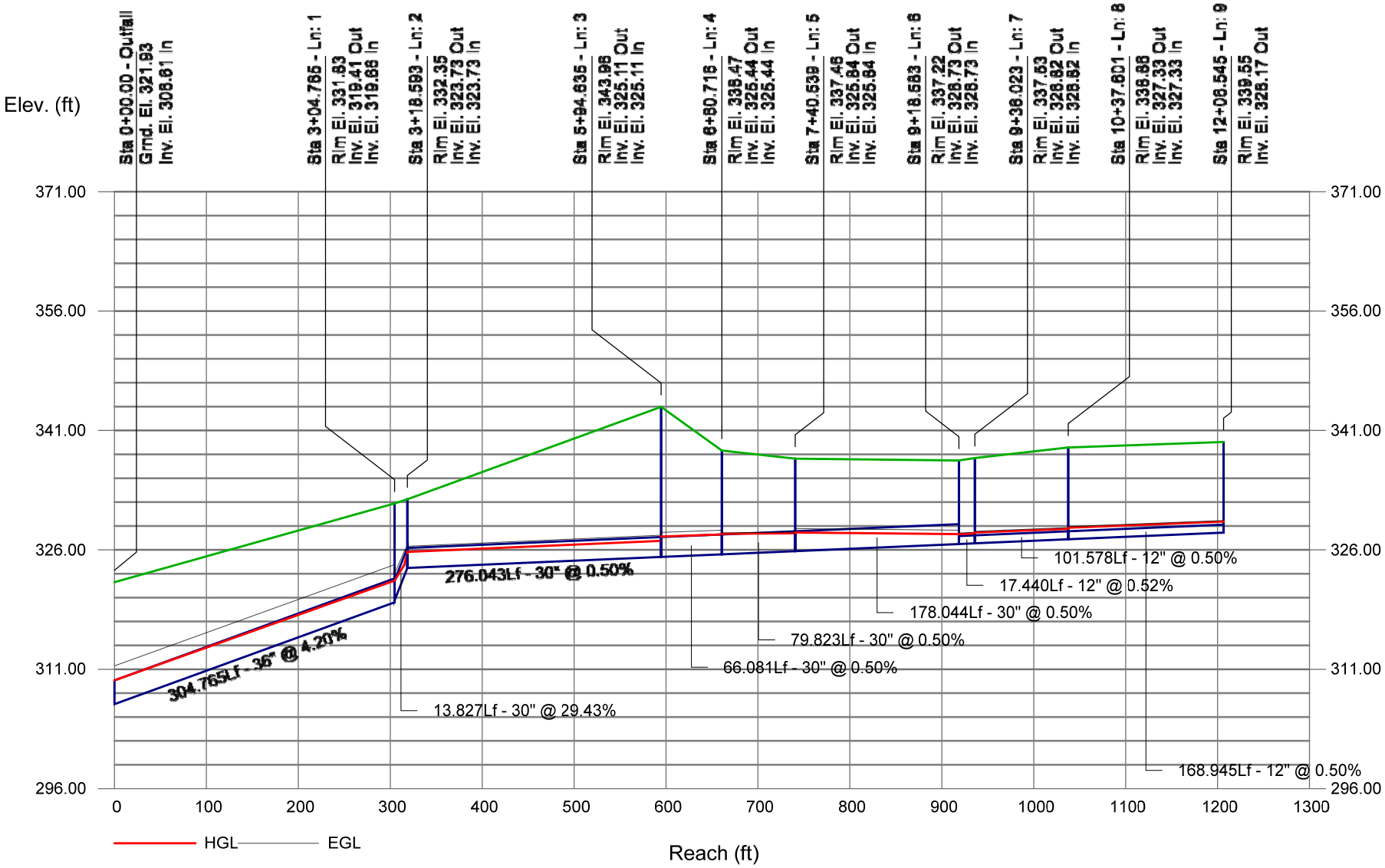
Col. 22 Energy loss. Average Sf/100 x Line Length (Col. 21/100 x Col. 12). Equals (EGL upstream - EGL downstream) +/- tolerance.

Col. 23 The junction loss coefficient (K).

Col. 24 Minor loss. (Col. 23 x Col. 18). Is added to upstream HGL and used as the starting HGL for the next upstream line(s).

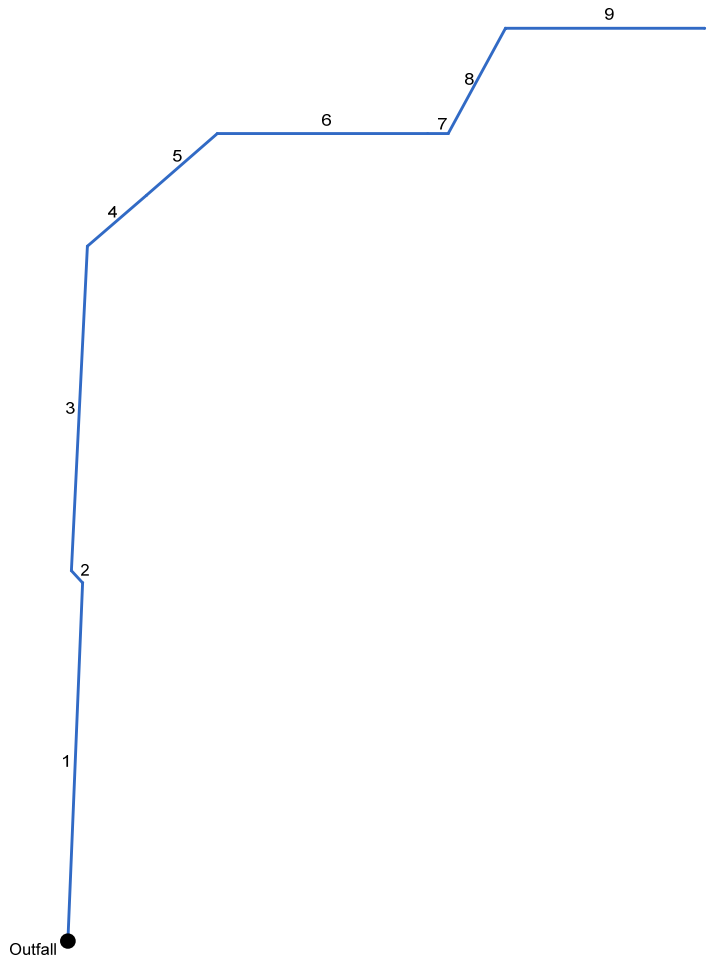
Storm Sewer Profile

Proj. file: STO 300.stm



Attachment 15 – 25yr HGL Analysis for Bypass Pipe including Maximum Existing Upstream Flows & 10yr Peak Flows

Hydraflow Storm Sewers Extension for Autodesk® Civil 3D® Plan



Project File: STO 300.stm	Number of lines: 9	Date: 6/9/2022

Hydraulic Grade Line Computations

Line	Size	Q	Downstream								Len	Upstream								Check		JL coeff	Minor loss
			Invert elev (ft)	HGL elev (ft)	Depth (ft)	Area (sqft)	Vel (ft/s)	Vel head (ft)	EGL elev (ft)	Sf (%)		Invert elev (ft)	HGL elev (ft)	Depth (ft)	Area (sqft)	Vel (ft/s)	Vel head (ft)	EGL elev (ft)	Sf (%)	Ave Sf (%)	Enrgy loss (ft)		
(1)	(in) (2)	(cfs) (3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(ft) (12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(K) (23)	(ft) (24)
1	36	85.58	306.61	309.61	3.00	6.89	12.11	2.28	311.89	1.647	304.765	319.41	322.23	2.82**	6.89	12.42	2.40	324.62	1.423	1.535	n/a	0.75	1.80
2	30	28.64	319.66	322.23	2.50	3.83	5.84	0.53	322.76	0.488	13.827	323.73	325.55 j	1.82**	3.83	7.47	0.87	326.42	0.627	0.558	n/a	0.76	n/a
3	30	28.64	323.73	325.75	2.02*	4.25	6.73	0.70	326.46	0.500	276.043	325.11	327.13	2.02	4.25	6.73	0.70	327.84	0.500	0.500	1.379	0.76	0.54
4	30	28.64	325.11	327.67	2.50	4.91	5.84	0.53	328.20	0.488	66.081	325.44	327.94	2.50	4.91	5.83	0.53	328.47	0.476	0.482	0.319	0.15	0.08
5	30	13.74	325.44	328.02	2.50	4.91	2.80	0.12	328.14	0.112	79.823	325.84	328.09	2.25	4.65	2.96	0.14	328.22	0.099	0.106	0.084	0.70	0.10
6	30	13.74	325.84	328.18	2.34	2.45	2.88	0.49	328.67	0.000	178.044	326.73	327.98	1.25**	2.45	5.62	0.49	328.47	0.000	0.000	n/a	0.15	0.07
7	12	2.40	326.73	327.98	1.00	0.79	3.06	0.15	328.12	0.454	17.440	326.82	328.06	1.00	0.79	3.06	0.15	328.20	0.454	0.454	0.079	0.90	0.13
8	12	2.40	326.82	328.19	1.00	0.79	3.06	0.15	328.33	0.454	101.578	327.33	328.65	1.00	0.79	3.06	0.15	328.79	0.454	0.454	0.461	0.90	0.13
9	12	2.40	327.33	328.78	1.00	0.79	3.06	0.15	328.92	0.454	168.945	328.17	329.55	1.00	0.79	3.06	0.15	329.69	0.454	0.454	0.767	1.00	0.15

Project File: STO 300.stm | Number of lines: 9 | Run Date: 6/9/2022

Notes: * depth assumed; ** Critical depth.; j-Line contains hyd. jump ; c = cir e = ellip b = box

Hydraflow HGL Computation Procedure

General Procedure:

Hydraflow computes the HGL using the Bernoulli energy equation. Manning's equation is used to determine energy losses due to pipe friction. In a standard step, iterative procedure, Hydraflow assumes upstream HGLs until the energy equation balances. If the energy equation cannot balance, supercritical flow exists and critical depth is temporarily assumed at the upstream end. A supercritical flow Profile is then computed using the same procedure in a downstream direction using momentum principles.

Col. 1 The line number being computed. Calculations begin at Line 1 and proceed upstream.

Col. 2 The line size. In the case of non-circular pipes, the line rise is printed above the span.

Col. 3 Total flow rate in the line.

Col. 4 The elevation of the downstream invert.

Col. 5 Elevation of the hydraulic grade line at the downstream end. This is computed as the upstream HGL + Minor loss of this line's downstream line.

Col. 6 The downstream depth of flow inside the pipe (HGL - Invert elevation) but not greater than the line size.

Col. 7 Cross-sectional area of the flow at the downstream end.

Col. 8 The velocity of the flow at the downstream end, (Col. 3 / Col. 7).

Col. 9 Velocity head (Velocity squared / 2g).

Col. 10 The elevation of the energy grade line at the downstream end, HGL + Velocity head, (Col. 5 + Col. 9).

Col. 11 The friction slope at the downstream end (the S or Slope term in Manning's equation).

Col. 12 The line length.

Col. 13 The elevation of the upstream invert.

Col. 14 Elevation of the hydraulic grade line at the upstream end.

Col. 15 The upstream depth of flow inside the pipe (HGL - Invert elevation) but not greater than the line size.

Col. 16 Cross-sectional area of the flow at the upstream end.

Col. 17 The velocity of the flow at the upstream end, (Col. 3 / Col. 16).

Col. 18 Velocity head (Velocity squared / 2g).

Col. 19 The elevation of the energy grade line at the upstream end, HGL + Velocity head, (Col. 14 + Col. 18) .

Col. 20 The friction slope at the upstream end (the S or Slope term in Manning's equation).

Col. 21 The average of the downstream and upstream friction slopes.

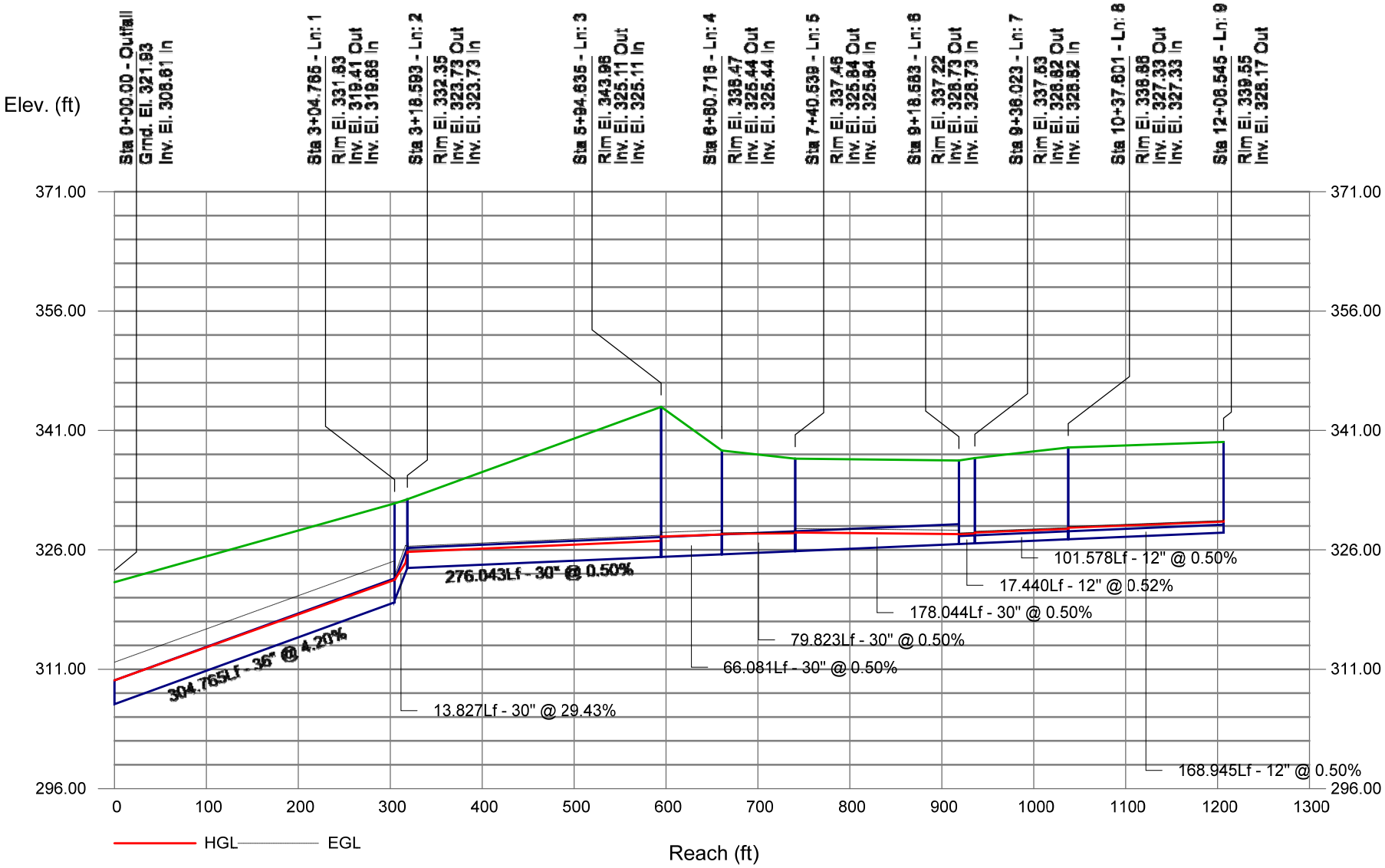
Col. 22 Energy loss. Average Sf/100 x Line Length (Col. 21/100 x Col. 12). Equals (EGL upstream - EGL downstream) +/- tolerance.

Col. 23 The junction loss coefficient (K).

Col. 24 Minor loss. (Col. 23 x Col. 18). Is added to upstream HGL and used as the starting HGL for the next upstream line(s).

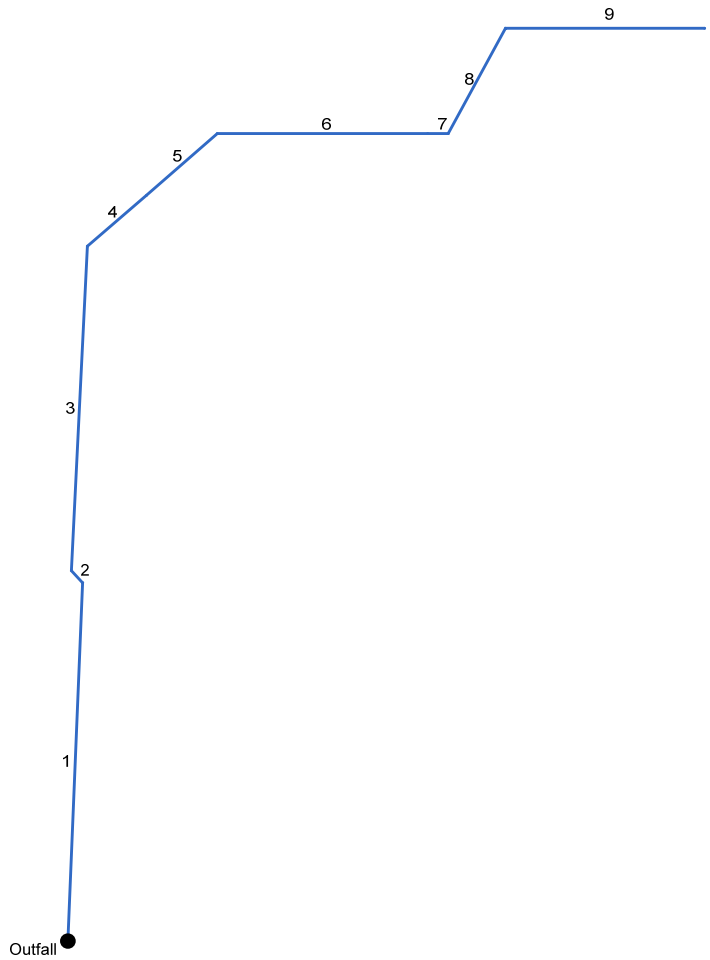
Storm Sewer Profile

Proj. file: STO 300.stm



Attachment 16 – 25yr HGL Analysis for Bypass Pipe including Maximum Existing Upstream Flows & 10yr Peak Flows

Hydraflow Storm Sewers Extension for Autodesk® Civil 3D® Plan



Project File: New.stm	Number of lines: 9	Date: 6/9/2022

Hydraulic Grade Line Computations

Line	Size	Q	Downstream								Len	Upstream								Check		JL coeff	Minor loss
			Invert elev (ft)	HGL elev (ft)	Depth (ft)	Area (sqft)	Vel (ft/s)	Vel head (ft)	EGL elev (ft)	Sf (%)		Invert elev (ft)	HGL elev (ft)	Depth (ft)	Area (sqft)	Vel (ft/s)	Vel head (ft)	EGL elev (ft)	Sf (%)	Ave Sf (%)	Enrgy loss (ft)		
(1)	(in) (2)	(cfs) (3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(ft) (12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(K) (23)	(ft) (24)
1	36	101.6	306.61	309.61	3.00	7.00	14.37	3.21	312.82	2.321	304.765	319.41	322.31	2.90**	7.00	14.52	3.28	325.59	2.035	2.178	n/a	0.75	2.46
2	30	28.64	319.66	322.31	2.50	3.83	5.84	0.53	322.84	0.488	13.827	323.73	325.55 j	1.82**	3.83	7.47	0.87	326.42	0.627	0.558	n/a	0.76	n/a
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5	30	13.74	325.44	328.02	2.50	4.91	2.80	0.12	328.14	0.112	79.823	325.84	328.09	2.25	4.65	2.96	0.14	328.22	0.099	0.106	0.084	0.70	0.10
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Project File: New.stm | Number of lines: 9 | Run Date: 6/9/2022

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Col. 8 The velocity of the flow at the downstream end, (Col. 3 / Col. 7).

Col. 9 Velocity head (Velocity squared / 2g).

Col. 10 The elevation of the energy grade line at the downstream end, HGL + Velocity head, (Col. 5 + Col. 9).

Col. 11 The friction slope at the downstream end (the S or Slope term in Manning's equation).

Col. 12 The line length.

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Col. 15 The upstream depth of flow inside the pipe (HGL - Invert elevation) but not greater than the line size.

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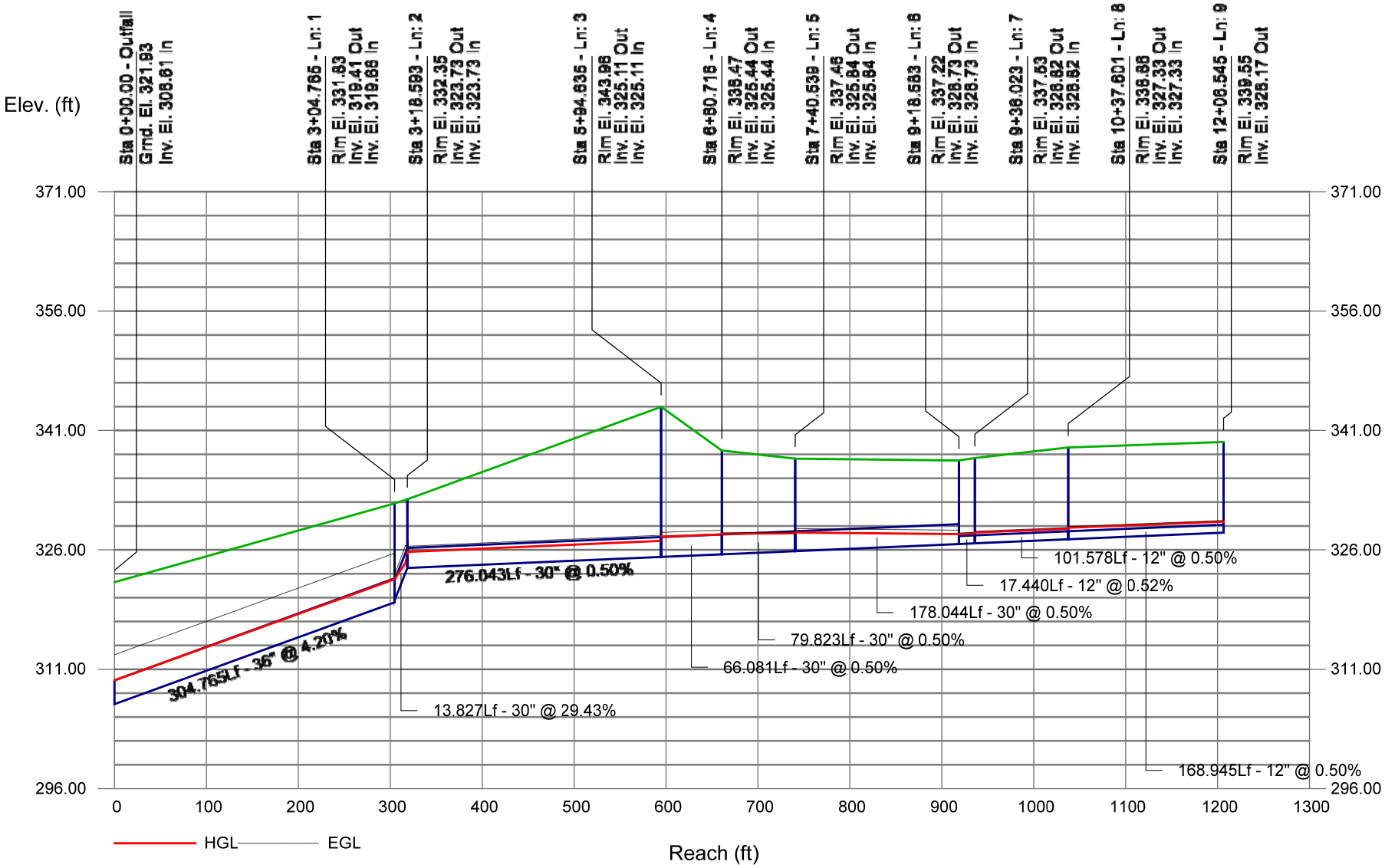
Storm Sewer Profile

Proj. file: New.stm