

Prepared for:



City of Las Vegas

Preliminary Drainage Report **Las Vegas Boulevard Widening I-515 to Owens Avenue**

WELCOME TO HISTORIC
CULTURAL CORRIDOR



LAS VEGAS
BLVD

Revised September 2013

Prepared by:



THE LOUIS BERGER GROUP, INC.

PRELIMINARY DRAINAGE REPORT

LAS VEGAS BOULEVARD WIDENING I-515 TO OWENS AVENUE

PREPARED FOR:

**CITY OF LAS VEGAS
DEPARTMENT OF PUBLIC WORKS
333 N. RANCHO ROAD
LAS VEGAS, NV 89106**



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1.0 INTRODUCTION

1.1 Project Overview

This report was prepared by The Louis Berger Group, Inc. (LBG) for the City of Las Vegas (City) and presents drainage engineering design and analysis for the Las Vegas Boulevard Widening, I-515 to Owens Avenue Project. The Project is located in the central part of the Las Vegas Valley, within the City of Las Vegas Cultural Corridor and crossing the I-515 Freeway, (see Figure 1.1). This report includes:

- Discussion of project impacts on regional flood control facilities, Federal Emergency Management Agency (FEMA) floodplain, and local drainage patterns;
- Detailed hydrological analysis quantifying the flows entering the project under existing and proposed conditions;
- A proposed drainage system designed to meet local and regional street flow criteria for the proposed roadway project while perpetuating the existing drainage patterns; and,
- Preliminary hydraulic calculations in support of the proposed drainage system.

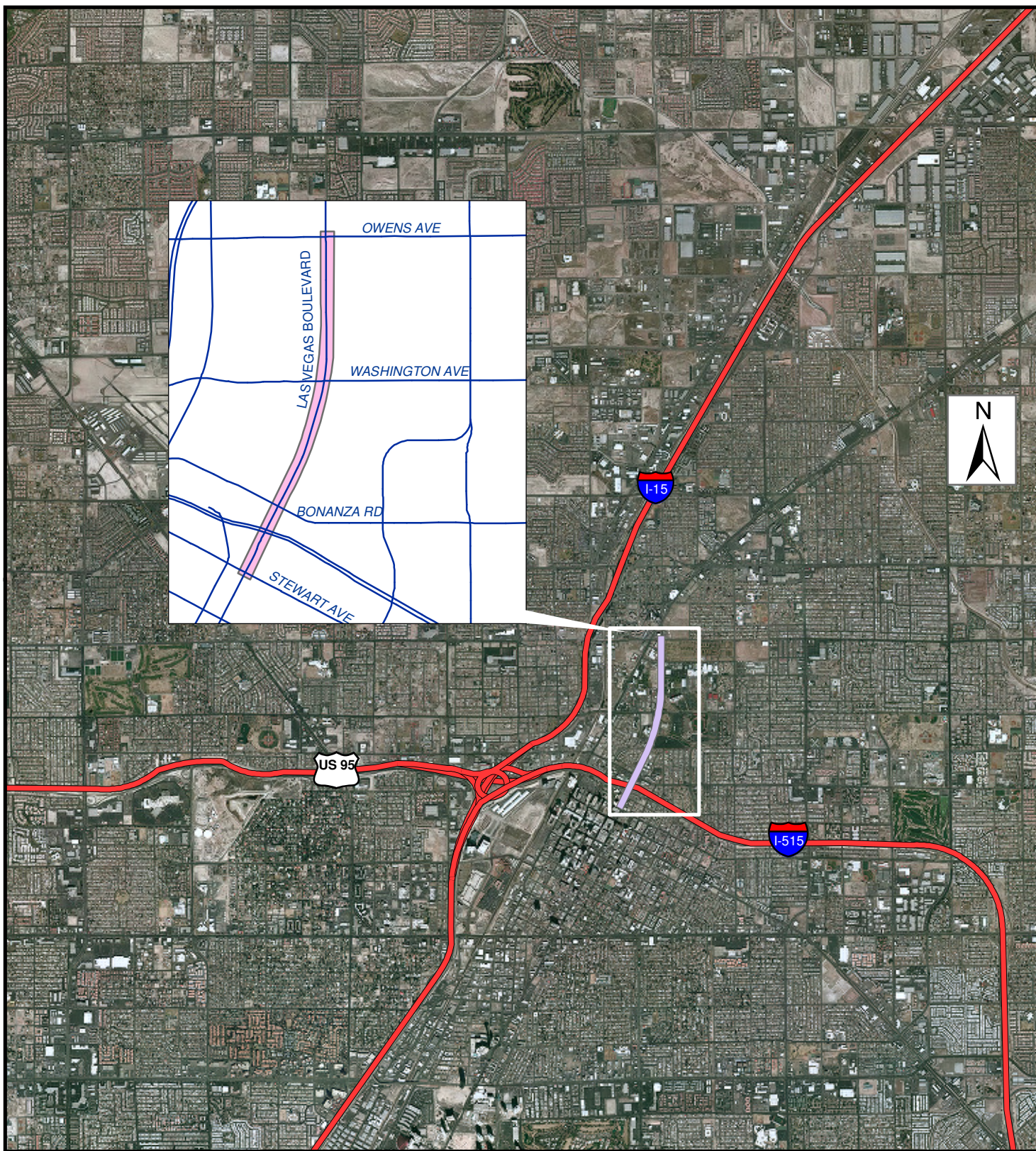
This study will be submitted to the City of North Las Vegas (City), Clark County Regional Flood Control District (CCRFCD), Regional Transportation Commission, and the Nevada Department of Transportation (NDOT) for review. It will be updated at the 90 percent design level of completion to incorporate their comments, include additional details, and hydraulic analyses for the proposed drainage system.

1.1.1 Project Description

The project includes improvements for approximately 6,500 linear feet of Las Vegas Boulevard from Stewart Avenue to Owens Avenue, including curb, gutter and sidewalk, reconfiguring the median islands, repaving, drainage, and utility relocations.

The first phase of the project, from Stewart Avenue to I-515, has been constructed. Flood control improvements for the first phase were minimal, designed only to provide a level of flood protection similar to that provided by existing facilities. Design of flood control facilities for the second phase of the project, from I-515 to Owens Avenue revisits design of the section from Stewart Avenue to I-515 once again from a regional flood control standpoint, as well as from I-515 to Owens Avenue.





Las Vegas Boulevard Widening I-515 to Owens Project Location Map



The Louis Berger Group, Inc.

Figure 1.1



City of Las Vegas

1.1.2 Existing Drainage Conditions

a. Stewart Avenue to Washington Avenue

Much of the Downtown Core of the City of Las Vegas drains to Las Vegas Boulevard. The area roughly bounded by Las Vegas Boulevard on the east, Charleston Boulevard on the south, Main Street on the west and I-515 on the north drains into Las Vegas Boulevard south of Stewart Avenue. Runoff is collected in a 48-inch RCP storm drain in Las Vegas Boulevard and conveyed northward along Las Vegas Boulevard. Flow in excess of the capacity of the 48-inch RCP is conveyed as surface flow in Las Vegas Boulevard.

The 48-inch RCP storm drain enters the Project area at Stewart Avenue and continues northward in Las Vegas Boulevard to Washington Avenue. The 48-inch RCP storm drain discharges into a 12' x 8' RCB in Washington Avenue.

In Las Vegas Boulevard, the 48-inch RCP runs under the east curb. In addition to conveying runoff from the Downtown Core, curb drop inlets collect the street runoff in Las Vegas Boulevard and runoff from the properties along the west side of Las Vegas Boulevard from I-515 to Washington Avenue.

Again, flow in excess of the capacity of the 48-inch RCP is conveyed as surface flow northward in Las Vegas Boulevard to Washington Avenue.

A 12'x8' RCB in Washington Avenue is a Regional Flood Control facility which enters Las Vegas Boulevard approximately 700 ft. south of Washington Avenue, follows the centerline of Las Vegas Boulevard northward to Washington Avenue and then turns eastward to follow Washington Avenue.

b. Washington Avenue to Owens Avenue

The area bounded by Las Vegas Boulevard on the east, Washington Avenue on the south, Main Street on the west and Owens Avenue on the north drains into Las Vegas Boulevard between Washington Avenue and Owens Avenue. The street runoff in Las Vegas Boulevard and from properties west of Las Vegas Boulevard is collected in an existing 18-inch to 24-inch RCP storm drain which begins approximately 900 feet north of Washington Avenue and continues northward to Owens Avenue. Runoff is collected in curb drop inlets into the 18-inch to 24-inch RCP storm drain which runs beneath the west curb.

At Owens Avenue, the storm flow bubbles out into Owens Avenue as surface flow. Flow in excess of the capacity of the storm drain flows northward in Las Vegas Boulevard to Owens Avenue.



The 18-inch to 24-inch RCP storm drain in Las Vegas Boulevard from Washington Avenue to Owens Avenue is very shallow, with less than 2 feet of cover.

1.1.3 Proposed Drainage Conditions

To accommodate predicted flows, a second storm drain is proposed to be constructed in Las Vegas Boulevard from Stewart Avenue to Washington Avenue. The proposed new storm drain would supplement the capacity of the existing 48-inch RCP to carry flood flows. The proposed second storm drain would be a 48-inch RCP which would collect runoff in and along Las Vegas Boulevard from Stewart Avenue to Washington Avenue, leaving the existing 48-inch RCP to continue to convey runoff from the Downtown Core, south of Stewart Avenue, northward to the 12'x8' RCB in Washington Avenue.

The existing 48-inch RCP in Las Vegas Boulevard was inspected with a video camera and found to be in good condition. Replacement of the existing 48-inch RCP is therefore, not considered to be necessary.

The existing 18-inch to 24-inch RCP storm drain from Washington Avenue to Owens Avenue has so little cover that it will be excavated during pavement replacement for Las Vegas Boulevard. Therefore, it is proposed to replace the existing storm drain with a new storm drain varying in size from 18-inches at Adams Avenue to 60-inches at Owens Avenue.

A future RFCD 12'x11' RCB is planned for Owens Avenue. Initially, the 24-inch to 60-inch RCP storm drain in Las Vegas Boulevard will bubble out into Owens Avenue. However, in the future, it can be connected to the planned Owens Avenue 12'x11' RCB.

1.1.4 Design Criteria

The project will be designed in conformance with the applicable criteria established by Clark County Regional Flood Control District (CCRFCD) in 1999 and documented in the Hydrologic Criteria and Drainage Design Manual (Manual). The design criteria related to the proposed project are summarized in Table 1.1.



1.2 Design Criteria

Table 1.1 - Conformance with CCRFCD Design Criteria

Topic	Manual Section	Manual Page	Comments
Design Storm	304.2	315	The proposed storm drains will be designed such that street flow criteria are met for the 10 year and 100 year storm events.
Rainfall	500	501 - 506	Rainfall depth, duration and distribution will be applied as outlined in Section 500.
Time of Concentration and Runoff Curve Number	601 and 602	603 – 610	Time of concentration and precipitation losses will be developed using procedures outlined in these sections as applicable to the SCS Unit Hydrograph method.
Hydrology	600	610 – 625	Rainfall-runoff modeling will be performed primarily using HEC-1 Flood Hydrograph Package SCS Unit Hydrograph procedure. Methods and equations used are consistent with the Manual.
Storm Drain Design Parameters	802	804 - 809	Storm drain design parameters will be consistent with the requirements of the manual except as described in Table 3.2.
Storm Drain Hydraulics	804	811	Storm drain hydraulic grade line (HGL) will be evaluated using Water Surface Pressure Gradient (WSPG) hydraulic model.
Storm Inlet Hydraulics	805	815	Drop inlet capacities will be determined using the Federal Highway Administration's V-Urban computer model. A 50-percent clogging factor will be applied to all drop inlets.
Minimum Conduit Size	1204.1.1	1210	Minimum conduit size used will be 18" diameter.

1.3 Previous Studies

City-Wide Hydrology Analysis

The City Wide Hydrology Analysis and facilities inventory was prepared by Montgomery Watson in 1995 for the project area. Since the project area was already developed at the time of the study in 1995, it provides a reasonably accurate delineation of hydrologic basin boundaries.

Las Vegas Valley Flood Control Facilities Master Plan Update

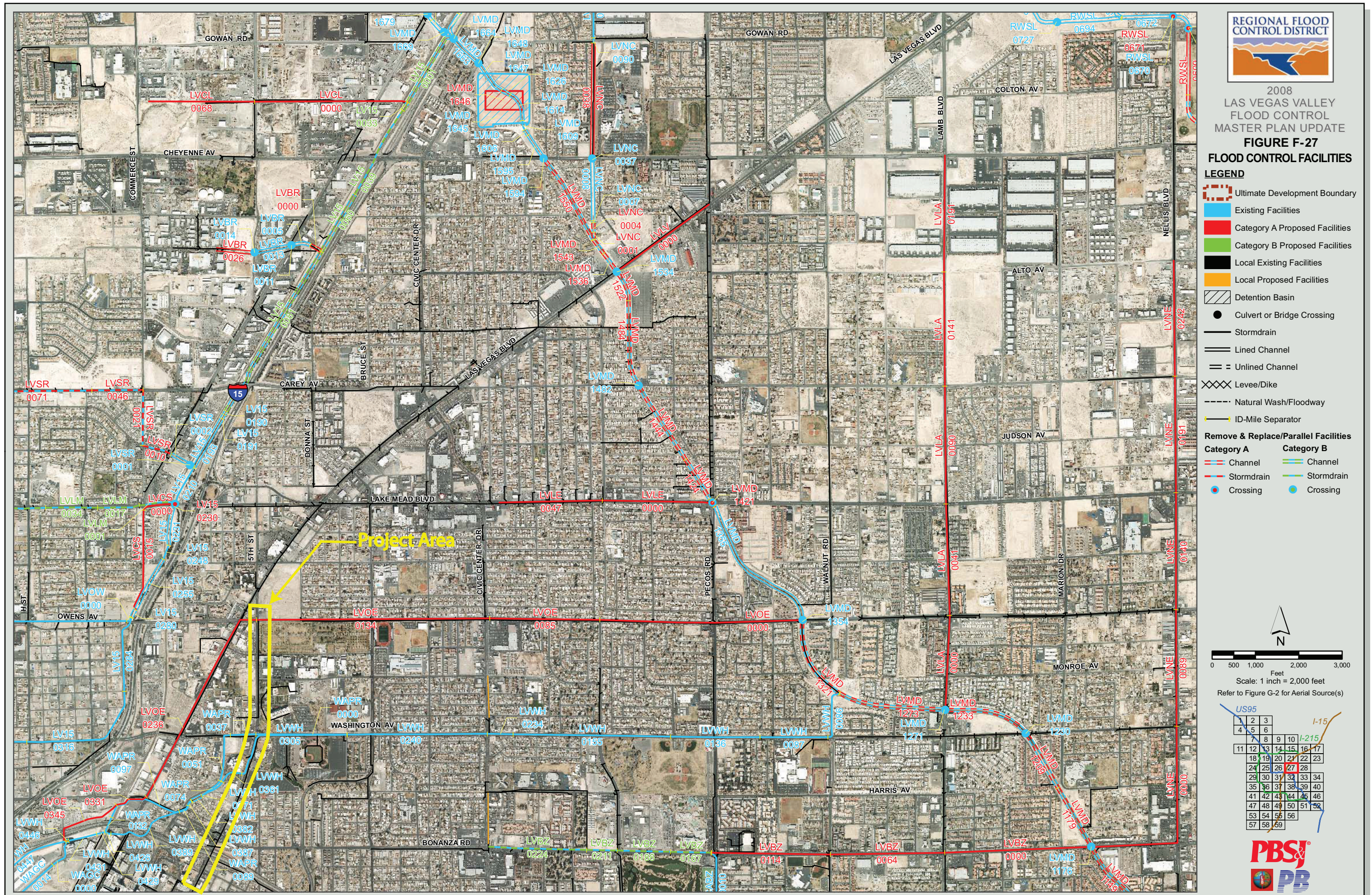
The Clark County Regional Flood Control District (CCRFCD) Flood Control Master Plan Update for the Las Vegas Valley (MPU 2008) shows flood control facilities for the project area. Figures 2.1a and 2.1b are reproductions of MPU Figure F-27 for the project area. Existing MPU flood control facilities in the project area are blue and the proposed are red. The only new flood control facility proposed by the CCRFCD for this area is the Owens Avenue System (LVOE 0134) at the north end of the project. Other facilities affected by this project include 12'x8' RCB's in Las Vegas Boulevard and Washington Avenue, respectively, identified as LVWH 0361, LVWH 305 WAPR 00110000 and WAPR 0337. Table 2.1 provides details of the facilities.

The proposed 48-inch RCP storm drain that is part of this project will connect to the Washington Avenue Channel (LVWH 0361). The proposed connection will not affect the functionality of that system.

Table 2.1 - Proposed MPU Flood Control Facilities (MPU, 2008)

ID / River Mile	Status	Facility Description	Length (ft)	Flow (cfs)
LVWH		Washington Avenue Channel		
0361	Existing	12'X8' RCB	548	1607
0305	Existing	12'X8' RCB	2950	1607
LVOE		Owens Avenue System		
0134	Proposed	12'x11' RCB	5380	2607
WAPR		Washington Avenue Channel Parallel		
0037	Existing	12'x8' RCB	590	1607
0000	Existing	12'x8' RCB	1200	1607





ID / River Mile	Status	Facility Description	Length (ft.)	Flow (cfs)	HEC-1 Node	HEC-1 Model	Tributary Area (sq.mi.)	Channel Slope (%) **	ID / River Mile	Status	Facility Description	Length (ft.)	Flow (cfs)	HEC-1 Node	HEC-1 Model	Tributary Area (sq.mi.)	Channel Slope (%) **	ID / River Mile	Status	Facility Description	Length (ft.)	Flow (cfs)	HEC-1 Node	HEC-1 Model	Tributary Area (sq.mi.)	Channel Slope (%) **	ID / River Mile	Status	Facility Description	Length (ft.)	Flow (cfs)	HEC-1 Node	HEC-1 Model	Tributary Area (sq.mi.)	Channel Slope (%) **				
CABZ	E	CEDAR AVENUE - BONANZA	1450					0.30	LVLV		LAKE MEAD DRAIN TO LAS VEGAS WASH							LVMH	E	WASHINGTON AVENUE CHANNEL																			
0010	E	60" RCP							0000	P1	12" X 8" RCB	2500	1030	CLV1B-2	WEST3	1.20	0.40	1648	E	3 Span Bridge 95'W 8'-10'D 2:1 SS @ Civil Center	120	11998	CHYPKIN	CCWEST5	73.97	0.70	0389	E	12' X 8' RCB	2110	1607	(1/2) CV1-C	SW5SC	15.16	0.90				
LV15		FREEWAY CHANNEL							0047	P1	12" X 6" RCB	2400	845	CLV1B-1	WEST3	0.89	0.50	1663	E	Conc Chnl 80'W 10'D 2:1 SS	700	11966	3C99B-7	CCWEST5	73.66	0.70	0426	E	16' X 8' RCB	150	1607	(1/2) CV1-C	SW5SC	15.16	1.08				
0000	E	Conc Chnl 20'W 10'D 1:1 SS (Replace w/ LV150001)	1800	4778	2CLV1E-3	CWEST4	11.12	0.18	0000	E	43"X 68" HERCP (Replace w/ LVLMO001)	847	994	CLM20-C	NW3SC	1.36	4.60	1664	E	3 Span Bridge 75'W 10'D 2:1 SS @ I-15	120	11966	3C99B-7	CCWEST5	73.66	0.70	0429	E	Splitter Structure (2: 12' X 8' RCB)	190	2870	DCLC21	SW5	22.79	1.90				
0001	P0	Conc Chnl 55'W 10'D 0:1 SS (Replaces LV150000)	1800	4778	2CLV1E-3	CWEST4	11.12	0.18	0001	P0	12' X 5' RCB (Replaces LVLMO000)	847	994	CLM20-C	NW3SC	1.36	4.60	1665	E	Transition Structure	200	7358	CLV99B-5	WEST5	48.77	0.36	0431	E	3: 14.33' X 10' RCB	665	2870	DCLC21	SW5	22.79	0.15				
0032	E	Conc Chnl 20'W 10'D 1:1 SS (Replace w/ LV150033)	200	4301	2CLV1D-5	CWEST4	10.22	0.18	0016	E	54" RCP (Replace w/ LVLMO017)	965	994	CLM20-C	NW3SC	1.36	4.38	1669	E	Free Span Bridge 55'W 12'D @ UPRR	40	7358	CLV99B-5	WEST5	48.77	0.36	0446	E	Junction Structure	69	2870	DCLC21	SW5	22.79	0.15				
0033	P0	Conc Chnl 50'W 10'D 0:1 SS (Replaces LV150032)	200	4301	2CLV1D-5	CWEST4	10.22	0.18	0017	P0	12' X 5' RCB (Replaces LVLMO016)	965	994	CLM20-C	NW3SC	1.36	4.38	1670	E	Conc Chnl 82'W 10'D 0:1 SS	370	7358	CLV99B-5	WEST5	48.77	1.69	0447	E	3: 14.33' X 10' RCB	1955	4978	CCAL93	SW5	22.19	0.15				
0038	E	2: 8' X 10' RCB (Replace w/ LV150039)	2200	4301	2CLV1D-5	CWEST4	10.22	0.75	0033	E	60" RCP (Replace w/ LVLMO034)	1186	994	CLM20-C	NW3SC	1.36	1.62	1677	E	Conc Chnl 80'W 10'D 2:1 SS	119	7358	CLV99B-5	WEST5	48.77	0.37													
0039	P0	2: 13' X 10' RCB (Replaces LV150038)	2200	4301	2CLV1D-5	CWEST4	10.22	0.75	0034	P0	12' X 5' RCB (Replaces LVLMO033)	1186	994	CLM20-C	NW3SC	1.36	1.62	1679	E	4 Span Bridge 100'W 12'D 2:1 SS @ Losee	120	7358	CLV99B-5	WEST5	48.77	0.37													
0059	E	Conc Chnl 20'W 10'D 1:1 SS (Replace w/ LV150060)	1600	4301	2CLV1D-5	CWEST4	10.22	0.18	0039	E	72" RCP (Replace w/ LVLMO060)	5952	994	CLM20-C	NW3SC	1.36	0.66	1680	E	Conc Chnl 80'W 10'D 2:1 SS	480	7358	CLV99B-5	WEST5	48.77	0.37													
0060	P0	Conc Chnl 50'W 10'D 0:1 SS (Replaces LV150059)	1600	4301	2CLV1D-5	CWEST4	10.22	0.18	0060	P0	12' X 6' RCB (Replaces LVLMO059)	5952	994	CLM20-C	NW3SC	1.36	0.66																						
0080	E	Conc Chnl 20'W 10'D 1:1 SS (Replace w/ LV150081)	4300	3953	CLV1D-4	CWEST4	9.42	0.18	LVLV		LAS VEGAS BLVD DRAIN							0000	E	Earth Chnl 40'W 8'-10'D 2:1 SS (Replace w/ LVNC0001)	173	1182	CLW100	CWEST5	13.62	0.45	0670	E	3: 10' X 7' RCBC @ Nellis	100	3178*	CCSLNL	^	RW4SC	8.62	0.56			
0081	P0	Conc Chnl 45'W 10'D 0:1 SS (Replaces LV150080)	4300	3953	CLV1D-4	CWEST4	9.42	0.18	0000	P1	2: 10' X 9' RCB	2600	987	CLW075-4	WEST3	1.03	0.10	0001	P2	18' X 6' RCB (Replaces LVNC0000)	173	1182	CLW100	CWEST5	13.62	0.45	0671	P1	Add 3: 12' X 7' RCBC @ Nellis	100	2009*	CCSLNL	^	RW4SC	8.62	0.56			
0190	E	Conc Chnl 20'W 10'D 1:1 SS with Drop Structures	100	3776	CW1C2	NW4SC	8.84	0.18	1148	E	Earth Chnl 70'W 18'-20'D 1.5:1 SS (Replace w/ LVMD1149)	1675	13944	CCBN15-C	CLVWASH5	112.59	0.41	0003	E	Earth Chnl 40'W 8'-10'D 2:1 SS (Replace w/ LVNC0004)	216	1182	CLW100	CWEST5	13.62	1.15	0672	E	Conc Chnl 14'W 8'D 1.5:1 SS	1130	2924	CC47C-4	RW3SC	3.94	0.56				
0191	E	Conc Chnl 20'W 10'D 1:1 SS with Drop Structures	100	3776	CW1C2	NW4SC	8.84	0.18	1149	P1	Conc Chnl 70'W 10'D 1.5:1 SS (Replaces LVMD1148)	1675	13944	CCBN15-C	CLVWASH5	112.59	0.41	0004	P2	Conc Chnl 18'-21'W 8'D 0:1 SS (Replaces LVNC0003)	216	1182	CLW100	CWEST5	13.62	1.15	0694	E	Conc Chnl 10'W 8'D 1.5:1 SS	1500	1696	C47C4	RW3SC	2.40	0.56				
0193	E	Conc Chnl 20'W 10'D 1:1 SS with Drop Structures	1300	3776	CW1C2	NW4SC	8.84	0.18	1176	E	5 Span Bridge 110'W 20'D 2:1 SS @ Bonanza	120	12690	CLVW04-C	CLVWASH5	106.80	0.57	0007	E	Drop Structure 16'W 2.8'D 3:1 SS	50	1182	CLW100	CWEST5	13.62	0.70	0727	E	3: 10' X 8' RCBC	100	1601	C307E3	RW3SC	2.25	0.56				
0210	E	3: 12' X 9' RCB	900	3123	CCVG24	NW3SC	7.07	0.18	1178	E	Earth Chnl 30'W 18'-20'D 2:1 SS (Replace w/ LVMD1179)	1500	12690	CLVW04-C	CLVWASH5	106.80	0.57	0038	E	2: 132" CMPC @ Cheyenne	120	1182	CLW100	CWEST5	13.62	0.70	0728	E	Conc Chnl 12'W 8.5'D 1.5:1 SS	1345	1601	C307E3	RW3SC	2.25	0.56				
0229	E	2: 7.5' X 3' RCBC @ Lake Mead (Replace w/ LV150230)	125	1011	DRAILRD	NW3	5.22	1.10	1179	P1	Conc Chnl 60'W 9.5'D 2:1 SS (Replaces LVMD1178)	1500	12690	CLVW04-C	CLVWASH5	106.80	0.57	0090	E	3: 12' X 6' RCB	120	1182	CLW100	CWEST5	13.62	0.70													
0230	P2	12' X 4.5' RCBC @ Lake Mead (Replaces LV150029)	125	1011	DRAILRD	NW3	5.22	1.10	1208	E	Bank-Stab. Chnl 65'W 15'D 2:1 SS (Replace w/ LVMD1209)	1420	12690	CLVW04-C	CLVWASH5	106.80	0.32	0091	E	14' X 6' RCAP	1325	1182	CLW100	CWEST5	13.62	0.52													
0231	E	Conc Chnl 8'W 8'D 0:1 SS	900	1011	DRAILRD	NW3	5.22	2.50	1209	P1	Conc Chnl 60'W 10.5'D 2:1 SS (Replaces LVMD1208)	1420	12690	CLVW04-C	CLVWASH5	106.80	0.32																						
0248	E	8' X 6' RCBC @ UPRR	350	1011	DRAILRD	NW3	5.22	1.34	1230	E	4 Span Bridge 162'W 13'D @ Washington	105	12654	CCLVW03	CLVWASH5	106.53	0.73																						
0255	E	Conc Chnl 8'W 8'D 0:1 SS	1330	1011	DRAILRD	NW3	5.22	2.00	1232	E	Bank-Stab. Chnl 48'W 8'D 2:1 SS (Replace w/ LVMD1233)	1900	12654	CCLVW03	CLVWASH5	106.53	0.73																						
0280	E	Conc Chnl 30'W 8'D 0:1 SS	200	2022	CCVG10	NW3	5.22	2.00	1233	P1	Conc Chnl 90'W 8'D 0:1 SS (Replaces LVMD1232)	1900	12654	CCLVW03	CLVWASH5	106.53	0.73																						
0284	E	14' X 6' RCB	1790	1221	CVG10-C	NW3	4.84	0.50	1271	E	4 Span Bridge 94'W 10'-12'D 2:1 SS @ Lamb	120	11954	CCLVW01C	CLVWASH5	103.23	0.38																						
0316	E	11' X 6' RCB	3010	985	CWA20-C	NW3	4.46	0.59	1272	E	Earth Chnl 80'W 10'D 2:1 SS (Replace w/ LVMD1273)	2400	11954	CCLVW01C	CLVWASH5	103.23	0.38																						
0372	E	9' X 6' RCB	1970	985	CWA20-C	NW3	4.46	0.66	1273	P1	Conc Chnl 80'W 9'D 2:1 SS (Replaces LVMD1272)	2400	11954	CCLVW01C	CLVWASH5	103.23	0.38																						
LVBR		LAS VEGAS - BROOK							1320	E	Gabion Chnl 100'W 10'D 2:1 SS (Replace w/ LVMD1321)	1950	8636	CKK-C1	CLVWASH5	100.94	0.38																						
0000	P1	Conc Chnl 12'W 4.5'D 2:1 SS	285	989	CLV1D-5	WEST3	0.80	2.90	1321	P1	Conc Chnl 80'W 7.5'D 2:1 SS (Replaces LVMD1320)	1950	8636	CKK-C1	CLVWASH5	100.94	0.38																						
0005	E	Conc Chnl 9'W 5'D 2:1 SS	375	989	CLV1D-5	WEST3	0.80	2.67	1354	E	5 Span Bridge 110'W 7'-8'D 2:1 SS @ Owens	120	8504	2CLV1B-2	CCWEST5	78.09	0.58																						
0011	E	11' X 3' RCBC @ Losee	150	989	CLV1D-5	WEST3	0.80	2.90	1355	E	Gabion Chnl 100'W 10'D 2:1 SS	3432	8504	2CLV1B-2	CCWEST5	78.09	0.58																						
0013	E	Conc Chnl 12'W 4.5'D 2:1 SS	750	989	CLV1D-5	WEST3	0.80	2.60	1420	E	7: 8'-12' X 8' RCBC @ Lake Mead (Replace w/ LVMD1421)	200	8291	CLW64-4	CCWEST5	76.89	0.60																						
0014	E	12' X 4' RCBC @ N. 5th St	100	989	CLV1D-5	WEST3	0.80	2.60	1421	P1	2 Span Bridge 84'W 8'D @ Lake Mead (Replaces LVMD1420)	200	8291	CLW64-4	CCWEST5	76.89	0.60																						
0026	P1	Conc Chnl 12'W 4.5'D 2:1 SS	850	989	CLV1D-5	WEST3	0.80	4.30	1423	E	Earth Chnl 60'W 8'D 1:1 SS (Replace w/ LVMD1424)	1060	8291	CLW64-4	CCWEST5	76.89	0.60																						
LVBZ		LAS VEGAS WASH - BONANZA							1424	P2	Conc Chnl 84'W 13'D 0:1 SS (Replaces LVMD1423)	1060	8291	CLW64-4	CCWEST5	76.89	0.34																						
0000	P1	2: 12' X 7' RCB	3400	1636	CBN15-C	SW3	2.40	0.40	1443	E	Earth Chnl 60'W 8'D 1:1 SS (Replace w/ LVMD1444)	2000	8291	CLW64-4	CCWEST5	76.89	0.60																						
0064	P1	2: 12' X 6' RCB	2630	1449	CBN12-C	SW3	2.12	0.40	1444	P2	Conc Chnl 84'W 8'D 0:1 SS (Replaces LVMD1443)	2000	8291	CLW64-4	CCWEST5	76.89	0.34																						
0114	P1	2: 12' X 6' RCB	2740	1256	CBN10-C	SW3	1.79	0.40	1482	E	1 Span Bridge 99'W 7'D @ Carey	72	8291	CLW64-4	CCWEST5	76.89	1.00																						
0166	E	54" RCP (Replace w/ LVBZ0167)	1095	1051	CBN09	SW3	1.54	0.45	1483	E	Earth Chnl 75'W 6'D 2:1 SS (Replace w/ LVMD1484)	1950	8291	CLW64-4	CCWEST5	76.89	0.40																						
0167	P0	10' X 9' RCB (Replaces LVBZ0166)	1095	1051	CBN09	SW3	1.54	0.45	1484	P2	Conc Chnl 84'W 8'-9'D 0:1 SS (Replaces LVMD1483)	1950	8291	CLW64-4	CCWEST5	76.89	0.37																						
0187	E	48" RCP (Replace w/ LVBZ0188)	1235	1051	CBN09																																		

1.4 FEMA Flood Insurance Rate Map

The Federal Emergency Management Agency (FEMA) publishes Flood Insurance Rate Maps (FIRM) showing areas subject to inundation during the 100-year flood event. Figure 2.2a and 2.2b are reproductions of the FIRM for Clark County, Nevada and Incorporated Areas (Community 320003) Panels 2160E and 2170E, effective date September 27, 2002. The project is located outside of any special flood hazard areas.



NOTES TO USERS

This map is for use in administering the National Flood Insurance Program. It does not necessarily identify all areas subject to flooding, particularly from local drainage sources of small size. The community map repository should be consulted for possible updated or additional flood hazard information.

To obtain more detailed information in areas where **Base Flood Elevations** (BFEs) and/or **floodways** have been determined, users are encouraged to consult the Flood Profiles and Floodway Data and/or Summary of Stillwater Elevations tables contained within the Flood Insurance Study (FIS) report that accompanies this FIRM. Users should be aware that BFEs shown on the FIRM represent rounded whole-foot elevations. These BFEs are intended for flood insurance rating purposes only and should not be used as the sole source of flood elevation information. Accordingly, flood elevation data presented in the FIS report should be utilized in conjunction with the FIRM for purposes of construction and/or floodplain management.

Coastal Base Flood Elevations shown on this map apply only to landward of 0.0' North American Vertical Datum of 1988 (NAVD 88). Users of this FIRM should be aware that coastal flood elevations are also provided in the Summary of Stillwater Elevations table in the Flood Insurance Study report for this jurisdiction. Elevations shown in the Summary of Stillwater Elevations table should be used for construction and/or floodplain management purposes when they are higher than the elevations shown on this FIRM.

Boundaries of the **floodways** were computed at cross sections and interpolated between cross sections. The floodways were based on hydraulic considerations with regard to requirements of the National Flood Insurance Program. Floodway widths and other pertinent floodway data are provided in the Flood Insurance Study report for this jurisdiction.

Certain areas not in Special Flood Hazard Areas may be protected by **flood control structures**. Refer to Section 2.4 "Flood Protection Measures" of the Flood Insurance Study report for information on flood control structures for this jurisdiction.

The **projection** used in the preparation of this map was Universal Transverse Mercator (UTM) Zone 11. The horizontal datum was NAD83. Differences in datum, spheroid, projection or UTM zones used in the production of FIRMs for adjacent jurisdictions may result in slight positional differences in map features across jurisdiction boundaries. These differences do not affect the accuracy of this FIRM.

Flood elevations on this map are referenced to the North American Vertical Datum of 1988. These flood elevations must be compared to structure and ground elevations referenced to the same vertical datum. For information regarding conversion between the National Geodetic Vertical Datum of 1929 and the North American Vertical Datum of 1988, visit the National Geodetic Survey website at <http://www.ngs.noaa.gov/> or contact the National Geodetic Survey at the following address:

NGS Information Services
NOAA, N/NGS12
National Geodetic Survey
SSM-C-3, #9202
1315 East-West Highway
Silver Spring, MD 20910-3282

To obtain current elevation, description, and/or location information for **bench marks** shown on this map, please contact the Information Services Branch of the National Geodetic Survey at (301) 713-3242, or visit its website at <http://www.ngs.noaa.gov/>.

Base map information shown on this FIRM was provided in digital format by the Clark County GIS Management Office (GISMO).

This map reflects more detailed and up-to-date **stream channel configurations** than those shown on the previous FIRM for this jurisdiction. The floodplains and floodways that were transferred from the previous FIRM may have been adjusted to conform to these new stream channel configurations. As a result, the Flood Profiles and Floodway Data tables in the Flood Insurance Study report (which contains authoritative hydraulic data) may reflect stream channel distances that differ from what is shown on this map.

Corporate limits shown on this map are based on the best data available at the time of publication. Because changes due to annexations or de-annexations may have occurred after this map was published, map users should contact appropriate community officials to verify current corporate limit locations.

Please refer to the separately printed **Map Index** for an overview map of the county showing the layout of map panels; community map repository addresses; and a Listing of Communities table containing National Flood Insurance Program dates for each community as well as a listing of the panels on which each community is located.

For information and questions about this map, available products associated with this FIRM including historic versions of this FIRM, how to order products or the National Flood Insurance Program in general, please call the FEMA Map Information eXchange at 1-877-FEMA-MAP (1-877-336-2627) or visit the FEMA Map Service Center website at <http://msc.fema.gov>. Available products may include previously issued Letters of Map Change, a Flood Insurance Study Report, and/or digital versions of this map. Many of these products can be ordered or obtained directly from the website. Users may determine the current map date for each FIRM panel by visiting the FEMA Map Service Center website or by calling the FEMA Map Information eXchange.

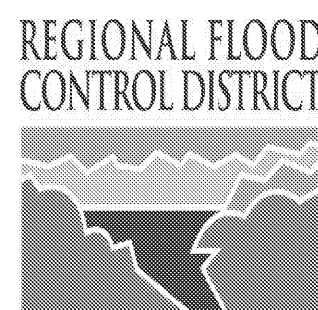
The Digital Flood Insurance Rate Map (DFIRM) was produced through a unique partnership between Clark County and the Federal Emergency Management Agency (FEMA). Clark County has developed a long-term approach of floodplain management to decrease the costs associated with flooding. This is demonstrated by the Clark County commitment to share and maintain floodplain layers within their Geographic Information System Management Office (GISMO).

This DFIRM reflects several innovative features. These include:

+ Southern Nevada GIS - Cooperation among local government agencies throughout Clark County. The foundation of cooperation is the GIS Interlocal Agreements formed between fourteen regional participants. In part, the agreements specify that the Clark County GIS Management Office (GISMO) will be responsible for maintaining a GIS data warehouse and associated Southern Nevada GIS metadata.

+ The GISMO's responsibilities go beyond maintaining the GIS data warehouse. GISMO also maintains the Street Centerline Database used by 911 dispatch services. This centerline database serves as the base map for this DFIRM.

DIGITAL DATA AVAILABILITY: <http://www.co.clark.nv.us/ceit/gismo/gismo.htm>



CLARK COUNTY
UNINCORPORATED AREAS
320003

CLARK COUNTY
UNINCORPORATED AREAS
320003

FIGURE 2.2a

LEGEND

SPECIAL FLOOD HAZARD AREAS (SFHAs) SUBJECT TO INUNDATION BY THE 1% ANNUAL CHANCE FLOOD

The 1% annual chance flood (100-year flood), also known as the base flood, is the flood that has a 1% chance of being equaled or exceeded in any given year. The Special Flood Hazard Area is the area subject to flooding by the 1% annual chance flood. Areas of Special Flood Hazard include Zones A, AE, AH, AO, AR, A99, V and VE. The Base Flood Elevation is the water-surface elevation of the 1% annual chance flood.

ZONE A
No Base Flood Elevations determined.
ZONE AE
Base Flood Elevations determined.
ZONE AH
Flood depths of 1 to 3 feet (usually areas of ponding); Base Flood Elevations determined.
ZONE AO
Flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average depths determined. For areas of alluvial fan flooding, velocities also determined.
ZONE AR
Special Flood Hazard Area formerly protected from the 1% annual chance flood by a flood control system that was subsequently decertified. Zone AR indicates that the former flood control system is being restored to provide protection from the 1% annual chance or greater flood.
ZONE A99
Area to be protected from 1% annual chance flood by a Federal flood protection system under construction; no Base Flood Elevations determined.
ZONE V
Coastal flood zone with velocity hazard (wave action); no Base Flood Elevations determined.
ZONE VE
Coastal flood zone with velocity hazard (wave action); Base Flood Elevations determined.

FLOODWAY AREAS IN ZONE AE

The floodway is the channel of a stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 1% annual chance flood can be carried without substantial increases in flood heights.

OTHER FLOOD AREAS

ZONE X
Areas of 0.2% annual chance flood; areas of 1% annual chance flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 1% annual chance flood.

OTHER AREAS

ZONE X
Areas determined to be outside the 0.2% annual chance floodplain.
ZONE D
Areas in which flood hazards are undetermined, but possible.

COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

OTHERWISE PROTECTED AREAS (OPAs)

CBRS areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas.

Floodplain boundary
 Floodway boundary
 Zone D boundary
 CBRS and OPA boundary
 Boundary dividing Special Flood Hazard Areas of different Base Flood Elevations, flood depths or flood velocities.
 Base Flood Elevation line and value; elevation in feet*
 Base Flood Elevation value where uniform within zone; elevation in feet*

* Referenced to the North American Vertical Datum of 1988 (NAVD 88)
 Cross section line

Transect line

97°07'30" 32°22'30"
42°15'00"N
6000000 FT
Geographic coordinates referenced to the North American Datum of 1983 (NAD 83)
1000-meter Universal Transverse Mercator grid ticks, zone 11
5000-foot grid ticks: Nevada State Plane coordinate system, east zone (FIPSZONE 2701), Transverse Mercator

DX55110
M1.5
Bench mark (see explanation in Notes to Users section of this FIRM panel)
River Mile

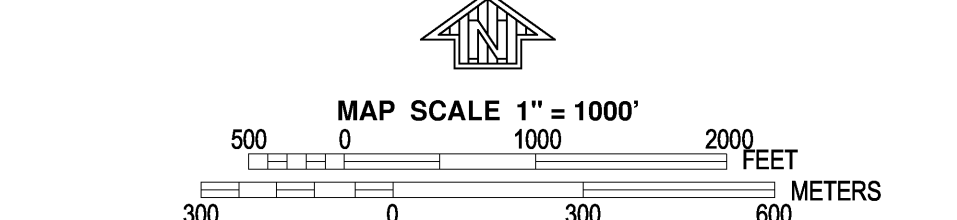
MAP REPOSITORIES
Refer to Map Repositories list on Map Index

EFFECTIVE DATE OF COUNTYWIDE FLOOD INSURANCE RATE MAP
August 16, 1995
EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL

November 16, 2011 - to reflect updated topographic information. To change floodway, to add Base Flood Elevations, to update corporate limits, to change Base Flood Elevations, to add Special Flood Hazard Areas, to change Special Flood Hazard Areas, to delete Special Flood Hazard Areas, to change zone designations, to add roads and road names, and to incorporate previously issued Letters of Map Revision.

For community map revision history prior to countywide mapping, refer to the Community Map History table located in the Flood Insurance Study report for this jurisdiction.

To determine if flood insurance is available in this community, contact your insurance agent or call the National Flood Insurance Program at 1-800-638-6620.



PANEL 2160F

FIRM
FLOOD INSURANCE RATE MAP
CLARK COUNTY,
NEVADA
AND INCORPORATED AREAS

PANEL 2160 OF 4090
(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
CLARK COUNTY	320003	2160	F
LAS VEGAS, CITY OF	328276	2160	F
NORTH LAS VEGAS, CITY OF	320007	2160	F

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

32003C2160F

MAP REVISED

NOVEMBER 16, 2011

Federal Emergency Management Agency

NOTES TO USERS

This map is for use in administering the National Flood Insurance Program. It does not necessarily identify all areas subject to flooding, particularly from local drainage sources of small size. The community map repository should be consulted for possible updated or additional flood hazard information.

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1315 East-West Highway
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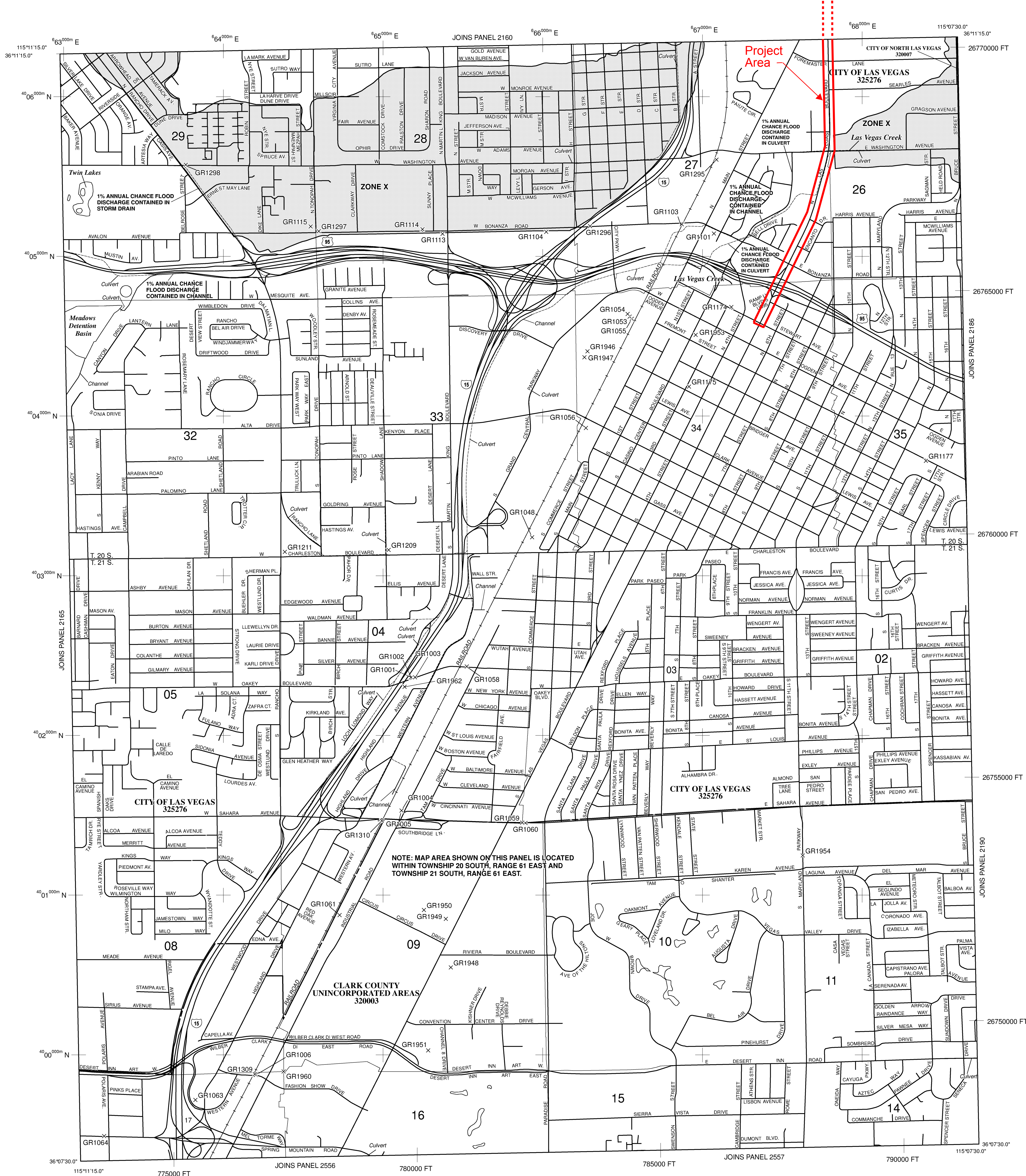
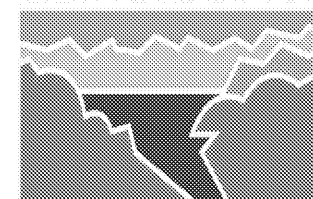
+ Southern Nevada GIS-Cooperation among local government agencies throughout Clark County. The foundation of cooperation is the GIS Interlocal Agreements formed between fourteen regional participants. In part, the agreements specify that the Clark County GIS Management Office (GISMO) will be responsible for maintaining a GIS data warehouse and associated Southern Nevada GIS metadata.

+ The GISMO's responsibilities go beyond maintaining the GIS data warehouse. GISMO also maintains the Street Centerline Database used by 911 dispatch services. This centerline database serves as the base map for this DFIRM.

DIGITAL DATA AVAILABILITY: <http://www.co.clark.nv.us/ceit/gismo/gismo.htm>



REGIONAL FLOOD
CONTROL DISTRICT



LEGEND

SPECIAL FLOOD HAZARD AREAS (SFHAs) SUBJECT TO INUNDATION BY THE 1% ANNUAL CHANCE FLOOD

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- ZONE A** No Base Flood Elevations determined.
- ZONE AE** Base Flood Elevations determined.
- ZONE AH** Flood depths of 1 to 3 feet (usually areas of ponding); Base Flood Elevations determined.
- ZONE AO** Flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average depths determined. For areas of alluvial fan flooding, velocities also determined.
- ZONE AR** Special Flood Hazard Area formerly protected from the 1% annual chance flood by a flood control system that was subsequently decertified. Zone AR indicates that the former flood control system is being restored to provide protection from the 1% annual chance or greater flood.
- ZONE A99** Area to be protected from 1% annual chance flood by a Federal flood protection system under construction; no Base Flood Elevations determined.
- ZONE V** Coastal flood zone with velocity hazard (wave action); no Base Flood Elevations determined.
- ZONE VE** Coastal flood zone with velocity hazard (wave action); Base Flood Elevations determined.

FLOODWAY AREAS IN ZONE AE

The floodway is the channel of a stream plus any adjacent floodplain areas that must keep free of encroachment so that the 1% annual chance flood can be carried without substantial increases in flood heights.

OTHER FLOOD AREAS

ZONE X Areas of 0.2% annual chance flood; areas of 1% annual chance flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 1% annual chance flood.

OTHER AREAS

- ZONE X** Areas determined to be outside the 0.2% annual chance floodplain.
- ZONE D** Areas in which flood hazards are undetermined, but possible.

COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

OTHERWISE PROTECTED AREAS (OPAs)

CBRS areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas.

- Floodplain boundary
- Floodway boundary
- Zone D boundary
- CBRS and OPA boundary
- Boundary dividing Special Flood Hazard Areas of different Base Flood Elevations, flood depths or flood velocities
- Base Flood Elevation line and value; elevation in feet*
- Base Flood Elevation value where uniform within zone; elevation in feet*

* Referenced to the North American Vertical Datum of 1988 (NAVD 88)

A A Cross section line

23 23 Transect line

97°07'30" 32°22'30" Geographic coordinates referenced to the North American Datum of 1983 (NAD 83)

42°15'00"N State Plane coordinate

6000000 FT 1000-meter Universal Transverse Mercator grid ticks, zone 11

5000-foot grid ticks: Nevada State Plane coordinate system, east zone (FIPSZONE 2701), Transverse Mercator

DX5510 x Bench mark (see explanation in Notes to Users section of this FIRM panel)

M1.5 River Mile

MAP REPOSITORIES

Refer to Map Repositories list on Map Index

EFFECTIVE DATE OF COUNTYWIDE FLOOD INSURANCE RATE MAP

August 16, 1995

EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL

November 16, 2011 - to reflect updated topographic information, to change floodway, to add Base Flood Elevations, to update corporate limits, to change Base Flood Elevations, to add Special Flood Hazard Areas, to change Special Flood Hazard Areas, to delete Special Flood Hazard Areas, to change zone designations, to add roads and road names, and to incorporate previously issued Letters of Map Revision.

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MAP SCALE 1" = 1000'

500 0 1000 2000 FEET

300 0 300 600 METERS

PANEL 2170F

FIRM

FLOOD INSURANCE RATE MAP

CLARK COUNTY,

NEVADA

AND INCORPORATED AREAS

PANEL 2170 OF 4090

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY NUMBER PANEL SUFFIX

CLARK COUNTY 320003 2170 F

LAS VEGAS, CITY OF 325276 2170 F

NORTH LAS VEGAS, CITY OF 320007 2170 F

NOTES 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

32003C2170F

MAP REVISED

NOVEMBER 16, 2011

Federal Emergency Management Agency

2.0 DESIGN METHODS AND CRITERIA

The proposed project was designed to be in conformance with the applicable criteria established by CCRFCD and documented in Hydrologic Criteria and Drainage Design Manual (CCRFCD, 1999). The following sections briefly describe the relevant methods and design criteria that were applied in this study. Results of the hydrologic modeling and hydraulic calculations are presented in Section 4 of this study.

3.0 HYDROLOGIC METHODS AND ANALYSIS

Two hydrologic conditions were evaluated for the purposes of this study, namely existing and developed conditions, with developed conditions representing post project construction. The existing conditions watershed model was prepared as a baseline from which to compare the effects of the project on the regional flow patterns and flow rates. The developed conditions watershed model is based on existing conditions with incorporation of proposed storm drains into the model. The developed conditions model was not broken down further into interim and future conditions models since the watershed is fully developed and major flood control facilities within the project area have been constructed.

The storm drain design is controlled by the 10 year flow criteria, so the 10 year 6 hour storm hydrology is critical to the storm drain design. Hydrology in the Las Vegas Valley Master Plan Update for the Clark County Regional Flood Control District (MPU) shows a flow split where Las Vegas Boulevard meets Mesquite Avenue with 167 cfs flowing north in the existing storm drain and the balance flowing east for the 100 year storm. The result of this is that the surface flow plus storm drain flow continuing north under the US 95 freeway for the 100 year storm should be 167 cfs or less. Since this section of the report concentrates on the assumptions and data used for preparing the hydrologic model, further detailed discussion of the model results as they relate to the design is reserved for later sections of the report.

3.1 Hydrologic Modeling

The design events evaluated for this project were the 6-hour duration, 10-year and 100-year return period storms. Four hydrologic models were prepared:

- 1) Existing Conditions 10-year, 6-hour Storm HEC-1 Model
- 2) Existing Conditions 100-year, 6-hour Storm HEC-1 Model
- 3) Proposed Conditions 10-year, 6-hour Storm HEC-1 Model
- 4) Proposed Conditions 100-year, 6-hour Storm HEC-1 Model

Output from the HEC-1 models is contained in Appendix A.



3.2 Drainage Basin and Sub-basin Delineation

The basins contributing runoff to areas within the project limits are delineated in Figure 3-1. The drainage boundaries were determined based on information contained in the 2008 Flood Control Master Plan Update, a review of regional topography included in the figure and field observations.

Flow Patterns South of I-515

The watershed south of I-515 is bounded by Main Street on the west, Las Vegas Boulevard on the east, and Charleston Boulevard on the south. Surface runoff in the project area watershed generally follows the terrain, flowing from west to east. A high point in Las Vegas Boulevard at Bridger Avenue intercepts surface flow south of that point; however, storm drain flow, which is represented in the HEC-1 model separately from surface flow, continues northward from the high point at Bridger Avenue to the Washington Avenue system. Bonneville Avenue is the low point on Las Vegas Boulevard between the high point at Bridger Avenue and the southern edge of the watershed at Charleston Boulevard where surface runoff collects and continues onward to the east and out of the watershed. The west half of Las Vegas Boulevard is represented in the model as a runoff collector north of Bridger Avenue, channeling flow from the watershed from the west to the north. Storm water collecting on the east half of the street discharges eastward from intersections with side streets. Runoff from I-515 is limited to a minor flow from on and off ramps.

Flow Patterns North of I-515

For the watershed north of I-515, the east half of Las Vegas Boulevard plays a similar role of a runoff collector redirecting flow from the west to the north. Between I-515 and Washington Avenue, Veterans Memorial Drive serves as a cutoff for flows from the west, due in large part to the presence of a 12'x8' RCB in Veterans Memorial Drive which discharges directly into the Washington Avenue parallel channel. Washington Avenue intercepts flows from the south due to the dual 12'x8' RCB's that collect runoff from the south and redirects it eastward under the street.

North of Washington Avenue, the watershed is bounded by I-15 on the west and Owens Avenue to the north. However, the Union Pacific Railroad tracks and Main Street are both runoff collectors which direct flow from the west to the north and into Owens Avenue. Consequently, only the area west of Main Street contributes to flows in Las Vegas Boulevard.



3.3 Hydrologic Modeling Methods and Parameters

The U.S. Army Corps of Engineers' Flood Hydrograph HEC-1 package was the hydrologic model used for the analysis of the drainage basins. The Soil Conservation Service Unit Hydrograph Method as described in the CCRFCD Drainage Design Manual, Section 606, was applied.

Hydrologic modeling was conducted according to the criteria outlined in the Manual, the HEC-1 Flood Hydrograph Package Users Manual (HEC 1998) for the Soil Conservation Service (SCS) Unit Hydrograph Option, and the Las Vegas Valley 2008 Master Plan Update (CCRFCD 2008) for the curve number calculations. Hydrographs were developed for the design storm of 100-year return period and 6-hour duration and 10-year return period and 6-hour duration. Direct and indirect input used for model generation included basin area, soils characterization, land use, curve numbers, topographic data, point precipitation, rainfall duration and time distribution, time of concentration, and hydrograph lag time. Procedures for developing input parameters are presented in the following sections, and supporting information is contained in Appendix A.

Baseline studies for drainage basin boundaries and flow patterns developed for the existing conditions hydrologic models were referenced from the City-Wide Hydrology Analysis and 2008 MPU. Some basins were modified slightly and subdivided based on field observations to further refine flow rates at critical design points.

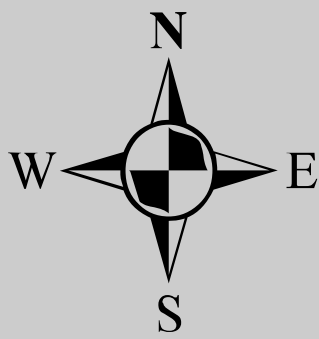
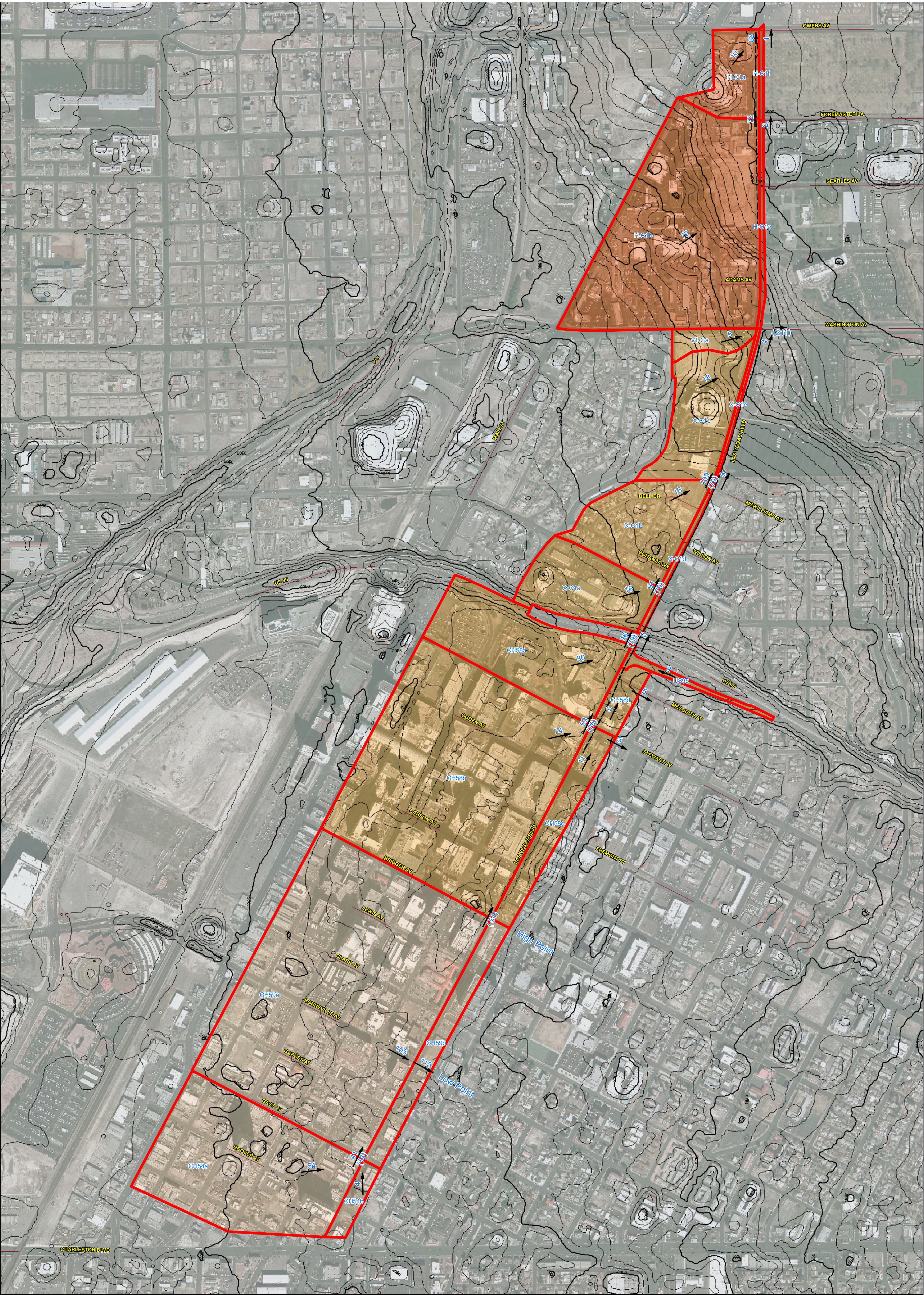
Developed conditions 10- and 100-year models were developed for the Las Vegas Boulevard Storm Drains in order to evaluate the size and location of drop inlets (Appendix B.3.b) and provide design flows.

Precipitation and Lag Time

10-year and 100-year Point Rainfall

Precipitation values (given on the PB cards of the HEC-1 model) for the 100-year storm from the baseline studies were not revised in this study. Precipitation values for the 10-year storm were based on a ratio of 0.57 to the 100-year precipitation value. These ratios are calculated from rainfall depths given in Table 505 in the Manual for the McCarran Airport area. Depth area reduction factors (DARF's) on the JR line of the 100-year model were multiplied by these ratios for the 2-year and 10-year models.





0 200 400 800 1,200 1,600
Scale (in feet)

**LAS VEGAS BOULEVARD
I-515 TO OWENS AVENUE**
Existing Conditions Drainage Basin Map
10 Year Storm

Figure 3.1a

Legend

Drainage Area

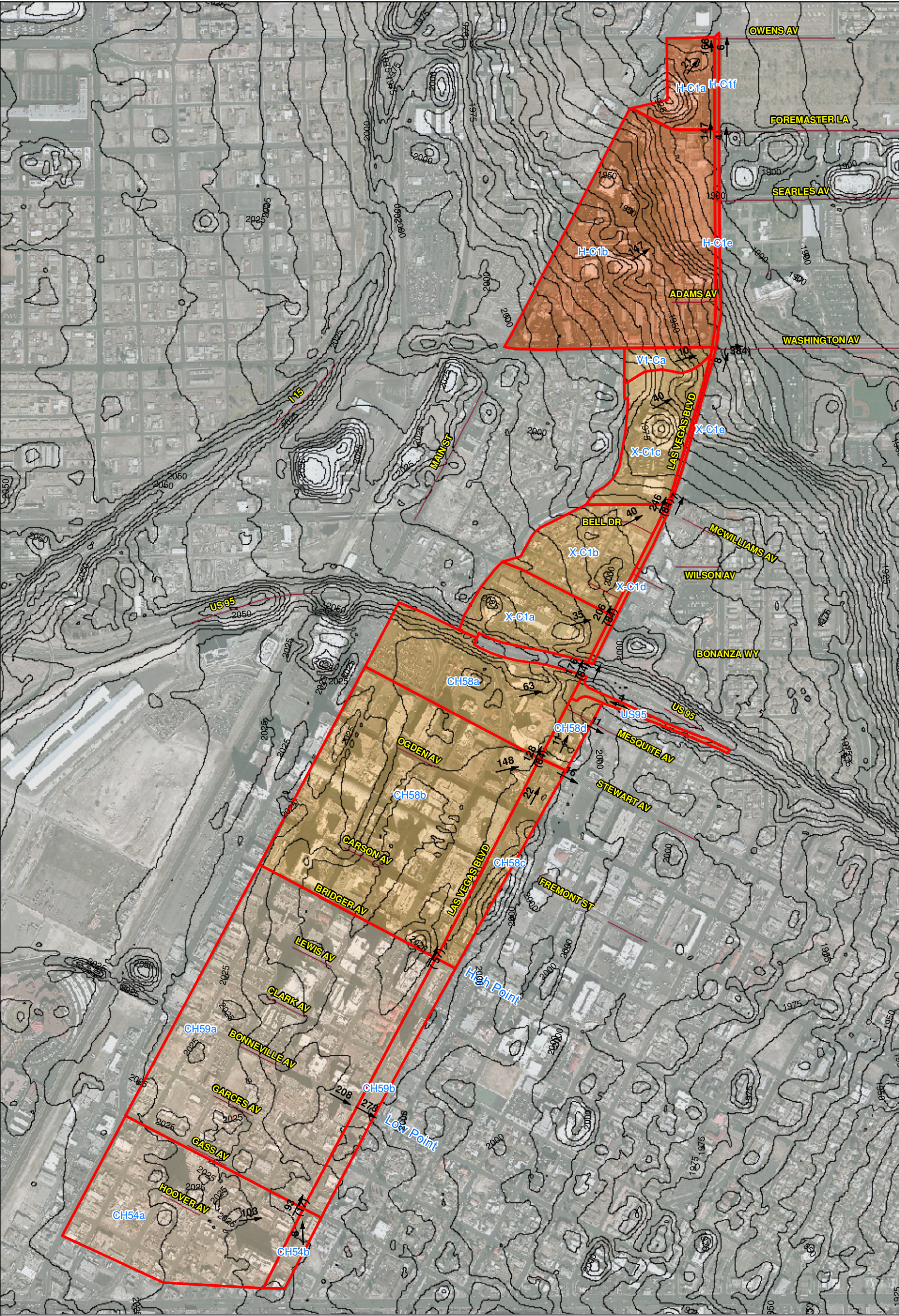
- Bonneville
- Owens
- Washington

Q10 - Surface Flow
Q10 - Storm Drain Flow

Subbasin Boundary

Existing Facilities







**LAS VEGAS BOULEVARD
I-15 TO OWENS AVENUE**

**Existing Conditions Drainage Basin Map
100 Year Storm**

Figure 3.1b

Legend

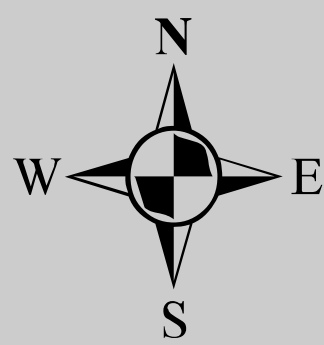
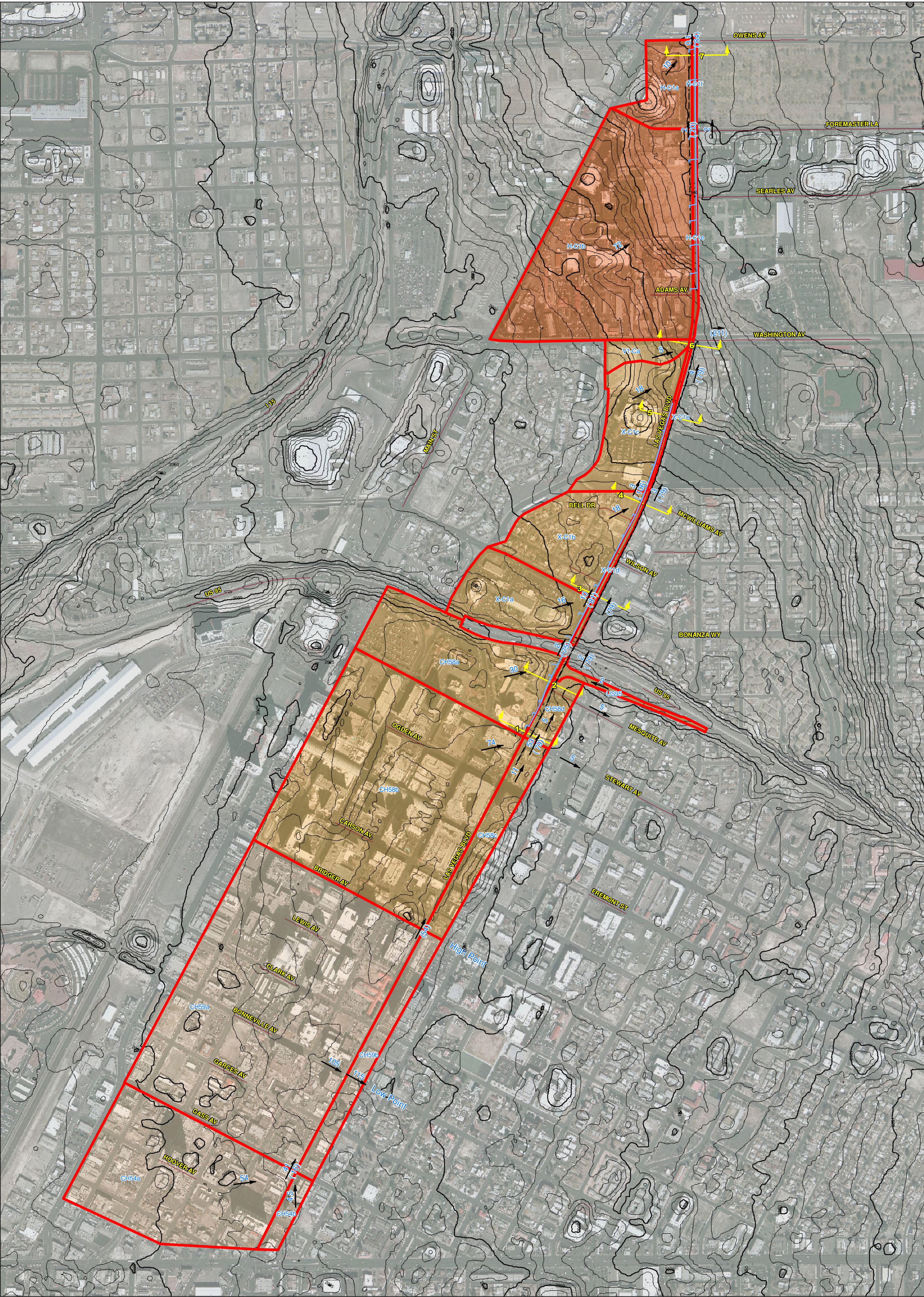
20.0 (5.6) Q100 - Surface Flow
Q100 - Storm Drain Flow

Subbasin Boundary

Drainage Area

- Bonneville
- Owens
- Washington





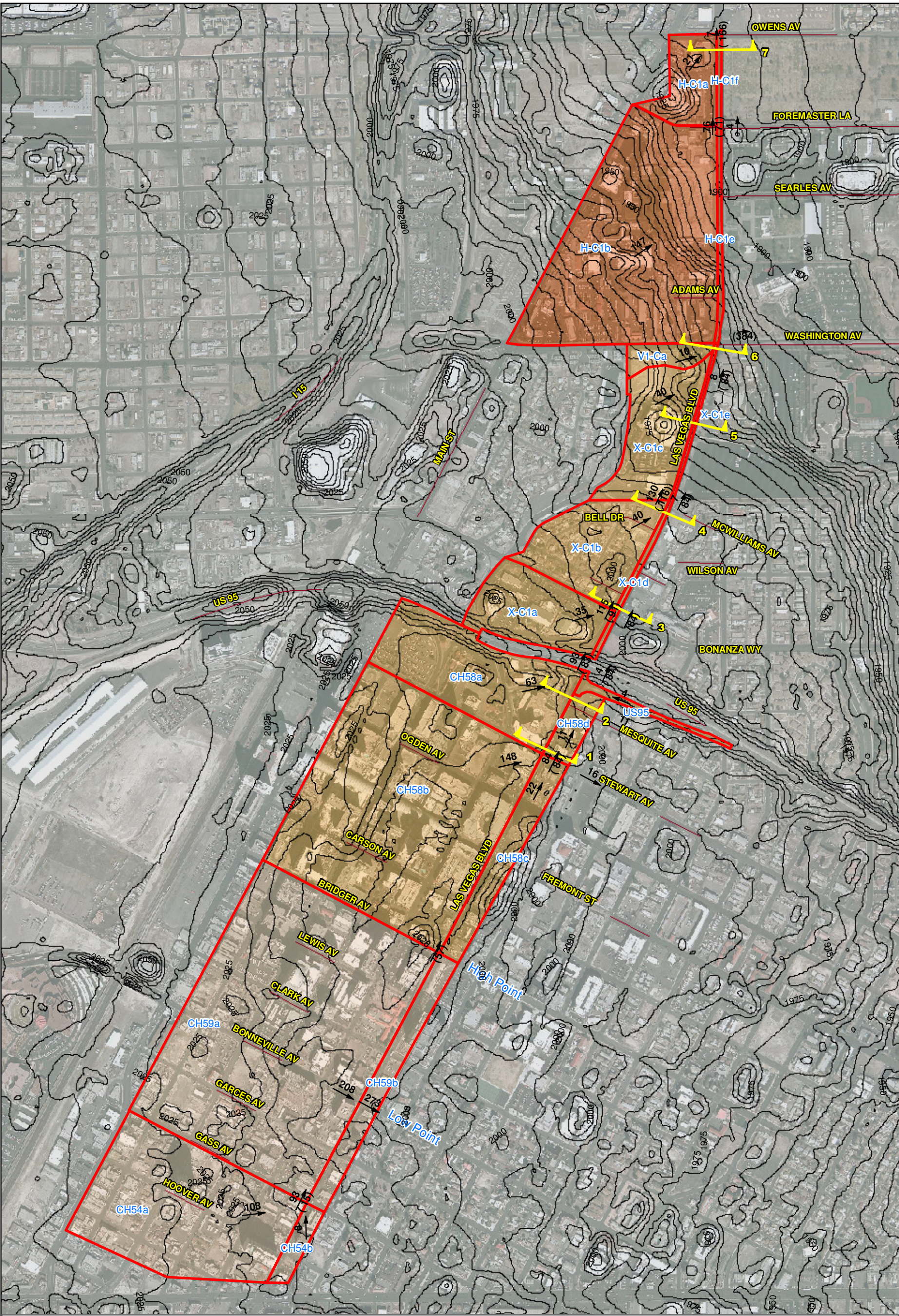
0 200 400 800 1,200 1,600
Scale (in feet)

**LAS VEGAS BOULEVARD
I-515 TO OWENS AVENUE**
**Proposed Conditions Drainage Basin Map
10 Year Storm**
Figure 3.2a

Legend

Drainage Area	Q10 - Surface Flow Q10 - Storm Drain Flow
Bonneville	Subbasin Boundary
Owens	Street Flow Section Location
Washington	Proposed Facilities
	Existing Facilities







**LAS VEGAS BOULEVARD
I-15 TO OWENS AVENUE**

**Proposed Conditions Drainage Basin Map
100 Year Storm**

Figure 3.2b

Legend

Bonneville	Owens	Washington
Subbasin Boundary	Proposed Facilities	Street Flow Section Location

Q100 - Surface Flow
Q100 - Storm Drain Flow



3.4 Storm Distribution Number (SDN)

Since the watershed is approximately a half of a square mile, an SDN3 storm distribution was used, per the CCRFCD Drainage Manual. The rainfall distribution is input into the HEC-1 model on the PC lines.

3.5 Lag Time and Routing

Calculations for estimating time of concentration and lag time are presented on Standard Form 4 in Appendix A.2. TLAG values are input into the HEC-1 model on the UD line.

3.6 Runoff Curve Numbers and Soils Classification

Curve numbers (CN's) were recalculated based on the methods outlined in the Las Vegas Valley 2008 Master Plan Update (CCRFCD 2008). Infiltration and storage characteristics of the subbasins were simulated in the HEC-1 model using runoff curve numbers. The curve number (CN) is based upon land use, soil type, vegetation type, and antecedent moisture content (AMC), which is a function of the amount of rainfall over a watershed in a period preceding a particular storm. AMC II was assumed, as recommended in the Manual.

Drainage basins were superimposed on the 2008 MPU soils and land use maps. Soil types are assigned hydrologic soil groups that characterize runoff potential and hydrologic soil groups. For a particular soil type and land use, the curve number matrix is used to determine the runoff curve number. These numbers were then adjusted slightly based on aerial photos and field observations. Soil and Land use maps overlaid by basin boundaries are shown on Figures A-1 and A-2 in Appendix A.

4.0 STORM DRAIN ALTERNATIVES – LAS VEGAS BOULEVARD

4.1 Existing System

South of Washington Avenue, the existing storm drain on the east side of Las Vegas Boulevard is located near the sidewalk, starting as an 18-inch pipe at Hoover Avenue and increasing in size to 48-inch by the time it reaches Stewart Avenue. The storm drain is connected through drop inlets along the curb in many locations. It continues as a 48-inch storm drain on the east side of the street until increasing to 60 inches approximately 350 feet before it connects to the 12'x8' RCB in Washington Avenue. The existing system conveys the 10 year flow of 77 cfs emanating from south of Stewart Avenue as well as a minor amount of flow on the east side of the street from properties fronting Las Vegas Boulevard. However, the existing 48-inch RCP does not have the



capacity to accommodate any of the surface flow entering Las Vegas Boulevard north of Stewart Avenue. A conditional assessment determined that the existing storm drain is in reasonably good shape except for a damaged section approximately 54 feet south of the 12'x8' RCB. There is an abandoned 24-inch RCP on the west side of the street.

North of Washington Avenue an 18-inch / 24-inch RCP is located on the west side of the street. This system is also connected through the drop inlets located along the curb. The storm drain will be removed since it interferes with roadway construction. The depth of the storm drain is less than 2 feet and the paving box is 2 feet deep. The storm drain bubbles out at the downstream end at Owens Avenue.

A conditional assessment was done on the existing 48" storm drain in Las Vegas Boulevard from Stewart Avenue to its connection to the Washington Avenue RCB. The assessment demonstrated that the majority of the existing facility was still serviceable and the City directed that it will remain in service for the time being.

4.2 Alternatives - Stewart Avenue to Washington Avenue

Two alternatives were considered for storm drain improvements in connection with the Las Vegas Boulevard Widening Project between Stewart Avenue and Washington Avenue. The alternatives are both 10 year systems since that is the controlling storm to meet CCRFCD street flow criteria in Las Vegas Boulevard. The alternatives are:

- 1) Leave the existing 48-inch storm in place and construct another 36-inch / 48-inch storm drain in parallel along the west side of the street, connecting it to the Washington Avenue System. Hydraulic calculations demonstrate that the existing storm drain has a maximum capacity of 77 cfs at Las Vegas Boulevard near Mesquite Avenue. A second storm drain provides the capacity to accommodate the 167 cfs prescribed in the MPU.
- 2) Replace the existing system with a new 48-inch / 54-inch storm drain designed to accommodate the 167 prescribed in the MPU, abandoning the existing storm drain.

Table 4.1 – Alternative 1 - Dual System Incremental Costs

Pay Item	Flow Rate (cfs)	Pay Unit	Approx. Quantity	Unit Price	Total Cost
36" RCP	47	LF	477	\$105	\$50,085
42" RCP	79	LF	850	\$120	\$102,000
48" RCP	103	LF	1973	\$150	\$295,950
Convert DI to MH		EA	3	\$5,000	\$15,000
Total					\$463,035



Table 4.2 - Alternative 2 - Single System Incremental Costs

Pay Item	Flow Rate (cfs)	Pay Unit	Approx. Quantity	Unit Price	Total Cost
Extend Laterals to East Side		LF	350	\$60	\$21,000
Remove Existing 48" RCP		LF	3500	\$65	\$227,500
48" RCP	120	LF	486	\$150	\$72,900
54" RCP	184	LF	3014	\$165	\$497,310
Total					\$818,710

With both alternatives, the existing system of drop inlets will require reconstruction with the widening and reconstruction of Las Vegas Boulevard.

Alternative 1 would be the least expensive since a new, parallel storm drain pipe supplementing the existing storm drain pipe would be smaller in size, and thus less costly to install than a larger pipe required to replace and upsize the existing storm drain.

Since the existing storm drain pipe is in good condition, constructing a second, parallel pipe to increase system capacity is recommended.

4.3 Alternatives – Adams Avenue to Owens Avenue

The three alternatives considered for the storm drain improvements in connection with the Las Vegas Boulevard Widening Project between Washington Avenue at Owens Avenue are:

- 1) Remove the existing system under the west side of the street. Construct a new RCP storm drain under the east side of the street increasing in size from 24 inches to 60 inches. A bubbler would be installed at Owens Avenue until such time as the Owens Avenue RCB is constructed. The last 600 feet of the storm drain is upsized to 60-inch RCP to accommodate the 100 year flow entering the planned RCB in Owens Avenue. The remaining portion of the system would be a 10 year system with a maximum size of 48 inches.
- 2) This alternative is similar to the first except that the 48-foot RCP, to convey the 10 year flow, would be extended the last 600 feet to Owens Avenue instead of upsizing to the 60-inch RCP / 100 year system.



- 3) This alternative is to protect-in-place, remove and reset, or remove and replace, the existing storm drain pipe, depending on depth and condition. This alternative was rejected because the existing system is undersized to meet 10 year storm CCRFCD street flow design criteria.

5.0 STORM DRAIN DESIGN

Proposed storm drain facilities are shown in Figure 5.1. Methods applied for the sizing of storm drains and drop inlets are discussed briefly in this section.

5.1 Constraints - Stewart Avenue to Washington Avenue

Topographic constraints from Stewart Avenue to McWilliams Avenue are as follows: The design slope of the pipe is set as flat as possible to minimize excessive excavation and trench depth, while maintaining a large enough RCP slope to provide sufficient flow capacity. From McWilliams Avenue to Washington Avenue, the grade of Las Vegas Boulevard is steeper so that storm drain slope is no longer controlled by conveyance requirements.

A minimum of 1 foot of cover above the hydraulic grade line is maintained in the design (See design plans for RCP profile). The pipe invert at the downstream end is controlled by the existing invert of the Washington Avenue System at the tie-in point. The storm drain will not be downsized at McWilliams Avenue in order to minimize potential clogging at the choke point, although this would be possible from a purely hydraulic standpoint due to the steeper slope north of McWilliams.

5.2 Constraints - Adams Avenue to Owens Avenue

For this section of the storm drain, slope is controlled by conveyance requirements, while maintaining minimum cover requirements and minimizing excessive trench depths. The layout of the storm drain is on the east side of Las Vegas Boulevard in order to minimize utility conflicts. A stub will be provided to connect the storm drain to the future Owens Avenue System. Until the Owens Avenue System is constructed, the inlets at the downstream end, at Owens Avenue, will act as bubblers. A 36" sanitary sewer (SS) line runs east-west along the south side of Owens Avenue near the terminus of the proposed 60" RCP storm drain. The elevation of the sewer will be confirmed before finalizing the storm drain elevations.

5.3 Drop Inlet Design

Designing a collection system for runoff along Las Vegas Boulevard presented a challenge since the street is very flat in places. The majority of the proposed inlets are conventional curb and grate type inlets.



Small inlets are provided at selected locations to collect the 10 year flow and direct it into the storm drain. New drop inlets will be added to the east side of Las Vegas Boulevard and connected to the existing RCP storm drain to replace those that will require removal due to widening of the street. Drop inlet calculations were done with Flowmaster and the results are included in Appendix B.1. Tables B.1 and B.2 summarize the intercepted and bypass flow for the drop inlets on the west side of Las Vegas Boulevard. The dry lane column represents conditions on the upstream side of the drop inlets. Dry lane minimum widths are generally met with a few exceptions. Meeting the minimum width requirement in every location is not feasible due to the flat road profile in many locations. Since the locations that the dry lane is not met the depth times velocities are low, this should not be a problem. Appendix B.2 has street flow hydraulic sections for critical locations along Las Vegas Boulevard (see Figures 3.2a and 3.2b for locations). The results are summarized in Tables B.3 through B.6. Note that in all locations depth times velocity requirements are met. See Figures B.1 through B.8 for drop inlet intercepted and bypass flows.

5.4 Storm Drain Design

The storm drain system was divided into two reaches for analytical purposes. The north storm drain, from Adams Avenue to Owens Avenue, and the south storm drain, from Stewart Avenue to Washington Avenue. Intercepted flows from drop inlets were diverted from the appropriate concentrations points in the HEC-1 models (see Appendix A.3). These were then recombined at the end of the HEC-1 model to form the basis for input flows into the WSPG model.

Appendix B.3 shows the input and output of both the north and south WSPG models. The results show that storm drains functions primarily as non-pressurized supercritical flow.

The design will consider a bleeder at the downstream end near Owens Avenue (See Figure 5.2) connecting to an existing storm drain located about 1000 feet east of Las Vegas Boulevard on Owens Avenue. Due to the presence of a 36" sanitary sewer line in Owens Avenue just downstream of the capped proposed storm drain, more detailed survey information is needed for this sanitary sewer and the existing storm drain to the east in order to complete the design. A preliminary design of the bleeder is shown on construction sheets SD-22 and SD-23. Calculations in Appendix B.c.3 show that the head loss for the bubblers is approximately 0.17'.

5.5 Utility Conflicts

If the 60" RCP is extended in the future to connect to the future 12'x11' RCB in Owens Avenue, then the 60" RCP profile should be set so that it can cross the 36" SS (see Figure 5.2) so that the 36" SS will not have to be relocated. Pending further survey information on the 36" SS, the profile of the proposed storm drain may be raised from what is shown on the plans in order to eliminate conflict with the SS.



A 12" sanitary sewer must cross under the proposed storm drain at Foremaster Lane in order to avoid lowering the proposed storm drain at the crossing to the point where the storm drain cannot cross over the 36" sanitary sewer downstream.

Coordination with utility companies is ongoing and the final disposition of some of the crossing utilities is yet to be finalized. Possible utility conflicts with the storm drain are listed below:

Item	Station
Telephone	"L" 13+80
Telephone	"L" 23+50
Water Service	"L" 33+30
2" PE Gas	"L" 41+35
Telephone	"L" 55+20
Cable TV	"L" 56+25
Telephone	"L" 61+45
2" Steel Gas Line	"L" 63+25
2" Steel Gas Line	"L" 66+25
12" Water Line	"L" 66+40
Cable TV	"L" 66+50





Legend

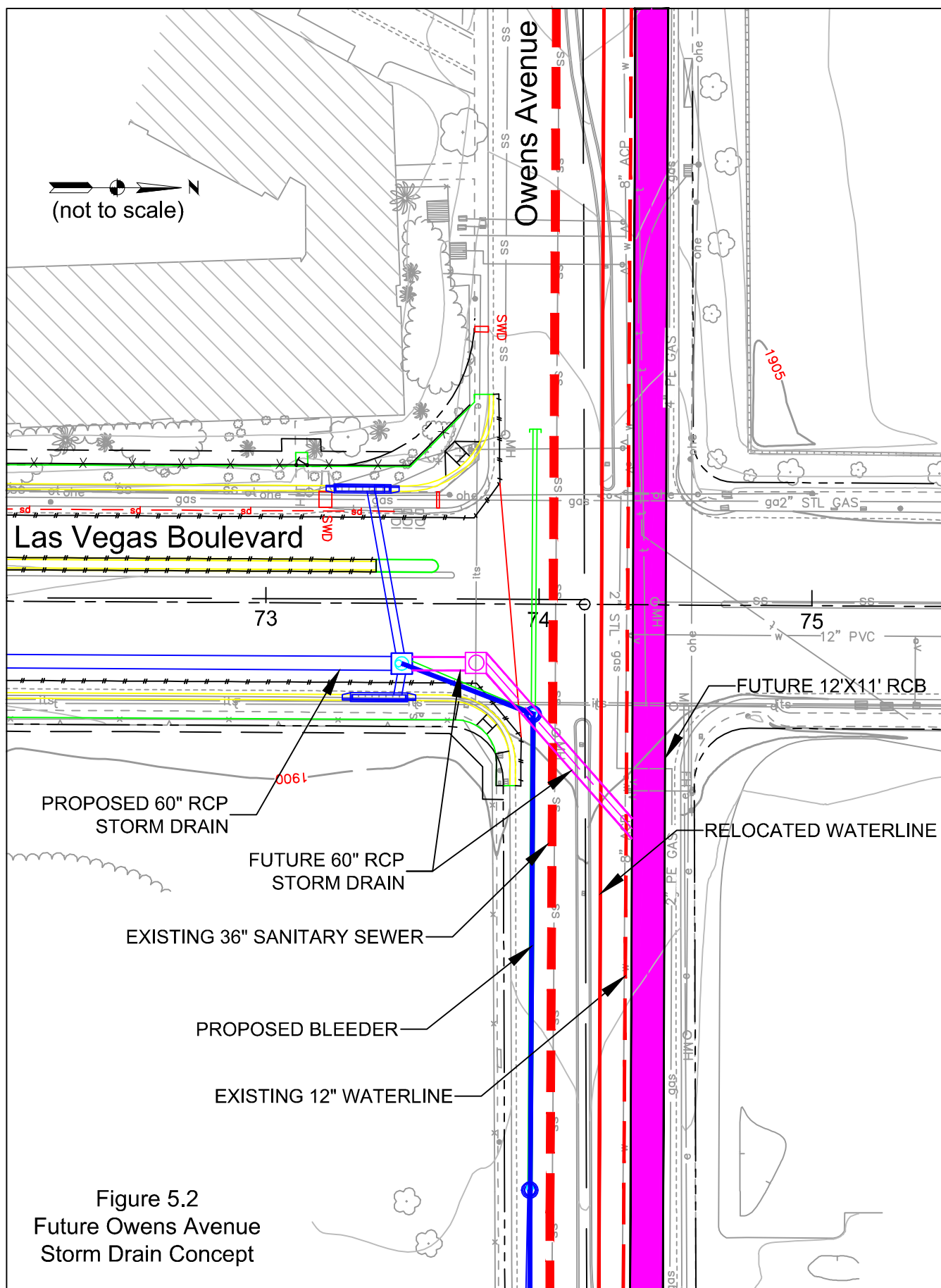
- Existing MPU Facilities
- Future MPU Facilities
- Existing Local Facilities
- Proposed Facilities

**LAS VEGAS BOULEVARD
I-15 TO OWENS AVENUE**

Proposed Storm Drain Facilities

Figure 5.1





6.0 COST ESTIMATE

Table 6.1 – Drainage Facilities Cost Estimate

Item Number	Item Description	Quantity	Unit	Unit Price	Total
202.08	Removal of RCP Storm Drain	2,674	LF	\$50.00	\$133,700
202.09	Removal of Drop Inlet	24	EA	\$2,280.00	\$54,720
202.10	Removal of Existing Sidewalk Drain	6	EA	\$200.00	\$1,200
603.01	18-Inch Reinforced Concrete Pipe (Class III)	2,338	LF	\$59.00	\$137,942
603.02	24-Inch Reinforced Concrete Pipe (Class III)	414	LF	\$95.00	\$39,330
603.03	30-Inch Reinforced Concrete Pipe (Class III)	95	LF	\$100.00	\$9,500
603.04	36-Inch Reinforced Concrete Pipe (Class III)	341	LF	\$120.00	\$40,920
603.05	42-Inch Reinforced Concrete Pipe (Class III)	1,707	LF	\$150.00	\$256,050
603.06	48-Inch Reinforced Concrete Pipe (Class III)	2,222	LF	\$120.00	\$266,640
603.07	60-Inch Reinforced Concrete Pipe (Class III)	230	LF	\$210.00	\$48,300
603.08	RCP Plug	11	EA	\$1,000.00	\$11,000
603.09	RCP Collar	5	EA	\$500.00	\$2,500
609.01	Adjust Storm Drain Manhole Grade Rings	1	EA	\$3,000.00	\$3,000
609.02	Sidewalk Drain	80	LF	\$200.00	\$16,000
609.03	60" Type I Manhole	2	EA	\$3,000.00	\$6,000
609.04	60" Type III Manhole, Modified	28	EA	\$6,180.00	\$173,040
609.05	48" Type I Manhole	6	EA	\$18,000.00	\$108,000
609.06	NDOT Type 2 Drop Inlet	2	EA	\$3,000.00	\$6,000
609.07	Drop Inlet Type "DM" (L=2.5 feet)	17	EA	\$4,500.00	\$76,500
609.08	Drop Inlet Type "DM" (L=5 feet)	1	EA	\$9,000.00	\$9,000
609.09	Drop Inlet Type "DM" (L=12.5 feet)	5	EA	\$9,500.00	\$47,500
609.10	Drop Inlet Type "DM" (L=15 feet)	2	EA	\$14,300.00	\$28,600
609.11	Drop Inlet Type "DM" (L=17.5 feet)	2	EA	\$16,000.00	\$32,000
609.12	Drop Inlet Type "DM" (L=20 feet)	13	EA	\$18,000.00	\$234,000
609.13	Riser Drop Inlet	4	EA	\$3,000.00	\$12,000

Drainage Sub-Total	\$1,753,442
Contingencies (10%)	\$175,344
Total Drainage Facilities Construction Cost	\$1,928,786

The total estimated cost for drainage facilities for this project is \$1,928,786.



7.0 CONCLUSION

From Stewart Avenue to Washington Avenue, proposed storm drain improvements in this project will upgrade flood control so that it provides 10 year protection as well as meeting 10 year and 100 year requirements outlined in the Manual.

From Washington Avenue to Foremaster Lane, the proposed storm drain improvements will eventually provide the same level of protection once they are tied into the future Owens Avenue System. In addition, from Foremaster Lane to Owens Avenue, the system is designed to provide 100 year protection once the Owens Avenue System is completed.



8.0 REFERENCES

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5. FEMA, 2002. Flood Insurance Rate Map, Clark County, Nevada and Incorporated Areas, Panel 2160 of 4090, prepared by the Federal Emergency Management Agency, September 2002, available at <http://www.ccrfcd.org>.
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