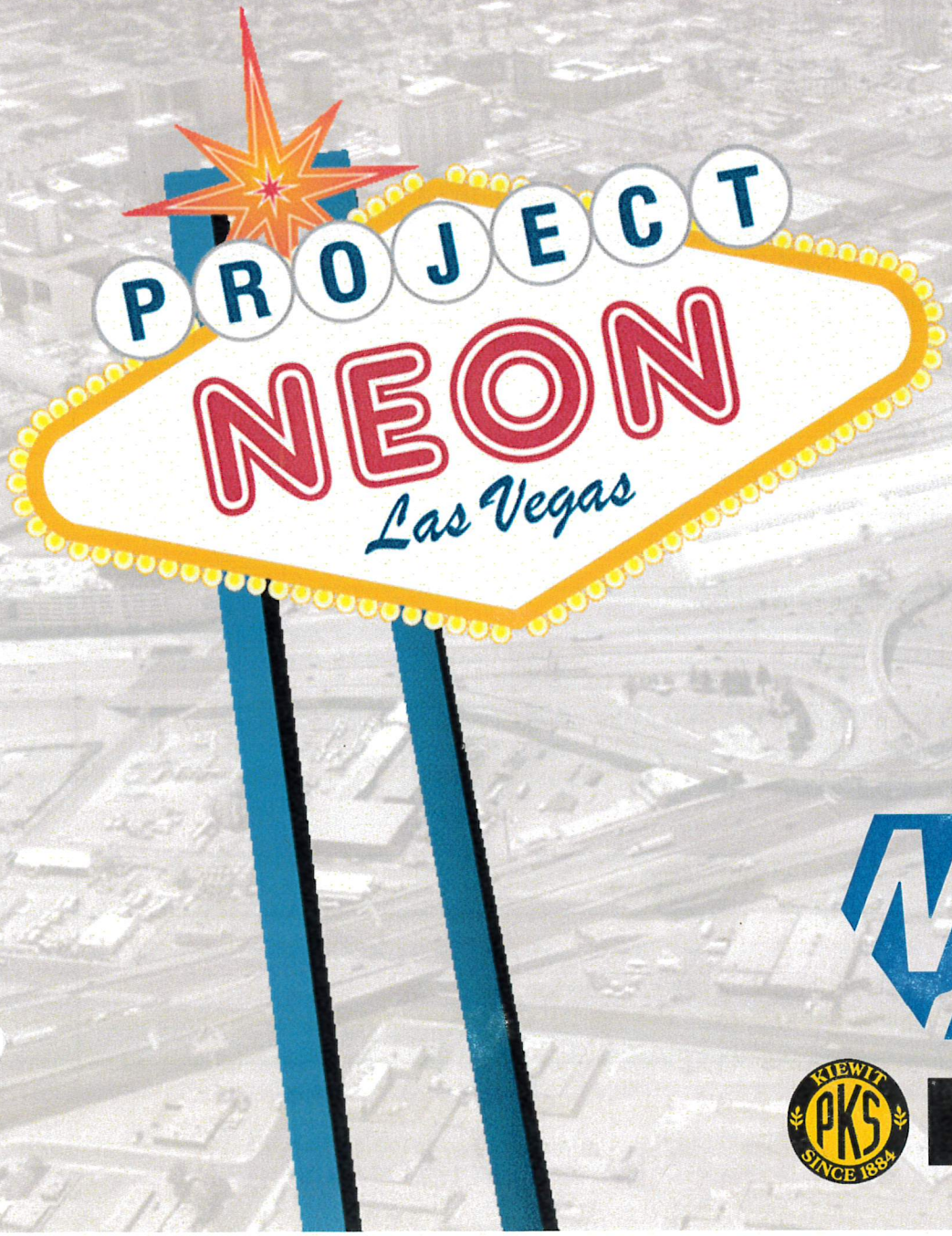
Project Neon Drainage Report
CW-17 – Project-Wide Hydrologic Analysis

10 February 2016



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Design Builder – Kiewit Infrastructure West Co.

Notice

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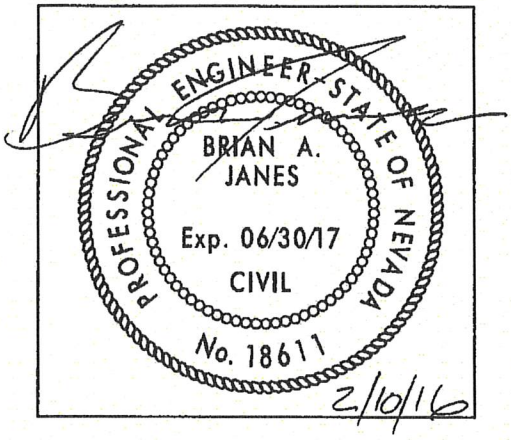
Table 1. Document History

Job number: 100047698			**Document ref: CW-17**			
Revision	Purpose description	Originated	Checked	Reviewed	Authorised	Date
Rev 0	Drainage Report – Hydrologic Analysis	NM	BJ	BR	JD	2/10/2016

Table 2. Creator Signoff

Client	Kiewit Infrastructure West Co.
Project	Project Neon Design Build
Document Title	Project Neon Drainage Report - CW-17 - Project Wide Hydrologic Analysis - Preliminary
Task Name/Technical Provision Ref No.	TP 8.3.1 and 8.5.1
Job Number	RFP Number 001-15-015
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Executive Summary

Project Neon is located within the City of Las Vegas in Clark County, Nevada (Township 21 S, Range 61 E, Sections 4, 8, 9, 28 and Township 20S, Range 61E, Sections 28, 29, 33). The project includes improvements to local roadways, I-15, and US 95. The project improvements extend along I-15 from Desert Inn Road to Bonanza Road, US-95 from Rancho Road to City Parkway, and the local roadways surrounding these improvements.

This drainage report summarizes Design Unit CW-17 of Project NEON which involves hydrologic analysis to determine the peak 10-year and 100-year design flows impacting CCRFCD and roadway drainage facilities within the project vicinity to ensure no adverse impacts are caused by the proposed project improvements. The criteria, methodology, and analysis presented in this report are consistent with the CCRFCD *Hydrologic Criteria and Drainage Design Manual* (hereafter referred to as the Design Manual). The 2013 Las Vegas Valley Flood Control Master Plan Update (MPU) was also used as a primary reference to guide the analysis and modeling effort.

The project site is located in an area referred to as the "Central Watershed" within the MPU. The Existing, Interim, and Ultimate Condition were analyzed for this project. The Existing Condition represents the current watershed as it is today, without proposed Project Neon improvements or future CCRFCD facilities in place. The Interim Condition represents the existing watershed but with the proposed Project Neon improvements in place. The Ultimate condition represents the fully developed off-site watershed with all proposed CCRFCD facilities and Project Neon improvements in place.

This report presents the offsite hydrologic parameters such as subbasin characteristics, rainfall, depth-area-reduction-factors, soils parameters, routing methods, flow diversions, and storm centering. HEC-1 Version 4.1 (dated June 1998) was used for the hydrologic modeling in order to be consistent with the MPU process and previous Project Neon studies. The HEC-1 model from the 2013 MPU (Central Watershed) was used as the base HEC-1 model and modified as necessary based on current, best available data and information obtained for this project.

The overall objective of the drainage design is to design new facilities or relocate/modify existing facilities in a manner that will match or improve upon existing drainage and flow conditions with no adverse impacts to adjacent properties or upstream/downstream facilities in accordance with applicable criteria, Nevada drainage law, and good industry and engineering practice. It is important to note that the existing regional facilities in the project area do not have sufficient capacity to convey all of the 100-year flows in the project area. This means that there is a significant amount of runoff conveyed on the surface and on the nearby roadways in the Existing Condition. This will continue to be the case in the Interim Condition even after the Project Neon facilities are constructed; however, the project will perpetuate or improve upon the existing drainage and flow conditions and will not create any adverse impacts to adjacent property owners or upstream/downstream properties. When the full buildout of proposed MPU facilities occurs, the regional facilities in the project area and in upstream watersheds will adequately convey the 100-year flows and greatly reduce surface flooding in the project area.

1. Introduction & Purpose

The purpose of this Drainage Report is to describe the criteria, parameters, considerations, assumptions, and methodology used in the hydrologic analysis of the offsite watershed in order to determine the peak 10-year and 100-year design flows for the CCRFCD regional facilities and the local roadways associated with Project Neon. This Drainage Report includes pertinent aspects of the project explored to date and facilitates review of the analysis by Nevada Department of Transportation (NDOT), Clark County Regional Flood Control District (CCRFCD), the City of Las Vegas (CLV), and other stakeholders.

It is important to note that the analysis presented with this Drainage Report is still a work in progress and represents the latest information corresponding to the Preliminary Design Submittal for the Project Hydrology. Thus, the analysis and information presented herein is subject to amendments, additions, and revisions in the future as comments are received and more analyses are completed throughout the detailed design phase. The content presented herein will later be updated as necessary and incorporated into the Drainage Design Report at the Final submittal.

1.1. Project Location and Description

Project Neon is located within the City of Las Vegas in Clark County, Nevada (Township 21 S, Range 61 E, Sections 4, 8, 9, 28 and Township 20S, Range 61E, Sections 28, 29, 33). The project includes improvements to local roadways, I-15, and US 95. See the Vicinity Map shown in **Figure 1**.

The project improvements extend along I-15 from Desert Inn Road to Bonanza Road, US-95 from Rancho Road to City Parkway, and the local roadways surrounding these improvements. The CCRFCD regional facilities encompassed in this project are described in the 2013 Las Vegas Valley Flood Control MPU as facility numbers FW15 0000 through 0150 (referred to as the Freeway Channel hereafter), LCCH 0000 and 0013, FWCH 0000 and 0020, FWOK 0000, FWUP 0000, and FWWL 0000. The facility map and inventory table from the MPU for the CCRFCD facilities can be found in **Appendix A.7.**

The drainage facility improvements include realigning the Freeway Channel from just north of Sahara Avenue to the confluence structure with the Freeway Channel Bypass Facility along Western Avenue. The realignment will move the Freeway Channel west beyond the proposed I-15 limits to perpetuate the City's maintenance access. The project will remove the 2-10'x8' RCBs (FW15 0125 and 0150) and replace with a 20'x8' RCB. The project will also remove the 3-12'x9' RCBs and 3-12'x10' RCBs (FW15 0089 and 0100) and replace with 2-18'x9' RCBs or 2-18'x10' RCBs. Local storm drains will also be adjusted with the roadway improvements within the project area.

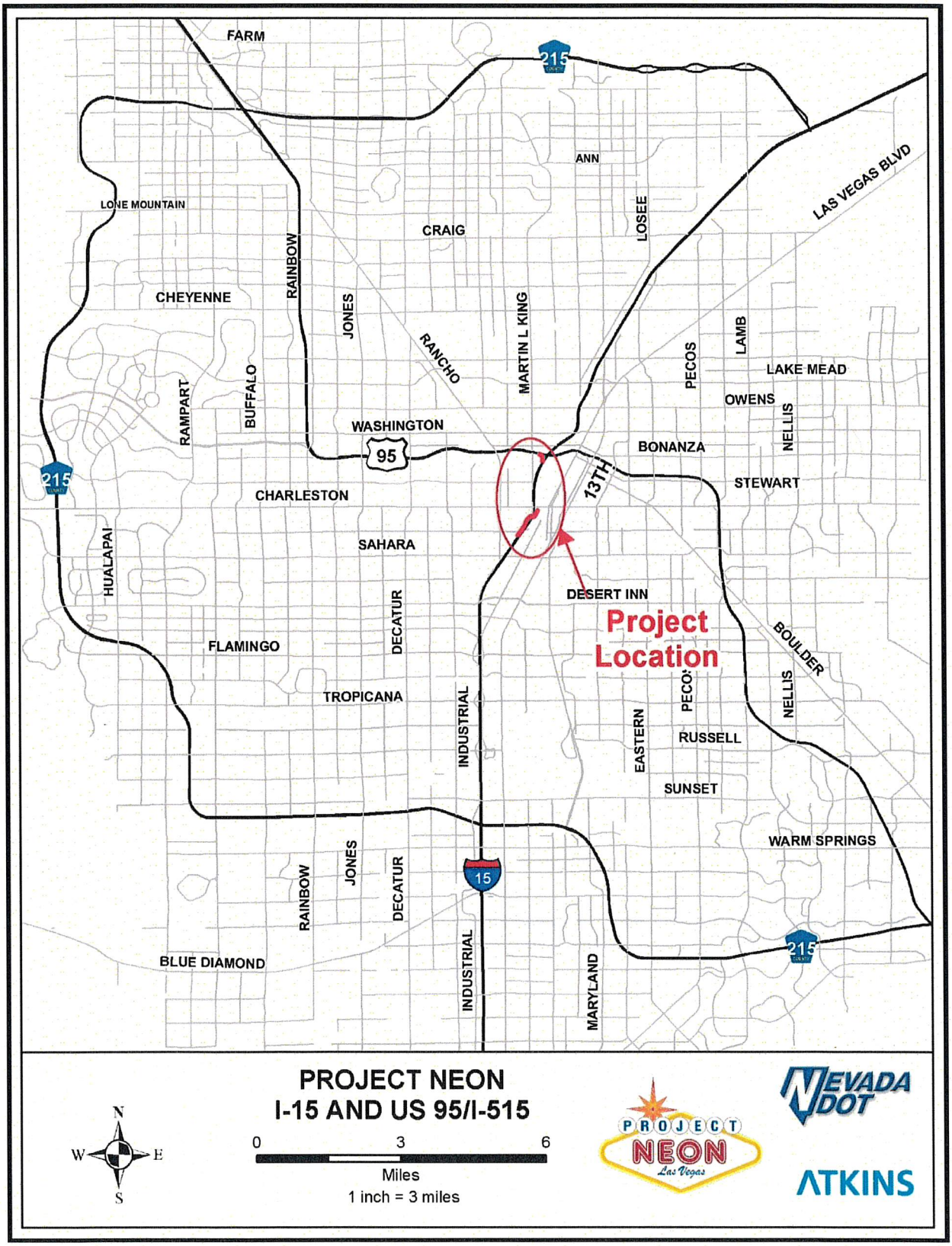


Figure 1. Project Neon Vicinity Map

1.2. Overall Project Scope

The project consists of roadway, drainage, bridge construction, and ramp improvements for I-15 (Desert Inn Road to US 95) and US 95 (I-15 to Rancho Drive). Local roadways that will be improved to accommodate the freeway improvements include Sahara Avenue, Oakey Boulevard/Wyoming Avenue, Martin Luther King (MLK) Boulevard, Charleston Boulevard, Alta Drive/Bonneville Avenue, Pinto Lane, Symphony Parkway, Western Avenue, and Grand Central Parkway. The following is an abbreviated description of the overall project scope components:

- US 95 and I-15 HOV connectivity, ramp and collector-distributor
- Northbound I-15 connectivity for HOV lanes
- I-15 to US 95 HOV direct connector
- Bridges, retaining walls, and other structural infrastructure
- Local road design and reconfiguration
- Onsite pavement drainage
- CCRFCD facility realignment/protection
- Signing, lighting, and Intelligent Transportation Systems (ITS)

1.3. Drainage Design Scope

The project will realign/improve existing drainage facilities or install new facilities as needed to collect and discharge stormwater runoff to perpetuate existing drainage patterns and match or improve upon the conveyance capacity of the existing CCRFCD facility with no adverse impacts to adjacent properties or upstream and downstream facilities. The following is a description of the overall drainage scope components:

- Perform hydrologic analysis for the project to identify 10-year and 100-year design flow rates for existing and proposed CCRFCD facilities and local roadways.
- Identify appropriate design flow rates for onsite and offsite drainage facilities.
- Perform hydraulic analysis of CCRFCD facilities in the Existing, Interim, and Ultimate Condition.
- Determine the hydraulic capacity of the Freeway Channel in the Existing, Interim, and Ultimate condition and ensure that the existing capacity is maintained or improved.
- Realign or protect CCRFCD facilities to provide maintenance access with primary access points outside NDOT's control of access.
- Design pavement drainage to meet inundation criteria and safely convey roadway flows to existing discharge points.
- Provide Erosion and Sediment Control Plans (ESCPs) for all earth-disturbing activities.
- Incorporate permanent erosion protection to minimize erosion and deposition from stormwater runoff.

The project has internally been divided into separate drainage segments to facilitate the design:

- Segment 1 – I-15 Onsite Analysis
- Segment 2 – US-95 Onsite analysis
- Segment 3 – I-15 South of Sahara Onsite analysis
- Segment 4 – Local Roadways
- Segment 4 – CCRFCD Facilities

1.4. Drainage Design Team

Table 1 lists key personnel associated with project drainage design.

Table 1. Drainage Design Team

Name	Title/Responsibility
Eric Yount	NDOT Drainage Project Manager
Brian Wilson	NDOT Hydraulic Engineer
Ken Gilbreth	NDOT Reviewer (CH2M)
Brook Demitropoulos	NDOT Reviewer (CH2M)
Brian Janes	Drainage Discipline Lead (Atkins)
Nicole Melton	Segment 1 Drainage Lead (Atkins)
Kamal Qaiser	Segment 2 & 3 Drainage Lead (Atkins)
Noel Laughlin	Segment 4 Drainage Lead (HDR)
Mike Warnick	CCRFCD Design Lead (Atkins)
Nicole Melton	Project Hydrology Lead (Atkins)
Dan Stucky	Segments 2 through 4 QC (Atkins)
Jacob Beedle	Segment 1 QC (Atkins)
Harshal Desai	CCRFCD Design QC (Atkins)
Brian Rowley	Project Hydrology QC (Atkins)

2. Design Procedures and Criteria

2.1. Drainage Criteria

The drainage criteria conforms foremost to Technical Provisions listed in the *Request for Proposals, RFP Number: 001-15-015, To Design and Construct The Project Neon Design-Build Project through a Design-Build Contract – Volume II – Technical Provisions*, issued by the Nevada Department of Transportation on November 9, 2015.

In addition to the specific criteria outlined in the Technical Provisions, general criteria and standards conform to the following documents:

- 2014 Standard Specifications for Road and Bridge Construction, NDOT
- 2010 Standard Plans for Road and Bridge, NDOT
- Drainage Manual 2nd Edition, NDOT, December 2006
- Hydrologic Criteria and Drainage Design Manual, Clark County Regional Flood Control District, August 1999, and subsequent revisions

The following sections provide additional details and information regarding the hydrologic analysis methodology.

2.1.1. Hydrologic Procedures and Criteria

The hydrologic analysis for this report was performed to determine the peak 10-year and 100-year design flows impacting CCRFCD and local roads facilities within the project vicinity to ensure no adverse impacts are caused by the proposed project improvements. The criteria, methodology, and analysis process are consistent with the CCRFCD *Hydrologic Criteria and Drainage Design Manual* (hereafter referred to as the Design Manual) and the CCRFCD 2013 MPU.

2.1.1.1. Existing, Interim, and Ultimate Condition

The Existing, Interim, and Ultimate Condition were analyzed for this project. The Existing Condition represents the current watershed as it is today, without proposed Project Neon improvements or future CCRFCD facilities in place and will be discussed further within **Section 3** of this report. The Interim Condition represents the existing watershed but with the proposed Project Neon improvements in place. The Ultimate condition represents the fully developed off-site watershed with all proposed CCRFCD facilities and Project Neon improvements in place. More detail for the Interim and Ultimate Conditions can be found in **Section** 4 of this report.

2.1.1.2. Design Storm Frequency

Multiple design storm return frequencies are considered for the design of drainage facilities for Project Neon. Error! Reference source not found. provides a summary of the various design storm frequencies used to analyze the facilities along the project corridor.

Table 2. Design Flow Frequency Summary

Jurisdiction	Design Condition	Design Storm Return Frequency (years)
NDOT	NDOT Offsite Facility Design – Culverts, Channels, Bridges	50
NDOT	No adverse impacts to Existing Condition Drainage Patterns	100
NDOT	NDOT Onsite Drainage Design – I-15 Mainline, US-95 Mainline, Viaduct, Ramps, CD Roads	25
CLV/CCRFCD	CCRFCD Regional Facility Design	100
CLV/RTC	CCRFCD Local "Major" Event Facility Design (Local Streets)	100
CLV/RTC	CCRFCD Local "Minor" Event Facility Design (Local Streets)	10

2.1.1.3. Subbasin Delineation

Offsite drainage basin delineation and establishment of subbasin characteristics were performed in the previous Project Neon – Phase I Report and the Preliminary Drainage Design Report for NEON for the P3 Improvements. Previous studies are summarized in **Section 3.1.1** of this report. The Project Neon – Phase I Report was based on the analysis included in the 2008 MPU, but subdivided some of the "Central Watershed" subbasins when necessary within the vicinity of I-15 to obtain flow rates at more specific locations along the existing Freeway Channel corridor (FW15 0000 to FW15 0175). The Ultimate Condition subbasin delineation follows the MPU with the exception of the most northeastern basin of AL93-C which was reduced in size and renamed as AL93-B to only account for flows impacting the project area.

These subbasin delineations were reviewed, accepted, and followed for the purposes of this analysis. Subbasin Maps for the Existing and Interim Condition can be found in **Appendix A.1.1** and the Ultimate Condition Subbasin Map can be found in **Appendix A.1.4**. Differences in subbasin area between the MPU compared to the Existing/Interim Condition for project Neon are detailed in **Figure 2** and **Figure 3**.

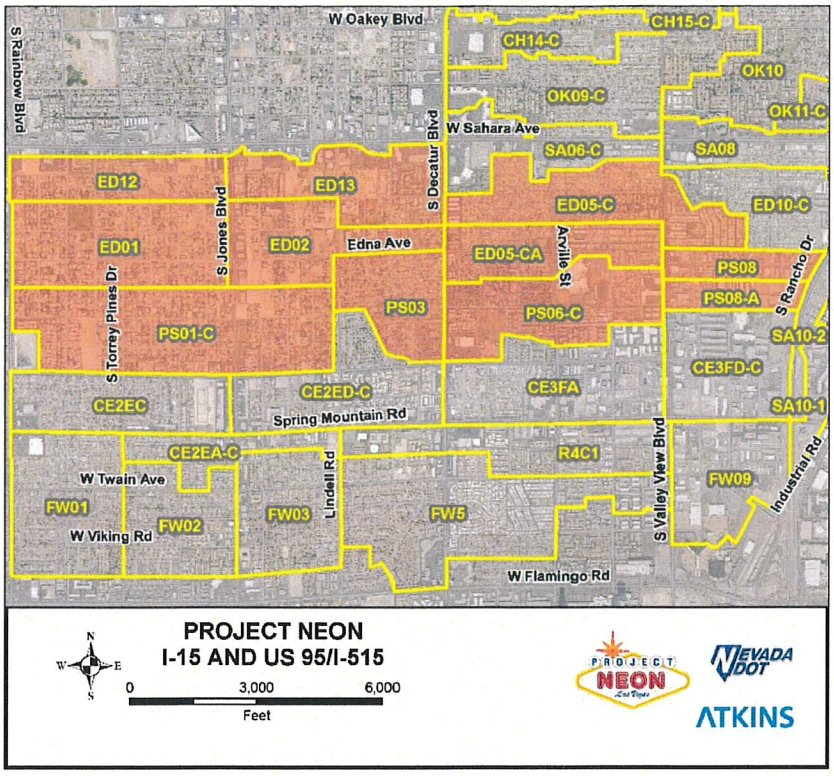


Figure 2. Subbasins Altered from MPU (southwest basins)

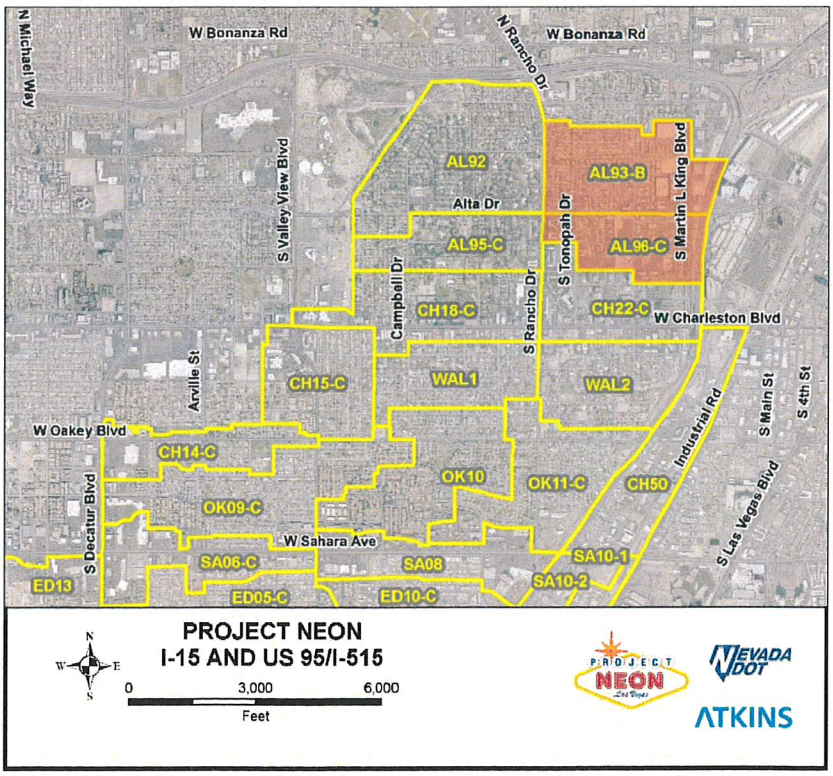


Figure 3. Subbasins Altered from MPU (north basins)

2.1.1.4. Hydrologic Parameters

The development of the hydrologic parameters is briefly described below. These parameters may be subject to amendment and revision prior to the Final submittal as more detailed analysis is completed.

Rainfall – The design storms pertinent to this project are the 10-year and the 100-year, 6-hour storm events. The project area falls within the McCarran Airport Rainfall Area from and thus precipitation depths are based on Table 505 in the Design Manual. The SDN3 storm distribution was used to determine design flows at concentration points where the tributary area is less than 8 square miles and the SDN4 storm distribution was used for tributary areas between 8 and 12 square miles.

Depth-Area Reduction Factor – Depth-area reduction factors (DARFs) were applied to rainfall depths in the hydrologic models at each concentration point based on upstream tributary area in order to account for rainfall variation. The DARFs follow Table 503 in the Design Manual and are shown in **Table 3**.

Table 3. List of HEC-1 Depth-Area Reduction Factors

SDN3		SDN4	
Area (sq-mi)	DARF	Area (sq-mi)	DARF
0 to 0.5	0.99	8 to 9	0.875
0.5 to 1	0.975	9 to 10	0.865
1 to 2	0.95	10 to 11	0.857
2 to 3	0.925	11 to 12	0.85
3 to 4	0.915		
4 to 5	0.908		
5 to 6	0.903		
6 to 7	0.895		
7 to 8	0.885		

Soils/Land Use/Curve Numbers – Soils data in the hydrologic analysis was based on the same soils information that was used in the 2008 MPU, which is the Soil Survey of the Las Vegas Valley Area by the National Conservation Resources Service (NRCS), dated July 1985. It should be noted that the NRCS has updated the available soils data since that time. The updated soils data was reviewed as part of this project, but it was determined that the differences were not significant in terms of impacting overall design flows. In an effort to be consistent with the MPU and previous design reports that have been completed for this project, the 2008 MPU soils data was used for the project.

The Land Use information was also based on the information that was used during the development of the 2008 MPU, which is still valid because of the highly developed nature of the watershed. This information is also consistent with previous project reports.

Rainfall losses due to soil infiltration, depression storage, and other factors are computed using the NRCS curve number (CN) method described in the Design Manual. Since there was no change to the soils data or the land use information, the curve numbers used in the analysis are the same as the previous Project Neon reports and were not changed.

Lag Time – The lag times used in the HEC-1 model were also referenced from previous Project Neon reports. These values are still valid and did not need to be updated.

Routing – The routing parameters in the HEC-1 model were based on the Muskingum-Cunge method for floodwave routing to be consistent with the 2013 MPU. Minor adjustments were made as needed for locations that do not have MPU facilities in place. Sahara Avenue, Twain Avenue, Valley View Boulevard, and Decatur Boulevard south of Sahara Avenue all have future MPU facilities, but flows along these streets were routed based on roadway conveyance in the Existing and Interim Conditions.

2.1.1.5. Computer Modeling

HEC-1 Version 4.1 (dated June 1998) was used for the hydrologic modeling in order to be consistent with the MPU process and previous Project Neon reports. The HEC-1 model from the 2013 MPU (Central Watershed) was used as the base HEC-1 model and modified as necessary based on updated subbasin delineation, parameters, documented flow splits, and diversions. Descriptive information has been included in the HEC-1 input file on the "ID" and "KM" cards. There are several HEC-1 models to represent various design scenarios, including the 10-year and 100-year rainfall scenarios in the Existing, Interim, and Ultimate Condition for both the SDN3 and SDN4 distribution. The Existing Condition HEC-1 models can be found in **Appendix A.2**, Interim Condition models in **Appendix A.3**, and Ultimate Condition models in **Appendix A.4**.

2.1.1.6. Concentration Points

Peak flows were combined in HEC-1 for the 10-year and 100-year models using concentration points. These concentration points are inserted into the HEC-1 model as needed to obtain peak flow rates at key design points for the project. Concentration points are located along the existing Freeway Channel, local roadways adjacent to I-15, and locations on the east side of the freeway.

2.1.1.7. Referenced Portions of the Model (Flow Diversions)

Certain portions of the HEC-1 model were referenced from previous studies/models. A summary of the referenced information incorporated into the model is included below.

- **The intersection of Desert Inn Road and Decatur Boulevard:** Overland flow is conveyed east on the surface of Desert Inn Road based on a referenced diversion. At the intersection, a portion of the surface flow is diverted north to Spring Mountain Road, and the remaining flow will continue east along Desert Inn Road. This is documented in the "City of Las Vegas City Wide Hydrology Analysis" completed by PBS&J in 1997.
- **The intersection of Valley View Boulevard and Twain Avenue:** Overland flow is conveyed east along Twain Avenue on the surface. At the intersection, a portion of the flow is diverted south to the Flamingo-Tropicana Watershed, while the remaining flow will split north to Spring Mountain Road. This flow split follows the hydrologic model from the "Preliminary Drainage Design Report for NEON for the P3 Improvements" by Louis Berger in 2013.
- **Spring Mountain Road and the I-15 corridor:** Overland flow from the east is conveyed along Spring Mountain Road and Twain Avenue to the I-15 bridge overpass on Spring Mountain Road. A portion of the flow will be diverted out of the watershed to the Spring Mountain Detention Basin, while the remaining flow will continue underneath the freeway overpass and travel north on the east side of the freeway along surface streets and adjacent to the UPRR. This flow split is documented within the "Hydraulic Design Report for I-15 Widening" by Louis Berger in 1999.
- **Sahara Avenue and the I-15 corridor:** An existing flow split is included in the model at Sahara Avenue under the I-15 overpass. Overland flow traveling east along Sahara Avenue converges at the overpass. A portion of the runoff is collected in the Freeway Channel, some of the runoff continues east under the freeway, while the remainder of the flow will be conveyed north along the I-15 corridor and local roadways toward Oakey Boulevard. This flow split is documented in the "Offsite Hydrology Report for Project NEON" by VTN in 2004.
- **The intersection of Alta Drive and Rancho Drive:** There is an existing flow split documented in the "Predesign Report for I-15 Freeway Channel" by Parsons Brinckerhoff in 1999. Overland flow is conveyed from the east to the intersection. The flow split will direct a portion of the flow south along Rancho Drive and the remaining will continue east toward the I-15 corridor.
- **Pinto Lane and I-15:** There is an existing 48" RCP within Pinto Lane that will cause a flow diversion of approximately 90 cfs to be conveyed north to Alta Drive.

- **Discovery Drive/Symphony Parkway and Martin Luther King Boulevard:** There is an existing 48" RCP that will divert 70 cfs of flow north within Martin Luther King Boulevard to the Las Vegas Creek Channel. The remaining overland runoff will continue east on Alta Drive and combine with the Freeway Channel in the Existing Condtion.

2.1.1.8. Storm Centering

Storm centering situates the design storm over the watershed in such a way that it maximizes the peak or "governing" design discharge at given points within the watershed. In large, urban watersheds such as this project, storm centering is relevant because it produces the greatest peak at each proposed drainage facility, whether it be a large regional facility, lateral storm drain, or local roadway drainage facility.

Storm centering requires that care must be taken with respect to the storm-cover area, DARFS, storm distributions, and tributary areas. For example, the tributary area associated with diverted flow does not automatically carry on in the HEC-1 model downstream and has to be tracked manually. **Table 4** below details locations where area is manually adjusted for flow diversions due to storm centering in the Existing/ Interim condition.

Table 4. Storm Centering Adjustments (100-Year Existing Condition)

Node	HEC-1 Model Values		Corrected Values	
	Area (sq-mi)	DARF	Area (sq-mi)	DARF
DCPS03	0.00	0.99	0.58	0.975
CCPS03	0.70	0.975	1.28	0.95
DSAHARA2	0.00	0.99	0.99	0.975
DSAHARA3	0.00	0.99	4.67	0.908
DOAKEY	0.00	0.99	5.83	0.903
CCH50	2.73	0.925	8.57	0.875
DWESTERN	2.73	0.925	8.57	0.875
DWAL2	0.00	0.99	6.29	0.895
CCH22	1.38	0.95	7.67	0.885
CDAL93B	0.28	0.99	0.71	0.975
DWALL	0.00	0.99	9.02	0.865
GCI*	0.00	0.99	7.81	0.885
DCHARL	0.00	0.99	10.4	0.857
UNDRPSS*	0.00	0.99	7.81	0.885

*See following paragraph for description of storm centering at GCI and UNDRPSS

One special case storm centering scenario (called "GCI" HEC-1 Model) was used in the analysis in order to determine the governing or "worst case" design flow at the GCI overpass, which is the location where the new bridge on Grand Central Parkway crosses over the UPRR. This storm centering was necessary because the Freeway Channel only has capacity to convey a portion of the 100-year storm, meaning a significant amount of flow will remain on the surface and be conveyed east under I-15 and then north along Western Avenue and the UPPR alignment to the GCI overpass. The total tributary area for this combination point is 9.02 square miles, which is slightly over the 8-square mile criteria for the SDN3 distribution. A separate hydrologic model was created to reduce the tributary area below 8 square miles in order to use a lower depth reduction and the SDN3 storm distribution, which produces the worst case design flow at this location. This storm centering scenario was

developed by removing 5 subbasins in the upstream corner of the project watershed south of Spring Mountain Road and west of Lindell Road. The subbasins removed are CE2EC, CE2EA-C, FW01, FW02, and FW03 that have a total tributary area of 1.21 square miles. The flow from this hydrologic model produces the governing design flow at the GCI, which is important because this is a key design location where flooding has occurred in the past. See **Figure 4** for a figure of the removed subbasins for the modified hydrologic model. The HEC-1 models for this storm centering scenario can be found in **Appendices A.2.5 – A.2.8** and **A.3.5 – A.3.8**.

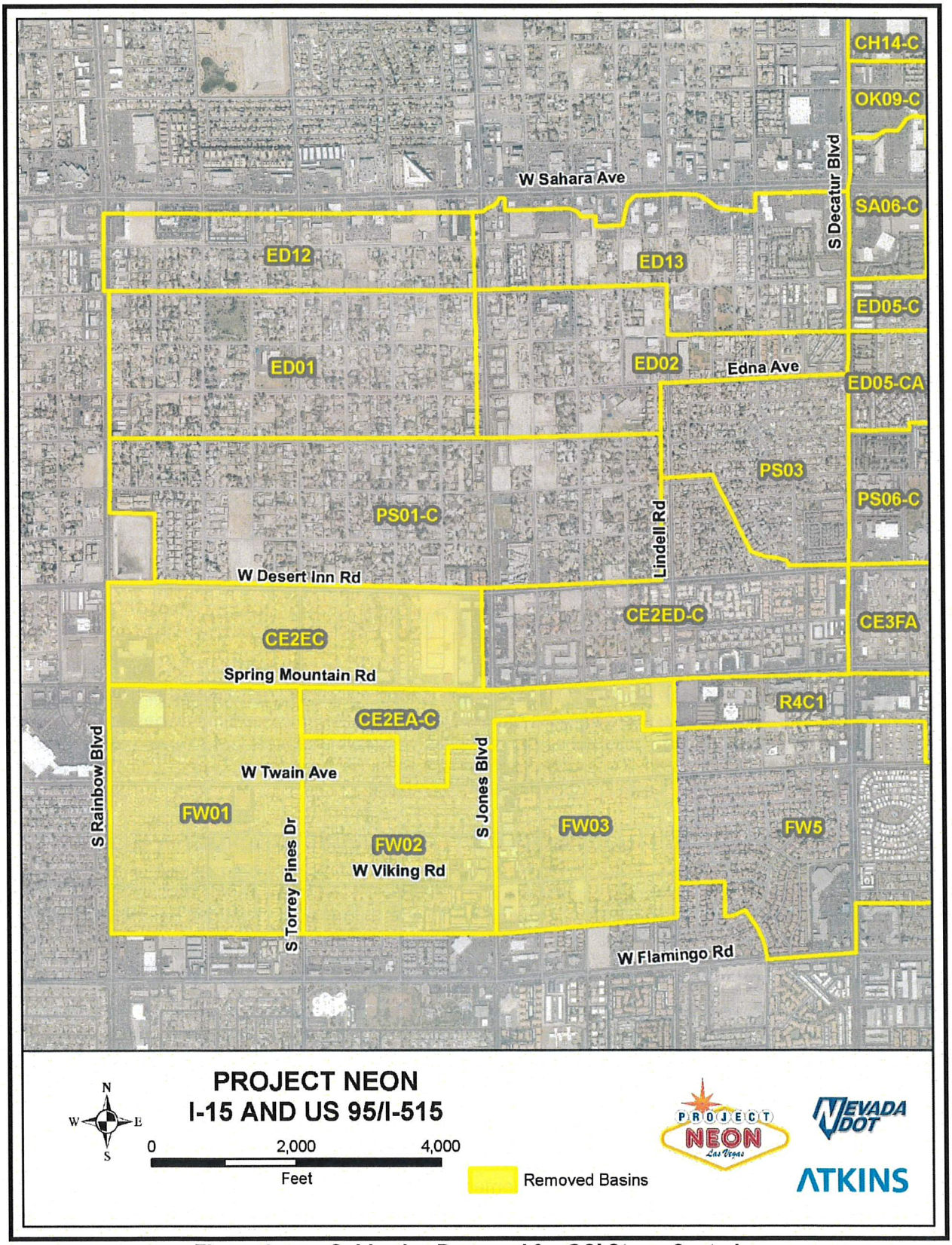


Figure 4. Subbasins Removed for GCI Storm Centering

2.1.2. Hydraulic Procedures and Criteria

The hydraulic procedures and criteria are discussed in detail in the other Design Units reports, refer to S4-06 for discussion of the hydraulic analysis and Freeway Channel capacity.

2.1.3. Design Assumptions and Issues

Below is a list of Design Assumptions used for the Project-Wide Hydrology Analysis:

- The Existing Condition and Interim Condition curve numbers are based off of fully developed land use conditions in the project watershed
- The freeway is elevated throughout the project area and the 100-year flows are either conveyed within the CCRFCD facilities, alongside the freeway, or in major cross streets under the freeways
- Flows that are conveyed to the east side of the freeway will be routed to the GCI overpass and then conveyed north to the Charleston underpass

Below is a list of Design Issues for the Project-Wide Hydrology Analysis:

- The existing CCRFCD facility only conveys a portion of the 100-year flows in the existing and interim conditions
- Limited facility sizing at the downstream end of the project in Existing, Interim, and Ultimate conditions
- Uncertainty with documented flow splits

2.2. Agency Regulations

This section provides a summary of the regulations that govern the project analysis.

2.2.1. Drainage Manual Section 1.3

Section 1.3 of the NDOT Drainage Manual states that each project must consider the effects that the project will have on other property and should avoid impacts to those properties. When determining whether a property is impacted, historic drainage patterns should be considered as well as the necessity of changes to historic patterns and if those changes would cause damage. The design of the project drainage facilities is intended to maintain existing condition storm water flows and drainage patterns.

2.2.2. Code of Federal Regulations Title 23 Part 650 Subparts A & B

The Code of Federal Regulations (CFR) Title 23 Part 650 Subpart A deals with location and hydraulic design of encroachments on floodplains and encourages avoiding incompatible development within floodplains, minimizing encroachments, restoring and preserving natural floodplain areas, and meeting National Flood Insurance Program (NFIP) standards. This project is not within a mapped floodplain.

CFR Title 23 Part 650 Subpart B defines the Federal Highway Administration's (FHWA's) policy on erosion and sediment control on highway construction projects. In general, the policy states that erosion and sediment damage to highways and adjacent properties should be minimized and pollution of surface and ground water resources should be reduced or eliminated. This project will incorporate erosion control measures as needed to minimize scour and sediment mobilization. Additionally, disturbed soil and new slopes will be treated with rock mulch and seeding per the Landscape plans.

2.2.3. Federal Emergency Management Agency (FEMA)

Panel 32003C2170F of Federal Emergency Management Agency's (FEMA) Flood Insurance Rate Maps (FIRMs) shows the project area is not within a Special Flood Hazard Area. The project lies within an area of unshaded Zone X and is designated to be outside the 500-year floodplain. FIRMettes showing the project area and the FIRM are included in **Appendix A.6**.

2.2.4. Regulatory Agency Requirements

No additional regulatory agency requirements are noted for this project.

2.2.5. Regional Flood Control Requirements

This project complies with CCRFCD Design Manual and is generally consistent with the 2013 MPU.

It is important to note that during the previous RFP drainage analysis the diversion at Sahara Avenue and I-15 was modified so that only 900 cfs was conveyed north within the existing Freeway Channel, instead of the 1,450 cfs that was used in the 2013 MPU. Per direction from CCRFCD, the Ultimate Condition model for Project Neon reverted back to the MPU flow split without alterations, meaning 1,450 cfs is conveyed north. This additional 550 cfs conveyed to the north means that Freeway Channel will not have capacity to convey the 100-year flow in the Ultimate Condition, and there will still be surcharging and surface flooding in the vicinity of Charleston Boulevard. The Freeway Channel will not be modified downstream of Charleston Boulevard as part of this project.

During the future Las Vegas Valley MPU, this flow split and the proposed regional facility in Sahara Avenue (from I-15 to Boulder Highway, BHSA 0000-0331) should be re-evaluated at a regional level to determine if additional flow can be conveyed to the east in the proposed Sahara Avenue facility to alleviate the flooding that will occur along the Freeway Channel corridor on the east side of I-15. In other words, reducing the flow split at Sahara Avenue and I-15 to convey 900 cfs north in the Freeway Channel will require a larger proposed facility in Sahara Avenue, but will be very beneficial to the performance of the overall regional system in the Ultimate Condition.

2.3. Compliance

This project complies with NDOT drainage policies as well as all applicable federal (CFR Title 23 Part 650 subparts A & B), state, and local regulations.

3. Existing Condition

This section summarizes the Existing Condition offsite hydrologic analysis. It is important to note that the hydrologic modeling and diversions in the model are dependent on the capacity of the Freeway Channel and the amount of surface runoff that is collected and conveyed in the system. In other words, the hydrologic and hydraulic analysis are interdependent and several model iterations were run to ensure the flow splits in the HEC-1 model accurately represent the amount of flow conveyed in the Freeway Channel. The existing Freeway Channel has previously been analyzed as part of Design Unit S4-06 to determine the amount of overland flow captured by the facility. Refer to the Drainage Report S4-06 for additional information.

3.1.1. Previous Reports and Other Information

Reference studies that were reviewed and utilized for the hydrologic analysis of Project Neon include the following:

- Preliminary Drainage Design Report for NEON for the P3 Improvements, December 2013.
- 2013 CCRFCD Flood Control Master Plan Update of the Las Vegas Valley, 2013.
- Offsite Hydrology Report for Project NEON, April 2004.
- Predesign Report for I-15 Freeway Channel, May 1999.
- I-15 Freeway Channel Hydraulic Calculations, April 1999.
- Hydraulic Design Report, I-15 Freeway Channel Union Pacific Railroad to Sahara Avenue, November 1996.

3.1.2. Drainage Basin Characteristics

The watershed area impacting the project encompasses approximately 11 square miles of urbanized, developed area in the central portion of the City. The overall drainage pattern in the study area is from west to east, with runoff being conveyed on surface streets or in minor storm drain facilities or major regional facilities..

3.1.3. 100-year Flow Patterns

The existing watershed within the project limits is generally bounded by Rainbow Boulevard and Decatur Boulevard on the west, US-95 on the north, Flamingo Road on the south, and the UPRR on the east. Offsite flow is conveyed to the east toward the I-15 corridor and is captured primarily by the existing Freeway Channel on the west side of the I-15. The existing Freeway Channel was designed for Ultimate Condition flow which is less than the Existing Condition flow because future upstream regional facilities have not been built which will convey flows away from the Freeway Channel at Sahara Avenue. In the Existing Condition, flow that is unable to be captured by the Freeway Channel will bypass the system and be conveyed as overland flow along local roadways and major cross streets under I-15. Bypass flow from Spring Mountain Road, Sahara Avenue, Oakey Boulevard, Western Avenue, Waldman Avenue, and Charleston Boulevard is conveyed along the eastern side of the Freeway and along UPRR until eventually ending up at the Charleston underpass.

The HEC-1 model was created and the simulation was run to determine the existing condition flows at key design points based on the appropriate HEC-1 node, model, tributary area, DARF, and storm distribution. In order to account for flow entering the Freeway Channel at major cross streets, diversions were used in the HEC-1 models to separate the sub-grade flow entering the Freeway Chanenl from the surface runoff that would remain on the street. These diversions at Sahara Avenue, Oakey Boulevard, Waldman Avenue, Western Avenue, Wall Street, Charleston Boulevard, and Alta Drive were developed using the maximum capacity of the Freeway Channel, which was assumed to be the flowrate resulting in a HGL elevation that was no higher than the existing grade above the facility. This capacity assumption was in place to avoid surcharging inlets within the vicinity of the project. See **Appendix A.1** for all Existing Condition HEC Models, and **Table 5** for 100-year flow results for key points along the project corridor.

Table 5. Key Project Design Points

Intersection	Node	Tributary Area Existing (sq-mi)	Model	Existing Condition 100-Year Flow (cfs)
King's Way/I-15	CED10-C	3.69	SDN3	2505
Sahara/I-15 - Flow from Sahara	CSA08	0.99	SDN3	832
Sahara/I-15 - Overland East [1]	DSAHARA2	0.99	SDN3	647
Sahara/I-15 FC	CCSA08	4.67	SDN3	2631
Sahara/I-15 - Overland North	DSAHARA3	4.67	SDN3	89
Sahara/I-15 FC Facility Flow	DCCSA08	4.67	SDN3	2542
Oakey/I-15 Flow from Oakey	1COK11C	5.83	SDN3	890
Oakey/I-15 FC	COK11C	5.83	SDN3	3415
Oakey/I-15 - Overland East	DOAKEY	5.83	SDN3	715
Oakey/I-15 FC Facility Flow	DCOK11-C	5.83	SDN3	2700
Waldman/I-15 Flow from Waldman	CWAL2	0.45	SDN3	418
Waldman /I-15 FC	CCWAL2	6.29	SDN3	3028
Waldman/I-15 - Overland North	DWAL2	6.29	SDN3	53
Waldman/I-15 FC Facility Flow	DCCWAL2	6.29	SDN3/4	2975
Spring Mountain/I-15 - Overland East	DSPM	2	SDN3	799
Western/Sahara	CCSA10-2	3.47	SDN3	1556
Western/Wall St.[2]	CCH50	8.57	SDN4	1266
Western/ U/S Wall St. - Overland North	DWESTERN	8.57	SDN4	746
Western/ U/S Wall St. - Facility Flow	DCCH50	8.57	SDN4	520
Western/ Wall Confluence	CCCH50	9.02	SDN4	3430
Wall/ I-15 - Overland North	DWALL	9.02	SDN4	454
Wall/I-15 FC Facility Flow	DCCCH50	9.02	SDN4	2976
Charleston/I-15 - Flow from Charleston	CCH22	7.67	SDN3	946
Charleston/I-15 FC	CCCH22	10.4	SDN4	3715
Charleston/I-15 - Overland East	DCHARL	10.4	SDN4	738
Charleston/I-15 FC Facility Flow	DCCCH22	10.4	SDN4	2977
Pinto/I-15 - Flow from Pinto [3]	AL96-C	0.18	SDN3	218
Pinto/I-15 - Flow North in 48" RCP	DPINTO	0.18	SDN3	90
Pinto/I-15 FC Facility Flow	CAL96	10.58	SDN4	3033
Alta/I-15 - Flow north in 48" RCP	DDISC	0.28	SDN3	70
Alta/I-15 Flow from Alta	CDAL93B	0.71	SDN3	227
Alta/I-15 FC	CAL93	10.87	SDN4	3248
Alta/I-15 - Overland east	DALTA	10.87	SDN4	0
Atla/I-15 FC Facility Flow	DCAL93	10.87	SDN4	3248
GCI over UPRR	GCI	7.81	SDN3	1539

3.1.4. FEMA Information

Refer to **Section 2.2.3** for FEMA information.

3.1.5. Existing Drainage Facilities

The existing drainage facilities within the project limits consist of CCRFCD facilities, local onsite systems for the freeways and local roads, and local offsite systems. The existing drainage facilities are discussed in detail within separate Drainage Reports for the associated Design Unit.

3.1.6. Stability Issues (Aggradation, Degradation, Erosion, Scour)

The watershed area draining to the Project Neon drainage facilities is essentially fully developed. There does not appear to be any significant offsite stability issues. As the onsite analysis progresses with each Design Unit, onsite areas will also be analyzed for areas of local scour, erosion, or rilling of slopes.

3.1.7. Existing Environmental Issues

According to the Preliminary Jurisdictional Determination Report and the U.S. Army Corps of Engineers, the only potential Waters of the U.S. is the onsite local facility south of Sahara Avenue, parallel to I-15. The proposed offsite improvements will not modify this channel or have an effect on any other adjacent surface waters. Several proposed onsite drop inlets are proposed in this area and will be discussed in those design reports. Applicable federal, state, and local water quality standards will be followed during construction.

3.2. Figures & Summary Tables

Several Figures and Summary Table have been prepared to show the results of the hydrologic analysis. These are detailed in the following sections.

3.2.1. Existing Facility Summary Table

Existing facilities have been discussed in Design Unit S4-06.

3.2.2. Existing Watershed Summary Table

Appendix A.5 provides a table that summarizes the Existing, Interim, and Ultimate Condition flows within the project watershed along key points of the I-15 corridor for the 10-year and 100-year design storms.

3.2.3. Existing Watershed Basin Map

The Existing Condition watershed and subbasins are shown on the Existing and Interim Conditions Subbasin Map in **Appendix A.1.1**. A detailed map of the flow splits along I-15 and project design points has also been included in **Appendix A.1.2**.

4. Design Recommendations

4.1. General Design Recommendations

The general design approach for this design unit is to develop offsite hydrologic information for the design of the CCRFCD facilities and local roads systems within the project vicinity to match or improve upon existing drainage and flow conditions with no adverse impacts to adjacent properties or upstream/downstream facilities in accordance with applicable criteria, Nevada drainage law, and good industry and engineering practice. This Section of the report primarily describes the Interim and Ultimate Condition hydrology and proposed facilities.

4.2. Design Alternatives

This section does not apply. Design build projects do not document a formalized alternatives analysis phase.

4.3. Proposed/Selected Alternative

Offsite hydrology detailed in this report has been developed to quantify the 10-year and 100-year design flows at key points within the project. Refer to other Design Unit Drainage Reports for additional discussion about proposed alternatives.

4.3.1. Onsite Facilities

Onsite facility analysis will be included within the Drainage Reports for each Segment.

4.3.2. Offsite Facilities

Refer to Design Unit S4-06 Drainage Report for information regarding offsite facilities.

4.3.2.1. Drainage Basin Characteristics and Flow Patterns – Interim Condition

The Interim Condition watershed is the same as the Existing Condition watershed described in **Section 3.1.2**. See **Appendix A.1.1** for the Existing and Interim Condition Subbasin Map and **Appendix A.1.3** for a zoomed in figure of key concentration points along the Freeway Channel and the east side of I-15.

In general, the drainage patterns and flow rates in the Existing Condition and the Interim Condition are very similar. However, several of the Project Neon improvements will result in some changes to the drainage facilities and flow patterns in the area. These changes are summarized below:

- **Pinto Lane:** In the Existing Condition there is a flow split at Pinto Lane and the I-15 Freeway Channel. Approximately 90 cfs is conveyed north in the Pinto storm drain, and the remaining 108 cfs collects within the RCB underneath I-15. However, in the Interim Condition the RCB connection into the existing Freeway Channel is removed and all of the flow attributed to the Pinto tributary area will be collected and conveyed north to Alta Drive.
- **Waldman Avenue:** The flow split at Waldman Avenue and the Freeway Channel does not occur in the Interim Condition hydrologic analysis. The proposed CCRFCD facility size has been optimized to allow more flow to be captured at this location. The area is a low spot and with the expansion of the freeway footprint the surcharge flow would not be able to be conveyed to the north along MLK Boulevard to Wall Street as it does in the Existing Condition.
- **Western Avenue Confluence Structure:** Optimization of the CCRFCD facility will improve the confluence structure with the Western Avenue lateral since more flow will be taken into the Freeway Channel at the Waldman Avenue lateral.

- **GCI:** In the Interim Condition, the roadway improvements to Grand Central Parkway will extend the alignment through Charleston Boulevard and go up and over the existing UPRR. The flow along the east side of the I-15 will be conveyed to this point. The culverts under this bridge structure will be required to be designed to perpetuate existing drainage flow patterns and have no adverse impacts to adjacent properties.

4.3.2.2. Drainage Basin Characteristics and Flow Patterns – Ultimate Condition

The Ultimate Condition assumes the watershed is fully developed and that all future regional facilities are built and functioning. The major difference to this model from the existing and interim conditions is the completion of the Sahara Avenue Regional Facility (FWSA 0000) that will significantly reduce the offsite watershed south of Sahara Avenue. The rest of the watershed for the Ultimate Conditions analysis generally maintains the same drainage patterns from the Existing and Interim Conditions. The Ultimate Condition Subbasin Map can be found in **Appendix A.1.4** and a zoomed in map of the Freeway Channel with key points identified can be found in **Appendix A.1.5**. A comparison of the flows from Existing, Interim, and Ultimate Conditions for the 10-year and 100-year storms can be found within a table in **Appendix A.5**.

4.3.3. Water Quality, Erosion, and Sediment Control

Existing drainage patterns are being perpetuated. The CCRFCD facilities designed with this report are concrete lined facilities. As the design expands to other Segments the design will include elements to mitigate any erosion and sediment transport along the project.

4.3.4. Proprietary Items

No proprietary stormwater/drainage items are proposed with this project.

4.3.5. Drainage Cost Estimate

This section does not apply. Design build projects do not submit cost estimates.

4.3.6. Right-of-Way Impacts

The proposed drainage design does not impact the right-of-way limits and is within the identified project construction limits.

4.3.7. Utility Relocations

Not included in this report.

4.3.8. Special Provisions Issues

No special provision issues are noted.

4.3.9. Maintenance Plan

Not included in this report.

4.4. Figures & Summary Tables

The project related proposed/ultimate conditions summary tables and figures and their locations are summarized in this section.

4.4.1. Proposed Facility Summary Table

Not included in this report.

4.4.2. Interim Watershed Flow Summary Table

Appendix A.1.1 and **A.1.3** summarize the Interim Condition flows within the project watershed. **Appendix A.1.4** and **A.1.5** summarize the Ultimate Condition flows within the project watershed. 2013 MPU subbasins were used as a base for the models and divided as necessary for key design points along the project corridor. A flow summary comparison table has been included in **Appendix A.5**.

4.4.3. Interim Watershed Basin Map

The Interim Condition Watershed and subbasins are shown on the Basin Map in **Appendix A.1.1**. A detailed map of the flow splits along I-15 and project design points has been included in **Appendix A.1.3**. The Ultimate Condition Watershed and subbasins are shown on the Basin Map in **Appendix A.1.4**. A detailed map of the flows along I-15 and project design points has been included in **Appendix A.1.5**.

4.4.4. Onsite Drainage Summary Table

For the purposes of this report onsite drainage has not been analyzed. As the design of these Segments progresses a summary table will be included in the report.

4.4.5. Onsite Drainage Basin Map

For the purposes of this report onsite drainage has not been analyzed. As the design of these Segments progresses basin maps will be included in the report.

4.4.6. FEMA Floodplain Map

Refer to **Section 2.2.3** for FEMA information.

4.4.7. Master Plan and Neighborhood Plan Flood Control Facilities Map

See Design Unit S4-06 Drainage Report for the 2013 MPU facility locations and inventory.

5. References

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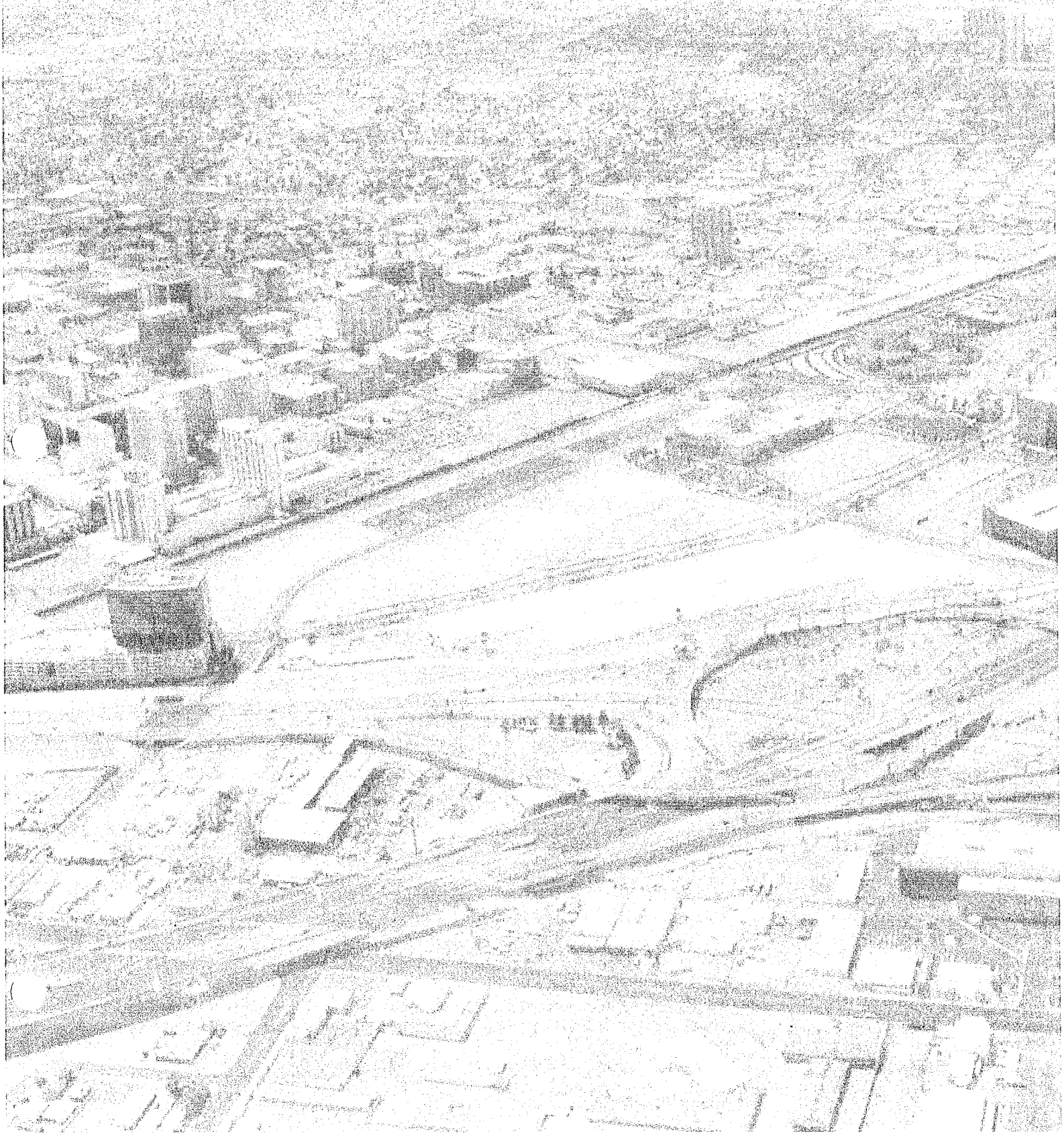
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Nevada Department of Transportation, December 2006. *Nevada Department of Transportation Drainage Manual, 2nd Edition.*

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Appendix A. Hydrologic Information and Computations



A.1. Offsite Subbasin Maps

A.1.1. Existing and Interim Conditions Subbasin Map

Combination Point	Drainage Area (Square Miles)		100 -year Flow (CFS)		10 -year Flow (CFS)	
	Existing Condition	Interim Condition	Existing Condition	Interim Condition	Existing Condition	Interim Condition
CCE2ED-C	0.58	0.58	508	508	200	200
CCE3FA	0.93	0.93	578	578	226	226
CCE3FD-C	1.22	1.22	799	799	343	343
CPS03	0.7	0.7	451	451	166	166
CCPS03	1.28	1.28	682	682	273	273
CPS06-C	1.58	1.58	907	907	352	352
CRCPS06	2.22	2.22	1629	1629	640	640
CPS08-A	2.29	2.29	1655	1655	651	651
CED02	0.55	0.55	437	437	162	162
CED05-CA	0.66	0.66	518	518	195	195
CPS08	0.72	0.72	545	545	202	202
CCPS08	3.01	3.01	2094	2094	782	782
CED05-C	3.47	3.47	2420	2420	918	918
CED10-C	3.69	3.69	2505	2505	956	956
CED13	0.57	0.57	547	547	235	235
CSA06-C	0.77	0.77	731	731	311	311
CSA08	0.99	0.99	832	832	349	349
CCSA08	4.67	4.67	2631	2631	1018	1018
COK09-C	0.55	0.55	453	453	207	207
COK10	0.85	0.85	721	721	322	322
1COK11C	5.83	5.83	890	890	377	377
COK11C	5.83	5.83	3415	3414	1341	1340
CWAL2	0.45	0.45	418	418	163	163
CCWAL2	6.29	6.29	3028	3035	1405	1407
CFW2	0.56	0.56	310	310	77	77
CFW3	0.82	0.82	529	529	158	158
CFW5	1.34	1.34	893	893	304	304
CR4C1	1.74	1.74	948	948	204	204
CFW09	2	2	1059	1059	247	247
CSA10-2	2.48	2.48	1077	1077	306	306
CCSA10-2	3.47	3.47	1556	1556	524	524
CCH50	8.57	8.57	1266	1266	489	489
CCCH50	9.02	9.02	3430	3437	1578	1577
CCH18-C	0.53	0.53	538	538	230	230
CAL95	0.62	0.62	286	286	93	93
CCCH18-C	1.15	1.15	783	783	307	307
CCH22	7.67	1.38	946	1008	371	421
CCCH22	10.4	10.4	3715	3775	1762	1762
CAL96	10.58	-	3033	-	1759	-
CDAL93B	0.71	0.71	227	227	47	47
CAL93B	-	0.89	-	413	-	153
CAL93	10.87	10.87	3248	3311	1806	1809
GCI*	7.81	7.81	1539	1482	43	43
UNDRPSS*	7.81	7.81	1539	1482	43	43

* SDN3 storm centering for the GCI and UNDRPSS combination points, with the upstream subbasins diverted out of the model to produce a smaller storm centering

See Existing Condition Flow Exhibit and Interim Condition Flow Exhibit for flow details along the Freeway Channel

Existing and Interim Condition Hydrology Summary Map

Legend

- Flow Arrows
- HEC-1 Combination Points
- Clark County 5' Contours (1996)
- Existing and Interim Basins

MPU Facilities

- Existing
- Future

N

0 2,000 4,000 Feet

PROJECT NEON Las Vegas

NEVADA DOT

ATKINS

A.1.2. Existing Condition Flow Exhibit Along Freeway Channel



Existing Condition Flow Exhibit Along Freeway Channel

Legend

- HEC-1 Combination Points (100-year flow / 10-year flow)
- Diversions (100-year flow [10-year flow])
- Existing Basins
- Clark County 5' Contours (1996)

MPU Facilities

- Existing
- Future

N

0 150 300 600 Feet

PROJECT NEON Las Vegas

NEVADA DOT

ATKINS

A.1.3. Interim Condition Flow Exhibit Along Freeway Channel



Interim Condition Flow Exhibit Along Freeway Channel

Legend

- HEC-1 Combination Points
- Diversions
- Proposed MPU Facility Alignment
- Existing MPU Facility Alignment
- Existing Basins
- Clark County 5' Contours

MPU Facilities

- Existing
- Future

N

0 150 300 600 Feet

PROJECT NEON Las Vegas

NEVADA DOT

ATKINS

A.1.4. Ultimate Condition Subbasin Map

Combination Point	Drainage Area (Square Miles)	100 -year Flow (CFS)	10 -year Flow (CFS)
CFW2	0.56	310	77
CFW3	0.82	529	158
CFW5	1.34	922	328
CR4C1	1.74	1006	233
CCE2ED-C	0.58	508	200
CCE3FA	2.67	1475	414
CPS03	0.6	521	202
CED12	0.44	404	162
CED13	0.65	598	245
CED02	1.21	1018	400
CCPS03	2.39	1624	629
CPS06	2.78	1941	749
CCPS06	4.88	3240	1114
CCE3FD-C	0.54	433	244
CRCPS06	5.41	3578	1301
CPS08	5.59	3674	1340
CCPS08	6.03	3968	1462
CED10-C	6.25	4104	1514
CSA08	0.42	486	236
CCSA08	6.67	4442	1665
COK09-C	0.55	453	207
COK10	0.85	721	322
1COK11C	1.16	928	410
COK11C	7.83	2296	1170
CWAL2	0.45	418	163
CCWAL2	8.28	2451	1087
CCH50	8.54	2618	1160
CCH18-C	0.53	538	230
CAL95	0.62	286	93
CCCH18-C	1.15	783	307
CCH22	1.38	1008	421
CCCH22	9.92	3351	1433
CDAL93B	0.71	227	47
CAL93B	0.89	413	153
CAL93	10.39	3294	1448

See Ultimate Condition Flow Exhibit for flow detail along the Freeway Channel

Ultimate Condition Hydrology Summary Map

Legend

- Ultimate Flow Arrows
- HEC-1 Combination Points
- Basin ID / 100-yr Flow / 10-yr Flow
- Clark County 5' Contours (1996)
- Ultimate Basins

MPU Facilities

- Existing
- Future

N

0 2,000 4,000 Feet

PROJECT NEON Las Vegas

NEVADA DOT

ATKINS

A.1.5. Ultimate Condition Flow Exhibit Along Freeway Channel


Alta Dr
W Charleston Blvd
E Charleston Blvd
W Oakey Blvd
E Oakey Blvd
W Sahara Ave
Waldman Ave
S Rancho Dr
S Jones Blvd
S Martin Luther King Blvd
S Commerce St
S Main St
Industrial Rd
Match Existing
10' X 9' RCB
2: 18' X 10' RCB
2: 18' X 9' RCB
20' X 8' RCB
20' X 10' RCB
DCCCH22
3037 cfs [1433 cfs] in the facility
DCHAR1
334 cfs [0 cfs] diverted to the east
DCAL93
2261 cfs [744 cfs] in the facility
DDSSC
70 cfs [70 cfs] diverted to the north
DSAHARA
2992 cfs [833 cfs] diverted to the east
DCCSA08
1469 cfs [833 cfs] in the facility
CCH150
2618 cfs
4160 cfs
CCH22
1008 cfs
421 cfs
CCCH22
1371 cfs
1433 cfs
CCCH18C
307 cfs
CCH18C
538 cfs
230 cfs
CAL93B
222 cfs
47 cfs
CAL93B
413 cfs
153 cfs
CAL93
1734 cfs
1448 cfs
CAL95
436 cfs
93 cfs
CWAL2
418 cfs
153 cfs
CCWAL2
561 cfs
1097 cfs
CCK11C
2296 cfs
1170 cfs
1CCK11C
928 cfs
410 cfs
CSA08
485 cfs
236 cfs
CCSA08
4442 cfs
1664 cfs
2618 cfs [1160 cfs] in the facility
2296 cfs [1170 cfs] in the facility
1365 cfs [1097 cfs] in the facility
AL92
AL93B
AL95C
AL93C
CCH18C
CCH22
WAL2
CK11C
CH50
SA08
Ultimate Condition Flow Exhibit
Along Freeway Channel
Legend
Diversions
HEC- 1 Combination Points
Ultimate Basins
Proposed MPU Facility Alignment
Existing MPU Facility Alignment
Clark County 5' Contours
MPU Facilities
Existing
Future
N
0 150 300 600
Feet
PROJECT NEON Las Vegas
NEVADA DOT
ATKINS