Manson Area
Stormwater Management Plan

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February 2018

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MANSON AREA STORMWATER MANAGEMENT PLAN

Chelan County Public Works

February 2018

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TABLE OF CONTENTS

Section	Title	Page #
1	Introduction	1
2	Study Area Characteristics	5
2.1	Soil Conditions	5
2.2	Current and Future Land Use	5
2.3	Site Hydrology	6
2.4	Data Collection	9
3	Hydrologic Model Description	9
4	Existing Stormwater System	16
4.1	Existing Collection System	16
4.2	Existing Outfalls	16
5	Capital Improvements	17
5.1	Overview	17
5.2	Recommended Collection System Improvements	17
5.3	Water Quality Treatment	18
5.4	Funding	28
6	Summary and Recommendations	32

APPENDICES

Appendix A Hydrologic Modeling Data

Appendix B Cost Estimate Detail

LIST OF TABLES

Table 1: Hydrologic Events 6

Table 2: Hydrologic Modeling Inputs 15

Table 3: Capital Improvements Listing 20

Table 4: Regional Stormwater Utilities 30

Figure # Title Page #

LIST OF FIGURES

Figure 1: Planning Area 3
Figure 2: Soils Map 7
Figure 3: Existing Stormwater System 11
Figure 4: Stormwater Modeling Sub-Basins 13
Figure 5: Phase I Improvements 22
Figure 6: Phase II Improvements 24
Figure 7: Phase III Improvements 26

1 INTRODUCTION

The Manson Stormwater Management Plan was prepared in 2002 by Hammond Collier Wade Livingstone. The plan summarized the findings of a detailed hydrologic modeling effort and presented a capital improvement program consisting of primary and secondary collection systems.

The improvements recommended in the 2002 plan focused on collection and conveyance to address recurring flooding and erosion problems. The plan also recognized the potential for impacts on Lake Chelan water quality and identified constructed wetlands and/or detention basins as possible stormwater treatment alternatives. However due to the cost and limited availability of waterfront property specific stormwater treatment locations were not identified.

Since 2002 land use in the Manson area has transitioned from agricultural to more residential and resort development uses. The flooding and erosion problems have persisted and the concern for Lake Chelan water quality has been heightened. In addition stormwater technology has advanced and there has been state-wide acceptance of low impact development (LID) storm water control measures. The County has requested an update to the 2002 plan to reflect current and future land use along with a financially viable capital improvement plan. The following objectives of the updated planning effort were established:

1. Review and compile relevant modeling and mapping data from the 2002 plan. Update the data to reflect current land use and new stormwater facilities.
2. Identify existing problem areas based on input from County maintenance staff and the Manson community.
3. Identify future problem areas based on land use trends and anticipated regulatory requirements.
4. Identify stormwater treatment and discharge methods that will address the Lake Chelan water quality concerns.
5. Develop capital improvements to address the problem areas and treatment needs with an emphasis on low impact development and financial feasibility.
6. Prioritize the capital improvements and coordinate the listing with funding sources and other roadway and utility improvement projects.

The updated planning began with a tour of the problem areas conducted by Chelan County Public Works Department staff and PACE during March 2016. Public Works staff provided a follow-up mapping summary of the problem area with priorities identified. These priorities along with the treatment objectives were incorporated in a phased capital improvement plan with potential funding sources identified.

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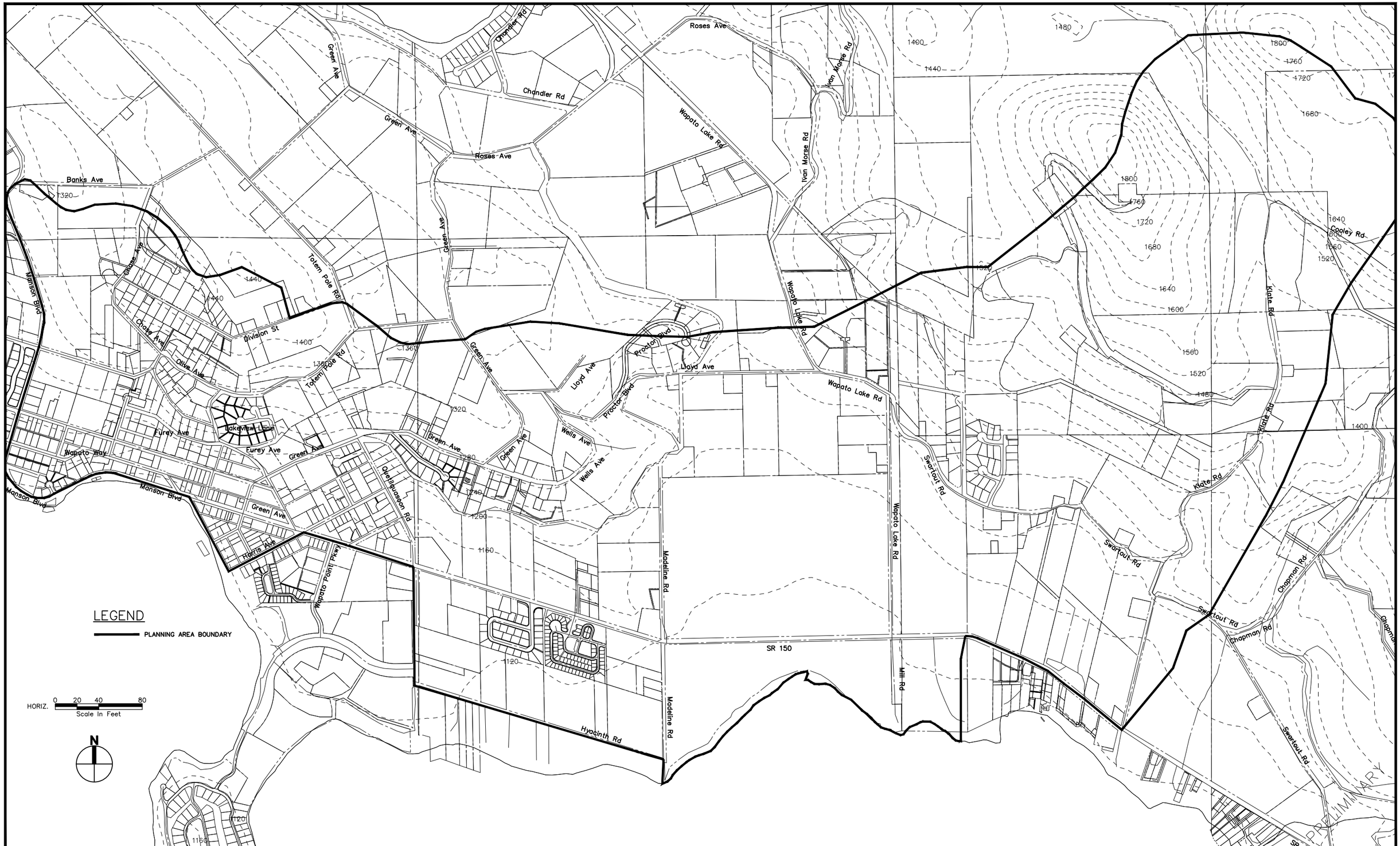

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PLANNING AREA

FIGURE
1

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2 STUDY AREA CHARACTERISTICS

2.1 Soil Conditions

The Manson area is comprised of three distinct soil types: Antilon, Chelan and Entiat. The soils distribution is shown in Figure 2. The following soils information is from the United States Department of Agriculture's (USDA) Natural Resource Conservation Service (NRCS) (formerly known as the Soil Conservation Service) Soil Survey for the Chelan Area of Washington.

The Antilon series consists of moderately well drained (hydrologic class C), moderately coarse textured soils that formed in pumice, volcanic ash and loess underlain by lake sediment. These soils are typically found in the Lake Chelan area on low lying terraces with slopes ranging from 0 to 25%. Antilon soils are commonly underlain at a depth of 30 inches by silty clay, which has poor infiltration and results in lateral movement of surface drainage.

The Chelan series soils are comprised of well-drained (hydrologic class B), moderately coarse textured soils that formed in pumice, volcanic ash, and loess over non-sorted, gravelly, cobbly, or bouldery deposits of glacial till. The Chelan soils are generally found on the terraces surrounding the lake and have no restrictive layers within 60 inches of the surface. They are very well drained and can withstand high rates of irrigation with only minor amounts of runoff occurring.

The Entiat series soils are well-drained (hydrologic class D), moderately coarse textured soils that are formed of decomposing granodiorite, granite, or gneiss bedrock. The soil is relatively thin with bedrock commonly found within 30 inches of the surface. Surface runoff varies from slow to rapid depending for the most part on the slope, which can range from 0 to 65% for this soil type.

The study area is comprised primarily of slopes facing from southeast to southwest and ranging from 0 to 30%.

2.2 Current and Future Land Use

When updating this plan for current standards, much of the land use determined in the previous HCWL 2002 report was maintained. Aside from a very small amount of new development, the downtown core and vast majority of Basins 1 through 3 were very similar to the conditions modeled in the 2002 report. A relatively significant amount of land further east in Basin 5 has transitioned from orchard into vineyard, which could be anticipated to produce more runoff, but this was not closely scrutinized otherwise as the downtown area is the focus in this report.

Future values were determined in Basins 1 through 3 by extrapolating the land use of a downtown, residential block onto the larger basin areas. This is assuming that in approximately 20 years, land near the downtown area in basins 1 through 3 will be significantly more developed. This was done with consideration for soil types in each

basin, and curve numbers were increased accordingly. See the table in the Stormwater System section to compare Current and Future values.

The 2002 HCWL concept assumed a large amount of pipe flow for its time of concentration calculations for the various basins. This has been adjusted for the existing conditions model, but kept for the future land use model as it is assumed that further developed land will allow stormwater to collect more quickly than the current state of many areas under analysis.

2.3 Site Hydrology

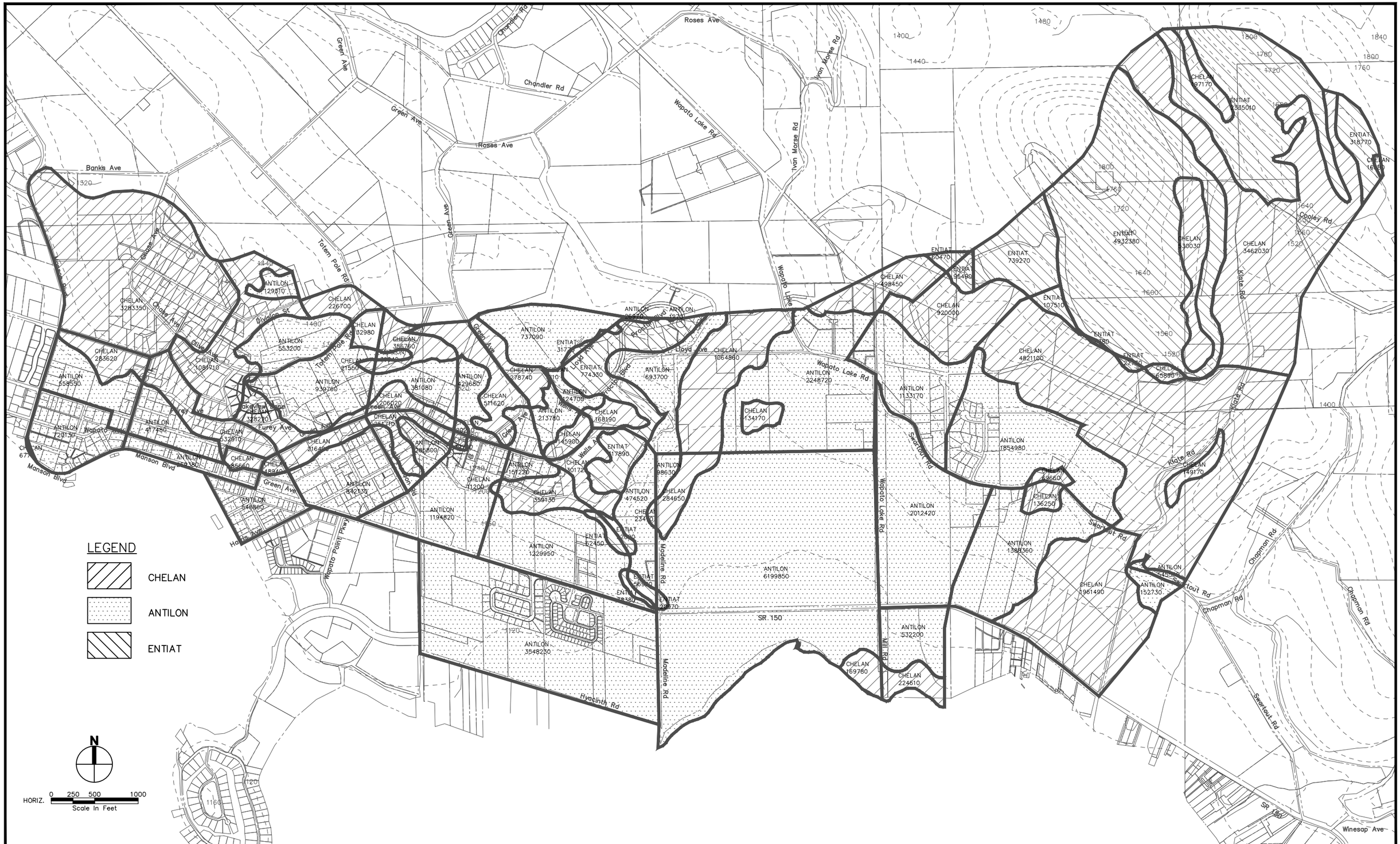
The site hydrology is somewhat unique due to the physical location of the community. The area receives approximately 12 inches of rain per year with a significant portion of this coming in the form of snow. Due to the south facing nature of the area snow is rarely accumulated on the slopes, whereas it can accumulate to a couple of feet deep on the flat terraces.

The site was modeled using the StormSHED™ computer program, as developed by Engenious Systems, Inc., and which incorporates the USDA NRCS rainfall distribution tables. The tables were developed to reflect the fact that in different parts of the country the rainfall distribution over time varies significantly. As an example the rainfall received in the coastal regions of the Pacific Coast tends to be more evenly distributed over time while that received in the interior west is more focused in a short period with minimal amounts received otherwise. Typically weather events approach the Manson area from the west over the Cascade Mountains. Across the lake and to the west of Manson is the 4000-foot elevation Slide Ridge, which acts as a buffer between Manson and the prevailing weather. It can be said that the Manson area, at 1100 to 1800 feet in elevation, sits directly in the “rain shadow” of Slide Ridge. The Manson area also has the distinction of lying on the line where the NRCS maps differentiate between what is known as the Type IA and Type II storm patterns. This line is quite arbitrary in that no exact science was used to determine its location. A judgement was made to use the Type 1A based on observed similarities between the Manson climate and many others in that area.

Table 1: Hydrologic Events

Storm Event	Precipitation
2-year 24-hour	1.00 inches*
10-year 24-hour	2.00 inches*
25-year 24-hour	2.50 inches*
100-year 24-hour	3.00 inches*
Water Quality Storm	0.62 inches*
East WA 3-Hour	0.34 inches*

**Values from Eastern Washington Stormwater Manual Isopluvial maps, or manual instruction/methodology*



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SOILS MAP

FIGURE
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2.4 Data Collection

The majority of data collected for this project was completed by HCWL staff preparing the 2002 HCWL report. This specifically included any GPS location marking, feature location, mapping, and basin delineation. A number of trips were made to the field to verify the locations and severity of a number of known problem areas following summer storms. These were documented by marking previously-generated maps and with a number of photographs.

A fundamental part of this planning effort during the assembly of the 2002 report was the identification of existing stormwater system elements. This was accomplished through the use of a backpack GPS unit. Each culvert, storm drain, drainage ditch and other stormwater feature was field located and the positioning coordinates recorded for inclusion in the Chelan County Geographic Information System (GIS) system on a drainage layer (see Figure 3). Generally the field information correlated well with the County GIS layers, but due to the County parcel map not being a survey grade map not all of the drainage components located in the field are aligned properly with the representative property lines. In some cases certain features were not located in the initial discovery work due to mislabeled manhole covers, covered up catch basins or outfalls, etc.

3 HYDROLOGIC MODEL DESCRIPTION

The Hydrologic model was developed by utilizing the data and inputs developed in the 2002 HCWL report. Many of the basins delineated there were determined to be adequate and representative of the current drainage paths. Some alterations needed to be made, however, in order to accurately represent stormwater infrastructure installed in county projects more recently. These are specifically located on Quetilquasoon Road as well as Manson Boulevard.

To address the conceptual plans for additional conveyance infrastructure around Quatis Street, a new sub-basin has been developed named B-1H which is derived from parts of surrounding basins. Figure 4 shows subbasin boundaries and the B-1H modification.

Basin 4, being Tribal Land, was largely ignored aside from initial comparisons when testing the inputs of the 2002 report. Basin 5, being further away from the more densely populated town center, was also only briefly examined and adjusted for changes in land use between 2002 and 2017.

Due to storm conveyance infrastructure installed between 2002 and 2017 along South Quetilquasoon Road, Basin 3 was split into two sub-basins. Thus, in the tables in Section 4: Existing Stormwater System, sub-basins B-3-1 and B-3-2 will be listed as separate basins under existing conditions.

Each of the individual collection areas was analyzed using the StormSHED™ computer software to determine their runoff from the design storms listed in Table 1. The study area was first reviewed in the field to determine where the flow paths for storm runoff would actually be

located (see Figure 4 for sub-basin areas.) The next step was to delineate individual collection areas and determine the routing that would be logical to deliver the runoff to the ultimate point of discharge into the waters of Lake Chelan. These runoff values were then routed through the conceptual pipe network to reach the lakeshore. Pipe diameters were estimated for each reach in the primary routing path to provide capacity to accommodate the 100-year storm event.

The StormSHED™ modeling software approaches the simulation of runoff based on the following parameters.

- Standard Soil Conservation Service (SCS) TR-20 methodology (Ref NEH-4).
- Uses TR-55 time of concentration methods (sheet, shallow, or channel flow).
- Uses curvilinear unit hydrograph (instead of triangular).
- Supports Santa Barbara Unit Hydrograph routing as an alternate to SCS routing.
- Automatically computes directly connected runoff hydrograph when appropriate.
- Uses storage-indication method (also known as puls) reservoir routing algorithm.
- Uses Manning's equation for uniform flow computations (velocity).
- For reach routing, the program supports the travel time translation for accumulating the time of concentration (tc) at each node, or can attenuate the hydrographs as it is being routed through reaches using storage, convex, kinematic or Muskingum-Cunge routing.

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EXISTING STORMWATER SYSTEM

FIGURE
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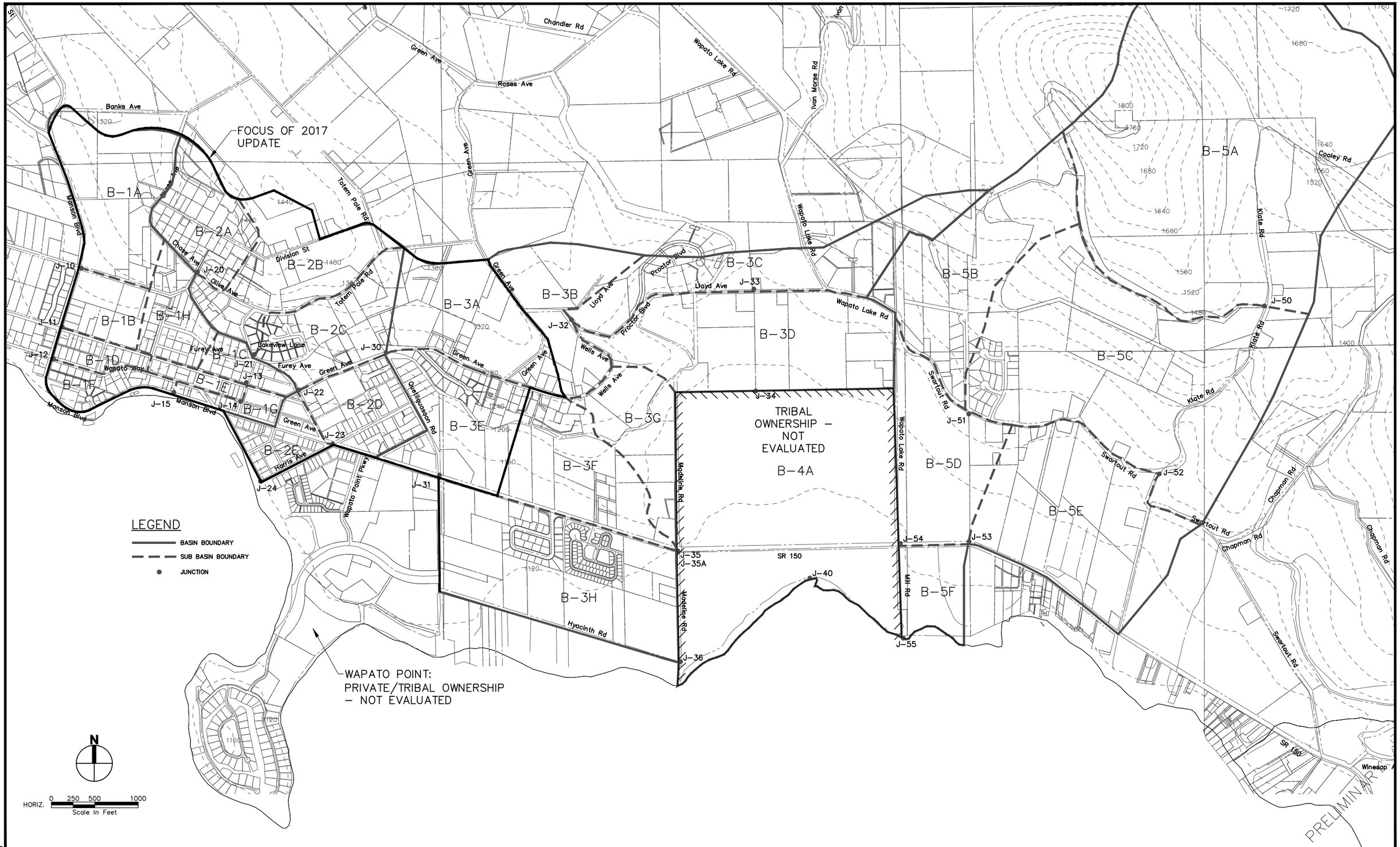

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STORMWATER MODELING SUB-BASINS

FIGURE
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Table 2 summarizes the assumed values for the runoff parameters in each of the sub-basins as used in the modeling efforts. More complete information in the form of printouts of modeling inputs and outputs can be found in the appendix.

Table 2: Hydrologic Modeling Inputs

Basin Name	Sub-Basin Name	Area in acres	Weighted CN for Developed Conditions	Time of Concentration in hours
B-1		**121.9**		
	B-1A	48.0	72.00	0.54
	B-1B	19.0	77.68	0.45
	B-1C	19.0	74.37	0.50
	B-1D	8.0	83.00	0.42
	B-1E	9.8	82.84	0.35
	B-1F	11.3	82.86	0.44
	B-1G	6.8	88.53	0.27
B-2		**141.3**		
	B-2A	27.0	72.00	0.35
	B-2B	43.6	75.20	0.45
	B-2C	32.7	77.94	0.42
	B-2D	24.3	79.15	0.40
	B-2E	13.7	89.60	0.30
B-3		**397.2**		
	B-3A	44.6	72.81	0.41
	B-3B	32.3	75.80	0.41
	B-3C	49.8	76.00	0.30
	B-3D	79.6	76.18	0.44
	B-3E	40.8	79.50	0.32
	B-3F	42.2	79.52	0.31
	B-3G	26.4	80.20	0.43
	B-3H	81.5	81.00	0.74
B-4		**152.7**		
	B-4A	152.7	73.11	0.90
B-5		**538.5**		
	B-5A	267.0	60.61	0.21
	B-5B	66.3	78.27	0.37
	B-5C	58.0	80.23	0.51
	B-5D	46.2	80.00	0.43
	B-5E	83.6	74.23	0.61
	B-5F	17.4	77.01	0.54

4 EXISTING STORMWATER SYSTEM

4.1 Existing Collection System

The Manson area is served by numerous, existing, public and private stormwater collection and disposal systems. These were either constructed as part of a highway construction project or as a component of a land development project. Specific areas served include:

- Bay View Storage
- Vista del Lago
- Manson Orchards
- Manson Schools
- Summerset Development
- Main Street in Downtown
- Wapato Ridge Development
- Proposed Manson Bay Market site
- Mill Bay Waterfront Estates
- Mill Bay Park

4.2 Existing Outfalls

There are a number of existing stormwater systems discharging to the lake. Four are specifically within Chelan County jurisdiction and are identified as locations for potential water quality treatment enhancement:

- Manson Boulevard Discharge – Direct pipe discharge
- Harris Avenue Discharge – Direct pipe discharge
- Quetilquasoon Road Discharge – Upstream biofiltration facility with direct pipe discharge
- McLaren Street – Direct pipe discharge

McLaren Street's outfall is an exception in the list above because it does not have any potential treatment enhancement proposed in this plan. This is due to the lack of real estate between it and Lake Chelan. Later in this report it is proposed that the McLaren outfall be rerouted to the nearby Harris outfall for treatment.

In addition to the existing stormwater system there exists in the Manson area a number of old agricultural drains, some of which are still functioning in one fashion or another. They were not located in the process of conducting the field survey of existing features and it is not clear if they carry irrigation return flows, stormwater runoff, some combination of the two, or are no longer functioning. The planning process assumed that due to their age they would not serve as an integral part of any future collection system and were therefore not included in the modeling effort.

5 CAPITAL IMPROVEMENTS

5.1 Overview

The initial system inventory, Public Works staff input, and the results of the stormwater modeling were used to develop a listing of stormwater improvements. The following criteria were used as a guide in categorizing and scheduling the improvements.

1. Private and public property damage – Will the improvement address an immediate property damage issue?
2. Maintenance – Will the improvement eliminate an on-going maintenance problem?
3. Water Quality – Will the improvement enhance Lake Chelan water quality and address the TMDL obligations?
4. Growth – Will the improvement address a long term growth need?

In general, the criteria are arranged in order of priority. Property damage and maintenance were the focus of the planning effort and thus took the highest priority. Since most improvements will address multiple criteria and others may have benefits that don't match the criteria, some judgment was used in prioritizing projects.

5.2 Recommended Collection System Improvements

Three phases of improvements were identified as follows:

Phase 1 – Address Existing Erosion and Flooding: The intent of Phase 1 is to address the immediate flooding and erosion problems and also put in place the critical infrastructure for Phase 2. These improvements generally consist of stabilized ditches in the upper basin and new collection piping in the lower areas. Stormwater treatment at the Harris Avenue and Manson Boulevard outfalls is included in Phase 1.

Phase 2 – Extend Collection System: The collection system would be extended to the upper basin under Phase 2. Catch basins at the roadway edges or curb flowlines and storm manholes on the trunk sewers would be included.

Phase 3 – Low Priority and Long Term: Phase 3 would address remaining needs that are not immediate and do not contribute to flooding or Lake Chelan water quality problems.

Table 3 lists the phases and project components with estimated costs. Figures 5 through 7 show the locations. Cost detail is provided in the appendix.

Roadway Improvements – It is important to note that stormwater improvements and road improvements should be coordinated and combined wherever possible. Stormwater improvements that could easily accommodate curb, gutter, sidewalk and widening are identified in Table 3. The Totem Pole Road and Quetilquasoon Road corridors are key areas that would likely qualify for pedestrian and roadway funding and should continue to be investigated.

5.3 Water Quality Treatment

Lake Chelan is an oligotrophic body of water and a primary function of installing a stormwater collection system in the Manson area is to provide the ability to treat the runoff before it enters the waters of lake. Prior studies (Lake Chelan Water Quality Plan 2010) have identified pollutants from urban drainage to include: (1) suspended sediments and particulates from erosion; (2) automotive-generated heavy metals such as lead, zinc, copper and cadmium; (3) oil and grease; (4) nutrients such as nitrogen and phosphorous; (5) salt deicing agents; (6) fecal related bacteria from pet and livestock wastes; (7) pesticides used for residential and roadway shoulder weed control; (8) various other deleterious toxic inorganic and organic chemicals which may originate from traffic accident related spills and residential/business discharges; and (9) floatable debris.

Of the nine categories of pollutants identified in the Lake Chelan Water Quality Plan the Manson area has the potential to contribute all of them. It is incumbent on the public as well as governmental agencies to make every effort to control the transport of these materials and remove them by all practical means.

Phosphorus has been identified as one of the primary contributors to the degradation of water quality in Lake Chelan (Lake Chelan Water Quality Plan, 2010). The primary anthropogenic non-point sources of phosphorous include runoff from 1) land areas being mined for phosphorous deposits, 2) agricultural areas, and 3) urban/residential areas. Because phosphorous has a high affinity for soil very little is actually transported in runoff as a dissolved component. Instead it adsorbs itself to the soil particles and is transported into the water bodies as sediment. Another means of introducing phosphorous into a water body is through the overboard discharge of sewage from boats.

Phosphorous that is adsorbed onto soil particles and introduced into water bodies such as Lake Chelan is generally not available for use. Lakes act as natural phosphorous sinks with the phosphorous containing particles sinking to the bottom and being covered with other sediment. It is possible for some of the phosphorous to be introduced into the water column by either the activity of benthic invertebrates or water chemistry changes due to lake turnover. Because phosphorous was identified in the Lake Chelan Water Quality Plan as the limiting factor in controlling periphytic and planktonic algal growth it is important to restrict the introduction of phosphorous into the lake as much as possible.

The Stormwater Management Manual for Eastern Washington (SWMMEW) describes a number of Best Management Practices (BMPs) for treating stormwater. Assuming that land does not have to be acquired from private owners at a cost-prohibitive price, the most cost-effective method is generally to construct either a biofiltration swale or a bioinfiltration pond. For example, here is an opportunity to construct a bioinfiltration swale near the South Harris Avenue discharge point. This will provide treatment to stormwater collected and conveyed through Basin B-2.

Washington State's Department of Ecology (DOE) provides a list of approved treatment technologies. In locations with limited space for things such as biofiltration swales on bioinfiltration ponds, these devices can offer an effective, albeit often expensive, method of treating stormwater. Media cartridges can be installed in large concrete vaults or in-line catch basin configurations. The media cartridge option would be most applicable at Manson Boulevard near the fire station to treat stormwater collected in Basin B-1.

Table 3: Capital Improvements

= Project could include pedestrian and roadway improvements

Stormwater CIP Project List

Phase		Title	Location	Problem - Overview	Improvement	Improvement Costs
1 - Address Existing Erosion & Flooding	A	Harris Avenue	SR 150 - Pedoi	Provide conveyance to Lake Chelan	30 in. dia. Trunk w/ SDMH's & CB's	$ 448,000
	B	Harris Avenue Treatment Facility	Discharge to Lake Chelan - Harris Avenue	Provide treatment prior to lake discharge	Biofiltration swale	$ 170,000
	C	McLaren Outfall Intertie	Discharge to Lake Chelan -McLaren Avenue	Eliminate point discharge	18 in. dia. Trunk w/ SDMH's & CB's	$ 158,000
	D	Manson Boulevard Treatment Facility	Discharge to Lake Chelan - Marina	Provide treatment prior to lake discharge	Treatment/filtration device	$ 287,000
	E	Totem Pole Road	SR150 - Green Avenue	Flooding	30 in. dia. Trunk w/ SDMH's & CB's	$ 340,000
	F	Green Avenue	Totem Pole - H.A. Ditch	Flooding, erosion	12 in. dia. Trunk w/ SDMH's & CB's	$ 244,000
	G	Totem Pole Road	Green Avenue - Hill Street	Ditch erosion, downslope flooding, groundwater	Excavate and stabilize ditches, culverts as req'd	$ 340,000
	H	Green Avenue	Coral/Terrace - Wells, Coral Stub	Ditch erosion, downslope flooding	Excavate and stabilize ditches, culverts as req'd	$ 184,000
	I	Lakeshore Drive	Chase - Quatis Facility	Ditch erosion, downslope flooding	Excavate and stabilize ditches, culverts as req'd, storage basin	$ 253,000
	J	Green Avenue	SR150 - Boetzske Avenue	Shoulder erosion, sediment, flooding	Reconstruct, replace existing inlets	$ 55,000
	K	Quatis Street & Wapato Way	Quatis CDS - Manson Blvd	Ditch erosion, downslope flooding	18 in. dia. Trunk w/ SDMH's & CB's	$ 615,000
	L	Division Street	Totem Pole - 1,300 ft west	Ditch erosion, sedimentation	Excavate and stabilize ditches, culverts as req'd	$ 51,000
					Subtotal Phase 1	***$ 3,145,000***
2 - Capital Improvements - Collection	A	Totem Pole Road	Green Avenue - Olive Avenue		24 in. dia. Trunk w/ SDMH's & CB's	$ 856,000
	B	Lakeshore Drive	Chase - Totem Pole		18 in. dia. Trunk w/ SDMH's & CB's	$ 515,000
	C	Totem Pole Road	Olive Avenue - Hill Street		12 in. dia. Trunk w/ SDMH's & CB's	$ 788,000
	D	Quetilquasoon Road	SR150 - Green		18 in. dia. Trunk w/ SDMH's & CB's	$ 514,000
	E	Green Avenue	Quetilquasoon Road - Coral/Terrace		18 in. dia. Trunk w/ SDMH's & CB's	$ 225,000
					Subtotal Phase 2	***$ 2,898,000***
3 - Capital Improvements - Low Priority/Long Term	A	Quetilquasoon Treatment Facility	Discharge to Lake Chelan - Quetilquasoon Road		Biofiltration swale	$ 166,000
	B	Green Avenue	H.A. Ditch - Quetilquasoon		12 in. dia. Trunk w/ SDMH's & CB's	$ 166,000
	C	Green Avenue	SR150 - Boetzske		Upgrade connection to Manson Blvd	$ 387,000
					Subtotal Phase 3	***$ 719,000***

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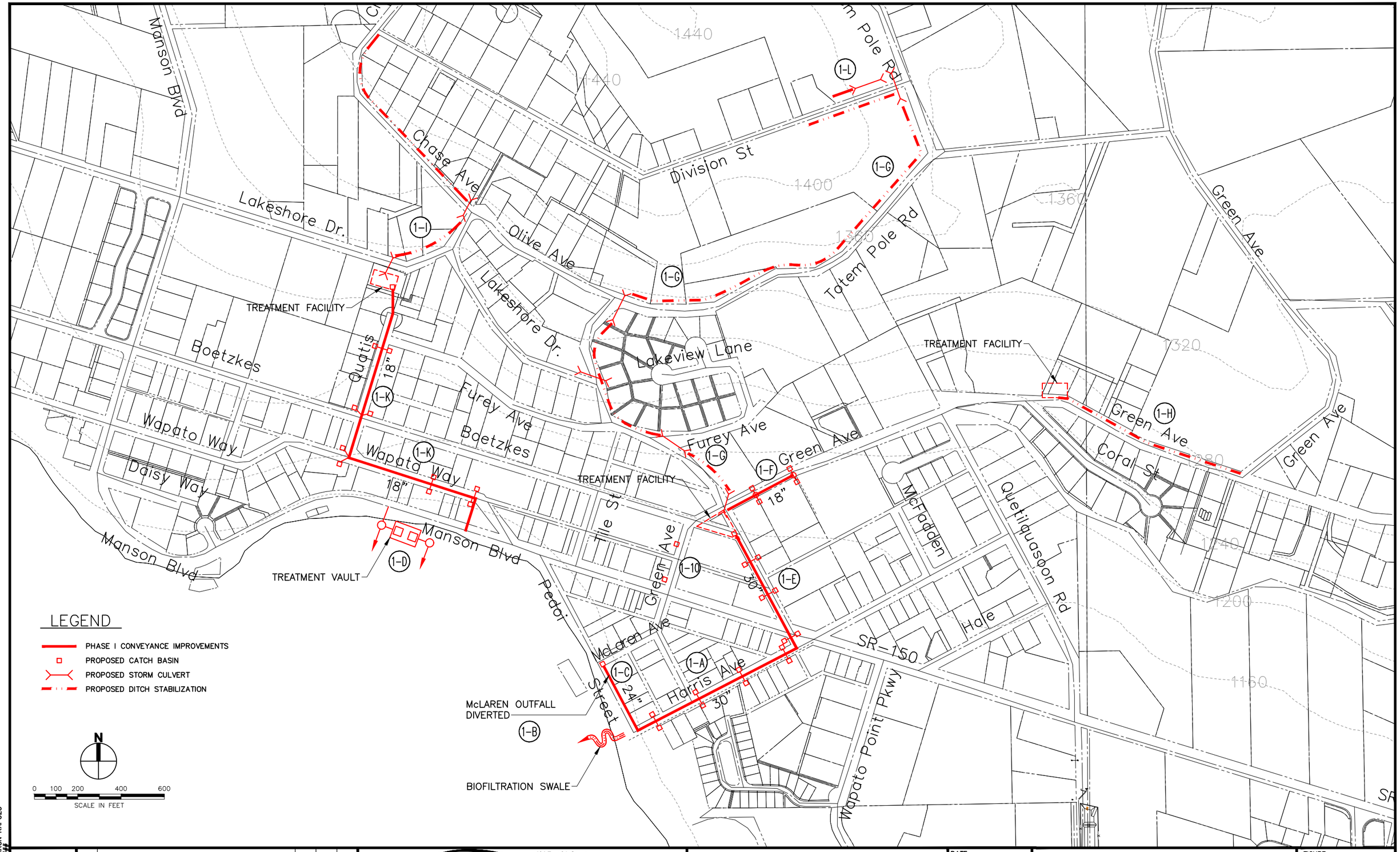

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MANSON AREA STORMWATER MANAGEMENT PLAN
CAPITAL IMPROVEMENTS

DATE
JAN 2018

SCALE
SHOWN

PHASE I IMPROVEMENTS

FIGURE
5

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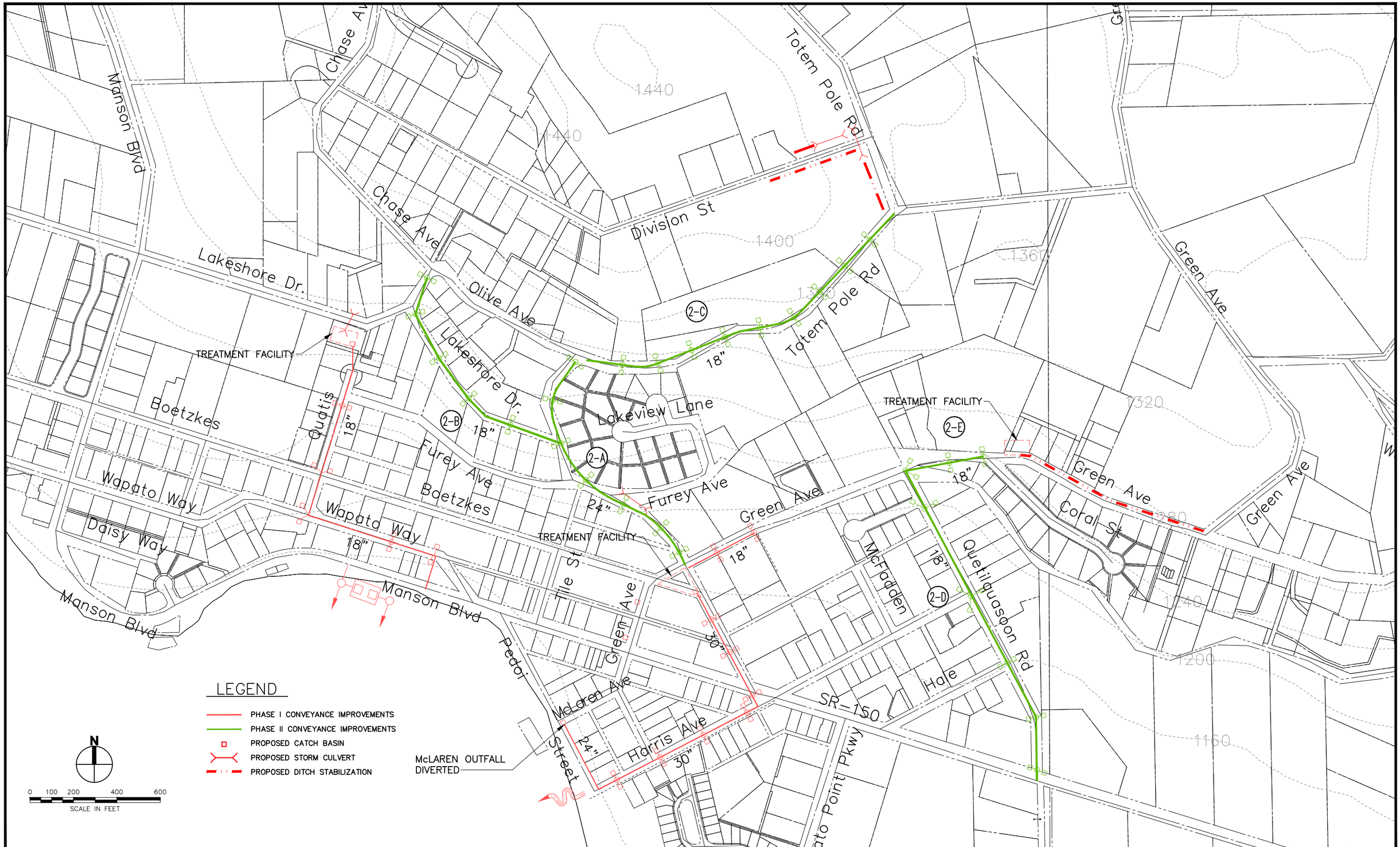

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USER NAME: AARON RAPOZO
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MANSON AREA STORMWATER MANAGEMENT PLAN
CAPITAL IMPROVEMENTS

DATE
JAN 2018

SCALE
SHOWN

PHASE II IMPROVEMENTS

FIGURE
6

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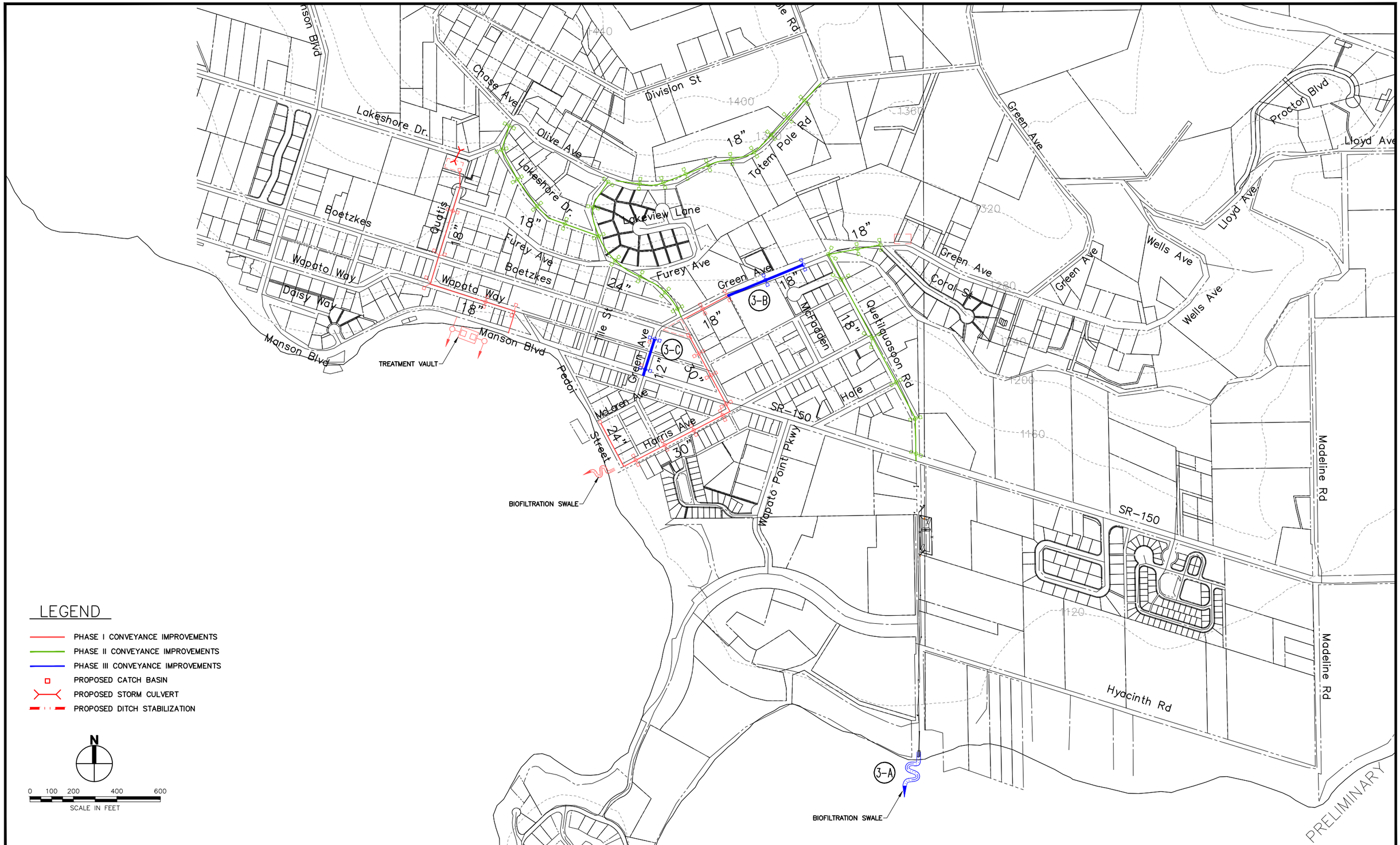

LEGEND

- PHASE I CONVEYANCE IMPROVEMENTS
- PHASE II CONVEYANCE IMPROVEMENTS
- PHASE III CONVEYANCE IMPROVEMENTS
- PROPOSED CATCH BASIN
- PROPOSED STORM CULVERT
- PROPOSED DITCH STABILIZATION

N

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USER NAME: AARON RAPOZO
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	SYM	REVISION	DATE	BY	APP'D

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MANSON AREA STORMWATER MANAGEMENT PLAN
CAPITAL IMPROVEMENTS

DATE
JAN 2018

SCALE
SHOWN

PHASE III IMPROVEMENTS

FIGURE
7

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5.4 Funding

Numerous sources of funding may be available to finance the stormwater improvement projects listed in tables 3, 4, and 5. The following have been identified as having potential:

1. County General and/or Road Funds:

   If available, the County may utilize general and/or road fund revenue to address the stormwater improvements. The extent to which these funds are available would be determined during the annual budgeting process. As history has shown, however, these funds are limited for projects of this nature.

2. Washington Department of Ecology Water Quality Program:

   Ecology administers three sources of funding under the annual integrated funding cycle for water quality projects:

   a. Centennial Clean Water Grant Program (Centennial), which historically received money from the Water Quality Account (cigarette tax dedicated to water quality), but as of 2009 is funded though state bonds.
   b. Federal Clean Water Act Section 319 Nonpoint-Source Grant Program (Section 319), which is allocated through the federal General Fund - Environmental Protection Agency (EPA) funds.
   c. Washington State Water Pollution Control Revolving Fund Loan Program (Revolving Fund), which is supported by a federal EPA Capitalization grant, state match, and interest and loan repayments.

   Water Quality Program applications are typically due in September each year and administered during the following fiscal year. It is important to note that the program emphasizes providing financial assistance to municipalities required to comply with Ecology's NPDES Municipal Stormwater Permit for Phase II communities as well as projects that are associated with a water quality benefit.

3. Transportation Grant Funding:

   As shown in Table 3 several of the storm water projects could include pedestrian and roadway improvements that would qualify for transportation funding. Current programs that could be considered are:

   a. Pedestrian and Bicycle Safety – Administered by the Washington State Department of Transportation (WSDOT) this program funds projects that enhance biking and walking safety. All public agencies are eligible to apply.
   b. Safe Routes to School – This program is also administered by WSDOT and funds projects located within two miles of a school that also improves biking and walking safety. The County has previously submitted Totem Pole Road for this program but the project was not selected. If combined with water quality funding the project may rank higher.

c. Surface Transportation Program (STP) – The STP is a federally funded program administrated by WSDOT and the Chelan-Douglas Transportation Council. Bicycle and pedestrian improvement projects can be funded by STP. Funding is distributed annually at the Transportation Council level.

d. Rural Arterial Program (RAP) – The RAP is administered by the County Road Administration Board (CRAB) and funds county rural arterial road improvements.

e. Urban Sidewalk Program (USP) – Administered by the Washington state Transportation Improvement Board (TIB) this program establishes highly connected pedestrian networks in downtowns and activity centers. Urban unincorporated areas qualify.

f. Urban Arterial Program (UAP) – Also Administered by TIB the UAP funds projects that enhance arterial safety and requires sidewalk on both sides.

g. Complete Streets Program – Complete Streets is a TIB program that funds arterial retrofits to improve safety. The County would need to adopt a complete streets ordinance to be eligible.

These transportation funding programs have varying funding cycles and requirements. Contacting the program representatives to review the funding cycles, matching requirements, and eligibility criteria is recommended.

4. Flood Control Zone District:

In 2014, Chelan County Board of County Commissioners established a flood control taxing district in response to the growing frequency and severity of flash and stage flooding within the county. A portion of the annual revenue is dedicated to planning, designing, and constructing flood mitigation projects and are prioritized within the 2017 *Comprehensive Flood Hazard Management Plan* action plan matrix. The intent is to present a long-term vision for managing all flood hazards in Chelan County and recommend near-term actions to achieve that vision. The District's Board of Supervisors with assistance from the District Administrator and Steering Committee members identify projects for funding consideration. Though Manson has not been identified as a priority area, the action plan matrix is updated over time to reflect prioritization by the Supervisors.

5. Public Works Board – Construction Loan Program:

Administered by the Washington State Public Works Board, the Construction Loan Program provides low interest loans to counties, cities, and special purpose districts to repair, replace, or create public works infrastructure. Any of the stormwater improvements described above would qualify. Interest rates vary from 0.5 to 2.0 percent, depending on percent matched by the applicant and the loans have a 20 year payback period. The program limits the amount borrowed by a jurisdiction at $10.0 million per biennium. Applications are due in May of each year and administered during the following year. Over the last several years, this loan program has remained unfunded by the state legislator.

6. Federal Bureau of Reclamation:

   The Lake Chelan Reclamation District irrigation system is federally owned by the Bureau of Reclamation. The Bureau has two funding programs available to projects that may be affected by irrigation facilities:

   a. WaterSMART Program: The WaterSMART program targets projects that improve irrigation water conservation. However projects that promote the treatment and use of impaired waters within a specific locale are also eligible.
   b. Loan Guarantee Program: The Loan Guarantee Program issue loan guarantees to assist non-federal borrowers in financing rural water projects, extraordinary maintenance and rehabilitation of Reclamation project facilities, and improvements to infrastructure directly related to a Reclamation project.

   These programs are highly competitive nationwide. At the moment none of the Manson stormwater issues have any relation to the irrigation system. However as the projects develop there may be opportunities to provide water conservation benefits or coordinate stormwater improvements with necessary improvements to the irrigation infrastructure.

7. Stormwater Utility:

   Chelan County currently has a stormwater utility in place for the Wenatchee urbanized area. A stormwater utility for the Manson area dedicated to implementing the capital improvements described in this plan may be an option. Several local jurisdictions that are subject to Ecology's NPDES Municipal Stormwater Permit for Phase II communities have established stormwater utilities. The methods of assignment and fees are summarized in Table 4.

Table 4: Regional Stormwater Utilities

Jurisdiction	Rate
City of East Wenatchee[a]	$45.00/residential parcel/year Prorated for commercial/ industrial/multi-family exceeding 2,750 SF of impervious area.
City of Wenatchee	$7.55/ERU/month
City of Moses Lake[a]	$5.60/ residential unit/month Prorated for commercial/ industrial/multi-family exceeding 6,000 SF of impervious area.
City of Ellensburg	$7.88/ residential unit/month Prorated for commercial/ industrial/multi-family exceeding 3,900 SF of impervious area.
Chelan County[a]	$5.50/single family residence/month Prorated for commercial/ industrial/multi-family exceeding 4,600 SF of impervious area.
Douglas County[a]	$45.00/residential parcel/year Prorated for commercial/ industrial/multi-family exceeding 2,750 SF of impervious area.

[a]Provides a credit to the fee for on-site stormwater control facilities.

6 SUMMARY AND RECOMMENDATIONS

Due to repetitive damage to public and private property resulting from limited Stormwater conveyance in the Manson basin, this Comprehensive Plan proposes capital improvements that, when implemented, will assist in solving the reoccurring drainage problems in this Chelan County community. Once this Comprehensive Plan is adopted, the first step for the Public Works Department should be working cooperatively with the County Commissioners, Manson Community Council, and the Manson Community to determine a funding strategy. Funding opportunities, as outlined in Section 5.4 of this plan, should be considered and expanded upon when opportunities present themselves. Additional consideration should be given to combining multiple projects into one in order to more efficiently expedite the implementation of the necessary capital improvements outlined in this Plan.

APPENDIX A

HYDROLOGIC MODELING DATA

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Appended on: Wednesday, May 24, 2017 10:31:17 AM

ROUTEHYD [] THRU [B-1] USING [E WA 3hr Depth] AND [EWash-3hr.rac] NOTZERO RELATIVE SCS/SBUH

Gravity Analysis using 3 hr duration storm

Reach ID	Area (ac)	Flow (cfs)	Full Q (cfs)	Full ratio	nDepth (ft)	Depth ratio	Size	nVel (ft/s)	fVel (ft/s)	Infil Vol (cf)	CBasin / Hyd
P-10	42.71	0.0118	43.9096	0.0003	0.0213	0.0142	18 in Diam	2.3427	24.8477	0.00	B-1A
P-11	56.53	0.048	102.10	0.0005	0.0346	0.0173	24 in Diam	3.966	32.4987	0.00	B-1B
P-12A	64.53	0.236	212.87	0.0011	0.0621	0.0249	30 in Diam	7.2831	43.3657	0.00	B-1D
P-12B	64.53	0.236	52.0215	0.0045	0.1457	0.0486	36 in Diam	1.8649	7.3595	0.00	
P-13	10.82	0.002	16.3178	0.0001	0.0119	0.0119	12 in Diam	1.153	20.7764	0.00	B-1C
P-14B	20.62	0.3522	42.5986	0.0083	0.0963	0.0642	18 in Diam	7.3624	24.1059	0.00	B-1E
P-17	18.65	0.0261	17.2434	0.0015	0.029	0.029	12 in Diam	3.9856	21.955	0.00	B-1H
P-14A	39.27	0.3606	19.105	0.0189	0.1905	0.0953	24 in Diam	2.3688	6.0813	0.00	
P-15	46.07	0.9091	23.8531	0.0381	0.2664	0.1332	24 in Diam	3.6554	7.5927	0.00	B-1G
B1 OUTLET	121.90	1.4006	206.07	0.0068	0.2059	0.0588	42 in Diam	6.1181	21.4189	0.00	B-1F

HGL Analysis

From Node	To Node	HG El (ft)	App (ft)	Bend (ft)	Junct Loss (ft)	Adjusted HG El (ft)	Max El (ft)
							1104.8511
No approach losses at node J-15 because inverts and/or crowns are offset.							
J-16	J-16A	1105.4366	------	0.0014	0.0003	1105.4382	1110.0000
J-12A	J-16	1105.4663	0.8237	0.2935	------	1104.9361	1111.0000
J-12	J-12A	1165.0488	------	0.0605	------	1165.1093	1170.0000
No approach losses at node J-10 because inverts and/or crowns are offset.							
J-11	J-12	1199.0023	------	0.0069	------	1199.0092	1205.0000
J-10	J-11	1249.9905	------	------	------	1249.9905	1255.0000

J-15	J-16	1105.4552	0.0871	0.0206	------	1105.3887	1110.0000
J-19	J-15	1106.2719	------	0.4635	0.0508	1106.7862	1111.0000
No approach losses at node J-13 because inverts and/or crowns are offset.							
J-14	J-19	1135.2359	------	0.0000	------	1135.2359	1140.0000
J-13	J-14	1154.9740	------	------	------	1154.9740	1160.0000
J-18	J-19	1173.0317	------	------	------	1173.0317	1178.0000

Conduit Notes

Reach	HW Depth (ft)	HW/D ratio	Q (cfs)	TW Depth (ft)	Dc (ft)	Dn (ft)	Comment
B1 OUTLET	0.4366	0.1247	1.40	0.3511	0.3511	0.2059	SuperCrit flow, Inlet end controls
P-12B	3.4383	1.1461	0.24	3.4382	0.1490	0.1457	Outlet Control
P-12A	0.0488	0.0195	0.24	0.9361	0.1555	0.0621	SuperCrit flow, Inlet end controls
P-11	0.0023	0.0011	0.05	0.1093	0.0741	0.0346	SuperCrit flow, Inlet end controls
P-10	-0.0095	-0.0063	0.01	0.0389	0.0389	0.0213	SuperCrit flow, Inlet end controls
P-15	3.4427	1.7213	0.91	3.4382	0.3278	0.2664	Outlet Control
P-14A	0.2719	0.1360	0.36	1.3887	0.2049	0.1905	SuperCrit flow, Inlet end controls
P-14B	0.2359	0.1572	0.35	0.7862	0.2159	0.0963	SuperCrit flow, Inlet end controls
P-13	-0.0260	-0.0260	0.00	20.2359	0.0183	0.0119	SuperCrit flow, Inlet end controls
P-17	0.0317	0.0317	0.03	0.7862	0.0650	0.0290	SuperCrit flow, Inlet end controls

Node and Reach invert report

Node and Reach invert report				
Node	J-10		Out ie	1250.00 ft
	Reach	P-10	I.E. Out	1250.00 ft
Node	J-11		Out ie	1199.00 ft
	Reach	P-10	I.E. In	1200.00 ft
	Reach	P-11	I.E. Out	1199.00 ft
Node	J-12		Out ie	1165.00 ft
	Reach	P-11	I.E. In	1165.00 ft
	Reach	P-12A	I.E. Out	1165.00 ft

Node	J-12A		Out ie	1104.00 ft
	Reach	P-12A	I.E. In	1104.00 ft
	Reach	P-12B	I.E. Out	1104.00 ft
Node	J-13		Out ie	1155.00 ft
	Reach	P-13	I.E. Out	1155.00 ft
Node	J-14		Out ie	1135.00 ft
	Reach	P-13	I.E. In	1115.00 ft
	Reach	P-14B	I.E. Out	1135.00 ft
Node	J-18		Out ie	1173.00 ft
	Reach	P-17	I.E. Out	1173.00 ft
Node	J-19		Out ie	1106.00 ft
	Reach	P-14B	I.E. In	1106.00 ft
	Reach	P-17	I.E. In	1106.00 ft
	Reach	P-14A	I.E. Out	1106.00 ft
Node	J-15		Out ie	1104.00 ft
	Reach	P-14A	I.E. In	1104.00 ft
	Reach	P-15	I.E. Out	1104.00 ft
Node	J-16		Out ie	1102.00 ft
	Reach	P-12B	I.E. In	1102.00 ft
	Reach	P-15	I.E. In	1102.00 ft
	Reach	B1 OUTLET	I.E. Out	1105.00 ft

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Appended on: Wednesday, May 24, 2017 10:37:50 AM

ROUTEHYD [] THRU [B-1] USING [WQS] AND [TYPE1A.RAC] NOTZERO RELATIVE SCS/SBUH

Gravity Analysis using 24 hr duration storm

Reach ID	Area (ac)	Flow (cfs)	Full Q (cfs)	Full ratio	nDepth (ft)	Depth ratio	Size	nVel (ft/s)	fVel (ft/s)	Infil Vol (cf)	CBasin / Hyd
P-10	42.71	0.1696	43.9096	0.0039	0.0676	0.0451	18 in Diam	5.9906	24.8477	0.00	B-1A
P-11	56.53	0.2476	102.10	0.0024	0.0728	0.0364	24 in Diam	6.76	32.4987	0.00	B-1B
P-12A	64.53	0.3112	212.87	0.0015	0.0713	0.0285	30 in Diam	7.8198	43.3657	0.00	B-1D
P-12B	64.53	0.3112	52.0215	0.006	0.1656	0.0552	36 in Diam	2.0332	7.3595	0.00	
P-13	10.82	0.0418	16.3178	0.0026	0.0375	0.0375	12 in Diam	4.3743	20.7764	0.00	B-1C
P-14B	20.62	0.1917	42.5986	0.0045	0.0726	0.0484	18 in Diam	6.0944	24.1059	0.00	B-1E
P-17	18.65	0.0919	17.2434	0.0053	0.0523	0.0523	12 in Diam	5.8554	21.955	0.00	B-1H
P-14A	39.27	0.2244	19.105	0.0117	0.1525	0.0762	24 in Diam	2.0465	6.0813	0.00	
P-15	46.07	0.458	23.8531	0.0192	0.1921	0.096	24 in Diam	2.9727	7.5927	0.00	B-1G
B1 OUTLET	121.90	0.727	206.07	0.0035	0.1516	0.0433	42 in Diam	5.0011	21.4189	0.00	B-1F

HGL Analysis

From Node	To Node	HG El (ft)	App (ft)	Bend (ft)	Junct Loss (ft)	Adjusted HG El (ft)	Max El (ft)
							1104.7514
No approach losses at node J-15 because inverts and/or crowns are offset.							
J-16	J-16A	1105.3032	------	0.0004	0.0001	1105.3037	1110.0000
J-12A	J-16	1105.3318	0.9495	0.3383	------	1104.7206	1111.0000
J-12	J-12A	1165.0802	------	0.1758	------	1165.2560	1170.0000
No approach losses at node J-10 because inverts and/or crowns are offset.							
J-11	J-12	1199.1304	------	0.0451	------	1199.1754	1205.0000
J-10	J-11	1250.1403	------	------	------	1250.1403	1255.0000

J-15	J-16	1105.3173	0.0650	0.0154	------	1105.2677	1110.0000
J-19	J-15	1106.2130	------	0.3176	0.1866	1106.7172	1111.0000
No approach losses at node J-13 because inverts and/or crowns are offset.							
J-14	J-19	1135.1571	------	0.0000	------	1135.1571	1140.0000
J-13	J-14	1155.0612	------	------	------	1155.0612	1160.0000
J-18	J-19	1173.1101	------	------	------	1173.1101	1178.0000

Conduit Notes

Reach	HW Depth (ft)	HW/D ratio	Q (cfs)	TW Depth (ft)	Dc (ft)	Dn (ft)	Comment
B1 OUTLET	0.3032	0.0866	0.73	0.2514	0.2514	0.1516	SuperCrit flow, Inlet end controls
P-12B	3.3038	1.1013	0.31	3.3037	0.1704	0.1656	Outlet Control
P-12A	0.0802	0.0321	0.31	0.7206	0.1789	0.0713	SuperCrit flow, Inlet end controls
P-11	0.1304	0.0652	0.25	0.2560	0.1690	0.0728	SuperCrit flow, Inlet end controls
P-10	0.1403	0.0935	0.17	0.1510	0.1510	0.0676	SuperCrit flow, Inlet end controls
P-15	3.3048	1.6524	0.46	3.3037	0.2314	0.1921	Outlet Control
P-14A	0.2130	0.1065	0.22	1.2677	0.1610	0.1525	SuperCrit flow, Inlet end controls
P-14B	0.1571	0.1047	0.19	0.7172	0.1606	0.0726	SuperCrit flow, Inlet end controls
P-13	0.0612	0.0612	0.04	20.1571	0.0826	0.0375	SuperCrit flow, Inlet end controls
P-17	0.1101	0.1101	0.09	0.7172	0.1235	0.0523	SuperCrit flow, Inlet end controls

Node and Reach invert report

Node and Reach invert report				
Node	J-10		Out ie	1250.00 ft
	Reach	P-10	I.E. Out	1250.00 ft
Node	J-11		Out ie	1199.00 ft
	Reach	P-10	I.E. In	1200.00 ft
	Reach	P-11	I.E. Out	1199.00 ft
Node	J-12		Out ie	1165.00 ft
	Reach	P-11	I.E. In	1165.00 ft
	Reach	P-12A	I.E. Out	1165.00 ft

Node	J-12A		Out ie	1104.00 ft
	Reach	P-12A	I.E. In	1104.00 ft
	Reach	P-12B	I.E. Out	1104.00 ft
Node	J-13		Out ie	1155.00 ft
	Reach	P-13	I.E. Out	1155.00 ft
Node	J-14		Out ie	1135.00 ft
	Reach	P-13	I.E. In	1115.00 ft
	Reach	P-14B	I.E. Out	1135.00 ft
Node	J-18		Out ie	1173.00 ft
	Reach	P-17	I.E. Out	1173.00 ft
Node	J-19		Out ie	1106.00 ft
	Reach	P-14B	I.E. In	1106.00 ft
	Reach	P-17	I.E. In	1106.00 ft
	Reach	P-14A	I.E. Out	1106.00 ft
Node	J-15		Out ie	1104.00 ft
	Reach	P-14A	I.E. In	1104.00 ft
	Reach	P-15	I.E. Out	1104.00 ft
Node	J-16		Out ie	1102.00 ft
	Reach	P-12B	I.E. In	1102.00 ft
	Reach	P-15	I.E. In	1102.00 ft
	Reach	B1 OUTLET	I.E. Out	1105.00 ft

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Appended on: Wednesday, May 24, 2017 10:33:50 AM

ROUTEHYD [] THRU [B-1] USING [2 yr 24 hr] AND [TYPE1A.RAC] NOTZERO RELATIVE SCS/SBUH

Gravity Analysis using 24 hr duration storm

Reach ID	Area (ac)	Flow (cfs)	Full Q (cfs)	Full ratio	nDepth (ft)	Depth ratio	Size	nVel (ft/s)	fVel (ft/s)	Infil Vol (cf)	CBasin / Hyd
P-10	42.71	0.6801	43.9096	0.0155	0.1303	0.0869	18 in Diam	9.0908	24.8477	0.00	B-1A
P-11	56.53	1.085	102.10	0.0106	0.1447	0.0724	24 in Diam	10.687	32.4987	0.00	B-1B
P-12A	64.53	1.4966	212.87	0.007	0.1497	0.0599	30 in Diam	12.4843	43.3657	0.00	B-1D
P-12B	64.53	1.4966	52.0215	0.0288	0.35	0.1167	36 in Diam	3.2457	7.3595	0.00	
P-13	10.82	0.1671	16.3178	0.0102	0.071	0.071	12 in Diam	6.7678	20.7764	0.00	B-1C
P-14B	20.62	0.8527	42.5986	0.02	0.147	0.098	18 in Diam	9.5519	24.1059	0.00	B-1E
P-17	18.65	0.5064	17.2434	0.0294	0.1178	0.1178	12 in Diam	9.7415	21.955	0.00	B-1H
P-14A	39.27	1.3553	19.105	0.0709	0.3608	0.1804	24 in Diam	3.513	6.0813	0.00	
P-15	46.07	2.0751	23.8531	0.087	0.3986	0.1993	24 in Diam	4.6629	7.5927	0.00	B-1G
B1 OUTLET	121.90	4.1675	206.07	0.0202	0.3447	0.0985	42 in Diam	8.5114	21.4189	0.00	B-1F

HGL Analysis

From Node	To Node	HG El (ft)	App (ft)	Bend (ft)	Junct Loss (ft)	Adjusted HG El (ft)	Max El (ft)
							1105.1115
No approach losses at node J-15 because inverts and/or crowns are offset.							
J-16	J-16A	1105.7892	------	0.0074	0.0030	1105.7996	1110.0000
J-12A	J-16	1105.8300	2.4202	0.8623	------	1104.2722	1111.0000
J-12	J-12A	1165.3752	------	0.4395	------	1165.8147	1170.0000
No approach losses at node J-10 because inverts and/or crowns are offset.							
J-11	J-12	1199.3871	------	0.1039	------	1199.4909	1205.0000
J-10	J-11	1250.3514	------	------	------	1250.3514	1255.0000

J-15	J-16	1105.8352	0.1916	0.0453	------	1105.6890	1110.0000
J-19	J-15	1106.5400	------	0.7801	0.5414	1107.8615	1111.0000
No approach losses at node J-13 because inverts and/or crowns are offset.							
J-14	J-19	1135.4070	------	0.0007	------	1135.4077	1140.0000
J-13	J-14	1155.1754	------	------	------	1155.1754	1160.0000
J-18	J-19	1173.3473	------	------	------	1173.3473	1178.0000

Conduit Notes

Reach	HW Depth (ft)	HW/D ratio	Q (cfs)	TW Depth (ft)	Dc (ft)	Dn (ft)	Comment
B1 OUTLET	0.7892	0.2255	4.17	0.6115	0.6115	0.3447	SuperCrit flow, Inlet end controls
P-12B	3.8020	1.2673	1.50	3.7996	0.3787	0.3500	Outlet Control
P-12A	0.3752	0.1501	1.50	0.3976	0.3976	0.1497	SuperCrit flow, Inlet end controls
P-11	0.3871	0.1935	1.09	0.8147	0.3594	0.1447	SuperCrit flow, Inlet end controls
P-10	0.3514	0.2343	0.68	0.3060	0.3060	0.1303	SuperCrit flow, Inlet end controls
P-15	3.8227	1.9114	2.08	3.7996	0.5002	0.3986	Outlet Control
P-14A	0.5400	0.2700	1.36	1.6890	0.4020	0.3608	SuperCrit flow, Inlet end controls
P-14B	0.4070	0.2713	0.85	1.8615	0.3438	0.1470	SuperCrit flow, Inlet end controls
P-13	0.1754	0.1754	0.17	20.4077	0.1672	0.0710	SuperCrit flow, Inlet end controls
P-17	0.3473	0.3473	0.51	1.8615	0.2952	0.1178	SuperCrit flow, Inlet end controls

Node and Reach invert report

Node and Reach invert report				
Node	J-10		Out ie	1250.00 ft
	Reach	P-10	I.E. Out	1250.00 ft
Node	J-11		Out ie	1199.00 ft
	Reach	P-10	I.E. In	1200.00 ft
	Reach	P-11	I.E. Out	1199.00 ft
Node	J-12		Out ie	1165.00 ft
	Reach	P-11	I.E. In	1165.00 ft
	Reach	P-12A	I.E. Out	1165.00 ft

Node	J-12A		Out ie	1104.00 ft
	Reach	P-12A	I.E. In	1104.00 ft
	Reach	P-12B	I.E. Out	1104.00 ft
Node	J-13		Out ie	1155.00 ft
	Reach	P-13	I.E. Out	1155.00 ft
Node	J-14		Out ie	1135.00 ft
	Reach	P-13	I.E. In	1115.00 ft
	Reach	P-14B	I.E. Out	1135.00 ft
Node	J-18		Out ie	1173.00 ft
	Reach	P-17	I.E. Out	1173.00 ft
Node	J-19		Out ie	1106.00 ft
	Reach	P-14B	I.E. In	1106.00 ft
	Reach	P-17	I.E. In	1106.00 ft
	Reach	P-14A	I.E. Out	1106.00 ft
Node	J-15		Out ie	1104.00 ft
	Reach	P-14A	I.E. In	1104.00 ft
	Reach	P-15	I.E. Out	1104.00 ft
Node	J-16		Out ie	1102.00 ft
	Reach	P-12B	I.E. In	1102.00 ft
	Reach	P-15	I.E. In	1102.00 ft
	Reach	B1 OUTLET	I.E. Out	1105.00 ft

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Appended on: Wednesday, May 24, 2017 10:35:30 AM

ROUTEHYD [] THRU [B-1] USING [25 year] AND [TYPE1A.RAC] NOTZERO RELATIVE SCS/SBUH

Gravity Analysis using 24 hr duration storm

Reach ID	Area (ac)	Flow (cfs)	Full Q (cfs)	Full ratio	nDepth (ft)	Depth ratio	Size	nVel (ft/s)	fVel (ft/s)	Infil Vol (cf)	CBasin / Hyd
P-10	42.71	9.373	43.9096	0.2135	0.4707	0.3138	18 in Diam	19.7499	24.8477	0.00	B-1A
P-11	56.53	13.0441	102.10	0.1278	0.4826	0.2413	24 in Diam	22.3303	32.4987	0.00	B-1B
P-12A	64.53	15.7152	212.87	0.0738	0.4594	0.1837	30 in Diam	25.3929	43.3657	0.00	B-1D
P-12B	64.53	15.7152	52.0215	0.3021	1.1312	0.3771	36 in Diam	6.4426	7.3595	0.00	
P-13	10.82	2.4666	16.3178	0.1512	0.2622	0.2622	12 in Diam	15.0251	20.7764	0.00	B-1C
P-14B	20.62	6.0525	42.5986	0.1421	0.3814	0.2543	18 in Diam	17.1047	24.1059	0.00	B-1E
P-17	18.65	5.2495	17.2434	0.3044	0.3787	0.3787	12 in Diam	19.2592	21.955	0.00	B-1H
P-14A	39.27	11.233	19.105	0.588	1.1029	0.5514	24 in Diam	6.3243	6.0813	0.00	
P-15	46.07	14.0726	23.8531	0.59	1.1052	0.5526	24 in Diam	7.9021	7.5927	0.00	B-1G
B1 OUTLET	121.90	33.2649	206.07	0.1614	0.9505	0.2716	42 in Diam	15.7433	21.4189	0.00	B-1F

HGL Analysis

From Node	To Node	HG El (ft)	App (ft)	Bend (ft)	Junct Loss (ft)	Adjusted HG El (ft)	Max El (ft)
							1106.2868
J-16	J-16A	1107.5099	------	0.0753	0.0394	1107.6246	1110.0000
J-12A	J-16	1107.9246	0.1592	0.0567	------	1107.8221	1111.0000
J-12	J-12A	1166.7599	------	1.9187	------	1168.6786	1170.0000
No approach losses at node J-10 because inverts and/or crowns are offset.							
J-11	J-12	1200.8459	------	0.4902	------	1201.3360	1205.0000
J-10	J-11	1252.0143	------	------	------	1252.0143	1255.0000
J-15	J-16	1108.7025	0.1985	0.0470	------	1108.5510	1110.0000

J-19	J-15	1109.4988	0.1822	0.1003	0.0915	1109.5084	1111.0000
No approach losses at node J-13 because inverts and/or crowns are offset.							
J-14	J-19	1136.3525	------	0.1490	------	1136.5015	1140.0000
J-13	J-14	1155.9663	------	------	------	1155.9663	1160.0000
J-18	J-19	1175.1843	------	------	------	1175.1843	1178.0000

Conduit Notes

Reach	HW Depth (ft)	HW/D ratio	Q (cfs)	TW Depth (ft)	Dc (ft)	Dn (ft)	Comment
B1 OUTLET	2.5099	0.7171	33.26	1.7868	1.7868	0.9505	SuperCrit flow, Inlet end controls
P-12B	5.8966	1.9655	15.72	5.6246	1.2656	1.1312	Outlet Control
P-12A	1.7599	0.7040	15.72	3.8221	1.3386	0.4594	SuperCrit flow, Inlet end controls
P-11	1.8459	0.9229	13.04	3.6786	1.2996	0.4826	SuperCrit flow, Inlet end controls
P-10	2.0143	1.3429	9.37	1.3360	1.1834	0.4707	SuperCrit flow, Inlet end controls
P-15	6.6900	3.3450	14.07	5.6246	1.3517	1.1052	Outlet Control
P-14A	5.4708	2.7354	11.23	4.5510	1.2041	1.1029	Outlet Control
P-14B	1.3525	0.9017	6.05	3.5084	0.9503	0.3814	SuperCrit flow, Inlet end controls
P-13	0.9663	0.9663	2.47	21.5015	0.6730	0.2622	SuperCrit flow, Inlet end controls
P-17	2.1843	2.1843	5.25	3.5084	0.9289	0.3787	SuperCrit flow, Inlet end controls

Node and Reach invert report

Node and Reach invert report				
Node	J-10		Out ie	1250.00 ft
	Reach	P-10	I.E. Out	1250.00 ft
Node	J-11		Out ie	1199.00 ft
	Reach	P-10	I.E. In	1200.00 ft
	Reach	P-11	I.E. Out	1199.00 ft
Node	J-12		Out ie	1165.00 ft
	Reach	P-11	I.E. In	1165.00 ft
	Reach	P-12A	I.E. Out	1165.00 ft
Node	J-12A		Out ie	1104.00 ft
	Reach	P-12A	I.E. In	1104.00 ft

	Reach	P-12B	I.E. Out	1104.00 ft
Node	J-13		Out ie	1155.00 ft
	Reach	P-13	I.E. Out	1155.00 ft
Node	J-14		Out ie	1135.00 ft
	Reach	P-13	I.E. In	1115.00 ft
	Reach	P-14B	I.E. Out	1135.00 ft
Node	J-18		Out ie	1173.00 ft
	Reach	P-17	I.E. Out	1173.00 ft
Node	J-19		Out ie	1106.00 ft
	Reach	P-14B	I.E. In	1106.00 ft
	Reach	P-17	I.E. In	1106.00 ft
	Reach	P-14A	I.E. Out	1106.00 ft
Node	J-15		Out ie	1104.00 ft
	Reach	P-14A	I.E. In	1104.00 ft
	Reach	P-15	I.E. Out	1104.00 ft
Node	J-16		Out ie	1102.00 ft
	Reach	P-12B	I.E. In	1102.00 ft
	Reach	P-15	I.E. In	1102.00 ft
	Reach	B1 OUTLET	I.E. Out	1105.00 ft

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Appended on: Wednesday, May 24, 2017 10:36:33 AM

ROUTEHYD [] THRU [B-1] USING [100 year] AND [TYPE1A.RAC] NOTZERO RELATIVE SCS/SBUH

Gravity Analysis using 24 hr duration storm

Reach ID	Area (ac)	Flow (cfs)	Full Q (cfs)	Full ratio	nDepth (ft)	Depth ratio	Size	nVel (ft/s)	fVel (ft/s)	Infil Vol (cf)	CBasin / Hyd
P-10	42.71	13.0984	43.9096	0.2983	0.5618	0.3745	18 in Diam	21.678	24.8477	0.00	B-1A
P-11	56.53	18.0446	102.10	0.1767	0.5685	0.2842	24 in Diam	24.5381	32.4987	0.00	B-1B
P-12A	64.53	21.539	212.87	0.1012	0.5362	0.2145	30 in Diam	27.8887	43.3657	0.00	B-1D
P-12B	64.53	21.539	52.0215	0.414	1.3458	0.4486	36 in Diam	7.0105	7.3595	0.00	
P-13	10.82	3.4574	16.3178	0.2119	0.3126	0.3126	12 in Diam	16.4808	20.7764	0.00	B-1C
P-14B	20.62	8.0695	42.5986	0.1894	0.4425	0.295	18 in Diam	18.5269	24.1059	0.00	B-1E
P-17	18.65	7.174	17.2434	0.416	0.4498	0.4498	12 in Diam	20.9431	21.955	0.00	B-1H
P-14A	39.27	15.1543	19.105	0.7932	1.3449	0.6725	24 in Diam	6.7451	6.0813	0.00	
P-15	46.07	18.7177	23.8531	0.7847	1.3346	0.6673	24 in Diam	8.4034	7.5927	0.00	B-1G
B1 OUTLET	121.90	44.7453	206.07	0.2171	1.1084	0.3167	42 in Diam	17.1018	21.4189	0.00	B-1F

HGL Analysis

From Node	To Node	HG El (ft)	App (ft)	Bend (ft)	Junct Loss (ft)	Adjusted HG El (ft)	Max El (ft)
							1106.5864
J-16	J-16A	1108.0179	------	0.1414	0.0725	1108.2319	1110.0000
J-12A	J-16	1108.7708	0.2990	0.1065	------	1108.5784	1111.0000
J-12	J-12A	1167.1800	------	0.1269	------	1167.3069	1170.0000
No approach losses at node J-10 because inverts and/or crowns are offset.							
J-11	J-12	1201.5618	------	0.0690	------	1201.6308	1205.0000
J-10	J-11	1252.8641	------	------	------	1252.8641	1255.0000
J-15	J-16	1110.1293	0.3613	0.0855	------	1109.8535	1110.0000

J-19	J-15	1111.5555	0.3238	0.1783	0.1654	1111.1000	1111.0000
No approach losses at node J-13 because inverts and/or crowns are offset.							
J-14	J-19	1136.7188	------	0.2927	------	1137.0115	1140.0000
J-13	J-14	1156.3743	------	------	------	1156.3743	1160.0000
J-18	J-19	1176.4130	------	------	------	1176.4130	1178.0000

Conduit Notes

Reach	HW Depth (ft)	HW/D ratio	Q (cfs)	TW Depth (ft)	Dc (ft)	Dn (ft)	Comment
B1 OUTLET	3.0179	0.8623	44.75	2.0864	2.0864	1.1084	SuperCrit flow, Inlet end controls
P-12B	6.7428	2.2476	21.54	6.2319	1.4922	1.3458	Outlet Control
P-12A	2.1800	0.8720	21.54	4.5784	1.5774	0.5362	SuperCrit flow, Inlet end controls
P-11	2.5618	1.2809	18.04	2.3069	1.5305	0.5685	SuperCrit flow, Inlet end controls
P-10	2.8641	1.9094	13.10	1.6308	1.3546	0.5618	SuperCrit flow, Inlet end controls
P-15	8.1168	4.0584	18.72	6.2319	1.5576	1.3346	Outlet Control
P-14A	7.5275	3.7638	15.15	5.8535	1.4039	1.3449	Outlet Control
P-14B	1.7188	1.1459	8.07	5.1000	1.1011	0.4425	SuperCrit flow, Inlet end controls
P-13	1.3743	1.3743	3.46	22.0115	0.7949	0.3126	SuperCrit flow, Inlet end controls
P-17	3.4130	3.4130	7.17	5.1000	0.9769	0.4498	SuperCrit flow, Inlet end controls

Node and Reach invert report

Node and Reach invert report				
Node	J-10		Out ie	1250.00 ft
	Reach	P-10	I.E. Out	1250.00 ft
Node	J-11		Out ie	1199.00 ft
	Reach	P-10	I.E. In	1200.00 ft
	Reach	P-11	I.E. Out	1199.00 ft
Node	J-12		Out ie	1165.00 ft
	Reach	P-11	I.E. In	1165.00 ft
	Reach	P-12A	I.E. Out	1165.00 ft
Node	J-12A		Out ie	1104.00 ft
	Reach	P-12A	I.E. In	1104.00 ft

	Reach	P-12B	I.E. Out	1104.00 ft
Node	J-13		Out ie	1155.00 ft
	Reach	P-13	I.E. Out	1155.00 ft
Node	J-14		Out ie	1135.00 ft
	Reach	P-13	I.E. In	1115.00 ft
	Reach	P-14B	I.E. Out	1135.00 ft
Node	J-18		Out ie	1173.00 ft
	Reach	P-17	I.E. Out	1173.00 ft
Node	J-19		Out ie	1106.00 ft
	Reach	P-14B	I.E. In	1106.00 ft
	Reach	P-17	I.E. In	1106.00 ft
	Reach	P-14A	I.E. Out	1106.00 ft
Node	J-15		Out ie	1104.00 ft
	Reach	P-14A	I.E. In	1104.00 ft
	Reach	P-15	I.E. Out	1104.00 ft
Node	J-16		Out ie	1102.00 ft
	Reach	P-12B	I.E. In	1102.00 ft
	Reach	P-15	I.E. In	1102.00 ft
	Reach	B1 OUTLET	I.E. Out	1105.00 ft

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Appended on: Wednesday, May 24, 2017 10:20:26 AM

ROUTEHYD [] THRU [B-1] USING [E WA 3hr Depth] AND [EWash-3hr.rac] NOTZERO RELATIVE SCS/SBUH

Gravity Analysis using 3 hr duration storm

Reach ID	Area (ac)	Flow (cfs)	Full Q (cfs)	Full ratio	nDepth (ft)	Depth ratio	Size	nVel (ft/s)	fVel (ft/s)	Infil Vol (cf)	CBasin / Hyd
P-10	42.71	0.6724	43.9096	0.0153	0.1297	0.0864	18 in Diam	9.0578	24.8477	0.00	FB-1A
P-11	56.53	1.2598	102.10	0.0123	0.1566	0.0783	24 in Diam	11.0467	32.4987	0.00	FB-1B
P-12A	64.53	1.6072	212.87	0.0075	0.1543	0.0617	30 in Diam	12.8232	43.3657	0.00	FB-1D
P-12B	64.53	1.6072	52.0215	0.0309	0.3622	0.1207	36 in Diam	3.316	7.3595	0.00	
P-13	10.82	0.1782	16.3178	0.0109	0.0734	0.0734	12 in Diam	6.8775	20.7764	0.00	FB-1C
P-14B	20.62	0.6238	42.5986	0.0146	0.1271	0.0847	18 in Diam	8.6585	24.1059	0.00	FB-1E
P-17	18.65	0.9086	17.2434	0.0527	0.1558	0.1558	12 in Diam	11.6386	21.955	0.00	FB-1H
P-14A	39.27	1.5183	19.105	0.0795	0.3805	0.1903	24 in Diam	3.6458	6.0813	0.00	
P-15	46.07	2.124	23.8531	0.089	0.4032	0.2016	24 in Diam	4.694	7.5927	0.00	FB-1G
B1 OUTLET	121.90	4.1644	206.07	0.0202	0.3446	0.0985	42 in Diam	8.5096	21.4189	0.00	FB-1F

HGL Analysis

From Node	To Node	HG El (ft)	App (ft)	Bend (ft)	Junct Loss (ft)	Adjusted HG El (ft)	Max El (ft)
							1105.1112
No approach losses at node J-15 because inverts and/or crowns are offset.							
J-16	J-16A	1105.7889	------	0.0077	0.0032	1105.7999	1110.0000
J-12A	J-16	1105.8307	2.5533	0.9098	------	1104.1872	1111.0000
J-12	J-12A	1165.3953	------	0.4696	------	1165.8648	1170.0000
No approach losses at node J-10 because inverts and/or crowns are offset.							
J-11	J-12	1199.4260	------	0.1031	------	1199.5291	1205.0000
J-10	J-11	1250.3490	------	------	------	1250.3490	1255.0000

J-15	J-16	1105.8366	0.2064	0.0488	------	1105.6791	1110.0000
J-19	J-15	1106.5731	------	3.3933	0.8955	1110.8619	1111.0000
No approach losses at node J-13 because inverts and/or crowns are offset.							
J-14	J-19	1135.3369	------	0.0008	------	1135.3377	1140.0000
J-13	J-14	1155.1830	------	------	------	1155.1830	1160.0000
J-18	J-19	1173.4991	------	------	------	1173.4991	1178.0000

Conduit Notes

Reach	HW Depth (ft)	HW/D ratio	Q (cfs)	TW Depth (ft)	Dc (ft)	Dn (ft)	Comment
B1 OUTLET	0.7889	0.2254	4.16	0.6112	0.6112	0.3446	SuperCrit flow, Inlet end controls
P-12B	3.8027	1.2676	1.61	3.7999	0.3921	0.3622	Outlet Control
P-12A	0.3953	0.1581	1.61	0.4122	0.4122	0.1543	SuperCrit flow, Inlet end controls
P-11	0.4260	0.2130	1.26	0.8648	0.3872	0.1566	SuperCrit flow, Inlet end controls
P-10	0.3490	0.2326	0.67	0.3043	0.3043	0.1297	SuperCrit flow, Inlet end controls
P-15	3.8241	1.9121	2.12	3.7999	0.5062	0.4032	Outlet Control
P-14A	0.5731	0.2866	1.52	1.6791	0.4260	0.3805	SuperCrit flow, Inlet end controls
P-14B	0.3369	0.2246	0.62	4.8619	0.2929	0.1271	SuperCrit flow, Inlet end controls
P-13	0.1830	0.1830	0.18	20.3377	0.1729	0.0734	SuperCrit flow, Inlet end controls
P-17	0.4991	0.4991	0.91	4.8619	0.3998	0.1558	SuperCrit flow, Inlet end controls

Node and Reach invert report

Node and Reach invert report				
Node	J-10		Out ie	1250.00 ft
	Reach	P-10	I.E. Out	1250.00 ft
Node	J-11		Out ie	1199.00 ft
	Reach	P-10	I.E. In	1200.00 ft
	Reach	P-11	I.E. Out	1199.00 ft
Node	J-12		Out ie	1165.00 ft
	Reach	P-11	I.E. In	1165.00 ft
	Reach	P-12A	I.E. Out	1165.00 ft

Node	J-12A		Out ie	1104.00 ft
	Reach	P-12A	I.E. In	1104.00 ft
	Reach	P-12B	I.E. Out	1104.00 ft
Node	J-13		Out ie	1155.00 ft
	Reach	P-13	I.E. Out	1155.00 ft
Node	J-14		Out ie	1135.00 ft
	Reach	P-13	I.E. In	1115.00 ft
	Reach	P-14B	I.E. Out	1135.00 ft
Node	J-18		Out ie	1173.00 ft
	Reach	P-17	I.E. Out	1173.00 ft
Node	J-19		Out ie	1106.00 ft
	Reach	P-14B	I.E. In	1106.00 ft
	Reach	P-17	I.E. In	1106.00 ft
	Reach	P-14A	I.E. Out	1106.00 ft
Node	J-15		Out ie	1104.00 ft
	Reach	P-14A	I.E. In	1104.00 ft
	Reach	P-15	I.E. Out	1104.00 ft
Node	J-16		Out ie	1102.00 ft
	Reach	P-12B	I.E. In	1102.00 ft
	Reach	P-15	I.E. In	1102.00 ft
	Reach	B1 OUTLET	I.E. Out	1105.00 ft

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Appended on: Wednesday, May 24, 2017 10:11:46 AM

ROUTEHYD [] THRU [B-1] USING [WQS] AND [TYPE1A.RAC] NOTZERO RELATIVE SCS/SBUH

Gravity Analysis using 24 hr duration storm

Reach ID	Area (ac)	Flow (cfs)	Full Q (cfs)	Full ratio	nDepth (ft)	Depth ratio	Size	nVel (ft/s)	fVel (ft/s)	Infil Vol (cf)	CBasin / Hyd
P-10	42.71	0.4026	43.9096	0.0092	0.101	0.0673	18 in Diam	7.8454	24.8477	0.00	FB-1A
P-11	56.53	0.6683	102.10	0.0065	0.1154	0.0577	24 in Diam	9.1977	32.4987	0.00	FB-1B
P-12A	64.53	0.8464	212.87	0.004	0.1141	0.0457	30 in Diam	10.5574	43.3657	0.00	FB-1D
P-12B	64.53	0.8464	52.0215	0.0163	0.2668	0.0889	36 in Diam	2.7339	7.3595	0.00	
P-13	10.82	0.1029	16.3178	0.0063	0.0566	0.0566	12 in Diam	5.823	20.7764	0.00	FB-1C
P-14B	20.62	0.3188	42.5986	0.0075	0.0922	0.0615	18 in Diam	7.1044	24.1059	0.00	FB-1E
P-17	18.65	0.4497	17.2434	0.0261	0.1114	0.1114	12 in Diam	9.3878	21.955	0.00	FB-1H
P-14A	39.27	0.7637	19.105	0.04	0.2729	0.1364	24 in Diam	2.9657	6.0813	0.00	
P-15	46.07	1.0423	23.8531	0.0437	0.2849	0.1425	24 in Diam	3.8008	7.5927	0.00	FB-1G
B1 OUTLET	121.90	2.1254	206.07	0.0103	0.2495	0.0713	42 in Diam	6.9901	21.4189	0.00	FB-1F

HGL Analysis

From Node	To Node	HG El (ft)	App (ft)	Bend (ft)	Junct Loss (ft)	Adjusted HG El (ft)	Max El (ft)
							1104.934
No approach losses at node J-15 because inverts and/or crowns are offset.							
J-16	J-16A	1105.5483	------	0.0019	0.0008	1105.5509	1110.0000
J-12A	J-16	1105.5797	1.7307	0.6167	------	1104.4657	1111.0000
J-12	J-12A	1165.2395	------	0.3255	------	1165.5650	1170.0000
No approach losses at node J-10 because inverts and/or crowns are offset.							
J-11	J-12	1199.2803	------	0.0773	------	1199.3577	1205.0000
J-10	J-11	1250.2531	------	------	------	1250.2531	1255.0000

J-15	J-16	1105.5693	0.1366	0.0323	------	1105.4650	1110.0000
J-19	J-15	1106.4006	------	2.2077	0.5964	1109.2047	1111.0000
No approach losses at node J-13 because inverts and/or crowns are offset.							
J-14	J-19	1135.2212	------	0.0003	------	1135.2215	1140.0000
J-13	J-14	1155.1257	------	------	------	1155.1257	1160.0000
J-18	J-19	1173.3225	------	------	------	1173.3225	1178.0000

Conduit Notes

Reach	HW Depth (ft)	HW/D ratio	Q (cfs)	TW Depth (ft)	Dc (ft)	Dn (ft)	Comment
B1 OUTLET	0.5483	0.1566	2.13	0.4340	0.4340	0.2495	SuperCrit flow, Inlet end controls
P-12B	3.5517	1.1839	0.85	3.5509	0.2830	0.2668	Outlet Control
P-12A	0.2395	0.0958	0.85	0.4657	0.2978	0.1141	SuperCrit flow, Inlet end controls
P-11	0.2803	0.1402	0.67	0.5650	0.2754	0.1154	SuperCrit flow, Inlet end controls
P-10	0.2531	0.1687	0.40	0.2341	0.2341	0.1010	SuperCrit flow, Inlet end controls
P-15	3.5568	1.7784	1.04	3.5509	0.3518	0.2849	Outlet Control
P-14A	0.4006	0.2003	0.76	1.4650	0.2999	0.2729	SuperCrit flow, Inlet end controls
P-14B	0.2212	0.1475	0.32	3.2047	0.2048	0.0922	SuperCrit flow, Inlet end controls
P-13	0.1257	0.1257	0.10	20.2215	0.1306	0.0566	SuperCrit flow, Inlet end controls
P-17	0.3225	0.3225	0.45	3.2047	0.2777	0.1114	SuperCrit flow, Inlet end controls

Node and Reach invert report

Node and Reach invert report				
Node	J-10		Out ie	1250.00 ft
	Reach	P-10	I.E. Out	1250.00 ft
Node	J-11		Out ie	1199.00 ft
	Reach	P-10	I.E. In	1200.00 ft
	Reach	P-11	I.E. Out	1199.00 ft
Node	J-12		Out ie	1165.00 ft
	Reach	P-11	I.E. In	1165.00 ft
	Reach	P-12A	I.E. Out	1165.00 ft

Node	J-12A		Out ie	1104.00 ft
	Reach	P-12A	I.E. In	1104.00 ft
	Reach	P-12B	I.E. Out	1104.00 ft
Node	J-13		Out ie	1155.00 ft
	Reach	P-13	I.E. Out	1155.00 ft
Node	J-14		Out ie	1135.00 ft
	Reach	P-13	I.E. In	1115.00 ft
	Reach	P-14B	I.E. Out	1135.00 ft
Node	J-18		Out ie	1173.00 ft
	Reach	P-17	I.E. Out	1173.00 ft
Node	J-19		Out ie	1106.00 ft
	Reach	P-14B	I.E. In	1106.00 ft
	Reach	P-17	I.E. In	1106.00 ft
	Reach	P-14A	I.E. Out	1106.00 ft
Node	J-15		Out ie	1104.00 ft
	Reach	P-14A	I.E. In	1104.00 ft
	Reach	P-15	I.E. Out	1104.00 ft
Node	J-16		Out ie	1102.00 ft
	Reach	P-12B	I.E. In	1102.00 ft
	Reach	P-15	I.E. In	1102.00 ft
	Reach	B1 OUTLET	I.E. Out	1105.00 ft

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Appended on: Wednesday, May 24, 2017 10:13:25 AM

ROUTEHYD [] THRU [B-1] USING [2 yr 24 hr] AND [TYPE1A.RAC] NOTZERO RELATIVE SCS/SBUH

Gravity Analysis using 24 hr duration storm

Reach ID	Area (ac)	Flow (cfs)	Full Q (cfs)	Full ratio	nDepth (ft)	Depth ratio	Size	nVel (ft/s)	fVel (ft/s)	Infil Vol (cf)	CBasin / Hyd
P-10	42.71	2.3193	43.9096	0.0528	0.234	0.156	18 in Diam	13.1806	24.8477	0.00	FB-1A
P-11	56.53	3.4311	102.10	0.0336	0.2508	0.1254	24 in Diam	15.065	32.4987	0.00	FB-1B
P-12A	64.53	4.0823	212.87	0.0192	0.2399	0.096	30 in Diam	16.9722	43.3657	0.00	FB-1D
P-12B	64.53	4.0823	52.0215	0.0785	0.5673	0.1891	36 in Diam	4.3952	7.3595	0.00	
P-13	10.82	0.6009	16.3178	0.0368	0.131	0.131	12 in Diam	9.9051	20.7764	0.00	FB-1C
P-14B	20.62	1.4128	42.5986	0.0332	0.187	0.1247	18 in Diam	11.1267	24.1059	0.00	FB-1E
P-17	18.65	1.5823	17.2434	0.0918	0.2046	0.2046	12 in Diam	13.6927	21.955	0.00	FB-1H
P-14A	39.27	2.9868	19.105	0.1563	0.5341	0.2671	24 in Diam	4.432	6.0813	0.00	
P-15	46.07	3.7381	23.8531	0.1567	0.5348	0.2674	24 in Diam	5.5365	7.5927	0.00	FB-1G
B1 OUTLET	121.90	8.7173	206.07	0.0423	0.4914	0.1404	42 in Diam	10.6032	21.4189	0.00	FB-1F

HGL Analysis

From Node	To Node	HG El (ft)	App (ft)	Bend (ft)	Junct Loss (ft)	Adjusted HG El (ft)	Max El (ft)
							1105.3917
J-16	J-16A	1106.1766	------	0.0051	0.0027	1106.1844	1110.0000
J-12A	J-16	1106.2308	4.4729	1.5937	------	1103.3516	1111.0000
J-12	J-12A	1165.7436	------	0.8733	------	1166.6169	1170.0000
No approach losses at node J-10 because inverts and/or crowns are offset.							
J-11	J-12	1199.7915	------	0.2183	------	1200.0098	1205.0000
J-10	J-11	1250.7351	------	------	------	1250.7351	1255.0000
J-15	J-16	1106.2721	0.0140	0.0033	------	1106.2614	1110.0000

J-19	J-15	1106.8211	------	4.6967	1.4918	1111.1000	1111.0000
No approach losses at node J-13 because inverts and/or crowns are offset.							
J-14	J-19	1135.5499	------	0.0088	------	1135.5587	1140.0000
J-13	J-14	1155.3920	------	------	------	1155.3920	1160.0000
J-18	J-19	1173.7100	------	------	------	1173.7100	1178.0000

Conduit Notes

Reach	HW Depth (ft)	HW/D ratio	Q (cfs)	TW Depth (ft)	Dc (ft)	Dn (ft)	Comment
B1 OUTLET	1.1766	0.3362	8.72	0.8917	0.8917	0.4914	SuperCrit flow, Inlet end controls
P-12B	4.2028	1.4009	4.08	4.1844	0.6310	0.5673	Outlet Control
P-12A	0.7436	0.2974	4.08	0.6643	0.6643	0.2399	SuperCrit flow, Inlet end controls
P-11	0.7915	0.3957	3.43	1.6169	0.6479	0.2508	SuperCrit flow, Inlet end controls
P-10	0.7351	0.4901	2.32	0.5760	0.5760	0.2340	SuperCrit flow, Inlet end controls
P-15	4.2596	2.1298	3.74	4.1844	0.6777	0.5348	Outlet Control
P-14A	0.8211	0.4105	2.99	2.2614	0.6032	0.5341	SuperCrit flow, Inlet end controls
P-14B	0.5499	0.3666	1.41	5.1000	0.4456	0.1870	SuperCrit flow, Inlet end controls
P-13	0.3920	0.3920	0.60	20.5587	0.3224	0.1310	SuperCrit flow, Inlet end controls
P-17	0.7100	0.7100	1.58	5.1000	0.5340	0.2046	SuperCrit flow, Inlet end controls

Node and Reach invert report

Node and Reach invert report				
Node	J-10		Out ie	1250.00 ft
	Reach	P-10	I.E. Out	1250.00 ft
Node	J-11		Out ie	1199.00 ft
	Reach	P-10	I.E. In	1200.00 ft
	Reach	P-11	I.E. Out	1199.00 ft
Node	J-12		Out ie	1165.00 ft
	Reach	P-11	I.E. In	1165.00 ft
	Reach	P-12A	I.E. Out	1165.00 ft
Node	J-12A		Out ie	1104.00 ft

	Reach	P-12A	I.E. In	1104.00 ft
	Reach	P-12B	I.E. Out	1104.00 ft
Node	J-13		Out ie	1155.00 ft
	Reach	P-13	I.E. Out	1155.00 ft
Node	J-14		Out ie	1135.00 ft
	Reach	P-13	I.E. In	1115.00 ft
	Reach	P-14B	I.E. Out	1135.00 ft
Node	J-18		Out ie	1173.00 ft
	Reach	P-17	I.E. Out	1173.00 ft
Node	J-19		Out ie	1106.00 ft
	Reach	P-14B	I.E. In	1106.00 ft
	Reach	P-17	I.E. In	1106.00 ft
	Reach	P-14A	I.E. Out	1106.00 ft
Node	J-15		Out ie	1104.00 ft
	Reach	P-14A	I.E. In	1104.00 ft
	Reach	P-15	I.E. Out	1104.00 ft
Node	J-16		Out ie	1102.00 ft
	Reach	P-12B	I.E. In	1102.00 ft
	Reach	P-15	I.E. In	1102.00 ft
	Reach	B1 OUTLET	I.E. Out	1105.00 ft

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Appended on: Wednesday, May 24, 2017 10:15:09 AM

ROUTEHYD [] THRU [B-1] USING [25 year] AND [TYPE1A.RAC] NOTZERO RELATIVE SCS/SBUH

Gravity Analysis using 24 hr duration storm

Reach ID	Area (ac)	Flow (cfs)	Full Q (cfs)	Full ratio	nDepth (ft)	Depth ratio	Size	nVel (ft/s)	fVel (ft/s)	Infil Vol (cf)	CBasin / Hyd
P-10	42.71	14.3573	43.9096	0.327	0.5848	0.3899	18 in Diam	22.511	24.8477	0.00	FB-1A
P-11	56.53	19.6588	102.10	0.1925	0.5949	0.2975	24 in Diam	25.0935	32.4987	0.00	FB-1B
P-12A	64.53	22.7681	212.87	0.107	0.5504	0.2201	30 in Diam	28.4087	43.3657	0.00	FB-1D
P-12B	64.53	22.7681	52.0215	0.4377	1.3891	0.463	36 in Diam	7.1106	7.3595	0.00	
P-13	10.82	3.7052	16.3178	0.2271	0.3239	0.3239	12 in Diam	16.8213	20.7764	0.00	FB-1C
P-14B	20.62	7.5687	42.5986	0.1777	0.4276	0.2851	18 in Diam	18.2229	24.1059	0.00	FB-1E
P-17	18.65	7.4937	17.2434	0.4346	0.4612	0.4612	12 in Diam	21.1704	21.955	0.00	FB-1H
P-14A	39.27	15.03	19.105	0.7867	1.337	0.6685	24 in Diam	6.7344	6.0813	0.00	
P-15	46.07	17.9733	23.8531	0.7535	1.2966	0.6483	24 in Diam	8.3394	7.5927	0.00	FB-1G
B1 OUTLET	121.90	45.0567	206.07	0.2186	1.1125	0.3179	42 in Diam	17.1329	21.4189	0.00	FB-1F

HGL Analysis

From Node	To Node	HG El (ft)	App (ft)	Bend (ft)	Junct Loss (ft)	Adjusted HG El (ft)	Max El (ft)
							1106.5939
J-16	J-16A	1108.0314	------	0.1580	0.0758	1108.2652	1110.0000
J-12A	J-16	1108.8642	0.3341	0.1190	------	1108.6492	1111.0000
J-12	J-12A	1167.2669	------	0.1507	------	1167.4176	1170.0000
No approach losses at node J-10 because inverts and/or crowns are offset.							
J-11	J-12	1201.7572	------	0.0829	------	1201.8402	1205.0000
J-10	J-11	1253.2149	------	------	------	1253.2149	1255.0000
J-15	J-16	1110.0157	0.3554	0.0841	------	1109.7444	1110.0000

J-19	J-15	1111.4191	0.2848	0.1568	0.1564	1111.1000	1111.0000
No approach losses at node J-13 because inverts and/or crowns are offset.							
J-14	J-19	1136.5828	------	0.3361	------	1136.9190	1140.0000
J-13	J-14	1156.4655	------	------	------	1156.4655	1160.0000
J-18	J-19	1176.6540	------	------	------	1176.6540	1178.0000

Conduit Notes

Reach	HW Depth (ft)	HW/D ratio	Q (cfs)	TW Depth (ft)	Dc (ft)	Dn (ft)	Comment
B1 OUTLET	3.0314	0.8661	45.06	2.0939	2.0939	1.1125	SuperCrit flow, Inlet end controls
P-12B	6.8362	2.2787	22.77	6.2652	1.5365	1.3891	Outlet Control
P-12A	2.2669	0.9068	22.77	4.6492	1.6238	0.5504	SuperCrit flow, Inlet end controls
P-11	2.7572	1.3786	19.66	2.4176	1.5936	0.5949	SuperCrit flow, Inlet end controls
P-10	3.2149	2.1433	14.36	1.8402	1.3906	0.5848	SuperCrit flow, Inlet end controls
P-15	8.0032	4.0016	17.97	6.2652	1.5276	1.2966	Outlet Control
P-14A	7.3911	3.6955	15.03	5.7444	1.3982	1.3370	Outlet Control
P-14B	1.5828	1.0552	7.57	5.1000	1.0660	0.4276	SuperCrit flow, Inlet end controls
P-13	1.4655	1.4655	3.71	21.9190	0.8203	0.3239	SuperCrit flow, Inlet end controls
P-17	3.6540	3.6540	7.49	5.1000	0.9806	0.4612	SuperCrit flow, Inlet end controls

Node and Reach invert report

Node and Reach invert report				
Node	J-10		Out ie	1250.00 ft
	Reach	P-10	I.E. Out	1250.00 ft
Node	J-11		Out ie	1199.00 ft
	Reach	P-10	I.E. In	1200.00 ft
	Reach	P-11	I.E. Out	1199.00 ft
Node	J-12		Out ie	1165.00 ft
	Reach	P-11	I.E. In	1165.00 ft
	Reach	P-12A	I.E. Out	1165.00 ft
Node	J-12A		Out ie	1104.00 ft
	Reach	P-12A	I.E. In	1104.00 ft

	Reach	P-12B	I.E. Out	1104.00 ft
Node	J-13		Out ie	1155.00 ft
	Reach	P-13	I.E. Out	1155.00 ft
Node	J-14		Out ie	1135.00 ft
	Reach	P-13	I.E. In	1115.00 ft
	Reach	P-14B	I.E. Out	1135.00 ft
Node	J-18		Out ie	1173.00 ft
	Reach	P-17	I.E. Out	1173.00 ft
Node	J-19		Out ie	1106.00 ft
	Reach	P-14B	I.E. In	1106.00 ft
	Reach	P-17	I.E. In	1106.00 ft
	Reach	P-14A	I.E. Out	1106.00 ft
Node	J-15		Out ie	1104.00 ft
	Reach	P-14A	I.E. In	1104.00 ft
	Reach	P-15	I.E. Out	1104.00 ft
Node	J-16		Out ie	1102.00 ft
	Reach	P-12B	I.E. In	1102.00 ft
	Reach	P-15	I.E. In	1102.00 ft
	Reach	B1 OUTLET	I.E. Out	1105.00 ft

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Appended on: Wednesday, May 24, 2017 10:16:16 AM

ROUTEHYD [] THRU [B-1] USING [100 year] AND [TYPE1A.RAC] NOTZERO RELATIVE SCS/SBUH

Gravity Analysis using 24 hr duration storm

Reach ID	Area (ac)	Flow (cfs)	Full Q (cfs)	Full ratio	nDepth (ft)	Depth ratio	Size	nVel (ft/s)	fVel (ft/s)	Infil Vol (cf)	CBasin / Hyd
P-10	42.71	18.861	43.9096	0.4295	0.6872	0.4582	18 in Diam	23.8883	24.8477	0.00	FB-1A
P-11	56.53	25.6477	102.10	0.2512	0.6832	0.3416	24 in Diam	27.0572	32.4987	0.00	FB-1B
P-12A	64.53	29.6265	212.87	0.1392	0.6296	0.2518	30 in Diam	30.555	43.3657	0.00	FB-1D
P-12B	64.53	29.6265	52.0215	0.5695	1.6217	0.5406	36 in Diam	7.5983	7.3595	0.00	
P-13	10.82	4.8694	16.3178	0.2984	0.3746	0.3746	12 in Diam	18.1278	20.7764	0.00	FB-1C
P-14B	20.62	9.816	42.5986	0.2304	0.4892	0.3261	18 in Diam	19.616	24.1059	0.00	FB-1E
P-17	18.65	9.5901	17.2434	0.5562	0.5332	0.5332	12 in Diam	22.5164	21.955	0.00	FB-1H
P-14A	39.27	19.372	19.105	1.014	1.6661	0.833	24 in Diam	6.9271	6.0813	0.00	
P-15	46.07	23.0647	23.8531	0.9669	1.5832	0.7916	24 in Diam	8.6477	7.5927	0.00	FB-1G
B1 OUTLET	121.90	58.2264	206.07	0.2826	1.273	0.3637	42 in Diam	18.4153	21.4189	0.00	FB-1F

HGL Analysis

From Node	To Node	HG El (ft)	App (ft)	Bend (ft)	Junct Loss (ft)	Adjusted HG El (ft)	Max El (ft)
							1106.8909
J-16	J-16A	1108.5943	------	0.2676	0.1271	1108.9890	1110.0000
J-12A	J-16	1109.9838	0.5656	0.2015	------	1109.6197	1111.0000
J-12	J-12A	1167.9282	------	0.2565	------	1168.1847	1170.0000
No approach losses at node J-10 because inverts and/or crowns are offset.							
J-11	J-12	1202.6287	------	0.1432	------	1202.7719	1205.0000
J-10	J-11	1254.7336	------	------	------	1254.7336	1255.0000
J-15	J-16	1111.8637	0.5904	0.1397	------	1110.1000	1110.0000

J-19	J-15	1112.8635	0.4791	0.2638	0.2607	1111.1000	1111.0000
No approach losses at node J-13 because inverts and/or crowns are offset.							
J-14	J-19	1137.0954	------	0.5806	------	1137.6760	1140.0000
J-13	J-14	1156.9785	------	------	------	1156.9785	1160.0000
J-18	J-19	1178.4945	------	------	------	1178.1000	1178.0000

Conduit Notes

Reach	HW Depth (ft)	HW/D ratio	Q (cfs)	TW Depth (ft)	Dc (ft)	Dn (ft)	Comment
B1 OUTLET	3.5943	1.0270	58.23	2.3909	2.3909	1.2730	SuperCrit flow, Inlet end controls
P-12B	7.9558	2.6519	29.63	6.9890	1.7635	1.6217	Outlet Control
P-12A	2.9282	1.1713	29.63	5.6197	1.8561	0.6296	SuperCrit flow, Inlet end controls
P-11	3.6287	1.8144	25.65	3.1847	1.7780	0.6832	SuperCrit flow, Inlet end controls
P-10	4.7336	3.1557	18.86	2.7719	1.4586	0.6872	SuperCrit flow, Inlet end controls
P-15	9.8512	4.9256	23.06	6.9890	1.7084	1.5832	Outlet Control
P-14A	8.8355	4.4177	19.37	6.1000	1.5829	1.6661	Outlet Control
P-14B	2.0954	1.3970	9.82	5.1000	1.2089	0.4892	SuperCrit flow, Inlet end controls
P-13	1.9785	1.9785	4.87	22.6760	0.9098	0.3746	SuperCrit flow, Inlet end controls
P-17	5.4945	5.4945	9.59	5.1000	>D	0.5332	SuperCrit flow, Inlet end controls

Node and Reach invert report

Node and Reach invert report				
Node	J-10		Out ie	1250.00 ft
	Reach	P-10	I.E. Out	1250.00 ft
Node	J-11		Out ie	1199.00 ft
	Reach	P-10	I.E. In	1200.00 ft
	Reach	P-11	I.E. Out	1199.00 ft
Node	J-12		Out ie	1165.00 ft
	Reach	P-11	I.E. In	1165.00 ft
	Reach	P-12A	I.E. Out	1165.00 ft
Node	J-12A		Out ie	1104.00 ft
	Reach	P-12A	I.E. In	1104.00 ft

	Reach	P-12B	I.E. Out	1104.00 ft
Node	J-13		Out ie	1155.00 ft
	Reach	P-13	I.E. Out	1155.00 ft
Node	J-14		Out ie	1135.00 ft
	Reach	P-13	I.E. In	1115.00 ft
	Reach	P-14B	I.E. Out	1135.00 ft
Node	J-18		Out ie	1173.00 ft
	Reach	P-17	I.E. Out	1173.00 ft
Node	J-19		Out ie	1106.00 ft
	Reach	P-14B	I.E. In	1106.00 ft
	Reach	P-17	I.E. In	1106.00 ft
	Reach	P-14A	I.E. Out	1106.00 ft
Node	J-15		Out ie	1104.00 ft
	Reach	P-14A	I.E. In	1104.00 ft
	Reach	P-15	I.E. Out	1104.00 ft
Node	J-16		Out ie	1102.00 ft
	Reach	P-12B	I.E. In	1102.00 ft
	Reach	P-15	I.E. In	1102.00 ft
	Reach	B1 OUTLET	I.E. Out	1105.00 ft

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Appended on: Wednesday, May 24, 2017 10:49:30 AM

ROUTEHYD [] THRU [B-2] USING [E WA 3hr Depth] AND [EWash-3hr.rac] NOTZERO RELATIVE SCS/SBUH

Gravity Analysis using 3 hr duration storm

Reach ID	Area (ac)	Flow (cfs)	Full Q (cfs)	Full ratio	nDepth (ft)	Depth ratio	Size	nVel (ft/s)	fVel (ft/s)	Infil Vol (cf)	CBasin / Hyd
P-20	27.00	0.0001	39.4973	0.00	0.0151	0.01	18 in Diam	0.0379	22.3509	0.00	B-2A
P-21	70.60	0.0495	86.6874	0.0006	0.0378	0.0189	24 in Diam	3.5931	27.5935	0.00	B-2B
P-22	103.30	0.1696	118.81	0.0014	0.0704	0.0282	30 in Diam	4.3428	24.2044	0.00	B-2C
P-23	127.60	0.3529	86.2929	0.0041	0.1156	0.0462	30 in Diam	4.3188	17.5794	0.00	B-2D
B-2 OUTLET	141.30	1.5922	84.0134	0.019	0.2386	0.0954	30 in Diam	6.6748	17.1151	0.00	B-2E

HGL Analysis

From Node	To Node	HG El (ft)	App (ft)	Bend (ft)	Junct Loss (ft)	Adjusted HG El (ft)	Max El (ft)
							1114.9102
J-24	J-24A	1115.5281	------	0.0451	------	1115.5732	1120.0000
J-23	J-24	1135.2301	------	0.7727	------	1136.0028	1140.0000
J-22	J-23	1165.1271	------	0.0017	------	1165.1288	1170.0000
J-21	J-22	1214.0310	------	0.0000	------	1214.0310	1220.0000
J-20	J-21	1305.0151	------	------	------	1305.0151	1310.0000

Conduit Notes

Reach	HW Depth (ft)	HW/D ratio	Q (cfs)	TW Depth (ft)	Dc (ft)	Dn (ft)	Comment
B-2 OUTLET	0.5281	0.2112	1.59	0.4102	0.4102	0.2386	SuperCrit flow, Inlet end controls
P-23	0.2301	0.0920	0.35	0.5732	0.1905	0.1156	SuperCrit flow, Inlet end controls
P-22	0.1271	0.0509	0.17	1.0028	0.1318	0.0704	SuperCrit flow, Inlet end controls
P-21	0.0310	0.0155	0.05	0.1288	0.0755	0.0378	SuperCrit flow, Inlet end controls
P-20	0.0151	0.0101	0.00	0.0310	0.0000	0.0151	Outlet Control M1 Backwater

Subcritical, M-1 Profile

Subcritical flow starts at downstream end and progresses upstream until normal depth is reached.

y ft	A sf	R	V ft	Eft	dEft	Sf ft	Savg ft	So-Sf ft	dx ft	Station ft	Elev ft
0.031	0.0088	0.0204	0.0129	0.030961	0.00	0.000001	0.00	0.00	0.00	1350.00	1214.041

0.0303	0.0086	0.02	0.0133	0.030326	0.000635	0.000001	0.000001	0.067399	0.009429	1349.9906	1214.041
0.0297	0.0083	0.0196	0.0137	0.02969	0.000635	0.000001	0.000001	0.067399	0.009429	1349.9811	1214.041
0.0291	0.008	0.0192	0.0142	0.029055	0.000635	0.000001	0.000001	0.067399	0.009428	1349.9717	1214.041
0.0284	0.0078	0.0188	0.0147	0.028419	0.000635	0.000002	0.000001	0.067399	0.009428	1349.9623	1214.041
0.0278	0.0075	0.0184	0.0152	0.027784	0.000635	0.000002	0.000002	0.067398	0.009428	1349.9529	1214.041
0.0271	0.0073	0.0179	0.0157	0.027149	0.000635	0.000002	0.000002	0.067398	0.009427	1349.9434	1214.041
0.0265	0.007	0.0175	0.0163	0.026513	0.000635	0.000002	0.000002	0.067398	0.009427	1349.934	1214.041
0.0259	0.0068	0.0171	0.0169	0.025878	0.000635	0.000002	0.000002	0.067398	0.009427	1349.9246	1214.041
0.0252	0.0065	0.0167	0.0175	0.025243	0.000635	0.000003	0.000002	0.067398	0.009426	1349.9152	1214.041
0.0246	0.0063	0.0163	0.0182	0.024607	0.000635	0.000003	0.000003	0.067397	0.009426	1349.9057	1214.041
0.024	0.006	0.0159	0.0189	0.023972	0.000635	0.000003	0.000003	0.067397	0.009425	1349.8963	1214.041
0.0233	0.0058	0.0154	0.0197	0.023337	0.000635	0.000004	0.000003	0.067397	0.009425	1349.8869	1214.041
0.0227	0.0056	0.015	0.0205	0.022702	0.000635	0.000004	0.000004	0.067396	0.009424	1349.8775	1214.041
0.0221	0.0053	0.0146	0.0214	0.022067	0.000635	0.000005	0.000004	0.067396	0.009423	1349.868	1214.041
0.0214	0.0051	0.0142	0.0224	0.021432	0.000635	0.000005	0.000005	0.067395	0.009422	1349.8586	1214.041
0.0208	0.0049	0.0138	0.0234	0.020797	0.000635	0.000006	0.000006	0.067394	0.009421	1349.8492	1214.041
0.0202	0.0047	0.0134	0.0245	0.020162	0.000635	0.000007	0.000006	0.067394	0.00942	1349.8398	1214.041
0.0195	0.0044	0.0129	0.0257	0.019527	0.000635	0.000008	0.000007	0.067393	0.009418	1349.8303	1214.041
0.0189	0.0042	0.0125	0.027	0.018893	0.000635	0.000009	0.000009	0.067391	0.009416	1349.8209	1214.041
0.0182	0.004	0.0121	0.0284	0.018258	0.000634	0.000011	0.00001	0.06739	0.009414	1349.8115	1214.0409
0.0176	0.0038	0.0117	0.03	0.017624	0.000634	0.000012	0.000012	0.067388	0.009412	1349.8021	1214.0409
0.017	0.0036	0.0113	0.0317	0.01699	0.000634	0.000015	0.000013	0.067387	0.009409	1349.7927	1214.0409
0.0163	0.0034	0.0108	0.0335	0.016356	0.000634	0.000017	0.000016	0.067384	0.009405	1349.7833	1214.0409
0.0157	0.0032	0.0104	0.0356	0.015723	0.000633	0.00002	0.000019	0.067381	0.009401	1349.7739	1214.0409
0.0151	0.003	0.01	0.0379	0.01509	0.000633	0.000024	0.000022	0.067378	0.009396	1349.7645	1214.0409
0.0144	0.0028	0.0096	0.0404	0.014457	0.000633	0.000029	0.000027	0.067373	0.009389	1349.7551	1214.0409

The depth of flow at the **upper** end of the reach is **0.0151 ft**.
Flow has returned to normal. The flow depth returned to normal 0.2355 ft from the downstream lower end of reach.

Node and Reach invert report

Node and Reach invert report				
Node	J-20		Out ie	1305.00 ft
	Reach	P-20	I.E. Out	1305.00 ft
Node	J-21		Out ie	1215.00 ft
	Reach	P-20	I.E. In	1214.00 ft
	Reach	P-21	I.E. Out	1214.00 ft
Node	J-22		Out ie	1165.00 ft
	Reach	P-21	I.E. In	1165.00 ft
	Reach	P-22	I.E. Out	1165.00 ft
Node	J-23		Out ie	1135.00 ft
	Reach	P-22	I.E. In	1135.00 ft
	Reach	P-23	I.E. Out	1135.00 ft

Node	J-24		Out ie	1115.00 ft
	Reach	P-23	I.E. In	1115.00 ft
	Reach	B-2 OUTLET	I.E. Out	1115.00 ft

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Appended on: Wednesday, May 24, 2017 10:50:28 AM

ROUTEHYD [] THRU [B-2] USING [WQS] AND [TYPE1A.RAC] NOTZERO RELATIVE SCS/SBUH

Gravity Analysis using 24 hr duration storm

Reach ID	Area (ac)	Flow (cfs)	Full Q (cfs)	Full ratio	nDepth (ft)	Depth ratio	Size	nVel (ft/s)	fVel (ft/s)	Infil Vol (cf)	CBasin / Hyd
P-20	27.00	0.0975	39.4973	0.0025	0.0551	0.0367	18 in Diam	4.6677	22.3509	0.00	B-2A
P-21	70.60	0.304	86.6874	0.0035	0.0864	0.0432	24 in Diam	6.428	27.5935	0.00	B-2B
P-22	103.30	0.4953	118.81	0.0042	0.1166	0.0467	30 in Diam	5.9823	24.2044	0.00	B-2C
P-23	127.60	0.6512	86.2929	0.0075	0.1542	0.0617	30 in Diam	5.1974	17.5794	0.00	B-2D
B-2 OUTLET	141.30	0.8293	84.0134	0.0099	0.1744	0.0697	30 in Diam	5.5203	17.1151	0.00	B-2E

HGL Analysis

From Node	To Node	HG El (ft)	App (ft)	Bend (ft)	Junct Loss (ft)	Adjusted HG El (ft)	Max El (ft)
							1114.7947
J-24	J-24A	1115.3709	------	0.0653	------	1115.4362	1120.0000
J-23	J-24	1135.3236	------	1.4663	------	1136.7899	1140.0000
J-22	J-23	1165.2546	------	0.0053	------	1165.2599	1170.0000
J-21	J-22	1214.1824	------	0.0019	------	1214.1843	1220.0000
J-20	J-21	1305.1026	------	------	------	1305.1026	1310.0000

Conduit Notes

Reach	HW Depth (ft)	HW/D ratio	Q (cfs)	TW Depth (ft)	Dc (ft)	Dn (ft)	Comment
B-2 OUTLET	0.3709	0.1484	0.83	0.2947	0.2947	0.1744	SuperCrit flow, Inlet end controls
P-23	0.3236	0.1295	0.65	0.4362	0.2604	0.1542	SuperCrit flow, Inlet end controls
P-22	0.2546	0.1018	0.50	1.7899	0.2267	0.1166	SuperCrit flow, Inlet end controls
P-21	0.1824	0.0912	0.30	0.2599	0.1877	0.0864	SuperCrit flow, Inlet end controls

P-20	0.1026	0.0684	0.10	0.1843	0.1138	0.0551	SuperCrit flow, Inlet end controls

Node and Reach invert report

Node and Reach invert report				
Node	J-20		Out ie	1305.00 ft
	Reach	P-20	I.E. Out	1305.00 ft
Node	J-21		Out ie	1215.00 ft
	Reach	P-20	I.E. In	1214.00 ft
	Reach	P-21	I.E. Out	1214.00 ft
Node	J-22		Out ie	1165.00 ft
	Reach	P-21	I.E. In	1165.00 ft
	Reach	P-22	I.E. Out	1165.00 ft
Node	J-23		Out ie	1135.00 ft
	Reach	P-22	I.E. In	1135.00 ft
	Reach	P-23	I.E. Out	1135.00 ft
Node	J-24		Out ie	1115.00 ft
	Reach	P-23	I.E. In	1115.00 ft
	Reach	B-2 OUTLET	I.E. Out	1115.00 ft

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Appended on: Wednesday, May 24, 2017 10:51:23 AM

ROUTEHYD [] THRU [B-2] USING [2 yr 24 hr] AND [TYPE1A.RAC] NOTZERO RELATIVE SCS/SBUH

Gravity Analysis using 24 hr duration storm

Reach ID	Area (ac)	Flow (cfs)	Full Q (cfs)	Full ratio	nDepth (ft)	Depth ratio	Size	nVel (ft/s)	fVel (ft/s)	Infil Vol (cf)	CBasin / Hyd
P-20	27.00	0.3704	39.4973	0.0094	0.102	0.068	18 in Diam	7.1046	22.3509	0.00	B-2A
P-21	70.60	1.3323	86.6874	0.0154	0.1732	0.0866	24 in Diam	10.0704	27.5935	0.00	B-2B
P-22	103.30	2.4127	118.81	0.0203	0.2467	0.0987	30 in Diam	9.6292	24.2044	0.00	B-2C
P-23	127.60	3.3952	86.2929	0.0393	0.3384	0.1354	30 in Diam	8.5374	17.5794	0.00	B-2D
B-2 OUTLET	141.30	4.8871	84.0134	0.0582	0.409	0.1636	30 in Diam	9.334	17.1151	0.00	B-2E

HGL Analysis

From Node	To Node	HG El (ft)	App (ft)	Bend (ft)	Junct Loss (ft)	Adjusted HG El (ft)	Max El (ft)
							1115.229
J-24	J-24A	1115.9701	------	0.1762	------	1116.1463	1120.0000
J-23	J-24	1135.7938	------	3.7990	------	1139.5928	1140.0000
J-22	J-23	1165.6359	------	0.0130	------	1165.6489	1170.0000
J-21	J-22	1214.4686	------	0.0043	------	1214.4729	1220.0000
J-20	J-21	1305.2518	------	------	------	1305.2518	1310.0000

Conduit Notes

Reach	HW Depth (ft)	HW/D ratio	Q (cfs)	TW Depth (ft)	Dc (ft)	Dn (ft)	Comment
B-2 OUTLET	0.9701	0.3880	4.89	0.7290	0.7290	0.4090	SuperCrit flow, Inlet end controls
P-23	0.7938	0.3175	3.40	1.1463	0.6043	0.3384	SuperCrit flow, Inlet end controls
P-22	0.6359	0.2544	2.41	4.5928	0.5073	0.2467	SuperCrit flow, Inlet end controls
P-21	0.4686	0.2343	1.33	0.6489	0.3985	0.1732	SuperCrit flow, Inlet end controls

P-20	0.2518	0.1678	0.37	0.4729	0.2242	0.1020	SuperCrit flow, Inlet end controls

Node and Reach invert report

Node and Reach invert report				
Node	J-20		Out ie	1305.00 ft
	Reach	P-20	I.E. Out	1305.00 ft
Node	J-21		Out ie	1215.00 ft
	Reach	P-20	I.E. In	1214.00 ft
	Reach	P-21	I.E. Out	1214.00 ft
Node	J-22		Out ie	1165.00 ft
	Reach	P-21	I.E. In	1165.00 ft
	Reach	P-22	I.E. Out	1165.00 ft
Node	J-23		Out ie	1135.00 ft
	Reach	P-22	I.E. In	1135.00 ft
	Reach	P-23	I.E. Out	1135.00 ft
Node	J-24		Out ie	1115.00 ft
	Reach	P-23	I.E. In	1115.00 ft
	Reach	B-2 OUTLET	I.E. Out	1115.00 ft

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Appended on: Wednesday, May 24, 2017 10:53:35 AM

ROUTEHYD [] THRU [B-2] USING [25 year] AND [TYPE1A.RAC] NOTZERO RELATIVE SCS/SBUH

Gravity Analysis using 24 hr duration storm

Reach ID	Area (ac)	Flow (cfs)	Full Q (cfs)	Full ratio	nDepth (ft)	Depth ratio	Size	nVel (ft/s)	fVel (ft/s)	Infil Vol (cf)	CBasin / Hyd
P-20	27.00	6.1226	39.4973	0.155	0.3987	0.2658	18 in Diam	16.258	22.3509	0.00	B-2A
P-21	70.60	16.4742	86.6874	0.19	0.5909	0.2955	24 in Diam	21.2269	27.5935	0.00	B-2B
P-22	103.30	25.8662	118.81	0.2177	0.7928	0.3171	30 in Diam	19.3392	24.2044	0.00	B-2C
P-23	127.60	33.2748	86.2929	0.3856	1.078	0.4312	30 in Diam	16.4262	17.5794	0.00	B-2D
B-2 OUTLET	141.30	39.0761	84.0134	0.4651	1.1989	0.4795	30 in Diam	16.7954	17.1151	0.00	B-2E

HGL Analysis

From Node	To Node	HG El (ft)	App (ft)	Bend (ft)	Junct Loss (ft)	Adjusted HG El (ft)	Max El (ft)
							1116.6089
J-24	J-24A	1118.7688	------	0.1111	------	1118.8799	1120.0000
J-23	J-24	1138.2186	------	1.1377	------	1139.3562	1140.0000
J-22	J-23	1167.5959	------	0.0035	------	1167.5994	1170.0000
J-21	J-22	1216.2807	------	0.0010	------	1216.2817	1220.0000
J-20	J-21	1306.3715	------	------	------	1306.3715	1310.0000

Conduit Notes

Reach	HW Depth (ft)	HW/D ratio	Q (cfs)	TW Depth (ft)	Dc (ft)	Dn (ft)	Comment
B-2 OUTLET	3.7688	1.5075	39.08	2.1089	2.1089	1.1989	SuperCrit flow, Inlet end controls
P-23	3.2186	1.2874	33.27	3.8799	1.9630	1.0780	SuperCrit flow, Inlet end controls
P-22	2.5959	1.0384	25.87	4.3562	1.7341	0.7928	SuperCrit flow, Inlet end controls
P-21	2.2807	1.1403	16.47	2.5994	1.4643	0.5909	SuperCrit flow, Inlet end controls

P-20	1.3715	0.9143	6.12	2.2817	0.9561	0.3987	SuperCrit flow, Inlet end controls

Node and Reach invert report

Node and Reach invert report				
Node	J-20		Out ie	1305.00 ft
	Reach	P-20	I.E. Out	1305.00 ft
Node	J-21		Out ie	1215.00 ft
	Reach	P-20	I.E. In	1214.00 ft
	Reach	P-21	I.E. Out	1214.00 ft
Node	J-22		Out ie	1165.00 ft
	Reach	P-21	I.E. In	1165.00 ft
	Reach	P-22	I.E. Out	1165.00 ft
Node	J-23		Out ie	1135.00 ft
	Reach	P-22	I.E. In	1135.00 ft
	Reach	P-23	I.E. Out	1135.00 ft
Node	J-24		Out ie	1115.00 ft
	Reach	P-23	I.E. In	1115.00 ft
	Reach	B-2 OUTLET	I.E. Out	1115.00 ft

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Appended on: Wednesday, May 24, 2017 10:54:23 AM

ROUTEHYD [] THRU [B-2] USING [100 year] AND [TYPE1A.RAC] NOTZERO RELATIVE SCS/SBUH

Gravity Analysis using 24 hr duration storm

Reach ID	Area (ac)	Flow (cfs)	Full Q (cfs)	Full ratio	nDepth (ft)	Depth ratio	Size	nVel (ft/s)	fVel (ft/s)	Infil Vol (cf)	CBasin / Hyd
P-20	27.00	8.6294	39.4973	0.2185	0.4766	0.3177	18 in Diam	17.8749	22.3509	0.00	B-2A
P-21	70.60	22.8589	86.6874	0.2637	0.7009	0.3504	24 in Diam	23.2882	27.5935	0.00	B-2B
P-22	103.30	35.446	118.81	0.2983	0.9363	0.3745	30 in Diam	21.1173	24.2044	0.00	B-2C
P-23	127.60	45.359	86.2929	0.5256	1.2881	0.5152	30 in Diam	17.7902	17.5794	0.00	B-2D
B-2 OUTLET	141.30	52.5891	84.0134	0.626	1.4333	0.5733	30 in Diam	18.0651	17.1151	0.00	B-2E

HGL Analysis

From Node	To Node	HG El (ft)	App (ft)	Bend (ft)	Junct Loss (ft)	Adjusted HG El (ft)	Max El (ft)
							1116.83
J-24	J-24A	1120.3984	------	0.2064	------	1120.1000	1120.0000
J-23	J-24	1139.4687	------	2.1364	------	1140.1000	1140.0000
J-22	J-23	1168.4479	------	0.0068	------	1168.4547	1170.0000
J-21	J-22	1217.1563	------	0.0021	------	1217.1584	1220.0000
J-20	J-21	1306.8076	------	------	------	1306.8076	1310.0000

Conduit Notes

Reach	HW Depth (ft)	HW/D ratio	Q (cfs)	TW Depth (ft)	Dc (ft)	Dn (ft)	Comment
B-2 OUTLET	5.3984	2.1594	52.59	2.3300	2.3300	1.4333	SuperCrit flow, Inlet end controls
P-23	4.4687	1.7875	45.36	5.1000	2.2318	1.2881	SuperCrit flow, Inlet end controls
P-22	3.4479	1.3792	35.45	5.1000	2.0212	0.9363	SuperCrit flow, Inlet end controls
P-21	3.1563	1.5781	22.86	3.4547	1.7022	0.7009	SuperCrit flow, Inlet end controls

P-20	1.8076	1.2051	8.63	3.1584	1.1378	0.4766	SuperCrit flow, Inlet end controls

Node and Reach invert report

Node and Reach invert report				
Node	J-20		Out ie	1305.00 ft
	Reach	P-20	I.E. Out	1305.00 ft
Node	J-21		Out ie	1215.00 ft
	Reach	P-20	I.E. In	1214.00 ft
	Reach	P-21	I.E. Out	1214.00 ft
Node	J-22		Out ie	1165.00 ft
	Reach	P-21	I.E. In	1165.00 ft
	Reach	P-22	I.E. Out	1165.00 ft
Node	J-23		Out ie	1135.00 ft
	Reach	P-22	I.E. In	1135.00 ft
	Reach	P-23	I.E. Out	1135.00 ft
Node	J-24		Out ie	1115.00 ft
	Reach	P-23	I.E. In	1115.00 ft
	Reach	B-2 OUTLET	I.E. Out	1115.00 ft

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Appended on: Wednesday, May 24, 2017 10:46:08 AM

ROUTEHYD [] THRU [B-2] USING [E WA 3hr Depth] AND [EWash-3hr.rac] NOTZERO RELATIVE SCS/SBUH

Gravity Analysis using 3 hr duration storm

Reach ID	Area (ac)	Flow (cfs)	Full Q (cfs)	Full ratio	nDepth (ft)	Depth ratio	Size	nVel (ft/s)	fVel (ft/s)	Infil Vol (cf)	CBasin / Hyd
P-20	27.00	0.4503	39.4973	0.0114	0.1126	0.075	18 in Diam	7.4727	22.3509	0.00	FB-2A
P-21	70.60	1.1309	86.6874	0.013	0.1611	0.0806	24 in Diam	9.5083	27.5935	0.00	FB-2B
P-22	103.30	2.047	118.81	0.0172	0.2283	0.0913	30 in Diam	9.1582	24.2044	0.00	FB-2C
P-23	127.60	2.4498	86.2929	0.0284	0.2898	0.1159	30 in Diam	7.7222	17.5794	0.00	FB-2D
B-2 OUTLET	141.30	3.4949	84.0134	0.0416	0.3481	0.1393	30 in Diam	8.432	17.1151	0.00	FB-2E

HGL Analysis

From Node	To Node	HG El (ft)	App (ft)	Bend (ft)	Junct Loss (ft)	Adjusted HG El (ft)	Max El (ft)
							1115.1134
J-24	J-24A	1115.8078	------	0.1441	------	1115.9519	1120.0000
J-23	J-24	1135.6650	------	3.4364	------	1139.1014	1140.0000
J-22	J-23	1165.5798	------	0.0116	------	1165.5914	1170.0000
J-21	J-22	1214.4247	------	0.0048	------	1214.4295	1220.0000
J-20	J-21	1305.2837	------	------	------	1305.2837	1310.0000

Conduit Notes

Reach	HW Depth (ft)	HW/D ratio	Q (cfs)	TW Depth (ft)	Dc (ft)	Dn (ft)	Comment
B-2 OUTLET	0.8078	0.3231	3.49	0.6134	0.6134	0.3481	SuperCrit flow, Inlet end controls
P-23	0.6650	0.2660	2.45	0.9519	0.5112	0.2898	SuperCrit flow, Inlet end controls
P-22	0.5798	0.2319	2.05	4.1014	0.4667	0.2283	SuperCrit flow, Inlet end controls
P-21	0.4247	0.2123	1.13	0.5914	0.3668	0.1611	SuperCrit flow, Inlet end controls

P-20	0.2837	0.1891	0.45	0.4295	0.2479	0.1126	SuperCrit flow, Inlet end controls

Node and Reach invert report

Node and Reach invert report				
Node	J-20		Out ie	1305.00 ft
	Reach	P-20	I.E. Out	1305.00 ft
Node	J-21		Out ie	1215.00 ft
	Reach	P-20	I.E. In	1214.00 ft
	Reach	P-21	I.E. Out	1214.00 ft
Node	J-22		Out ie	1165.00 ft
	Reach	P-21	I.E. In	1165.00 ft
	Reach	P-22	I.E. Out	1165.00 ft
Node	J-23		Out ie	1135.00 ft
	Reach	P-22	I.E. In	1135.00 ft
	Reach	P-23	I.E. Out	1135.00 ft
Node	J-24		Out ie	1115.00 ft
	Reach	P-23	I.E. In	1115.00 ft
	Reach	B-2 OUTLET	I.E. Out	1115.00 ft

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Appended on: Wednesday, May 24, 2017 10:40:56 AM

ROUTEHYD [] THRU [B-2] USING [WQS] AND [TYPE1A.RAC] NOTZERO RELATIVE SCS/SBUH

Gravity Analysis using 24 hr duration storm

Reach ID	Area (ac)	Flow (cfs)	Full Q (cfs)	Full ratio	nDepth (ft)	Depth ratio	Size	nVel (ft/s)	fVel (ft/s)	Infil Vol (cf)	CBasin / Hyd
P-20	27.00	0.2573	39.4973	0.0065	0.0864	0.0576	18 in Diam	6.3182	22.3509	0.00	FB-2A
P-21	70.60	0.6677	86.6874	0.0077	0.1245	0.0622	24 in Diam	8.2197	27.5935	0.00	FB-2B
P-22	103.30	1.1224	118.81	0.0094	0.1707	0.0683	30 in Diam	7.7103	24.2044	0.00	FB-2C
P-23	127.60	1.3536	86.2929	0.0157	0.2185	0.0874	30 in Diam	6.4575	17.5794	0.00	FB-2D
B-2 OUTLET	141.30	1.7963	84.0134	0.0214	0.2529	0.1012	30 in Diam	6.9121	17.1151	0.00	FB-2E

HGL Analysis

From Node	To Node	HG El (ft)	App (ft)	Bend (ft)	Junct Loss (ft)	Adjusted HG El (ft)	Max El (ft)
							1114.9367
J-24	J-24A	1115.5636	------	0.1008	------	1115.6644	1120.0000
J-23	J-24	1135.4824	------	2.4357	------	1137.9181	1140.0000
J-22	J-23	1165.4123	------	0.0087	------	1165.4209	1170.0000
J-21	J-22	1214.3073	------	0.0034	------	1214.3107	1220.0000
J-20	J-21	1305.2003	------	------	------	1305.2003	1310.0000

Conduit Notes

Reach	HW Depth (ft)	HW/D ratio	Q (cfs)	TW Depth (ft)	Dc (ft)	Dn (ft)	Comment
B-2 OUTLET	0.5636	0.2254	1.80	0.4367	0.4367	0.2529	SuperCrit flow, Inlet end controls
P-23	0.4824	0.1930	1.35	0.6644	0.3776	0.2185	SuperCrit flow, Inlet end controls
P-22	0.4123	0.1649	1.12	2.9181	0.3389	0.1707	SuperCrit flow, Inlet end controls
P-21	0.3073	0.1536	0.67	0.4209	0.2753	0.1245	SuperCrit flow, Inlet end controls

P-20	0.2003	0.1335	0.26	0.3107	0.1867	0.0864	SuperCrit flow, Inlet end controls

Node and Reach invert report

Node and Reach invert report				
Node	J-20		Out ie	1305.00 ft
	Reach	P-20	I.E. Out	1305.00 ft
Node	J-21		Out ie	1215.00 ft
	Reach	P-20	I.E. In	1214.00 ft
	Reach	P-21	I.E. Out	1214.00 ft
Node	J-22		Out ie	1165.00 ft
	Reach	P-21	I.E. In	1165.00 ft
	Reach	P-22	I.E. Out	1165.00 ft
Node	J-23		Out ie	1135.00 ft
	Reach	P-22	I.E. In	1135.00 ft
	Reach	P-23	I.E. Out	1135.00 ft
Node	J-24		Out ie	1115.00 ft
	Reach	P-23	I.E. In	1115.00 ft
	Reach	B-2 OUTLET	I.E. Out	1115.00 ft

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Appended on: Wednesday, May 24, 2017 10:42:26 AM

ROUTEHYD [] THRU [B-2] USING [2 yr 24 hr] AND [TYPE1A.RAC] NOTZERO RELATIVE SCS/SBUH

Gravity Analysis using 24 hr duration storm

Reach ID	Area (ac)	Flow (cfs)	Full Q (cfs)	Full ratio	nDepth (ft)	Depth ratio	Size	nVel (ft/s)	fVel (ft/s)	Infil Vol (cf)	CBasin / Hyd
P-20	27.00	1.5112	39.4973	0.0383	0.2002	0.1335	18 in Diam	10.7722	22.3509	0.00	FB-2A
P-21	70.60	3.8677	86.6874	0.0446	0.2877	0.1438	24 in Diam	13.91	27.5935	0.00	FB-2B
P-22	103.30	6.0853	118.81	0.0512	0.3841	0.1536	30 in Diam	12.7299	24.2044	0.00	FB-2C
P-23	127.60	7.4362	86.2929	0.0862	0.4958	0.1983	30 in Diam	10.7703	17.5794	0.00	FB-2D
B-2 OUTLET	141.30	8.8583	84.0134	0.1054	0.5466	0.2186	30 in Diam	11.1613	17.1151	0.00	FB-2E

HGL Analysis

From Node	To Node	HG El (ft)	App (ft)	Bend (ft)	Junct Loss (ft)	Adjusted HG El (ft)	Max El (ft)
							1115.4922
J-24	J-24A	1116.3520	------	0.2804	------	1116.6323	1120.0000
J-23	J-24	1136.2231	------	6.6395	------	1140.1000	1140.0000
J-22	J-23	1166.0699	------	0.0248	------	1166.0947	1170.0000
J-21	J-22	1214.8784	------	0.0100	------	1214.8884	1220.0000
J-20	J-21	1305.5806	------	------	------	1305.5806	1310.0000

Conduit Notes

Reach	HW Depth (ft)	HW/D ratio	Q (cfs)	TW Depth (ft)	Dc (ft)	Dn (ft)	Comment
B-2 OUTLET	1.3520	0.5408	8.86	0.9922	0.9922	0.5466	SuperCrit flow, Inlet end controls
P-23	1.2231	0.4893	7.44	1.6323	0.9057	0.4958	SuperCrit flow, Inlet end controls
P-22	1.0699	0.4279	6.09	5.1000	0.8163	0.3841	SuperCrit flow, Inlet end controls
P-21	0.8784	0.4392	3.87	1.0947	0.6895	0.2877	SuperCrit flow, Inlet end controls

P-20	0.5806	0.3870	1.51	0.8884	0.4613	0.2002	SuperCrit flow, Inlet end controls

Node and Reach invert report

Node and Reach invert report				
Node	J-20		Out ie	1305.00 ft
	Reach	P-20	I.E. Out	1305.00 ft
Node	J-21		Out ie	1215.00 ft
	Reach	P-20	I.E. In	1214.00 ft
	Reach	P-21	I.E. Out	1214.00 ft
Node	J-22		Out ie	1165.00 ft
	Reach	P-21	I.E. In	1165.00 ft
	Reach	P-22	I.E. Out	1165.00 ft
Node	J-23		Out ie	1135.00 ft
	Reach	P-22	I.E. In	1135.00 ft
	Reach	P-23	I.E. Out	1135.00 ft
Node	J-24		Out ie	1115.00 ft
	Reach	P-23	I.E. In	1115.00 ft
	Reach	B-2 OUTLET	I.E. Out	1115.00 ft

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Appended on: Wednesday, May 24, 2017 10:43:08 AM

ROUTEHYD [] THRU [B-2] USING [25 year] AND [TYPE1A.RAC] NOTZERO RELATIVE SCS/SBUH

Gravity Analysis using 24 hr duration storm

Reach ID	Area (ac)	Flow (cfs)	Full Q (cfs)	Full ratio	nDepth (ft)	Depth ratio	Size	nVel (ft/s)	fVel (ft/s)	Infil Vol (cf)	CBasin / Hyd
P-20	27.00	9.3198	39.4973	0.236	0.4948	0.3299	18 in Diam	18.3344	22.3509	0.00	FB-2A
P-21	70.60	23.8981	86.6874	0.2757	0.7178	0.3589	24 in Diam	23.5666	27.5935	0.00	FB-2B
P-22	103.30	35.8539	118.81	0.3018	0.9422	0.3769	30 in Diam	21.1826	24.2044	0.00	FB-2C
P-23	127.60	44.2128	86.2929	0.5124	1.2687	0.5075	30 in Diam	17.6768	17.5794	0.00	FB-2D
B-2 OUTLET	141.30	49.9747	84.0134	0.5948	1.3887	0.5555	30 in Diam	17.8456	17.1151	0.00	FB-2E

HGL Analysis

From Node	To Node	HG El (ft)	App (ft)	Bend (ft)	Junct Loss (ft)	Adjusted HG El (ft)	Max El (ft)
							1116.7996
J-24	J-24A	1120.0456	------	0.1961	------	1120.1000	1120.0000
J-23	J-24	1139.3336	------	2.1858	------	1140.1000	1140.0000
J-22	J-23	1168.4862	------	0.0074	------	1168.4936	1170.0000
J-21	J-22	1217.3124	------	0.0024	------	1217.3148	1220.0000
J-20	J-21	1306.9875	------	------	------	1306.9875	1310.0000

Conduit Notes

Reach	HW Depth (ft)	HW/D ratio	Q (cfs)	TW Depth (ft)	Dc (ft)	Dn (ft)	Comment
B-2 OUTLET	5.0456	2.0183	49.97	2.2996	2.2996	1.3887	SuperCrit flow, Inlet end controls
P-23	4.3336	1.7334	44.21	5.1000	2.2124	1.2687	SuperCrit flow, Inlet end controls
P-22	3.4862	1.3945	35.85	5.1000	2.0316	0.9422	SuperCrit flow, Inlet end controls
P-21	3.3124	1.6562	23.90	3.4936	1.7325	0.7178	SuperCrit flow, Inlet end controls

P-20	1.9875	1.3250	9.32	3.3148	1.1803	0.4948	SuperCrit flow, Inlet end controls

Node and Reach invert report

Node and Reach invert report				
Node	J-20		Out ie	1305.00 ft
	Reach	P-20	I.E. Out	1305.00 ft
Node	J-21		Out ie	1215.00 ft
	Reach	P-20	I.E. In	1214.00 ft
	Reach	P-21	I.E. Out	1214.00 ft
Node	J-22		Out ie	1165.00 ft
	Reach	P-21	I.E. In	1165.00 ft
	Reach	P-22	I.E. Out	1165.00 ft
Node	J-23		Out ie	1135.00 ft
	Reach	P-22	I.E. In	1135.00 ft
	Reach	P-23	I.E. Out	1135.00 ft
Node	J-24		Out ie	1115.00 ft
	Reach	P-23	I.E. In	1115.00 ft
	Reach	B-2 OUTLET	I.E. Out	1115.00 ft

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Appended on: Wednesday, May 24, 2017 10:43:53 AM

ROUTEHYD [] THRU [B-2] USING [100 year] AND [TYPE1A.RAC] NOTZERO RELATIVE SCS/SBUH

Gravity Analysis using 24 hr duration storm

Reach ID	Area (ac)	Flow (cfs)	Full Q (cfs)	Full ratio	nDepth (ft)	Depth ratio	Size	nVel (ft/s)	fVel (ft/s)	Infil Vol (cf)	CBasin / Hyd
P-20	27.00	12.242	39.4973	0.3099	0.5726	0.3817	18 in Diam	19.7482	22.3509	0.00	FB-2A
P-21	70.60	31.4252	86.6874	0.3625	0.8327	0.4164	24 in Diam	25.3878	27.5935	0.00	FB-2B
P-22	103.30	46.9317	118.81	0.395	1.0929	0.4372	30 in Diam	22.7518	24.2044	0.00	FB-2C
P-23	127.60	57.9129	86.2929	0.6711	1.4999	0.60	30 in Diam	18.834	17.5794	0.00	FB-2D
B-2 OUTLET	141.30	65.1639	84.0134	0.7756	1.655	0.662	30 in Diam	18.8946	17.1151	0.00	FB-2E

HGL Analysis

From Node	To Node	HG El (ft)	App (ft)	Bend (ft)	Junct Loss (ft)	Adjusted HG El (ft)	Max El (ft)
							1116.9212
J-24	J-24A	1122.3464	------	0.3364	------	1120.1000	1120.0000
J-23	J-24	1141.1743	------	3.7452	------	1140.1000	1140.0000
J-22	J-23	1169.6927	------	0.0128	------	1169.7055	1170.0000
J-21	J-22	1218.6499	------	0.0041	------	1218.6540	1220.0000
J-20	J-21	1307.6271	------	------	------	1307.6271	1310.0000

Conduit Notes

Reach	HW Depth (ft)	HW/D ratio	Q (cfs)	TW Depth (ft)	Dc (ft)	Dn (ft)	Comment
B-2 OUTLET	7.3464	2.9386	65.16	2.4212	2.4212	1.6550	SuperCrit flow, Inlet end controls
P-23	6.1743	2.4697	57.91	5.1000	2.3783	1.4999	SuperCrit flow, Inlet end controls
P-22	4.6927	1.8771	46.93	5.1000	2.2570	1.0929	SuperCrit flow, Inlet end controls
P-21	4.6499	2.3249	31.43	4.7055	1.8825	0.8327	SuperCrit flow, Inlet end controls

P-20	2.6271	1.7514	12.24	4.6540	1.3243	0.5726	SuperCrit flow, Inlet end controls

Node and Reach invert report

Node and Reach invert report				
Node	J-20		Out ie	1305.00 ft
	Reach	P-20	I.E. Out	1305.00 ft
Node	J-21		Out ie	1215.00 ft
	Reach	P-20	I.E. In	1214.00 ft
	Reach	P-21	I.E. Out	1214.00 ft
Node	J-22		Out ie	1165.00 ft
	Reach	P-21	I.E. In	1165.00 ft
	Reach	P-22	I.E. Out	1165.00 ft
Node	J-23		Out ie	1135.00 ft
	Reach	P-22	I.E. In	1135.00 ft
	Reach	P-23	I.E. Out	1135.00 ft
Node	J-24		Out ie	1115.00 ft
	Reach	P-23	I.E. In	1115.00 ft
	Reach	B-2 OUTLET	I.E. Out	1115.00 ft

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Appended on: Wednesday, May 24, 2017 11:01:23 AM

ROUTEHYD [] THRU [B-3-1] USING [E WA 3hr Depth] AND [EWash-3hr.rac] NOTZERO RELATIVE SCS/SBUH

Gravity Analysis using 3 hr duration storm

Reach ID	Area (ac)	Flow (cfs)	Full Q (cfs)	Full ratio	nDepth (ft)	Depth ratio	Size	nVel (ft/s)	fVel (ft/s)	Infil Vol (cf)	CBasin / Hyd
P-30	44.60	0.0321	34.5591	0.0009	0.0345	0.023	18 in Diam	3.0939	19.5564	0.00	B-3A
P-31	85.40	0.8162	32.7648	0.0249	0.2181	0.109	24 in Diam	4.3976	10.4293	0.00	B-3E
P-36	85.40	0.8162	71.7614	0.0114	0.1874	0.0749	30 in Diam	4.8852	14.6191	0.00	
B-3-1 OUTLET	85.40	0.8162	84.5004	0.0097	0.207	0.069	36 in Diam	3.8325	11.9544	0.00	

HGL Analysis

From Node	To Node	HG El (ft)	App (ft)	Bend (ft)	Junct Loss (ft)	Adjusted HG El (ft)	Max El (ft)
							1103.7839
No approach losses at node J-37 because inverts and/or crowns are offset.							
J-38	J-38A	1107.3127	------	0.0042	------	1107.3169	1118.3700
J-37	J-38	1135.0844	------	0.0015	------	1135.0860	1140.0000
No approach losses at node J-30 because inverts and/or crowns are offset.							
J-31	J-37	1138.5180	------	0.0013	------	1138.5193	1145.1800
J-30	J-31	1220.0488	------	------	------	1220.0488	1225.0000

Conduit Notes

Reach	HW Depth (ft)	HW/D ratio	Q (cfs)	TW Depth (ft)	Dc (ft)	Dn (ft)	Comment
B-3-1 OUTLET	0.3327	0.1109	0.82	0.2779	0.2779	0.2070	SuperCrit flow, Inlet end controls
P-36	0.3744	0.1498	0.82	0.2922	0.2922	0.1874	SuperCrit flow, Inlet end controls
P-31	0.4080	0.2040	0.82	0.9760	0.3102	0.2181	SuperCrit flow, Inlet end controls
P-30	0.0488	0.0325	0.03	0.0653	0.0653	0.0345	SuperCrit flow, Inlet end controls

Node and Reach invert report

Node and Reach invert report				
Node	J-30		Out ie	1220.00 ft
	Reach	P-30	I.E. Out	1220.00 ft
Node	J-31		Out ie	1138.11 ft
	Reach	P-30	I.E. In	1140.00 ft
	Reach	P-31	I.E. Out	1138.11 ft
Node	J-37		Out ie	1134.71 ft
	Reach	P-31	I.E. In	1134.11 ft
	Reach	P-36	I.E. Out	1134.71 ft
Node	J-38		Out ie	1106.98 ft
	Reach	P-36	I.E. In	1112.53 ft
	Reach	B-3-1 OUTLET	I.E. Out	1106.98 ft

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Appended on: Wednesday, May 24, 2017 10:58:11 AM

ROUTEHYD [] THRU [B-3-1] USING [WQS] AND [TYPE1A.RAC] NOTZERO RELATIVE SCS/SBUH

Gravity Analysis using 24 hr duration storm

Reach ID	Area (ac)	Flow (cfs)	Full Q (cfs)	Full ratio	nDepth (ft)	Depth ratio	Size	nVel (ft/s)	fVel (ft/s)	Infil Vol (cf)	CBasin / Hyd
P-30	44.60	0.1955	34.5591	0.0057	0.0806	0.0538	18 in Diam	5.3149	19.5564	0.00	B-3A
P-31	85.40	0.5147	32.7648	0.0157	0.1749	0.0875	24 in Diam	3.8328	10.4293	0.00	B-3E
P-36	85.40	0.5147	71.7614	0.0072	0.151	0.0604	30 in Diam	4.239	14.6191	0.00	
B-3-1 OUTLET	85.40	0.5147	84.5004	0.0061	0.1671	0.0557	36 in Diam	3.3195	11.9544	0.00	

HGL Analysis

From Node	To Node	HG El (ft)	App (ft)	Bend (ft)	Junct Loss (ft)	Adjusted HG El (ft)	Max El (ft)
							1103.7257
No approach losses at node J-37 because inverts and/or crowns are offset.							
J-38	J-38A	1107.2349	------	0.0031	------	1107.2380	1118.3700
J-37	J-38	1135.0023	------	0.0011	------	1135.0035	1140.0000
No approach losses at node J-30 because inverts and/or crowns are offset.							
J-31	J-37	1138.4301	------	0.0037	------	1138.4338	1145.1800
J-30	J-31	1220.1794	------	------	------	1220.1794	1225.0000

Conduit Notes

Reach	HW Depth (ft)	HW/D ratio	Q (cfs)	TW Depth (ft)	Dc (ft)	Dn (ft)	Comment
B-3-1 OUTLET	0.2549	0.0850	0.51	0.2197	0.2197	0.1671	SuperCrit flow, Inlet end controls
P-36	0.2923	0.1169	0.51	0.2310	0.2310	0.1510	SuperCrit flow, Inlet end controls
P-31	0.3201	0.1600	0.51	0.8935	0.2457	0.1749	SuperCrit flow, Inlet end controls
P-30	0.1794	0.1196	0.20	0.1623	0.1623	0.0806	SuperCrit flow, Inlet end controls

Node and Reach invert report

Node and Reach invert report				
Node	J-30		Out ie	1220.00 ft
	Reach	P-30	I.E. Out	1220.00 ft
Node	J-31		Out ie	1138.11 ft
	Reach	P-30	I.E. In	1140.00 ft
	Reach	P-31	I.E. Out	1138.11 ft
Node	J-37		Out ie	1134.71 ft
	Reach	P-31	I.E. In	1134.11 ft
	Reach	P-36	I.E. Out	1134.71 ft
Node	J-38		Out ie	1106.98 ft
	Reach	P-36	I.E. In	1112.53 ft
	Reach	B-3-1 OUTLET	I.E. Out	1106.98 ft

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Appended on: Wednesday, May 24, 2017 10:59:01 AM

ROUTEHYD [] THRU [B-3-1] USING [2 yr 24 hr] AND [TYPE1A.RAC] NOTZERO RELATIVE SCS/SBUH

Gravity Analysis using 24 hr duration storm

Reach ID	Area (ac)	Flow (cfs)	Full Q (cfs)	Full ratio	nDepth (ft)	Depth ratio	Size	nVel (ft/s)	fVel (ft/s)	Infil Vol (cf)	CBasin / Hyd
P-30	44.60	0.8451	34.5591	0.0245	0.162	0.108	18 in Diam	8.2068	19.5564	0.00	B-3A
P-31	85.40	2.9723	32.7648	0.0907	0.407	0.2035	24 in Diam	6.483	10.4293	0.00	B-3E
P-36	85.40	2.9723	71.7614	0.0414	0.3474	0.1389	30 in Diam	7.1946	14.6191	0.00	
B-3-1 OUTLET	85.40	2.9723	84.5004	0.0352	0.3844	0.1281	36 in Diam	5.6218	11.9544	0.00	

HGL Analysis

From Node	To Node	HG El (ft)	App (ft)	Bend (ft)	Junct Loss (ft)	Adjusted HG El (ft)	Max El (ft)
							1104.0434
No approach losses at node J-37 because inverts and/or crowns are offset.							
J-38	J-38A	1107.6631	------	0.0091	------	1107.6721	1118.3700
J-37	J-38	1135.4566	------	0.0033	------	1135.4599	1140.0000
No approach losses at node J-30 because inverts and/or crowns are offset.							
J-31	J-37	1138.9223	------	0.0088	------	1138.9312	1145.1800
J-30	J-31	1220.4249	------	------	------	1220.4249	1225.0000

Conduit Notes

Reach	HW Depth (ft)	HW/D ratio	Q (cfs)	TW Depth (ft)	Dc (ft)	Dn (ft)	Comment
B-3-1 OUTLET	0.6831	0.2277	2.97	0.5374	0.5374	0.3844	SuperCrit flow, Inlet end controls
P-36	0.7466	0.2986	2.97	0.5647	0.5647	0.3474	SuperCrit flow, Inlet end controls
P-31	0.8123	0.4062	2.97	1.3499	0.6017	0.4070	SuperCrit flow, Inlet end controls
P-30	0.4249	0.2833	0.85	0.3422	0.3422	0.1620	SuperCrit flow, Inlet end controls

Node and Reach invert report

Node and Reach invert report				
Node	J-30		Out ie	1220.00 ft
	Reach	P-30	I.E. Out	1220.00 ft
Node	J-31		Out ie	1138.11 ft
	Reach	P-30	I.E. In	1140.00 ft
	Reach	P-31	I.E. Out	1138.11 ft
Node	J-37		Out ie	1134.71 ft
	Reach	P-31	I.E. In	1134.11 ft
	Reach	P-36	I.E. Out	1134.71 ft
Node	J-38		Out ie	1106.98 ft
	Reach	P-36	I.E. In	1112.53 ft
	Reach	B-3-1 OUTLET	I.E. Out	1106.98 ft

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Appended on: Wednesday, May 24, 2017 10:59:52 AM

ROUTEHYD [] THRU [B-3-1] USING [25 year] AND [TYPE1A.RAC] NOTZERO RELATIVE SCS/SBUH

Gravity Analysis using 24 hr duration storm

Reach ID	Area (ac)	Flow (cfs)	Full Q (cfs)	Full ratio	nDepth (ft)	Depth ratio	Size	nVel (ft/s)	fVel (ft/s)	Infil Vol (cf)	CBasin / Hyd
P-30	44.60	10.1015	34.5591	0.2923	0.5557	0.3704	18 in Diam	16.9668	19.5564	0.00	B-3A
P-31	85.40	23.485	32.7648	0.7168	1.2532	0.6266	24 in Diam	11.3355	10.4293	0.00	B-3E
P-36	85.40	23.485	71.7614	0.3273	0.975	0.39	30 in Diam	13.2494	14.6191	0.00	
B-3-1 OUTLET	85.40	23.485	84.5004	0.2779	1.0815	0.3605	36 in Diam	10.2318	11.9544	0.00	

HGL Analysis

From Node	To Node	HG El (ft)	App (ft)	Bend (ft)	Junct Loss (ft)	Adjusted HG El (ft)	Max El (ft)
							1105.0675
No approach losses at node J-37 because inverts and/or crowns are offset.							
J-38	J-38A	1109.1695	------	0.0307	------	1109.2003	1118.3700
J-37	J-38	1137.1697	------	0.0043	------	1137.1741	1140.0000
No approach losses at node J-30 because inverts and/or crowns are offset.							
J-31	J-37	1141.2755	------	0.0378	------	1141.3133	1145.1800
J-30	J-31	1222.1250	------	------	------	1222.1250	1225.0000

Conduit Notes

Reach	HW Depth (ft)	HW/D ratio	Q (cfs)	TW Depth (ft)	Dc (ft)	Dn (ft)	Comment
B-3-1 OUTLET	2.1895	0.7298	23.48	1.5615	1.5615	1.0815	SuperCrit flow, Inlet end controls
P-36	2.4597	0.9839	23.48	1.6500	1.6500	0.9750	SuperCrit flow, Inlet end controls
P-31	3.1655	1.5827	23.48	3.0641	1.7208	1.2532	SuperCrit flow, Inlet end controls
P-30	2.1250	1.4167	10.10	1.3133	1.2246	0.5557	SuperCrit flow, Inlet end controls

Node and Reach invert report

Node and Reach invert report				
Node	J-30		Out ie	1220.00 ft
	Reach	P-30	I.E. Out	1220.00 ft
Node	J-31		Out ie	1138.11 ft
	Reach	P-30	I.E. In	1140.00 ft
	Reach	P-31	I.E. Out	1138.11 ft
Node	J-37		Out ie	1134.71 ft
	Reach	P-31	I.E. In	1134.11 ft
	Reach	P-36	I.E. Out	1134.71 ft
Node	J-38		Out ie	1106.98 ft
	Reach	P-36	I.E. In	1112.53 ft
	Reach	B-3-1 OUTLET	I.E. Out	1106.98 ft

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Appended on: Wednesday, May 24, 2017 11:00:38 AM

ROUTEHYD [] THRU [B-3-1] USING [100 year] AND [TYPE1A.RAC] NOTZERO RELATIVE SCS/SBUH

Gravity Analysis using 24 hr duration storm

Reach ID	Area (ac)	Flow (cfs)	Full Q (cfs)	Full ratio	nDepth (ft)	Depth ratio	Size	nVel (ft/s)	fVel (ft/s)	Infil Vol (cf)	CBasin / Hyd
P-30	44.60	13.9779	34.5591	0.4045	0.6644	0.443	18 in Diam	18.5016	19.5564	0.00	B-3A
P-31	85.40	31.5179	32.7648	0.9619	1.575	0.7875	24 in Diam	11.8764	10.4293	0.00	B-3E
P-36	85.40	31.5179	71.7614	0.4392	1.1599	0.4639	30 in Diam	14.1383	14.6191	0.00	
B-3-1 OUTLET	85.40	31.5179	84.5004	0.373	1.2695	0.4232	36 in Diam	11.076	11.9544	0.00	

HGL Analysis

From Node	To Node	HG El (ft)	App (ft)	Bend (ft)	Junct Loss (ft)	Adjusted HG El (ft)	Max El (ft)
							1105.3366
No approach losses at node J-37 because inverts and/or crowns are offset.							
J-38	J-38A	1109.6148	------	0.0350	------	1109.6498	1118.3700
J-37	J-38	1137.7674	------	0.0078	------	1137.7752	1140.0000
No approach losses at node J-30 because inverts and/or crowns are offset.							
J-31	J-37	1142.6946	------	0.0082	------	1142.7028	1145.1800
J-30	J-31	1223.0725	------	------	------	1223.0725	1225.0000

Conduit Notes

Reach	HW Depth (ft)	HW/D ratio	Q (cfs)	TW Depth (ft)	Dc (ft)	Dn (ft)	Comment
B-3-1 OUTLET	2.6348	0.8783	31.52	1.8306	1.8306	1.2695	SuperCrit flow, Inlet end controls
P-36	3.0574	1.2230	31.52	1.9130	1.9130	1.1599	SuperCrit flow, Inlet end controls
P-31	4.5846	2.2923	31.52	3.6652	1.8836	1.5750	SuperCrit flow, Inlet end controls
P-30	3.0725	2.0484	13.98	2.7028	1.3809	0.6644	SuperCrit flow, Inlet end controls

Node and Reach invert report

Node and Reach invert report				
Node	J-30		Out ie	1220.00 ft
	Reach	P-30	I.E. Out	1220.00 ft
Node	J-31		Out ie	1138.11 ft
	Reach	P-30	I.E. In	1140.00 ft
	Reach	P-31	I.E. Out	1138.11 ft
Node	J-37		Out ie	1134.71 ft
	Reach	P-31	I.E. In	1134.11 ft
	Reach	P-36	I.E. Out	1134.71 ft
Node	J-38		Out ie	1106.98 ft
	Reach	P-36	I.E. In	1112.53 ft
	Reach	B-3-1 OUTLET	I.E. Out	1106.98 ft

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Appended on: Wednesday, May 24, 2017 11:03:16 AM

ROUTEHYD [] THRU [B-3-1] USING [E WA 3hr Depth] AND [EWash-3hr.rac] NOTZERO RELATIVE SCS/SBUH

Gravity Analysis using 3 hr duration storm

Reach ID	Area (ac)	Flow (cfs)	Full Q (cfs)	Full ratio	nDepth (ft)	Depth ratio	Size	nVel (ft/s)	fVel (ft/s)	Infil Vol (cf)	CBasin / Hyd
P-30	44.60	1.1987	34.5591	0.0347	0.1909	0.1273	18 in Diam	9.157	19.5564	0.00	FB-3A
P-31	85.40	3.1473	32.7648	0.0961	0.4189	0.2094	24 in Diam	6.5881	10.4293	0.00	FB-3E
P-36	85.40	3.1473	71.7614	0.0439	0.3568	0.1427	30 in Diam	7.3274	14.6191	0.00	
B-3-1 OUTLET	85.40	3.1473	84.5004	0.0372	0.3951	0.1317	36 in Diam	5.718	11.9544	0.00	

HGL Analysis

From Node	To Node	HG El (ft)	App (ft)	Bend (ft)	Junct Loss (ft)	Adjusted HG El (ft)	Max El (ft)
							1104.0589
No approach losses at node J-37 because inverts and/or crowns are offset.							
J-38	J-38A	1107.6848	------	0.0094	------	1107.6942	1118.3700
J-37	J-38	1135.4799	------	0.0034	------	1135.4833	1140.0000
No approach losses at node J-30 because inverts and/or crowns are offset.							
J-31	J-37	1138.9481	------	0.0110	------	1138.9591	1145.1800
J-30	J-31	1220.5188	------	------	------	1220.5188	1225.0000

Conduit Notes

Reach	HW Depth (ft)	HW/D ratio	Q (cfs)	TW Depth (ft)	Dc (ft)	Dn (ft)	Comment
B-3-1 OUTLET	0.7048	0.2349	3.15	0.5529	0.5529	0.3951	SuperCrit flow, Inlet end controls
P-36	0.7699	0.3080	3.15	0.5814	0.5814	0.3568	SuperCrit flow, Inlet end controls
P-31	0.8381	0.4190	3.15	1.3733	0.6198	0.4189	SuperCrit flow, Inlet end controls
P-30	0.5188	0.3459	1.20	0.4093	0.4093	0.1909	SuperCrit flow, Inlet end controls

Node and Reach invert report

Node and Reach invert report				
Node	J-30		Out ie	1220.00 ft
	Reach	P-30	I.E. Out	1220.00 ft
Node	J-31		Out ie	1138.11 ft
	Reach	P-30	I.E. In	1140.00 ft
	Reach	P-31	I.E. Out	1138.11 ft
Node	J-37		Out ie	1134.71 ft
	Reach	P-31	I.E. In	1134.11 ft
	Reach	P-36	I.E. Out	1134.71 ft
Node	J-38		Out ie	1106.98 ft
	Reach	P-36	I.E. In	1112.53 ft
	Reach	B-3-1 OUTLET	I.E. Out	1106.98 ft

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Appended on: Wednesday, May 24, 2017 11:04:30 AM

ROUTEHYD [] THRU [B-3-1] USING [WQS] AND [TYPE1A.RAC] NOTZERO RELATIVE SCS/SBUH

Gravity Analysis using 24 hr duration storm

Reach ID	Area (ac)	Flow (cfs)	Full Q (cfs)	Full ratio	nDepth (ft)	Depth ratio	Size	nVel (ft/s)	fVel (ft/s)	Infil Vol (cf)	CBasin / Hyd
P-30	44.60	0.6562	34.5591	0.019	0.1433	0.0955	18 in Diam	7.6311	19.5564	0.00	FB-3A
P-31	85.40	1.6226	32.7648	0.0495	0.3022	0.1511	24 in Diam	5.432	10.4293	0.00	FB-3E
P-36	85.40	1.6226	71.7614	0.0226	0.2598	0.1039	30 in Diam	6.0037	14.6191	0.00	
B-3-1 OUTLET	85.40	1.6226	84.5004	0.0192	0.2881	0.096	36 in Diam	4.6804	11.9544	0.00	

HGL Analysis

From Node	To Node	HG El (ft)	App (ft)	Bend (ft)	Junct Loss (ft)	Adjusted HG El (ft)	Max El (ft)
							1103.8995
No approach losses at node J-37 because inverts and/or crowns are offset.							
J-38	J-38A	1107.4694	------	0.0063	------	1107.4757	1118.3700
J-37	J-38	1135.2503	------	0.0023	------	1135.2526	1140.0000
No approach losses at node J-30 because inverts and/or crowns are offset.							
J-31	J-37	1138.6969	------	0.0076	------	1138.7045	1145.1800
J-30	J-31	1220.3675	------	------	------	1220.3675	1225.0000

Conduit Notes

Reach	HW Depth (ft)	HW/D ratio	Q (cfs)	TW Depth (ft)	Dc (ft)	Dn (ft)	Comment
B-3-1 OUTLET	0.4894	0.1631	1.62	0.3935	0.3935	0.2881	SuperCrit flow, Inlet end controls
P-36	0.5403	0.2161	1.62	0.4142	0.4142	0.2598	SuperCrit flow, Inlet end controls
P-31	0.5869	0.2934	1.62	1.1426	0.4411	0.3022	SuperCrit flow, Inlet end controls
P-30	0.3675	0.2450	0.66	0.3006	0.3006	0.1433	SuperCrit flow, Inlet end controls

Node and Reach invert report

Node and Reach invert report				
Node	J-30		Out ie	1220.00 ft
	Reach	P-30	I.E. Out	1220.00 ft
Node	J-31		Out ie	1138.11 ft
	Reach	P-30	I.E. In	1140.00 ft
	Reach	P-31	I.E. Out	1138.11 ft
Node	J-37		Out ie	1134.71 ft
	Reach	P-31	I.E. In	1134.11 ft
	Reach	P-36	I.E. Out	1134.71 ft
Node	J-38		Out ie	1106.98 ft
	Reach	P-36	I.E. In	1112.53 ft
	Reach	B-3-1 OUTLET	I.E. Out	1106.98 ft

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Appended on: Wednesday, May 24, 2017 11:05:20 AM

ROUTEHYD [] THRU [B-3-1] USING [2 yr 24 hr] AND [TYPE1A.RAC] NOTZERO RELATIVE SCS/SBUH

Gravity Analysis using 24 hr duration storm

Reach ID	Area (ac)	Flow (cfs)	Full Q (cfs)	Full ratio	nDepth (ft)	Depth ratio	Size	nVel (ft/s)	fVel (ft/s)	Infil Vol (cf)	CBasin / Hyd
P-30	44.60	2.9564	34.5591	0.0855	0.2963	0.1976	18 in Diam	11.9592	19.5564	0.00	FB-3A
P-31	85.40	6.4488	32.7648	0.1968	0.6017	0.3009	24 in Diam	8.1031	10.4293	0.00	FB-3E
P-36	85.40	6.4488	71.7614	0.0899	0.5063	0.2025	30 in Diam	9.0624	14.6191	0.00	
B-3-1 OUTLET	85.40	6.4488	84.5004	0.0763	0.5599	0.1866	36 in Diam	7.0765	11.9544	0.00	

HGL Analysis

From Node	To Node	HG El (ft)	App (ft)	Bend (ft)	Junct Loss (ft)	Adjusted HG El (ft)	Max El (ft)
							1104.3038
No approach losses at node J-37 because inverts and/or crowns are offset.							
J-38	J-38A	1108.0248	------	0.0144	------	1108.0392	1118.3700
J-37	J-38	1135.8475	------	0.0051	------	1135.8526	1140.0000
No approach losses at node J-30 because inverts and/or crowns are offset.							
J-31	J-37	1139.3625	------	0.0188	------	1139.3812	1145.1800
J-30	J-31	1220.8758	------	------	------	1220.8758	1225.0000

Conduit Notes

Reach	HW Depth (ft)	HW/D ratio	Q (cfs)	TW Depth (ft)	Dc (ft)	Dn (ft)	Comment
B-3-1 OUTLET	1.0448	0.3483	6.45	0.7978	0.7978	0.5599	SuperCrit flow, Inlet end controls
P-36	1.1375	0.4550	6.45	0.8415	0.8415	0.5063	SuperCrit flow, Inlet end controls
P-31	1.2525	0.6262	6.45	1.7426	0.8995	0.6017	SuperCrit flow, Inlet end controls
P-30	0.8758	0.5838	2.96	0.6534	0.6534	0.2963	SuperCrit flow, Inlet end controls

Node and Reach invert report

Node and Reach invert report				
Node	J-30		Out ie	1220.00 ft
	Reach	P-30	I.E. Out	1220.00 ft
Node	J-31		Out ie	1138.11 ft
	Reach	P-30	I.E. In	1140.00 ft
	Reach	P-31	I.E. Out	1138.11 ft
Node	J-37		Out ie	1134.71 ft
	Reach	P-31	I.E. In	1134.11 ft
	Reach	P-36	I.E. Out	1134.71 ft
Node	J-38		Out ie	1106.98 ft
	Reach	P-36	I.E. In	1112.53 ft
	Reach	B-3-1 OUTLET	I.E. Out	1106.98 ft

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Appended on: Wednesday, May 24, 2017 11:06:24 AM

ROUTEHYD [] THRU [B-3-1] USING [25 year] AND [TYPE1A.RAC] NOTZERO RELATIVE SCS/SBUH

Gravity Analysis using 24 hr duration storm

Reach ID	Area (ac)	Flow (cfs)	Full Q (cfs)	Full ratio	nDepth (ft)	Depth ratio	Size	nVel (ft/s)	fVel (ft/s)	Infil Vol (cf)	CBasin / Hyd
P-30	44.60	15.9483	34.5591	0.4615	0.716	0.4773	18 in Diam	19.1554	19.5564	0.00	FB-3A
P-31	85.40	32.5235	32.7648	0.9926	1.6266	0.8133	24 in Diam	11.8858	10.4293	0.00	FB-3E
P-36	85.40	32.5235	71.7614	0.4532	1.1807	0.4723	30 in Diam	14.2573	14.6191	0.00	
B-3-1 OUTLET	85.40	32.5235	84.5004	0.3849	1.2922	0.4307	36 in Diam	11.165	11.9544	0.00	

HGL Analysis

From Node	To Node	HG El (ft)	App (ft)	Bend (ft)	Junct Loss (ft)	Adjusted HG El (ft)	Max El (ft)
							1105.3594
No approach losses at node J-37 because inverts and/or crowns are offset.							
J-38	J-38A	1109.6692	------	0.0356	------	1109.7048	1118.3700
J-37	J-38	1137.8521	------	0.0083	------	1137.8605	1140.0000
No approach losses at node J-30 because inverts and/or crowns are offset.							
J-31	J-37	1142.9015	------	0.0107	------	1142.9121	1145.1800
J-30	J-31	1223.6711	------	------	------	1223.6711	1225.0000

Conduit Notes

Reach	HW Depth (ft)	HW/D ratio	Q (cfs)	TW Depth (ft)	Dc (ft)	Dn (ft)	Comment
B-3-1 OUTLET	2.6892	0.8964	32.52	1.8534	1.8534	1.2922	SuperCrit flow, Inlet end controls
P-36	3.1421	1.2569	32.52	1.9419	1.9419	1.1807	SuperCrit flow, Inlet end controls
P-31	4.7915	2.3957	32.52	3.7505	1.8957	1.6266	SuperCrit flow, Inlet end controls
P-30	3.6711	2.4474	15.95	2.9121	1.4238	0.7160	SuperCrit flow, Inlet end controls

Node and Reach invert report

Node and Reach invert report				
Node	J-30		Out ie	1220.00 ft
	Reach	P-30	I.E. Out	1220.00 ft
Node	J-31		Out ie	1138.11 ft
	Reach	P-30	I.E. In	1140.00 ft
	Reach	P-31	I.E. Out	1138.11 ft
Node	J-37		Out ie	1134.71 ft
	Reach	P-31	I.E. In	1134.11 ft
	Reach	P-36	I.E. Out	1134.71 ft
Node	J-38		Out ie	1106.98 ft
	Reach	P-36	I.E. In	1112.53 ft
	Reach	B-3-1 OUTLET	I.E. Out	1106.98 ft

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Appended on: Wednesday, May 24, 2017 11:07:14 AM

ROUTEHYD [] THRU [B-3-1] USING [100 year] AND [TYPE1A.RAC] NOTZERO RELATIVE SCS/SBUH

Gravity Analysis using 24 hr duration storm

Reach ID	Area (ac)	Flow (cfs)	Full Q (cfs)	Full ratio	nDepth (ft)	Depth ratio	Size	nVel (ft/s)	fVel (ft/s)	Infil Vol (cf)	CBasin / Hyd
P-30	44.60	20.6886	34.5591	0.5986	0.8366	0.5577	18 in Diam	20.4202	19.5564	0.00	FB-3A
P-31	85.40	41.9067	32.7648	1.279	-----	na	24 in Diam	13.3393	10.4293	0.00	FB-3E
P-36	85.40	41.9067	71.7614	0.584	1.3727	0.5491	30 in Diam	15.1799	14.6191	0.00	
B-3-1 OUTLET	85.40	41.9067	84.5004	0.4959	1.4931	0.4977	36 in Diam	11.9273	11.9544	0.00	

HGL Analysis

From Node	To Node	HG El (ft)	App (ft)	Bend (ft)	Junct Loss (ft)	Adjusted HG El (ft)	Max El (ft)
							1105.6155
No approach losses at node J-37 because inverts and/or crowns are offset.							
J-38	J-38A	1110.1734	------	0.0404	------	1110.2138	1118.3700
J-37	J-38	1138.7709	------	0.0139	------	1138.7848	1140.0000
No approach losses at node J-30 because inverts and/or crowns are offset.							
J-31	J-37	1148.6422	2.1283	0.0180	------	1145.2800	1145.1800
J-30	J-31	1225.4340	------	------	------	1225.1000	1225.0000

Conduit Notes

Reach	HW Depth (ft)	HW/D ratio	Q (cfs)	TW Depth (ft)	Dc (ft)	Dn (ft)	Comment
B-3-1 OUTLET	3.1934	1.0645	41.91	2.1095	2.1095	1.4931	SuperCrit flow, Inlet end controls
P-36	4.0609	1.6244	41.91	2.1688	2.1688	1.3727	SuperCrit flow, Inlet end controls
P-31	14.5322	7.2661	41.91	4.6748	1.9600	>D	Outlet Control
P-30	5.4340	3.6227	20.69	5.2800	1.4711	0.8366	SuperCrit flow, Inlet end controls

Node and Reach invert report

Node and Reach invert report				
Node	J-30		Out ie	1220.00 ft
	Reach	P-30	I.E. Out	1220.00 ft
Node	J-31		Out ie	1138.11 ft
	Reach	P-30	I.E. In	1140.00 ft
	Reach	P-31	I.E. Out	1138.11 ft
Node	J-37		Out ie	1134.71 ft
	Reach	P-31	I.E. In	1134.11 ft
	Reach	P-36	I.E. Out	1134.71 ft
Node	J-38		Out ie	1106.98 ft
	Reach	P-36	I.E. In	1112.53 ft
	Reach	B-3-1 OUTLET	I.E. Out	1106.98 ft

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APPENDIX B

COST ESTIMATE DETAIL

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PLANNING LEVEL CONSTRUCTION COST OPINION

PROJECT: **Harris Avenue - SR 150 - Pedoi Street** **CHECK BY:**

Project ID: **CIP 1-A**

BY: **LMC** **DATE:** **1/30/2018**

ITEM NO.	ITEM	QUANTITY	UNIT	UNIT PRICE	AMOUNT
Construction Elements					
1	Pavement Sawcut	1,760	LF	$ 2.00	$ 3,520
2	Catch Basin Type 1	12	EA	$ 1,800	$ 21,600
3	Manhole, 48 inch diam. Type 1	6	EA	$ 3,000.00	$ 18,000
4	Corr. Polyethylene Storm Sewer Pipe 12" dia.	144	LF	$ 38.00	$ 5,472
5	Corr. Polyethylene Storm Sewer Pipe 18" dia.	0	LF	$ 75.00	$ -
6	Corr. Polyethylene Storm Sewer Pipe 30" dia.	880	LF	$ 115.00	$ 101,200
7	Crushed Surfacing Base Course - Trench Repair	329	Ton	$ 22.00	$ 7,228
8	Crushed Surfacing Top Course - Trench Repair	79	Ton	$ 27.00	$ 2,138
9	HMA Cl. 1/2 PG 64-28 - Trench Repair	132	Ton	$ 85.00	$ 11,220
10	Pedoi Intertie/Lake Discharge	1	LS	$ 5,000	$ 5,000
11	Shoring or Extra Excavation Class B	1	LS	$ 1,000	$ 1,000
				Subtotal Construction Elements	$ 176,378
				2018 Cost Escalation + 5%	**$ 185,197**
Required Ancillary Items					
12	Construction Contingency		20%		$ 37,039
13	Dewatering	0	LS	$ 10,000	$ -
14	Erosion/Water Pollution Control		15%	(see note 3)	$ 27,780
15	Project Temporary Traffic Control		10%	(see note 4)	$ 18,520
16	Construction Surveying & Staking	1	LS	$ 10,000	$ 10,000
				Subtotal Ancillary	$ 93,339
				Subtotal Construction + Ancillary	**$ 278,536**
Mobilization					
17	Mobilization		10%		$ 27,854
				Subtotal Construction + Ancillary	**$ 306,389**
Tax/Engineering/Management/Permitting					
18	Sales Tax		8.2%	(see note 8)	$ 25,124
19	Engineering/Legal/Admin/Utility Coordination		25%	(see note 7)	$ 76,597
20	Construction Management		10%		$ 30,639
21	Permitting		3%		$ 9,192
22	Land and Right Of Way	0.00	acre	$ 60,000	$ -
				Subtotal	$ 141,552
				Subtotal Construction + Ancillary + Mobilization + Tax/Engineering/Management/Permitting	**$ 447,941**
2018 Dollars				**Total Planning Level Construction Cost Opinion (Rounded)**	**$ 448,000**

Notes:

1. The above cost opinion is in 2018 dollars and does not include future escalation, financing, or O&M costs.
2. The order-of-magnitude cost opinion has been prepared for guidance in project evaluation from the information available at the time of preparation and for the assumptions stated. The final costs of the project may be more or less.
3. Recommedned minimum is 5%. Increase percentage if work is in or immediately adjacent to flowing or standing water, steep slope, and/or other erosion-prone conditions.
4. Recommended minimum is 5%. Increase percentage if work is in or immediately adjacent to secondary, arterial, or other high-volume road or temporarily closes a roadway.
5. Pipe costs includes excavation and bedding.
6. Right of way acquisition is assumed to not be required.
7. Utility conflicts have not been researched.
8. If the work is subject to Wa. DOR Rule 171 sales taxes will be included in unit prices.

PLANNING LEVEL CONSTRUCTION COST OPINION

PROJECT: **Harris Avenue Treatment Facility** **CHECK BY:**

Project ID: **CIP 1-B**

BY: **LMC** **DATE:** **1/30/2018**

ITEM NO.	ITEM	QUANTITY	UNIT	UNIT PRICE	AMOUNT
Construction Elements					
1	Construct Biofiltration Swale	1	LS	$ 50,000	$ 50,000
2	Removal of Structures and Obstructions	1	LS	$ 5,000.00	$ 5,000
3	Manhole, 48 inch diam. Type 1	1	EA	$ 3,000.00	$ 3,000
4	Corr. Polyethylene Storm Sewer Pipe 30" dia.	40	LF	$ 115.00	$ 4,600
5	Shoring or Extra Excavation Class B	1	LS	$ 1,000	$ 1,000
			Subtotal Construction Elements		$ 63,600
			2018 Cost Escalation + 5%		**$ 66,780**
Required Ancillary Items					
6	Construction Contingency		20%		$ 12,720
7	Dewatering	0	LS	$ 10,000	$ -
8	Erosion/Water Pollution Control		15%	(see note 3)	$ 9,540
9	Project Temporary Traffic Control		10%	(see note 4)	$ 6,360
10	Construction Surveying & Staking	1	LS	$ 10,000	$ 10,000
				Subtotal Ancillary	$ 38,620
			Subtotal Construction + Ancillary		**$ 105,400**
Mobilization					
11	Mobilization		10%		$ 10,540
			Subtotal Construction + Ancillary		**$ 115,940**
Tax/Engineering/Management/Permitting					
12	Sales Tax		8.2%	(see note 8)	$ 9,507
13	Engineering/Legal/Admin/Utility Coordination		25%	(see note 7)	$ 28,985
14	Construction Management		10%		$ 11,594
15	Permitting		3%		$ 3,478
16	Land and Right Of Way	0.00	acre	$ 60,000	$ -
				Subtotal	$ 53,564
	Subtotal Construction + Ancillary + Mobilization + Tax/Engineering/Management/Permitting				**$ 169,504**
2018 Dollars	**Total Planning Level Construction Cost Opinion (Rounded)**				**$ 170,000**

Notes:

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2. The order-of-magnitude cost opinion has been prepared for guidance in project evaluation from the information available at the time of preparation and for the assumptions stated. The final costs of the project may be more or less.
3. Recommedned minimum is 5%. Increase percentage if work is in or immediately adjacent to flowing or standing water, steep slope, and/or other erosion-prone conditions.
4. Recommended minimum is 5%. Increase percentage if work is in or immediately adjacent to secondary, arterial, or other high-volume road or temporarily closes a roadway.
5. Pipe costs includes excavation and bedding.
6. Right of way acquisition is assumed to not be required.
7. Utility conflicts have not been researched.
8. If the work is subject to Wa. DOR Rule 171 sales taxes will be included in unit prices.

PLANNING LEVEL CONSTRUCTION COST OPINION

PROJECT: **McLaren Outfall Intertie** **CHECK BY:**

Project ID: **CIP 1-C**

BY: **LMC** **DATE:** **1/30/2018**

ITEM NO.	ITEM	QUANTITY	UNIT	UNIT PRICE	AMOUNT
Construction Elements					
1	Reconstructed Ditch with Check Dams & Quarry Spall Lining	0	LF	$ 17	$ -
2	Pavement Sawcut	850	LF	$ 2.00	$ 1,700
3	Catch Basin Type 1	6	EA	$ 1,800	$ 10,800
4	Manhole, 48 inch diam. Type 1	3	EA	$ 3,000.00	$ 9,000
5	Corr. Polyethylene Storm Sewer Pipe 12" dia.	0	LF	$ 38.00	$ -
6	Corr. Polyethylene Storm Sewer Pipe 18" dia.	350	LF	$ 75.00	$ 26,250
7	Corr. Polyethylene Storm Sewer Pipe 30" dia.	0	LF	$ 115.00	$ -
8	Crushed Surfacing Base Course - Trench Repair	159	Ton	$ 22.00	$ 3,491
9	Crushed Surfacing Top Course - Trench Repair	38	Ton	$ 27.00	$ 1,033
10	HMA Cl. 1/2 PG 64-28 - Trench Repair	64	Ton	$ 85.00	$ 5,419
11	Shoring or Extra Excavation Class B	1	LS	$ 1,000	$ 1,000
				Subtotal Construction Elements	$ 58,692
				2018 Cost Escalation + 5%	**$ 61,627**
Required Ancillary Items					
12	Construction Contingency		20%		$ 11,738
13	Dewatering	0	LS	$ 10,000	$ -
14	Erosion/Water Pollution Control		15%	(see note 3)	$ 8,804
15	Project Temporary Traffic Control		10%	(see note 4)	$ 5,869
16	Construction Surveying & Staking	1	LS	$ 10,000	$ 10,000
				Subtotal Ancillary	$ 36,411
				Subtotal Construction + Ancillary	**$ 98,038**
Mobilization					
17	Mobilization		10%		$ 9,804
				Subtotal Construction + Ancillary	**$ 107,842**
Tax/Engineering/Management/Permitting					
18	Sales Tax		8.2%	(see note 8)	$ 8,843
19	Engineering/Legal/Admin/Utility Coordination		25%	(see note 7)	$ 26,961
20	Construction Management		10%		$ 10,784
21	Permitting		3%		$ 3,235
22	Land and Right Of Way	0.00	acre	$ 60,000	$ -
				Subtotal	$ 49,823
				Subtotal Construction + Ancillary + Mobilization + Tax/Engineering/Management/Permitting	**$ 157,665**
2018 Dollars				**Total Planning Level Construction Cost Opinion (Rounded)**	**$ 158,000**

Notes:

1. The above cost opinion is in 2018 dollars and does not include future escalation, financing, or O&M costs.
2. The order-of-magnitude cost opinion has been prepared for guidance in project evaluation from the information available at the time of preparation and for the assumptions stated. The final costs of the project may be more or less.
3. Recommedned minimum is 5%. Increase percentage if work is in or immediately adjacent to flowing or standing water, steep slope, and/or other erosion-prone conditions.
4. Recommended minimum is 5%. Increase percentage if work is in or immediately adjacent to secondary, arterial, or other high-volume road or temporarily closes a roadway.
5. Pipe costs includes excavation and bedding.
6. Right of way acquisition is assumed to not be required.
7. Utility conflicts have not been researched.
8. If the work is subject to Wa. DOR Rule 171 sales taxes will be included in unit prices.

PLANNING LEVEL CONSTRUCTION COST OPINION

PROJECT: **Manson Boulevard Treatment Facility** **CHECK BY:**

Project ID: **CIP 1-D**

BY: **LMC** **DATE:** **1/30/2018**

ITEM NO.	ITEM	QUANTITY	UNIT	UNIT PRICE	AMOUNT
Construction Elements					
1	Stormwater Treatment Vault	1	LS	$ 90,000	$ 90,000
2	Removal of Structures and Obstructions	1	LS	$ 4,000	$ 4,000
3	Manhole, 48 inch diam. Type 1	1	EA	$ 3,000	$ 3,000
4	Overflow Structure	1	EA	$ 4,000	$ 4,000
5	Corr. Polyethylene Storm Sewer Pipe 42" dia.	20	LF	$ 115.00	$ 2,300
6	Roadway Repair	1	LS	$ 8,000.00	$ 8,000
7	Shoring or Extra Excavation Class B	1	LS	$ 1,000	$ 1,000
				Subtotal Construction Elements	$ 112,300
				2018 Cost Escalation + 5%	**$ 117,915**
Required Ancillary Items					
8	Construction Contingency		20%		$ 22,460
9	Dewatering	0	LS	$ 10,000	$ -
10	Erosion/Water Pollution Control		15%	(see note 3)	$ 16,845
11	Project Temporary Traffic Control		10%	(see note 4)	$ 11,230
12	Construction Surveying & Staking	1	LS	$ 10,000	$ 10,000
				Subtotal Ancillary	$ 60,535
				Subtotal Construction + Ancillary	**$ 178,450**
Mobilization					
13	Mobilization		10%		$ 17,845
				Subtotal Construction + Ancillary	**$ 196,295**
Tax/Engineering/Management/Permitting					
14	Sales Tax		8.2%	(see note 8)	$ 16,096
15	Engineering/Legal/Admin/Utility Coordination		25%	(see note 7)	$ 49,074
16	Construction Management		10%		$ 19,630
17	Permitting		3%		$ 5,889
18	Land and Right Of Way	0.00	acre	$ 60,000	$ -
				Subtotal	$ 90,688
				Subtotal Construction + Ancillary + Mobilization + Tax/Engineering/Management/Permitting	**$ 286,983**
2018 Dollars				**Total Planning Level Construction Cost Opinion (Rounded)**	**$ 287,000**

Notes:

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2. The order-of-magnitude cost opinion has been prepared for guidance in project evaluation from the information available at the time of preparation and for the assumptions stated. The final costs of the project may be more or less.
3. Recommedned minimum is 5%. Increase percentage if work is in or immediately adjacent to flowing or standing water, steep slope, and/or other erosion-prone conditions.
4. Recommended minimum is 5%. Increase percentage if work is in or immediately adjacent to secondary, arterial, or other high-volume road or temporarily closes a roadway.
5. Pipe costs includes excavation and bedding.
6. Right of way acquisition is assumed to not be required.
7. Utility conflicts have not been researched.
8. If the work is subject to Wa. DOR Rule 171 sales taxes will be included in unit prices.

PLANNING LEVEL CONSTRUCTION COST OPINION

PROJECT: **Totem Pole Road - Green Basin - SR 150** **CHECK BY:**

Project ID: **CIP 1-E**

BY: **LMC** **DATE:** **1/30/2018**

ITEM NO.	ITEM	QUANTITY	UNIT	UNIT PRICE	AMOUNT
Construction Elements					
1	Pavement Sawcut	1,470	LF	$ 2.00	$ 2,940
2	Catch Basin Type 1	6	EA	$ 1,800	$ 10,800
3	Manhole, 48 inch diam. Type 1	3	EA	$ 3,000.00	$ 9,000
4	Corr. Polyethylene Storm Sewer Pipe 12" dia.	75	LF	$ 38.00	$ 2,850
5	Corr. Polyethylene Storm Sewer Pipe 18" dia.	0	LF	$ 75.00	$ -
6	Corr. Polyethylene Storm Sewer Pipe 30" dia.	660	LF	$ 115.00	$ 75,900
7	Crushed Surfacing Base Course - Trench Repair	274	Ton	$ 22.00	$ 6,037
8	Crushed Surfacing Top Course - Trench Repair	66	Ton	$ 27.00	$ 1,786
9	HMA Cl. 1/2 PG 64-28 - Trench Repair	110	Ton	$ 85.00	$ 9,371
10	SR150 Intertie	1	LS	$ 10,000	$ 10,000
11	Shoring or Extra Excavation Class B	1	LS	$ 1,000	$ 1,000
				Subtotal Construction Elements	$ 129,684
				2018 Cost Escalation + 5%	**$ 136,168**
Required Ancillary Items					
12	Construction Contingency		20%		$ 25,937
13	Dewatering	0	LS	$ 10,000	$ -
14	Erosion/Water Pollution Control		10%	(see note 3)	$ 12,968
15	Project Temporary Traffic Control		20%	(see note 4)	$ 25,937
16	Construction Surveying & Staking	1	LS	$ 10,000	$ 10,000
				Subtotal Ancillary	$ 74,842
				Subtotal Construction + Ancillary	**$ 211,010**
Mobilization					
17	Mobilization		10%		$ 21,101
				Subtotal Construction + Ancillary	**$ 232,111**
Tax/Engineering/Management/Permitting					
18	Sales Tax		8.2%	(see note 8)	$ 19,033
19	Engineering/Legal/Admin/Utility Coordination		25%	(see note 7)	$ 58,028
20	Construction Management		10%		$ 23,211
21	Permitting		3%		$ 6,963
22	Land and Right Of Way	0.00	acre	$ 60,000	$ -
				Subtotal	$ 107,235
				Subtotal Construction + Ancillary + Mobilization + Tax/Engineering/Management/Permitting	**$ 339,347**
2018 Dollars				**Total Planning Level Construction Cost Opinion (Rounded)**	**$ 340,000**

Notes:

1. The above cost opinion is in 2018 dollars and does not include future escalation, financing, or O&M costs.
2. The order-of-magnitude cost opinion has been prepared for guidance in project evaluation from the information available at the time of preparation and for the assumptions stated. The final costs of the project may be more or less.
3. Recommedned minimum is 5%. Increase percentage if work is in or immediately adjacent to flowing or standing water, steep slope, and/or other erosion-prone conditions.
4. Recommended minimum is 5%. Increase percentage if work is in or immediately adjacent to secondary, arterial, or other high-volume road or temporarily closes a roadway.
5. Pipe costs includes excavation and bedding.
6. Right of way acquisition is assumed to not be required.
7. Utility conflicts have not been researched.
8. If the work is subject to Wa. DOR Rule 171 sales taxes will be included in unit prices.

PLANNING LEVEL CONSTRUCTION COST OPINION

PROJECT: **Green Avenue - Totem Pole to Housing Authority Ditch** **CHECK BY:**

Project ID: **CIP 1-F**

BY: **LMC** **DATE:** **1/30/2018**

ITEM NO.	ITEM	QUANTITY	UNIT	UNIT PRICE	AMOUNT
Construction Elements					
1	Reconstructed Ditch with Check Dams & Quarry Spall Lining	2,200	LF	$ 17	$ 37,400
2	Pavement Sawcut	800	LF	$ 2.00	$ 1,600
3	Catch Basin Type 1	4	EA	$ 1,800	$ 7,200
4	Manhole, 48 inch diam. Type 1	2	EA	$ 3,000.00	$ 6,000
5	Corr. Polyethylene Storm Sewer Pipe 12" dia.	48	LF	$ 38.00	$ 1,824
6	Corr. Polyethylene Storm Sewer Pipe 18" dia.	400	LF	$ 75.00	$ 30,000
7	Crushed Surfacing Base Course - Trench Repair	149	Ton	$ 22.00	$ 3,285
8	Crushed Surfacing Top Course - Trench Repair	36	Ton	$ 27.00	$ 972
9	HMA Cl. 1/2 PG 64-28 - Trench Repair	60	Ton	$ 85.00	$ 5,100
10	Shoring or Extra Excavation Class B	1	LS	$ 1,000	$ 1,000
				Subtotal Construction Elements	$ 94,381
				2018 Cost Escalation + 5%	**$ 99,100**
Required Ancillary Items					
11	Construction Contingency		20%		$ 18,876
12	Dewatering	0	LS	$ 10,000	$ -
13	Erosion/Water Pollution Control		15%	(see note 3)	$ 14,157
14	Project Temporary Traffic Control		10%	(see note 4)	$ 9,438
15	Construction Surveying & Staking	1	LS	$ 10,000	$ 10,000
				Subtotal Ancillary	$ 52,472
				Subtotal Construction + Ancillary	**$ 151,572**
Mobilization					
16	Mobilization		10%		$ 15,157
				Subtotal Construction + Ancillary	**$ 166,729**
Tax/Engineering/Management/Permitting					
17	Sales Tax		8.2%	(see note 8)	$ 13,672
18	Engineering/Legal/Admin/Utility Coordination		25%	(see note 7)	$ 41,682
19	Construction Management		10%		$ 16,673
20	Permitting		3%		$ 5,002
21	Land and Right Of Way	0.00	acre	$ 60,000	$ -
				Subtotal	$ 77,029
				Subtotal Construction + Ancillary + Mobilization + Tax/Engineering/Management/Permitting	**$ 243,758**
2018 Dollars				**Total Planning Level Construction Cost Opinion (Rounded)**	**$ 244,000**

Notes:

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2. The order-of-magnitude cost opinion has been prepared for guidance in project evaluation from the information available at the time of preparation and for the assumptions stated. The final costs of the project may be more or less.
3. Recommedned minimum is 5%. Increase percentage if work is in or immediately adjacent to flowing or standing water, steep slope, and/or other erosion-prone conditions.
4. Recommended minimum is 5%. Increase percentage if work is in or immediately adjacent to secondary, arterial, or other high-volume road or temporarily closes a roadway.
5. Pipe costs includes excavation and bedding.
6. Right of way acquisition is assumed to not be required.
7. Utility conflicts have not been researched.
8. If the work is subject to Wa. DOR Rule 171 sales taxes will be included in unit prices.

PLANNING LEVEL CONSTRUCTION COST OPINION

PROJECT: **Totem Pole Road - Hill Street - Green Avenue** **CHECK BY:**

Project ID: **CIP 1-G**

BY: **LMC** **DATE:** **1/30/2018**

ITEM NO.	ITEM	QUANTITY	UNIT	UNIT PRICE	AMOUNT
Construction Elements					
1	Reconstructed Ditch with Check Dams & Quarry Spall Lining	2,700	LF	$ 17	$ 45,900
2	Pavement Sawcut	600	LF	$ 2.00	$ 1,200
3	Corr. Polyethylene Culvert Pipe 12" dia.	130	LF	$ 42.00	$ 5,460
4	Corr. Polyethylene Culvert Pipe 18" dia.	180	LF	$ 75.00	$ 13,500
5	Corr. Polyethylene Culvert Pipe 24" dia.	300	LF	$ 95.00	$ 28,500
6	Flared End Section 12 In. Diam	4	EA	$ 200.00	$ 800
7	Flared End Section 18 In. Diam	8	EA	$ 250.00	$ 2,000
8	Flared End Section 24 In. Diam	6	EA	$ 300.00	$ 1,800
9	Attenuation Basin - Furey	1	LS	$ 20,000.00	$ 20,000
10	Attenuation Basin - Green/Totem intersection	1	LS	$ 25,000.00	$ 25,000
11	Crushed Surfacing Base Course - Trench Repair	84	Ton	$ 22.00	$ 1,848
12	Crushed Surfacing Top Course - Trench Repair	20	Ton	$ 27.00	$ 547
13	HMA Cl. 1/2 PG 64-28 - Trench Repair	34	Ton	$ 85.00	$ 2,869
14	Shoring or Extra Excavation Class B	1	LS	$ 1,000	$ 1,000
15	Groundwater Drain System	1	LS	$ 8,000	$ 8,000
				Subtotal Construction Elements	$ 158,424
				2018 Cost Escalation + 5%	**$ 166,345**
Required Ancillary Items					
16	Construction Contingency		20%		$ 31,685
17	Dewatering	0	LS	$ 10,000	$ -
18	Erosion/Water Pollution Control		5%	(see note 3)	$ 7,921
19	Project Temporary Traffic Control		10%	(see note 4)	$ 15,842
20	Construction Surveying & Staking	1	LS	$ 5,000	$ 5,000
				Subtotal Ancillary	$ 60,448
				Subtotal Construction + Ancillary	**$ 226,793**
Mobilization					
21	Mobilization		10%		$ 22,679
				Subtotal Construction + Ancillary+ Mobilization	**$ 249,472**
Tax/Engineering/Management/Permitting					
22	Sales Tax		8.2%	(see note 8)	$ 20,457
23	Engineering/Legal/Admin/Utility Coordination		15%	(see note 7)	$ 37,421
24	Construction Management		10%		$ 24,947
25	Permitting		3%		$ 7,484
26	Land and Right Of Way	0.00	acre	$ 60,000	$ -
				Subtotal	$ 90,309
				Subtotal Construction + Ancillary + Mobilization + Tax/Engineering/Management/Permitting	**$ 339,781**
2018 Dollars				**Total Planning Level Construction Cost Opinion (Rounded)**	**$ 340,000**

Notes:

1. The above cost opinion is in 2018 dollars and does not include future escalation, financing, or O&M costs.
2. The order-of-magnitude cost opinion has been prepared for guidance in project evaluation from the information available at the time of preparation and for the assumptions stated. The final costs of the project may be more or less.
3. Recommedned minimum is 5%. Increase percentage if work is in or immediately adjacent to flowing or standing water, steep slope, and/or other erosion-prone conditions.
4. Recommended minimum is 5%. Increase percentage if work is in or immediately adjacent to secondary, arterial, or other high-volume road or temporarily closes a roadway.
5. Pipe costs includes excavation and bedding.
6. Right of way acquisition is assumed to not be required.
7. Utility conflicts have not been researched.
8. If the work is subject to Wa. DOR Rule 171 sales taxes will be included in unit prices.

PLANNING LEVEL CONSTRUCTION COST OPINION

PROJECT: **Green Avenue - Coral/Terrace Intersection - Wells Avenue, Coral Stub** **CHECK BY:**

Project ID: **CIP 1-H**

BY: **LMC** **DATE:** **1/30/2018**

ITEM NO.	ITEM	QUANTITY	UNIT	UNIT PRICE	AMOUNT
Construction Elements					
1	Reconstructed Ditch with Check Dams & Quarry Spall Lining	970	LF	$ 17	$ 16,490
2	Pavement Sawcut	330	LF	$ 2.00	$ 660
3	Catch Basin Type 1	6	EA	$ 1,800	$ 10,800
4	Manhole, 48 inch diam. Type 1	3	EA	$ 3,000.00	$ 9,000
3	Corr. Polyethylene Culvert Pipe 12" dia.	165	LF	$ 42.00	$ 6,930
4	Corr. Polyethylene Culvert Pipe 18" dia.	150	LF	$ 75.00	$ 11,250
5	Corr. Polyethylene Culvert Pipe 24" dia.	0	LF	$ 95.00	$ -
6	Flared End Section 12 In. Diam	0	EA	$ 200.00	$ -
7	Flared End Section 18 In. Diam	8	EA	$ 250.00	$ 2,000
8	Flared End Section 24 In. Diam	0	EA	$ 300.00	$ -
9	Attenuation Basin - Coral/Terrace	1	LS	$ 20,000.00	$ 20,000
10	Crushed Surfacing Base Course - Trench Repair	130	Ton	$ 22.00	$ 2,864
11	Crushed Surfacing Top Course - Trench Repair	31	Ton	$ 27.00	$ 847
12	HMA Cl. 1/2 PG 64-28 - Trench Repair	52	Ton	$ 85.00	$ 4,447
13	Shoring or Extra Excavation Class B	1	LS	$ 1,000	$ 1,000
14	Groundwater Drain System	0	LS	$ 8,000	$ -
				Subtotal Construction Elements	$ 86,288
				2018 Cost Escalation + 5%	**$ 90,603**
Required Ancillary Items					
15	Construction Contingency		20%		$ 17,258
16	Dewatering	0	LS	$ 10,000	$ -
17	Erosion/Water Pollution Control		5%	(see note 3)	$ 4,314
18	Project Temporary Traffic Control		10%	(see note 4)	$ 8,629
19	Construction Surveying & Staking	1	LS	$ 2,000	$ 2,000
				Subtotal Ancillary	$ 32,201
				Subtotal Construction + Ancillary	**$ 122,804**
Mobilization					
20	Mobilization		10%		$ 12,280
				Subtotal Construction + Ancillary+ Mobilization	**$ 135,084**
Tax/Engineering/Management/Permitting					
21	Sales Tax		8.2%	(see note 8)	$ 11,077
22	Engineering/Legal/Admin/Utility Coordination		15%	(see note 7)	$ 20,263
23	Construction Management		10%		$ 13,508
24	Permitting		3%		$ 4,053
25	Land and Right Of Way	0.00	acre	$ 60,000	$ -
				Subtotal	$ 48,900
				Subtotal Construction + Ancillary + Mobilization + Tax/Engineering/Management/Permitting	**$ 183,985**
2018 Dollars				**Total Planning Level Construction Cost Opinion (Rounded)**	**$ 184,000**

Notes:

1. The above cost opinion is in 2018 dollars and does not include future escalation, financing, or O&M costs.
2. The order-of-magnitude cost opinion has been prepared for guidance in project evaluation from the information available at the time of preparation and for the assumptions stated. The final costs of the project may be more or less.
3. Recommedned minimum is 5%. Increase percentage if work is in or immediately adjacent to flowing or standing water, steep slope, and/or other erosion-prone conditions.
4. Recommended minimum is 5%. Increase percentage if work is in or immediately adjacent to secondary, arterial, or other high-volume road or temporarily closes a roadway.
5. Pipe costs includes excavation and bedding.
6. Right of way acquisition is assumed to not be required.
7. Utility conflicts have not been researched.
8. If the work is subject to Wa. DOR Rule 171 sales taxes will be included in unit prices.

PLANNING LEVEL CONSTRUCTION COST OPINION

PROJECT: **Lakeshore Drive - Division to Quatis Basin** **CHECK BY:**

Project ID: **CIP 1-I**

BY: **LMC** **DATE:** **1/30/2018**

ITEM NO.	ITEM	QUANTITY	UNIT	UNIT PRICE	AMOUNT
Construction Elements					
1	Reconstructed Ditch with Check Dams & Quarry Spall Lining	1,570	LF	$ 17	$ 26,690
2	Pavement Sawcut	50	LF	$ 2.00	$ 100
3	Corr. Polyethylene Culvert Pipe 12" dia.	200	LF	$ 42.00	$ 8,400
4	Corr. Polyethylene Culvert Pipe 18" dia.	140	LF	$ 75.00	$ 10,500
5	Corr. Polyethylene Culvert Pipe 24" dia.	0	LF	$ 95.00	$ -
6	Flared End Section 12 In. Diam	0	EA	$ 200.00	$ -
7	Flared End Section 18 In. Diam	6	EA	$ 250.00	$ 1,500
8	Flared End Section 24 In. Diam	0	EA	$ 300.00	$ -
9	Attenuation Basin - Quatis Woods	1	LS	$ 40,000.00	$ 40,000
10	Crushed Surfacing Base Course - Trench Repair	25	Ton	$ 22.00	$ 554
11	Crushed Surfacing Top Course - Trench Repair	6	Ton	$ 27.00	$ 164
12	HMA Cl. 1/2 PG 64-28 - Trench Repair	10	Ton	$ 85.00	$ 861
13	Shoring or Extra Excavation Class B	1	LS	$ 1,000	$ 1,000
14	Groundwater Drain System	0	LS	$ 8,000	$ -
				Subtotal Construction Elements	$ 89,769
				2018 Cost Escalation + 5%	**$ 94,258**
Required Ancillary Items					
15	Construction Contingency		20%		$ 17,954
16	Dewatering	0	LS	$ 10,000	$ -
17	Erosion/Water Pollution Control		5%	(see note 3)	$ 4,488
18	Project Temporary Traffic Control		10%	(see note 4)	$ 8,977
19	Construction Surveying & Staking	1	LS	$ 5,000	$ 5,000
				Subtotal Ancillary	$ 36,419
				Subtotal Construction + Ancillary	**$ 130,677**
Mobilization					
20	Mobilization		10%		$ 13,068
				Subtotal Construction + Ancillary+ Mobilization	**$ 143,744**
Tax/Engineering/Management/Permitting					
21	Sales Tax		8.2%	(see note 8)	$ 11,787
22	Engineering/Legal/Admin/Utility Coordination		20%	(see note 7)	$ 28,749
23	Construction Management		20%		$ 28,749
24	Permitting		3%		$ 4,312
25	Land and Right Of Way	0.35	acre	$ 100,000	$ 35,000
				Subtotal	$ 108,597
				Subtotal Construction + Ancillary + Mobilization + Tax/Engineering/Management/Permitting	**$ 252,341**
2018 Dollars				**Total Planning Level Construction Cost Opinion (Rounded)**	**$ 253,000**

Notes:

1. The above cost opinion is in 2018 dollars and does not include future escalation, financing, or O&M costs.
2. The order-of-magnitude cost opinion has been prepared for guidance in project evaluation from the information available at the time of preparation and for the assumptions stated. The final costs of the project may be more or less.
3. Recommedned minimum is 5%. Increase percentage if work is in or immediately adjacent to flowing or standing water, steep slope, and/or other erosion-prone conditions.
4. Recommended minimum is 5%. Increase percentage if work is in or immediately adjacent to secondary, arterial, or other high-volume road or temporarily closes a roadway.
5. Pipe costs includes excavation and bedding.
6. Right of way acquisition is assumed to not be required.
7. Utility conflicts have not been researched.
8. If the work is subject to Wa. DOR Rule 171 sales taxes will be included in unit prices.

PLANNING LEVEL CONSTRUCTION COST OPINION

PROJECT: **Green Avenue - Boetzke - SR150 - Inlets** **CHECK BY:**

Project ID: **CIP 1-J**

BY: **LMC** **DATE:** **1/30/2018**

ITEM NO.	ITEM	QUANTITY	UNIT	UNIT PRICE	AMOUNT
Construction Elements					
1	Pavement Sawcut	220	LF	$ 2.00	$ 440
2	Catch Basin Type 1	3	EA	$ 1,800	$ 5,400
3	Manhole, 48 inch diam. Type 1	0	EA	$ 3,000.00	$ -
4	Corr. Polyethylene Storm Sewer Pipe 12" dia.	0	LF	$ 38.00	$ -
5	Corr. Polyethylene Storm Sewer Pipe 18" dia.	0	LF	$ 75.00	$ -
6	Corr. Polyethylene Storm Sewer Pipe 24" dia.	0	LF	$ 95.00	$ -
7	Crushed Surfacing Base Course - Trench Repair	62	Ton	$ 22.00	$ 1,355
8	Crushed Surfacing Top Course - Trench Repair	15	Ton	$ 27.00	$ 401
9	HMA Cl. 1/2 PG 64-28 - Trench Repair	25	Ton	$ 85.00	$ 2,104
10	SR150 Intertie	1	LS	$ 10,000	$ 10,000
11	Shoring or Extra Excavation Class B	1	LS	$ 1,000	$ 1,000
				Subtotal Construction Elements	$ 20,700
				2018 Cost Escalation + 5%	**$ 21,735**
Required Ancillary Items					
12	Construction Contingency		20%		$ 4,140
13	Dewatering	0	LS	$ 10,000	$ -
14	Erosion/Water Pollution Control		10%	(see note 3)	$ 2,070
15	Project Temporary Traffic Control		20%	(see note 4)	$ 4,140
16	Construction Surveying & Staking	1	LS	$ 2,000	$ 2,000
				Subtotal Ancillary	$ 12,350
				Subtotal Construction + Ancillary	**$ 34,085**
Mobilization					
17	Mobilization		10%		$ 3,408
				Subtotal Construction + Ancillary	**$ 37,493**
Tax/Engineering/Management/Permitting					
18	Sales Tax		8.2%	(see note 8)	$ 3,074
19	Engineering/Legal/Admin/Utility Coordination		25%	(see note 7)	$ 9,373
20	Construction Management		10%		$ 3,749
21	Permitting		3%		$ 1,125
22	Land and Right Of Way	0.00	acre	$ 60,000	$ -
				Subtotal	$ 17,322
				Subtotal Construction + Ancillary + Mobilization + Tax/Engineering/Management/Permitting	**$ 54,815**
2018 Dollars				**Total Planning Level Construction Cost Opinion (Rounded)**	**$ 55,000**

Notes:

1. The above cost opinion is in 2018 dollars and does not include future escalation, financing, or O&M costs.
2. The order-of-magnitude cost opinion has been prepared for guidance in project evaluation from the information available at the time of preparation and for the assumptions stated. The final costs of the project may be more or less.
3. Recommedned minimum is 5%. Increase percentage if work is in or immediately adjacent to flowing or standing water, steep slope, and/or other erosion-prone conditions.
4. Recommended minimum is 5%. Increase percentage if work is in or immediately adjacent to secondary, arterial, or other high-volume road or temporarily closes a roadway.
5. Pipe costs includes excavation and bedding.
6. Right of way acquisition is assumed to not be required.
7. Utility conflicts have not been researched.
8. If the work is subject to Wa. DOR Rule 171 sales taxes will be included in unit prices.

PLANNING LEVEL CONSTRUCTION COST OPINION

PROJECT: **Quatis Street & Wapato Way** **CHECK BY:**

Project ID: **CIP 1-K**

BY: **LMC** **DATE:** **1/30/2018**

ITEM NO.	ITEM	QUANTITY	UNIT	UNIT PRICE	AMOUNT
Construction Elements					
1	Pavement Sawcut	3,100	LF	$ 2.00	$ 6,200
2	Catch Basin Type 1	12	EA	$ 1,800	$ 21,600
3	Manhole, 48 inch diam. Type 1	5	EA	$ 3,000.00	$ 15,000
4	Corr. Polyethylene Storm Sewer Pipe 12" dia.	144	LF	$ 38.00	$ 5,472
5	Corr. Polyethylene Storm Sewer Pipe 18" dia.	1,600	LF	$ 75.00	$ 120,000
6	Corr. Polyethylene Storm Sewer Pipe 24" dia.	0	LF	$ 75.00	$ -
7	Crushed Surfacing Base Course - Trench Repair	488	Ton	$ 22.00	$ 10,743
8	Crushed Surfacing Top Course - Trench Repair	118	Ton	$ 27.00	$ 3,178
9	HMA Cl. 1/2 PG 64-28 - Trench Repair	196	Ton	$ 85.00	$ 16,677
10	SR150 Intertie	1	LS	$ 10,000	$ 10,000
11	Shoring or Extra Excavation Class B	1	LS	$ 1,000	$ 1,000
12	Water quality treatment - bioinfiltration or drywell	1	LS	$ 50,000	$ 50,000
				Subtotal Construction Elements	$ 259,870
				2018 Cost Escalation + 5%	**$ 272,864**
Required Ancillary Items					
13	Construction Contingency		20%		$ 51,974
14	Dewatering	0	LS	$ 10,000	$ -
15	Erosion/Water Pollution Control		10%	(see note 3)	$ 25,987
16	Project Temporary Traffic Control		10%	(see note 4)	$ 25,987
17	Construction Surveying & Staking	1	LS	$ 5,000	$ 5,000
				Subtotal Ancillary	$ 108,948
				Subtotal Construction + Ancillary	**$ 381,812**
Mobilization					
18	Mobilization		10%		$ 38,181
				Subtotal Construction + Ancillary	**$ 419,993**
Tax/Engineering/Management/Permitting					
19	Sales Tax		8.2%	(see note 8)	$ 34,439
20	Engineering/Legal/Admin/Utility Coordination		25%	(see note 7)	$ 104,998
21	Construction Management		10%		$ 41,999
22	Permitting		3%		$ 12,600
23	Land and Right Of Way	0.00	acre	$ 60,000	$ -
				Subtotal	$ 194,037
				Subtotal Construction + Ancillary + Mobilization + Tax/Engineering/Management/Permitting	**$ 614,030**
2018 Dollars				**Total Planning Level Construction Cost Opinion (Rounded)**	**$ 615,000**

Notes:

1. The above cost opinion is in 2018 dollars and does not include future escalation, financing, or O&M costs.
2. The order-of-magnitude cost opinion has been prepared for guidance in project evaluation from the information available at the time of preparation and for the assumptions stated. The final costs of the project may be more or less.
3. Recommedned minimum is 5%. Increase percentage if work is in or immediately adjacent to flowing or standing water, steep slope, and/or other erosion-prone conditions.
4. Recommended minimum is 5%. Increase percentage if work is in or immediately adjacent to secondary, arterial, or other high-volume road or temporarily closes a roadway.
5. Pipe costs includes excavation and bedding.
6. Right of way acquisition is assumed to not be required.
7. Utility conflicts have not been researched.
8. If the work is subject to Wa. DOR Rule 171 sales taxes will be included in unit prices.

PLANNING LEVEL CONSTRUCTION COST OPINION

PROJECT: **Division Street - Totem Pole Intersection** **CHECK BY:**

Project ID: **CIP 1-L**

BY: **LMC** **DATE:** **1/30/2018**

ITEM NO.	ITEM	QUANTITY	UNIT	UNIT PRICE	AMOUNT
Construction Elements					
1	Reconstructed Ditch with Check Dams & Quarry Spall Lining	700	LF	$ 17	$ 11,900
2	Pavement Sawcut	60	LF	$ 2.00	$ 120
3	Corr. Polyethylene Culvert Pipe 12" dia.	180	LF	$ 42.00	$ 7,560
4	Corr. Polyethylene Culvert Pipe 18" dia.	0	LF	$ 75.00	$ -
5	Corr. Polyethylene Culvert Pipe 24" dia.	0	LF	$ 95.00	$ -
6	Flared End Section 12 In. Diam	4	EA	$ 200.00	$ 800
7	Flared End Section 18 In. Diam	0	EA	$ 250.00	$ -
8	Flared End Section 24 In. Diam	0	EA	$ 300.00	$ -
9	Crushed Surfacing Base Course - Trench Repair	8	Ton	$ 22.00	$ 185
10	Crushed Surfacing Top Course - Trench Repair	2	Ton	$ 27.00	$ 55
11	HMA Cl. 1/2 PG 64-28 - Trench Repair	3	Ton	$ 85.00	$ 287
12	Shoring or Extra Excavation Class B	1	LS	$ 1,000	$ 1,000
				Subtotal Construction Elements	$ 21,906
				2018 Cost Escalation + 5%	**$ 23,002**
Required Ancillary Items					
13	Construction Contingency		20%		$ 4,381
14	Dewatering	0	LS	$ 10,000	$ -
15	Erosion/Water Pollution Control		5%	(see note 3)	$ 1,095
16	Project Temporary Traffic Control		15%	(see note 4)	$ 3,286
17	Construction Surveying & Staking	1	LS	$ 2,000	$ 2,000
				Subtotal Ancillary	$ 10,763
				Subtotal Construction + Ancillary	**$ 33,764**
Mobilization					
18	Mobilization		10%		$ 3,376
				Subtotal Construction + Ancillary+ Mobilization	**$ 37,141**
Tax/Engineering/Management/Permitting					
19	Sales Tax		8.2%	(see note 8)	$ 3,046
20	Engineering/Legal/Admin/Utility Coordination		15%	(see note 7)	$ 5,571
21	Construction Management		10%		$ 3,714
22	Permitting		3%		$ 1,114
23	Land and Right Of Way	0.00	acre	$ 60,000	$ -
				Subtotal	$ 13,445
				Subtotal Construction + Ancillary + Mobilization + Tax/Engineering/Management/Permitting	**$ 50,586**
2018 Dollars				**Total Planning Level Construction Cost Opinion (Rounded)**	**$ 51,000**

Notes:

1. The above cost opinion is in 2018 dollars and does not include future escalation, financing, or O&M costs.
2. The order-of-magnitude cost opinion has been prepared for guidance in project evaluation from the information available at the time of preparation and for the assumptions stated. The final costs of the project may be more or less.
3. Recommedned minimum is 5%. Increase percentage if work is in or immediately adjacent to flowing or standing water, steep slope, and/or other erosion-prone conditions.
4. Recommended minimum is 5%. Increase percentage if work is in or immediately adjacent to secondary, arterial, or other high-volume road or temporarily closes a roadway.
5. Pipe costs includes excavation and bedding.
6. Right of way acquisition is assumed to not be required.
7. Utility conflicts have not been researched.
8. If the work is subject to Wa. DOR Rule 171 sales taxes will be included in unit prices.

PLANNING LEVEL CONSTRUCTION COST OPINION

PROJECT: **Totem Pole Road- Green Avenue - Olive Avenue** **CHECK BY:** **KN of PACE Engineers**

Project ID: **CIP 2-A**

BY: **LMC of PACE Engineers** **DATE:** **1/30/2018**

ITEM NO.	ITEM	QUANTITY	UNIT	UNIT PRICE	AMOUNT
Construction Elements					
1	Pavement Sawcut	2,640	LF	$ 2.00	$ 5,280
2	Roadway Excavation Incl. Haul	470	CY	$ 12.00	$ 5,640
3	Removal of Structures and Obstruction	1	LS	$ 10,000	$ 10,000
4	Cement Conc. Traffic Curb and Gutter	0	LF	$ 22.00	$ -
5	Cement Conc. Traffic Curb	0	LF	$ 15.00	$ -
6	Crushed Surfacing Base Course	610	Ton	$ 22.00	$ 13,420
7	Crushed Surfacing Top Course	160	Ton	$ 27.00	$ 4,320
8	HMA Cl. 1/2 PG 64-28	230	Ton	$ 85.00	$ 19,550
9	Paint Line - Fog Line	0	LF	$ 3.00	$ -
10	Painted Stop Line	0	LF	$ 6.00	$ -
11	Painted Crosswalk Line	0	LF	$ 8.00	$ -
12	Cement Concrete Sidewalks	0	SY	$ 60.00	$ -
13	Cement Concrete Curb Ramp Type Parallel A	0	EA	$ 2,000	$ -
14	Cement Concrete Driveway Entrance - Type 2	0	SY	$ 60.00	$ -
15	Catch Basin Type 1	14	EA	$ 1,800	$ 25,200
16	Manhole, 48 inch diam. Type 1	8	EA	$ 3,000.00	$ 24,000
17	Corr. Polyethylene Culvert Pipe 18" dia.	0	LF	$ 75.00	$ -
18	Flared End Section 18 In. Diam	0	EA	$ 150.00	$ -
19	Corr. Polyethylene Storm Sewer Pipe 12" dia.	168	LF	$ 42.00	$ 7,056
19	Corr. Polyethylene Storm Sewer Pipe18" dia.	0	LF	$ 75.00	$ -
20	**Corr. Polyethylene Storm Sewer Pipe 24" dia.**	1,300	LF	$ 95.00	$ 123,500
21	Crushed Surfacing Base Course - Trench Repair	0	Ton	$ 22.00	$ -
22	Crushed Surfacing Top Course - Trench Repair	0	Ton	$ 27.00	$ -
23	HMA Cl. 1/2 PG 64-28 - Trench Repair	0	Ton	$ 130.00	$ -
24	Structure Excavation Class B, incl. haul	160	CY	$ 8.00	$ 1,280
25	Shoring or Extra Excavation Class B	1	LS	$ 5,000	$ 5,000
26	Attenuation Basin - Furey	1	LS	$ 20,000.00	$ 20,000
27	Attenuation Basin - Green/Totem intersection	1	LS	$ 25,000.00	$ 25,000
28	Groundwater Drain System	1	LS	$ 8,000	$ 8,000
29	Reconstructed Ditch with Check Dams & Quarry Spall Lining	1,300	LF	$ 17	$ 22,100
				Subtotal Construction Elements	$ 319,346
				2018 Cost Escalation + 5%	**$ 335,313**
Required Ancillary Items					
30	Construction Contingency		20%		$ 63,869
31	Dewatering	0	LS	$ 10,000	$ -
32	Erosion/Water Pollution Control		15%	(see note 3)	$ 47,902
33	Project Temporary Traffic Control		10%	(see note 4)	$ 31,935
34	Construction Surveying & Staking	1	LS	$ 10,000	$ 10,000
				Subtotal Ancillary	$ 153,706
				Subtotal Construction + Ancillary	**$ 489,019**
Mobilization					
35	Mobilization		10%		$ 48,902
				Subtotal Construction + Ancillary	**$ 537,921**
Tax/Engineering/Management/Permitting					
36	Sales Tax		8.2%	(see note 8)	$ 44,110
37	Engineering/Legal/Admin/Utility Coordination		25%	(see note 7)	$ 134,480
38	Construction Management		20%		$ 107,584
39	Permitting		3%		$ 16,138
40	Land and Right Of Way	0.25	acre	$ 60,000	$ 15,152
				Subtotal	$ 317,463
				Subtotal Construction + Ancillary + Mobilization + Tax/Engineering/Management/Permitting	**$ 855,384**
2018 Dollars				**Total Planning Level Construction Cost Opinion (Rounded)**	**$ 856,000**

Notes:

1. The above cost opinion is in 2018 Dollars and does not include future escalation, financing, or O&M costs.
2. The order-of-magnitude cost opinion has been prepared for guidance in project evaluation from the information available at the time of preparation and for the assumptions stated. The final costs of the project may be more or less.
3. Recommedned minimum is 5%. Increase percentage if work is in or immediately adjacent to flowing or standing water, steep slope, and/or other erosion-prone conditions.
4. Recommended minimum is 5%. Increase percentage if work is in or immediately adjacent to secondary, arterial, or other high-volume road or temporarily closes a roadway.
5. Pipe costs includes excavation and bedding.
6. Right of way acquisition is assumed to not be required.
7. Utility conflicts have not been researched.
8. If the work is subject to Wa. DOR Rule 171 sales taxes will be included in unit prices.

PLANNING LEVEL CONSTRUCTION COST OPINION

PROJECT: **Lakeshore Drive - Chase to Totem Pole** **CHECK BY:**

Project ID: **CIP 2-B**

BY: **LMC** **DATE:** **1/30/2018**

ITEM NO.	ITEM	QUANTITY	UNIT	UNIT PRICE	AMOUNT
Construction Elements					
1	Reconstructed Ditch with Check Dams & Quarry Spall Lining	2,400	LF	$ 17	$ 40,800
2	Pavement Sawcut	2,400	LF	$ 2.00	$ 4,800
3	Catch Basin Type 1	10	EA	$ 1,800	$ 18,000
4	Manhole, 48 inch diam. Type 1	5	EA	$ 3,000.00	$ 15,000
5	Corr. Polyethylene Storm Sewer Pipe 12" dia.	240	LF	$ 38.00	$ 9,120
6	Corr. Polyethylene Storm Sewer Pipe 18" dia.	1,200	LF	$ 75.00	$ 90,000
7	Corr. Polyethylene Storm Sewer Pipe 30" dia.	0	LF	$ 115.00	$ -
8	Crushed Surfacing Base Course - Trench Repair	448	Ton	$ 22.00	$ 9,856
9	Crushed Surfacing Top Course - Trench Repair	108	Ton	$ 27.00	$ 2,916
10	HMA Cl. 1/2 PG 64-28 - Trench Repair	180	Ton	$ 85.00	$ 15,300
11	Shoring or Extra Excavation Class B	1	LS	$ 1,000	$ 1,000
				Subtotal Construction Elements	$ 206,792
				2018 Cost Escalation + 5%	**$ 217,132**
Required Ancillary Items					
12	Construction Contingency		20%		$ 41,358
13	Dewatering	0	LS	$ 10,000	$ -
14	Erosion/Water Pollution Control		15%	(see note 3)	$ 31,019
15	Project Temporary Traffic Control		10%	(see note 4)	$ 20,679
16	Construction Surveying & Staking	1	LS	$ 10,000	$ 10,000
				Subtotal Ancillary	$ 103,056
				Subtotal Construction + Ancillary	**$ 320,188**
Mobilization					
17	Mobilization		10%		$ 32,019
				Subtotal Construction + Ancillary	**$ 352,207**
Tax/Engineering/Management/Permitting					
18	Sales Tax		8.2%	(see note 8)	$ 28,881
19	Engineering/Legal/Admin/Utility Coordination		25%	(see note 7)	$ 88,052
20	Construction Management		10%		$ 35,221
21	Permitting		3%		$ 10,566
22	Land and Right Of Way	0.00	acre	$ 60,000	$ -
				Subtotal	$ 162,720
				Subtotal Construction + Ancillary + Mobilization + Tax/Engineering/Management/Permitting	**$ 514,926**
2018 Dollars				**Total Planning Level Construction Cost Opinion (Rounded)**	**$ 515,000**

Notes:

1. The above cost opinion is in 2018 Dollars and does not include future escalation, financing, or O&M costs.
2. The order-of-magnitude cost opinion has been prepared for guidance in project evaluation from the information available at the time of preparation and for the assumptions stated. The final costs of the project may be more or less.
3. Recommedned minimum is 5%. Increase percentage if work is in or immediately adjacent to flowing or standing water, steep slope, and/or other erosion-prone conditions.
4. Recommended minimum is 5%. Increase percentage if work is in or immediately adjacent to secondary, arterial, or other high-volume road or temporarily closes a roadway.
5. Pipe costs includes excavation and bedding.
6. Right of way acquisition is assumed to not be required.
7. Utility conflicts have not been researched.
8. If the work is subject to Wa. DOR Rule 171 sales taxes will be included in unit prices.

PLANNING LEVEL CONSTRUCTION COST OPINION

PROJECT: **Totem Pole Road- Olive Avenue to Hill Street** **CHECK BY:**

Project ID: **CIP 2-C**

BY: **LMC** **DATE:** **1/30/2018**

ITEM NO.	ITEM	QUANTITY	UNIT	UNIT PRICE	AMOUNT
Construction Elements					
1	Reconstructed Ditch with Check Dams & Quarry Spall Lining	3,400	LF	$ 17	$ 57,800
2	Pavement Sawcut	3,400	LF	$ 2.00	$ 6,800
3	Catch Basin Type 1	20	EA	$ 1,800	$ 36,000
4	Manhole, 48 inch diam. Type 1	10	EA	$ 3,000.00	$ 30,000
5	Corr. Polyethylene Storm Sewer Pipe 12" dia.	240	LF	$ 38.00	$ 9,120
6	Corr. Polyethylene Storm Sewer Pipe 18" dia.	1,700	LF	$ 75.00	$ 127,500
7	Corr. Polyethylene Storm Sewer Pipe 30" dia.	0	LF	$ 115.00	$ -
8	Crushed Surfacing Base Course - Trench Repair	821	Ton	$ 22.00	$ 18,069
9	Crushed Surfacing Top Course - Trench Repair	198	Ton	$ 27.00	$ 5,346
10	HMA Cl. 1/2 PG 64-28 - Trench Repair	330	Ton	$ 85.00	$ 28,050
11	Shoring or Extra Excavation Class B	1	LS	$ 1,000	$ 1,000
				Subtotal Construction Elements	$ 319,685
				2018 Cost Escalation + 5%	**$ 335,670**
Required Ancillary Items					
12	Construction Contingency		20%		$ 63,937
13	Dewatering	0	LS	$ 10,000	$ -
14	Erosion/Water Pollution Control		15%	(see note 3)	$ 47,953
15	Project Temporary Traffic Control		10%	(see note 4)	$ 31,969
16	Construction Surveying & Staking	1	LS	$ 10,000	$ 10,000
				Subtotal Ancillary	$ 153,858
				Subtotal Construction + Ancillary	**$ 489,528**
Mobilization					
17	Mobilization		10%		$ 48,953
				Subtotal Construction + Ancillary	**$ 538,481**
Tax/Engineering/Management/Permitting					
18	Sales Tax		8.2%	(see note 8)	$ 44,155
19	Engineering/Legal/Admin/Utility Coordination		25%	(see note 7)	$ 134,620
20	Construction Management		10%		$ 53,848
21	Permitting		3%		$ 16,154
22	Land and Right Of Way	0.00	acre	$ 60,000	$ -
				Subtotal	$ 248,778
				Subtotal Construction + Ancillary + Mobilization + Tax/Engineering/Management/Permitting	**$ 787,259**
2018 Dollars				**Total Planning Level Construction Cost Opinion (Rounded)**	**$ 788,000**

Notes:

1. The above cost opinion is in 2018 Dollars and does not include future escalation, financing, or O&M costs.
2. The order-of-magnitude cost opinion has been prepared for guidance in project evaluation from the information available at the time of preparation and for the assumptions stated. The final costs of the project may be more or less.
3. Recommedned minimum is 5%. Increase percentage if work is in or immediately adjacent to flowing or standing water, steep slope, and/or other erosion-prone conditions.
4. Recommended minimum is 5%. Increase percentage if work is in or immediately adjacent to secondary, arterial, or other high-volume road or temporarily closes a roadway.
5. Pipe costs includes excavation and bedding.
6. Right of way acquisition is assumed to not be required.
7. Utility conflicts have not been researched.
8. If the work is subject to Wa. DOR Rule 171 sales taxes will be included in unit prices.

PLANNING LEVEL CONSTRUCTION COST OPINION

PROJECT: Q'soon Street - SR150 - Green Avenue **CHECK BY:** KN of PACE Engineers

Project ID: CIP 2-D

BY: LMC of PACE Engineers **DATE:** 1/30/2018

ITEM NO.	ITEM	QUANTITY	UNIT	UNIT PRICE	AMOUNT
Construction Elements					
1	Pavement Sawcut	3,000	LF	$ 2.00	$ 6,000
2	Roadway Excavation Incl. Haul	0	CY	$ 12.00	$ -
3	Removal of Structures and Obstruction	1	LS	$ 10,000	$ 10,000
4	Cement Conc. Traffic Curb and Gutter	0	LF	$ 22.00	$ -
5	Cement Conc. Traffic Curb	0	LF	$ 15.00	$ -
6	Crushed Surfacing Base Course	0	Ton	$ 22.00	$ -
7	Crushed Surfacing Top Course	0	Ton	$ 27.00	$ -
8	HMA Cl. 1/2 PG 64-28	0	Ton	$ 85.00	$ -
9	Paint Line - Fog Line	0	LF	$ 3.00	$ -
10	Painted Stop Line	0	LF	$ 6.00	$ -
11	Painted Crosswalk Line	0	LF	$ 8.00	$ -
12	Cement Concrete Sidewalks	0	SY	$ 60.00	$ -
13	Cement Concrete Curb Ramp Type Parallel A	0	EA	$ 2,000	$ -
14	Cement Concrete Driveway Entrance - Type 2	0	SY	$ 60.00	$ -
15	Catch Basin Type 1	15	EA	$ 1,800	$ 27,000
16	Manhole, 48 inch diam. Type 1	6	EA	$ 3,000.00	$ 18,000
17	Corr. Polyethylene Culvert Pipe 18" dia.	0	LF	$ 75.00	$ -
18	Flared End Section 18 In. Diam	0	EA	$ 150.00	$ -
19	Corr. Polyethylene Storm Sewer Pipe 12" dia.	125	LF	$ 42.00	$ 5,250
19	Corr. Polyethylene Storm Sewer Pipe18" dia.	1,500	LF	$ 75.00	$ 112,500
20	Corr. Polyethylene Storm Sewer Pipe 24" dia.	0	LF	$ 95.00	$ -
21	Crushed Surfacing Base Course - Trench Repair	350	Ton	$ 22.00	$ 7,700
22	Crushed Surfacing Top Course - Trench Repair	90	Ton	$ 27.00	$ 2,430
23	HMA Cl. 1/2 PG 64-28 - Trench Repair	130	Ton	$ 130.00	$ 16,900
24	Structure Excavation Class B, incl. haul	120	CY	$ 8.00	$ 960
25	Shoring or Extra Excavation Class B	1	LS	$ 1,000	$ 1,000
26	Groundwater Drain System	0	LS	$ 8,000	$ -
27	Reconstructed Ditch with Check Dams & Quarry Spall Lining	0	LF	$ 17	$ -
				Subtotal Construction Elements	$ 207,740
				2018 Cost Escalation + 5%	**$ 218,127**
Required Ancillary Items					
28	Construction Contingency		20%		$ 41,548
29	Dewatering	0	LS	$ 10,000	$ -
30	Erosion/Water Pollution Control		5%	(see note 3)	$ 10,387
31	Project Temporary Traffic Control		10%	(see note 4)	$ 20,774
32	Construction Surveying & Staking	1	LS	$ 8,000	$ 8,000
				Subtotal Ancillary	$ 80,709
				Subtotal Construction + Ancillary	**$ 298,836**
Mobilization					
33	Mobilization		10%		$ 29,884
				Subtotal Construction + Ancillary	**$ 328,720**
Tax/Engineering/Management/Permitting					
34	Sales Tax		8.2%	(see note 8)	$ 26,955
35	Engineering/Legal/Admin/Utility Coordination		25%	(see note 7)	$ 82,180
36	Construction Management		20%		$ 65,744
37	Permitting		3%		$ 9,862
38	Land and Right Of Way	0.00	acre	$ 60,000	$ -
				Subtotal	$ 184,740
				Subtotal Construction + Ancillary + Mobilization + Tax/Engineering/Management/Permitting	**$ 513,460**
2018 Dollars				**Total Planning Level Construction Cost Opinion (Rounded)**	**$ 514,000**

Notes:

1. The above cost opinion is in 2018 Dollars and does not include future escalation, financing, or O&M costs.
2. The order-of-magnitude cost opinion has been prepared for guidance in project evaluation from the information available at the time of preparation and for the assumptions stated. The final costs of the project may be more or less.
3. Recommedned minimum is 5%. Increase percentage if work is in or immediately adjacent to flowing or standing water, steep slope, and/or other erosion-prone conditions.
4. Recommended minimum is 5%. Increase percentage if work is in or immediately adjacent to secondary, arterial, or other high-volume road or temporarily closes a roadway.
5. Pipe costs includes excavation and bedding.
6. Right of way acquisition is assumed to not be required.
7. Utility conflicts have not been researched.
8. If the work is subject to Wa. DOR Rule 171 sales taxes will be included in unit prices.

PLANNING LEVEL CONSTRUCTION COST OPINION

PROJECT: Green Avenue - Q'soon Street - Coral/Terrace **CHECK BY:**

Project ID: CIP 2-E

BY: LMC of PACE Engineers **DATE:** 1/30/2018

ITEM NO.	ITEM	QUANTITY	UNIT	UNIT PRICE	AMOUNT
Construction Elements					
1	Pavement Sawcut	840	LF	$ 2.00	$ 1,680
2	Roadway Excavation Incl. Haul	0	CY	$ 12.00	$ -
3	Removal of Structures and Obstruction	1	LS	$ 10,000	$ 10,000
4	Cement Conc. Traffic Curb and Gutter	0	LF	$ 22.00	$ -
5	Cement Conc. Traffic Curb	0	LF	$ 15.00	$ -
6	Crushed Surfacing Base Course	230	Ton	$ 22.00	$ 5,060
7	Crushed Surfacing Top Course	60	Ton	$ 27.00	$ 1,620
8	HMA Cl. 1/2 PG 64-28	0	Ton	$ 85.00	$ -
9	Paint Line - Fog Line	0	LF	$ 3.00	$ -
10	Painted Stop Line	0	LF	$ 6.00	$ -
11	Painted Crosswalk Line	0	LF	$ 8.00	$ -
12	Cement Concrete Sidewalks	0	SY	$ 60.00	$ -
13	Cement Concrete Curb Ramp Type Parallel A	0	EA	$ 2,000	$ -
14	Cement Concrete Driveway Entrance - Type 2	0	SY	$ 60.00	$ -
15	Catch Basin Type 1	6	EA	$ 1,800	$ 10,800
16	Manhole, 48 inch diam. Type 1	3	EA	$ 3,000.00	$ 9,000
17	Corr. Polyethylene Culvert Pipe 18" dia.	0	LF	$ 75.00	$ -
18	Flared End Section 18 In. Diam	0	EA	$ 150.00	$ -
19	Corr. Polyethylene Storm Sewer Pipe 12" dia.	75	LF	$ 42.00	$ 3,150
19	Corr. Polyethylene Storm Sewer Pipe18" dia.	420	LF	$ 75.00	$ 31,500
20	Corr. Polyethylene Storm Sewer Pipe 24" dia.	0	LF	$ 95.00	$ -
21	Crushed Surfacing Base Course - Trench Repair	230	Ton	$ 22.00	$ 5,060
22	Crushed Surfacing Top Course - Trench Repair	60	Ton	$ 27.00	$ 1,620
23	HMA Cl. 1/2 PG 64-28 - Trench Repair	90	Ton	$ 130.00	$ 11,700
24	Structure Excavation Class B, incl. haul	70	CY	$ 8.00	$ 560
25	Shoring or Extra Excavation Class B	1	LS	$ 1,000	$ 1,000
26	Attenuation Basin - Furey	0	LS	$ 20,000.00	$ -
27	Attenuation Basin - Green/Totem intersection	0	LS	$ 25,000.00	$ -
28	Groundwater Drain System	0	LS	$ 8,000	$ -
29	Reconstructed Ditch with Check Dams & Quarry Spall Lining	0	LF	$ 17	$ -
				Subtotal Construction Elements	$ 92,750
				2018 Cost Escalation + 5%	**$ 97,388**
Required Ancillary Items					
30	Construction Contingency		20%		$ 18,550
31	Dewatering	0	LS	$ 10,000	$ -
32	Erosion/Water Pollution Control		5%	(see note 3)	$ 4,638
33	Project Temporary Traffic Control		10%	(see note 4)	$ 9,275
34	Construction Surveying & Staking	1	LS	$ 8,000	$ 8,000
				Subtotal Ancillary	$ 40,463
				Subtotal Construction + Ancillary	**$ 137,850**
Mobilization					
35	Mobilization		10%		$ 13,785
				Subtotal Construction + Ancillary	**$ 151,635**
Tax/Engineering/Management/Permitting					
36	Sales Tax		0.0%	(see note 8)	$ -
37	Engineering/Legal/Admin/Utility Coordination		25%	(see note 7)	$ 37,909
38	Construction Management		20%		$ 30,327
39	Permitting		3%		$ 4,549
40	Land and Right Of Way	0.00	acre	$ 60,000	$ -
				Subtotal	$ 72,785
				Subtotal Construction + Ancillary + Mobilization + Tax/Engineering/Management/Permitting	**$ 224,420**
2018 Dollars				**Total Planning Level Construction Cost Opinion (Rounded)**	**$ 225,000**

Notes:

1. The above cost opinion is in 2018 Dollars and does not include future escalation, financing, or O&M costs.
2. The order-of-magnitude cost opinion has been prepared for guidance in project evaluation from the information available at the time of preparation and for the assumptions stated. The final costs of the project may be more or less.
3. Recommedned minimum is 5%. Increase percentage if work is in or immediately adjacent to flowing or standing water, steep slope, and/or other erosion-prone conditions.
4. Recommended minimum is 5%. Increase percentage if work is in or immediately adjacent to secondary, arterial, or other high-volume road or temporarily closes a roadway.
5. Pipe costs includes excavation and bedding.
6. Right of way acquisition is assumed to not be required.
7. Utility conflicts have not been researched.
8. If the work is subject to Wa. DOR Rule 171 sales taxes will be included in unit prices.

PLANNING LEVEL CONSTRUCTION COST OPINION

PROJECT: **Quetilquasoon Outfall Treatment** **CHECK BY:**

Project ID: **CIP 3-A**

BY: **LMC** **DATE:** **1/30/2018**

ITEM NO.	ITEM	QUANTITY	UNIT	UNIT PRICE	AMOUNT
Construction Elements					
1	Construct Biofiltration Swale	1	LS	$ 50,000	$ 50,000
2	Removal of Structures and Obstructions	1	LS	$ 5,000.00	$ 5,000
3	Manhole, 48 inch diam. Type 1	1	EA	$ 3,000.00	$ 3,000
4	Corr. Polyethylene Storm Sewer Pipe 30" dia.	25	LF	$ 115.00	$ 2,875
5	Shoring or Extra Excavation Class B	1	LS	$ 1,000	$ 1,000
			Subtotal Construction Elements		$ 61,875
			2018 Cost Escalation + 5%		**$ 64,969**
Required Ancillary Items					
6	Construction Contingency		20%		$ 12,375
7	Dewatering	0	LS	$ 10,000	$ -
8	Erosion/Water Pollution Control		15%	(see note 3)	$ 9,281
9	Project Temporary Traffic Control		10%	(see note 4)	$ 6,188
10	Construction Surveying & Staking	1	LS	$ 10,000	$ 10,000
				Subtotal Ancillary	$ 37,844
			Subtotal Construction + Ancillary		**$ 102,813**
Mobilization					
11	Mobilization		10%		$ 10,281
			Subtotal Construction + Ancillary		**$ 113,094**
Tax/Engineering/Management/Permitting					
12	Sales Tax		8.2%	(see note 8)	$ 9,274
13	Engineering/Legal/Admin/Utility Coordination		25%	(see note 7)	$ 28,273
14	Construction Management		10%		$ 11,309
15	Permitting		3%		$ 3,393
16	Land and Right Of Way	0.00	acre	$ 60,000	$ -
				Subtotal	$ 52,249
	Subtotal Construction + Ancillary + Mobilization + Tax/Engineering/Management/Permitting				**$ 165,343**
2018 Dollars	**Total Planning Level Construction Cost Opinion (Rounded)**				**$ 166,000**

Notes:

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2. The order-of-magnitude cost opinion has been prepared for guidance in project evaluation from the information available at the time of preparation and for the assumptions stated. The final costs of the project may be more or less.
3. Recommedned minimum is 5%. Increase percentage if work is in or immediately adjacent to flowing or standing water, steep slope, and/or other erosion-prone conditions.
4. Recommended minimum is 5%. Increase percentage if work is in or immediately adjacent to secondary, arterial, or other high-volume road or temporarily closes a roadway.
5. Pipe costs includes excavation and bedding.
6. Right of way acquisition is assumed to not be required.
7. Utility conflicts have not been researched.
8. If the work is subject to Wa. DOR Rule 171 sales taxes will be included in unit prices.

PLANNING LEVEL CONSTRUCTION COST OPINION

PROJECT: Green Avenue - H. A. Ditch to Q'soon **CHECK BY:**

Project ID: CIP 3-B

BY: LMC **DATE:** 1/30/2018

ITEM NO.	ITEM	QUANTITY	UNIT	UNIT PRICE	AMOUNT
Construction Elements					
1	Pavement Sawcut	1,300	LF	$ 2.00	$ 2,600
2	Catch Basin Type 1	6	EA	$ 1,800	$ 10,800
3	Manhole, 48 inch diam. Type 1	3	EA	$ 3,000.00	$ 9,000
4	Corr. Polyethylene Storm Sewer Pipe 12" dia.	722	LF	$ 38.00	$ 27,436
5	Corr. Polyethylene Storm Sewer Pipe 18" dia.	0	LF	$ 75.00	$ -
6	Corr. Polyethylene Storm Sewer Pipe 30" dia.	0	LF	$ 115.00	$ -
7	Crushed Surfacing Base Course - Trench Repair	243	Ton	$ 22.00	$ 5,339
8	Crushed Surfacing Top Course - Trench Repair	59	Ton	$ 27.00	$ 1,580
9	HMA Cl. 1/2 PG 64-28 - Trench Repair	98	Ton	$ 85.00	$ 8,288
10	Shoring or Extra Excavation Class B	1	LS	$ 1,000	$ 1,000
				Subtotal Construction Elements	$ 66,042
				2018 Cost Escalation + 5%	**$ 69,344**
Required Ancillary Items					
11	Construction Contingency		20%		$ 13,208
12	Dewatering	0	LS	$ 10,000	$ -
13	Erosion/Water Pollution Control		15%	(see note 3)	$ 9,906
14	Project Temporary Traffic Control		10%	(see note 4)	$ 6,604
15	Construction Surveying & Staking	1	LS	$ 10,000	$ 10,000
				Subtotal Ancillary	$ 39,719
				Subtotal Construction + Ancillary	**$ 109,063**
Mobilization					
16	Mobilization		10%		$ 10,906
				Subtotal Construction + Ancillary	**$ 119,969**
Tax/Engineering/Management/Permitting					
17	Sales Tax		0.0%	(see note 8)	$ -
18	Engineering/Legal/Admin/Utility Coordination		25%	(see note 7)	$ 29,992
19	Construction Management		10%		$ 11,997
20	Permitting		3%		$ 3,599
21	Land and Right Of Way	0.00	acre	$ 60,000	$ -
				Subtotal	$ 45,588
	Subtotal Construction + Ancillary + Mobilization + Tax/Engineering/Management/Permitting				**$ 165,557**
2018 Dollars	**Total Planning Level Construction Cost Opinion (Rounded)**				**$ 166,000**

Notes:

1. The above cost opinion is in 2018 Dollars and does not include future escalation, financing, or O&M costs.
2. The order-of-magnitude cost opinion has been prepared for guidance in project evaluation from the information available at the time of preparation and for the assumptions stated. The final costs of the project may be more or less.
3. Recommedned minimum is 5%. Increase percentage if work is in or immediately adjacent to flowing or standing water, steep slope, and/or other erosion-prone conditions.
4. Recommended minimum is 5%. Increase percentage if work is in or immediately adjacent to secondary, arterial, or other high-volume road or temporarily closes a roadway.
5. Pipe costs includes excavation and bedding.
6. Right of way acquisition is assumed to not be required.
7. Utility conflicts have not been researched.
8. If the work is subject to Wa. DOR Rule 171 sales taxes will be included in unit prices.

PLANNING LEVEL CONSTRUCTION COST OPINION

PROJECT: **Green Avenue- SR150 - Boetzke** **CHECK BY:**

Project ID: **CIP 3-C**

BY: **LMC of PACE Engineers** **DATE:** **1/30/2018**

ITEM NO.	ITEM	QUANTITY	UNIT	UNIT PRICE	AMOUNT
Construction Elements					
1	Pavement Sawcut	60	LF	$ 2.00	$ 120
2	Roadway Excavation Incl. Haul	590	CY	$ 12.00	$ 7,080
3	Removal of Structures and Obstruction	1	LS	$ 10,000	$ 10,000
4	Cement Conc. Traffic Curb and Gutter	1,060	LF	$ 22.00	$ 23,320
5	Cement Conc. Traffic Curb	0	LF	$ 15.00	$ -
6	Crushed Surfacing Base Course	760	Ton	$ 22.00	$ 16,720
7	Crushed Surfacing Top Course	190	Ton	$ 27.00	$ 5,130
8	HMA Cl. 1/2 PG 64-28	290	Ton	$ 85.00	$ 24,650
9	Paint Line - Fog Line	0	LF	$ 3.00	$ -
10	Painted Stop Line	0	LF	$ 6.00	$ -
11	Painted Crosswalk Line	112	LF	$ 8.00	$ 896
12	Cement Concrete Sidewalks	300	SY	$ 60.00	$ 18,000
13	Cement Concrete Curb Ramp Type Parallel A	2	EA	$ 2,000	$ 4,000
14	Cement Concrete Driveway Entrance - Type 2	55	SY	$ 60.00	$ 3,307
15	Catch Basin Type 1	6	EA	$ 1,800	$ 10,800
16	Manhole, 48 inch diam. Type 1	3	EA	$ 3,000.00	$ 9,000
17	Corr. Polyethylene Culvert Pipe 18" dia.	0	LF	$ 75.00	$ -
18	Flared End Section 18 In. Diam	0	EA	$ 150.00	$ -
19	Corr. Polyethylene Storm Sewer Pipe 12" dia.	0	LF	$ 42.00	$ -
19	Corr. Polyethylene Storm Sewer Pipe 18" dia.	300	LF	$ 75.00	$ 22,500
20	Corr. Polyethylene Storm Sewer Pipe 24" dia.	0	LF	$ 95.00	$ -
21	Crushed Surfacing Base Course - Trench Repair	0	Ton	$ 22.00	$ -
22	Crushed Surfacing Top Course - Trench Repair	0	Ton	$ 27.00	$ -
23	HMA Cl. 1/2 PG 64-28 - Trench Repair	0	Ton	$ 130.00	$ -
24	Structure Excavation Class B, incl. haul	0	CY	$ 8.00	$ -
25	Shoring or Extra Excavation Class B	1	LS	$ 5,000.00	$ 5,000
26	SR 150 Intertie	1	LS	$ 10,000.00	$ 10,000
27	Attenuation Basin - Furey	0	LS	$ 20,000.00	$ -
28	Attenuation Basin - Green/Totem intersection	0	LS	$ 25,000.00	$ -
29	Groundwater Drain System	1	LS	$ 8,000.00	$ 8,000
30	Reconstructed Ditch with Check Dams & Quarry Spall Lining	0	LF	$ 17.00	$ -
				Subtotal Construction Elements	$ 178,523
				2018 Cost Escalation + 5%	**$ 187,449**
Required Ancillary Items					
31	Construction Contingency		20%		$ 35,705
32	Dewatering	0	LS	$ 10,000	$ -
33	Erosion/Water Pollution Control		5%	(see note 3)	$ 8,926
34	Project Temporary Traffic Control		10%	(see note 4)	$ 17,852
35	Construction Surveying & Staking	1	LS	$ 5,000	$ 5,000
				Subtotal Ancillary	$ 67,483
				Subtotal Construction + Ancillary	**$ 254,932**
Mobilization					
36	Mobilization		10%		$ 25,493
				Subtotal Construction + Ancillary	**$ 280,425**
Tax/Engineering/Management/Permitting					
37	Sales Tax		0.0%	(see note 8)	$ -
38	Engineering/Legal/Admin/Utility Coordination		25%	(see note 7)	$ 70,106
39	Construction Management		10%		$ 28,042
40	Permitting		3%		$ 8,413
41	Land and Right Of Way	0.00	acre	$ 60,000	$ -
				Subtotal	$ 106,561
				Subtotal Construction + Ancillary + Mobilization + Tax/Engineering/Management/Permitting	**$ 386,986**
2018 Dollars				**Total Planning Level Construction Cost Opinion (Rounded)**	**$ 387,000**

Notes:

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2. The order-of-magnitude cost opinion has been prepared for guidance in project evaluation from the information available at the time of preparation and for the assumptions stated. The final costs of the project may be more or less.
3. Recommedned minimum is 5%. Increase percentage if work is in or immediately adjacent to flowing or standing water, steep slope, and/or other erosion-prone conditions.
4. Recommended minimum is 5%. Increase percentage if work is in or immediately adjacent to secondary, arterial, or other high-volume road or temporarily closes a roadway.
5. Pipe costs includes excavation and bedding.
6. Right of way acquisition is assumed to not be required.
7. Utility conflicts have not been researched.
8. If the work is subject to Wa. DOR Rule 171 sales taxes will be included in unit prices.