PRELIMINARY HYDROLOGIC DRAINAGE STUDY REPORT FOR CAPITOL MALL

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1 Introduction

1.1 Purpose of Study

This report presents the data, hydrologic and hydraulic analyses, and conclusions of a preliminary drainage study performed for the proposed Capitol Mall Project. The information, data, and calculations presented herein are intended to provide preliminary drainage information for the application of a Special Use Permit in accordance with the Carson City Municipal Code.

A cross-reference with the Special Use Permit Utility Plan will aid in the understanding of this report. Please note - this study is intended to be a working document and will be updated and/or revised as needed to correspond with design modifications. In addition, in the interest of brevity and clarity, this report will defer to figures, tables, and the data and calculations contained in the appendices whenever possible.

1.2 Project Location and Description

The Capitol Mall Project is approximately 10.5 acres in size and is located within the core of Carson City, Nevada. This site is situated within NW ¼ of Section 17, Township 14 North, and Range 20 East of the Mount Diablo Meridian (refer to Exhibit 1, *Vicinity Map*). The project site is within the existing Assessor Parcel Numbers (APN's) as well as the adjacent dedicated roadways listed below:
003-223-01, 004-191-11, 004-191-12, 004-202-01, 004-202-02, 004-202-08, 004-211-11, 004-211-05, 004-211-07, 004-211-08, 004-211-09, 004-211-10, 004-213-01, 004-213-02, 004-213-03, 004-213-04, 004-213-05, 004-213-06, 004-214-01, 004-214-02, 004-216-01, 004-216-02, 004-216-03, 004-216-04, 004-216-05, 004-221-01, 004-224-02, 004-224-03, 004-224-04, 004-224-05, 004-224-07, 004-224-08, 004-225-01, 004-225-02, 004-225-03, 004-225-04.

Exhibit 2, the *Existing Hydrological Analysis*, illustrates the location and orientation of the project and its proposed lots and roadway locations. The subject property is bounded to the west by N. Curry Street, to the north by E. Robinson Street, and to the east by N. Stewart Street, and south by E. Musser Street.

According to the Federal Emergency Management Agency (FEMA) Flood Insurance Rate Map (FIRM) Community-Panel Number 3200010092F, the subject property is in Shaded Zone X. Shaded Zone X is an area determined to be outside the 100-year floodplain, but is an area of moderate flood hazard. Reference FEMA panel in Appendix A.

The purpose of this report is to analyze the existing and proposed conditions of the subject property based on the 5-year and 100-year peak flow events. The report contains the following sections: (1) Methodology, (2) Existing Hydrology, (3) Proposed Hydrology, and (4) Conclusion.

2 Methodologies and Assumptions

2.1 Hydrologic Analysis Methods

Hydrologic analyses were performed to determine the peak discharge for the 5-year and 100-year peak flow events. *Autodesk Sanitary and Storm Analysis* (SSA) was used to perform a *Rational Method* analysis to model the hydrologic basins that contribute in the existing and proposed conditions.

Parameters for peak storm flow and runoff volume estimates presented herein were determined using the data and methodologies presented in the *Carson City Municipal Code, Division 14 – Storm Drainage* section. In instances where the Carson City Municipal Code, Division 14 (CCMC-14) was lacking information or specificity, the Washoe County *Hydrologic Criteria and Drainage Design Manual (1996)* and/or the other appropriate sources and software user manuals were referenced.

For the existing and proposed on-site hydrologic conditions, the Rational Method was utilized in accordance with the CCMC-14. A minimum time of concentration of 10-minutes was used for all sub-basins for a conservative analysis.

The rainfall characteristics were modeled using the NOAA database (http://dipper.nws.noaa.gov/hdsc/pfds/sa/nv_pfds.html) to determine site specific depth of precipitation (Appendix A).

2.2 Hydraulic Modeling Methods

Hydraulic analyses were performed using the associated hydrologic data to provide the estimates of the elevation of floods for the selected recurrence intervals. Water-surface elevations were computed in SSA using hydrodynamic routing. Hydrodynamic routing solves the complete Saint Venant equations throughout the drainage network and includes modeling of backwater effects, flow reversal, surcharging, lopped connections, pressure flow, and interconnected ponds. Hydrodyanmic routing provides a formulation for channels and pipes, including translation and attenuation effects.

2.3 Assumptions

Since the Rational Method was employed for developed on-site peak storm flow estimations, reductions associated with hydrograph routing and combining have been neglected from the analyses herein. This contributes to the conservative nature of the 'worst case' analysis methods applied in this study.

3 Existing Drainage Conditions

3.1 Existing Off-Site Drainage

The subject property is located in the Ash Canyon Drainage and is in a Shaded Zone X. The effective hydraulic model routes a portion of the 100-year peak flood event through the site. The flows enter the northwestern edge of the subject property at the intersection of N. Curry Street and E. Robinson Street. The peak flood flows in an easterly – southeasterly direction and eventually combine with other surface flows at the intersection of N. Stewart Street and E. Musser Street.

3.2 Existing On-Site Drainage

The existing hydrologic analysis was based on the fact that the site was previously developed and the existing hydrologic sub-basins were delineated based on the existing stormdrain system.

For the existing catchment a time of concentration (Tc) and the Rational Method coefficients were selected, taking into consideration the catchment characteristics, which include catchment area and land cover. Weighted run-off coefficients were calculated for each basin (Table 1). A 5-year intensity of 1.47 in/hr and 100-year intensity of 3.57 in/hr were used. Table 1 and Figure 2 summarize the characteristics of on-site catchments in to study area. Reference Appendix B for the complete Rational Method analysis. Reference Figure 2 (Existing Hydrologic Conditions) in the map pocket for existing hydrology drainage map and the associated hydrologic sub-area.

Table 1 – Existing Conditions Rational Method Model Summary for the Capitol Mall Project, Carson City, Nevada.

Sub-Basin	Area (Ac.)	Rational Method Coefficient (C_5/C_{100})	Time of Concentration (min)	Rainfall Intensity (I_5/I_{100}) (in/hr.)	5-Year Peak Flows (cfs)	100-Year Peak Flows (cfs)
X-01	3.10	0.89/0.94	10.00	1.47/3.57	4.06	10.40
X-02	3.39	0.90/0.95	10.00	1.47/3.57	4.60	11.80
X-03	2.56	0.89/0.95	10.00	1.47/3.57	3.35	8.68
X-04	2.56	0.89/0.94	10.00	1.47/3.57	3.35	8.59
X-05	2.57	0.89/0.94	10.00	1.47/3.57	3.36	8.62
TOTAL	**14.18**	**-----**	**-----**	**-----**	**18.72**	**48.09**

The 5-year and 100-year peak flows from on-site catchment in the existing condition are 18.72 cfs and 48.09 cfs, respectively. The existing flows are conveyed in the existing stormdrain system and routed in a southeasterly direction.

4 Proposed Drainage Conditions

4.1 Proposed Off-Site Drainage

The previously discussed effective peak flow event (Section 3.1) will be routed around the proposed buildings within the existing and proposed stormdrain and the proposed streets.

4.2 Proposed On-Site Drainage

The sub-areas took into account the proposed on-site and off-site flows that affect the site. The associated calculated 5-year and 100-year peak flows can be found in Table 2. Both pipe sizes and catch basins have been sized to accommodate the proposed flows. Reference Figure 3 in the map pocket for the associated hydrologic sub-areas and the proposed catch basins. For the catch basin design and analysis, the project site was divided into seven on-site drainage basins. Weighted run-off coefficients were calculated for each basin (Table 2). A 5-year intensity of 1.47 in/hr and 100-year intensity of 3.57 in/hr were used. All drainage for the basins will be contained in swales and the roadway and will travel to the catch basins. From the catch basins, the flow will be routed through the proposed storm drain system and eventually connecting to the existing stormdrain facilities. Refer to Appendix C, *Hydrologic Analysis* for all data and supporting calculations using the Rational Method.

Table 2 – Proposed Conditions Rational Method Model Summary for the Capitol Mall Project, Carson City, Nevada.

Sub-Basin	Area (Ac.)	Rational Method Coefficient (C_5/C_{100})	Time of Concentration (min)	Rainfall Intensity (I_5/I_{100}) (in/hr)	5-Year Peak Flows (cfs)	100-Year Peak Flows (cfs)
P-01	3.10	0.88/0.94	10.00	1.47/3.57	4.01	10.40
P-02	1.84	0.90/0.95	10.00	1.47/3.57	2.43	6.24
P-03	1.78	0.89/0.94	10.00	1.47/3.57	2.33	5.97
P-04	0.27	0.85/0.92	10.00	1.47/3.57	0.34	0.89
P-05	0.38	0.87/0.93	10.00	1.47/3.57	0.49	1.26
P-06	0.37	0.83/0.90	10.00	1.47/3.57	0.45	1.19
P-07	0.36	0.83/0.90	10.00	1.47/3.57	0.44	1.16
P-08	0.36	0.83/0.90	10.00	1.47/3.57	0.44	1.16
P-09	0.60	0.81/0.89	10.00	1.47/3.57	0.71	1.91
P-10	0.71	0.82/0.89	10.00	1.47/3.57	0.86	2.26
P-11	0.46	0.80/0.88	10.00	1.47/3.57	0.54	1.45

Sub-Basin	Area (Ac.)	Rational Method Coefficient (C_5/C_{100})	Time of Concentration (min)	Rainfall Intensity (I_5/I_{100}) (in/hr)	5-Year Peak Flows (cfs)	100-Year Peak Flows (cfs)
P-12	0.46	0.80/0.88	10.00	1.47/3.57	0.54	1.45
P-13	0.95	0.76/0.86	10.00	1.47/3.57	1.06	2.92
P-14	0.55	0.79/0.88	10.00	1.47/3.57	0.64	1.73
P-15	0.31	0.80/0.88	10.00	1.47/3.57	0.37	0.97
P-16	0.34	0.80/0.88	10.00	1.47/3.57	0.40	1.07
P-17	1.38	0.85/0.92	10.00	1.47/3.57	1.72	4.53
TOTAL	**14.18**	**-----**	**-----**	**-----**	**17.77**	**46.56**

4.3 Detention

There is no increase in flows from the existing and proposed conditions due to additional landscaping. This is due to the subject property being previously developed and having larger runoff coefficients in the existing condition. According to the existing and proposed hydrologic analysis, the existing 5-year and 100-year condition flows are 18.72 cfs and 48.09 cfs, respectively. The proposed 5-year and 100-year condition flows are 17.77 cfs and 46.56 cfs. Therefore, according to CCMC-14, no detention facilities are required.

5 Conclusions and Recommendations

5.1 General Considerations

This study is intended to be a working document and may require updates and revisions to address the status of the improvement plans. As grading designs and surface water flow patterns are refined with subsequent plan editions, revisions may be required for the street flow and catch basin interception/bypass calculations provided herein.

5.2 Regulations and Master Plans

The proposed improvements and the analyses presented herein are in accordance with drainage regulations presented in *Carson City Municipal Code, Division 14 – Storm Drainage* section. In instances where the Carson City Municipal Code, Division 14 (CCMC-14) was lacking information or specificity, the Washoe County *Hydrologic Criteria and Drainage Design Manual (1996)* and/or the other appropriate sources and software user manuals were referenced.

The proposed development will comply with the Carson City Code 12.09.080 (3) to protect the water system from infiltration and to prevent either infiltration into the sanitary sewer or discharge of sanitary sewer into the floodwaters.

The following is intended to address *Carson City Code 12.09.080 (8) Standards for Critical Structures which states, "Critical structures are not authorized in a Special flood Hazard area, unless:*

a. All alternative locations in Flood Zone X have been considered and rejected.
b. All alternative locations in Flood Zone Shaded X have been considered and rejected."

During the site selection process it was determined that Capitol Mall is located completely within a Shaded Flood Zone X. Based upon these factors, we believe the current site is appropriate for the proposed facility.

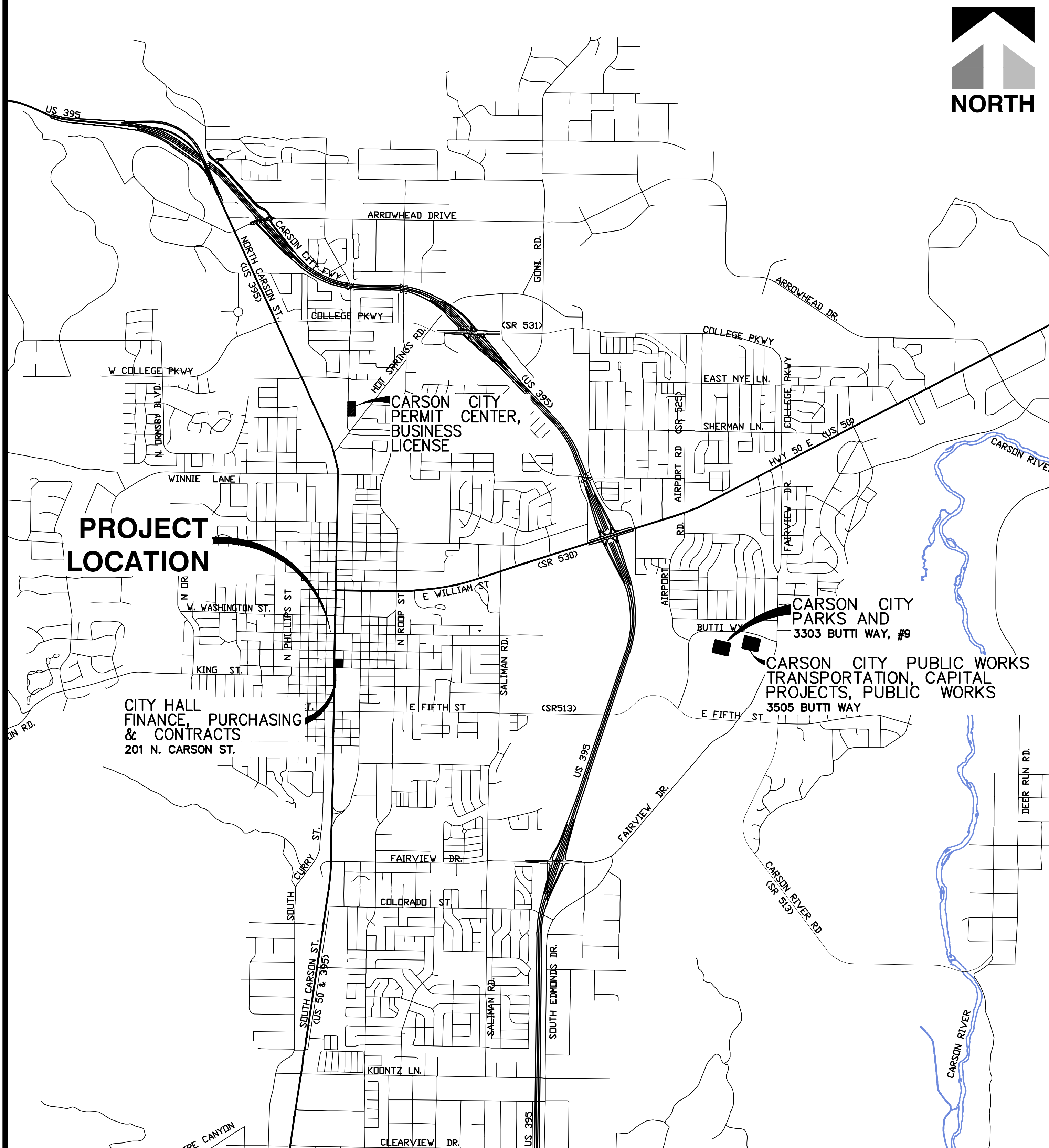
It is anticipated that the proposed fill will be balanced by a hydraulically equivalent volume of excavation below the base flood elevation and will be designed to drain freely to the water course.

5.3 Impacts to Adjacent Properties

The performance of the proposed project improvements, roadways, and storm water conveyance facilities, once constructed, will not adversely impact upstream or downstream properties adjacent to this site. The development of this site for the uses proposed will not increase upstream or downstream storm flow runoff rates, volumes, velocities, depths, and will not influence floodplain boundaries.

5.4 Standards of Practice

This study was prepared using the degree of care and skill ordinarily exercised, under similar circumstances, by reputable professional engineers practicing in this and similar localities.



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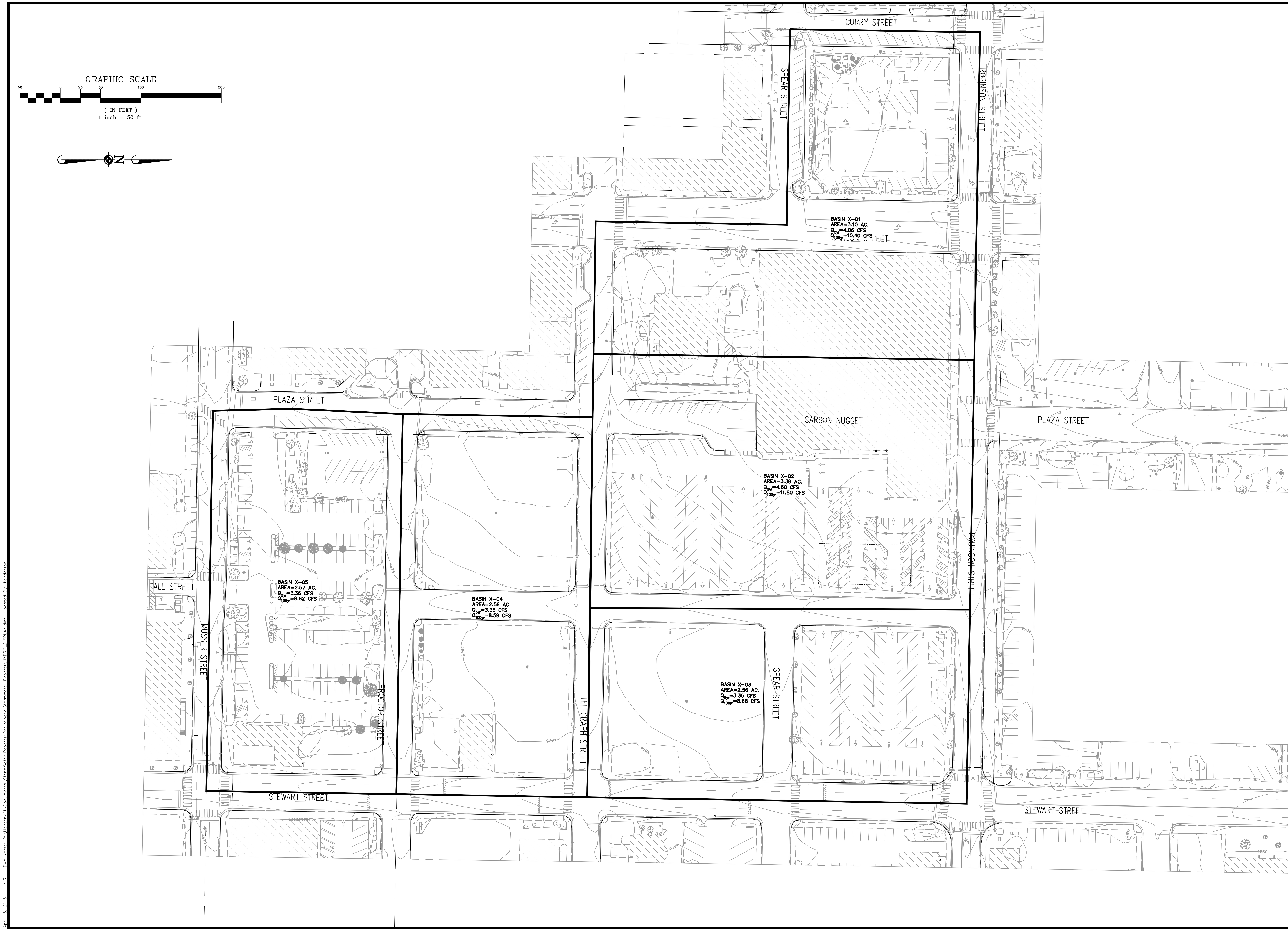
STORMWATER SYSTEM ANALYSIS REPORT FOR

CAPITOL MALL SPECIAL USE PERMIT

VICINITY MAP

PROJ. MGR.:	MJR	SHEET	
DRAWN BY:	JPB	EXHIBIT	1 OF 3
DATE:	MARCH 2015		
SCALE:	NTS	MAC.CCNV.01	

Dwg Name: P:\Maccnv01\Documents\StormWater Reports\Preliminary Stormwater Reports\Vicinity Map.dwg Updated By: CDettling 18:24



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SPECIAL USE PERMIT FOR

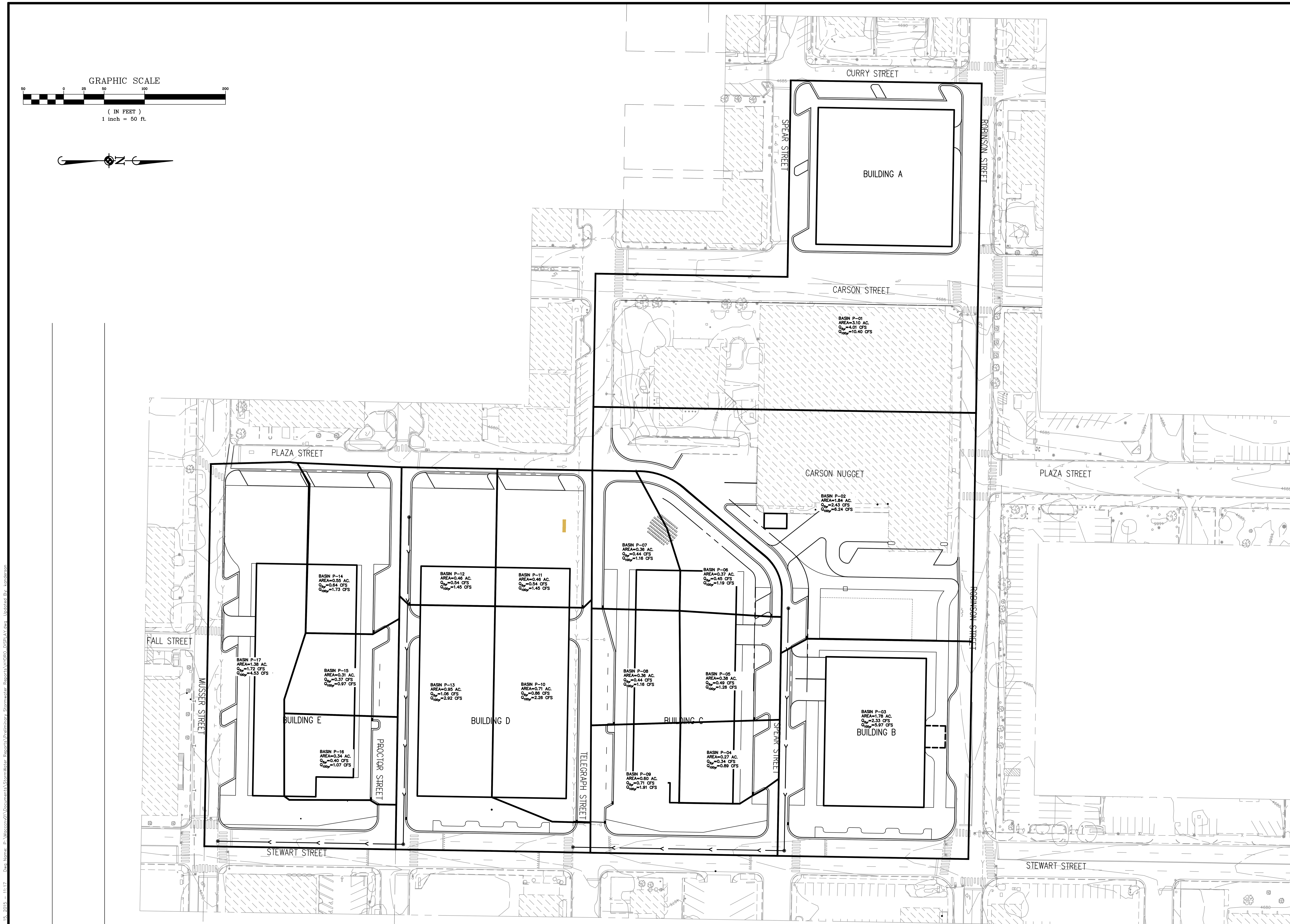
CAPITOL MALL

EXISTING HYDROLOGICAL ANALYSIS

PROJ. MGR.:	KWA
PROJ. ASSOC.:	MJR
DRAWN BY:	CRD
DATE:	MARCH 2015
SCALE:	1" = 50'

SHEET 2 OF 3

MAC.CCNV.01



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SPECIAL USE PERMIT FOR

CAPITOL MALL

PROPOSED HYDROLOGICAL ANALYSIS

PROJ. MGR.:	KWA
PROJ. ASSOC.:	MJR
DRAWN BY:	CRD
DATE:	MARCH 2015
SCALE:	1" = 50'

SHEET 3 OF 3

MAC.CCNV.01

APPENDIX A

SUPPORTING DATA

NOAA Atlas 14, Volume 1, Version 5
Location name: Carson City, Nevada, US*
Latitude: 39.1698°, Longitude: -119.7717°
Elevation: 4706 ft*
* source: Google Maps

POINT PRECIPITATION FREQUENCY ESTIMATES

Sanja Perica, Sarah Dietz, Sarah Heim, Lillian Hiner, Kazungu Maitaria, Deborah Martin, Sandra Pavlovic, Ishani Roy, Carl Trypaluk, Dale Unruh, Fenglin Yan, Michael Yekta, Tan Zhao, Geoffrey Bonnin, Daniel Brewer, Li-Chuan Chen, Tye Parzybok, John Yarchoan

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches/hour)[1]

Duration	Average recurrence interval (years)									
	1	**2**	**5**	**10**	**25**	**50**	**100**	**200**	**500**	**1000**
5-min	**1.16** (1.01-1.37)	**1.45** (1.26-1.72)	**1.93** (1.66-2.29)	**2.40** (2.04-2.84)	**3.16** (2.60-3.76)	**3.86** (3.08-4.61)	**4.69** (3.61-5.65)	**5.69** (4.21-6.97)	**7.27** (5.08-9.11)	**8.70** (5.78-11.1)
10-min	**0.888** (0.762-1.04)	**1.10** (0.960-1.31)	**1.47** (1.27-1.75)	**1.83** (1.55-2.17)	**2.41** (1.99-2.86)	**2.94** (2.35-3.51)	**3.57** (2.75-4.31)	**4.33** (3.20-5.31)	**5.53** (3.86-6.93)	**6.62** (4.41-8.45)
15-min	**0.732** (0.632-0.864)	**0.912** (0.792-1.08)	**1.22** (1.04-1.44)	**1.51** (1.28-1.79)	**1.99** (1.64-2.36)	**2.43** (1.94-2.90)	**2.95** (2.28-3.56)	**3.58** (2.65-4.39)	**4.57** (3.20-5.73)	**5.47** (3.64-6.98)
30-min	**0.494** (0.426-0.582)	**0.614** (0.532-0.728)	**0.820** (0.704-0.974)	**1.02** (0.864-1.21)	**1.34** (1.10-1.59)	**1.64** (1.31-1.95)	**1.99** (1.53-2.40)	**2.41** (1.78-2.96)	**3.08** (2.15-3.86)	**3.68** (2.45-4.70)
60-min	**0.305** (0.263-0.360)	**0.380** (0.330-0.450)	**0.507** (0.435-0.602)	**0.630** (0.535-0.746)	**0.828** (0.684-0.984)	**1.01** (0.808-1.21)	**1.23** (0.949-1.48)	**1.49** (1.10-1.83)	**1.90** (1.33-2.39)	**2.28** (1.52-2.91)
2-hr	**0.208** (0.185-0.238)	**0.257** (0.229-0.294)	**0.328** (0.290-0.374)	**0.390** (0.341-0.445)	**0.484** (0.412-0.555)	**0.568** (0.472-0.658)	**0.663** (0.537-0.778)	**0.778** (0.610-0.926)	**0.976** (0.732-1.21)	**1.16** (0.840-1.47)
3-hr	**0.166** (0.149-0.186)	**0.206** (0.186-0.233)	**0.258** (0.231-0.291)	**0.301** (0.267-0.339)	**0.362** (0.315-0.409)	**0.414** (0.354-0.472)	**0.472** (0.396-0.544)	**0.547** (0.449-0.640)	**0.668** (0.531-0.811)	**0.785** (0.608-0.988)
6-hr	**0.116** (0.104-0.130)	**0.145** (0.130-0.162)	**0.180** (0.161-0.201)	**0.207** (0.184-0.231)	**0.244** (0.214-0.274)	**0.273** (0.237-0.309)	**0.303** (0.258-0.346)	**0.337** (0.281-0.390)	**0.387** (0.315-0.455)	**0.431** (0.343-0.516)
12-hr	**0.077** (0.068-0.086)	**0.096** (0.086-0.108)	**0.121** (0.107-0.136)	**0.140** (0.124-0.158)	**0.166** (0.145-0.188)	**0.187** (0.161-0.212)	**0.207** (0.176-0.238)	**0.228** (0.190-0.266)	**0.256** (0.208-0.304)	**0.279** (0.221-0.336)
24-hr	**0.051** (0.046-0.056)	**0.064** (0.058-0.070)	**0.081** (0.073-0.089)	**0.094** (0.085-0.104)	**0.113** (0.102-0.125)	**0.128** (0.115-0.141)	**0.144** (0.128-0.159)	**0.160** (0.141-0.178)	**0.182** (0.158-0.204)	**0.200** (0.171-0.226)
2-day	**0.031** (0.027-0.034)	**0.039** (0.035-0.043)	**0.049** (0.044-0.055)	**0.058** (0.052-0.065)	**0.070** (0.062-0.079)	**0.079** (0.070-0.090)	**0.090** (0.078-0.102)	**0.100** (0.087-0.115)	**0.115** (0.098-0.133)	**0.127** (0.106-0.148)
3-day	**0.023** (0.020-0.025)	**0.028** (0.025-0.032)	**0.036** (0.032-0.041)	**0.043** (0.038-0.049)	**0.052** (0.046-0.059)	**0.060** (0.052-0.068)	**0.068** (0.059-0.077)	**0.076** (0.065-0.087)	**0.088** (0.074-0.101)	**0.097** (0.081-0.113)
4-day	**0.018** (0.016-0.021)	**0.023** (0.021-0.026)	**0.030** (0.027-0.034)	**0.036** (0.032-0.041)	**0.044** (0.038-0.050)	**0.050** (0.043-0.057)	**0.057** (0.049-0.065)	**0.064** (0.054-0.073)	**0.074** (0.062-0.086)	**0.082** (0.068-0.096)
7-day	**0.012** (0.011-0.014)	**0.016** (0.014-0.018)	**0.020** (0.018-0.023)	**0.024** (0.021-0.027)	**0.029** (0.026-0.033)	**0.033** (0.029-0.038)	**0.038** (0.033-0.043)	**0.042** (0.036-0.048)	**0.049** (0.041-0.056)	**0.054** (0.045-0.063)
10-day	**0.010** (0.008-0.011)	**0.012** (0.011-0.014)	**0.016** (0.014-0.018)	**0.019** (0.016-0.021)	**0.022** (0.020-0.025)	**0.026** (0.022-0.029)	**0.029** (0.025-0.033)	**0.032** (0.027-0.036)	**0.037** (0.031-0.042)	**0.040** (0.034-0.047)
20-day	**0.006** (0.005-0.007)	**0.007** (0.007-0.008)	**0.010** (0.009-0.011)	**0.011** (0.010-0.013)	**0.014** (0.012-0.015)	**0.015** (0.013-0.017)	**0.017** (0.015-0.019)	**0.019** (0.016-0.021)	**0.021** (0.018-0.024)	**0.023** (0.019-0.026)
30-day	**0.004** (0.004-0.005)	**0.006** (0.005-0.006)	**0.007** (0.007-0.008)	**0.009** (0.008-0.010)	**0.010** (0.009-0.011)	**0.011** (0.010-0.013)	**0.013** (0.011-0.014)	**0.014** (0.012-0.016)	**0.016** (0.014-0.018)	**0.017** (0.015-0.019)
45-day	**0.004** (0.003-0.004)	**0.004** (0.004-0.005)	**0.006** (0.005-0.006)	**0.007** (0.006-0.007)	**0.008** (0.007-0.009)	**0.009** (0.008-0.010)	**0.010** (0.009-0.011)	**0.011** (0.009-0.012)	**0.012** (0.010-0.013)	**0.013** (0.011-0.014)
60-day	**0.003** (0.003-0.003)	**0.004** (0.003-0.004)	**0.005** (0.004-0.006)	**0.006** (0.005-0.006)	**0.007** (0.006-0.007)	**0.007** (0.007-0.008)	**0.008** (0.007-0.009)	**0.009** (0.008-0.010)	**0.010** (0.008-0.011)	**0.010** (0.009-0.011)

[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

Please refer to NOAA Atlas 14 document for more information.

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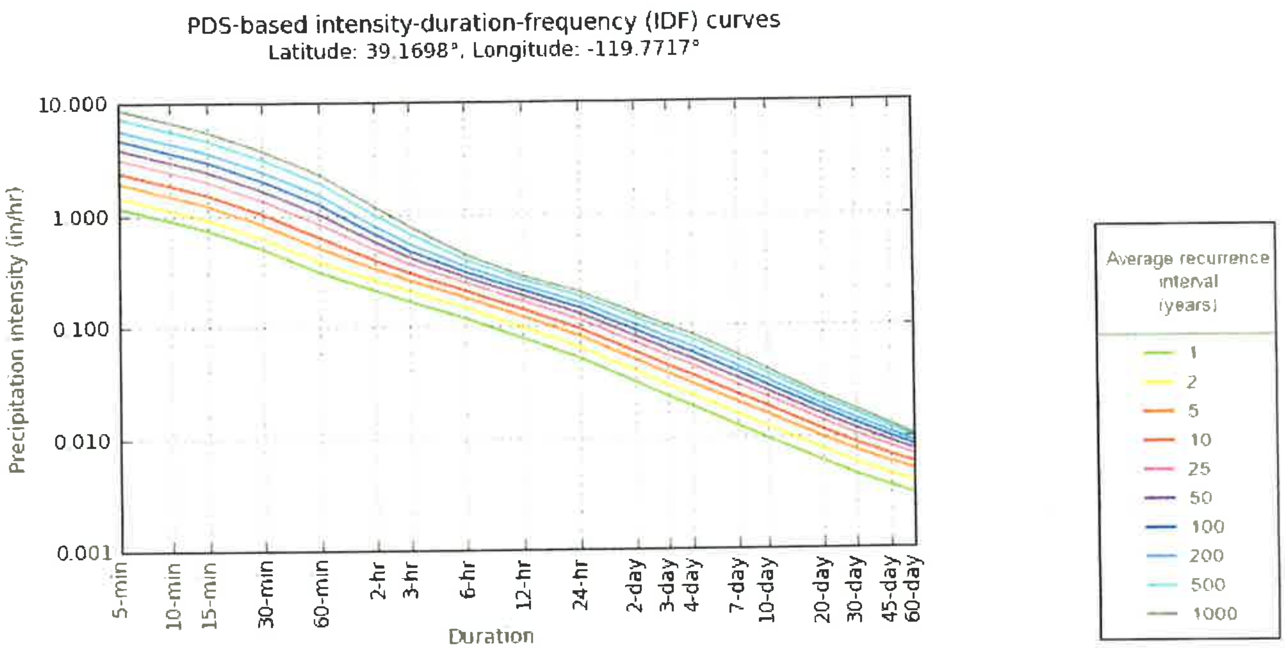
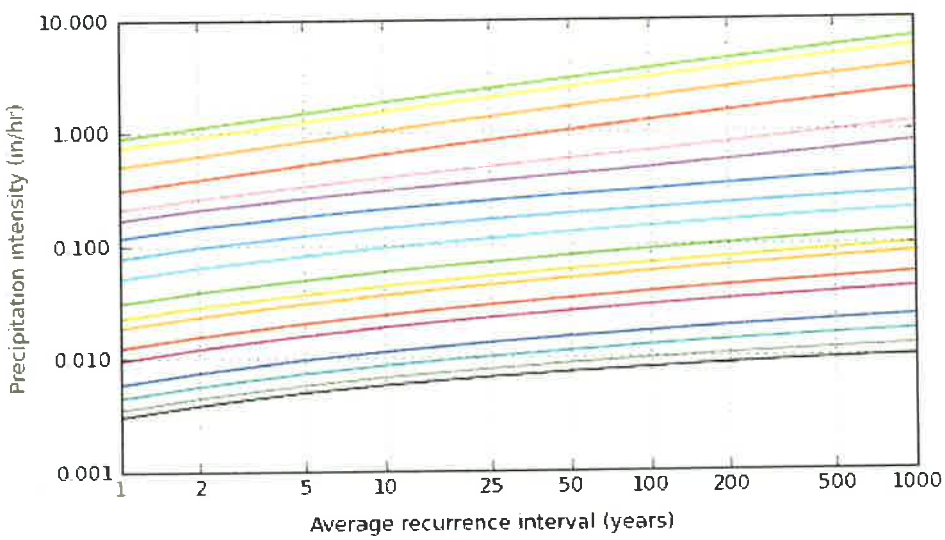
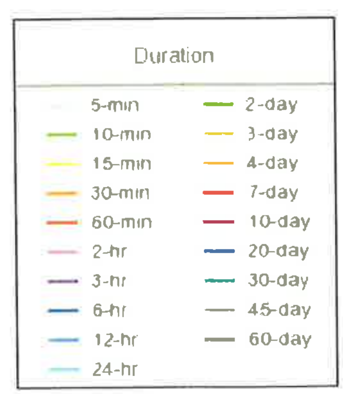
PF graphical





NOAA Atlas 14, Volume 1, Version 5 Created (GMT): Tue Dec 16 00:47:50 2014



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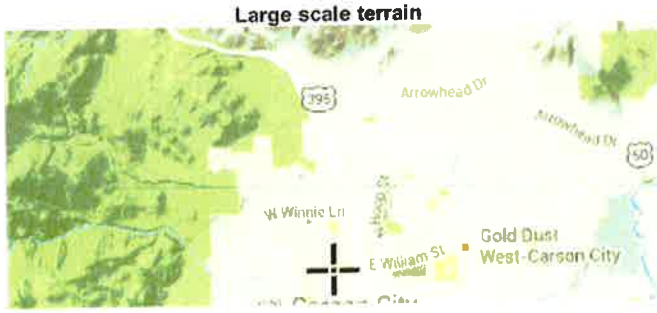
Maps & aerials

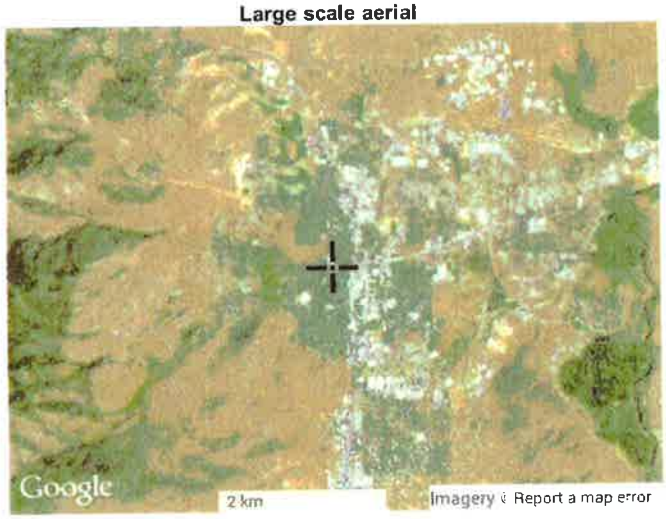
Small scale terrain

Large scale terrain



Large scale map

Large scale aerial



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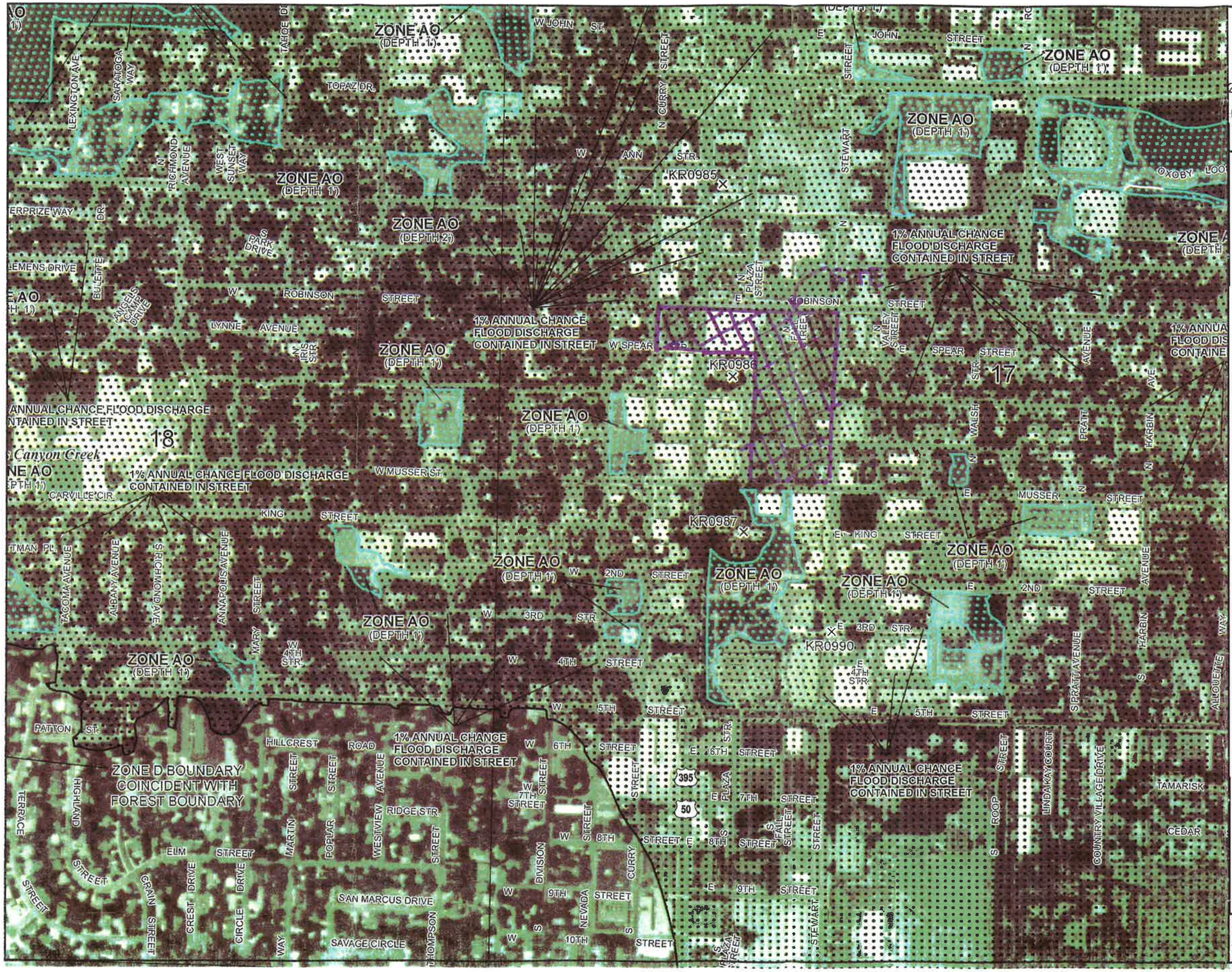
US Department of Commerce
National Oceanic and Atmospheric Administration
National Weather Service
Office of Hydrologic Development
1325 East West Highway
Silver Spring, MD 20910
Questions?: HDSC.Questions@noaa.gov

Disclaimer



MAP SCALE 1" = 500'

250 0 500 1000 FEET

METERS

NFIP

PANEL 0092F

NATIONAL FLOOD INSURANCE PROGRAM

FIRM

FLOOD INSURANCE RATE MAP

CARSON CITY,
NEVADA
INDEPENDENT CITY

PANEL 92 OF 275
(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX

Notice to User: The Map Number shown below should be used when placing map orders; the Community Number shown above should be used on insurance applications for the subject community.

MAP NUMBER
3200010092F

MAP REVISED
FEBRUARY 19, 2014

Federal Emergency Management Agency

14.1 - Drainage policy introduction and basic principles.

Adequate drainage systems shall be provided in order to preserve and promote the general health, welfare, and economic well being of the region. Drainage is a regional feature that affects all of Carson City. Drainage plans shall be consistent with and integrated with the Carson City drainage master plan upon adoption. This characteristic of drainage requires coordination and cooperation from both the public and private sectors.

Storm water drainage systems are an integral part of the development process. The planning of drainage facilities shall be included in the development process and in preparation of improvement plans.

Drainage systems require space to accommodate conveyance and storage functions. When the space requirements are considered, the provision for adequate drainage becomes a competing use for space along with other land uses.

Storm drainage planning for all development shall include the allocation of space for drainage facility construction and maintenance, which may entail the dedication of right-of-way and/or easements. The provision of multi-use facilities such as combining with parks, open space, and recreation needs is strongly encouraged.

14.1.1 Water Rights. All drainage systems shall be planned and constructed with consideration given to the existing water rights and applicable water laws.

14.1.2 Reasonable Use of Drainage. Downstream properties shall not be unreasonably burdened with increased flow rates, negative impacts, or unreasonable changes in manner of flow from upstream properties. Drainage problems shall not be transferred from one location to another. However, downstream properties cannot block natural or existing runoff through their site and shall accept runoff from upstream properties.

"Reasonable use of drainage" is defined for planning purposes, as providing an economic and hydraulically efficient drainage system which is demonstrated not to adversely and unreasonably impact downstream properties within reason. This "reasonable use of drainage" therefore allows development to occur while preserving the rights of adjacent property owners.

14.1.3 Change in Manner of Flow. Development shall tend to concentrate existing natural sheet flow into point flows at property lines. These point flows are generally associated with outlets from gutter flow, storm drains, and detention facilities. Downstream properties may experience a longer duration of storm flows, and greater flows in general due to a shortened time of concentration. Discharge of point flows on downstream property can cause increased erosion at the discharge point and further downstream. Therefore, downstream facilities shall be evaluated for runoff capacity during the design and review process. Mitigation of these point flows can be accomplished through energy dissipaters or flow spreaders. Point flows shall be discharged to downstream properties at non-erosive velocities and depths of flow.

14.1.4 Diversion of Drainage. Development can alter the historic or natural drainage paths. When these alterations result in a local on-site drainage system that discharges back into the natural drainage-way or wash at or near the historic location, then the alterations (inter-basin transfer) are generally acceptable. However, when flows from the local on-site drainage system do not return to the historic drainage-way or wash, then inter-basin transfer may result. These inter-basin transfers are generally not acceptable. Planning and design of drainage systems shall not be based on the premise that storm water can be transferred from one basin to another unless part of an adopted city regional drainage system plan.

The flow of storm runoff shall be maintained within its natural drainage course unless reasonable use is demonstrated otherwise. When storm water is discharged into an existing drainage course, the peak discharge into the water course shall not adversely affect or cause damage to property along the drainage course now or in the future based on existing zoning and the Carson City master plan build-out conditions. Erosional impacts due to concentration of flows and increased flow durations shall be evaluated and mitigated.

14.1.5 Water Quality. Storm drainage improvements shall incorporate water quality and erosion controls in accordance with the Nevada "Handbook of Best Management Practices," this division, and accepted engineering practice. Storm drainage leaving a development may not be of a quality that shall adversely affect downstream uses.

14.1.6 Drainage Improvements. Drainage improvements consist of curb and gutter, inlets and storm drains, culverts, bridges, swales, ditches, channels, detention areas, and other drainage facilities required to convey design storm runoff to the point of discharge. Drainage improvements are further defined as on-site (private) facilities that serve a specific development and are privately owned and maintained or off-site (public) facilities. Public and private drainage facilities shall be constructed in accordance with the requirements of this division.

14.1.7 Floodplain Management. Floodplain management shall provide the guidance, conditions, and restrictions for development in floodplain areas while protecting the public's health, safety, welfare, and property from danger and damage. Development within the Federal Emergency Management Agency (FEMA) designated floodplains shall comply with CCMC, and requirements of the National Flood Insurance Program (NFIP).

14.1.8 Storm Runoff Detention. Detention is considered a viable method to reduce storm runoff from developed properties. Temporarily detaining storm runoff can significantly reduce downstream flood hazards as well as pipe and channel requirements. Storage also provides for sediment and debris collection which reduces maintenance requirements for downstream channels and streams.

Local detention storage for land development, which includes subdividing land, shall be required when the development increases flows and downstream conveyance capacities of the drainage system are not capable of handling non-detained flows, and the developer elects to not upgrade the existing storm drainage system. Onsite detention storage shall be sized to detain sufficient runoff to limit flows from a five (5) year storm (Q5) to their predevelopment condition.

The capacity of downstream conveyance systems shall be analyzed in accordance with this division and shall be based on runoff from the development as fully improved. Local detention can also be required when designated in flood or drainage master plans to reduce the peak rate in regional facilities.

Exemptions to the detention policy may be granted by the city for the following:

1. Developments which discharge directly to a regional flood control facility, provided the facility is completed per the adopted plan and designed for the contributing flows.
2. Locations where a local detention facility is designed and constructed to serve several developments and the contributing flows.
3. Downstream facilities are upgraded to accommodate the increased flow.
4. Where the downstream facilities are adequate to carry up to one hundred (100) year flows.

All exemptions are subject to approval by the city.

14.1.9 Lower Watershed Design. In certain circumstances, i.e., close to the drainage system's point of discharge, it may be desirable to not detain storm water runoff. The option to directly discharge shall be at the sole option of the city and after review of a flood route analysis.

14.1.10 Storm Runoff Retention and Infiltration. Storm runoff retention and infiltration has been used to eliminate the need for constructing outlet structures and for ease of construction. However, problems with retention basins and infiltration facilities include perpetual maintenance requirements, soil expansion, siltation, decreasing infiltration capacity, insect abatement and also poses a hazard to city groundwater resources through possible contamination.

14.1.11 Drainage Facilities Maintenance. An important part of all storm drainage facilities is the continued maintenance of the facilities to insure they shall function as designed. Maintenance of detention facilities involves removal of debris and sediment. Such tasks are necessary to preclude the facility from becoming unhealthy and to retain the effectiveness of the detention basin. Sediment and debris must also be periodically removed from channels and storm drains. Trashrack and street inlets must be regularly cleared of debris to maintain system capacity. Channel bank erosion, damage to drop structures, crushing of pipe inlets and outlets, and deterioration to the facilities must be repaired to avoid reduced conveyance capability, unsightliness, and ultimate failure.

All drainage facilities shall be designed to minimize facility maintenance as well as to provide ease of maintenance and include maintenance access to the drainage facility. The owner of the drainage facilities shall be responsible for mosquito control and the method of control shall comply with Carson City environmental health department.

The property owner or developer shall be responsible for maintenance of all privately owned on-site drainage facilities including, but not limited to, inlets, pipes, channels, and detention basins, unless otherwise required or modified by separate agreement. Shall the property owner or developer fail to adequately maintain said facilities, Carson City shall be given the right to enter said property, upon proper notice, for the purposes of maintenance. All such maintenance costs shall be assessed against the owner(s). A maintenance agreement shall be provided to the city for all projects.

14.1.12 Drainage Easements. Easements shall be provided where necessary for access and maintenance of the storm drain system.

(Ord. 2001-23, Development Standards).

14.2 - Technical criteria.

14.2.1 Design Storm Events. Drainage facilities shall be designed to convey the run off for the twenty-four (24) hour duration storm with a recurrence interval for a minor storm event (five (5) year) and a major storm event (one hundred (100) year).

14.2.1.1 Storm Runoff Determination. Storm runoff (rates and volumes) shall be determined in accordance with the following methods (other methods may be used if approved by development engineering):

Contributing Basin Area (A)	Computation Procedure
A ≤ 100 Acres	Rational formula, SCS TR-55, or HEC-1 SCS Unit Hydrograph or Kinematic Wave)
10 SM.> A ≥ 100 Acres	SCS TR-55 or HEC-1 (SCS Unit Hydrograph or Kinematic Wave)
A > 10 S.M.	HEC-1 (SCS Unit Hydrograph or Kinematic Wave)

14.2.1.2 Rainfall. Rainfall data tables and storm design information shall be derived from the NOAA Atlas, latest edition, or other city approval.

14.2.1.3 Streets. The use of streets to convey runoff, although naturally occurring, interferes with the primary function of the street for transportation purposes. Streets are, however, an important component in the storm drainage system due to their large storm carrying capacity obtained for little or no drainage costs. In order to balance these two competing street uses, limits on the street carrying capacity are required based on the street classification related to emergency usage during storm and flood events.

The allowable street capacity for different roadway functional classifications shall be determined in accordance with Table 14.1 and Table 14.2. To ensure cleaning velocities at low flows, gutters shall have a minimum slope of four-tenths of one percent (0.40%).

14.2.1.4 Culverts, Bridges, Valley Gutter and Dip Sections. Culverts and bridges shall be installed where natural or manmade drainage channels are crossed by streets. Valley gutters, or "dip sections," shall be permitted on local streets. The amount of channel flow which crosses over the street shall be minimized (not more than 0.5 feet) to protect the street embankment and pavement from erosion damage as well as to protect vehicles and pedestrians from dangerous flow depths and velocities. Bridges and culvert crossings under streets shall be sized for the required design storm capacity in accordance with Table 14.1

Table 14.1
Design Storm Events for Crossings

Design Storm Criteria	Design Storm Event (see Notes)
1. Local Streets	25-year return period, 24-hour duration
2. Arterial and Collector Streets	100-year return period, 24-hour duration
3. Developments (commercial, industrial, residential)	5-year return period, 24-hour duration

Notes:

1. All development shall provide emergency flow paths for a one hundred (100) year peak storm in accordance with Table 14.2

2. Refer to section 14.3.1 for additional situations where the drainage system shall be designed for not less than a one hundred (100) year return period, twenty-four (24) hour duration.

3. Refer to section 14.1.8 for additional requirements for projects located within a floodplain.

(Ord. 2001-23, Development Standards).

14.3 - Storm drain system.

14.3.1 Introduction. The size of the storm drain system is generally governed by the design storm peak flows as shown in Table 14.2. There are conditions, however, when the storm drain system design shall be governed by the one hundred (100) year return period, twenty-four (24) hour duration storm flows. Storm drain systems shall be designed for not less than a one hundred (100) year peak storm for the following situations:

1. Locations where street flow is collected in a sump with no allowable overflow capacity.
2. Locations where the desired one hundred (100) year return period, twenty-four (24) hour duration storm flow direction is not reflected by the street flow direction during a one hundred (100) year return period, twenty-four (24) hour duration storm (i.e., flow splits at intersections).

If a storm drain is to be designed to convey one hundred (100) year return period, twenty-four (24) hour duration storm flows, then the inlets to the storm drain shall be designed accordingly.

Table 14.2
Design Storm Street Capacity Limitations

Roadway Functional Classification	Maximum Limits of Street Inundation (See Notes)
1) Arterial	Q5 Storm: Flow contained in R/W. No curb overtopping. A minimum forty-eight foot (48) wide dry lane centered shall be maintained and in each direction twenty-four feet (24). Runoff in excess of street capacity shall be piped. Q100 Storm: Flow contained to not inundate structures. Maximum depth at gutter flow line shall be 1 foot (1). A minimum twelve foot (12) wide dry lane shall be maintained in each direction or twenty-four feet (24) centered.
2) Collector	Q5 Storm: Flow contained in R/W. No curb overtopping. A minimum eighteen foot (18) wipe dry lane centered shall be maintained. Runoff in excess of street capacity shall be piped. Q100 Storm: Flow contained to not inundate structures. Maximum depth at gutter flow line shall be one foot (1). A minimum twelve foot (12) wide dry lane shall be maintained centered.
3) Local or Industrial Street	Q5 Storm: Flow contained in R/W. No curb overtopping. A minimum twelve foot (I2) wide dry lane centered shall be maintained. Runoff in excess of street capacity shall be piped. Q100 Storm: Flow contained to not inundate structures. Maximum depth at gutter flow line shall be one foot (1). Street flooded.

Notes:

1. Where no curb exists, encroachment onto adjacent property shall be allowed but must contained to not inundate structures.

2. Other criteria such as the Federal Housing Administration regulations may impose standards more restrictive than cited.

14.3.2 Design Criteria.

14.3.2.1 Allowable Storm Drain Capacity.

The storm drain capacity calculations shall begin at the storm drain outlet and proceed upstream, accounting for all energy losses. The Energy Grade Line (EGL) and Hydraulic Grade Line (HGL) shall be calculated to include all hydraulic losses including friction, expansion, constriction, bend, and junction losses. The available energy at all junctions and transitions shall be checked to

Table 14.3
Allowable Storm Inlet Types and Capacity Factors

Inlet or Catch Basin Type	Permitted Use	Permitted Location Condition	Capacity Factor
Catch Basin Type 1	Private Use Only	Sump	0.65
Catch Basin Type 1A	Street with Curb and Gutter	Continuous Grade Sump	0.70 (Grate), 0.80 (Curb Opening) 0.65
Catch Basin Type 3	Landscaped or Unimproved Areas	Sump	0.50
Catch Basin Type 4	Street with Curb and Gutter	Continuous Grade Sump	0.70 (Grate), 0.80 (Curb Opening) 0.65

Notes:

1. Capacity factor is applied to the theoretical inlet capacity to obtain the allowable inlet capacity to account for factors which reduce actual inlet capacity.

14.3.5 Design Standards for Culverts. Culverts shall be designed and constructed using the following standards. The analysis and design shall consider design flow, culvert size and material, entrance structure layout, outlet structure layout, and erosion protection.

14.3.5.1 Culvert Sizing Criteria.

14.3.5.1.1 Design Frequency. As indicated in section 14.2.1.4 (culverts), all culverts shall be designed to pass the flow from the design storm including an overflow section where permitted.

14.3.5.1.2 Minimum Size. The minimum culvert size shall be eighteen inches (18") diameter for round pipe or an equivalent flow area for other pipe shapes.

14.3.5.2 Culvert Materials. Culverts shall be RCP in accordance with the standard details under roadways, and other traffic areas. For rural residential driveways CMP is allowed. The use of dip sections rather than culverts are encouraged for rural residential driveway crossings.

14.3.5.3 Outlet Protection. Outlet erosion protection for discharges to channels with unlined bottoms shall be provided as follows:

Outlet Velocity (fps)	Required Outlet Protection
Less than 5	Rip-rap protection
Between 5 and l5	Rip-rap protection or energy dissipater
Greater than 15	Energy dissipater

RATIONAL FORMULA METHOD
RUNOFF COEFFICIENTS

Land Use or Surface Characteristics	Aver. % Impervious Area	Runoff Coefficients 5-Year (C_5)	Runoff Coefficients 100-Year (C_{100})
Business/Commercial:			
Downtown Areas	85	.82	.85
Neighborhood Areas	70	.65	.80
Residential:			
(Average Lot Size)			
⅛ Acre or Less (Multi-Unit)	65	.60	.78
¼ Acre	38	.50	.65
⅛ Acre	30	.45	.60
½ Acre	25	.40	.55
1 Acre	20	.35	.50
Industrial:	72	.68	.82
Open Space: (Lawns, Parks, Golf Courses)	5	.05	.30
Undeveloped Areas:			
Range	0	.20	.50
Forest	0	.05	.30
Streets/Roads:			
Paved	100	.88	.93
Gravel	20	.25	.50
Drives/Walks:	95	.87	.90
Roof:	90	.85	.87

Notes:

1. Composite runoff coefficients shown for Residential, Industrial, and Business/Commercial Areas assume irrigated grass landscaping for all pervious areas. For development with landscaping other than irrigated grass, the designer must develop project specific composite runoff coefficients from the surface characteristics presented in this table.

VERSION: April 30, 2009	REFERENCE: USDCM, DROCOG, 1969 (with modifications)	TABLE 701

WTC ENGINEERING INC

APPENDIX B

EXISTING HYDROLOGICAL ANALYSIS

Project Description

File Name	5-YEAR_EXISTING.SPF	
Description	Capitol Mall Hydrologic Analysis 5-Year Existing	

Project Options

Flow Units	CFS	
Elevation Type	Elevation	
Hydrology Method	Rational	
Time of Concentration (TOC) Method	SCS TR-55	
Link Routing Method	Hydrodynamic	
Enable Overflow Ponding at Nodes	YES	
Skip Steady State Analysis Time Periods	NO	

Analysis Options

Start Analysis On	Mar 19, 2015	00:00:00
End Analysis On	Mar 20, 2015	00:00:00
Start Reporting On	Mar 19, 2015	00:00:00
Antecedent Dry Days	0	days
Runoff (Dry Weather) Time Step	0 01:00:00	days hh:mm:ss
Runoff (Wet Weather) Time Step	0 00:05:00	days hh:mm:ss
Reporting Time Step	0 00:05:00	days hh:mm:ss
Routing Time Step	30	seconds

Number of Elements

	Qty
Rain Gages	0
Subbasins	5
Nodes	5
Junctions	0
Outfalls	5
Flow Diversions	0
Inlets	0
Storage Nodes	0
Links	0
Channels	0
Pipes	0
Pumps	0
Orifices	0
Weirs	0
Outlets	0
Pollutants	0
Land Uses	0

Rainfall Details

Return Period	5 year(s)

Subbasin Summary

SN	Subbasin ID	Area (ac)	Weighted Runoff Coefficient	Total Rainfall (in)	Total Runoff (in)	Total Runoff Volume (ac-in)	Peak Runoff (cfs)	Time of Concentration (days hh:mm:ss)
1	X-01	3.10	0.8900	0.25	0.22	0.68	4.06	0 00:10:00
2	X-02	3.48	0.9000	0.25	0.22	0.77	4.60	0 00:10:00
3	X-03	2.56	0.8900	0.25	0.22	0.56	3.35	0 00:10:00
4	X-04	2.56	0.8900	0.25	0.22	0.56	3.35	0 00:10:00
5	X-05	2.57	0.8900	0.25	0.22	0.56	3.36	0 00:10:00

Node Summary

SN	Element ID	Element Type	Invert Elevation (ft)	Ground/Rim (Max) Elevation (ft)	Initial Water Elevation (ft)	Surcharge Elevation (ft)	Ponded Area (ft^2)	Peak Inflow (cfs)	Max HGL Elevation Attained (ft)	Max Surcharge Depth Attained (ft)	Min Freeboard Attained (ft)	Time of Peak Flooding Occurrence (days hh:mm)	Total Flooded Volume (ac-in)	Total Time Flooded (min)
1	Out-01	Outfall	0.00					0.00	0.00					
2	Out-02	Outfall	0.00					0.00	0.00					
3	Out-03	Outfall	0.00					0.00	0.00					
4	Out-04	Outfall	0.00					0.00	0.00					
5	Out-05	Outfall	0.00					0.00	0.00					

Project Description

File Name	100-YEAR_EXISTING.SPF
Description	Capitol Mall Hydrologic Analysis 100-Year Existing Conditions

Project Options

Flow Units	CFS
Elevation Type	Elevation
Hydrology Method	Rational
Time of Concentration (TOC) Method	SCS TR-55
Link Routing Method	Hydrodynamic
Enable Overflow Ponding at Nodes	YES
Skip Steady State Analysis Time Periods	NO

Analysis Options

Start Analysis On	Mar 19, 2015	00:00:00
End Analysis On	Mar 20, 2015	00:00:00
Start Reporting On	Mar 19, 2015	00:00:00
Antecedent Dry Days	0	days
Runoff (Dry Weather) Time Step	0 01:00:00	days hh:mm:ss
Runoff (Wet Weather) Time Step	0 00:05:00	days hh:mm:ss
Reporting Time Step	0 00:05:00	days hh:mm:ss
Routing Time Step	30	seconds

Number of Elements

	Qty
Rain Gages	0
Subbasins	5
Nodes	5
Junctions	0
Outfalls	5
Flow Diversions	0
Inlets	0
Storage Nodes	0
Links	0
Channels	0
Pipes	0
Pumps	0
Orifices	0
Weirs	0
Outlets	0
Pollutants	0
Land Uses	0

Rainfall Details

Return Period	100 year(s)

Subbasin Summary

SN	Subbasin ID	Area (ac)	Weighted Runoff Coefficient	Total Rainfall (in)	Total Runoff (in)	Total Runoff Volume (ac-in)	Peak Runoff (cfs)	Time of Concentration (days hh:mm:ss)
1	X-01	3.10	0.9400	0.60	0.56	1.73	10.40	0 00:10:00
2	X-02	3.48	0.9500	0.60	0.57	1.97	11.80	0 00:10:00
3	X-03	2.56	0.9500	0.60	0.57	1.45	8.68	0 00:10:00
4	X-04	2.56	0.9400	0.60	0.56	1.43	8.59	0 00:10:00
5	X-05	2.57	0.9400	0.60	0.56	1.44	8.62	0 00:10:00

Node Summary

SN	Element ID	Element Type	Invert Elevation (ft)	Ground/Rim (Max) Elevation (ft)	Initial Water Elevation (ft)	Surcharge Elevation (ft)	Ponded Area (ft^2)	Peak Inflow (cfs)	Max HGL Elevation Attained (ft)	Max Surcharge Depth Attained (ft)	Min Freeboard Attained (ft)	Time of Peak Flooding Occurrence (days hh:mm)	Total Flooded Volume (ac-in)	Total Time Flooded (min)
1	Out-01	Outfall	0.00					0.00	0.00					
2	Out-02	Outfall	0.00					0.00	0.00					
3	Out-03	Outfall	0.00					0.00	0.00					
4	Out-04	Outfall	0.00					0.00	0.00					
5	Out-05	Outfall	0.00					0.00	0.00					

APPENDIX C

PROPOSED HYDROLOGICAL ANALYSIS

Project Description

File Name	5-YEAR_PROPOSED.SPF
Description	Capitol Mall Hydrologic Analysis 5-Year Proposed Conditions

Project Options

Flow Units	CFS
Elevation Type	Elevation
Hydrology Method	Rational
Time of Concentration (TOC) Method	SCS TR-55
Link Routing Method	Hydrodynamic
Enable Overflow Ponding at Nodes	YES
Skip Steady State Analysis Time Periods	NO

Analysis Options

Start Analysis On	Mar 19, 2015	00:00:00
End Analysis On	Mar 20, 2015	00:00:00
Start Reporting On	Mar 19, 2015	00:00:00
Antecedent Dry Days	0	days
Runoff (Dry Weather) Time Step	0 01:00:00	days hh:mm:ss
Runoff (Wet Weather) Time Step	0 00:05:00	days hh:mm:ss
Reporting Time Step	0 00:05:00	days hh:mm:ss
Routing Time Step	30	seconds

Number of Elements

	Qty
Rain Gages	0
Subbasins	17
Nodes	30
Junctions	12
Outfalls	2
Flow Diversions	0
Inlets	16
Storage Nodes	0
Links	28
Channels	0
Pipes	28
Pumps	0
Orifices	0
Weirs	0
Outlets	0
Pollutants	0
Land Uses	0

Rainfall Details

Return Period	5 year(s)

Subbasin Summary

SN	Subbasin ID	Area (ac)	Weighted Runoff Coefficient	Total Rainfall (in)	Total Runoff (in)	Total Runoff Volume (ac-in)	Peak Runoff (cfs)	Time of Concentration (days hh:mm:ss)
1	P-01	3.10	0.8800	0.25	0.22	0.67	4.01	0 00:10:00
2	P-02	1.84	0.9000	0.25	0.22	0.40	2.43	0 00:10:00
3	P-03	1.78	0.8900	0.25	0.22	0.39	2.33	0 00:10:00
4	P-04	0.27	0.8500	0.25	0.21	0.06	0.34	0 00:10:00
5	P-05	0.38	0.8700	0.25	0.21	0.08	0.49	0 00:10:00
6	P-06	0.37	0.8300	0.25	0.20	0.08	0.45	0 00:10:00
7	P-07	0.36	0.8300	0.25	0.20	0.07	0.44	0 00:10:00
8	P-08	0.36	0.8300	0.25	0.20	0.07	0.44	0 00:10:00
9	P-09	0.60	0.8100	0.25	0.20	0.12	0.71	0 00:10:00
10	P-10	0.71	0.8200	0.25	0.20	0.14	0.86	0 00:10:00
11	P-11	0.46	0.8000	0.25	0.20	0.09	0.54	0 00:10:00
12	P-12	0.46	0.8000	0.25	0.20	0.09	0.54	0 00:10:00
13	P-13	0.95	0.7600	0.25	0.19	0.18	1.06	0 00:10:00
14	P-14	0.55	0.7900	0.25	0.19	0.11	0.64	0 00:10:00
15	P-15	0.31	0.8000	0.25	0.20	0.06	0.37	0 00:10:00
16	P-16	0.34	0.8000	0.25	0.20	0.07	0.40	0 00:10:00
17	P-17	1.38	0.8500	0.25	0.21	0.29	1.72	0 00:10:00

Node Summary

SN	Element ID	Element Type	Invert Elevation (ft)	Ground/Rim (Max) Elevation (ft)	Initial Water Elevation (ft)	Surcharge Elevation (ft)	Ponded Area (ft^2)	Peak Inflow (cfs)	Max HGL Elevation Attained (ft)	Max Surcharge Depth Attained (ft)	Min Freeboard Attained (ft)	Time of Peak Flooding Occurrence (days hh:mm)	Total Flooded Volume (ac-in)	Total Time Flooded (min)
1	Jun-03	Junction	4672.80	4679.00	4672.80	4679.00	19.64	2.88	4673.40	0.00	5.60	0 00:00	0.00	0.00
2	Jun-04	Junction	4669.60	4677.00	4669.60	4676.00	19.64	5.75	4670.30	0.00	6.70	0 00:00	0.00	0.00
3	Jun-05	Junction	4666.00	4674.00	4666.00	4674.00	19.64	12.13	4667.05	0.00	6.95	0 00:00	0.00	0.00
4	Jun-07	Junction	4663.20	4674.00	4663.20	4674.00	19.64	2.81	4663.67	0.00	10.33	0 00:00	0.00	0.00
5	Jun-08	Junction	4660.80	4674.00	4660.80	4674.00	19.64	33.77	4662.19	0.00	11.81	0 00:00	0.00	0.00
6	Jun-09	Junction	4670.00	4675.00	4670.00	4675.00	19.64	0.53	4670.20	0.00	4.80	0 00:00	0.00	0.00
7	Jun-12	Junction	4672.00	4678.00	4672.00	4678.00	19.64	3.24	4672.50	0.00	5.50	0 00:00	0.00	0.00
8	Jun-13	Junction	4672.90	4680.00	4672.90	4680.00	19.64	4.01	4673.98	0.00	6.02	0 00:00	0.00	0.00
9	Jun-14	Junction	4669.10	4678.00	4669.10	4678.00	19.64	14.41	4669.78	0.00	8.22	0 00:00	0.00	0.00
10	Jun-15	Junction	4667.60	4676.00	4667.60	4676.00	19.64	5.00	4668.24	0.00	7.76	0 00:00	0.00	0.00
11	Jun-16	Junction	4667.00	4673.00	4667.00	4673.00	19.64	1.51	4667.32	0.00	5.68	0 00:00	0.00	0.00
12	Jun-17	Junction	4662.10	4675.00	4662.10	4675.00	19.64	0.01	4663.48	0.00	11.52	0 00:00	0.00	0.00
13	Out-03	Outfall	4664.00					11.83	4666.00					
14	Out-04	Outfall	4658.40					33.98	4661.90					

Link Summary

SN	Element ID	Element Type	From (Inlet) Node	To (Outlet) Node	Length (ft)	Inlet Invert Elevation (ft)	Outlet Invert Elevation (ft)	Average Slope (%)	Diameter or Height (in)	Manning's Roughness	Peak Flow (cfs)	Design Flow Capacity (cfs)	Peak Flow/ Design Flow Ratio	Peak Flow Velocity (ft/sec)	Peak Flow Depth (ft)	Peak Flow Depth/ Total Depth Ratio	Total Time Surcharged (min)	Reported Condition
1	Link-01	Pipe	Jun-09	Jun-16	172.41	4670.00	4637.10	19.0800	18.000	0.0130	0.53	13.86	0.04	2.59	0.26	0.17	0.00	Calculated
2	Link-02	Pipe	Jun-07	Jun-08	230.00	4663.20	4660.90	1.0000	24.000	0.0130	2.73	22.62	0.12	2.77	0.77	0.39	0.00	Calculated
3	Link-03	Pipe	Jun-03	Jun-12	120.56	4672.80	4672.10	0.5800	18.000	0.0100	2.79	10.41	0.27	4.57	0.57	0.38	0.00	Calculated
4	Link-04	Pipe	Jun-04	Jun-05	350.00	4669.60	4666.10	1.0000	18.000	0.0100	5.76	13.66	0.42	5.85	0.82	0.55	0.00	Calculated
5	Link-05	Pipe	Jun-05	Out-03	200.00	4666.00	4664.10	0.9500	24.000	0.0130	11.63	22.05	0.54	4.76	1.48	0.74	0.00	Calculated
6	Link-06	Pipe	Inlet-02	Jun-03	18.00	4677.00	4672.90	22.7800	18.000	0.0130	2.43	50.13	0.05	8.57	0.37	0.24	0.00	Calculated
7	Link-07	Pipe	Inlet-03	Jun-04	26.59	4674.00	4670.10	14.6700	12.000	0.0130	2.32	13.64	0.17	11.27	0.31	0.31	0.00	Calculated
8	Link-08	Pipe	Inlet-04	Jun-04	21.00	4674.00	4670.10	18.5700	12.000	0.0130	0.33	15.35	0.02	6.93	0.15	0.15	0.00	Calculated
9	Link-11	Pipe	Inlet-08	Jun-09	20.98	4675.00	4670.10	23.3600	12.000	0.0130	0.53	17.22	0.03	9.31	0.13	0.13	0.00	Calculated
10	Link-12	Pipe	Inlet-07	Jun-08	20.00	4669.00	4660.90	40.5000	12.000	0.1000	1.71	2.95	0.58	2.62	0.77	0.77	0.00	Calculated
11	Link-13	Pipe	Jun-08	Out-04	230.00	4660.80	4658.50	1.0000	42.000	0.0100	33.98	130.79	0.26	5.07	2.39	0.68	0.00	Calculated
12	Link-18	Pipe	Inlet-01	Jun-03	30.00	4677.00	4672.80	14.0000	12.000	0.0130	0.45	13.33	0.03	3.14	0.36	0.36	0.00	Calculated
13	Link-19	Pipe	Jun-12	Jun-04	189.45	4672.00	4669.70	1.2100	18.000	0.0100	3.23	15.05	0.21	5.57	0.55	0.37	0.00	Calculated
14	Link-20	Pipe	Inlet-09	Jun-12	12.72	4675.00	4672.00	23.5800	12.000	0.0130	0.48	17.30	0.03	5.53	0.30	0.30	0.00	Calculated
15	Link-21	Pipe	Inlet-05	Jun-07	39.51	4672.00	4663.20	22.2700	12.000	0.0130	1.06	16.81	0.06	8.61	0.32	0.32	0.00	Calculated
16	Link-22	Pipe	Jun-13	Jun-14	300.00	4672.90	4669.10	1.2700	24.000	0.0130	14.41	25.46	0.57	15.20	0.60	0.34	0.00	Calculated
17	Link-23	Pipe	Jun-14	Jun-15	150.00	4669.10	4667.70	0.9300	24.000	0.0130	4.60	21.86	0.21	5.18	0.65	0.33	0.00	Calculated
18	Link-24	Pipe	Jun-15	Jun-05	160.50	4667.60	4666.00	1.0000	24.000	0.0130	4.98	22.59	0.22	4.77	0.84	0.42	0.00	Calculated
19	Link-25	Pipe	Inlet-10	Jun-14	16.96	4675.00	4669.10	34.7900	12.000	0.0130	0.43	21.01	0.02	1.59	0.39	0.39	0.00	Calculated
20	Link-26	Pipe	Inlet-14	Jun-14	16.24	4675.00	4669.10	36.3300	12.000	0.0130	0.54	21.47	0.02	1.93	0.39	0.39	0.00	Calculated
21	Link-27	Pipe	Inlet-11	Jun-15	16.42	4673.00	4667.60	32.8900	12.000	0.0130	0.43	20.43	0.02	1.74	0.37	0.37	0.00	Calculated
22	Link-28	Pipe	Inlet-13	Jun-05	53.99	4675.00	4666.00	16.6700	12.000	0.0130	0.85	14.55	0.06	1.93	0.58	0.58	0.00	Calculated
23	Link-29	Pipe	Inlet-12	Jun-05	24.84	4672.00	4666.00	24.1500	12.000	0.0130	0.71	17.51	0.04	1.67	0.57	0.57	0.00	Calculated
24	Link-30	Pipe	Inlet-17	Jun-07	60.00	4671.00	4663.20	13.0000	12.000	0.0130	0.40	12.85	0.03	4.67	0.29	0.29	0.00	Calculated
25	Link-31	Pipe	Jun-16	Jun-07	197.59	4667.00	4633.30	17.0600	18.000	0.0130	1.44	14.57	0.10	3.89	0.39	0.26	0.00	Calculated
26	Link-32	Pipe	Inlet-15	Jun-16	35.00	4673.00	4667.00	17.1400	12.000	0.0150	0.63	12.78	0.05	5.88	0.23	0.23	0.00	Calculated
27	Link-33	Pipe	Inlet-16	Jun-16	10.00	4672.00	4667.00	50.0000	12.000	0.0130	0.36	25.19	0.01	5.52	0.20	0.20	0.00	Calculated
28	Link-34	Pipe	Jun-17	Jun-08	130.00	4662.10	4660.80	1.0000	42.000	0.0130	33.77	100.61	0.34	10.48	0.93	0.37	0.00	Calculated

Inlet Summary

SN	Element ID	Inlet Manufacturer	Manufacturer Part Number	Inlet Location	Number of Inlets	Catchbasin Invert Elevation (ft)	Max (Rim) Elevation (ft)	Initial Water Elevation (ft)	Ponded Area (ft²)	Peak Flow (cfs)	Peak Flow Intercepted by Inlet (cfs)	Peak Flow Bypassing Inlet (cfs)	Inlet Efficiency during Peak Flow (%)	Allowable Spread (ft)	Max Gutter Spread during Peak Flow (ft)
1	Inlet-01	FHWA HEC-22 GENERIC	N/A	On Sag	1	4677.00	4680.00	4677.00	10.00	0.45	N/A	N/A	N/A	7.00	1.07
2	Inlet-02	FHWA HEC-22 GENERIC	N/A	On Sag	1	4677.00	4680.00	4677.00	10.00	2.43	N/A	N/A	N/A	7.00	7.62
3	Inlet-03	FHWA HEC-22 GENERIC	N/A	On Sag	1	4674.00	4677.00	4674.00	10.00	2.33	N/A	N/A	N/A	7.00	7.28
4	Inlet-04	FHWA HEC-22 GENERIC	N/A	On Sag	1	4674.00	4677.00	4674.00	10.00	0.34	N/A	N/A	N/A	7.00	0.80
5	Inlet-05	FHWA HEC-22 GENERIC	N/A	On Sag	1	4672.00	4675.00	4672.00	10.00	1.06	N/A	N/A	N/A	7.00	2.60
6	Inlet-07	FHWA HEC-22 GENERIC	N/A	On Sag	1	4669.00	4672.00	4669.00	10.00	1.72	N/A	N/A	N/A	7.00	5.15
7	Inlet-08	FHWA HEC-22 GENERIC	N/A	On Sag	1	4675.00	4678.00	4675.00	10.00	0.54	N/A	N/A	N/A	7.00	1.28
8	Inlet-09	FHWA HEC-22 GENERIC	N/A	On Sag	1	4675.00	4678.00	4675.00	10.00	0.49	N/A	N/A	N/A	7.00	1.15
9	Inlet-10	FHWA HEC-22 GENERIC	N/A	On Sag	1	4675.00	4678.00	4675.00	10.00	0.44	N/A	N/A	N/A	7.00	1.04
10	Inlet-11	FHWA HEC-22 GENERIC	N/A	On Sag	1	4673.00	4676.00	4673.00	10.00	0.44	N/A	N/A	N/A	7.00	1.04
11	Inlet-12	FHWA HEC-22 GENERIC	N/A	On Sag	1	4672.00	4675.00	4672.00	10.00	0.71	N/A	N/A	N/A	7.00	1.69
12	Inlet-13	FHWA HEC-22 GENERIC	N/A	On Sag	1	4675.00	4672.00	4672.00	10.00	0.86	N/A	N/A	N/A	7.00	2.02
13	Inlet-14	FHWA HEC-22 GENERIC	N/A	On Sag	1	4675.00	4678.00	4675.00	10.00	0.54	N/A	N/A	N/A	7.00	1.28
14	Inlet-15	FHWA HEC-22 GENERIC	N/A	On Sag	1	4673.00	4676.00	4673.00	10.00	0.64	N/A	N/A	N/A	7.00	1.51
15	Inlet-16	FHWA HEC-22 GENERIC	N/A	On Sag	1	4672.00	4675.00	4672.00	10.00	0.36	N/A	N/A	N/A	7.00	0.86
16	Inlet-17	FHWA HEC-22 GENERIC	N/A	On Sag	1	4671.00	4674.00	4671.00	10.00	0.40	N/A	N/A	N/A	7.00	0.94

Project Description

File Name	100-YEAR_PROPOSED.SPF
Description	Capitol Mall Hydrologic Analysis 100-Year Proposed Conditions

Project Options

Flow Units	CFS
Elevation Type	Elevation
Hydrology Method	Rational
Time of Concentration (TOC) Method	SCS TR-55
Link Routing Method	Hydrodynamic
Enable Overflow Ponding at Nodes	YES
Skip Steady State Analysis Time Periods	NO

Analysis Options

Start Analysis On	Mar 19, 2015	00:00:00
End Analysis On	Mar 20, 2015	00:00:00
Start Reporting On	Mar 19, 2015	00:00:00
Antecedent Dry Days	0	days
Runoff (Dry Weather) Time Step	0 01:00:00	days hh:mm:ss
Runoff (Wet Weather) Time Step	0 00:05:00	days hh:mm:ss
Reporting Time Step	0 00:05:00	days hh:mm:ss
Routing Time Step	30	seconds

Number of Elements

	Qty
Rain Gages	0
Subbasins	17
Nodes	30
Junctions	12
Outfalls	2
Flow Diversions	0
Inlets	16
Storage Nodes	0
Links	28
Channels	0
Pipes	28
Pumps	0
Orifices	0
Weirs	0
Outlets	0
Pollutants	0
Land Uses	0

Rainfall Details

Return Period	100 year(s)

Node Summary

SN	Element ID	Element Type	Invert Elevation (ft)	Ground/Rim (Max) Elevation (ft)	Initial Water Elevation (ft)	Surcharge Elevation (ft)	Ponded Area (ft^2)	Peak Inflow (cfs)	Max HGL Elevation Attained (ft)	Max Surcharge Depth Attained (ft)	Min Freeboard Attained (ft)	Time of Peak Flooding Occurrence (days hh:mm)	Total Flooded Volume (ac-in)	Total Time Flooded (min)
1	Jun-03	Junction	4672.80	4679.00	4672.80	4679.00	19.64	7.42	4674.16	0.00	4.84	0 00:00	0.00	0.00
2	Jun-04	Junction	4669.60	4677.00	4669.60	4676.00	19.64	14.09	4673.70	0.00	3.30	0 00:00	0.00	0.00
3	Jun-05	Junction	4666.00	4674.00	4666.00	4674.00	19.64	26.53	4670.06	0.00	3.94	0 00:00	0.00	0.00
4	Jun-07	Junction	4663.20	4674.00	4663.20	4674.00	19.64	7.76	4664.05	0.00	9.95	0 00:00	0.00	0.00
5	Jun-08	Junction	4660.80	4674.00	4660.80	4674.00	19.64	81.72	4662.34	0.00	11.66	0 00:00	0.00	0.00
6	Jun-09	Junction	4670.00	4675.00	4670.00	4675.00	19.64	1.44	4670.32	0.00	4.68	0 00:00	0.00	0.00
7	Jun-12	Junction	4672.00	4678.00	4672.00	4678.00	19.64	8.02	4674.82	0.00	3.18	0 00:00	0.00	0.00
8	Jun-13	Junction	4672.90	4680.00	4672.90	4680.00	19.64	10.39	4674.82	0.00	5.18	0 00:00	0.00	0.00
9	Jun-14	Junction	4669.10	4678.00	4669.10	4678.00	19.64	31.95	4670.70	0.00	7.30	0 00:00	0.00	0.00
10	Jun-15	Junction	4667.60	4676.00	4667.60	4676.00	19.64	13.77	4670.95	0.00	5.05	0 00:00	0.00	0.00
11	Jun-16	Junction	4667.00	4673.00	4667.00	4673.00	19.64	4.06	4667.53	0.00	5.47	0 00:00	0.00	0.00
12	Jun-17	Junction	4662.10	4675.00	4662.10	4675.00	19.64	0.10	4664.45	0.00	10.55	0 00:00	0.00	0.00
13	Out-03	Outfall	4664.00					26.55	4666.00					
14	Out-04	Outfall	4658.40					49.26	4661.90					

Link Summary

SN	Element ID	Element Type	From (Inlet) Node	To (Outlet) Node	Length (ft)	Inlet Invert Elevation (ft)	Outlet Invert Elevation (ft)	Average Slope (%)	Diameter or Height (in)	Manning's Roughness	Peak Flow (cfs)	Design Flow Capacity (cfs)	Peak Flow/ Design Flow Ratio	Peak Flow Velocity (ft/sec)	Peak Flow Depth (ft)	Peak Flow Depth/ Total Depth Ratio	Total Time Surcharged (min)	Reported Condition
1	Link-01	Pipe	Jun-09	Jun-16	172.41	4670.00	4637.10	19.0800	18.000	0.0130	1.42	13.86	0.10	3.41	0.43	0.29	0.00	Calculated
2	Link-02	Pipe	Jun-07	Jun-08	230.00	4663.20	4660.90	1.0000	24.000	0.0130	7.58	22.62	0.34	5.40	0.95	0.48	0.00	Calculated
3	Link-03	Pipe	Jun-03	Jun-12	120.56	4672.80	4672.10	0.5800	18.000	0.0100	6.84	10.41	0.66	5.49	1.43	0.95	0.00	Calculated
4	Link-04	Pipe	Jun-04	Jun-05	350.00	4669.60	4666.10	1.0000	18.000	0.0100	12.20	13.66	0.89	6.90	1.50	1.00	7.00	SURCHARGED
5	Link-05	Pipe	Jun-05	Out-03	200.00	4666.00	4664.10	0.9500	24.000	0.0130	26.55	22.05	1.20	8.51	1.95	0.97	0.00	> CAPACITY
6	Link-06	Pipe	Inlet-02	Jun-03	18.00	4677.00	4672.90	22.7800	18.000	0.0130	6.25	50.13	0.12	9.40	0.79	0.53	0.00	Calculated
7	Link-07	Pipe	Inlet-03	Jun-04	26.59	4674.00	4670.10	14.6700	12.000	0.0130	5.74	13.64	0.42	12.30	0.90	0.90	0.00	Calculated
8	Link-08	Pipe	Inlet-04	Jun-04	21.00	4674.00	4670.10	18.5700	12.000	0.0130	0.88	15.35	0.06	7.25	0.58	0.58	0.00	Calculated
9	Link-11	Pipe	Inlet-08	Jun-09	20.98	4675.00	4670.10	23.3600	12.000	0.0130	1.44	17.22	0.08	11.14	0.22	0.22	0.00	Calculated
10	Link-12	Pipe	Inlet-07	Jun-08	20.00	4669.00	4660.90	40.5000	12.000	0.1000	3.45	2.95	1.17	4.44	1.00	1.00	2.00	SURCHARGED
11	Link-13	Pipe	Jun-08	Out-04	230.00	4660.80	4658.50	1.0000	42.000	0.0100	49.26	130.79	0.38	6.87	2.44	0.71	0.00	Calculated
12	Link-18	Pipe	Inlet-01	Jun-03	30.00	4677.00	4672.80	14.0000	12.000	0.0130	1.18	13.33	0.09	4.01	0.60	0.60	0.00	Calculated
13	Link-19	Pipe	Jun-12	Jun-04	189.45	4672.00	4669.70	1.2100	18.000	0.0100	7.99	15.05	0.53	5.80	1.50	1.00	4.00	SURCHARGED
14	Link-20	Pipe	Inlet-09	Jun-12	12.72	4675.00	4672.00	23.5600	12.000	0.0130	1.25	17.30	0.07	6.63	0.59	0.59	0.00	Calculated
15	Link-21	Pipe	Inlet-05	Jun-07	39.51	4672.00	4663.20	22.2700	12.000	0.0130	2.90	16.81	0.17	10.33	0.56	0.56	0.00	Calculated
16	Link-22	Pipe	Jun-13	Jun-14	300.00	4672.90	4669.10	1.2700	24.000	0.0130	31.95	25.46	1.25	15.95	1.19	0.61	0.00	> CAPACITY
17	Link-23	Pipe	Jun-14	Jun-15	150.00	4669.10	4667.70	0.9300	24.000	0.0130	12.63	21.86	0.58	6.12	1.80	0.90	0.00	Calculated
18	Link-24	Pipe	Jun-15	Jun-05	160.50	4667.60	4666.00	1.0000	24.000	0.0130	11.41	22.59	0.51	6.61	2.00	1.00	6.00	SURCHARGED
19	Link-25	Pipe	Inlet-10	Jun-14	16.96	4675.00	4669.10	34.7900	12.000	0.0130	1.15	21.01	0.05	2.43	0.58	0.58	0.00	Calculated
20	Link-26	Pipe	Inlet-14	Jun-14	16.24	4675.00	4669.10	36.3300	12.000	0.0130	1.43	21.47	0.07	2.99	0.59	0.59	0.00	Calculated
21	Link-27	Pipe	Inlet-11	Jun-15	16.42	4673.00	4667.60	32.8900	12.000	0.0130	1.15	20.43	0.06	2.43	0.58	0.58	0.00	Calculated
22	Link-28	Pipe	Inlet-13	Jun-05	53.99	4675.00	4666.00	16.6700	12.000	0.0130	2.24	14.55	0.15	4.27	0.63	0.63	0.00	Calculated
23	Link-29	Pipe	Inlet-12	Jun-05	24.84	4672.00	4666.00	24.1500	12.000	0.0130	1.89	17.51	0.11	3.76	0.61	0.61	0.00	Calculated
24	Link-30	Pipe	Inlet-17	Jun-07	60.00	4671.00	4663.20	13.0000	12.000	0.0130	1.06	12.85	0.08	5.67	0.52	0.52	0.00	Calculated
25	Link-31	Pipe	Jun-16	Jun-07	197.59	4667.00	4633.30	17.0600	18.000	0.0130	3.94	14.57	0.27	4.96	0.69	0.46	0.00	Calculated
26	Link-32	Pipe	Inlet-15	Jun-16	35.00	4673.00	4667.00	17.1400	12.000	0.0150	1.72	12.78	0.13	7.38	0.39	0.39	0.00	Calculated
27	Link-33	Pipe	Inlet-16	Jun-16	10.00	4672.00	4667.00	50.0000	12.000	0.0130	0.97	25.19	0.04	6.51	0.33	0.33	0.00	Calculated
28	Link-34	Pipe	Jun-17	Jun-08	130.00	4662.10	4660.80	1.0000	42.000	0.0130	81.72	100.61	0.81	15.13	1.33	0.55	0.00	Calculated