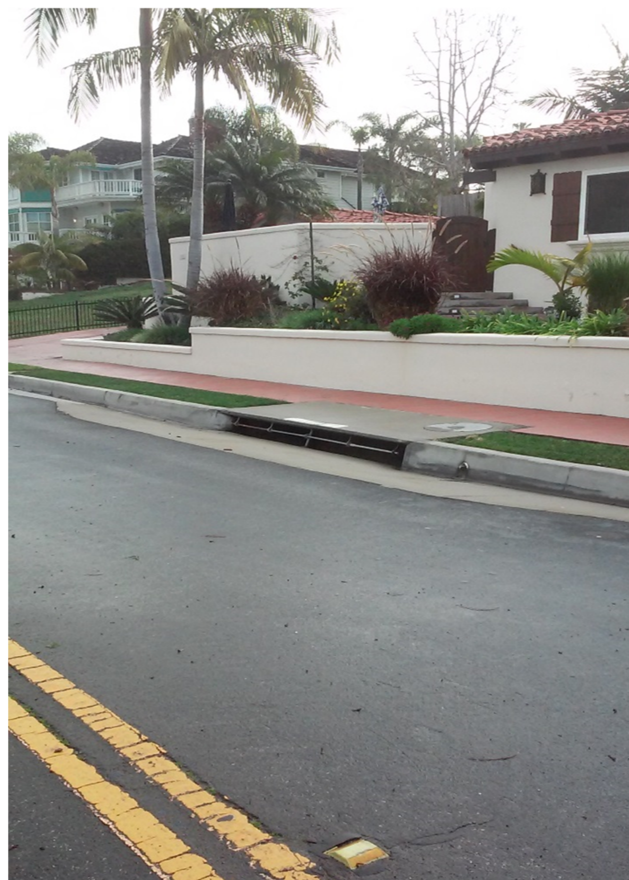
City of Lancaster

Master Plan of Drainage



Prepared
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May 2019

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REVISED DECEMBER 3, 2020(b)

CITY OF LANCASTER

MASTER PLAN OF DRAINAGE UPDATE

Revised December 3, 2020(b)

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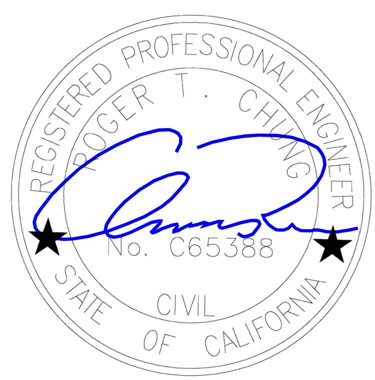

EXECUTIVE SUMMARY

The City of Lancaster (City) is located in southern California within Los Angeles County. The City is situated approximately 61 miles north of downtown Los Angeles and approximately 4 miles south of the Kern County line. It is separated from the Los Angeles Basin by the San Gabriel Mountains to the south, and from Bakersfield and the San Joaquin Valley by the Tehachapi Mountains to the west.

The City of Lancaster Master Plan of Drainage Update (MPDU) provides analysis of existing storm drain facilities within the City of Lancaster. Local drainage areas that were situated within the City's boundaries were identified and evaluated. Drainage from the City of Palmdale and unincorporated County of Los Angeles areas are tributary to the local watersheds. These local watersheds generally proceed in the northerly direction via overland flow beyond the City limits to Rosamond Lake.

The goal of the MPDU is to provide recommendations on any flooding issues relating to existing storm drain facilities and propose new facilities to accommodate the anticipated drainage from ultimate condition. To analyze all considered facilities, hydrologic and hydraulic analyses were performed using U.S. Army Corps of Engineers (USACE) Hydrologic Engineering Center Hydrologic Modeling System (HEC-HMS), and Bentley FlowMaster. These software applications were used to conduct hydrologic and hydraulic modeling. The analyses were based on as-built plans, GIS data obtained from Los Angeles County, GIS data obtained as part of the SR-14 master drainage study conducted in 2016, available topographical maps, field reviews, and the previous version of the City of Lancaster's master plan of drainage.

The Los Angeles County Hydrology Manual was used as the criteria for this MPDU.

The ultimate condition reflects fully developed condition based on the expected land uses as defined in the City of Lancaster General Plan Land Use Map, City of Palmdale General Plan Land Use Map, and Los Angeles County Antelope Valley Land Use Policy. Soil data was based on Soil Survey Geographic Data Base (SSURGO). Flow rates resulting from the hydrologic analyses were used to evaluate the hydraulic capacity of existing drainage facilities and identify adequate and deficient systems. Facility sizes were then developed for proposed facilities intended to address the identified deficiencies. The 25- and 50-year return frequencies were used for local and regional facility evaluations, respectively.

Existing pipe/channel segments were examined to determine their adequacy in carrying the ultimate condition flow rates computed in the MPDU. Bentley Flowmaster was used to compute the capacity of pipes/channels. Pipe/channel segments were identified to be deficient if the computed capacity was shown to be less than the ultimate condition flow rates.

Within the context of the MPDU, these deficiency determinations should be considered preliminary given that normal depth methods were used in the study. The Normal Depth analysis is a basic test of capacity and does not consider pressure flow or momentum in its evaluation. As such, if pipe replacement projects are moved into design, detailed hydraulic analysis of the overall system should be performed as a part of the design process.

Once a pipe deficiency was identified, the construction cost of correcting the deficiency was estimated. The pipe replacement was then prioritized based on the capability to service 10-year and 25-year storm events. Additional areas of concern which are prone to flooding were identified by City of Lancaster staff. These areas were reviewed, and mitigation measures were proposed as part of this MPDU.

Areas located on the extreme west and east sides of the City were determined to be remotely located in relationship to existing drainage infrastructure that could manage and convey runoff from such areas. Within the MPDU, these areas were identified as Natural Floodplain Management Areas. The predominate characteristic of these areas is that natural drainage patterns prevail upstream and downstream of individual parcels of land. Therefore, within these areas, proposed developments shall include floodplain management measures that mitigate the floodplain impacts associated with the development to less-than-significant levels. These measures will typically include the continued acceptance of pre-development flows from upstream areas tributary to the development, the safe conveyance of flow through or around the development without an adverse effect to adjacent properties, and the discharge of flows to downstream areas in a manner consistent with pre-development flow characteristics.

Within Natural Floodplain Management Areas, the City will not take ownership or participate in maintenance of flood management facilities and/or practices implement to mitigate impacts to existing drainage patterns. Areas within a development dedicated to flood mitigation will be encumbered with a drainage and maintenance covenant with the City to ensuring that flood mitigation features will be maintained. The drainage and maintenance covenant agreement will ensure that flood mitigation features remain configured as intended.

Upon the completion of defining the facilities required to manage storm water drainage within the City and unit prices for construction were applied to nominal lengths of the facilities to arrive at a total construction cost per facility reach. Right-of-way costs for open channel facilities were then added to the construction costs in order to account for the acquisition of land required for open channel facilities. Below grade conduits such as reinforced concrete pipes and reinforced concrete boxes were assumed to be located within existing public right-of-way. The total construction cost plus right-of-way was then increased for engineering and City administration costs. The Total Cost for the facility reach was then determined by adding a contingency to the total of the above-stated components. The total cost of MPDU facilities was determined to be $697,281,099.

The proposed drainage impact fee schedule was then calculated by taking the Total Cost for all MPDU facilities and dividing that number by the gross undeveloped acreage in the City. The undeveloped acreage was estimated to be 37,949 acres. This total undeveloped acreage includes the area within the Natural Floodplain Management Areas. Land in those areas will benefit from the MPDU facilities. The resulting cost per acre was the drainage impact fee for residential developments within the residential zoned land. Commercial and industrial drainage impact fees were determined by taking the cost per gross acre and dividing by 43,560 square feet per gross acre to obtain the cost per square foot.

Table E-1 below presents the results of the Fee Schedule as developed for the Master Plan of Drainage Update.

Table E-1
Drainage Impact Fee Schedule

Cost per Acre within Residential Zone	Cost per square foot of gross area of any other development within Commercial, Industrial Zone or any zone not indicated
$18,374	**$0.42**

Implementation of the MPDU will occur through the ministerial approval process in place at the City. Conditions of Approval will be issued that require certain commitments by the developer with respect to MPDU implementation.

Where a frontage(s) of a prosed development interface with a MDPU facility, the developer will typically be conditioned to construct that portion of the MDPU including the dedication of right-of-way required for the facility(s). Other drainage facilities not included in the MDPU may be necessary to convey storm water through the development; these facilities will be the developer's sole responsibility.

Additionally, drainage from a development needs to be properly conveyed downstream to a suitable receiving facility. The receiving facility must have the capacity to convey the flow from the development in a manner deemed satisfactory to the City. If these off-site facilities required of the development are facilities identified in the MDPU, then they may be subject to Drainage Impact Fee credit. Should these facilities not serve the needs of the MDPU, they will be developer's sole responsibility.

Developers that construct PDF may receive a credit against their Drainage Impact Fee. The value of the credit will be limited to the amount of the total fee due for the development. If the cost of the MDPU facilities exceed the total fee due, a fee credit certificate will be issued, which can be used to offset the Drainage Impact Fee associated with a subsequent development.

All developers are required to annex into the Lancaster Drainage Benefit Assessment District to provide for maintenance of facilities whether such facilities are part of the planned facilities or onsite, development-specific drainage facilities. Annexation is required whether drainage facilities are constructed or not. The developer will pay the fees necessary to annex into the district including the first year assessment.

MDPU facilities constructed by the City will be accepted into the Lancaster Drainage Benefit Assessment District for operation and maintenance purposes.

1. INTRODUCTION

The City of Lancaster (City) has retained Stantec Consulting Service, Inc. to provide comprehensive professional engineering services to prepare a Master Plan of Drainage Update for the City. The MPDU will serve as a resource for City officials to develop guidance for future development projects throughout the City and will provide updated recommendations for the assessment of Drainage Impact Fees for forthcoming developments within the City. The MPDU will also serve to identify potential projects and their associated budgets that will improve drainage conditions at specific locations within the City boundaries.

1.1. Location

The MPDU provides analysis of existing storm drain facilities located within the City of Lancaster, California. Lancaster, approximately 60,572 acres in size, is located in Los Angeles County. The City is generally bounded in the north, east and west by unincorporated Los Angeles County territory and by Palmdale to the south. See Figure 1-1 for a Regional Location Map.

1.2. Background

The original citywide MPDU was prepared by Willdan Associates in August 1981. In 1985, the City adopted the Antelope Valley Master Plan of Drainage (for the City of Lancaster portion) prepared by the County of Los Angeles. In 1987 the County revised the plan to increase the size of many of the drainage facilities as a result of the majority of the retention and detention basins being removed from the plan. An updated Master Plan Drainage Facilities supplement along with a revised drainage fee schedule was prepared in October 1992. A subsequent update to the Master Plan of Drainage was prepared in 2005 to address the reduction in drainage flow conveyed to the City of Lancaster from the City of Palmdale due to the construction of drainage facilities in Palmdale. This report also reflects drainage facilities constructed by private developments that differ from the Master Plan or Drainage and the conversion of open channels to closed conduits.

1.3. Purpose of Report

This report presents the analyses and results of a comprehensive study of the watersheds that affect the City of Lancaster.

The report will present the results of watershed delineations that will identify the existing storm drain systems that are deficient, propose new pipe sizes to accommodate the computed ultimate condition flows based on the City's Land Use Map and proposed new drainage facilities.

2. HYDROLOGIC ANALYSIS

The hydrologic analysis for this Master Plan of Drainage Update is comprised of numerous parts including data collection and review, software selection, watershed development and hydrologic modeling, and results analysis.

2.1. Data Collection and Review

Several sources of data were used co compile information about the project area. The sources and information gathered include:

- Los Angeles County LARIAC Data
  - Topographic information, 2-ft contours for portions of the study area

- Los Angeles County Department of Public Works (LACDPW)
  - Rainfall depth distributions for the 10-, 25-, and 50-year storm events
  - Rainfall design storm distribution curve
  - Land use data for Los Angeles County (LAC)
  - Soil data for the Antelope Valley

- City of Lancaster
  - Existing land use data for the City
  - Street centerlines
  - Existing storm drain pipes and channels: locations and construction plans
  - Previous Master Plans of Drainage reports and exhibits

- Soil Survey Geographic Data Base (SSURGO)
  - Soil data

- USGS Quad Maps
  - Additional topographic information for areas outside LARIAC boundaries

- Federal Emergency Management Agency (FEMA)
  - Flood Insurance Study for Los Angeles County

2.2. Software Selection

The hydrology analysis was completed using U.S. Army Corp of Engineers (USACE) Hydrologic Engineering Center Hydrologic Modeling System (HEC-HMS). Additionally, ArcGIS was used for geographical calculations and mapping.

WMS, developed by Aquaveo is specified in the Los Angeles County Hydrology Manual as approved software which is fully capable of implementing the MODRAT method for hydrologic modeling. MODRAT (Modified Rational Method) is an LAC specific model for determining peak runoff flow rates and volumes from a hydrologic network. However, WMS with MODRAT is limited to watersheds less than 999 acres, and times of concentration of 5-30 minutes (TC values grater than this limit are reduced to 30 minutes). Due to the nature of this project area, many of the watersheds do not need the limitations and cannot be modeled with this program. Moreover, limiting times of concentration to 30 minutes does not realistically portray the runoff conditions, and subdividing watersheds into areas that would meet this time limit tends to result in overly conservative values. For these reasons, the hydrologic network was modeled using HEC-HMS.

Developed and maintained by the USACE, HEC-HMS is a widely accepted model for hydrologic analysis which can incorporate a variety of calculation methods and routing options. HEC-HMS features a completely integrated work environment including a database, data entry utilities, computation engine and result reporting tools. The components of HEC-HMS include a basin model, meteorological model, and control specifications. This modeling software has no constructions on watershed size or time of concentration.

2.3. Watershed Development and Hydrologic Modeling

In order to estimate flow rates, five main steps were followed:

1. Watershed delineation for drainage areas within the City of Lancaster and within City of Palmdale and County of Los Angeles tributary to the City of Lancaster drainage.

2. Determination of the longest path of travel for each watershed (lag line) and the path of travel between connecting watersheds (reach).

3. Estimation of necessary model parameters for each watershed using collected data including:

   a. Basin area
   b. Rainfall depth
   c. Percent imperviousness
   d. Average curve number based on soil type and land use
   e. Lag line and reach geometry
   f. Time of concentration for each watershed and watershed connection

4. Development and execution of HEC-HMS models.

5. Verification, comparison, and reporting of modeling results.

2.3.1. Watershed Delineation

Watersheds were delineated for the drainage areas within the City of Lancaster and Unincorporated County of Los Angeles by assessing topographic information. Watersheds were delineated for the drainage areas within the City of Palmdale by referencing the City of Palmdale

Master Plan of Drainage Update dated August 1996 and assessing topographic information. These watersheds were subdivided at points where two or more points of concentration coincided.

2.3.2. Lag Lines and Reaches

Lag lines represent path of travel from the most hydrologic remote part of a watershed to the watershed outlet or concentration point. Reaches represent the path between concentration points of hydrologically connected watersheds. Both of these paths were determined by analyzing topographic information.

2.3.3. Model Parameters

As outlined in Section 2.2, several data sources were utilized for the collection of data necessary for the model. Data includes topographic information, land use, soil type, and rainfall distributions. GIS was used to perform geographical calculations, such as calculating an area weighted average, to determine the model parameters.

2.3.3.1. Watershed Areas

The delineated watershed boundaries were digitized and used to determine the area for each watershed.

2.3.3.2. Rainfall Depth

The precipitation depth for a given storm can vary widely from one area to another due to the unique topography and climate of the Antelope Valley, in particular the surrounding mountain ranges and high desert climate. LACDPW has developed rainfall depth distribution and 50-year, 24-hour isohyetal mapping for the entirety of Los Angeles County. This information was used to determine the average rainfall depth for each watershed for the 50-year storm event. The 10-year and 25-year storm event precipitation depths were extrapolated from the 50-year event utilizing rainfall frequency multiplication factors also developed by LACDPW, as noted in the Los Angeles County Hydrology Manual.

2.3.3.3. Percent Imperviousness

An area-weighted average percent impervious value was determined for each watershed utilizing land use data collected from the City of Lancaster, City of Palmdale and the County of Los Angeles and referencing Appendix D of the Los Angeles County Hydrology Manual.

In order to estimate the percent impervious for each watershed, the land use data was manipulated to group similar uses together and to clarify uses in order to assign a percent impervious to each area. Some land use clarifications included separating “Government” land uses into uses such as “Channel”, “Public Park” or “Government Building” as needed. Areas which had no land use assigned were given a land use based on visual inspection via Google Earth. Residential areas were classified into different densities (e.g. Low, Medium, High) based on the current zoning maps. Residential zones which are currently undeveloped were classified as “Vacant”.

Following this reclassification, each land use type was matched with a land use category and percent impervious as listed in Appendix D of the Los Angeles County Hydrology Manual. From here the area-weighted average percent impervious was estimated for each watershed.

2.3.3.4. Average Curve Number

An average curve number value was developed for each watershed basin within the study area. A curve number is a numerical value that is used to determine the expected runoff from an area. These values were developed using the United States Department of Agriculture (USDA) Natural Resource Conservation Service (NRCS) Curve Number Method as outlined in NRCS Technical Release 55 (TR-55): Urban Hydrology for Small Watersheds. The curve numbers were assigned based on land use and the Hydrologic Soil Group (HSG) of the underlying soil within the watershed. Soils are classified as having a HSG of “A”, “B”, “C”, or “D” which corresponds to the particular soil’s ability to infiltrate runoff.

The land use categories as previously determined were each assigned a corresponding curve number for each possible HSG. This assignment was made by relating each land use category to one of the options outlined in TR-55 based on description and percent imperviousness.

Using GIS, the curve numbers were assigned to each unique land use and soil type combination. This information was then used to determine an area weighted average curve number for each watershed.

2.3.3.5. Lag Line and Reach Geometry

The developed lag times and reaches were digitized and used to determine the overall length and average slope of each path. Additionally, the primary type of pathway (e.g. channel, piped, overland) was determined for each reach.

2.3.3.6. Time of Concentration

Time of concentration (Tc) represents the time required for a drop of water that falls on the most hydrologically remote portion of a watershed to reach the watershed outlet or concentration point. There are multitude of methods for calculating Tc. For this project, the method outlined in the NRCS TR-55 method and the U.S. Bureau of Reclamation Method (USBR Lag) method were used for the HEC-HMS modeling.

The LAC Hydrology Manual method uses the watershed size, soil type, percent impervious, rainfall depth, lag line length, and lag line slope in iteration to determine the Tc. However, this calculation is only valid for a Tc between 5 and 30 minutes. Due to limitations of the LAC method for determining Tc, the NRCS TR-55 and USBR Lag methods were utilized for modeling with HEC-HMS. The NRCS TR-55 method estimates runoff through the watershed using the concepts of sheet flow, shallow concentrated flow, open channel flow, or a combination of these. This method is applicable for watersheds less than one square mile in area. For watersheds greater than one square mile and/or with average basin slopes greater than 10%, the USBR Lag method was used. The USBR Lag method utilizes basin geometry, slope and roughness to estimate runoff travel times.

2.3.4. HEC-HMS Modeling

The HEC-HMS basin model is comprised of ten hydrologic trees. The main hydrologic tree connects the watersheds and reaches from west and central Lancaster to a single outlet at Pond 2 near Avenue G. The remaining nine hydrologic trees drain northerly or easterly and outlet at the north City boundary. Within the HEC-HMS model; time of concentration values were not truncated as the software was designed without limits on basin size or time of concentration length.

Within the tributary areas HEC-HMS modeling was performed without accounting for basin detention. Basin performance is unknown and assumed to operate on small storms. However, the facilities affected by this assumption are relatively few.

After verifying that all parameters were inputted, basin models were computed for 10-year, 25-year, and 50-year storm event scenarios. Supporting data to complete the modeling is included within the appendix for reference.

2.4. Hydrologic Modeling Results

Following the computation of the basins modeling for each of the 10-year, 25-year and 50-year storm event scenarios; the results were compiled and tabulated for verification, comparison and reporting measures. All of the results for each of the storm event scenarios for HEC-HMS modeling are located within the appendix for reference and review.

2.4.1. HEC-HMS Results

Table 1 HEC-HMS Discharges, below, outlines and compares modeling results between existing and ultimate conditions. The existing condition takes into consideration land use at the time this report is prepared. The proposed condition takes into consideration the fully developed land use based on the general plan from the City of Lancaster, City of Palmdale and the County of Los Angeles.

Hydrologic	Existing Condition			Proposed Condition		
Element	Q10 (cfs)	Q25 (cfs)	Q50 (cfs)	Q10 (cfs)	Q25 (cfs)	Q50 (cfs)
A0	225	325.6	411.9	339.2	453.8	549.1
A1	37	56.8	70.8	48.2	68.5	82.8
A1-2	37	56.8	70.8	48.1	68.4	82.6
A10	105	150.7	181.2	104.8	150.7	181.2
A10-11	113	151.7	188.3	112.5	151.7	188.3
A10/11	291	420.8	537.7	291.3	420.8	537.7
A11	271	387.7	490.4	271.3	387.7	490.4
A11-12	290	419.8	535.6	290.2	419.8	535.6
A11/14	448	646.4	818.5	448.0	646.4	818.5
A12	89	122.8	151.6	88.9	122.8	151.6
A13	86	112.3	128.5	85.7	112.3	128.5
A14	191	250.8	300.0	190.8	250.8	300.0
A14-15	447	646.0	817.1	447.4	646.0	817.1
A15	275	350.2	395.2	275.3	350.2	395.2
A15-19	6376	9339.3	11569.5	7252.6	10221.8	12465.1
A16	3146	4223.5	5015.3	3261.6	4336.8	5125.2
A16-17	3143	4220.1	5010.7	3259.1	4333.0	5120.8
A16/17	3223	4341.2	5168.7	3353.8	4470.3	5295.4
A17	148	219.8	283.0	182.4	255.7	319.6
A17-18	3210	4325.4	5149.9	3341.5	4454.3	5277.5
A17/18	3245	4396.5	5256.2	3368.9	4509.5	5357.5
A18	162	275.7	375.8	147.5	209.8	278.9
A18-19	3236	4384.2	5240.9	3359.4	4496.7	5343.1
A18/19	6906	10381.3	13036.7	7976.7	11417.9	14060.0
A19	196	279.0	329.9	263.3	343.8	392.9

Hydrologic	Existing Condition			Proposed Condition		
Element	Q10 (cfs)	Q25 (cfs)	Q50 (cfs)	Q10 (cfs)	Q25 (cfs)	Q50 (cfs)
A19-20	6902	10374.6	13030.7	7971.1	11411.3	14054.7
A19/20	6980	10485.9	13175.2	8086.3	11568.9	14244.7
A1/2	99	142.4	177.3	132.6	178.9	215.0
A2	75	105.0	129.8	100.5	132.1	157.9
A2-3	97	140.4	175.8	130.4	176.1	212.8
A20	332	457.3	560.2	529.6	656.0	757.2
A21	585	880.6	1134.5	761.3	1068.6	1328.4
A21/22	671	1023.3	1314.1	948.9	1318.1	1616.9
A22	87	144.0	181.1	192.3	254.9	293.9
A22-23	671	1023.1	1313.8	948.7	1318.0	1616.6
A22/23	699	1061.1	1359.9	992.7	1372.6	1679.1
A23	77	103.0	123.0	121.8	147.5	166.8
A23-POND2	7660	11504.7	14467.2	9067.1	12902.5	15868.2
A2/3	5944	8690.9	10718.7	6797.8	9531.3	11593.2
A3	136	188.1	230.2	164.4	214.5	255.2
A3-9	5937	8680.6	10702.7	6787.7	9519.8	11582.2
A4	155	223.6	272.0	154.9	223.6	272.0
A4-5	154	222.7	270.7	154.1	222.7	270.7
A5	41	54.4	65.5	41.0	54.4	65.5
A5/6	250	370.2	456.6	243.4	357.0	439.7
A6	112	165.1	202.7	103.8	150.5	183.8
A6-8	250	369.6	456.2	242.9	356.5	439.0
A6/8	374	541.2	666.9	386.0	548.1	672.1
A7	155	199.6	235.7	155.0	199.6	235.7
A8	101	137.9	168.9	121.6	160.7	193.2
A8-9	374	540.4	666.2	385.3	547.4	671.2
A8/9	6182	9052.2	11161.5	7055.4	9910.9	12059.2
A9	126	166.1	190.5	125.8	166.1	190.5
A9-15	6182	9045.0	11159.7	7053.7	9901.5	12046.7
A9/15	6477	9489.7	11731.7	7360.5	10360.4	12641.7
B0	1855	2533.2	3053.4	2037.9	2715.5	3234.0
B1	433	556.7	658.1	441.9	565.4	666.2
B1-B2	405	558.9	675.7	439.4	542.9	664.1
B10	25	33.2	39.3	25.5	34.2	40.3
B10-11	24	33.0	38.9	25.4	34.0	39.9
B10/11	52	72.7	88.6	63.3	84.1	99.9
B11	31	44.0	54.3	42.2	55.1	65.3
B11-12	51	72.3	88.2	62.8	83.3	99.0
B11/12	86	121.1	149.9	108.7	143.2	171.5
B12	39	54.2	67.7	50.4	64.8	77.8
B12-15	139	201.2	259.3	231.9	306.7	373.0

Hydrologic	Existing Condition			Proposed Condition		
Element	Q10 (cfs)	Q25 (cfs)	Q50 (cfs)	Q10 (cfs)	Q25 (cfs)	Q50 (cfs)
B12/15	464	640.9	800.2	528.9	701.2	859.9
B13	126	180.4	232.4	217.9	284.9	345.7
B13-14	125	179.1	230.3	215.8	283.0	343.5
B13/14	135	192.9	249.6	227.3	298.6	362.8
B14	30	40.5	50.2	29.8	40.5	50.2
B14-15	134	192.5	248.8	226.2	297.6	360.9
B14/15	140	201.5	260.8	233.7	307.7	373.3
B15	35	47.3	56.5	35.0	47.3	56.5
B15-21	464	637.7	798.3	527.2	700.6	856.7
B16	160	212.6	249.4	166.1	218.3	254.9
B16-17	158	210.9	246.6	164.4	216.5	251.9
B17	63	87.2	104.1	58.3	80.5	96.0
B17/19	304	422.1	504.4	306.2	421.6	502.2
B18	28	36.8	43.2	29.3	38.1	44.3
B19	153	209.1	247.8	152.9	209.1	247.8
B19-20	303	420.9	503.1	305.3	420.4	500.9
B19/20	357	493.2	592.6	386.5	522.2	621.7
B2	1343	1852.9	2216.0	1411.8	1921.2	2282.6
B20	62	83.6	102.8	89.4	112.9	133.5
B20-21	355	489.3	587.2	379.8	513.8	611.6
B20/21	744	1027.7	1262.7	820.1	1098.1	1333.6
B21	76	102.4	122.3	75.8	102.4	122.3
B21-33	742	1019.7	1259.3	815.7	1097.0	1327.6
B22	128	172.5	203.5	107.9	149.2	179.0
B22-23	128	171.5	203.0	107.6	148.8	178.0
B22/23	213	291.0	347.9	199.0	273.3	328.4
B23	113	150.8	179.7	122.8	159.6	187.7
B24	63	89.6	107.6	75.7	104.7	123.7
B24-27	225	306.1	366.2	271.5	350.7	408.7
B24/28	494	681.9	821.8	563.8	751.0	891.0
B25	79	106.2	125.2	82.9	109.7	128.5
B25-26	79	105.6	124.3	82.9	109.0	127.8
B26	47	66.3	79.4	58.2	76.7	89.2
B26/27	227	307.8	367.5	271.8	351.0	409.1
B27	121	158.8	188.7	153.4	190.5	219.3
B28	33	47.5	61.5	56.7	75.1	91.5
B28-31	493	679.8	822.8	562.1	748.0	886.8
B29	30	43.2	54.6	47.3	60.5	71.8
B29-30	68	94.7	118.0	68.3	94.7	118.0
B29/30	98	137.5	171.9	115.6	154.8	189.1
B2/3	2259	3113.7	3735.3	2382.9	3236.6	3855.0

Hydrologic	Existing Condition			Proposed Condition		
Element	Q10 (cfs)	Q25 (cfs)	Q50 (cfs)	Q10 (cfs)	Q25 (cfs)	Q50 (cfs)
B3	939	1276.4	1515.6	990.4	1326.5	1564.4
B3-4	2222	3067.7	3680.3	2344.8	3188.1	3797.9
B30	69	95.9	119.4	69.3	95.9	119.4
B30-31	98	136.9	171.5	115.0	154.3	188.6
B31	124	166.3	203.7	152.8	197.4	235.8
B31-32	20	29.7	36.3	24.9	33.8	40.1
B31/32	683	951.5	1162.1	804.4	1070.8	1278.6
B32	20	29.8	36.5	25.1	34.1	40.4
B32-33	680	948.3	1159.3	802.8	1070.2	1278.5
B32/33	1422	1977.0	2435.8	1593.6	2178.1	2622.8
B33	21	32.5	42.8	27.5	37.8	47.1
B33-34	1420	1970.3	2430.3	1592.7	2171.1	2618.4
B33/34	1433	1994.4	2460.1	1613.6	2205.3	2658.9
B34	31	46.1	57.1	48.7	66.4	78.8
B34-POND1	1421	1991.9	2437.2	1603.8	2191.8	2641.2
B35	57	76.5	89.4	57.4	76.5	89.4
B3/4	2488	3483.9	4212.6	2646.4	3646.2	4375.6
B4	560	814.8	992.2	643.1	900.6	1078.9
B5	326	440.3	543.0	297.7	399.3	492.5
B5-15	325	439.7	542.4	297.2	398.8	491.9
B5/12	326	440.3	543.0	297.7	399.3	492.5
B7	319	421.3	493.0	336.8	438.0	509.0
B7-8	315	417.3	488.9	332.8	433.9	504.8
B7/8	346	461.5	543.4	374.2	488.2	569.4
B8	31	44.2	54.5	41.4	54.3	64.6
B8-12	347	458.0	537.7	373.8	484.6	562.4
B9	46	62.4	75.0	46.2	62.4	75.0
B9-12	0	0.0	0.0	0.0	0.0	0.0
B9/12	460	623.4	744.5	511.2	672.6	792.1
C1	53	77.5	94.5	61.6	84.8	101.0
D1	426	549.7	646.0	436.2	559.7	655.5
D1-2	425	549.4	645.8	435.9	559.5	655.4
D10	113	147.7	174.7	112.6	147.7	174.7
D11	39	50.5	57.8	40.6	51.5	58.8
D11-12	39	50.2	57.5	40.4	51.2	58.4
D11/12	64	82.7	96.0	65.0	83.7	97.0
D12	25	32.8	38.9	25.0	32.8	38.9
D12-13	63	80.4	93.6	63.5	81.5	94.5
D12/13	82	106.7	124.8	83.1	107.9	126.0
D13	20	26.3	31.2	20.0	26.5	31.4
D14	105	137.2	161.5	130.5	146.8	170.8

Hydrologic	Existing Condition			Proposed Condition		
Element	Q10 (cfs)	Q25 (cfs)	Q50 (cfs)	Q10 (cfs)	Q25 (cfs)	Q50 (cfs)
D14-15	105	136.5	160.5	129.8	145.9	169.9
D14/15	128	168.2	197.8	153.3	177.8	207.2
D15	28	37.4	43.8	27.6	37.4	43.8
D16	86	113.4	134.2	112.5	139.4	159.6
D17	578	759.4	920.3	661.9	846.5	1008.9
D17-18	942	1232.7	1474.6	1071.8	1351.6	1592.4
D17/18	1508	2005.2	2409.2	1667.3	2151.6	2554.6
D18	182	258.5	325.9	205.6	283.3	351.1
D18-19	1495	1995.6	2401.3	1655.8	2142.9	2548.0
D18/21	1851	2512.2	3053.5	2012.4	2660.7	3202.9
D19	28	38.8	48.3	28.0	38.8	48.3
D1/2	441	571.0	673.1	453.9	583.2	684.6
D2	48	63.0	76.6	52.7	67.4	80.5
D2-3	441	570.9	672.3	453.8	582.7	683.3
D20	40	57.1	72.4	39.8	57.1	72.4
D21	17	25.0	31.9	18.5	26.3	33.1
D21-D22	1820	2507.1	3043.1	1988.2	2641.7	3192.0
D22	117	184.4	235.5	209.4	295.0	356.2
D2/3	485	639.6	759.9	500.0	653.5	772.9
D3	82	117.0	140.4	81.7	117.0	140.4
D3-4	484	639.3	758.2	499.1	653.0	770.9
D3/4	484	639.3	758.2	499.1	653.0	770.9
D4	26	36.4	44.7	25.5	36.4	44.7
D4-8	301	442.6	544.4	301.4	442.6	544.4
D4/8	326	477.8	587.7	326.0	477.8	587.7
D5	19	23.7	28.2	18.7	23.7	28.2
D5-6	19	23.7	28.1	18.6	23.7	28.1
D5/6	92	120.5	140.6	92.4	120.5	140.6
D6	74	96.8	112.4	73.7	96.8	112.4
D6-7	92	120.2	140.2	92.1	120.2	140.2
D6/7	174	236.5	284.1	174.0	236.5	284.1
D7	82	116.3	143.9	81.9	116.3	143.9
D7-8	173	235.5	283.1	173.2	235.5	283.1
D7/8	303	444.8	546.8	303.3	444.8	546.8
D8	130	209.3	263.7	130.1	209.3	263.7
D8/17	943	1236.9	1479.4	1074.5	1355.2	1598.2
D9	36	45.5	52.1	35.8	45.8	52.4
D9-10	35	44.8	51.5	35.6	45.1	51.6
D9/10	147	192.2	225.7	147.5	192.5	226.0
E1	110	171.3	218.1	110.4	171.3	218.1
E1-2	110	171.1	217.6	110.3	171.1	217.6

Hydrologic	Existing Condition			Proposed Condition		
Element	Q10 (cfs)	Q25 (cfs)	Q50 (cfs)	Q10 (cfs)	Q25 (cfs)	Q50 (cfs)
E1/2	119	184.6	234.9	119.4	184.6	234.9
E2	32	44.8	53.7	32.2	44.8	53.7
E2-3	119	184.4	234.4	119.3	184.4	234.4
E3	184	235.1	276.9	183.5	235.1	276.9
E3/4	262	343.2	415.7	269.6	351.1	423.5
E4	11	17.5	23.2	19.2	25.8	31.4
F1	76	103.6	124.0	76.1	103.6	124.0
F1-2	76	103.1	123.5	75.9	103.1	123.5
F1/2	244	377.7	478.9	273.9	411.3	514.5
F2	230	356.0	450.5	259.7	389.6	486.1
F2-3	244	377.6	478.8	273.7	411.2	514.2
F3	24	31.9	39.0	37.5	47.4	55.4
F3-5	146	202.1	249.5	271.7	345.8	401.3
F3/5	430	640.7	806.8	575.8	800.7	979.6
F4	54	82.5	102.9	118.2	152.5	175.6
F4-5	54	82.4	102.7	117.9	152.0	174.8
F4/5	147	205.6	253.4	275.3	348.6	404.9
F5	127	170.1	206.7	212.8	265.8	308.2
F5-6	430	637.0	802.2	574.5	799.8	977.5
F5/6	439	649.3	816.3	587.3	815.8	995.5
F6	35	46.3	53.4	46.9	58.9	66.1
F6-7	437	643.8	814.2	583.5	809.8	989.2
F6/7	453	667.8	841.7	605.7	843.1	1026.6
F7	94	123.2	141.3	115.8	145.7	163.6
F7-POND2	449	664.2	838.4	603.2	840.3	1023.6
F8	84	128.7	168.2	84.1	128.7	168.2
G0	6238	8197.9	9624.5	6464.2	8411.4	9830.3
G0-1	6237	8196.8	9623.3	6462.7	8410.8	9827.4
G0/1	7043	9273.4	10918.2	7228.9	9439.4	11071.6
G1	2333	3042.7	3610.3	2192.1	2877.7	3432.8
G1-2	7041	9271.4	10918.0	7226.9	9437.1	11070.5
G10	43	54.3	61.4	42.5	54.3	61.4
G11	74	92.4	103.5	73.9	92.4	103.5
G12	25	31.2	34.9	24.9	31.2	34.9
G12-13	7271	9584.6	11297.2	7544.2	9843.5	11545.9
G12/13	7273	9587.2	11300.1	7546.3	9846.1	11548.8
G13	20	27.9	32.5	20.4	27.9	32.5
G13-14	7273	9585.4	11299.6	7544.4	9844.8	11548.7
G13/14	7281	9596.4	11312.5	7552.5	9855.7	11561.6
G14	57	73.0	82.6	57.0	73.0	82.6
G14-15	7279	9595.7	11309.9	7552.3	9854.5	11559.2

Hydrologic	Existing Condition			Proposed Condition		
Element	Q10 (cfs)	Q25 (cfs)	Q50 (cfs)	Q10 (cfs)	Q25 (cfs)	Q50 (cfs)
G15	6	8.2	9.7	6.8	9.2	10.7
G15/16	7295	9617.7	11336.8	7567.8	9876.5	11586.6
G16	97	128.4	147.5	97.1	128.4	147.5
G17	19	27.0	31.7	24.9	32.7	37.5
G17-20	7294	9615.3	11336.4	7566.4	9875.0	11585.4
G17/20	7329	9664.6	11394.6	7602.0	9925.5	11644.7
G18	69	88.3	99.9	71.2	90.3	101.9
G18-19	69	88.2	99.7	70.9	90.1	101.7
G18-20	145	185.4	209.9	148.7	189.1	213.8
G18/19	146	185.9	210.3	149.2	189.7	214.1
G19	82	104.3	118.0	83.6	106.2	119.8
G1/2	7127	9389.5	11063.6	7319.1	9561.1	11221.8
G2	314	421.5	516.1	350.8	454.1	545.0
G2-3	7123	9385.5	11059.0	7315.6	9557.1	11216.6
G20	92	120.1	137.1	91.9	120.1	137.1
G20-23	7326	9663.5	11391.9	7600.8	9922.2	11642.6
G20/23	7331	9690.1	11437.7	7606.7	9951.1	11688.4
G21	12	17.3	20.2	13.2	18.0	21.0
G22	201	255.0	296.1	200.9	255.0	296.1
G23	135	171.7	200.0	134.7	171.7	200.0
G24	38	50.2	59.8	46.3	58.5	67.8
G2/3	7143	9409.5	11087.3	7335.8	9581.1	11244.9
G3	136	172.9	204.6	135.9	172.9	204.6
G3-4	7143	9408.6	11086.4	7334.9	9579.9	11243.8
G3/4	7195	9479.7	11170.8	7420.2	9687.2	11365.9
G4	202	276.1	327.9	367.4	457.2	517.1
G4-5	7194	9478.5	11169.3	7419.5	9686.1	11364.6
G5	4	7.5	10.2	16.9	20.9	24.1
G5/7	7222	9517.6	11218.6	7476.8	9757.4	11448.0
G6	42	59.8	75.1	114.7	139.7	159.6
G6-7	42	59.5	74.5	114.6	139.1	158.6
G6/7	56	82.7	105.9	160.5	200.1	231.7
G7	38	58.8	76.9	112.7	139.6	161.1
G7-9	7221	9516.4	11217.9	7476.2	9756.4	11447.1
G7/9	7263	9573.7	11286.5	7535.6	9833.1	11535.4
G8	125	161.5	186.0	146.6	183.3	207.8
G8-9	125	160.8	185.7	146.2	182.7	207.0
G8/9	139	184.1	217.2	198.8	253.4	291.0
G9	29	44.2	58.2	107.7	133.4	153.9
G9-11	7263	9572.5	11285.6	7534.6	9832.1	11534.8
G9/11	7272	9584.9	11299.5	7544.4	9844.5	11548.8

Hydrologic	Existing Condition			Proposed Condition		
Element	Q10 (cfs)	Q25 (cfs)	Q50 (cfs)	Q10 (cfs)	Q25 (cfs)	Q50 (cfs)
H1	118	156.2	180.2	183.1	229.0	256.6
H1-2	116	154.5	178.2	181.2	226.7	252.2
H1/2	159	222.5	262.9	311.6	394.6	444.3
H2	122	172.1	204.2	248.3	314.9	355.0
H2-3	156	220.3	261.2	311.0	392.8	443.1
H2/3	274	391.0	465.7	429.6	564.7	647.3
H3	150	207.2	243.3	150.4	207.2	243.3
H3-4	272	389.2	461.9	425.5	561.6	642.9
H3/6	553	757.5	896.5	816.6	1058.5	1214.7
H4	205	260.7	303.6	207.2	262.9	305.9
H5	6	8.9	11.2	24.9	31.2	34.9
H5-6	6	8.9	11.1	24.7	31.0	34.7
H5/6	93	131.5	156.1	211.6	265.0	297.0
H6	91	128.9	153.1	202.2	252.9	283.3
H6-7	547	749.9	889.5	807.6	1049.3	1206.5
H6/7	705	962.8	1145.9	1081.8	1391.3	1602.2
H7	175	236.7	285.5	309.4	382.9	438.3
H7-8	695	955.3	1134.2	1070.5	1386.6	1594.1
H7/8	754	1035.9	1232.1	1185.5	1525.0	1750.5
H8	59	80.6	97.8	115.1	139.4	157.6
I0	65	111.8	153.3	245.5	306.8	356.2
I0-1	65	111.6	152.8	244.9	305.9	355.5
I0/1	73	125.1	169.8	288.0	362.2	414.6
I1	40	69.5	88.8	153.2	191.6	214.6
I1-2	73	124.7	169.6	285.9	358.8	411.5
I1/2	115	209.8	286.1	388.7	507.1	590.3
I2	114	159.1	187.6	114.4	159.1	187.6
I2-3	115	208.1	283.6	387.9	505.7	588.9
I2/3	241	334.5	426.3	422.3	555.2	647.7
I3	171	234.4	274.9	170.6	234.4	274.9
I3-4	238	331.9	423.5	421.6	554.4	645.9
I3/4	330	468.2	595.2	562.4	752.8	885.3
I4	141	197.5	242.8	229.4	294.8	345.3
J1	279	422.9	548.0	848.3	1033.2	1181.1
J1-2	278	421.6	546.1	845.4	1030.1	1177.3
J1/2	287	438.4	567.9	883.3	1077.5	1232.1
J2	27	48.4	62.6	114.8	143.6	160.8
J2-3	287	437.7	567.1	882.4	1076.4	1230.3
J2/3	333	508.5	660.8	967.0	1194.2	1374.0
J3	133	182.6	222.5	174.1	229.9	273.9
J3-4	332	508.1	660.0	966.2	1192.5	1372.9

Hydrologic	Existing Condition			Proposed Condition		
Element	Q10 (cfs)	Q25 (cfs)	Q50 (cfs)	Q10 (cfs)	Q25 (cfs)	Q50 (cfs)
J3/4	340	517.9	670.6	976.6	1206.7	1390.5
J4	35	49.7	61.9	60.7	78.7	92.7
K0	237	359.1	445.5	324.9	443.6	526.6
K00	492	683.2	846.8	537.0	727.9	891.0
K00-0	491	681.4	844.0	535.8	725.9	887.9
K00-5	561	789.5	982.0	641.1	890.1	1086.9
K00/0	563	793.5	985.6	645.3	894.6	1092.7
K1	1055	1376.9	1602.1	1098.8	1418.1	1641.4
K1-2	1050	1371.7	1595.7	1093.2	1411.9	1634.7
K10	50	75.3	91.9	123.5	154.5	173.1
K10-11	2568	3601.6	4396.7	3425.5	4504.5	5326.9
K11	83	114.2	148.2	197.1	262.4	314.7
K11/13	2590	3647.6	4464.5	3545.1	4680.2	5542.3
K12	55	90.3	114.8	247.1	309.1	346.2
K12-13	55	89.1	112.6	246.4	305.7	343.8
K13	55	81.4	106.1	103.2	141.2	172.1
K13-14	2582	3638.2	4458.2	3523.4	4650.8	5512.5
K13/14	2582	3638.9	4459.5	3528.3	4662.9	5533.0
K14	91	127.8	156.8	108.3	143.8	171.7
K1/3	1900	2557.0	3031.4	2032.0	2682.7	3152.8
K2	320	420.0	507.2	377.6	474.7	558.8
K3	791	1081.5	1277.4	830.3	1119.9	1314.7
K3-4	1897	2553.0	3025.4	2028.2	2680.2	3145.5
K4	428	576.9	705.6	551.6	707.2	839.2
K4/6	2532	3501.4	4267.3	3157.2	4096.1	4830.9
K5	295	423.9	515.7	639.8	801.0	908.7
K6	766	989.3	1180.2	1055.9	1290.3	1485.7
K6-7	2525	3493.9	4229.4	3127.6	4063.1	4797.0
K6/7	2561	3555.3	4310.3	3326.8	4324.8	5095.4
K7	87	135.8	170.8	223.8	283.6	323.4
K7-8	2540	3529.6	4290.3	3243.2	4238.2	4999.7
K7/8	2580	3608.8	4392.3	3434.0	4496.6	5310.0
K8	189	297.3	371.4	710.2	888.2	995.0
K8-9	2567	3595.6	4383.2	3394.5	4452.1	5265.5
K9	67	99.8	120.9	153.1	191.5	214.5
K9/10	2569	3603.2	4398.0	3437.0	4511.0	5335.0
L1	795	1114.5	1331.3	867.8	1186.2	1401.5
L1-2	794	1113.6	1330.2	867.0	1185.8	1400.0
L10	115	194.4	260.7	546.4	661.8	748.3
L11	103	163.2	212.2	111.0	159.2	199.9
L1/2	849	1193.1	1426.9	917.9	1258.5	1490.2

Hydrologic	Existing Condition			Proposed Condition		
Element	Q10 (cfs)	Q25 (cfs)	Q50 (cfs)	Q10 (cfs)	Q25 (cfs)	Q50 (cfs)
L2	173	242.0	288.9	156.4	219.6	263.4
L2-3	845	1186.9	1419.4	912.7	1252.3	1481.8
L2/5	2061	3115.5	3874.2	3292.6	4472.8	5284.5
L3	705	1002.0	1207.4	940.9	1234.8	1435.2
L4	461	676.8	859.1	612.4	824.4	1001.7
L5	800	1225.2	1511.0	1596.2	2154.7	2505.1
L5-7	2052	3101.2	3857.7	3277.6	4453.5	5260.7
L5/7	2296	3552.2	4480.4	4044.1	5467.4	6474.2
L6	798	1142.5	1433.8	1081.0	1422.4	1707.5
L6-7	791	1132.9	1421.7	1071.7	1410.2	1692.6
L6/7	833	1212.7	1528.3	1202.8	1591.0	1906.1
L7	152	257.6	326.7	541.2	676.9	758.3
L7-10	130	214.8	283.4	587.6	717.6	813.3
L7-8	2287	3539.8	4462.6	4029.1	5445.8	6450.5
L7/11	2446	3959.2	5032.9	4940.2	6625.0	7820.3
L8	165	302.4	394.2	640.1	830.0	945.8
L9	159	254.6	316.9	224.6	315.6	375.2
L9-10	141	238.4	302.9	223.9	308.8	367.3
L9/10	141	240.9	308.9	591.5	722.3	818.5
M1	1521	2352.1	3073.2	1599.2	2280.5	2889.1
N1	4583	6281.4	7589.1	5005.8	6707.7	8011.7
N1-2	4581	6278.4	7585.5	5003.5	6704.4	8008.0
N1/2	5077	7121.6	8722.9	6197.0	8291.0	9911.1
N2	527	898.2	1209.5	1377.2	1780.7	2107.5
O1	28	48.9	66.0	42.9	64.7	82.4
POND1	5811	8494.0	10470.8	6631.6	9296.3	11303.8
POND2	14848	21164.7	26005.5	16599.8	22914.0	27758.7
POND2_JUNC	7660	11504.7	14467.2	9067.1	12902.5	15868.2
P1	110	187.0	250.8	288.0	373.2	441.1
Q1	432	818.8	1081.1	732.2	1154.3	1432.3
Q1-2	431	816.6	1078.4	730.3	1151.1	1428.4
Q1/2	437	847.3	1134.3	771.6	1237.2	1544.9
Q2	108	193.4	265.1	344.5	441.5	519.6
R1	24	39.2	51.3	33.9	49.4	61.8
S1	86	123.9	153.7	88.8	121.8	148.3
T1	20	26.4	31.0	21.5	27.4	31.9
T1-2	20	26.4	31.0	21.4	27.3	31.8
T1/2	35	44.1	50.9	36.2	45.0	51.7
T2	21	24.9	28.1	20.6	24.9	28.1
T2-3	23	29.4	34.4	23.9	30.3	35.2
T2/3	137	183.7	219.3	213.6	259.2	293.5

Hydrologic	Existing Condition			Proposed Condition		
Element	Q10 (cfs)	Q25 (cfs)	Q50 (cfs)	Q10 (cfs)	Q25 (cfs)	Q50 (cfs)
T3	134	178.9	213.3	209.3	253.5	286.6
Y1	2131	2926.5	3560.1	2258.3	3054.3	3687.5
Y1-2	2120	2910.9	3541.3	2246.0	3038.2	3668.1
Y1/2	2187	3045.7	3743.5	2333.7	3199.5	3900.6

3. HYDRAULIC ANALYSIS

The hydraulic analysis was completed using the FlowMaster Version 7.0 (FlowMaster) Computer Program developed by Haestad Methods, Inc. The input parameters for the storm drain pipe and channel modeling process include discharge, roughness coefficient, channel slope, diameter (for circular pipes), height and bottom width (for box pipes), left side/right side slopes and bottom width (for channels).

Where available, existing condition models were developed based on available GIS data provided by the City, GIS data collected by Stantec as part of the State Route 14 Drainage Study and as-built information. In areas where GIS data and as-built information were not available, Google Earth and site visits were used in determining hydraulic configurations.

Hydraulic analyses were performed for regional and lateral storm drain systems. The regional storm drain system is defined as the major trunk lines that convey flow between City boundaries. The regional storm drain lines are sized based on the 50-year storm event. The lateral storm drain lines are lines that collect significant portions of the City area and are sized to convey the 25-year flowrates.

Assumptions were required in the preparation of the hydraulics calculation for the slope of the storm drain lines. Where information on the slope of the storm drain line was not available, it was assumed that the storm drain line followed the grade of the roadway. The road gradient was computed from the 2-ft contours obtained from the Los Angeles County LARIAC Data.

Utilizing the results from the hydrology analysis, the hydraulic analysis was conducted to identify the existing storm drain systems that are adequate or deficient. If a storm drain system was found to be deficient, a new pipe size was determined to accommodate the computed ultimate condition flow and the new system was propose as a Master Plan Drainage Update facility.

4. PROPOSED DRAINAGE FACILITIES

4.1. Proposed Drainage Facilities

Proposed storm drain pipes were limited to 120-inches in the sizing analysis. The intent was to keep the storm drain pipes at a realistic depth. Reinforced concrete boxes (RCBs) are proposed where the required storm drain size exceeded 120-inches. Caltrans Standard Plan D81 and D83A were used as guidelines in determining the span and height of the RCBs.

Proposed earthen channels were assumed to have a 3:1 side slope for the purpose of estimating capacity and cost.

4.1.1 Natural Floodplain Management Areas

Natural Floodplain Management Areas have been designated in areas where existing flood management infrastructure is limited. In these areas, storm water flow is characterized by alluvial fan flow, or incised riverine conveyances prone to scour, erosion, and/or lateral migration. Development in these areas will typically not have an ability to discharge to an engineered flood control facility.

Natural Floodplain Management boundaries were identified at the easterly and westerly ends of the City. The westerly Natural Floodplain Management Area boundary is aligned along 70th St. W and follows the city boundary from the northerly limits to midway between 70th St. W and 80th St. W, then proceeds south to W Ave. K-4, then along W Ave. K-4 to midway between 80th St. W and 85th St. W, and then south to the southerly city boundary along W Ave. M. The easterly Natural Floodplain Management boundary extends along 55th St. E from the north City limit to the south City limit.

Within the Natural Floodplain Management Areas, no new drainage facilities are proposed. In these areas, proposed developments shall include floodplain management measures that mitigate the floodplain impacts associated with the development to less-than-significant levels. These measures shall include, but not be limited to, the continued acceptance of pre-development flows from upstream areas tributary to the development, the safe conveyance of flow through or around the development without an adverse effect to adjacent properties, and the discharge of flows to downstream areas in a manner consistent with pre-development flow characteristics.

Alternatively, developments in Natural Floodplain Management Areas may intercept flows from upstream areas tributary to the development and convey the flow downstream to an existing and suitable downstream engineered flood control facility, if one exists and is adequate for the acceptance of flow. Such a conveyance of flow shall be in an engineered flood control conveyance that is acceptable to the City including provisions for longitudinal and other access need and provide for maintenance by an appropriate entity acceptable to the City.

Certain types of developments may cause an increase in the peak discharge for given return frequencies ranging from the 2-year to the 50-year storm. In the absence of a downstream engineered flood control facility that has been designed to accept the increased peak discharge from the development, development in Natural Floodplain Management Areas shall be required to mitigate increases in peak discharges to at least 90% of pre-development levels.

Natural Floodplain Management Areas have been designated in areas where existing flood management infrastructure is limited. In these areas, storm water flow is characterized by alluvial fan flow, or incised riverine conveyances characterized by their propensity for scour, erosion, and/or lateral migration. Development in these areas will typically not have an ability to discharge to an engineered flood control facility. However, these areas will still be subject to the Drainage Impact Fee and its associated requirements given that they will benefit from the MPDU facilities.

4.2 Prioritization

All proposed improvements have been prioritized within the entire project area. The goal of this prioritization is to determine the projects with the greatest importance based upon the magnitude of flooding in the existing condition.

The proposed drainage facilities were prioritized into three categories:

1. <u>High Priority</u> – Identified as existing storm drain lines that do not have sufficient capacity to service computed 10-year ultimate condition flows.

2. <u>Medium Priority</u> – Identified as existing storm drain lines that do not have sufficient capacity to service computed 25-year ultimate condition flows.

3. <u>Low Priority</u> – New proposed facilities.

4.3. Cost Estimates

Cost estimates were created for the proposed storm drain improvements. Estimates were based on quantity estimates of proposed facility length, facility size and facility type. The estimation of probable construction cost for the proposed improvements was created by applying unit cost data, as collected during recent construction activities, or as published in current cost data manuals, to the estimated quantities. Unit costs for reinforced concrete pipes and reinforced concrete boxes are specified per linear foot. Unit costs for earthen channels are specified per cubic yard. Included in the unit cost are costs for excavation, shoring, bedding, backfill, compaction, removal of excess material, and trench resurfacing.

Right-of-way costs for open channel facilities were then added to the construction costs in order to account for the acquisition of land required for open channel facilities. Below grade conduits such as reinforced concrete pipes and reinforced concrete boxes were assumed to be located within existing public right-of-way. The total construction cost plus right-of-way was then increased for engineering and City administration costs. The Total Cost for each facility was then determined by adding a contingency to the total of the above-stated components.

The total cost of all MPDU facilities was determined to be $697,281,099.

5. AREAS OF CONCERN

The City has identified the following areas of concern in which drainage issues has occurred previously under existing conditions:

5.1. W Avenue M between 60th Street W and 65th Street W

5.1.1 Drainage Issue

Areas along W. Ave. M between 60th St. W and 65th St. W have flooded downstream areas in the past.

5.1.2 Assessment and Proposed Mitigation

Palmdale Master Plan of Drainage show the runoff from this subarea enters the Lancaster city boundary at the north extension of Kensington Circle. Field visit observed that the north side of Avenue M has an earthen berm and runoff directed east to 60th St. W. Data from Los Angeles County shows that a 48-inch RCP has been installed on Avenue M between 60th St. W and 62nd St. W. The flooding issue can be mitigated by installing a drainage facility at the low point / where flooding has occurred in the past and connect to the 48-inch RCP. Based on the hydrology and hydraulics calculations, the 48-inch RCP is adequate for the tributary area.

5.2. 5th Street E between E Avenue L and E Avenue K

5.2.1 Drainage Issue

The pipe section starts off on E Ave. L with a large diameter pipe and culminates at Lance’s Camper south of E Ave. K-8 in a much smaller pipe that is prone to blockage.

5.2.2 Assessment and Proposed Mitigation

GIS data and Lancaster’s Drainage Master Drainage Plan show that under existing condition, there is a 96-inch RCP on 5th St. E. from E. Ave. L to E. Ave. K-12. The pipe changes to a 24-inch RCP on Ave. E. K-12 and terminates at Lance’s Camper. A separate 24-inch RCP begins on E. Ave. K-4 and terminates on E. Ave. K. There is no drainage pipe connecting the 24-inch RCP between Lance’s Camper and E. Ave. K-4.

Based on results of the hydrology and hydraulics calculations, this master plan proposes to install a new 60-inch RCP from E. Ave. M to E. Ave. L. It is proposed that the existing 24-inch RCP and 96-inch RCP be removed, and the storm drain system continue to be 60-inch RCP between E. Ave. L and E. Ave. K.

5.3. E. Avenue K between 11th St. E and Carpenter Dr.

5.3.1 Drainage Issue

There is inadequate drainage between 11th St. E and Carpenter Dr. that either traps water at a bubble-up filling upstream catch basins with water and debris or floods the intersection of Challenger Way and E. Ave. K during storm events.

5.3.2 Assessment and Proposed Mitigation

There is an earthen corridor between 11th St. E and Carpenter Dr. that is servicing an existing 54-inch CIP. The 54-inch CIP extends north from north of E. Ave. L and services the residential tracts east of the pipe. The 54-inch CIP terminates near E. Ave. K-6 on the south end of the corridor. The corridor is moderately vegetated with brush. No drainage structure was observed on the north end or the corridor adjacent to E. Ave. K during site assessment.

It is proposed to construct an 18-inch storm drain lateral (SD D-4J) to pick up runoff from the corridor to alleviate impact to the drainage facilities upstream and downstream. This line will be connected to the existing storm drain on E. Ave. K. Further detailed investigation and assessment will need to be performed to determine the appropriate drainage structure to be installed.

6. PROPOSED DRAINAGE IMPACT FEE SCHEDULE

6.1. Basis of Fee Determination

The proposed drainage impact fee schedule calculated by taking the Total Cost for all MPDU facilities as reported in Section 4.3 and dividing that number by the gross undeveloped acreage in the City. The gross undeveloped acreage was estimated to be 37,949 acres. This total undeveloped acreage includes the area within the Natural Floodplain Management Areas since properties in those areas will benefit from the MPDU facilities. The result determined the cost per acre of residential development. Commercial and industrial drainage impact fees were determined by taking the cost per gross acre and dividing by 43,560 square feet per gross acre to obtain the cost per square foot.

Table 9-1 below presents the results of the Fee Schedule as developed for the Master Plan of Drainage Update.

Table 6-1
Drainage Impact Fee Schedule

Cost per Acre within Residential Zone	Cost per square foot of gross area of any other development within Commercial, Industrial Zone or any zone not indicated
$18,374	**$0.42**

6.2. Implementation

Implementation of the MPDU will occur through the ministerial approval process in place at the City. Conditions of Approval will be issued that require certain commitments by the developer with respect to MPDU implementation.

Where a frontage(s) of a prosed development interface with a MDPU facility, the developer will typically be conditioned to construct that portion of the MDPU including the dedication of right-of-way required for the facility(s). Other drainage facilities not included in the MDPU may be necessary to convey storm water through the development; these facilities will be the developer’s sole responsibility.

Additionally, drainage from a development needs to be properly conveyed downstream to a suitable receiving facility. The receiving facility must have the capacity to convey the flow from the development in a manner deemed satisfactory to the City. If these off-site facilities required of the development are facilities identified in the MDPU, then they may be subject to Drainage Impact

Fee credit. Should these facilities not serve the needs of the MDPU, they will be developer's sole responsibility.

Developers that construct PDF may receive a credit against their Drainage Impact Fee. The value of the credit will be limited to the amount of the total fee due for the development. If the cost of the MDPU facilities exceed the total fee due, a fee credit certificate will be issued, which can be used to offset the Drainage Impact Fee associated with a subsequent development.

6.3 Maintenance

All developers are required to annex into the Lancaster Drainage Benefit Assessment District to provide for maintenance of facilities whether such facilities are part of the planned facilities or onsite, development-specific drainage facilities. Annexation is required whether drainage facilities are constructed or not. The developer will pay the fees necessary to annex into the district including the first year assessment.

MDPU facilities constructed by the City will be accepted into the Lancaster Drainage Benefit Assessment District for operation and maintenance purposes.

6.4 Recommended Design Requirements

The design of drainage facilities shall be in accordance with the latest City of Lancaster Engineering Design Guidelines. Additionally, the City may require that other criteria be met in order to accommodate design conditions that are unique to any given facility.