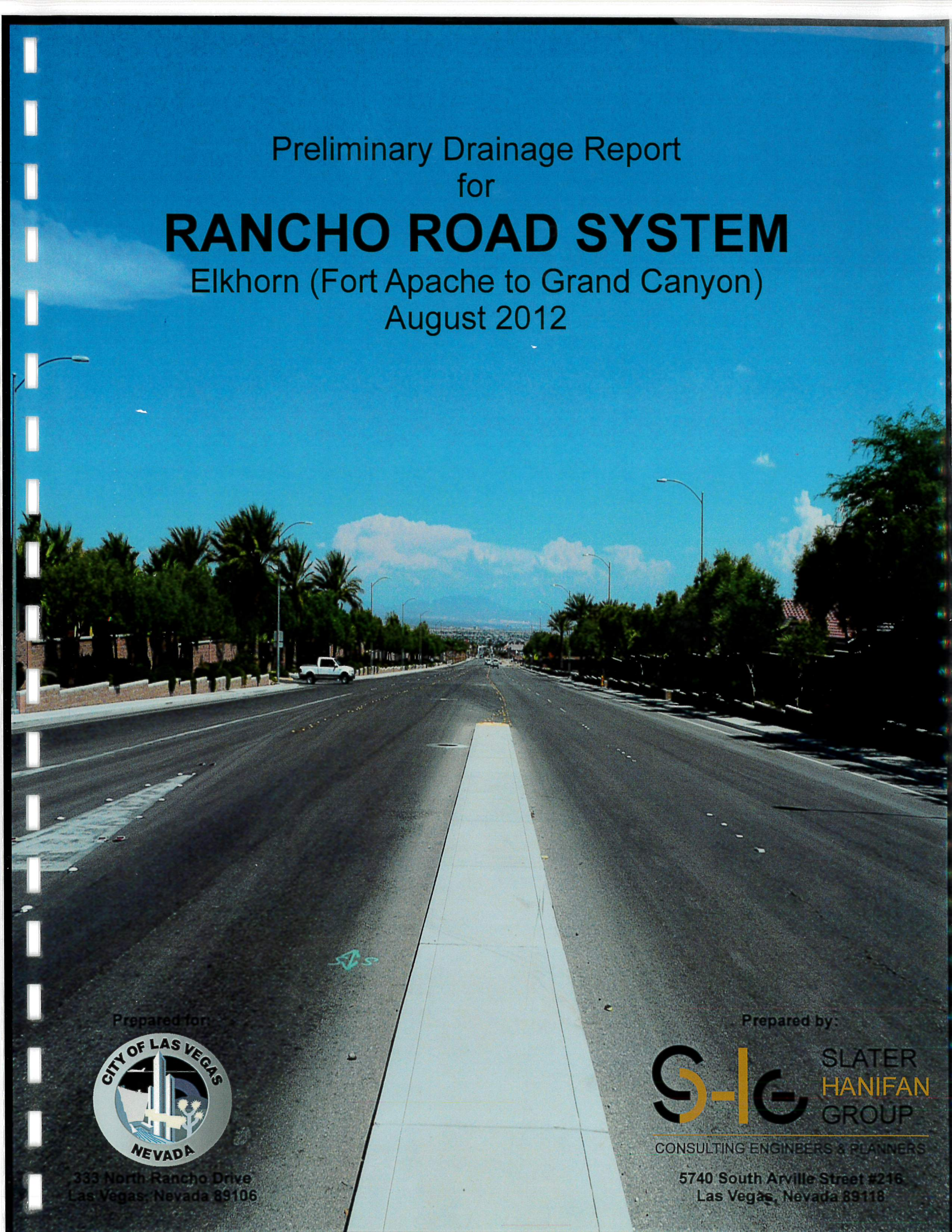
Preliminary Drainage Report
for
RANCHO ROAD SYSTEM
Elkhorn (Fort Apache to Grand Canyon)
August 2012



Prepared for:

CITY OF LAS VEGAS NEVADA

333 North Rancho Drive
Las Vegas, Nevada 89106

Prepared by:

SLATER HANIFAN GROUP

CONSULTING ENGINEERS & PLANNERS

5740 South Arville Street #216
Las Vegas, Nevada 89118

PRELIMINARY DRAINAGE REPORT
Rancho Rd System - Elkhorn
(Fort Apache to Grand Canyon)
City of Las Vegas, Nevada

Job No.: CLV1201.000
Date: August 2012

Prepared By:
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Prepared For:
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8/30/12

Mark Failla, P.E.
NV Professional Engineer No. 14566

Assisted By Kellin Collins, P.E.

HYDROLOGIC CRITERIA AND DRAINAGE DESIGN MANUAL

DRAINAGE STUDY INFORMATION FORM

Name of Development: Rancho Rd System-Elkhorn(Fort Apache to Grand Canyon) 30% Pre-Design Date: August 2012

Location of Development: a) Descriptive (Cross Streets): North/South: Grand Canyon Drive
East/West: Elkhorn Road

b) Section: 18 and 19 Township: 19 South Range: 60 East

c) APN: 125-18-889-006, 125-19-599-013, -001, 125-18-899-008, 125-19-599-014, 125-18-899-010, 125-19-599-002, 125-18-899-001, 125-19-599-020, 125-18-899-009 125-19-599-004, and 125-19-599-005

Name of Owner/Developer: City of Las Vegas

Telephone No.: (702) 229-6276 Fax No.: (702) 382-0848 E-mail Address: RMcConnell@lasvegasnevada.gov

Address: 333 N. Ranch Drive, Las Vegas, NV 89106

Contact Person – Name: Mark Failla, P.E. Telephone No.: (702) 284-5300

*E-mail Address: mfailla@shg-inc.com Fax No.: (702) 284-5399

Firm: Slater Hanifan Group

Address: 5740 S. Arville St. #216, Las Vegas, NV 89118

Type of Land Development/Land Disturbance Process:

☐	Rezoning	☐	Subdivison Map	☐	Clearing and grading Only
☐	Parcel Map	☐	Planned Unit Development	☒	Other (Please specify below)
☐	Large Parcel Map	☐	Building Permit		Regional Storm Drain Improvements

1. Total Owned Land Area: At Site: 0 acres (Public ROW) Being Developed/Disturbed: 0.50 linear mile of storm drain

2. Is a portion or all of the subject property located in a FEMA Flood Hazard Area? ☐ Yes** ☒ No

3. Is the property bordered or crossed by an existing or proposed Clark County Regional Flood Control District Master Planned Facility? ☒ Yes** ☐ No

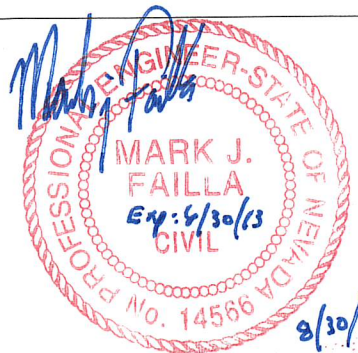
4. Proposed type of development (Residential, Commercial, Etc.): Regional Storm Drain Improvements

5. Approximate upstream land area which drains to the subject site: Approx. 1.75 square mile

6. Has the site drainage been evaluated in the past? ☒ Yes** ☐ No If yes, please identify documentation: (See Section 1.5 of report)

7. If known, please briefly identify the proposed discharge point(s) of runoff from the site: CCRFCD Facility RCHC 0250

8. Briefly describe your proposed schedule for the subject project: 30% Pre-Design, 70% Design, 90% Design, and 100% Design



8/30/12

Engineer's Seal

Submit this form as part of the required drainage study to the local entity which has jurisdiction over The subject property. This form may provide sufficient information to serve as the Conceptual Drainage Study.

*Newly Required Field

**Review and concurrence of the Clark County Regional Flood Control District is required

Local Entity File No.

Revision	Date

REFERENCE: ***CLV1201***

STANDARD FORM 1

Updated 05/01/2008

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1 INTRODUCTION

1.1 Project Overview & Study Purpose

The Rancho-Elkhorn Storm Drain (ESD) is a proposed flood control conveyance facility located along Elkhorn Road between Fort Apache Road and Grand Canyon Drive within the City of Las Vegas (CLV), Nevada. The proposed facility is identified as a portion of the Clark County Regional Flood Control District (CCRFCD) regional facility RCHB 0295 and is proposed as 2,452 LF of 7'w x 5'h RCB for conveyance of the 100-year storm event flow ranging between 607 cfs and 796 cfs. The ESD facility is designed to connect to a 7'w x 6'h RCB lateral junction stubbed in Elkhorn Road at Fort Apache Road as currently under design by others as part of the Rancho-Fort Apache Storm Drain project (regional facility RCHB 0250).

The ESD alignment is proposed within the north half of the roadway because it is less encumbered by existing utilities than the south half. Additionally, the ESD alignment is within the north half of the roadway because the storm flows are well divided between the north and south halves of Elkhorn Road, with the majority of flow contributing to and maintained on the north half of the street. Note that there is an existing 18-inch RCP storm drain system located within the south half of Elkhorn Road which is capable of intercepting and conveying storm flows contributing to the south half of the street.

The project also includes design of appurtenant drop inlet and lateral storm drain facilities necessary to intercept the 100-year frequency design storm, pavement and striping replacement, and incidental utility relocations.

As the prime engineering consultant for the design of the ESD project, Slater Hanifan Group (SHG) is responsible for project management, preparation of design reports, and preparation of construction documents. Assisting SHG are sub-consultants in the fields of geotechnical engineering, surveying, subsurface utility engineering, and environmental assessment. GES is conducting the geotechnical field exploration and interpretive report. Stanley Consultants is conducting the survey mapping, control, and right-of-way mapping. Cardno TBE is conducting the subsurface utility designation and potholing. MBP is conducting the Environmental Screening Analysis.

This report addresses the 30% pre-design of the proposed drainage improvements for the ESD. The following items have been performed and included in this report:

- Identified the relevant FEMA Special Flood Hazard Area (SFHA) mapping.
- Identified the project in relation to CCRFCD regional drainage facilities.
- Identified and reviewed previously approved drainage studies and improvement plans in the vicinity of the project.
- Provided an inventory of existing drainage facilities impacting the ESD.
- Determined 100-year storm event facility design flows.
- Analyzed street flow, such that hydraulic characteristics within the street sections are in accordance with local stormwater criteria.
- Preliminarily identified potential constraints to proposed drainage facilities.
- Designed proposed drainage facilities as recommended by this report.
- Prepared 30% drainage facility improvement plans.

1.2 Site Description

The ESD spans approximately 2,452 LF of Elkhorn Road, from Grand Canyon Drive to Fort Apache Road. The improvements are located within Sections 18 and 19, Township 19 South, Range 60 East within the City of Las Vegas, Nevada. Note that the centerline of Grand Canyon Drive at Elkhorn Road is the boundary limit of City of Las Vegas and unincorporated Clark County jurisdiction. It is noted that Clark County concurrence will be required for this project.

Currently, Elkhorn Road is fully improved from Grand Canyon Drive to Fort Apache Road. Elkhorn Road pavement terminates at Grand Canyon Drive and there is undeveloped land on the northwest and southwest corner of the Elkhorn Road and Grand Canyon Drive intersection. Existing improvements and topography shows that Elkhorn Road drains from west to east towards Fort Apache Road.

A location map, identified as Exhibit A, has been included in Appendix A for reference.

1.3 FEMA Flood Zone Designation

The limits of the ESD are located on FEMA Flood Insurance Rate Map (FIRM) Panel 32003C1745E dated September 27, 2002. The project is located within an un-shaded Zone 'X'. An un-shaded Zone 'X' is defined as an area determined to be outside the 0.2% annual chance flood.

Exhibit B, identifying the project site on the FIRM Panel identified above, has been included in Appendix A for reference. Note that the parcels identified as 'Clark County Unincorporated Areas' adjacent to the project site are no longer valid. Those parcels have been incorporated into the City of Las Vegas.

1.4 CCRFCD MPU & CLV Neighborhood Study Information

Figure F-13, from the 2008 CCRFCD Las Vegas Valley Flood Control Master Plan Update (CCRFCD 2008 MPU, Reference 1), shows that the project site consists of the east half of the planned CCRFCD regional facility RCHB 0295 for conveyance of 973 cfs. The drainage facility recommended by this report will discharge to the CCRFCD regional facility RCHB 0250 which is currently under design by others. It is noted that CCRFCD concurrence will be required for this project. Exhibits C and D identifying the project on the CCRFCD 2008 MPU Figures F-13 and H-13, respectively, have been included in Appendix A for reference.

The ESD is included in both the CLV Northwest Neighborhood Study (Reference 2) and the Northwest Neighborhood Study Phase 2 (Reference 3) documents. Both studies identify the ESD as a regional facility for conveyance of a 100-year flow of 1,166 cfs. Exhibits E and F identifying the project on Figure F-1 and Sheet 11, respectively from each document have been included in Appendix A for reference.

1.5 Reference Studies

Various approved drainage studies and improvement plans for projects in the vicinity of the ESD have been reviewed in preparation of this study. The following documents have been identified as relevant and are considered acceptable for reference. Relevant reference material utilized in preparation of this report has been excerpted and included in Appendix E.

- *Rancho-Fort Apache Storm Drain Study,* LBG (FASD Study, Reference 4): This study was utilized to reference the regional hydrologic analysis and the 7'w x 6'h RCB lateral junction stub design at Fort Apache to which the ESD mainline is proposed to connect. Two notable exceptions with the regional hydrologic analysis were identified by SHG in preparation of this study. These exceptions are described in detail in Section 1.6 of this report. Coordination with LBG has taken place to resolve the noted exceptions and are anticipated to be addressed in the next FASD submittal by LBG.

- *Master Drainage Study for Cliff's Edge*, VTN (Reference 5): This study was utilized to verify drainage patterns and contributing drainage areas west of Hualapai Way.

- *Cliff's Edge, Hualapai Way, Deer Springs to Grand Teton*, VTN (Hualapai Plans, Reference 6): These plans were utilized to verify drainage patterns and storm drain design flow along Hualapai Way between Elkhorn Road and Severance Lane.

- *Cliff's Edge/Providence, Elkhorn Road Street Improvements*, VTN (Reference 7): These plans were utilized to verify drainage patterns and storm drain design flow along Elkhorn Road west of Hualapai Way.

- *Elkhorn/Grand Canyon Unit 1 & Unit 2*, VTN (Grand Canyon Plans, Reference 8): These plans were utilized to verify existing and future storm drain design flow along Grand Canyon Drive between Elkhorn Road and Severance Lane.

1.6 Project Coordination

The following coordination has taken place in preparation of this study.

- *CLV & CCRFCD*: Three meetings have taken place: May 2, 2012, June 5, 2012, and July 31, 2012. The first meeting was the project kick-off meeting. The other two meetings were progress meetings which took place to present progress and discuss intermediate design recommendations and issues. Refer to meeting minutes included in Appendix F for additional details.

- *LBG*: Various meetings, phone calls, and email correspondence took place with LBG to coordinate with the concurrent FASD project. The FASD project established the regional hydrology inclusive of this ESD project and also provides the stub to which the ESD will connect. In review of the regional hydrologic modeling prepared as part of the FASD project, SHG identified two major exceptions which have been discussed and coordinated with LBG. Per discussion with LBG, it is anticipated that the next design level submittal for the FASD project will incorporate the noted exceptions. This ESD project has assumed that the noted revisions in drainage patterns will occur. Refer to email correspondence included in Appendix F for detailed discussion regarding the noted exceptions.

2 METHODOLOGY

2.1 Compliance

The methodologies utilized in the preparation of this study are in compliance with the Clark County Regional Flood Control District's Hydrologic and Drainage Design Manual (CCRFCD Manual, Reference 9).

2.2 Hydrologic Modeling

Modeling: The FASD Study provided regional hydrologic modeling inclusive of this ESD project. In an effort to coordinate design flows for the ESD established by the FASD Study, the regional analysis was referenced. Local flows directly impacting Elkhorn Road were prorated from the regional basins and design flows established by the FASD Study.

2.3 Hydraulic Modeling

Street Flow: Street flow was analyzed utilizing the Flowmaster Version 7.0 software by Haestad Methods. In accordance with the CCRFCD Manual, the depth times velocity factor (DxV) for street flow for the 10-year storm event must be less than or equal to 6 with a maximum depth of 1 foot. The depth times velocity factor (DxV) for street flow for the 100-year storm event must be less than or equal to 8 with a maximum depth of 2 feet. Additionally, transverse street flow on through traffic streets shall be at a depth less than or equal to 1-ft for the 100-year storm event. Since the ESD improvements are within a right-of-way greater than 80-ft in width, the following additional criteria for street flow must be satisfied:

- During the 10-year storm event, a 12-ft wide dry lane shall be maintained in each direction (without the use of a center turning lane),
- During the 10-year storm event, the flow depth at intersections with other streets of 80-ft or greater right-of-way width shall be at curb height or less.

Storm Drain and Drop Inlets: The hydraulic gradient line (HGL) for storm drain flows was determined utilizing the Water Surface and Pressure Gradient (WSPG) Hydraulic Analysis System software by the Los Angeles County Department of Public Works. The storm drain has been designed to convey both 100-year and 10-year flows. Continuous grade drop inlets were designed using a spreadsheet which utilizes equations taken from Section 805 of the CCRFCD Manual. Sump drop inlets were designed using a spreadsheet incorporating orifice and weir equations.

3 HYDROLOGY

3.1 Summary of Various Source Reported Flows

Various planning documents have reported design flow for the ESD. Additionally, and most recently, the regional analysis included as part of the FASD Study established design flows for the ESD. The following table summarizes the reported flows from the various documents.

Table 1: Summary of Various Source Reported Flows (100-Year)

Location	Source			
	CCRFCD MPU[1] (cfs)	CNLV NWNS[2] (cfs)	CNLV NWNS PH2[3] (cfs)	LBG FASD[4] (cfs)
Elkhorn: Grand Canyon to Tee Pee	973	1166	1166	554
Elkhorn: Tee Pee to Ft. Apache	973	1166	1166	608

1: CCRFCD 2008 MPU
2: CNLV Northwest Neighborhood Study
3: CNLV Northwest Neighborhood Study Phase 2
4: Rancho-Fort Apache Storm Drain Study (70%) by LBG

3.2 Regional Analysis

The FASD Study provided regional hydrologic modeling inclusive of this ESD project. In an effort to coordinate design flows for the ESD established by the FASD Study, the regional analysis was referenced. Excerpts from the regional analysis HEC-1 model included with the FASD Study are provided in Appendix E. A copy of the supporting Future Conditions Hydrology exhibit from the FASD Study is also included in Appendix E. The following table provides a summary of regional "parent" basins and computed 100-year peak flows included in the analysis and impacting the ESD.

Table 2: Summary of Regional Basin Flows
Ultimate Condition

Parent Basin[1]	Q_{100} (cfs)	Area (acres)	Unit Flow (cfs/acre)
NW53-CA	77	65.7	1.2
NW53-CB	133	120.3	1.1
NW66-CA	79	42.6	1.9
NW66-CB	9	6.5	1.4
NW77-CA	99	80.3	1.2
NW77-CB	74	42.3	1.7
NW77-CC	9	4.6	2.0

1: Parent Basin and Q_{100} referenced from FASD Study. See Exhibit G.

3.3 Local Analysis

In order to determine local flows directly impacting Elkhorn Road at various key locations, the regional "parent" basins and flow rates established by the FASD Study were prorated by dividing them into subbasins. The following table provides a summary of the prorated subbasins and flow rates utilized to determine design flows for the ESD. Exhibit G included in Appendix A provides a depiction of the regional "parent" basins and prorated subbasins.

Table 3: Summary of Local Prorated Flows

Ultimate Condition

Subbasin[1]	Q_{100} (cfs)	Area (acres)	Unit Flow (cfs/acre)
NW53-CA (a)	29	24.62	1.2
NW53-CA (b)	48	41.08	1.2
TOTAL	***77***	***65.70***	
NW53-CB (a)	53	47.75	1.1
NW53-CB (b)	37	33.13	1.1
NW53-CB (c)	44	39.42	1.1
TOTAL	***133***	***120.30***	
NW66-CA (a)	3	1.60	1.9
NW66-CA (b)	2	1.18	1.9
NW66-CA (c)	3	1.82	1.9
NW66-CA (d)	64	34.59	1.9
NW66-CA (e)	2	1.19	1.9
NW66-CA (f)	3	1.37	1.9
NW66-CA (g)	2	0.85	1.9
TOTAL	***79***	***42.60***	
NW66-CB (a)	4	2.78	1.4
NW66-CB (b)	2	1.33	1.4
NW66-CB (c)	0	0.33	1.4
NW66-CB (d)	1	0.61	1.4
NW66-CB (e)	1	0.82	1.4
NW66-CB (f)	1	0.49	1.4
NW66-CB (g)	0	0.14	1.4
TOTAL	***9***	***6.50***	
NW77-CA (a)	8	6.36	1.2
NW77-CA (b)	91	73.94	1.2
TOTAL	***99***	***80.30***	
NW77-CB (a)	4	2.07	1.7
NW77-CB (b)	6	3.61	1.7
NW77-CB (c)	64	36.62	1.7
TOTAL	***74***	***42.30***	
NW77-CC (a)	1	0.39	2.0
NW77-CC (b)	1	0.53	2.0
NW77-CC (c)	7	3.68	2.0
TOTAL	***9***	***4.60***	

1: See Exhibit G.

3.4 Summary of Design Flows

Design flows established for the ESD were determined by starting with the referenced regional flow HEC-1 Node "DOUTFLOW" (414cfs) from the FASD Study at the Hualapai Way and Elkhorn Road intersection. Based on the noted exceptions to the regional analysis previously discussed in Section 1.6, flow from referenced HEC-1 node "DNW77-C" (120 cfs) and prorated subbasins NW53-CAa (29cfs) and NW53-CBc (44 cfs) were directly added to the 414 cfs at the Hualapai Way and Elkhorn Road intersection for a total flow of 607 cfs. Local prorated flows were then added to the drainage system moving in a downstream direction. The following table provides a comparison of design flows established by the FASD Study for the ESD system and the adjusted design flows determined by this study.

Table 4: Summary of Elkhorn Mainline Storm Drain Flow - North Side

Ultimate Condition

Segment and Segment ID	Referenced HEC-1 Flow Q_{100} (cfs)	Adjusted Design Flow[1] Q_{100} (cfs)
Hualapai to Grand Canyon H/GC	554 CNW53-C	607 DOUTFLOW + DNW77-C + NW53-CA(a) + NW53-CB(c)
Grand Canyon to Tee Pee GC/TP	554 CNW53-C	786 H/GC + DNW77-CA(a) + NW53-CB(a+b) + FS3 + NW66-CA(b+f+c+d)
Tee Pee to Fort Apache TP/FA	608 C66-CB	796 GC/TP + NW66-CA(e+g) + NW66-CB(a+b+c)

1: See Exhibit G.

An 18-inch RCP storm drain system exists in the south side of Elkhorn Road between Grand Canyon Drive and Fort Apache Road. Storm flows impacting Elkhorn Road are well separated between the north and south halves of the street and the existing storm drain has sufficient capacity to accommodate the south side flows. The following table provides a summary of design flows determined by this study for the existing 18-inch storm drain system.

Table 5: Summary of Elkhorn Parallel Storm Drain (18-inch) Flow - South Side

Ultimate Condition

Segment and Segment ID	Referenced HEC-1 Flow Q_{100} (cfs)	Adjusted Design Flow[1] Q_{100} (cfs)
Hualapai to Grand Canyon H/GC	N/A	N/A
Grand Canyon to Tee Pee GC/TP	N/A	3.5 H/GC + NW77-CB(a+b) – 0.5 cfs bypass
Tee Pee to Fort Apache TP/FA	N/A	15 GC/TP + NW66-CB(d+e+f) + NW77-CC(a+b)

1: See Exhibit G.

4 FACILITY DESIGN

4.1 Alternative Considerations

The ESD mainline is proposed as a 7'w x 5'h RCB storm drain. Because the alignment is below an improved city street, a storm drain is appropriate for the design and other alternatives were not considered.

Various alternatives were considered for flow interception at the Grand Canyon/Elkhorn intersection and the Tee Pee/Elkhorn intersection. These are the two locations along the alignment where the majority of surface flow is introduced.

- *Grand Canyon/Elkhorn Intersection*: Exhibit I included in Appendix A depicts the two design alternatives considered for this intersection. Alternative 1 considers extension of the ESD west of the intersection with NDOT Type 2 sump drop inlets on the north and south sides of Elkhorn Road and a NDOT Type 2 sump drop inlet along the west side of Grand Canyon Drive. This alternative will likely require gas line relocations to accommodate the extension of the RCB. Alternative 2 considers termination of the ESD at the centerline of Grand Canyon Drive with a NDOT Type 2 sump drop inlet along the west side of Grand Canyon Drive and a 22.5-ft CM2 drop inlet just east of the intersection on the north side of Elkhorn Road. Per the CLV/CCRFCD progress meeting held on July 31, 2012, Alternative 1 was selected primarily to provide a facility extended thru the intersection and establish the future need of drop inlets in Elkhorn Road on the north and south sides prior to the intersection. Note that drop inlet costs between the two design alternatives were considered equivalent, however the extension of the ESD mainline (RCB) makes Alternative 1 more expensive, although justified.

- *Tee Pee/Elkhorn Intersection*: Exhibit J included in Appendix A depicts the two design alternatives considered for this intersection. Alternative 1 considers interception of 64 cfs discharging from a residential subdivision drainage easement via NDOT Type 2 sump drop inlets located within the drainage easement. This alternative requires relocation of approximately 250 LF of 8" PVC sanitary sewer line in order to connect a 30" RCP lateral storm drain from the inlet to the ESD mainline. Alternative 2 considers allowing the 64 cfs discharging from the residential subdivision drainage easement to surface flow thru the intersection and intercepting the flow with a 22.5-ft CM2 drop inlet located just east of the intersection on the north side of Elkhorn Road. Note that the CCRFCD criterion of 1-ft maximum flow depth for the 100-year storm event thru an intersection is met by this design. Per the CLV/CCRFCD progress meeting held on July 31, 2012, Alternative 1 was selected in order to reduce surface flow thru the intersection. Although Alternative 2 is less expensive, the improved drainage condition was felt justified for the cost.

4.2 Discussion of Facility Design

The ESD is proposed as 2,452 LF of 7'w x 5'h RCB for conveyance of the 100-year storm event flow ranging between 607 cfs and 796 cfs. The ESD facility is designed to connect to a 7'w x 6'h RCB lateral junction stubbed in Elkhorn Road at Fort Apache Road as currently under design by others as part of the Rancho-Fort Apache Storm Drain project.

The project also includes design of appurtenant drop inlet and lateral storm drain facilities necessary to intercept the 100-year frequency design storm.

The ESD alignment is proposed within the north half of the roadway because it is less encumbered by existing utilities than the south half. Additionally, the ESD alignment is within the north half of the roadway because the storm flows are well divided between the north and south halves of Elkhorn Road, with the majority of flow contributing to and maintained on the north half of the street. Note that an existing 18-inch RCP storm drain system located within the south half of Elkhorn Road which is capable of intercepting and conveying storm flows contributing to the south half of the street. Exhibit H included in Appendix A depicts the proposed facility designs.

4.3 Summary of Street Flow

The storm drain design was initiated by first evaluating street flow hydraulics and assessing the need/location for drop inlets necessary to intercept flow in order to meet CCRFCD street flow criteria. Drop inlets where then provided based on locations where street flow criteria would be exceeded and/or to meet the intent of the 100-year design flow conveyance of the regional facility. The following table provides a summary of 100-year storm event street flow hydraulics based on the proposed design (after drop inlet interception).

Table 6: Summary of Street Flow Hydraulics: 100-Year

Street Section[1]	Slope (%)	Cross Slope (%)	Q_{100} (cfs)	D_{100} (ft)	V_{100} (ft/s)	$D_{100}*V_{100}$
Elkhorn North Half Section A	2.1	2.0	37	0.62	5.75	3.57
Elkhorn South Half Section A	2.1	2.0	8	0.40	4.36	1.74
Elkhorn North Half Section B	3.4	2.0	0	0.00	0.00	0.00
Elkhorn South Half Section B	3.4	2.0	2	0.27	3.70	1.00
Elkhorn North Half Section C	3.4	3.2	1.5	0.25	3.83	0.96
Elkhorn South Half Section C	3.4	2.2	0	0.00	0.00	0.00
Elkhorn North Half Section D	3.4	3.6	1.5	0.25	3.91	0.98
Elkhorn South Half Section D	3.4	2.6	2.5	0.29	4.11	1.19
Elkhorn North Half Section E	3.4	4.0	4	0.34	5.24	1.78
Elkhorn South Half Section E	3.4	3.0	6.5	0.38	5.48	2.08
Elkhorn North Half Section F	3.4	3.0	3	0.31	4.41	1.37
Elkhorn South Half Section F	3.4	2.5	8	0.39	5.53	2.16
Grand Canyon West Half Section H	0.5	2.0	64	0.90	3.30	2.97
Grand Canyon East Half Section H	0.5	2.0	3	0.38	1.97	0.75

1 - See Exhibit H

Review of the table above indicates the proposed design will be in compliance with CCRFCD street flow criteria for the 100-year storm event.

Since Elkhorn Road is a greater than 80-foot right-of-way street, the 10-year CCRFCD criteria must also be met. The following table provides a summary of maximum flow rates in the street that will be compliant with 10-year CCRFCD criteria for dry lane, flow depth, and DxV.

Table 7: Summary of Street Flow Hydraulics: 10-Year Maximum Capacity

Roadway Reach	Slope (%)	Cross Slope (%)	Q_{10}[1] (cfs)	D_{10} (ft)	V_{10} (ft/s)	D_{10}*V_{10}	10-Year Dry Lane Width (ft)
Elkhorn-North Half Grand Canyon to Tee Pee	3.4	2.0	56	0.65	7.67	4.99	19.0
	3.4	3.2	55	0.72	8.31	5.98	25.8
	3.4	3.6	51	0.72	8.26	5.95	27.7
Elkhorn-South Half Grand Canyon to Tee Pee	3.4	2.0	55	0.65	7.64	4.97	19.0
	3.4	2.2	67	0.70	8.21	5.75	19.0
	3.4	2.6	62	0.71	8.27	5.87	22.2
Elkhorn-North Half Tee Pee to Ft. Apache	3.4	3.0	58	0.72	8.34	6.00	24.7
	3.4	3.5	52	0.72	8.27	5.95	27.3
	3.4	4.0	47	0.72	8.21	5.91	29.3
Elkhorn-South Half Tee Pee to Ft. Apache	3.4	2.5	64	0.71	8.29	5.89	21.4
	3.4	3.0	58	0.72	8.34	6.00	24.7
	3.4	3.5	52	0.72	8.27	5.95	27.3

1 – All flows presented in table are maximum half street flows meeting CCRFCD criteria.

Review of the table above indicates maximum street flows meeting 10-year criteria range from 47 cfs to 67 cfs. Note that in some cases dry lane dictates maximum flow rate and in other cases the DxV dictates maximum flow rate. In all cases, the maximum flow rate meeting 10-year criteria far exceeds design surface flows at any location even for the 100-year storm event.

4.4 Summary of Recommended Drop Inlets

The following table provides a summary of proposed drop inlets located based on where street flow criteria would be exceeded and/or to meet the intent of the 100-year design flow conveyance of the regional facility. Note that existing drop inlets were utilized to offset the need and size of proposed drop inlets.

Table 8: Summary of Drop Inlets				
Station	**Size & Type**	**Total Inflow Q_{100} (cfs)**	**Collected Q_{100} (cfs)**	**Bypass Q_{100} (cfs)**
Elkhorn North Side				
18+88.19 (south side)	(1) NDOT Type 2 Single Grate	8.0	8.0	0.0
19+20.67 19+30.52	(2) NDOT Type 2 Triple Grate	37.0	37.0	0.0
19+70.39 19+70.54 19+70.69	(3) NDOT Type 2 Triple Grate	64.0	64.0	0.0
20+34.00 (existing)	12-ft Neenah R-3295	3.0	3.0	0.0
27+99.00 (existing)	4.0-ft CM2	1.5	1.5	0.0
32+23.00 (existing)	4.0-ft CM2	1.5	1.5	0.0
32+42.29 32+50.28 32+58.28	(3) NDOT Type 2 Triple Grate	64.0	64.0	0.0
35+61.00 (existing)	4.0-ft CM2	4.0	3.0	1.0
41+77.00 (existing)	4.0-ft CM2	3.0	2.5	0.5
44+83.00	22.5-ft CM2 (proposed by others)	4.5	4.5	0.0
Elkhorn South Side				
25+37.00 (existing)	4.0-ft CM2	2.0	1.5	0.5
32+46.00 (existing)	4.0-ft CM2	2.5	2.0	0.5
34+61.00 (existing)	2.5-ft CM2	6.5	3.5	3.0
41+91.00 (existing)	2.5-ft CM2	8.0	3.5	4.5
45+50.00	22.5-ft CM2 (proposed by others)	4.5	4.5	0.0

4.5 Summary of Recommended Storm Drain

The following table provides a summary of proposed mainline and lateral storm drain as well as the design flows for the ESD located on the north side of Elkhorn Road.

Table 9: Summary of Storm Drain Facilities - Elkhorn North Side		
Station	**Facility Description**	**Design Flow (cfs)**
Mainline		
18+85.00 to 19+42.41	7'w x 5'h RCB	607.0
19+42.41 to 20+30.00	7'w x 5'h RCB	652.0
20+30.00 to 28+19.34	7'w x 5'h RCB	719.0
28+19.34 to 32+36.61	7'w x 5'h RCB	720.5
32+36.61 to 32+89.06	7'w x 5'h RCB	722.0
32+89.06 to 35+85.94	7'w x 5'h RCB	786.0
35+85.94 to 41+86.21	7'w x 5'h RCB	789.0
41+86.21 to 44+83.00	7'w x 5'h RCB to 7'w x 6'h RCB (proposed by others)	791.5
44+83.00 to 46+00.00	7'w x 6'h RCB (proposed by others)	796.0
Laterals		
19+42.41	24" RCP	37.0
19+42.41 (south side of Elkhorn)	18" RCP	8.0
20+30.00	42" RCP	67.0
28+19.34	18" RCP (existing)	1.5
32+36.61	18" RCP (existing)	1.5
32+89.06	30" RCP	64.0
35+85.94	18" RCP (existing)	3.0
41+86.21	18" RCP (existing)	2.5
44+83.00	30" RCP (proposed by others)	4.5

The following table provides a summary of proposed mainline and lateral storm drain as well as the design flows for the existing 18-inch RCP storm drain system located on the south side of Elkhorn Road.

Table 10: Summary of Storm Drain Facilities - Elkhorn South Side		
Station	**Facility Description**	**Design Flow (cfs)**
Mainline		
25+37.00 to 32+46.00	18" RCP (existing)	1.5
32+46.00 to 34+61.00	18" RCP (existing)	3.5
34+61.00 to 41+91.00	18" RCP (existing)	7.0
41+91.00 to 45+50.00	18" RCP (existing)	10.5
45+50.00 to 46+00.00	30" RCP (proposed by others)	15.0
Laterals		
25+37.00	18" RCP (existing)	1.5
32+46.00	18" RCP (existing)	2.0
34+61.00	18" RCP (existing)	3.5
41+91.00	18" RCP (existing)	3.5
45+50.00	30" RCP (proposed by others)	4.5

5 CONCLUSIONS & RECOMMENDATIONS

1. The project site is not located within a FEMA designated SFHA. FEMA acceptance is not required.

2. The project is a planned CCRFCD regional drainage facility, per the CCRFCD 2008 MPU. CCRFCD concurrence is required.

3. A portion of the project improvements are located within and adjacent to unincorporated Clark County. Clark County concurrence is required.

4. It has been determined that the existing storm drain system within Elkhorn Road does **not** provide enough capacity for the surface flow in Elkhorn Road to meet CCRFCD Manual criteria during the 100-year and 10-year storm events.

5. The proposed ESD project will effectively provide 100-year storm flow interception and conveyance for the remaining street flow in Elkhorn Road to meet CCRFCD Manual criteria during the 100-year and 10-year storm events.

6. Proposed flow velocities in the ESD mainline range from 17.5 to 28.5 fps. This exceeds the CCRFCD Manual criterion of a maximum velocity of 25 fps at some locations due to facility slopes ranging from 2.83% to 3.69%.

7. The accompanying 30% Design Plans support the concepts, drainage patterns, conclusions and/or recommendations discussed in this report.

6 REFERENCES

1. *CCRFCD 2008 Las Vegas Valley Flood Control Master Plan Update.* PBS&J, 2010.
2. *CLV Northwest Neighborhood Study.* September 1999.
3. *CLV Northwest Neighborhood Study Phase 2.* September 1999.
4. *Rancho-Fort Apache Storm Drain Study.* LBG, July 2012.
5. *Master Drainage Study for Cliff's Edge.* VTN, March 2004.
6. *Cliff's Edge, Hualapai Way, Deer Springs to Grand Teton.* VTN, May 2004.
7. *Cliff's Edge/Providence, Elkhorn Road Street Improvements.* VTN, February 2005
8. *Elkhorn/Grand Canyon Unit 1 & Unit 2.* VTN, 2002.
9. *Hydrologic Criteria and Drainage Design Manual.* Clark County Regional Flood Control District, 1990.

LIST OF APPENDICES

Appendix A Drainage Exhibits
- Exhibit A – Location Map
- Exhibit B – FEMA FIRM Map
- Exhibit C – CCRFCD 2008 MPU Facilities Map
- Exhibit D – CCRFCD 2008 MPU Hydrologic Map
- Exhibit E – NW Neighborhood Study Exhibit
- Exhibit F – NW Neighborhood Study Phase 2 Exhibit
- Exhibit G – Ultimate Condition Drainage Map
- Exhibit H – Storm Drain Facilities Exhibit
- Exhibit I – Grand Canyon and Elkhorn Alternatives
- Exhibit J – Tee Pee and Elkhorn Alternatives

Appendix B Street Flow Computations
- Street Flows Impacting Drop Inlets
- 10-Year Maximum Street Flow Capacities

Appendix C Drop Inlet Computations
- Sump Drop Inlet Computations
- Continuous Grade Drop Inlet Computations

Appendix D Storm Drain Hydraulic Analyses
- North Side Mainline WSPG Analysis
- Lateral Full Flow Capacity Computations

Appendix E Reference Material
- Rancho-Fort Apache Storm Drain Study, LBG
- Master Drainage Study for Cliff's Edge, VTN
- Cliff's Edge, Hualapai Way, Deer Springs to Grand Teton, VTN
- Cliff's Edge/Providence, Elkhorn Road Street Improvements, VTN
- Elkhorn/Grand Canyon Unit 1 & Unit 2, VTN

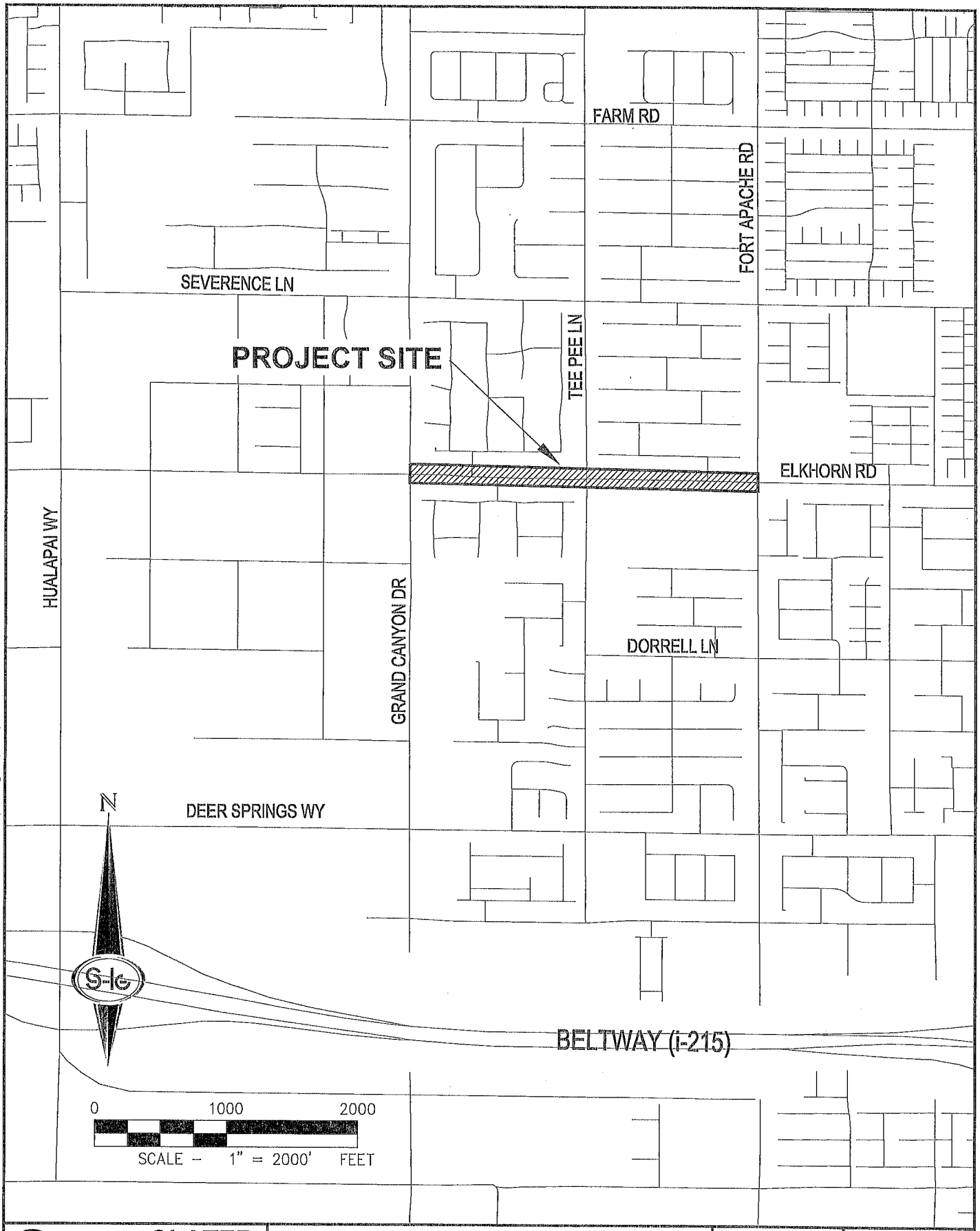
Appendix F Coordination Documents
- CLV/CCRFCD Kickoff Meeting Minutes – May 2, 2012
- CLV/CCRFCD Progress Meeting#1 Minutes – June 5, 2012
- CLV/CCRFCD Progress Meeting#2 Minutes – July 31, 2012
- LBG Email Correspondence – August 2, 2012

Appendix G 30% Storm Drain Plan & Profile

APPENDIX

APPENDIX A

Drainage Exhibits



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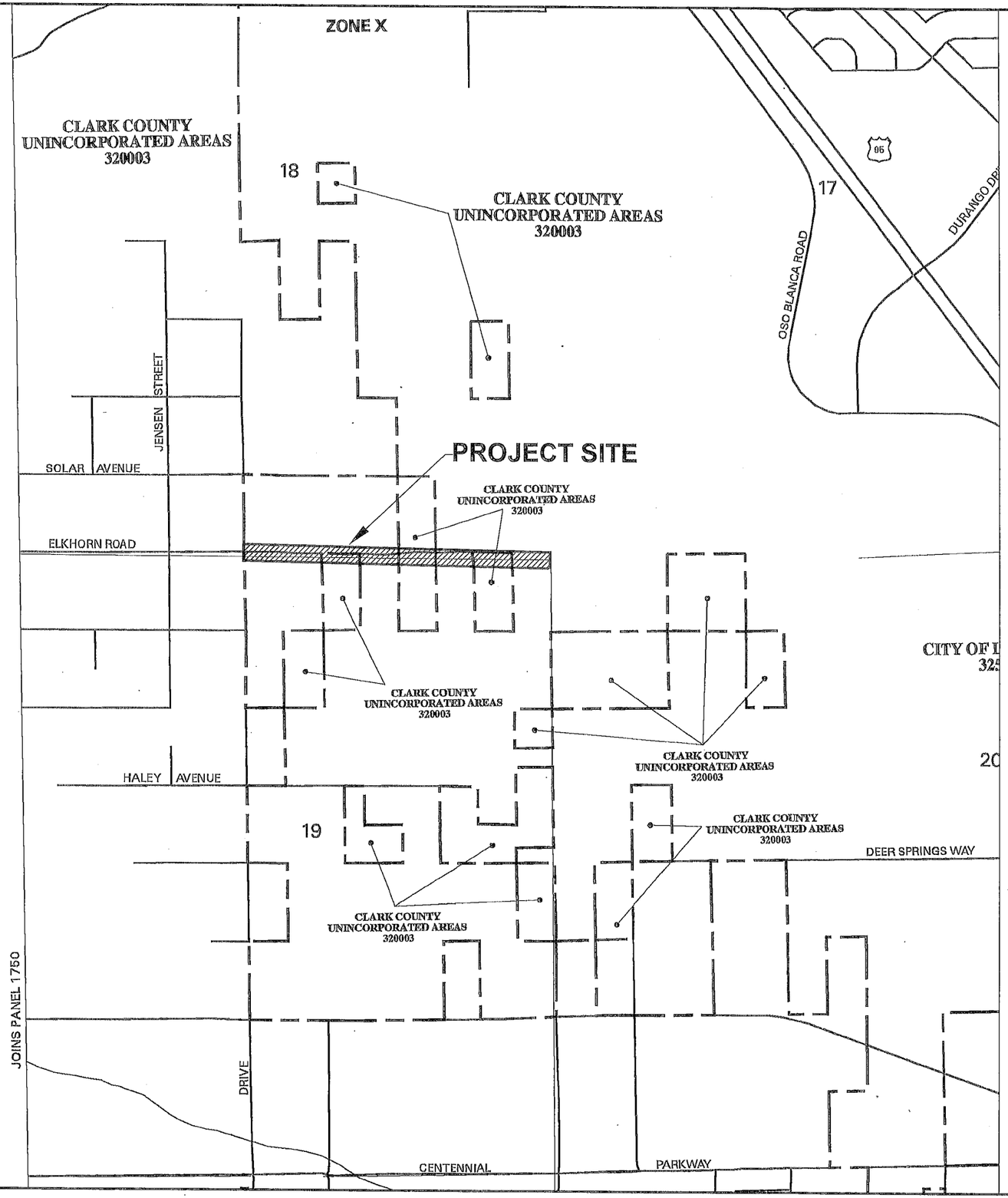
SLATER HANIFAN GROUP
CONSULTING ENGINEERS & PLANNERS
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PHONE (702) 284-5300 FAX (702) 284-5399

CITY OF LAS VEGAS

RANCHO RD SYSTEM - ELKHORN (FT APACHE TO GRAND CANYON)

LOCATION MAP

DATE: AUG 2012	PROJECT NO. CLV1201--000
DRAFTER: KC	
DESIGNER: KC	EXHIBIT A
CHECKED: MJF	SHEET 1 OF 1



0 1000 2000
SCALE -- 1"=1000' FEET

N

LEGEND

SPECIAL FLOOD HAZARD AREAS SUBJECT TO INUNDATION BY THE 1% ANNUAL CHANCE FLOOD EVENT

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 — Area of special flood hazard formerly protected from the 1% annual chance flood event 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 event.

ZONE A99 — Area to be protected from 1% annual chance flood event 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
- Coastal Barrier Boundary
- Boundary dividing Special Flood Hazard Areas of different Base Flood Elevations, flood depths or velocities.
- 513 — Base Flood Elevation line and value; elevation in feet*
- (EL 987) — Base Flood Elevation value where uniform within zone; elevation in feet*

*Referenced to the North American Vertical Datum of 1988

- (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)
- 4276000m — 1000-meter Universal Transverse Mercator grid values, zone 11
- 600000 FT — 5000-foot grid ticks
- DX5519K — Bench mark (see explanation in Notes to Users section of this FIRM panel).
- M1.5 — River Mile

NFIP

PANEL 1745 E

FIRM

FLOOD INSURANCE RATE MAP

CLARK COUNTY,
NEVADA AND
INCORPORATED AREAS

PANEL 1745 OF 4090

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
LAS VEGAS, CITY OF	320028	1745	E
CLARK COUNTY, UNINCORPORATED AREAS	320003	1745	E

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
32003C1745 E

MAP REVISED:
SEPTEMBER 27, 2002

Federal Emergency Management Agency

SLATER HANIFAN GROUP
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NO.	DESCRIPTION	DATE	BY	APP. DATE	APP.

CITY OF LAS VEGAS

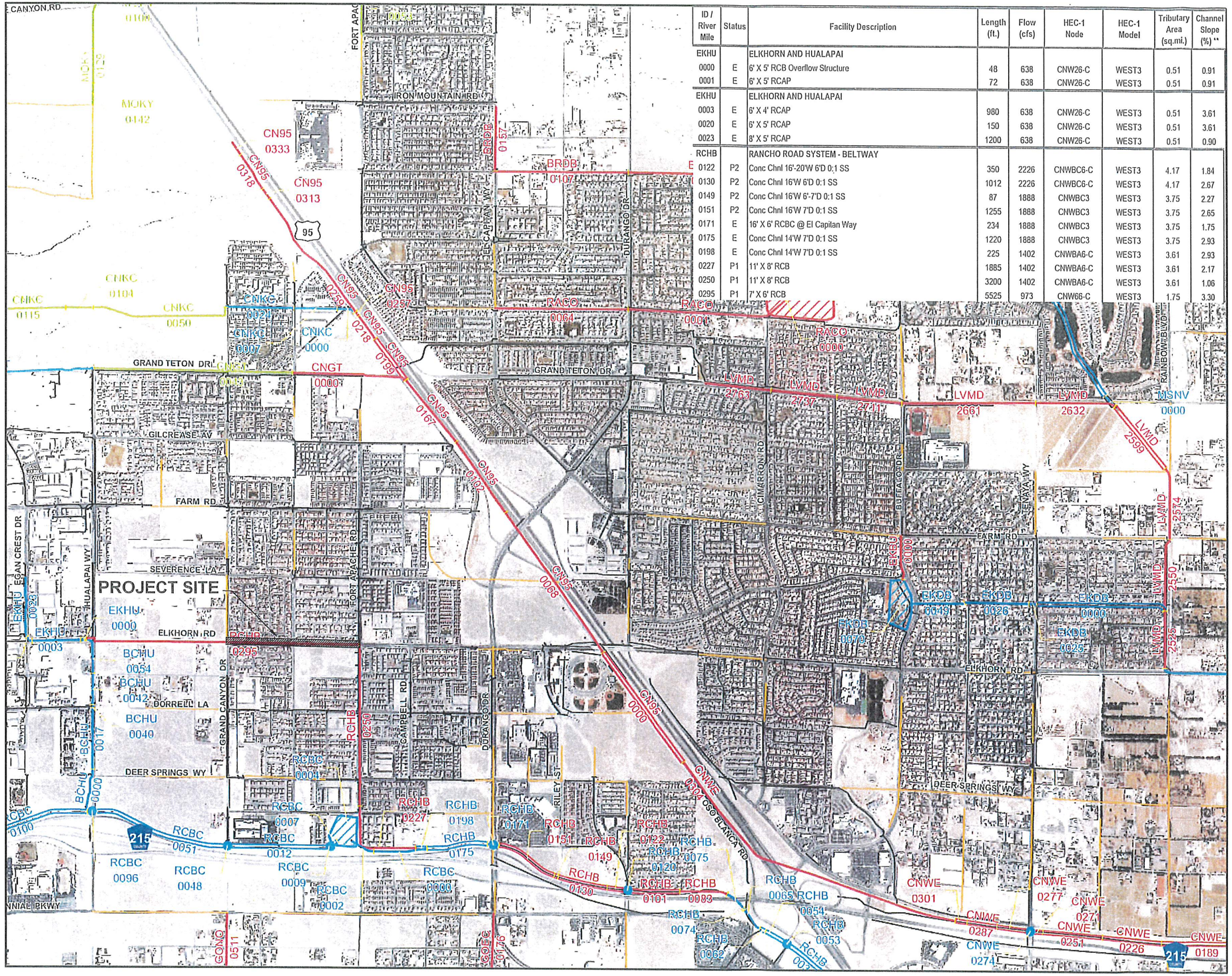
RANCHO RD SYSTEM - ELKHORN (FT APACHE TO GRAND CANYON)

FEMA FIRM MAP

DATE: AUG 2012
DRAFTER: KC
DESIGNER: KC
CHECKED: MJF
PROJECT NO.
CLV1201-000

EXHIBIT B
SHEET 1 OF 1

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ID / River Mile	Status	Facility Description	Length (ft.)	Flow (cfs)	HEC-1 Node	HEC-1 Model	Tributary Area (sq.mi.)	Channel Slope (%) **
EKHU		ELKHORN AND HUALAPAI						
0000	E	6' X 5' RCB Overflow Structure	48	638	CNW26-C	WEST3	0.51	0.91
0001	E	6' X 5' RCAP	72	638	CNW26-C	WEST3	0.51	0.91
EKHU		ELKHORN AND HUALAPAI						
0003	E	6' X 4' RCAP	980	638	CNW26-C	WEST3	0.51	3.61
0020	E	6' X 5' RCAP	150	638	CNW26-C	WEST3	0.51	3.61
0023	E	8' X 5' RCAP	1200	638	CNW26-C	WEST3	0.51	0.90
RCHB		RANCHO ROAD SYSTEM - BELTWAY						
0122	P2	Conc Chnl 16'-20'W 6'D 0:1 SS	350	2226	CNWBC6-C	WEST3	4.17	1.84
0130	P2	Conc Chnl 16'W 6'D 0:1 SS	1012	2226	CNWBC6-C	WEST3	4.17	2.67
0149	P2	Conc Chnl 16'W 6'-7'D 0:1 SS	87	1888	CNWBC3	WEST3	3.75	2.27
0151	P2	Conc Chnl 16'W 7'D 0:1 SS	1255	1888	CNWBC3	WEST3	3.75	2.65
0171	E	16' X 6' RCBC @ El Capitan Way	234	1888	CNWBC3	WEST3	3.75	1.75
0175	E	Conc Chnl 14'W 7'D 0:1 SS	1220	1888	CNWBC3	WEST3	3.75	2.93
0198	E	Conc Chnl 14'W 7'D 0:1 SS	225	1402	CNWBA6-C	WEST3	3.61	2.93
0227	P1	11' X 8' RCB	1885	1402	CNWBA6-C	WEST3	3.61	2.17
0250	P1	11' X 8' RCB	3200	1402	CNWBA6-C	WEST3	3.61	1.06
0295	P1	7' X 6' RCB	5525	973	CNW66-C	WEST3	1.75	3.30

REGIONAL FLOOD CONTROL DISTRICT

2008
LAS VEGAS VALLEY
FLOOD CONTROL
MASTER PLAN UPDATE

FIGURE F-13
FLOOD CONTROL FACILITIES

LEGEND

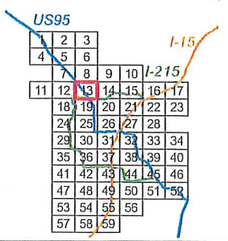
- Ultimate Development Boundary
- Existing Facilities
- Category A Proposed Facilities
- Category B Proposed Facilities
- Local Existing Facilities
- Local Proposed Facilities
- Detention Basin
- Culvert or Bridge Crossing
- Stormdrain
- Lined Channel
- Unlined Channel
- Levee/Dike
- Natural Wash/Floodway
- ID-Mile Separator

Remove & Replace/Parallel Facilities

Category A	Category B
Channel	Channel
Stormdrain	Stormdrain
Crossing	Crossing

N

0 500 1,000 2,000 3,000
Feet
Scale: 1 inch = 2,000 feet
Refer to Figure G-2 for Aerial Source(s)



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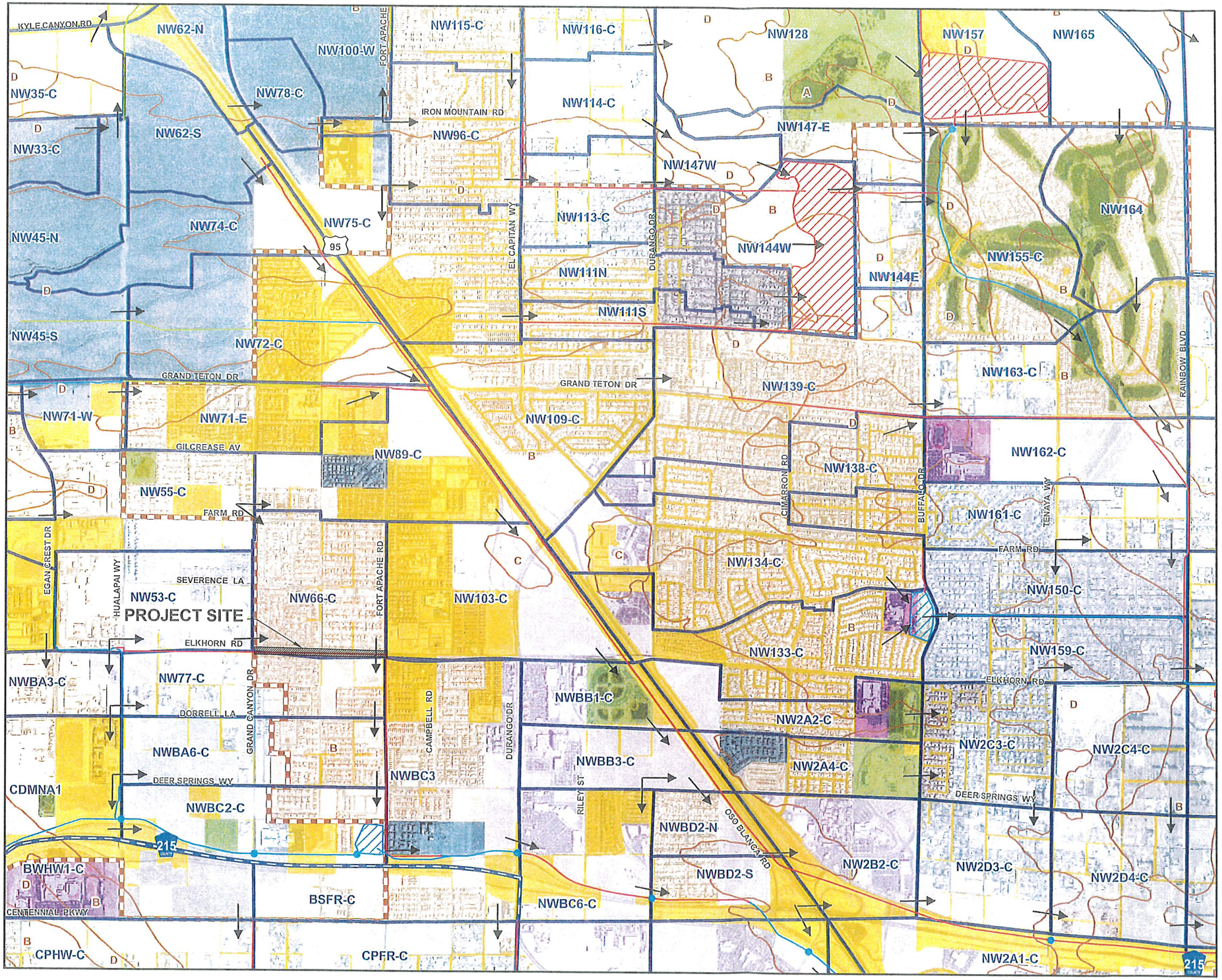
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CITY OF LAS VEGAS
RANCHO RD SYSTEM - ELKHORN (FT APACHE TO GRAND CANYON)
CCRFCD 2008 MPU FACILITIES MAP

DATE:	AUG 2012
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DESIGNER:	KC
CHECKED:	MJF
PROJECT NO.	CLV1201-000

EXHIBIT C
SHEET 1 OF 1

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REGIONAL FLOOD CONTROL DISTRICT

2008
LAS VEGAS VALLEY
FLOOD CONTROL
MASTER PLAN UPDATE

FIGURE H-13
HYDROLOGIC SUMMARY

LEGEND

- Ultimate Development Boundary
- Watershed Boundary
- Subbasin Boundary
- Drought Ordinance Boundary
- Flow Arrows

Flood Control Facilities

- Existing Facilities
- Category A Proposed Facilities
- Category B Proposed Facilities
- Category A Remove & Replace/ Parallel Facilities
- Category B Remove & Replace/ Parallel Facilities
- Type Hydrologic Soil Groups
  - A Low Runoff Potential
  - B Moderately Low Runoff Potential
  - C Moderately High Runoff Potential
  - D High Runoff Potential/Rock Outcrops

Typical Land Use

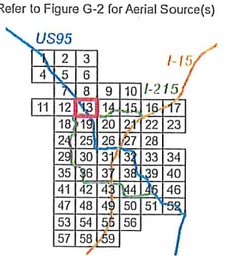
1	Undeveloped Land, Open Desert
2	Parks, Golf Courses
3	Rural
4 / 14*	Low Density Residential
5 / 15*	Medium Density Residential
6 / 16*	High Density Residential
7 / 17*	Public Facility, Residential
8 / 18*	Very High Density Residential
9 / 19*	Commerical, Retail, Casino, High Rise Condominiums
10 / 20*	Light Industrial
11 / 21*	Heavy Industrial
12 / 22*	Schools
13	Lakes

* Drought Ordinance Applied

N

0 500 1,000 2,000 3,000
Feet
Scale: 1 inch = 2,000 feet

Refer to Figure G-2 for Aerial Source(s)



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NO.	DESCRIPTION	DATE	BY	APP. DATE	APP.

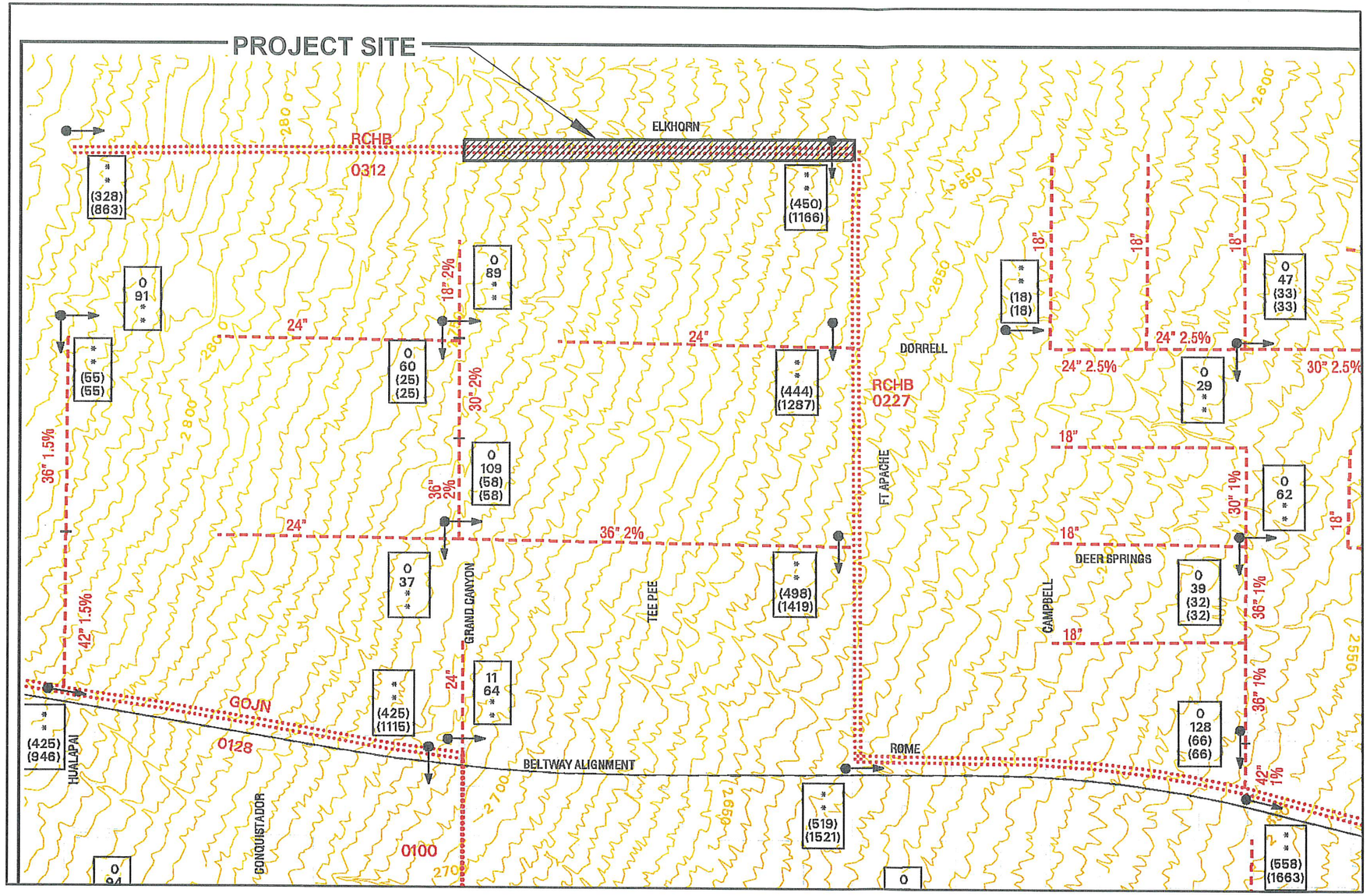
CITY OF LAS VEGAS

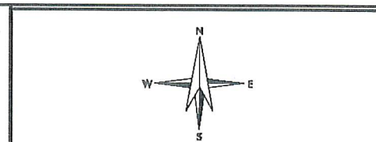
RANCHO RD SYSTEM - ELKHORN (FT APACHE TO GRAND CANYON)
CCRFCD 2008 MPU HYDROLOGIC MAP

DATE:	AUG 2012
DRAFTER:	KC
DESIGNER:	KC
CHECKED:	MJF
PROJECT NO.	CLV1201-000

EXHIBIT D
SHEET 1 OF 1

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800 600 400 200 0 400 800

(IN FEET)

SCALE: 1 INCH = 800 FEET

FLOW ARROW

250	10-YEAR STREET FLOW
500	100-YEAR STREET FLOW
(300)	10-YEAR FACILITY FLOW
(800)	100-YEAR FACILITY FLOW

(FLOWS IN CFS)

NOTE:

Ultimate drainage conditions are based on future CN values with all flood control facilities in place

See the "September 1999 City of Las Vegas Northwest Neighborhood Study Phase 2" for proposed facilities in and north of Elkhorn.

REVISED SEPTEMBER 1999

CITY OF LAS VEGAS NEVADA

NORTHWEST NEIGHBORHOOD STUDY

LEGEND

- EXISTING REGIONAL DETENTION BASINS
- PROPOSED REGIONAL DETENTION BASINS
- EXISTING LOCAL DETENTION BASINS
- EXISTING REGIONAL BRIDGES
- PROPOSED REGIONAL BRIDGES
- EXISTING LOCAL BRIDGES
- EXISTING REGIONAL CULVERT
- PROPOSED REGIONAL CULVERT
- EXISTING LOCAL CULVERT
- EXISTING REGIONAL PIPELINE
- PROPOSED REGIONAL PIPELINE
- EXISTING LOCAL PIPELINE
- PROPOSED LOCAL PIPLINE
- EXISTING REGIONAL CHANNEL
- PROPOSED REGIONAL CHANNEL
- EXISTING LOCAL CHANNEL
- PROPOSED REGIONAL PIPELINE (Not Included in 1999 MPU)
- PROPOSED REGIONAL CHANNEL (Not included in 1999 MPU)
- EXISTING REGIONAL DIKE/LEVEE
- PROPOSED REGIONAL DIKE/LEVEE
- EXISTING LOCAL DIKE/LEVEE
- EXISTING STORM WATER PUMPING STATION
- PROPOSED BELTWAY ALIGNMENT

FIGURE F-1

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CITY OF LAS VEGAS

RANCHO RD SYSTEM - ELKHORN (FT APACHE TO GRAND CANYON)

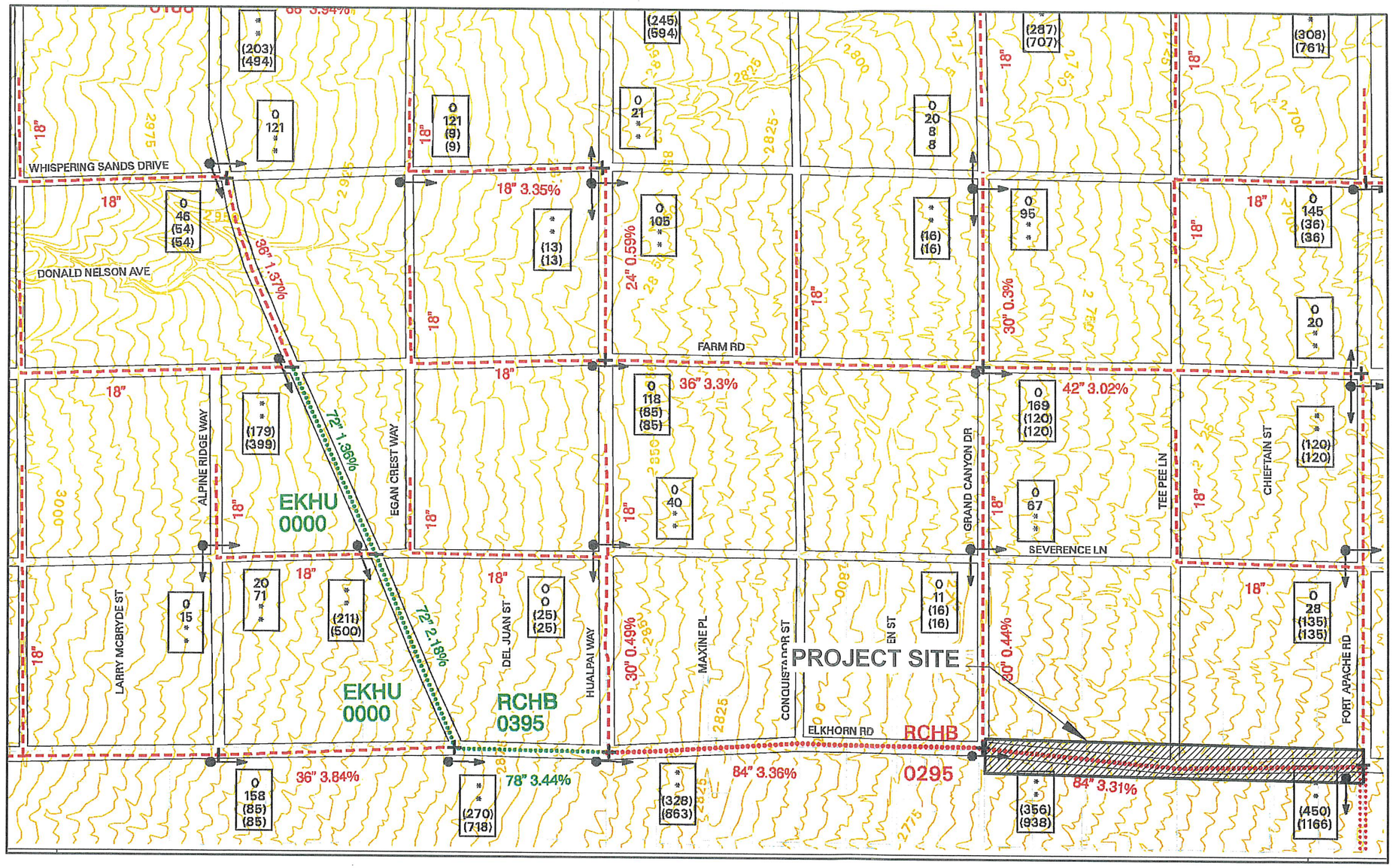
NORTHWEST NEIGHBORHOOD STUDY-FUTURE DRAINAGE CONDITION

DATE:	AUG 2012
DRAFTER:	KC
DESIGNER:	KC
CHECKED:	MJF
PROJECT NO.	CLV1201-000

EXHIBIT E

SHEET 1 OF 1

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CITY OF LAS VEGAS NEVADA

NORTHWEST NEIGHBORHOOD STUDY PHASE 2

LEGEND

- EXISTING REGIONAL DETENTION BASINS
- PROPOSED REGIONAL DETENTION BASINS (Not Included in 1996 MPU)
- EXISTING REGIONAL BRIDGES
- PROPOSED REGIONAL BRIDGES
- PROPOSED REGIONAL BRIDGES (Not Included in 1996 MPU)
- EXISTING LOCAL BRIDGES
- PROPOSED REGIONAL CULVERT
- EXISTING REGIONAL CULVERT
- EXISTING LOCAL CULVERT
- EXISTING REGIONAL PIPELINE
- PROPOSED REGIONAL PIPELINE
- PROPOSED REGIONAL PIPELINE (Not Included in 1996 MPU)
- EXISTING LOCAL PIPELINE
- PROPOSED LOCAL PIPELINE
- EXISTING REGIONAL CHANNEL
- PROPOSED REGIONAL CHANNEL
- EXISTING LOCAL CHANNEL
- PROPOSED LOCAL CHANNEL
- PROPOSED REGIONAL CHANNEL (Not Included in 1996 MPU)
- EXISTING REGIONAL DIKE/LEVEE
- PROPOSED REGIONAL DIKE/LEVEE
- PROPOSED REGIONAL DIKE/LEVEE (Not Included in 1996 MPU)
- PROPOSED LOCAL DIKE/LEVEE

N W E S

800 600 400 200 0 400 800

(IN FEET)
SCALE: 1 INCH = 800 FEET

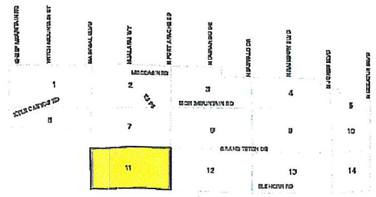
FLOW ARROW

250	10-YEAR STREET FLOW
500	100-YEAR STREET FLOW
(300)	10-YEAR FACILITY FLOW
(800)	100-YEAR FACILITY FLOW

(FLOWS IN CFS)

NOTE:
Ultimate drainage conditions are based on future CN values with all flood control facilities in place.
Regional facility identifiers were established based on the methodology used in the "1996 Clark County Regional Flood Control Master Plan Update for the Las Vegas Valley."

NOTE:
All regional facilities proposed in the "1996 Clark County Regional Flood Control Master Plan Update for the Las Vegas Valley" have been resized based on the flows developed in this study. In addition, many of these facilities have been changed from channels to reinforced concrete box culverts.



SLATER HANIFAN GROUP
CONSULTING ENGINEERS & PLANNERS
5740 S. ARVILLE STREET #216, LAS VEGAS, NV 89118
PHONE (702) 284-5300 FAX (702) 284-5390

NO.	DESCRIPTION	DATE	BY	APP. DATE	APP.

CITY OF LAS VEGAS
RANCHO RD SYSTEM - ELKHORN (FT APACHE TO GRAND CANYON)
NORTHWEST NEIGHBORHOOD STUDY PHASE 2-FUTURE DRAINAGE CONDITION

DATE: AUG 2012
DRAFTER: KC
DESIGNER: KC
CHECKED: MJF
PROJECT NO. CLV1201-000

EXHIBIT F
SHEET 1 OF 1

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LEGEND

- CFS — 100-YR SURFACE FLOW (CFS) - ELKHORN EXISTING FACILITY
- (CFS) — 100-YR DRAINAGE FACILITY FLOW (CFS) - ELKHORN EXISTING FACILITY
- CFS — 100-YR SURFACE FLOW (CFS) - ELKHORN PROPOSED FACILITY
- (CFS) — 100-YR DRAINAGE FACILITY FLOW (CFS) - ELKHORN PROPOSED FACILITY
- CFS — 100-YR SURFACE FLOW (CFS) - ELKHORN PROPOSED FACILITY (BY OTHERS)
- (CFS) — 100-YR DRAINAGE FACILITY FLOW (CFS) - ELKHORN PROPOSED FACILITY (BY OTHERS)
- EXISTING DRAINAGE FACILITY
- PROPOSED DRAINAGE FACILITY
- PROPOSED DRAINAGE FACILITY (BY OTHERS)
- REMOVE EXISTING DRAINAGE FACILITY
- (ID) — STREET SECTION

N

SCALE — 1" = 60' — 0 60 120 FEET

GRAND CANYON DR

TEE PEE LN

ELKHORN RD

(3) NDOT 2 "ER" 19+70

(2) NDOT 2 "ER" 19+20 & 19+30

30" RCP

12-FT NEENAH R-3295 "ER" 20+34

18" HDPE

TYPE II MANHOLE

42" RCP

7' x 5' RCB

18" RCP

PLUG

18" SD

(3) NDOT 2 "ER" 18+88

4-FT CM2 "ER" 25+37

"ER"

4-FT CM2 "ER" 27+99

(3) NDOT 2 "ER" 32+42, 32+50 & 32+58

4-FT CM2 "ER" 32+23

4-FT CM2 "ER" 32+46

SEE MATCH LINE A

SEE MATCH LINE A

4-FT CM2 "ER" 35+61

7' x 6' RCB

2.5-FT CM2 "ER" 34+61

4-FT CM2 "ER" 41+77

2.5-FT CM2 "ER" 41+91

22.5-FT CM2 "ER" 44+83

22.5-FT CM2 "ER" 45+50

FORT APACHE RD

60" SD

Typ CM are in 2.5' Increments

Hand Set

NO.	DESCRIPTION	DATE	BY	APP. DATE	APP.

SLATER HANIFAN GROUP
CONSULTING ENGINEERS & PLANNERS
5740 S. ARVILLE STREET #216, LAS VEGAS, NV 89118
PHONE (702) 284-5300 FAX (702) 284-5399

CITY OF LAS VEGAS

RANCHO RD SYSTEM - ELKHORN (FT APACHE TO GRAND CANYON)

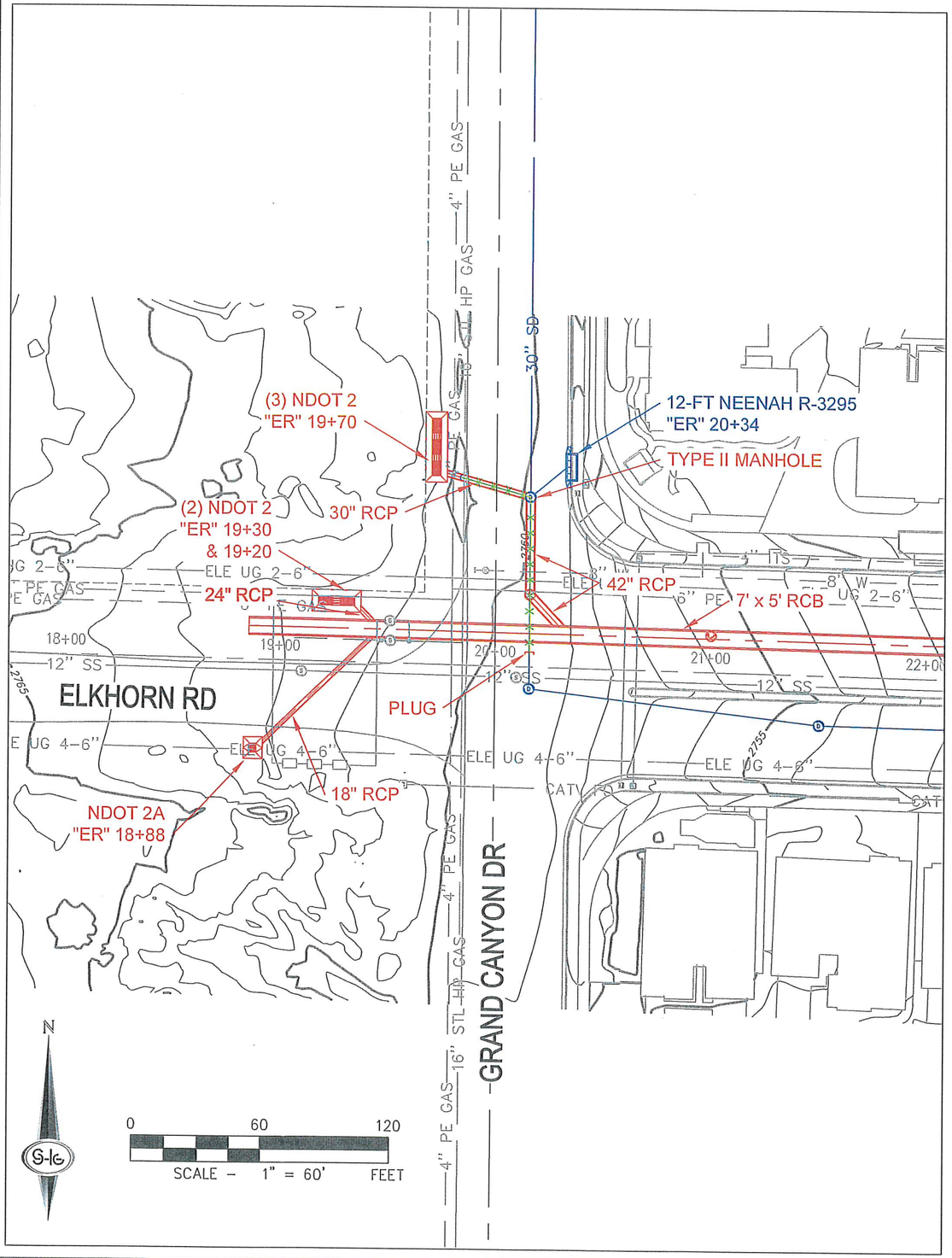
STORM DRAIN FACILITIES EXHIBIT

DATE: AUG 2012
DRAFTER: KC
DESIGNER: KC
CHECKED: MJF
PROJECT NO. CLV1201-000

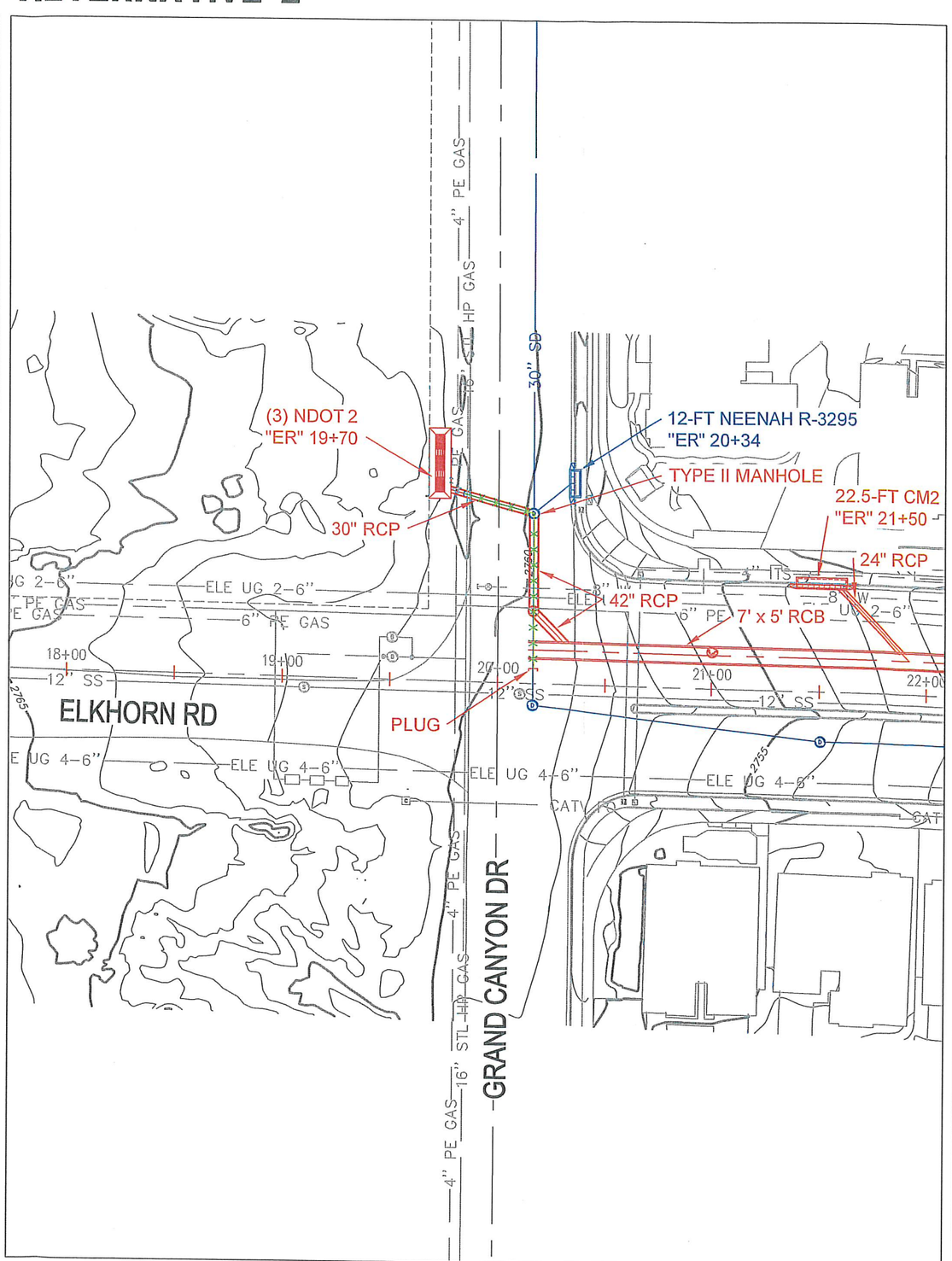
EXHIBIT H
SHEET 1 OF 1

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ALTERNATIVE 1 (RECOMMENDED)



ALTERNATIVE 2



SLATER HANIFAN GROUP
CONSULTING ENGINEERS & PLANNERS
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PHONE (702) 284-5300 FAX (702) 284-5399

NO.	DESCRIPTION	DATE	BY	APP. DATE	APP.

CITY OF LAS VEGAS

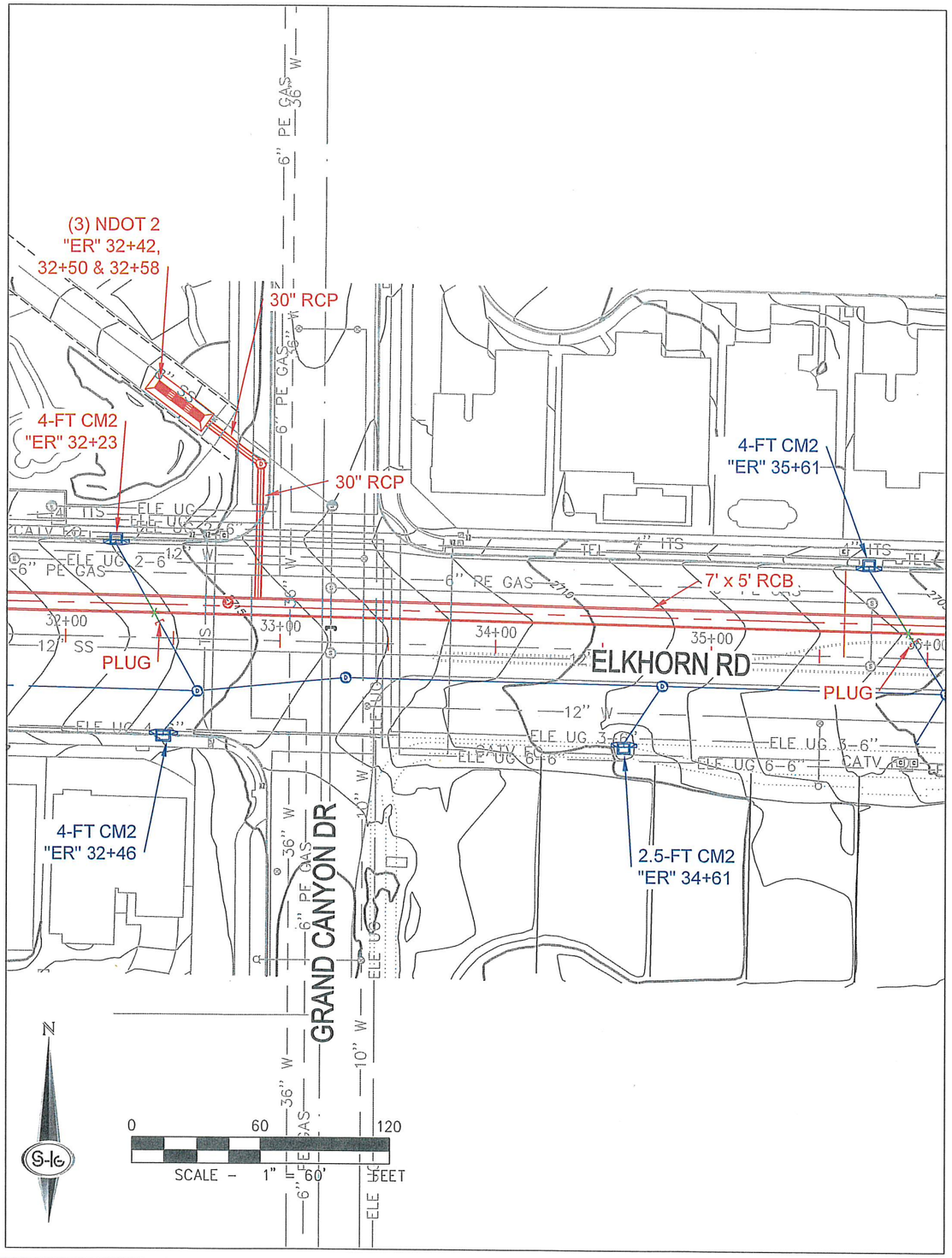
RANCHO RD SYSTEM - ELKHORN (FT APACHE TO GRAND CANYON)
GRAND CANYON AND ELKHORN ALTERNATIVES

DATE:	AUG 2012
DRAFTER:	KC
DESIGNER:	KC
CHECKED:	MJF
PROJECT NO.	CLV1201-000

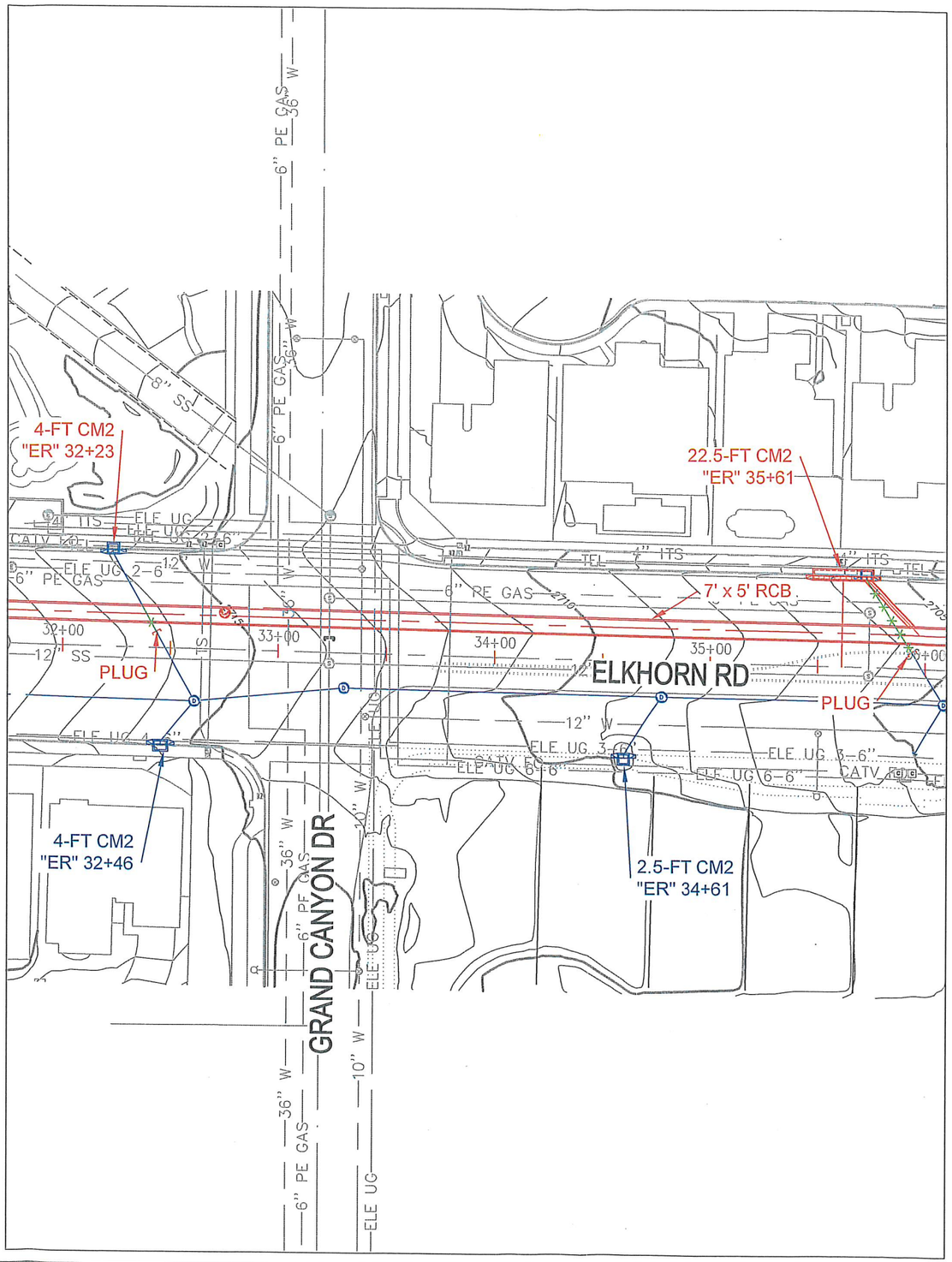
EXHIBIT I
SHEET 1 OF 1

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ALTERNATIVE 1 (RECOMMENDED)



ALTERNATIVE 2



SLATER HANIFAN GROUP
CONSULTING ENGINEERS & PLANNERS
5740 S. ARVILLE STREET #216, LAS VEGAS, NV 89118
PHONE (702) 284-5300 FAX (702) 284-5399

NO.	DESCRIPTION	DATE	BY	APP. DATE	APP.

CITY OF LAS VEGAS

RANCHO RD SYSTEM - ELKHORN (FT APACHE TO GRAND CANYON)
TEE PEE AND ELKHORN ALTERNATIVES

DATE:	AUG 2012
DRAFTER:	KC
DESIGNER:	KC
CHECKED:	MJF
PROJECT NO.	CLV1201-000

EXHIBIT J

SHEET 1 OF 1

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APPENDIX B

Street Flow Computations

Street Flows Impacting Drop Inlets

Elkhorn North Half Section A
Worksheet for Irregular Channel

Project Description	
Worksheet	Elkhorn North Half Section A
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Channel Slope	2.1000	%
Discharge	37.00	cfs

Options	
Current Roughness Method	Improved Lotter's Method
Open Channel Weighting Method	Improved Lotter's Method
Closed Channel Weighting Method	Horton's Method

Results		
Mannings Coefficient	0.013	
Water Surface Elevation	0.62	ft
Elevation Range	0.00 to 1.03	
Flow Area	6.4	ft²
Wetted Perimeter	30.29	ft
Top Width	29.71	ft
Actual Depth	0.62	ft
Critical Elevation	0.78	ft
Critical Slope	0.3914	%
Velocity	5.75	ft/s
Velocity Head	0.51	ft
Specific Energy	1.14	ft
Froude Number	2.18	
Flow Type	Supercritical	

Calculation Messages:
Water elevation exceeds lowest end station by 0.24255028e-1 ft.

Roughness Segments

Start Station	End Station	Mannings Coefficient
0+00.00	0+07.00	0.016
0+07.00	0+50.00	0.013

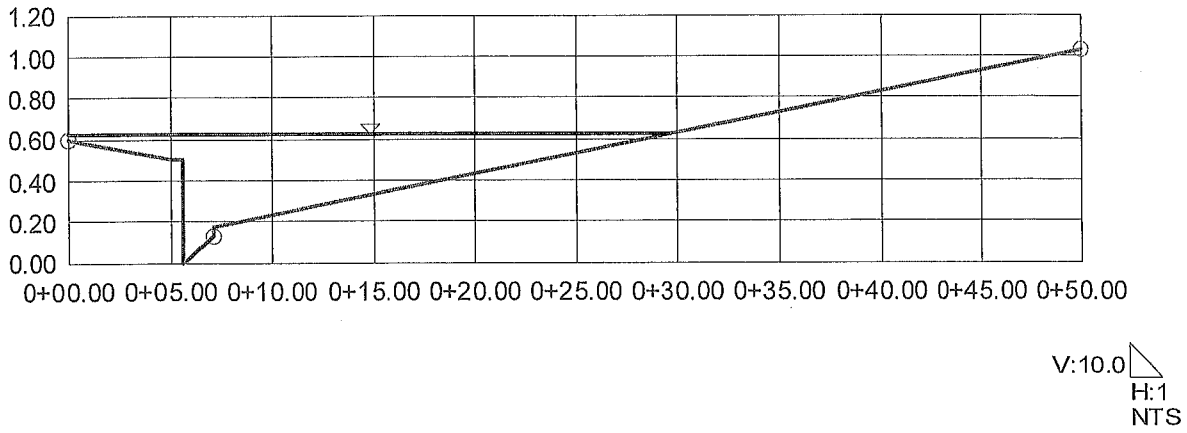
Natural Channel Points

Station (ft)	Elevation (ft)
0+00.00	0.60
0+05.00	0.50
0+05.50	0.50
0+05.50	0.00
0+07.00	0.13
0+07.00	0.17
0+50.00	1.03

Elkhorn North Half Section A
Cross Section for Irregular Channel

Project Description	
Worksheet	Elkhorn North Half Section A
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Channel Depth

Section Data		
Mannings Coefficient	0.013	
Channel Slope	2.1000	%
Water Surface Elevation	0.62	ft
Elevation Range	0.00 to 1.03	
Discharge	37.00	cfs



Elkhorn South Half Section A
Worksheet for Irregular Channel

Project Description	
Worksheet	Elkhorn South Half Section A
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Channel Slope	2.1000	%
Discharge	8.00	cfs

Options	
Current Roughness Method	Improved Lotter's Method
Open Channel Weighting Method	Improved Lotter's Method
Closed Channel Weighting Method	Horton's Method

Results		
Mannings Coefficient	0.013	
Water Surface Elevation	0.40	ft
Elevation Range	0.00 to 1.03	
Flow Area	1.8	ft²
Wetted Perimeter	13.48	ft
Top Width	13.04	ft
Actual Depth	0.40	ft
Critical Elevation	0.49	ft
Critical Slope	0.4540	%
Velocity	4.36	ft/s
Velocity Head	0.30	ft
Specific Energy	0.70	ft
Froude Number	2.05	
Flow Type	Supercritical	

Roughness Segments

Start Station	End Station	Mannings Coefficient
0+50.00	0+93.00	0.013
0+93.00	1+00.00	0.016

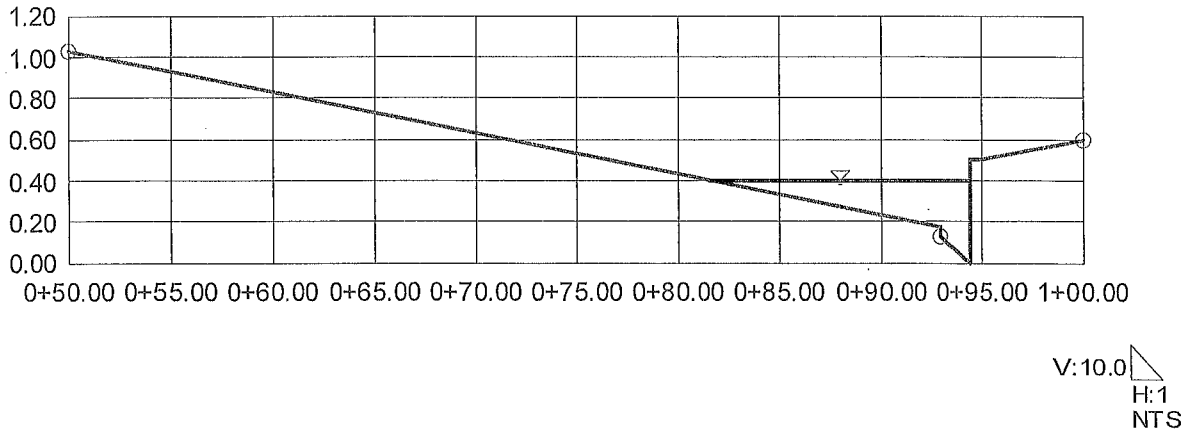
Natural Channel Points

Station (ft)	Elevation (ft)
0+50.00	1.03
0+93.00	0.17
0+93.00	0.13
0+94.50	0.00
0+94.50	0.50
0+95.00	0.50
1+00.00	0.60

Elkhorn South Half Section A
Cross Section for Irregular Channel

Project Description	
Worksheet	Elkhorn South Half Section A
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Channel Depth

Section Data		
Mannings Coefficient	0.013	
Channel Slope	2.1000	%
Water Surface Elevation	0.40	ft
Elevation Range	0.00 to 1.03	
Discharge	8.00	cfs



Elkhorn South Half Section B
Worksheet for Irregular Channel

Project Description	
Worksheet	Elkhorn South Half Section B
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Channel Slope	3.4000	%
Discharge	2.00	cfs

Options	
Current Roughness Method	Improved Lotter's Method
Open Channel Weighting Method	Improved Lotter's Method
Closed Channel Weighting Method	Horton's Method

Results		
Mannings Coefficient	0.014	
Water Surface Elevation	0.27	ft
Elevation Range	0.00 to 1.03	
Flow Area	0.5	ft²
Wetted Perimeter	6.68	ft
Top Width	6.36	ft
Actual Depth	0.27	ft
Critical Elevation	0.33	ft
Critical Slope	0.6090	%
Velocity	3.70	ft/s
Velocity Head	0.21	ft
Specific Energy	0.48	ft
Froude Number	2.24	
Flow Type	Supercritical	

Roughness Segments

Start Station	End Station	Mannings Coefficient
0+50.00	0+93.00	0.013
0+93.00	1+00.00	0.016

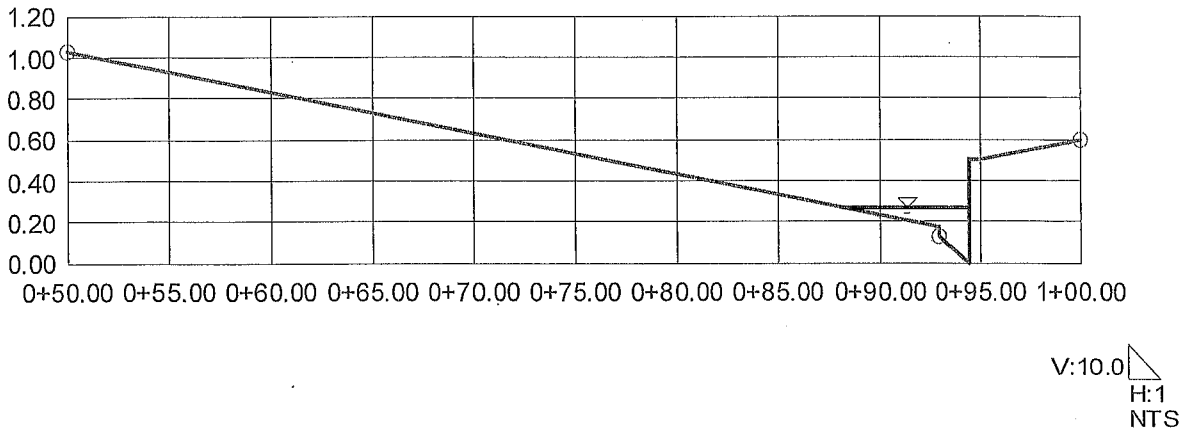
Natural Channel Points

Station (ft)	Elevation (ft)
0+50.00	1.03
0+93.00	0.17
0+93.00	0.13
0+94.50	0.00
0+94.50	0.50
0+95.00	0.50
1+00.00	0.60

Elkhorn South Half Section B
Cross Section for Irregular Channel

Project Description	
Worksheet	Elkhorn South Half Section B
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Channel Depth

Section Data	
Mannings Coefficient	0.014
Channel Slope	3.4000 %
Water Surface Elevation	0.27 ft
Elevation Range	0.00 to 1.03
Discharge	2.00 cfs



Elkhorn North Half Section C
Worksheet for Irregular Channel

Project Description	
Worksheet	Elkhorn North Half Section C
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Channel Slope	3.4000	%
Discharge	1.50	cfs

Options	
Current Roughness Method	Improved Lotter's Method
Open Channel Weighting Method	Improved Lotter's Method
Closed Channel Weighting Method	Horton's Method

Results		
Mannings Coefficient	0.014	
Water Surface Elevation	0.25	ft
Elevation Range	0.00 to 1.55	
Flow Area	0.4	ft²
Wetted Perimeter	4.40	ft
Top Width	4.10	ft
Actual Depth	0.25	ft
Critical Elevation	0.32	ft
Critical Slope	0.6487	%
Velocity	3.83	ft/s
Velocity Head	0.23	ft
Specific Energy	0.48	ft
Froude Number	2.19	
Flow Type	Supercritical	

Roughness Segments

Start Station	End Station	Mannings Coefficient
0+00.00	0+07.00	0.016
0+07.00	0+50.00	0.013

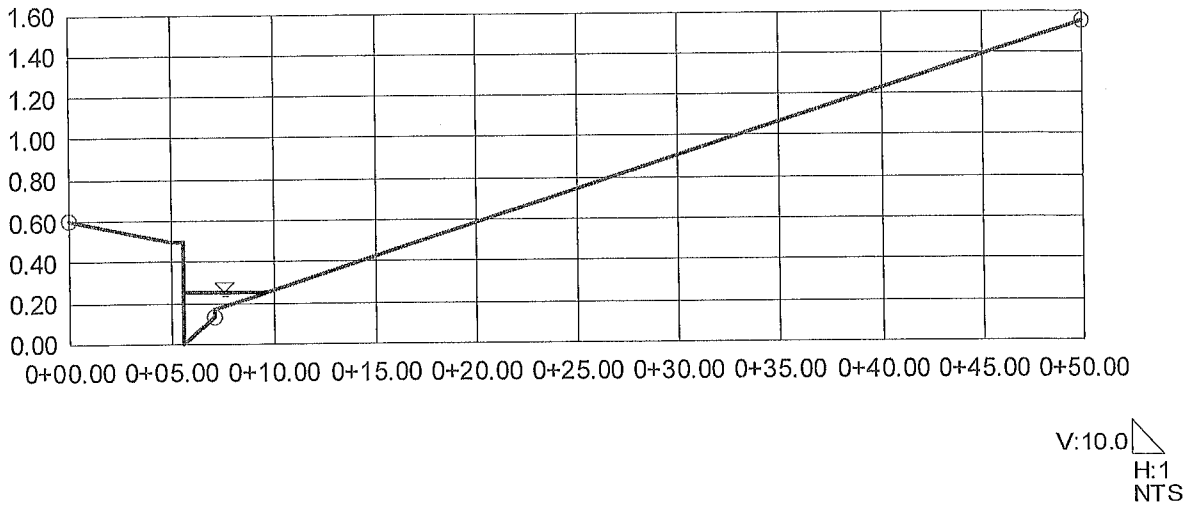
Natural Channel Points

Station (ft)	Elevation (ft)
0+00.00	0.60
0+05.00	0.50
0+05.50	0.50
0+05.50	0.00
0+07.00	0.13
0+07.00	0.17
0+50.00	1.55

Elkhorn North Half Section C
Cross Section for Irregular Channel

Project Description	
Worksheet	Elkhorn North Half Section C
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Channel Depth

Section Data		
Mannings Coefficient	0.014	
Channel Slope	3.4000	%
Water Surface Elevation	0.25	ft
Elevation Range	0.00 to 1.55	
Discharge	1.50	cfs



Elkhorn North Half Section D
Worksheet for Irregular Channel

Project Description	
Worksheet	Elkhorn North Half Section D
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Channel Slope	3.4000	%
Discharge	1.50	cfs

Options	
Current Roughness Method	Improved Lotter's Method
Open Channel Weighting Method	Improved Lotter's Method
Closed Channel Weighting Method	Horton's Method

Results		
Mannings Coefficient	0.014	
Water Surface Elevation	0.25	ft
Elevation Range	0.00 to 1.72	
Flow Area	0.4	ft²
Wetted Perimeter	4.15	ft
Top Width	3.84	ft
Actual Depth	0.25	ft
Critical Elevation	0.33	ft
Critical Slope	0.6440	%
Velocity	3.91	ft/s
Velocity Head	0.24	ft
Specific Energy	0.49	ft
Froude Number	2.19	
Flow Type	Supercritical	

Roughness Segments

Start Station	End Station	Mannings Coefficient
0+00.00	0+07.00	0.016
0+07.00	0+50.00	0.013

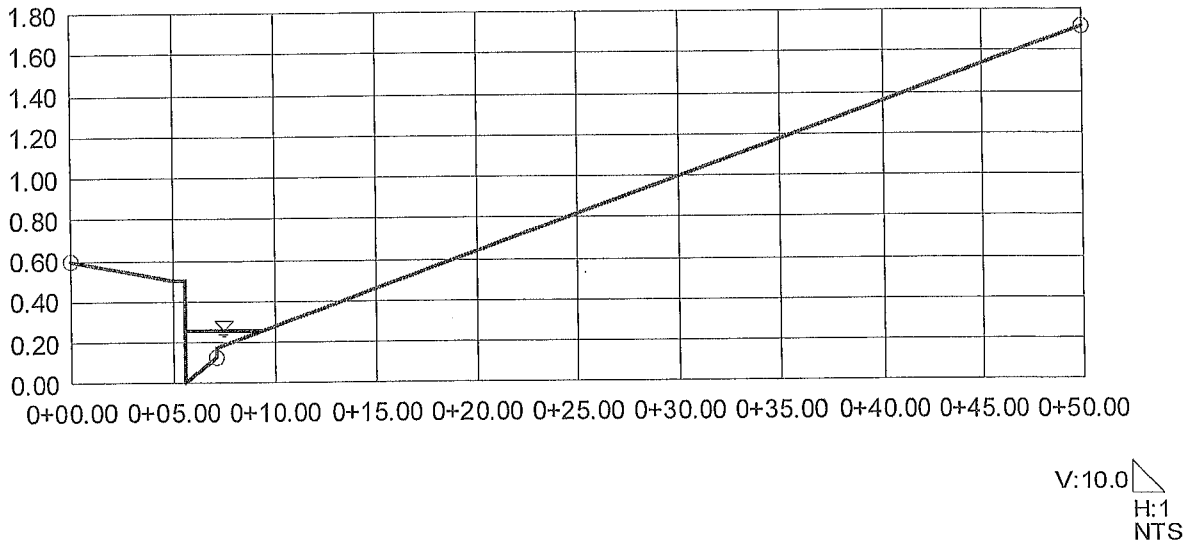
Natural Channel Points

Station (ft)	Elevation (ft)
0+00.00	0.60
0+05.00	0.50
0+05.50	0.50
0+05.50	0.00
0+07.00	0.13
0+07.00	0.17
0+50.00	1.72

Elkhorn North Half Section D
Cross Section for Irregular Channel

Project Description	
Worksheet	Elkhorn North Half Section D
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Channel Depth

Section Data	
Mannings Coefficient	0.014
Channel Slope	3.4000 %
Water Surface Elevation	0.25 ft
Elevation Range	0.00 to 1.72
Discharge	1.50 cfs



Elkhorn South Half Section D
Worksheet for Irregular Channel

Project Description	
Worksheet	Elkhorn South Half Section D
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Channel Slope	3.4000	%
Discharge	2.50	cfs

Options	
Current Roughness Method	Improved Lotter's Method
Open Channel Weighting Method	Improved Lotter's Method
Closed Channel Weighting Method	Horton's Method

Results		
Mannings Coefficient	0.014	
Water Surface Elevation	0.29	ft
Elevation Range	0.00 to 1.29	
Flow Area	0.6	ft²
Wetted Perimeter	6.41	ft
Top Width	6.07	ft
Actual Depth	0.29	ft
Critical Elevation	0.37	ft
Critical Slope	0.5810	%
Velocity	4.11	ft/s
Velocity Head	0.26	ft
Specific Energy	0.55	ft
Froude Number	2.29	
Flow Type	Supercritical	

Roughness Segments

Start Station	End Station	Mannings Coefficient
0+50.00	0+93.00	0.013
0+93.00	1+00.00	0.016

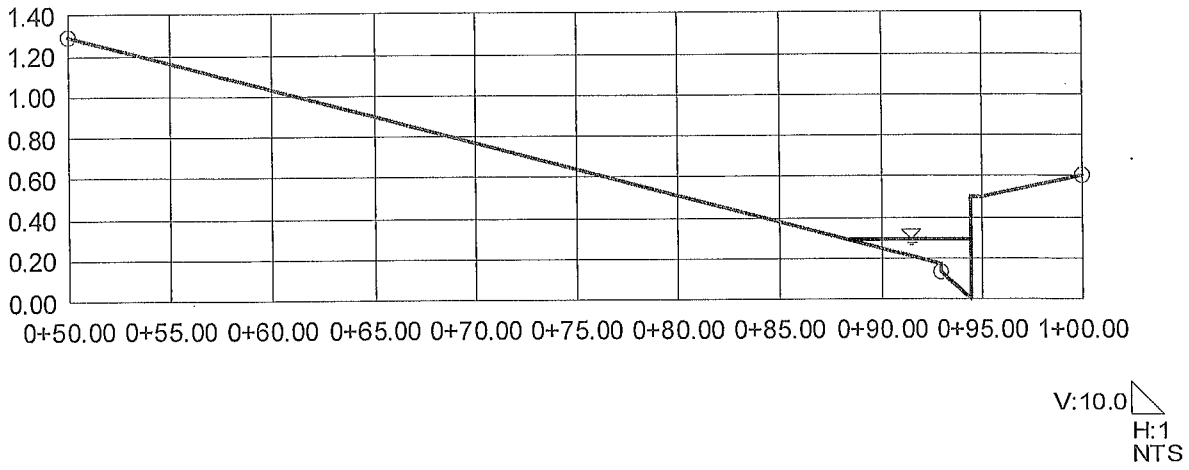
Natural Channel Points

Station (ft)	Elevation (ft)
0+50.00	1.29
0+93.00	0.17
0+93.00	0.13
0+94.50	0.00
0+94.50	0.50
0+95.00	0.50
1+00.00	0.60

Elkhorn South Half Section D
Cross Section for Irregular Channel

Project Description	
Worksheet	Elkhorn South Half Section D
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Channel Depth

Section Data		
Mannings Coefficient	0.014	
Channel Slope	3.4000	%
Water Surface Elevation	0.29	ft
Elevation Range	0.00 to 1.29	
Discharge	2.50	cfs



Elkhorn North Half Section E
Worksheet for Irregular Channel

Project Description	
Worksheet	Elkhorn North Half Section E
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Channel Slope	3.4000	%
Discharge	4.00	cfs

Options	
Current Roughness Method	Improved Lotter's Method
Open Channel Weighting Method	Improved Lotter's Method
Closed Channel Weighting Method	Horton's Method

Results		
Mannings Coefficient	0.013	
Water Surface Elevation	0.34	ft
Elevation Range	0.00 to 1.89	
Flow Area	0.8	ft²
Wetted Perimeter	6.10	ft
Top Width	5.71	ft
Actual Depth	0.34	ft
Critical Elevation	0.46	ft
Critical Slope	0.4721	%
Velocity	5.24	ft/s
Velocity Head	0.43	ft
Specific Energy	0.76	ft
Froude Number	2.52	
Flow Type	Supercritical	

Roughness Segments

Start Station	End Station	Mannings Coefficient
0+00.00	0+07.00	0.016
0+07.00	0+50.00	0.013

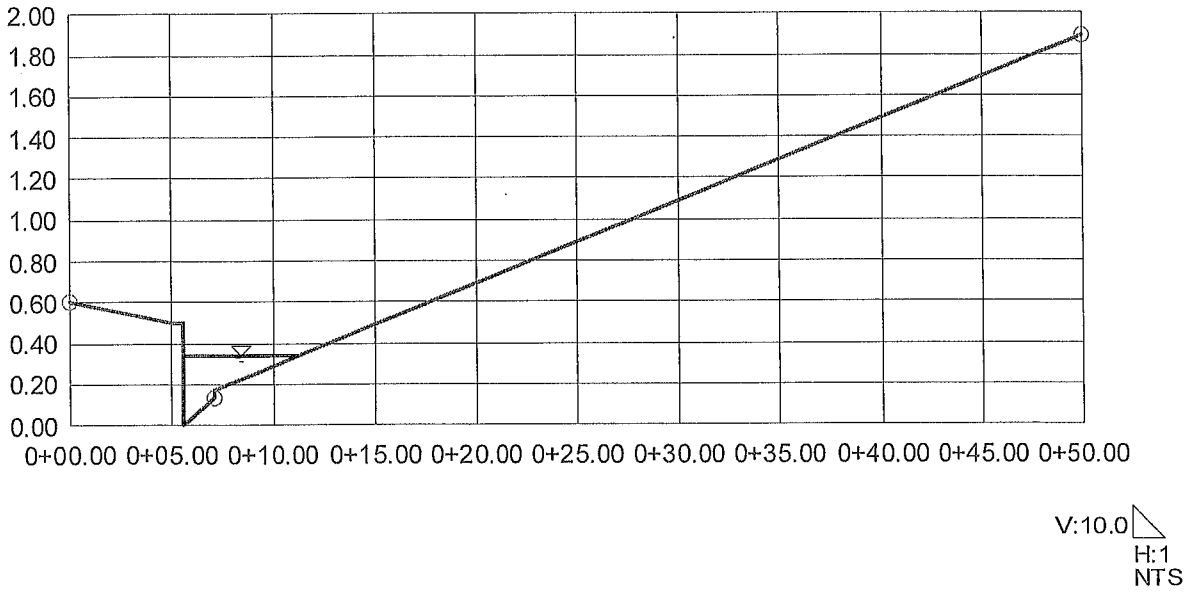
Natural Channel Points

Station (ft)	Elevation (ft)
0+00.00	0.60
0+05.00	0.50
0+05.50	0.50
0+05.50	0.00
0+07.00	0.13
0+07.00	0.17
0+50.00	1.89

Elkhorn North Half Section E
Cross Section for Irregular Channel

Project Description	
Worksheet	Elkhorn North Half Section E
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Channel Depth

Section Data		
Mannings Coefficient	0.013	
Channel Slope	3.4000	%
Water Surface Elevation	0.34	ft
Elevation Range	0.00 to 1.89	
Discharge	4.00	cfs



Elkhorn South Half Section E
Worksheet for Irregular Channel

Project Description	
Worksheet	Elkhorn South Half Section E
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Channel Slope	3.4000	%
Discharge	6.50	cfs

Options	
Current Roughness Method	Improved Lotter's Method
Open Channel Weighting Method	Improved Lotter's Method
Closed Channel Weighting Method	Horton's Method

Results		
Mannings Coefficient	0.013	
Water Surface Elevation	0.38	ft
Elevation Range	0.00 to 1.46	
Flow Area	1.2	ft²
Wetted Perimeter	8.84	ft
Top Width	8.42	ft
Actual Depth	0.38	ft
Critical Elevation	0.51	ft
Critical Slope	0.4608	%
Velocity	5.48	ft/s
Velocity Head	0.47	ft
Specific Energy	0.84	ft
Froude Number	2.57	
Flow Type	Supercritical	

Roughness Segments

Start Station	End Station	Mannings Coefficient
0+50.00	0+93.00	0.013
0+93.00	1+00.00	0.016

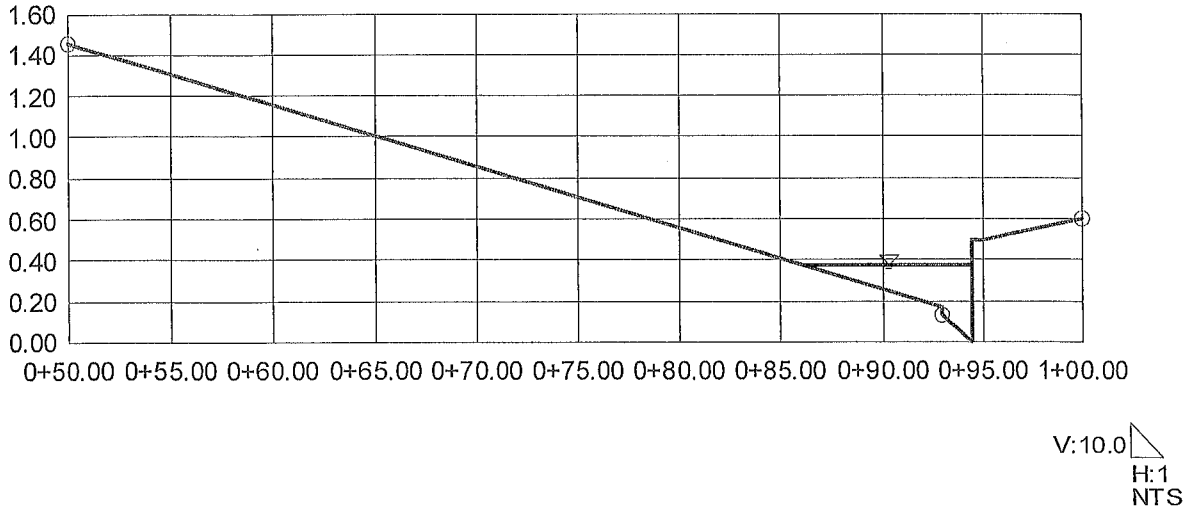
Natural Channel Points

Station (ft)	Elevation (ft)
0+50.00	1.46
0+93.00	0.17
0+93.00	0.13
0+94.50	0.00
0+94.50	0.50
0+95.00	0.50
1+00.00	0.60

Elkhorn South Half Section E
Cross Section for Irregular Channel

Project Description	
Worksheet	Elkhorn South Half Section E
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Channel Depth

Section Data		
Mannings Coefficient	0.013	
Channel Slope	3.4000	%
Water Surface Elevation	0.38	ft
Elevation Range	0.00 to 1.46	
Discharge	6.50	cfs



Elkhorn North Half Section F
Worksheet for Irregular Channel

Project Description	
Worksheet	Elkhorn North Half Section F
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Channel Slope	3.4000	%
Discharge	3.00	cfs

Options	
Current Roughness Method	Improved Lotter's Method
Open Channel Weighting Method	Improved Lotter's Method
Closed Channel Weighting Method	Horton's Method

Results		
Mannings Coefficient	0.014	
Water Surface Elevation	0.31	ft
Elevation Range	0.00 to 1.46	
Flow Area	0.7	ft²
Wetted Perimeter	6.45	ft
Top Width	6.09	ft
Actual Depth	0.31	ft
Critical Elevation	0.40	ft
Critical Slope	0.5627	%
Velocity	4.41	ft/s
Velocity Head	0.30	ft
Specific Energy	0.61	ft
Froude Number	2.33	
Flow Type	Supercritical	

Roughness Segments

Start Station	End Station	Mannings Coefficient
0+00.00	0+07.00	0.016
0+07.00	0+50.00	0.013

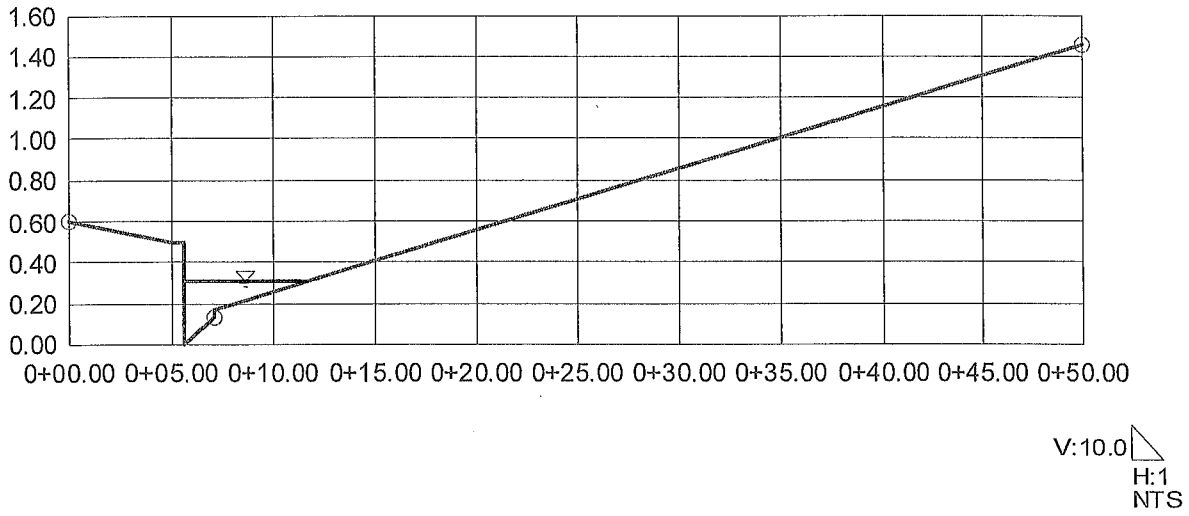
Natural Channel Points

Station (ft)	Elevation (ft)
0+00.00	0.60
0+05.00	0.50
0+05.50	0.50
0+05.50	0.00
0+07.00	0.13
0+07.00	0.17
0+50.00	1.46

Elkhorn North Half Section F
Cross Section for Irregular Channel

Project Description	
Worksheet	Elkhorn North Half Section F
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Channel Depth

Section Data		
Mannings Coefficient	0.014	
Channel Slope	3.4000	%
Water Surface Elevation	0.31	ft
Elevation Range	0.00 to 1.46	
Discharge	3.00	cfs



Elkhorn South Half Section F
Worksheet for Irregular Channel

Project Description	
Worksheet	Elkhorn South Half Section F
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Channel Slope	3.4000	%
Discharge	8.00	cfs

Options	
Current Roughness Method	Improved Lotter's Method
Open Channel Weighting Method	Improved Lotter's Method
Closed Channel Weighting Method	Horton's Method

Results		
Mannings Coefficient	0.013	
Water Surface Elevation	0.39	ft
Elevation Range	0.00 to 1.25	
Flow Area	1.4	ft²
Wetted Perimeter	10.68	ft
Top Width	10.25	ft
Actual Depth	0.39	ft
Critical Elevation	0.53	ft
Critical Slope	0.4552	%
Velocity	5.53	ft/s
Velocity Head	0.47	ft
Specific Energy	0.86	ft
Froude Number	2.59	
Flow Type	Supercritical	

Roughness Segments

Start Station	End Station	Mannings Coefficient
0+50.00	0+93.00	0.013
0+93.00	1+00.00	0.016

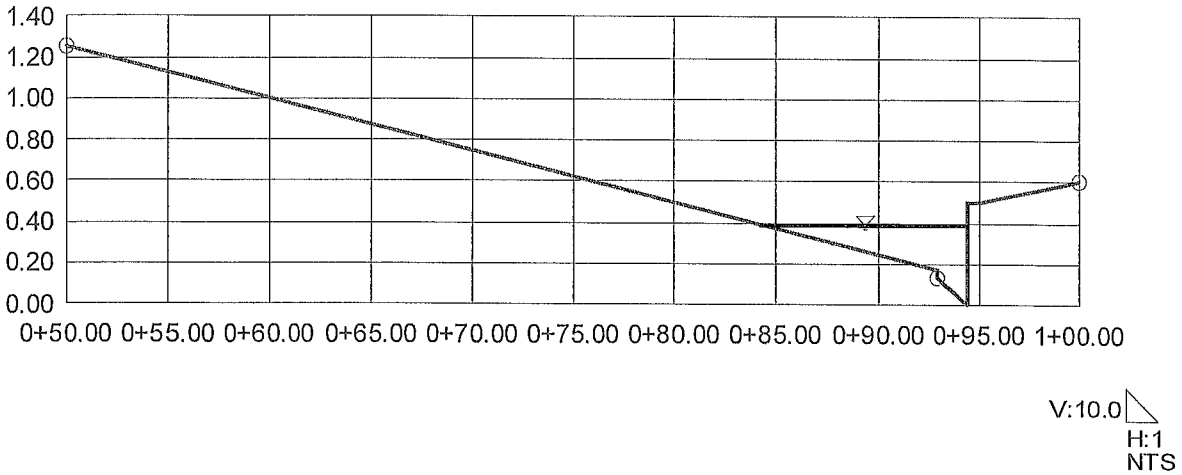
Natural Channel Points

Station (ft)	Elevation (ft)
0+50.00	1.25
0+93.00	0.17
0+93.00	0.13
0+94.50	0.00
0+94.50	0.50
0+95.00	0.50
1+00.00	0.60

Elkhorn South Half Section F
Cross Section for Irregular Channel

Project Description	
Worksheet	Elkhorn South Half Section F
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Channel Depth

Section Data		
Mannings Coefficient	0.013	
Channel Slope	3.4000	%
Water Surface Elevation	0.39	ft
Elevation Range	0.00 to 1.25	
Discharge	8.00	cfs



Grand Canyon West Half Section H
Worksheet for Irregular Channel

Project Description	
Worksheet	Grand Canyon West Half Section H
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Channel Slope	0.5000	%
Discharge	64.00	cfs

Options	
Current Roughness Method	Improved Lotter's Method
Open Channel Weighting Method	Improved Lotter's Method
Closed Channel Weighting Method	Horton's Method

Results		
Mannings Coefficient	0.019	
Water Surface Elevation	0.90	ft
Elevation Range	0.00 to 0.83	
Flow Area	19.4	ft²
Wetted Perimeter	40.46	ft
Top Width	40.00	ft
Actual Depth	0.90	ft
Critical Elevation	0.85	ft
Critical Slope	0.7421	%
Velocity	3.30	ft/s
Velocity Head	0.17	ft
Specific Energy	1.07	ft
Froude Number	0.84	
Flow Type	Subcritical	

Calculation Messages:
Water elevation exceeds lowest end station by 0.35496255 ft.

Roughness Segments		
Start Station	End Station	Mannings Coefficient
0+40.00	0+54.00	0.016
0+54.00	0+80.00	0.022

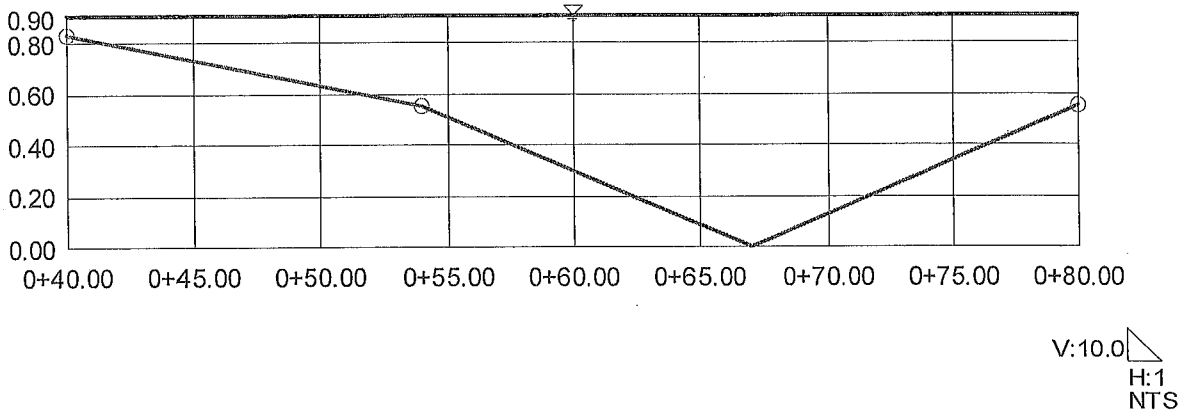
Natural Channel Points	
Station (ft)	Elevation (ft)
0+40.00	0.83
0+54.00	0.55
0+67.00	0.00
0+80.00	0.55

Notes: Note that the improvement plans of Grand Canyon show the future roadway improvement and not any interim roadway swale. A 33-ft patent easment is assumed.

Grand Canyon West Half Section H
Cross Section for Irregular Channel

Project Description	
Worksheet	Grand Canyon West Half Section H
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Channel Depth

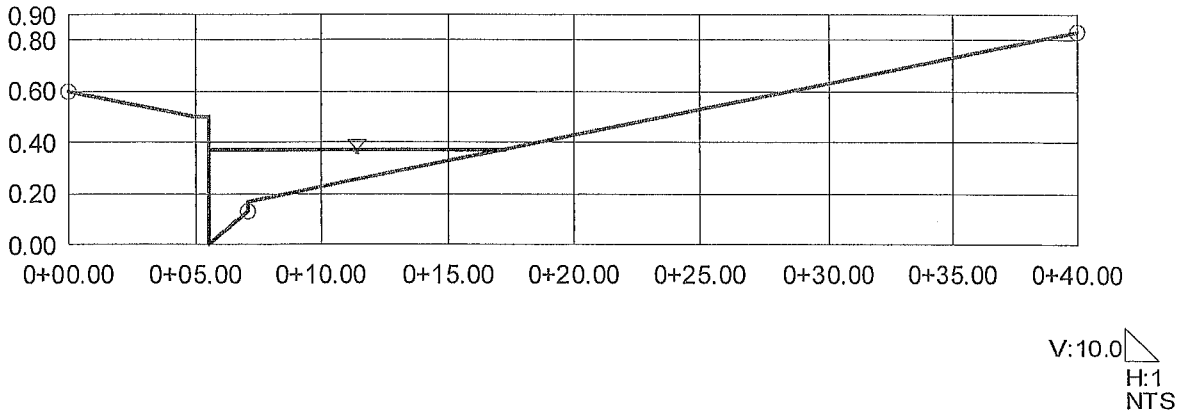
Section Data		
Mannings Coefficient	0.019	
Channel Slope	0.5000	%
Water Surface Elevation	0.90	ft
Elevation Range	0.00 to 0.83	
Discharge	64.00	cfs



Grand Canyon East Half Section H
Cross Section for Irregular Channel

Project Description	
Worksheet	Grand Canyon East Half Section H
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Channel Depth

Section Data		
Mannings Coefficient	0.013	
Channel Slope	0.5000	%
Water Surface Elevation	0.38	ft
Elevation Range	0.00 to 0.83	
Discharge	3.00	cfs



10-Year Maximum Street Flow Capacities

10-yr Capacity - Elkhorn North Half Grand Canyon to Tee Pee - 2.0% Cross Slope
Worksheet for Irregular Channel

Project Description	
Worksheet	10-yr Capacity - Elkhorn North Half Grand Canyon to Tee Pee - 2.0% Cross Slope
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Discharge

Input Data	
Channel Slope	3.4000 %
Water Surface Elevation	0.65 ft

Options	
Current Roughness Method	Improved Lotter's Method
Open Channel Weighting Method	Improved Lotter's Method
Closed Channel Weighting Method	Horton's Method

Results		
Mannings Coefficient	0.013	
Elevation Range	0.00 to 1.03	
Discharge	56.00	cfs
Flow Area	7.3	ft²
Wetted Perimeter	31.74	ft
Top Width	31.14	ft
Actual Depth	0.65	ft
Critical Elevation	0.89	ft
Critical Slope	0.3724	%
Velocity	7.67	ft/s
Velocity Head	0.92	ft
Specific Energy	1.57	ft
Froude Number	2.79	
Flow Type	Supercritical	

Calculation Messages:
Water elevation exceeds lowest end station by 0.5271829e-1 ft.

Roughness Segments		
Start Station	End Station	Mannings Coefficient
0+00.00	0+07.00	0.016
0+07.00	0+50.00	0.013

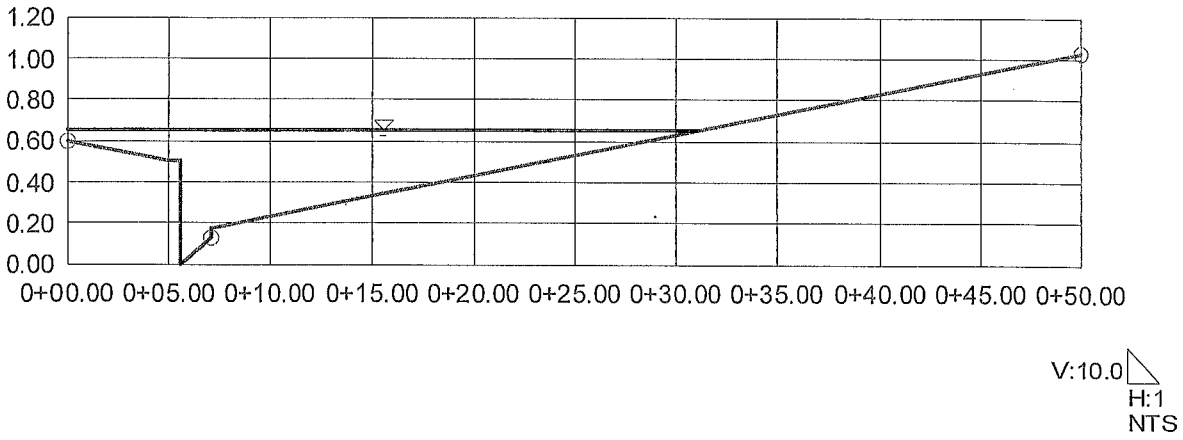
Natural Channel Points	
Station (ft)	Elevation (ft)
0+00.00	0.60
0+05.00	0.50
0+05.50	0.50
0+05.50	0.00
0+07.00	0.13
0+07.00	0.17
0+50.00	1.03

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10-yr Capacity - Elkhorn North Half Grand Canyon to Tee Pee - 2.0% Cross Slope
Cross Section for Irregular Channel

Project Description	
Worksheet	10-yr Capacity - Elkhorn North Half Grand Canyon to Tee Pee - 2.0% Cross Slope
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Discharge

Section Data		
Mannings Coefficient	0.013	
Channel Slope	3.4000	%
Water Surface Elevation	0.65	ft
Elevation Range	0.00 to 1.03	
Discharge	56.00	cfs



10-yr Capacity - Elkhorn North Half Grand Canyon to Tee Pee - 3.2% Cross Slope
Worksheet for Irregular Channel

Project Description	
Worksheet	10-yr Capacity - Elkhorn North Half Grand Canyon to Tee Pee - 3.2% Cross Slope
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Discharge

Input Data		
Channel Slope	3.4000	%
Water Surface Elevation	0.72	ft

Options	
Current Roughness Method	Improved Lotter's Method
Open Channel Weighting Method	Improved Lotter's Method
Closed Channel Weighting Method	Horton's Method

Results		
Mannings Coefficient	0.014	
Elevation Range	0.00 to 1.55	
Discharge	55.29	cfs
Flow Area	6.7	ft²
Wetted Perimeter	24.81	ft
Top Width	24.14	ft
Actual Depth	0.72	ft
Critical Elevation	1.00	ft
Critical Slope	0.3732	%
Velocity	8.31	ft/s
Velocity Head	1.07	ft
Specific Energy	1.79	ft
Froude Number	2.79	
Flow Type	Supercritical	

Calculation Messages:
Water elevation exceeds lowest end station by 0.12 ft.

Roughness Segments

Start Station	End Station	Mannings Coefficient
0+00.00	0+07.00	0.016
0+07.00	0+50.00	0.013

Natural Channel Points

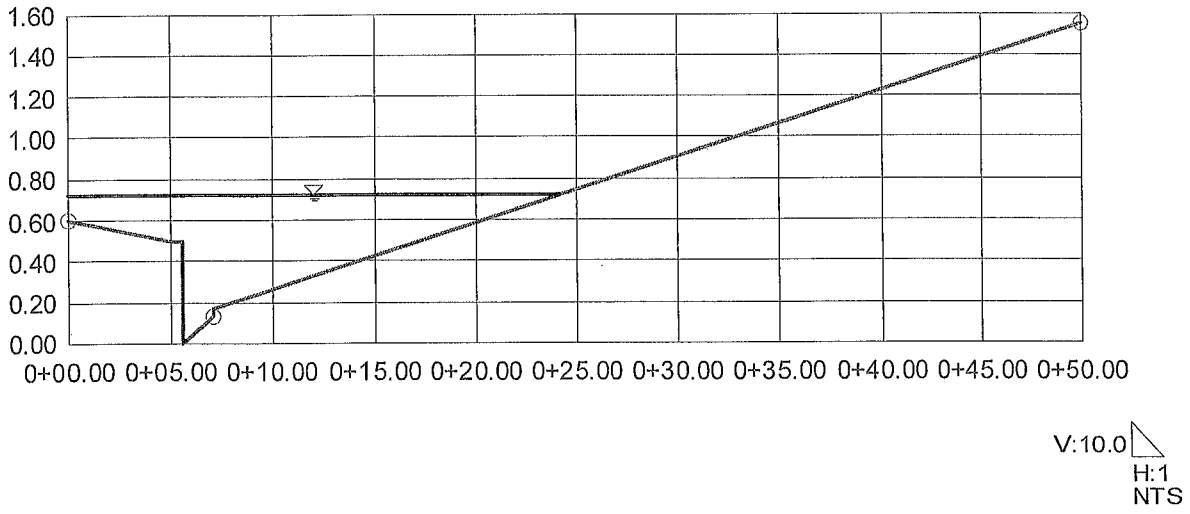
Station (ft)	Elevation (ft)
0+00.00	0.60
0+05.00	0.50
0+05.50	0.50
0+05.50	0.00
0+07.00	0.13
0+07.00	0.17
0+50.00	1.55

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10-yr Capacity - Elkhorn North Half Grand Canyon to Tee Pee - 3.2% Cross Slope
Cross Section for Irregular Channel

Project Description	
Worksheet	10-yr Capacity - Elkhorn North Half Grand Canyon to Tee Pee - 3.2% Cross Slope
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Discharge

Section Data		
Mannings Coefficient	0.014	
Channel Slope	3.4000	%
Water Surface Elevation	0.72	ft
Elevation Range	0.00 to 1.55	
Discharge	55.29	cfs



10-yr Capacity - Elkhorn North Half Grand Canyon to Tee Pee - 3.6% Cross Slope
Worksheet for Irregular Channel

Project Description	
Worksheet	10-yr Capacity - Elkhorn North Half Grand Canyon to Tee Pee - 3.6% Cross Slope
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Discharge

Input Data		
Channel Slope	3.4000	%
Water Surface Elevation	0.72	ft

Options	
Current Roughness Method	Improved Lotter's Method
Open Channel Weighting Method	Improved Lotter's Method
Closed Channel Weighting Method	Horton's Method

Results		
Mannings Coefficient	0.014	
Elevation Range	0.00 to 1.72	
Discharge	50.68	cfs
Flow Area	6.1	ft²
Wetted Perimeter	22.93	ft
Top Width	22.26	ft
Actual Depth	0.72	ft
Critical Elevation	1.00	ft
Critical Slope	0.3777	%
Velocity	8.26	ft/s
Velocity Head	1.06	ft
Specific Energy	1.78	ft
Froude Number	2.77	
Flow Type	Supercritical	

Calculation Messages:
Water elevation exceeds lowest end station by 0.12 ft.

Roughness Segments		
Start Station	End Station	Mannings Coefficient
0+00.00	0+07.00	0.016
0+07.00	0+50.00	0.013

Natural Channel Points	
Station (ft)	Elevation (ft)
0+00.00	0.60
0+05.00	0.50
0+05.50	0.50
0+05.50	0.00
0+07.00	0.13
0+07.00	0.17
0+50.00	1.72

10-yr Capacity - Elkhorn South Half Grand Canyon to Tee Pee - 2.2% Cross Slope
Worksheet for Irregular Channel

Project Description	
Worksheet	10-yr Capacity - Elkhorn South Half Grand Canyon to Tee Pee - 2.2% Cross Slope
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Discharge

Input Data		
Channel Slope	3.4000	%
Water Surface Elevation	0.70	ft

Options	
Current Roughness Method	Improved Lotter's Method
Open Channel Weighting Method	Improved Lotter's Method
Closed Channel Weighting Method	Horton's Method

Results		
Mannings Coefficient	0.014	
Elevation Range	0.00 to 1.12	
Discharge	67.03	cfs
Flow Area	8.2	ft²
Wetted Perimeter	31.64	ft
Top Width	30.99	ft
Actual Depth	0.70	ft
Critical Elevation	0.97	ft
Critical Slope	0.3652	%
Velocity	8.21	ft/s
Velocity Head	1.05	ft
Specific Energy	1.75	ft
Froude Number	2.82	
Flow Type	Supercritical	

Calculation Messages:
Water elevation exceeds lowest end station by 0.1 ft.

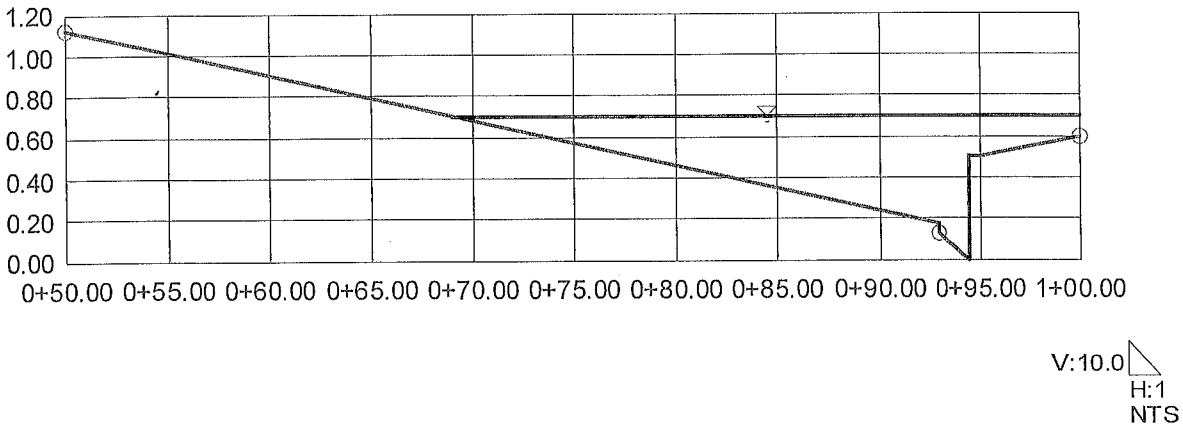
Roughness Segments		
Start Station	End Station	Mannings Coefficient
0+50.00	0+93.00	0.013
0+93.00	1+00.00	0.016

Natural Channel Points	
Station (ft)	Elevation (ft)
0+50.00	1.12
0+93.00	0.17
0+93.00	0.13
0+94.50	0.00
0+94.50	0.50
0+95.00	0.50
1+00.00	0.60

10-yr Capacity - Elkhorn South Half Grand Canyon to Tee Pee - 2.2% Cross Slope
Cross Section for Irregular Channel

Project Description	
Worksheet	10-yr Capacity - Elkhorn South Half Grand Canyon to Tee Pee - 2.2% Cross Slope
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Discharge

Section Data		
Mannings Coefficient	0.014	
Channel Slope	3.4000	%
Water Surface Elevation	0.70	ft
Elevation Range	0.00 to 1.12	
Discharge	67.03	cfs



10-yr Capacity - Elkhorn South Half Grand Canyon to Tee Pee - 2.6% Cross Slope
Worksheet for Irregular Channel

Project Description	
Worksheet	10-yr Capacity - Elkhorn South Half Grand Canyon to Tee Pee - 2.6% Cross Slope
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Discharge

Input Data		
Channel Slope	3.4000	%
Water Surface Elevation	0.71	ft

Options	
Current Roughness Method	Improved Lotter's Method
Open Channel Weighting Method	Improved Lotter's Method
Closed Channel Weighting Method	Horton's Method

Results		
Mannings Coefficient	0.014	
Elevation Range	0.00 to 1.29	
Discharge	61.79	cfs
Flow Area	7.5	ft²
Wetted Perimeter	28.40	ft
Top Width	27.73	ft
Actual Depth	0.71	ft
Critical Elevation	0.99	ft
Critical Slope	0.3682	%
Velocity	8.27	ft/s
Velocity Head	1.06	ft
Specific Energy	1.77	ft
Froude Number	2.81	
Flow Type	Supercritical	

Calculation Messages:
Water elevation exceeds lowest end station by 0.11 ft.

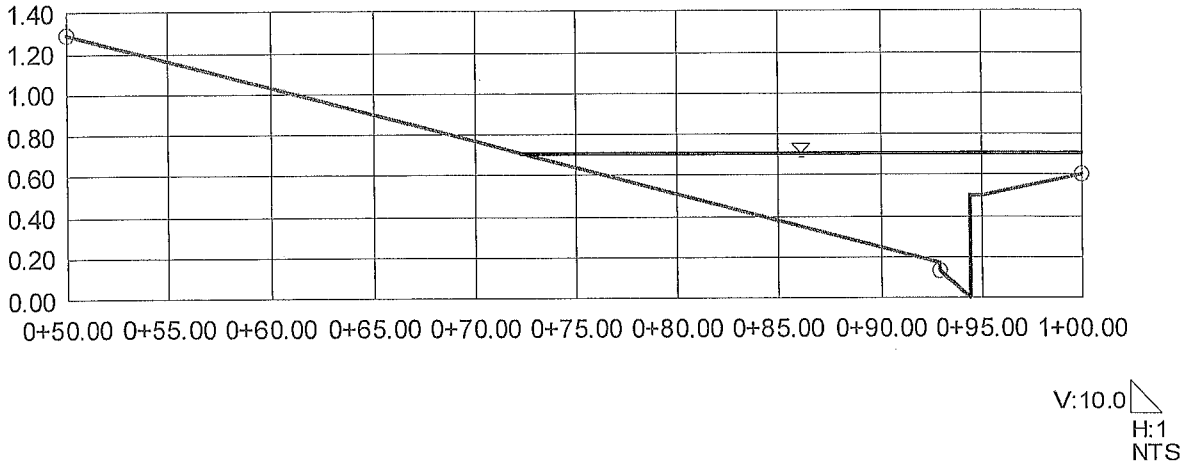
Roughness Segments		
Start Station	End Station	Mannings Coefficient
0+50.00	0+93.00	0.013
0+93.00	1+00.00	0.016

Natural Channel Points	
Station (ft)	Elevation (ft)
0+50.00	1.29
0+93.00	0.17
0+93.00	0.13
0+94.50	0.00
0+94.50	0.50
0+95.00	0.50
1+00.00	0.60

10-yr Capacity - Elkhorn South Half Grand Canyon to Tee Pee - 2.6% Cross Slope
Cross Section for Irregular Channel

Project Description	
Worksheet	10-yr Capacity - Elkhorn South Half Grand Canyon to Tee Pee - 2.6% Cross Slope
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Discharge

Section Data		
Mannings Coefficient	0.014	
Channel Slope	3.4000	%
Water Surface Elevation	0.71	ft
Elevation Range	0.00 to 1.29	
Discharge	61.79	cfs



10-yr Capacity - Elkhorn Nortth Half Tee Pee to Fort Apache - 3.0% Cross Slope
Worksheet for Irregular Channel

Project Description	
Worksheet	10-yr Capacity - Elkhorn Nortth Half Tee Pee to Fort Apache - 3.0% Cross Slope
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Discharge

Input Data		
Channel Slope	3.4000	%
Water Surface Elevation	0.72	ft

Options	
Current Roughness Method	Improved Lotter's Method
Open Channel Weighting Method	Improved Lotter's Method
Closed Channel Weighting Method	Horton's Method

Results		
Mannings Coefficient	0.014	
Elevation Range	0.00 to 1.46	
Discharge	58.22	cfs
Flow Area	7.0	ft²
Wetted Perimeter	26.01	ft
Top Width	25.33	ft
Actual Depth	0.72	ft
Critical Elevation	1.00	ft
Critical Slope	0.3708	%
Velocity	8.34	ft/s
Velocity Head	1.08	ft
Specific Energy	1.80	ft
Froude Number	2.80	
Flow Type	Supercritical	

Calculation Messages:
Water elevation exceeds lowest end station by 0.12 ft.

Roughness Segments

Start Station	End Station	Mannings Coefficient
0+00.00	0+07.00	0.016
0+07.00	0+50.00	0.013

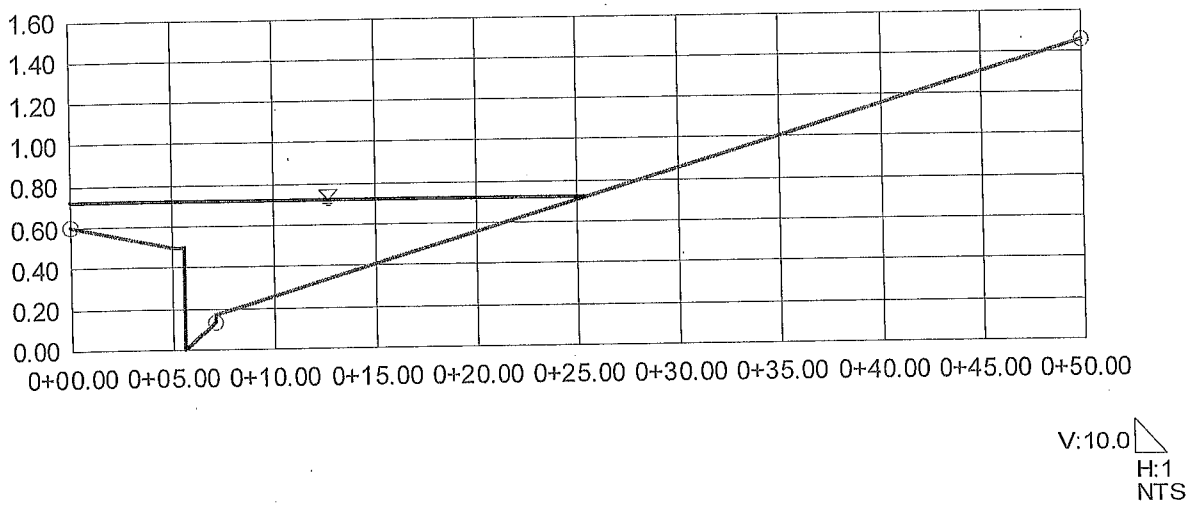
Natural Channel Points

Station (ft)	Elevation (ft)
0+00.00	0.60
0+05.00	0.50
0+05.50	0.50
0+05.50	0.00
0+07.00	0.13
0+07.00	0.17
0+50.00	1.46

10-yr Capacity - Elkhorn Nortth Half Tee Pee to Fort Apache - 3.0% Cross Slope
Cross Section for Irregular Channel

Project Description	
Worksheet	10-yr Capacity - Elkhorn Nortth Half Tee Pee to Fort Apache - 3.0% Cross Slope
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Discharge

Section Data	
Mannings Coefficient	0.014
Channel Slope	3.4000 %
Water Surface Elevation	0.72 ft
Elevation Range	0.00 to 1.46
Discharge	58.22 cfs



10-yr Capacity - Elkhorn Nortth Half Tee Pee to Fort Apache - 3.5% Cross Slope
Worksheet for Irregular Channel

Project Description	
Worksheet	10-yr Capacity - Elkhorn Nortth Half Tee Pee to Fort Apache - 3.5% Cross Slope
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Discharge

Input Data	
Channel Slope	3.4000 %
Water Surface Elevation	0.72 ft

Options	
Current Roughness Method	Improved Lotter's Method
Open Channel Weighting Method	Improved Lotter's Method
Closed Channel Weighting Method	Horton's Method

Results	
Mannings Coefficient	0.014
Elevation Range	0.00 to 1.68
Discharge	51.67 cfs
Flow Area	6.2 ft²
Wetted Perimeter	23.34 ft
Top Width	22.66 ft
Actual Depth	0.72 ft
Critical Elevation	1.00 ft
Critical Slope	0.3767 %
Velocity	8.27 ft/s
Velocity Head	1.06 ft
Specific Energy	1.78 ft
Froude Number	2.78
Flow Type	Supercritical

Calculation Messages:
Water elevation exceeds lowest end station by 0.12 ft.

Roughness Segments

Start Station	End Station	Mannings Coefficient
0+00.00	0+07.00	0.016
0+07.00	0+50.00	0.013

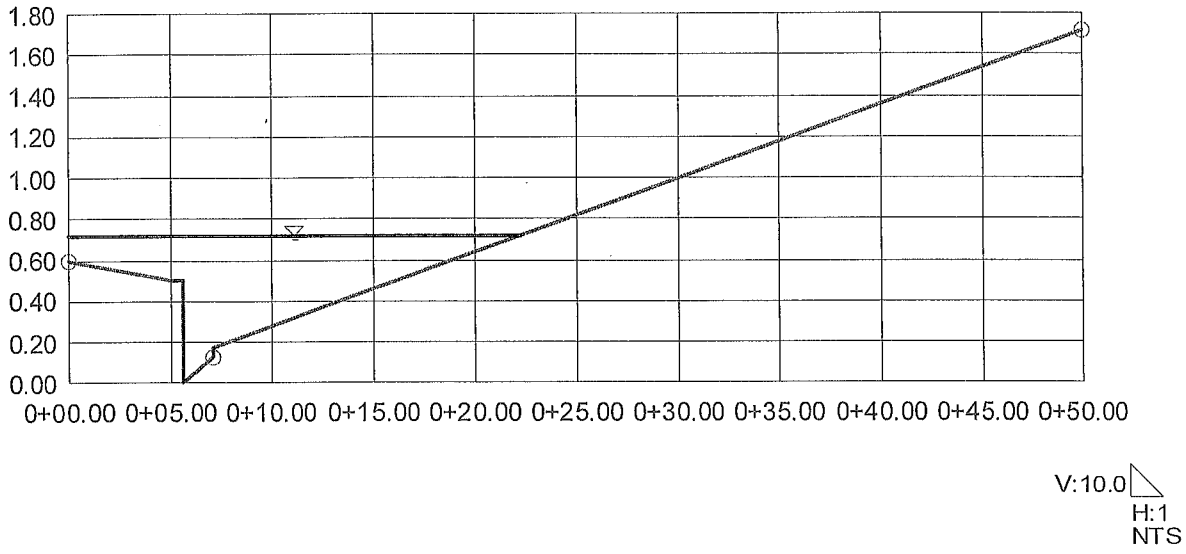
Natural Channel Points

Station (ft)	Elevation (ft)
0+00.00	0.60
0+05.00	0.50
0+05.50	0.50
0+05.50	0.00
0+07.00	0.13
0+07.00	0.17
0+50.00	1.68

10-yr Capacity - Elkhorn North Half Grand Canyon to Tee Pee - 3.6% Cross Slope
Cross Section for Irregular Channel

Project Description	
Worksheet	10-yr Capacity - Elkhorn North Half Grand Canyon to Tee Pee - 3.6% Cross Slope
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Discharge

Section Data		
Mannings Coefficient	0.014	
Channel Slope	3.4000	%
Water Surface Elevation	0.72	ft
Elevation Range	0.00 to 1.72	
Discharge	50.68	cfs



10-yr Capacity - Elkhorn South Half Grand Canyon to Tee Pee - 2.0% Cross Slope
Worksheet for Irregular Channel

Project Description	
Worksheet	10-yr Capacity - Elkhorn South Half Grand Canyon to Tee Pee - 2.0% Cross Slope
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Discharge

Input Data		
Channel Slope	3.4000	%
Water Surface Elevation	0.65	ft

Options	
Current Roughness Method	Improved Lotter's Method
Open Channel Weighting Method	Improved Lotter's Method
Closed Channel Weighting Method	Horton's Method

Results		
Mannings Coefficient	0.013	
Elevation Range	0.00 to 1.03	
Discharge	55.11	cfs
Flow Area	7.2	ft²
Wetted Perimeter	31.60	ft
Top Width	31.00	ft
Actual Depth	0.65	ft
Critical Elevation	0.89	ft
Critical Slope	0.3730	%
Velocity	7.64	ft/s
Velocity Head	0.91	ft
Specific Energy	1.56	ft
Froude Number	2.79	
Flow Type	Supercritical	

Calculation Messages:
Water elevation exceeds lowest end station by 0.05 ft.

Roughness Segments

Start Station	End Station	Mannings Coefficient
0+50.00	0+93.00	0.013
0+93.00	1+00.00	0.016

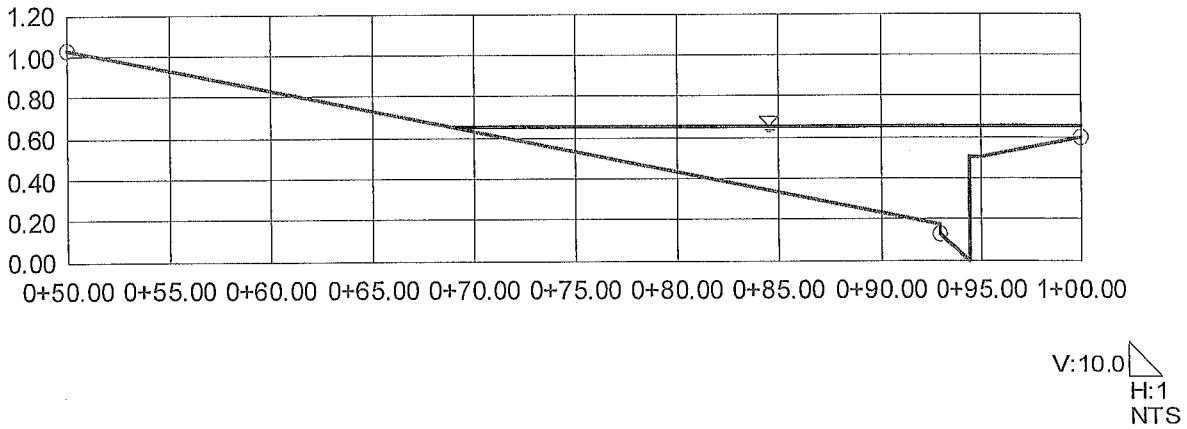
Natural Channel Points

Station (ft)	Elevation (ft)
0+50.00	1.03
0+93.00	0.17
0+93.00	0.13
0+94.50	0.00
0+94.50	0.50
0+95.00	0.50
1+00.00	0.60

10-yr Capacity - Elkhorn South Half Grand Canyon to Tee Pee - 2.0% Cross Slope
Cross Section for Irregular Channel

Project Description	
Worksheet	10-yr Capacity - Elkhorn South Half Grand Canyon to Tee Pee - 2.0% Cross Slope
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Discharge

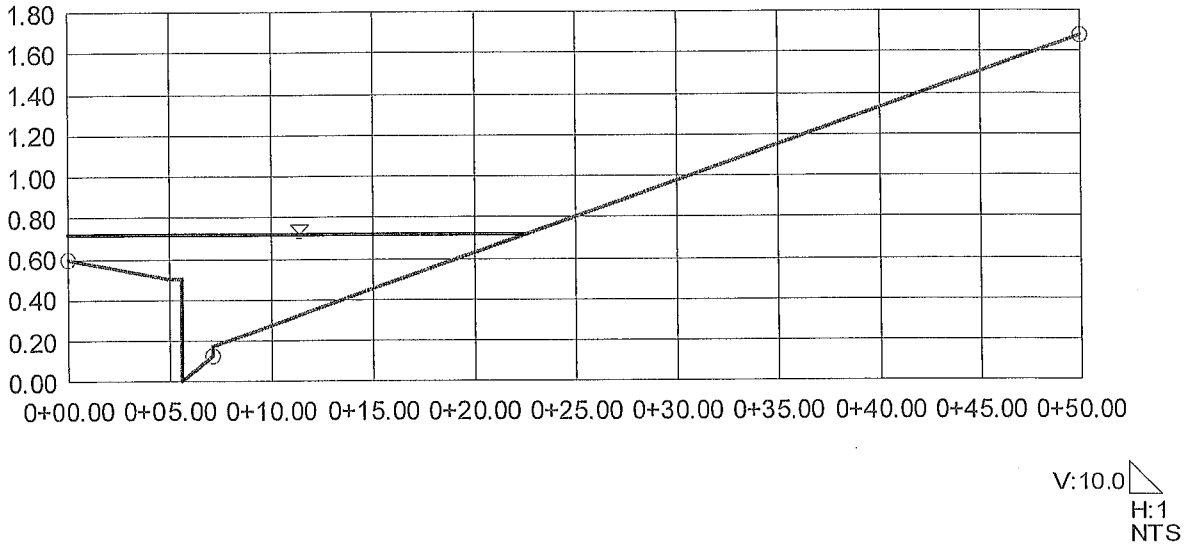
Section Data		
Mannings Coefficient	0.013	
Channel Slope	3.4000	%
Water Surface Elevation	0.65	ft
Elevation Range	0.00 to 1.03	
Discharge	55.11	cfs



10-yr Capacity - Elkhorn Nortth Half Tee Pee to Fort Apache - 3.5% Cross Slope
Cross Section for Irregular Channel

Project Description	
Worksheet	10-yr Capacity - Elkhorn Nortth Half Tee Pee to Fort Apache - 3.5% Cross Slope
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Discharge

Section Data	
Mannings Coefficient	0.014
Channel Slope	3.4000 %
Water Surface Elevation	0.72 ft
Elevation Range	0.00 to 1.68
Discharge	51.67 cfs



10-yr Capacity - Elkhorn Nortth Half Tee Pee to Fort Apache - 4.0% Cross Slope
Worksheet for Irregular Channel

Project Description	
Worksheet	10-yr Capacity - Elkhorn Nortth Half Tee Pee to Fort Apache - 4.0% Cross Slope
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Discharge

Input Data		
Channel Slope	3.4000	%
Water Surface Elevation	0.72	ft

Options	
Current Roughness Method	Improved Lotter's Method
Open Channel Weighting Method	Improved Lotter's Method
Closed Channel Weighting Method	Horton's Method

Results		
Mannings Coefficient	0.014	
Elevation Range	0.00 to 1.89	
Discharge	46.98	cfs
Flow Area	5.7	ft²
Wetted Perimeter	21.43	ft
Top Width	20.75	ft
Actual Depth	0.72	ft
Critical Elevation	0.99	ft
Critical Slope	0.3820	%
Velocity	8.21	ft/s
Velocity Head	1.05	ft
Specific Energy	1.77	ft
Froude Number	2.76	
Flow Type	Supercritical	

Calculation Messages:
Water elevation exceeds lowest end station by 0.12 ft.

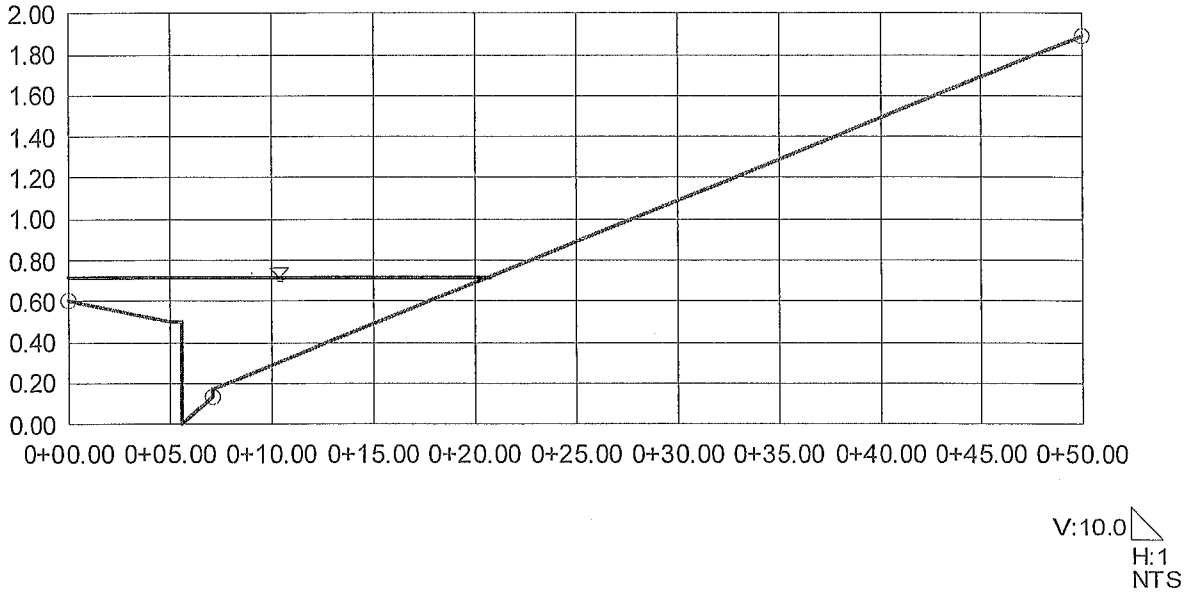
Roughness Segments		
Start Station	End Station	Mannings Coefficient
0+00.00	0+07.00	0.016
0+07.00	0+50.00	0.013

Natural Channel Points	
Station (ft)	Elevation (ft)
0+00.00	0.60
0+05.00	0.50
0+05.50	0.50
0+05.50	0.00
0+07.00	0.13
0+07.00	0.17
0+50.00	1.89

10-yr Capacity - Elkhorn Nortth Half Tee Pee to Fort Apache - 4.0% Cross Slope
Cross Section for Irregular Channel

Project Description	
Worksheet	10-yr Capacity - Elkhorn Nortth Half Tee Pee to Fort Apache - 4.0% Cross Slope
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Discharge

Section Data		
Mannings Coefficient	0.014	
Channel Slope	3.4000	%
Water Surface Elevation	0.72	ft
Elevation Range	0.00 to 1.89	
Discharge	46.98	cfs



10-yr Capacity - Elkhorn South Half Tee Pee to Fort Apache - 2.5% Cross Slope
Worksheet for Irregular Channel

Project Description	
Worksheet	10-yr Capacity - Elkhorn South Half Tee Pee to Fort Apache - 2.5% Cross Slope
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Discharge

Input Data		
Channel Slope	3.4000	%
Water Surface Elevation	0.71	ft

Options	
Current Roughness Method	Improved Lotter's Method
Open Channel Weighting Method	Improved Lotter's Method
Closed Channel Weighting Method	Horton's Method

Results		
Mannings Coefficient	0.014	
Elevation Range	0.00 to 1.25	
Discharge	63.62	cfs
Flow Area	7.7	ft²
Wetted Perimeter	29.16	ft
Top Width	28.50	ft
Actual Depth	0.71	ft
Critical Elevation	0.99	ft
Critical Slope	0.3670	%
Velocity	8.29	ft/s
Velocity Head	1.07	ft
Specific Energy	1.78	ft
Froude Number	2.81	
Flow Type	Supercritical	

Calculation Messages:
Water elevation exceeds lowest end station by 0.11 ft.

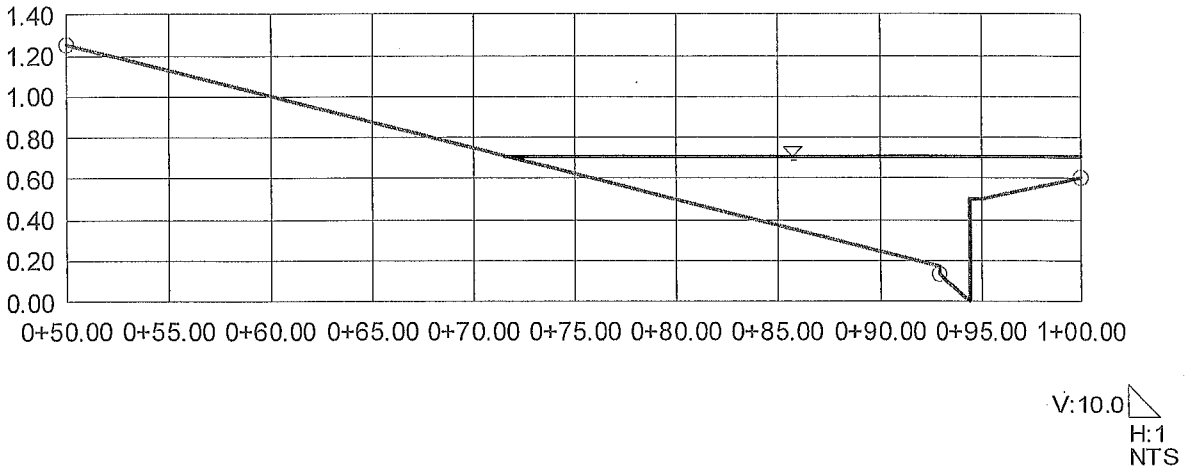
Roughness Segments		
Start Station	End Station	Mannings Coefficient
0+50.00	0+93.00	0.013
0+93.00	1+00.00	0.016

Natural Channel Points	
Station (ft)	Elevation (ft)
0+50.00	1.25
0+93.00	0.17
0+93.00	0.13
0+94.50	0.00
0+94.50	0.50
0+95.00	0.50
1+00.00	0.60

10-yr Capacity - Elkhorn South Half Tee Pee to Fort Apache - 2.5% Cross Slope
Cross Section for Irregular Channel

Project Description	
Worksheet	10-yr Capacity - Elkhorn South Half Tee Pee to Fort Apache - 2.5% Cross Slope
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Discharge

Section Data	
Mannings Coefficient	0.014
Channel Slope	3.4000 %
Water Surface Elevation	0.71 ft
Elevation Range	0.00 to 1.25
Discharge	63.62 cfs



10-yr Capacity - Elkhorn South Half Tee Pee to Fort Apache - 3.0% Cross Slope
Worksheet for Irregular Channel

Project Description	
Worksheet	10-yr Capacity - Elkhorn South Half Tee Pee to Fort Apache - 3.0% Cross Slope
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Discharge

Input Data		
Channel Slope	3.4000	%
Water Surface Elevation	0.72	ft

Options	
Current Roughness Method	Improved Lotter's Method
Open Channel Weighting Method	Improved Lotter's Method
Closed Channel Weighting Method	Horton's Method

Results		
Mannings Coefficient	0.014	
Elevation Range	0.00 to 1.46	
Discharge	58.22	cfs
Flow Area	7.0	ft²
Wetted Perimeter	26.01	ft
Top Width	25.33	ft
Actual Depth	0.72	ft
Critical Elevation	1.00	ft
Critical Slope	0.3708	%
Velocity	8.34	ft/s
Velocity Head	1.08	ft
Specific Energy	1.80	ft
Froude Number	2.80	
Flow Type	Supercritical	

Calculation Messages:
Water elevation exceeds lowest end station by 0.12 ft.

Roughness Segments

Start Station	End Station	Mannings Coefficient
0+50.00	0+93.00	0.013
0+93.00	1+00.00	0.016

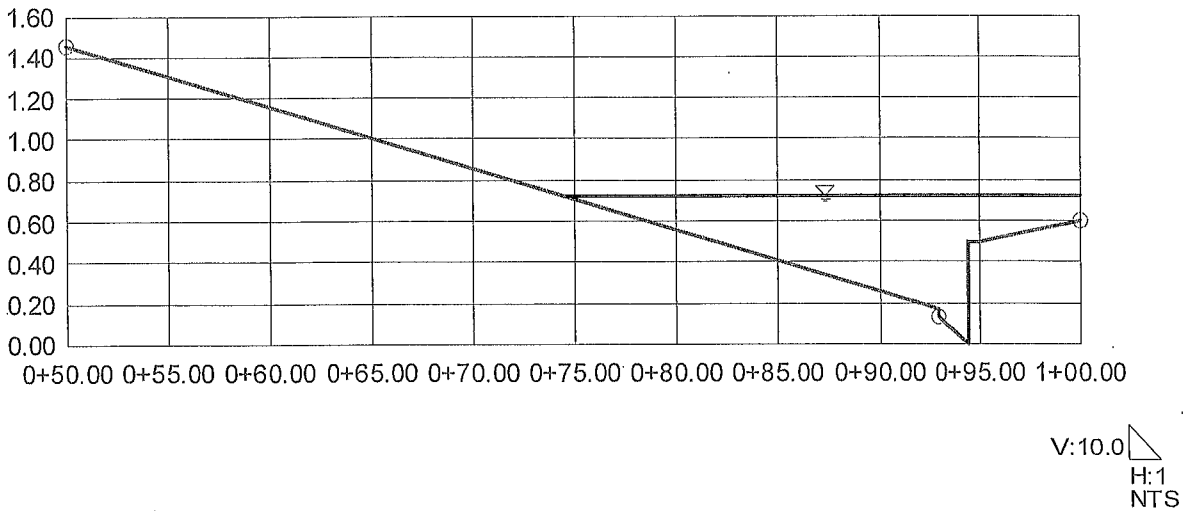
Natural Channel Points

Station (ft)	Elevation (ft)
0+50.00	1.46
0+93.00	0.17
0+93.00	0.13
0+94.50	0.00
0+94.50	0.50
0+95.00	0.50
1+00.00	0.60

10-yr Capacity - Elkhorn South Half Tee Pee to Fort Apache - 3.0% Cross Slope
Cross Section for Irregular Channel

Project Description	
Worksheet	10-yr Capacity - Elkhorn South Half Tee Pee to Fort Apache - 3.0% Cross Slope
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Discharge

Section Data		
Mannings Coefficient	0.014	
Channel Slope	3.4000	%
Water Surface Elevation	0.72	ft
Elevation Range	0.00 to 1.46	
Discharge	58.22	cfs



10-yr Capacity - Elkhorn South Half Tee Pee to Fort Apache - 3.5% Cross Slope
Worksheet for Irregular Channel

Project Description	
Worksheet	10-yr Capacity - Elkhorn South Half Tee Pee to Fort Apache - 3.5% Cross Slope
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Discharge

Input Data		
Channel Slope	3.4000	%
Water Surface Elevation	0.72	ft

Options	
Current Roughness Method	Improved Lotter's Method
Open Channel Weighting Method	Improved Lotter's Method
Closed Channel Weighting Method	Horton's Method

Results		
Mannings Coefficient	0.014	
Elevation Range	0.00 to 1.68	
Discharge	51.67	cfs
Flow Area	6.2	ft²
Wetted Perimeter	23.34	ft
Top Width	22.66	ft
Actual Depth	0.72	ft
Critical Elevation	1.00	ft
Critical Slope	0.3767	%
Velocity	8.27	ft/s
Velocity Head	1.06	ft
Specific Energy	1.78	ft
Froude Number	2.78	
Flow Type	Supercritical	

Calculation Messages:
Water elevation exceeds lowest end station by 0.12 ft.

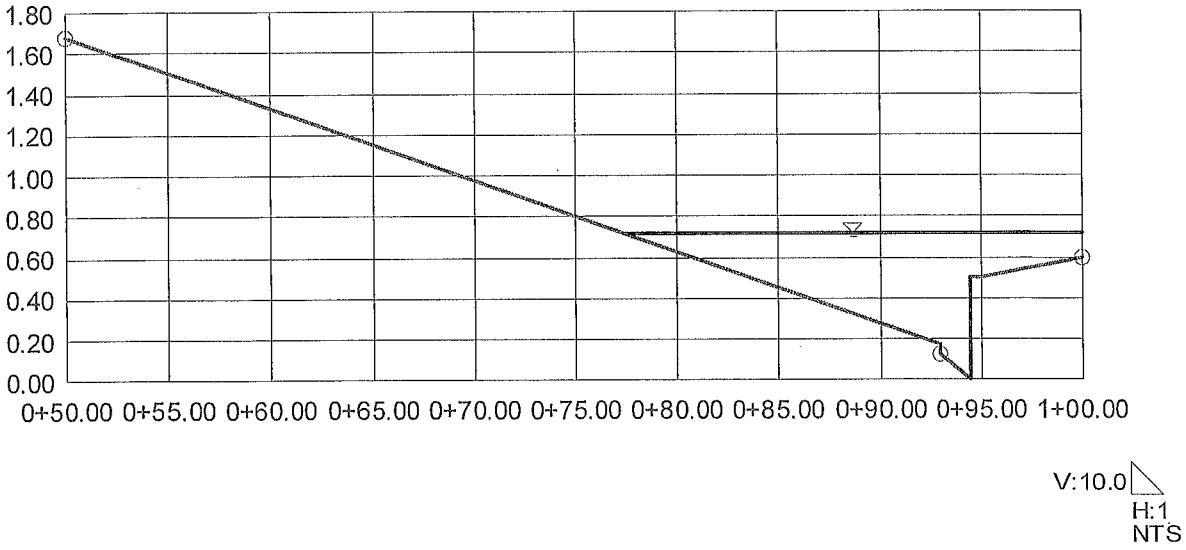
Roughness Segments		
Start Station	End Station	Mannings Coefficient
0+50.00	0+93.00	0.013
0+93.00	1+00.00	0.016

Natural Channel Points	
Station (ft)	Elevation (ft)
0+50.00	1.68
0+93.00	0.17
0+93.00	0.13
0+94.50	0.00
0+94.50	0.50
0+95.00	0.50
1+00.00	0.60

10-yr Capacity - Elkhorn South Half Tee Pee to Fort Apache - 3.5% Cross Slope
Cross Section for Irregular Channel

Project Description	
Worksheet	10-yr Capacity - Elkhorn South Half Tee Pee to Fort Apache - 3.5% Cross Slope
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Discharge

Section Data		
Mannings Coefficient	0.014	
Channel Slope	3.4000	%
Water Surface Elevation	0.72	ft
Elevation Range	0.00 to 1.68	
Discharge	51.67	cfs



APPENDIX C

Drop Inlet Computations

Sump Drop Inlet Computations

SLATER HANIFAN GROUP
CONSULTING ENGINEERS AND PLANNERS

Grate Inlet Sizing Computation

FACILITY DESCRIPTION

Project Name: Rancho Rd System - Elkhorn
Description: NDOT Type 2 - Station 19+72
File Name: CLV1201 Sump DI Sizing v111031.xlsx
By: MJF

Known Information:

Q =	Flow (cfs)	64.0
HW =	Available Headwater Depth (ft)	0.88
Cf =	Clogging factor (%)	50

Weir Conditions:

$$P = Q/(HW^{3/2}*Cw)$$

Cw =	Weir Coefficient	2.70
P =	Perimeter of grate (ft)	28.96
Pc =	Perimeter (w/clogging) (ft)	57.92
Ar =	Area Rectangular grate (ft2)	209.68
Ac =	Area of Circular Grate (ft2)	266.97

Orifice Conditions:

$$Ag = Q/(Co*(HW*2g)^{1/2})$$

Co =	Orifice Coefficient	0.67
Ag =	Grate Area (ft2)	12.73
Gf =	Grate Opening Factor	0.67
g =	Gravity (fps)	32.20
Ac =	Area Req (w/clogging) (ft2)	37.99

Worst Case Scenario Occurs Under Weir Conditions

Calculated Square Grate	L =	14.48 ft	* 57.9 LF Perimeter Legth Required.
	W =	14.48 ft	

Worst Case Scenario Occurs Under Weir Conditions

Calculated Circular Size	D =	221.2 in

Recommendations:

Provide three (3) NDOT Type 2 Drop Inlets Triple Grate (Dimensions: L=6', A=4', per NDOT STd Dwg. R-4.2.1) connected by 30" RCP with 30" RCP outlet pipe (Perimeter Length Provided = 60 LF)

5740 S. Arville St., Suite 216 - Las Vegas, NV 89118
Ph. 702-284-5300 - Fx. 702-284-5399

SLATER HANIFAN GROUP
CONSULTING ENGINEERS AND PLANNERS

Grate Inlet Sizing Computation

FACILITY DESCRIPTION

Project Name: Rancho Rd System - Elkhorn
Description: NDOT Type 2 - Station 19+34
File Name: CLV1201 Sump DI Sizing v111031.xlsx
By: MJF

Known Information:

Q =	Flow (cfs)	37.0
HW =	Available Headwater Depth (ft)	0.83
Cf =	Clogging factor (%)	50

Weir Conditions:

$$P = Q/(HW^{3/2}*Cw)$$

Cw =	Weir Coefficient	2.70
P =	Perimeter of grate (ft)	18.12
Pc =	Perimeter (w/clogging) (ft)	36.25
Ar =	Area Rectangular grate (ft2)	82.11
Ac =	Area of Circular Grate (ft2)	104.54

Orifice Conditions:

$$Ag = Q/(Co*(HW*2g)^{1/2})$$

Co =	Orifice Coefficient	0.67
Ag =	Grate Area (ft2)	7.55
Gf =	Grate Opening Factor	0.67
g =	Gravity (fps)	32.20
Ac =	Area Req (w/clogging) (ft2)	22.55

Worst Case Scenario Occurs Under Weir Conditions

Calculated Square Grate	L =	9.06 ft	*** 36.3 LF Perimeter Legth Required.**
	W =	9.06 ft	

Worst Case Scenario Occurs Under Weir Conditions

Calculated Circular Size	D =	138.4 in

Recommendations:

Provide two (2) NDOT Type 2 Drop Inlets Triple Grate (Dimensions: L=6', A=3', per NDOT STd Dwg. R-4.2.1) connected by 30" RCP with 24" RCP outlet pipe (Perimeter Length Provided = 36 LF)

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CONSULTING ENGINEERS AND PLANNERS

Grate Inlet Sizing Computation

FACILITY DESCRIPTION

Project Name: Rancho Rd System - Elkhorn
Description: NDOT Type 2 - Station 18+89
File Name: CLV1201 Sump DI Sizing v111031.xlsx
By: MJF

Known Information:

Q =	Flow (cfs)	8.0
HW =	Available Headwater Depth (ft)	0.83
Cf =	Clogging factor (%)	50

Weir Conditions:

$$P = Q/(HW^{3/2}*Cw)$$

Cw =	Weir Coefficient	2.70
P =	Perimeter of grate (ft)	3.92
Pc =	Perimeter (w/clogging) (ft)	7.84
Ar =	Area Rectangular grate (ft2)	3.84
Ac =	Area of Circular Grate (ft2)	4.89

Orifice Conditions:

$$Ag = Q/(Co*(HW*2g)^{1/2})$$

Co =	Orifice Coefficient	0.67
Ag =	Grate Area (ft2)	1.63
Gf =	Grate Opening Factor	0.67
g =	Gravity (fps)	32.20
Ac =	Area Req (w/clogging) (ft2)	4.88

Worst Case Scenario Occurs Under Orifice Conditions

Calculated Square Grate	L =	2.21 ft	*** 7.8 LF Perimeter Legth Required.**
	W =	2.21 ft	

Worst Case Scenario Occurs Under Weir Conditions

Calculated Circular Size	D =	29.9 in

Recommendations:

Provide one (1) NDOT Type 2 Drop Inlet Single Grate (Dimensions: L=2', A=2.5', per NDOT STd Dwg. R-4.2.1) with 18" RCP outlet pipe (Perimeter Length Provided = 9 LF)

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Grate Inlet Sizing Computation

FACILITY DESCRIPTION

Project Name: Rancho Rd System - Elkhorn
Description: NDOT Type 2 - Station 32+60
File Name: CLV1201 Sump DI Sizing v111031.xlsx
By: MJF

Known Information:

Q =	Flow (cfs)	64.0
HW =	Available Headwater Depth (ft)	0.88
Cf =	Clogging factor (%)	50

Weir Conditions:

$P = Q/(HW^{3/2}*Cw)$

Cw =	Weir Coefficient	2.70
P =	Perimeter of grate (ft)	28.96
Pc =	Perimeter (w/clogging) (ft)	57.92
Ar =	Area Rectangular grate (ft2)	209.68
Ac =	Area of Circular Grate (ft2)	266.97

Orifice Conditions:

$Ag = Q/(Co*(HW*2g)^{1/2})$

Co =	Orifice Coefficient	0.67
Ag =	Grate Area (ft2)	12.73
Gf =	Grate Opening Factor	0.67
g =	Gravity (fps)	32.20
Ac =	Area Req (w/clogging) (ft2)	37.99

Worst Case Scenario Occurs Under Weir Conditions

Calculated Square Grate	L =	14.48 ft	*** 57.9 LF Perimeter Legth Required.**
	W =	14.48 ft	

Worst Case Scenario Occurs Under Weir Conditions

Calculated Circular Size	D =	221.2 in

Recommendations:

Provide three (3) NDOT Type 2 Drop Inlets Triple Grate (Dimensions: L=6', A=4', per NDOT STd Dwg. R-4.2.1) connected by 30" RCP with 30" RCP outlet pipe (Perimeter Length Provided = 60 LF)

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Continuous Grade Drop Inlet Computations

	Project:	Rancho Rd System - Elkhorn	
	Title:	Neenah R-3295 (Continuous Grade)	
	Subtitle:	12.0-ft Drop Inlet at "ER" 20+34	
	By:	K.C.	
	Date:	August 28, 2012	
	Input:	**Variable:**	**Input:**
	Street Flow (cfs)	Q	3.0
	Longitudinal Slope (ft/ft)	S_o	0.0050
	Manning's Coefficient	n	0.016
	Street Flow Velocity (fps)	V	1.97
	Street Flow Depth (ft)	D	0.38
	Street Cross Slope (ft/ft)	S_x	0.020
	Grate Width (ft)	W	1.5
	Grate Depression (in)	D_g	2.0
	Length of Grate (ft)	L_g	12.00
	Length of Curb Opening (ft)	L_c	12.00
	Clogging Factor - Grate (%)	CF_g	50%
	Clogging Factor - Curb (%)	CF_c	50%
	Effective Grate Length (ft)	L_{ge}	6.0
	Effective Curb Opening Length (ft)	L_{ce}	6.00
	Output (Grate):	**Equation:**	**Output (Grate):**
[1]	R_f - Frontal Flow Factor	1-0.09*(V-V_x) if V>V_x; else Frontal Flow Factor=1	1.00
[2]	V_o - Splash Over Velocity (fps)	V_x=p+q*Lg-r*L_{ge}^2+sy*L_{ge}^3 ; where p=0.30,q=4.85,r=1.31,sy=0.15 (for Vane Grate)	14.64
[1]	E - Grate Flow Ratio	Frontal Flow/Side Flow	0.33
[2]	Q_w - Frontal Flow (cfs)	$Q_w = Q[1-(1-(W/T))^{2.67}]$	1.00
[1]	Q_s - Side Flow (cfs)	Q_s = Q-Qw	2.0
	T - Side Flow Spread (ft)	$(D-D_g)/S_x$	10.67
[1]	R_s - Side Flow Factor	$1/(1+(0.15*V^{1.8})/(S_x*L_{ge}^{2.3}))$	0.71
[1]	Q_{gi} - Intercepted Flow (cfs)	$(R_f*E+R_s*(1-E))*Q$	2.4
	Output (Curb):	**Equation:**	**Output (Curb):**
[1]	S_e - Equivalent Cross Slope (ft/ft)	S_x+S_g*E	0.057
	Q_{sx} - Remaining Flow After Grate Interception (cfs)	$Q-Q_{gi}$	0.584
	S_g - Gutter Cross Slope (ft/ft)	D_g/W	0.111
[1]	L_t - Effective Interception Length (ft)	$0.60*Q_{sx}^{0.42}*S_o^{0.30}*(1/n*S_e)^{0.6}$	6.52
[1]	Q_{ci} - Intercepted Flow (cfs)	$(1-(1-L_{ce}/L_t)^{1.8})*Q_{sx}$	0.6
		or Q_{sx} if L_t is less than L_{ce}	
	Output (Combination):		**Output (Combination):**
	Total Intercepted Flow (cfs)	Intercepted (Grate) + Intercepted (Curb)	**3.0**

[1] Formula referenced from the CCRFCD Manual

[2] Formula referenced from FHWA Urban Drainage Design Manual (HEC-22)

Project:	**Rancho Rd System - Elkhorn**	
Title:	**Mod. Type C Drop Inlet (Continuous Grade)**	
Subtitle:	**4.0-ft Drop Inlet at "ER" 25+37**	
By:	**K.C.**	
Date:	**August 28, 2012**	
Input:	**Variable:**	**Input:**
Street Flow (cfs)	Q	2.0
Longitudinal Slope (ft/ft)	S_o	0.0340
Manning's Coefficient	n	0.016
Street Flow Velocity (fps)	V	3.70
Street Flow Depth (ft)	D	0.27
Street Cross Slope (ft/ft)	S_x	0.020
Grate Width (ft)	W	1.5
Grate Depression (in)	D_g	2.0
Length of Grate (ft)	L_g	2.50
Length of Curb Opening (ft)	L_c	4.00
Clogging Factor - Grate (%)	CF_g	50%
Clogging Factor - Curb (%)	CF_c	50%
Effective Grate Length (ft)	L_{ge}	1.3
Effective Curb Opening Length (ft)	L_{ce}	2.00
Output (Grate):	**Equation:**	**Output (Grate):**
[1] R_f - Frontal Flow Factor	1-0.09*(V-V_x) if V>V_x; else Frontal Flow Factor=1	1.00
[2] V_o - Splash Over Velocity (fps)	V_x=p+q*Lg-r*L_{ge}^2+sy*L_{ge}^3 ; where p=0.30,q=4.85,r=1.31,sy=0.15 (for Vane Grate)	4.61
[1] E - Grate Flow Ratio	Frontal Flow/Side Flow	0.60
[2] Q_w - Frontal Flow (cfs)	$Q_w = Q[1-(1-(W/T))^{2.67}]$	1.20
[1] Q_s - Side Flow (cfs)	Q_s = Q-Qw	0.8
T - Side Flow Spread (ft)	$(D-D_g)/S_x$	5.17
[1] R_s - Side Flow Factor	$1/(1+(0.15*V^{1.8})/(S_x*L_{ge}^{2.3}))$	0.02
[1] Q_{gi} - Intercepted Flow (cfs)	$(R_f*E+R_s*(1-E))*Q$	1.2
Output (Curb):	**Equation:**	**Output (Curb):**
[1] S_e - Equivalent Cross Slope (ft/ft)	S_x+S_g*E	0.087
Q_{sx} - Remaining Flow After Grate Interception (cfs)	$Q-Q_{gi}$	0.784
S_g - Gutter Cross Slope (ft/ft)	D_g/W	0.111
[1] L_t - Effective Interception Length (ft)	$0.60*Q_{sx}^{0.42}*S_o^{0.30}*(1/n*S_e)^{0.6}$	10.19
[1] Q_{ci} - Intercepted Flow (cfs)	$(1-(1-L_{ce}/L_t)^{1.8})*Q_{sx}$	0.3
	or Q_{sx} if L_t is less than L_{ce}	
Output (Combination):		**Output (Combination):**
Total Intercepted Flow (cfs)	Intercepted (Grate) + Intercepted (Curb)	**1.5**

[1] Formula referenced from the CCRFCD Manual

[2] Formula referenced from FHWA Urban Drainage Design Manual (HEC-22)

	Project:	**Rancho Rd System - Elkhorn**	
	Title:	**Mod. Type C Drop Inlet (Continuous Grade)**	
	Subtitle:	**4.0-ft Drop Inlet at "ER" 27+99**	
	By:	**K.C.**	
	Date:	**August 28, 2012**	
	Input:	**Variable:**	**Input:**
	Street Flow (cfs)	Q	1.5
	Longitudinal Slope (ft/ft)	S_o	0.0340
	Manning's Coefficient	n	0.016
	Street Flow Velocity (fps)	V	3.83
	Street Flow Depth (ft)	D	0.25
	Street Cross Slope (ft/ft)	S_x	0.032
	Grate Width (ft)	W	1.5
	Grate Depression (in)	D_g	2.0
	Length of Grate (ft)	L_g	2.50
	Length of Curb Opening (ft)	L_c	4.00
	Clogging Factor - Grate (%)	CF_g	50%
	Clogging Factor - Curb (%)	CF_c	50%
	Effective Grate Length (ft)	L_{ge}	1.3
	Effective Curb Opening Length (ft)	L_{ce}	2.00
	Output (Grate):	**Equation:**	**Output (Grate):**
[1]	R_f - Frontal Flow Factor	1-0.09*(V-V_x) if V>V_x; else Frontal Flow Factor=1	1.00
[2]	V_o - Splash Over Velocity (fps)	V_x=p+q*Lg-r*L_{ge}^2+sy*L_{ge}^3 ; where p=0.30,q=4.85,r=1.31,sy=0.15 (for Vane Grate)	4.61
[1]	E - Grate Flow Ratio	Frontal Flow/Side Flow	0.90
[2]	Q_w - Frontal Flow (cfs)	$Q_w = Q[1-(1-(W/T))^{2.67}]$	1.35
[1]	Q_s - Side Flow (cfs)	Q_s = Q-Qw	0.2
	T - Side Flow Spread (ft)	$(D-D_g)/S_x$	2.60
[1]	R_s - Side Flow Factor	$1/(1+(0.15*V^{1.8})/(S_x*L_{ge}^{2.3}))$	0.03
[1]	Q_{gi} - Intercepted Flow (cfs)	$(R_f*E+R_s*(1-E))*Q$	1.4
	Output (Curb):	**Equation:**	**Output (Curb):**
[1]	S_e - Equivalent Cross Slope (ft/ft)	S_x+S_g*E	0.132
	Q_{sx} - Remaining Flow After Grate Interception (cfs)	$Q-Q_{gi}$	0.147
	S_g - Gutter Cross Slope (ft/ft)	D_g/W	0.111
[1]	L_t - Effective Interception Length (ft)	$0.60*Q_{sx}^{0.42}*S_o^{0.30}*(1/n*S_e)^{0.6}$	3.92
[1]	Q_{ci} - Intercepted Flow (cfs)	$(1-(1-L_{ce}/L_t)^{1.8})*Q_{sx}$	0.1
		or Q_{sx} if L_t is less than L_{ce}	
	Output (Combination):		**Output (Combination):**
	Total Intercepted Flow (cfs)	Intercepted (Grate) + Intercepted (Curb)	**1.5**

[1] Formula referenced from the CCRFCD Manual

[2] Formula referenced from FHWA Urban Drainage Design Manual (HEC-22)

Project:	**Rancho Rd System - Elkhorn**	
Title:	**Mod. Type C Drop Inlet (Continuous Grade)**	
Subtitle:	**4.0-ft Drop Inlet at "ER" 32+23**	
By:	**K.C.**	
Date:	**August 28, 2012**	
Input:	**Variable:**	**Input:**
Street Flow (cfs)	Q	1.5
Longitudinal Slope (ft/ft)	S_o	0.0340
Manning's Coefficient	n	0.016
Street Flow Velocity (fps)	V	3.91
Street Flow Depth (ft)	D	0.25
Street Cross Slope (ft/ft)	S_x	0.036
Grate Width (ft)	W	1.5
Grate Depression (in)	D_g	2.0
Length of Grate (ft)	L_g	2.50
Length of Curb Opening (ft)	L_c	4.00
Clogging Factor - Grate (%)	CF_g	50%
Clogging Factor - Curb (%)	CF_c	50%
Effective Grate Length (ft)	L_{ge}	1.3
Effective Curb Opening Length (ft)	L_{ce}	2.00
Output (Grate):	**Equation:**	**Output (Grate):**
[1] R_f - Frontal Flow Factor	1-0.09*(V-V_x) if V>V_x; else Frontal Flow Factor=1	1.00
[2] V_o - Splash Over Velocity (fps)	V_x=p+q*Lg-r*L_{ge}^2+sy*L_{ge}^3 ; where p=0.30,q=4.85,r=1.31,sy=0.15 (for Vane Grate)	4.61
[1] E - Grate Flow Ratio	Frontal Flow/Side Flow	0.94
[2] Q_w - Frontal Flow (cfs)	$Q_w = Q[1-(1-(W/T))^{2.67}]$	1.41
[1] Q_s - Side Flow (cfs)	Q_s = Q-Qw	0.1
T - Side Flow Spread (ft)	$(D-D_g)/S_x$	2.31
[1] R_s - Side Flow Factor	$1/(1+(0.15*V^{1.8})/(S_x*L_{ge}^{2.3}))$	0.03
[1] Q_{gi} - Intercepted Flow (cfs)	$(R_f*E+R_s*(1-E))*Q$	1.4
Output (Curb):	**Equation:**	**Output (Curb):**
[1] S_e - Equivalent Cross Slope (ft/ft)	S_x+S_g*E	0.140
Q_{sx} - Remaining Flow After Grate Interception (cfs)	$Q-Q_{gi}$	0.089
S_g - Gutter Cross Slope (ft/ft)	D_g/W	0.111
[1] L_t - Effective Interception Length (ft)	$0.60*Q_{sx}^{0.42}*S_o^{0.30}*(1/n*S_e)^{0.6}$	3.06
[1] Q_{ci} - Intercepted Flow (cfs)	$(1-(1-L_{ce}/L_t)^{1.8})*Q_{sx}$	0.1
	or Q_{sx} if L_t is less than L_{ce}	
Output (Combination):		**Output (Combination):**
Total Intercepted Flow (cfs)	Intercepted (Grate) + Intercepted (Curb)	**1.5**

[1] Formula referenced from the CCRFCD Manual

[2] Formula referenced from FHWA Urban Drainage Design Manual (HEC-22)

Project:	Rancho Rd System - Elkhorn	
Title:	Mod. Type C Drop Inlet (Continuous Grade)	
Subtitle:	4.0-ft Drop Inlet at "ER" 32+46	
By:	K.C.	
Date:	August 28, 2012	
Input:	**Variable:**	**Input:**
Street Flow (cfs)	Q	2.5
Longitudinal Slope (ft/ft)	S_o	0.0340
Manning's Coefficient	n	0.016
Street Flow Velocity (fps)	V	4.11
Street Flow Depth (ft)	D	0.29
Street Cross Slope (ft/ft)	S_x	0.026
Grate Width (ft)	W	1.5
Grate Depression (in)	D_g	2.0
Length of Grate (ft)	L_g	2.50
Length of Curb Opening (ft)	L_c	4.00
Clogging Factor - Grate (%)	CF_g	50%
Clogging Factor - Curb (%)	CF_c	50%
Effective Grate Length (ft)	L_{ge}	1.3
Effective Curb Opening Length (ft)	L_{ce}	2.00
Output (Grate):	**Equation:**	**Output (Grate):**
[1] R_f - Frontal Flow Factor	1-0.09*(V-V_x) if V>V_x; else Frontal Flow Factor=1	1.00
[2] V_o - Splash Over Velocity (fps)	V_x=p+q*Lg-r*L_{ge}^2+sy*L_{ge}^3 ; where p=0.30,q=4.85,r=1.31,sy=0.15 (for Vane Grate)	4.61
[1] E - Grate Flow Ratio	Frontal Flow/Side Flow	0.64
[2] Q_w - Frontal Flow (cfs)	$Q_w = Q[1-(1-(W/T))^{2.67}]$	1.59
[1] Q_s - Side Flow (cfs)	Q_s = Q-Qw	0.9
T - Side Flow Spread (ft)	$(D-D_g)/S_x$	4.74
[1] R_s - Side Flow Factor	$1/(1+(0.15*V^{1.8})/(S_x*L_{ge}^{2.3}))$	0.02
[1] Q_{gl} - Intercepted Flow (cfs)	$(R_f*E+R_s*(1-E))*Q$	1.6
Output (Curb):	**Equation:**	**Output (Curb):**
[1] S_e - Equivalent Cross Slope (ft/ft)	S_x+S_g*E	0.097
Q_{sx} - Remaining Flow After Grate Interception (cfs)	$Q-Q_{gl}$	0.886
S_g - Gutter Cross Slope (ft/ft)	D_g/W	0.111
[1] L_t - Effective Interception Length (ft)	$0.60*Q_{sx}^{0.42}*S_o^{0.30}*(1/n*S_e)^{0.6}$	10.03
[1] Q_{ci} - Intercepted Flow (cfs)	$(1-(1-L_{ce}/L_t)^{1.8})*Q_{sx}$	0.3
	or Q_{sx} if L_t is less than L_{ce}	
Output (Combination):		**Output (Combination):**
Total Intercepted Flow (cfs)	Intercepted (Grate) + Intercepted (Curb)	**1.9**

[1] Formula referenced from the CCRFCD Manual

[2] Formula referenced from FHWA Urban Drainage Design Manual (HEC-22)

Project:	**Rancho Rd System - Elkhorn**
Title:	**Mod. Type C Drop Inlet (Continuous Grade)**
Subtitle:	**2.5-ft Drop Inlet at "ER" 34+61**
By:	**K.C.**
Date:	**August 28, 2012**

	Input:	**Variable:**	**Input:**
	Street Flow (cfs)	Q	6.5
	Longitudinal Slope (ft/ft)	S_o	0.0340
	Manning's Coefficient	n	0.016
	Street Flow Velocity (fps)	V	5.48
	Street Flow Depth (ft)	D	0.38
	Street Cross Slope (ft/ft)	S_x	0.030
	Grate Width (ft)	W	1.5
	Grate Depression (in)	D_g	2.0
	Length of Grate (ft)	L_g	2.50
	Length of Curb Opening (ft)	L_c	2.50
	Clogging Factor - Grate (%)	CF_g	50%
	Clogging Factor - Curb (%)	CF_c	50%
	Effective Grate Length (ft)	L_{ge}	1.3
	Effective Curb Opening Length (ft)	L_{ce}	1.25
	Output (Grate):	**Equation:**	**Output (Grate):**
[1]	R_f - Frontal Flow Factor	$1-0.09*(V-V_x)$ if $V>V_x$; else Frontal Flow Factor=1	0.92
[2]	V_o - Splash Over Velocity (fps)	$V_x=p+q*Lg-r*L_{ge}\text{^}2+sy*L_{ge}\text{^}3$; where p=0.30,q=4.85,r=1.31,sy=0.15 (for Vane Grate)	4.61
[1]	E - Grate Flow Ratio	Frontal Flow/Side Flow	0.47
[2]	Q_w - Frontal Flow (cfs)	$Q_w = Q[1-(1-(W/T))^{2.67}]$	3.05
[1]	Q_s - Side Flow (cfs)	$Q_s = Q-Qw$	3.5
	T - Side Flow Spread (ft)	$(D-D_g)/S_x$	7.11
[1]	R_s - Side Flow Factor	$1/(1+(0.15*V^{1.8})/(S_x*L_{ge}^{2.3}))$	0.02
[1]	Q_{gi} - Intercepted Flow (cfs)	$(R_f*E+R_s*(1-E))*Q$	2.9
	Output (Curb):	**Equation:**	**Output (Curb):**
[1]	S_e - Equivalent Cross Slope (ft/ft)	S_x+S_g*E	0.082
	Q_{sx} - Remaining Flow After Grate Interception (cfs)	$Q-Q_{gi}$	3.639
	S_g - Gutter Cross Slope (ft/ft)	D_g/W	0.111
[1]	L_t - Effective Interception Length (ft)	$0.60*Q_{sx}^{0.42}*S_o^{0.30}*(1/n*S_e)^{0.6}$	20.05
[1]	Q_{ci} - Intercepted Flow (cfs)	$(1-(1-L_{ce}/L_t)^{1.8})*Q_{sx}$	0.4
		or Q_{sx} if L_t is less than L_{ce}	
	Output (Combination):		**Output (Combination):**
	Total Intercepted Flow (cfs)	Intercepted (Grate) + Intercepted (Curb)	**3.3**

[1] Formula referenced from the CCRFCD Manual

[2] Formula referenced from FHWA Urban Drainage Design Manual (HEC-22)

Project:	**Rancho Rd System - Elkhorn**	
Title:	**Mod. Type C Drop Inlet (Continuous Grade)**	
Subtitle:	**4.0-ft Drop Inlet at "ER" 35+61**	
By:	**K.C.**	
Date:	**August 28, 2012**	
Input:	**Variable:**	**Input:**
Street Flow (cfs)	Q	4.0
Longitudinal Slope (ft/ft)	S_o	0.0340
Manning's Coefficient	n	0.016
Street Flow Velocity (fps)	V	5.24
Street Flow Depth (ft)	D	0.34
Street Cross Slope (ft/ft)	S_x	0.036
Grate Width (ft)	W	1.5
Grate Depression (in)	D_g	2.0
Length of Grate (ft)	L_g	2.50
Length of Curb Opening (ft)	L_c	4.00
Clogging Factor - Grate (%)	CF_g	50%
Clogging Factor - Curb (%)	CF_c	50%
Effective Grate Length (ft)	L_{ge}	1.3
Effective Curb Opening Length (ft)	L_{ce}	2.00
Output (Grate):	**Equation:**	**Output (Grate):**
[1] R_f - Frontal Flow Factor	1-0.09*(V-V_x) if V>V_x; else Frontal Flow Factor=1	0.94
[2] V_o - Splash Over Velocity (fps)	V_x=p+q*Lg-r*L_{ge}^2+sy*L_{ge}^3 ; where p=0.30,q=4.85,r=1.31,sy=0.15 (for Vane Grate)	4.61
[1] E - Grate Flow Ratio	Frontal Flow/Side Flow	0.63
[2] Q_w - Frontal Flow (cfs)	$Q_w = Q[1-(1-(W/T))^{2.67}]$	2.52
[1] Q_s - Side Flow (cfs)	Q_s = Q-Qw	1.5
T - Side Flow Spread (ft)	$(D-D_g)/S_x$	4.81
[1] R_s - Side Flow Factor	$1/(1+(0.15*V^{1.8})/(S_x*L_{ge}^{2.3}))$	0.02
[1] Q_{gi} - Intercepted Flow (cfs)	$(R_f*E+R_s*(1-E))*Q$	2.4
Output (Curb):	**Equation:**	**Output (Curb):**
[1] S_e - Equivalent Cross Slope (ft/ft)	S_x+S_g*E	0.106
Q_{sx} - Remaining Flow After Grate Interception (cfs)	$Q-Q_{gi}$	1.590
S_g - Gutter Cross Slope (ft/ft)	D_g/W	0.111
[1] L_t - Effective Interception Length (ft)	$0.60*Q_{sx}^{0.42}*S_o^{0.30}*(1/n*S_e)^{0.6}$	12.14
[1] Q_{ci} - Intercepted Flow (cfs)	$(1-(1-L_{ce}/L_t)^{1.8})*Q_{sx}$	0.4
	or Q_{sx} if L_t is less than L_{ce}	
Output (Combination):		**Output (Combination):**
Total Intercepted Flow (cfs)	Intercepted (Grate) + Intercepted (Curb)	**2.8**

[1] Formula referenced from the CCRFCD Manual

[2] Formula referenced from FHWA Urban Drainage Design Manual (HEC-22)

Project:	**Rancho Rd System - Elkhorn**	
Title:	**Mod. Type C Drop Inlet (Continuous Grade)**	
Subtitle:	**4.0-ft Drop Inlet at "ER" 41+77**	
By:	**K.C.**	
Date:	**August 28, 2012**	
Input:	**Variable:**	**Input:**
Street Flow (cfs)	Q	3.0
Longitudinal Slope (ft/ft)	S_o	0.0340
Manning's Coefficient	n	0.016
Street Flow Velocity (fps)	V	4.41
Street Flow Depth (ft)	D	0.31
Street Cross Slope (ft/ft)	S_x	0.030
Grate Width (ft)	W	1.5
Grate Depression (in)	D_g	2.0
Length of Grate (ft)	L_g	2.50
Length of Curb Opening (ft)	L_c	4.00
Clogging Factor - Grate (%)	CF_g	50%
Clogging Factor - Curb (%)	CF_c	50%
Effective Grate Length (ft)	L_{ge}	1.3
Effective Curb Opening Length (ft)	L_{ce}	2.00
Output (Grate):	**Equation:**	**Output (Grate):**
[1] R_f - Frontal Flow Factor	1-0.09*(V-V_x) if V>V_x; else Frontal Flow Factor=1	1.00
[2] V_o - Splash Over Velocity (fps)	V_x=p+q*Lg-r*L_{ge}^2+sy*L_{ge}^3 ; where p=0.30,q=4.85,r=1.31,sy=0.15 (for Vane Grate)	4.61
[1] E - Grate Flow Ratio	Frontal Flow/Side Flow	0.63
[2] Q_w - Frontal Flow (cfs)	$Q_w = Q[1-(1-(W/T))^{2.67}]$	1.90
[1] Q_s - Side Flow (cfs)	Q_s = Q-Qw	1.1
T - Side Flow Spread (ft)	$(D-D_g)/S_x$	4.78
[1] R_s - Side Flow Factor	$1/(1+(0.15*V^{1.8})/(S_x*L_{ge}^{2.3}))$	0.02
[1] Q_{gi} - Intercepted Flow (cfs)	$(R_f*E+R_s*(1-E))*Q$	1.9
Output (Curb):	**Equation:**	**Output (Curb):**
[1] S_e - Equivalent Cross Slope (ft/ft)	S_x+S_g*E	0.100
Q_{sx} - Remaining Flow After Grate Interception (cfs)	$Q-Q_{gi}$	1.072
S_g - Gutter Cross Slope (ft/ft)	D_g/W	0.111
[1] L_t - Effective Interception Length (ft)	$0.60*Q_{sx}^{0.42}*S_o^{0.30}*(1/n*S_e)^{0.6}$	10.63
[1] Q_{ci} - Intercepted Flow (cfs)	$(1-(1-L_{ce}/L_t)^{1.8})*Q_{sx}$	0.3
	or Q_{sx} if L_t is less than L_{ce}	
Output (Combination):		**Output (Combination):**
Total Intercepted Flow (cfs)	Intercepted (Grate) + Intercepted (Curb)	**2.3**

[1] Formula referenced from the CCRFCD Manual

[2] Formula referenced from FHWA Urban Drainage Design Manual (HEC-22)

Project:	Rancho Rd System - Elkhorn	
Title:	Mod. Type C Drop Inlet (Continuous Grade)	
Subtitle:	2.5-ft Drop Inlet at "ER" 41+91	
By:	K.C.	
Date:	August 28, 2012	
Input:	**Variable:**	**Input:**
Street Flow (cfs)	Q	8.0
Longitudinal Slope (ft/ft)	S_o	0.0340
Manning's Coefficient	n	0.016
Street Flow Velocity (fps)	V	5.53
Street Flow Depth (ft)	D	0.39
Street Cross Slope (ft/ft)	S_x	0.025
Grate Width (ft)	W	1.5
Grate Depression (in)	D_g	2.0
Length of Grate (ft)	L_g	2.50
Length of Curb Opening (ft)	L_c	2.50
Clogging Factor - Grate (%)	CF_g	50%
Clogging Factor - Curb (%)	CF_c	50%
Effective Grate Length (ft)	L_{ge}	1.3
Effective Curb Opening Length (ft)	L_{ce}	1.25
Output (Grate):	**Equation:**	**Output (Grate):**
[1] R_f - Frontal Flow Factor	1-0.09*(V-V_x) if V>V_x; else Frontal Flow Factor=1	0.92
[2] V_o - Splash Over Velocity (fps)	V_x=p+q*Lg-r*L_{ge}^2+sy*L_{ge}^3 ; where p=0.30,q=4.85,r=1.31,sy=0.15 (for Vane Grate)	4.61
[1] E - Grate Flow Ratio	Frontal Flow/Side Flow	0.39
[2] Q_w - Frontal Flow (cfs)	$Q_w = Q[1-(1-(W/T))^{2.67}]$	3.10
[1] Q_s - Side Flow (cfs)	Q_s = Q-Qw	4.9
T - Side Flow Spread (ft)	$(D-D_g)/S_x$	8.93
[1] R_s - Side Flow Factor	$1/(1+(0.15*V^{1.8})/(S_x*L_{ge}^{2.3}))$	0.01
[1] Q_{gi} - Intercepted Flow (cfs)	$(R_f*E+R_s*(1-E))*Q$	2.9
Output (Curb):	**Equation:**	**Output (Curb):**
[1] S_e - Equivalent Cross Slope (ft/ft)	S_x+S_g*E	0.068
Q_{sx} - Remaining Flow After Grate Interception (cfs)	$Q-Q_{gi}$	5.092
S_g - Gutter Cross Slope (ft/ft)	D_g/W	0.111
[1] L_t - Effective Interception Length (ft)	$0.60*Q_{sx}^{0.42}*S_o^{0.30}*(1/n*S_e)^{0.6}$	25.83
[1] Q_{ci} - Intercepted Flow (cfs)	$(1-(1-L_{ce}/L_t)^{1.8})*Q_{sx}$	0.4
	or Q_{sx} if L_t is less than L_{ce}	
Output (Combination):		**Output (Combination):**
Total Intercepted Flow (cfs)	Intercepted (Grate) + Intercepted (Curb)	**3.3**

[1] Formula referenced from the CCRFCD Manual

[2] Formula referenced from FHWA Urban Drainage Design Manual (HEC-22)

APPENDIX D

Storm Drain Hydraulic Analyses

North Side Mainline WSPG Analysis

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T1 SLATER HANIFAN GROUP, 08-24-2012
T2 CITY OF LAS VEGAS, RANCHO RD SYSTEM - ELKHORN (FT APACHE TO GRAND CANYON)
T3 CLV1201.000, 30% PRE-DESIGN DRAINAGE REPORT, MAINLINE
SO  -4346.682667.20  7                          2672.20
R   -4186.162671.75  7      .015
JX  -4186.152671.75  7 18   .015     2.5         2675.28         57.00
R   -3585.882688.75  7      .015
JX  -3585.872688.75  7 18   .015     3.0         2692.25         57.00
R   -3385.002694.43  7      .015
R   -3375.002694.72  7      .015
R   -3290.002699.82  7      .015
R   -3289.072699.85  7      .015
JX  -3289.062699.85  7 30   .015    64.0         2702.35         90.00
R   -3236.852701.78  7      .015
JX  -3236.842701.78  7 18   .015     1.5         2705.28         60.00
R   -2819.782717.19  7      .015
JX  -2819.772717.19  7 18   .015     1.5         2720.69         49.00
R   -2040.012745.99  7      .015
JX  -2040.002745.99  7 42   .015    67.0         2745.99         45.00
R   -1942.922749.58  7      .015
JX  -1942.912749.58  7 18 24.015     8.0    37.02753.082752.58 45.00 45.00
R   -1885.002751.72  7      .015
SH  -1885.002751.72  7
CD   7  3              5.00    7.00
CD  18  4              1.5
CD  24  4              2.0
CD  30  4              2.5
CD  36  4              3.0
CD  42  4              3.5
CD  48  4              4.0
CD  54  4              4.5
CD  60  4              5.0
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O
Q          607.0
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DATE: 8/29/2012
TIME: 8:39

F0515P
WATER SURFACE PROFILE - CHANNEL DEFINITION LISTING PAGE 1

CARD CODE	SECT NO	CHN TYPE	NO OF PIERS	AVE PIER WIDTH	HEIGHT 1 DIAMETER	BASE WIDTH	ZL	ZR	INV DROP	Y(1)	Y(2)	Y(3)	Y(4)	Y(5)	Y(6)	Y(7)	Y(8)	Y(9)	Y(10)
CD	7	3	0	0.00	5.00	7.00	0.00	0.00	0.00										
CD	18	4			1.50														
CD	24	4			2.00														
CD	30	4			2.50														
CD	36	4			3.00														
CD	42	4			3.50														
CD	48	4			4.00														
CD	54	4			4.50														
CD	60	4			5.00														

F 0 5 1 5 P PAGE NO 3

WATER SURFACE PROFILE - TITLE CARD LISTING

HEADING LINE NO 1 IS -

SLATER HANIFAN GROUP, 08-24-2012

HEADING LINE NO 2 IS -

CITY OF LAS VEGAS, RANCHO RD SYSTEM - ELKHORN (FT APACHE TO GRAND CANYON)

HEADING LINE NO 3 IS -

CLV1201.000, 30% PRE-DESIGN DRAINAGE REPORT, MAINLINE

F 0 5 1 5 P PAGE NO 2

WATER SURFACE PROFILE - ELEMENT CARD LISTING

ELEMENT NO 1 IS A SYSTEM OUTLET

	STATION	INVERT	SECT	W S ELEV
U/S DATA	-4346.68	2667.20	7	2672.20

ELEMENT NO 2 IS A REACH

	STATION	INVERT	SECT	N	RADIUS	ANGLE	ANG PT	MAN H
U/S DATA	-4186.16	2671.75	7	0.015	0.00	0.00	0.00	0

ELEMENT NO 3 IS A JUNCTION

	STATION	INVERT	SECT	LAT-1	LAT-2	N	Q3	Q4	INVERT-3	INVERT-4	PHI 3	PHI 4
U/S DATA	-4186.15	2671.75	7	18	0	0.015	2.5	0.0	2675.28	0.00	57.00	0.00

THE ABOVE ELEMENT CONTAINED AN INVERT ELEV WHICH WAS NOT GREATER THAN THE PREVIOUS INVERT ELEV -WARNING
THE ABOVE ELEMENT CONTAINED AN INVERT ELEV WHICH WAS NOT GREATER THAN THE PREVIOUS INVERT ELEV -WARNING

ELEMENT NO 4 IS A REACH

	STATION	INVERT	SECT	N	RADIUS	ANGLE	ANG PT	MAN H
U/S DATA	-3585.88	2688.75	7	0.015	0.00	0.00	0.00	0

ELEMENT NO 5 IS A JUNCTION

	STATION	INVERT	SECT	LAT-1	LAT-2	N	Q3	Q4	INVERT-3	INVERT-4	PHI 3	PHI 4
U/S DATA	-3585.87	2688.75	7	18	0	0.015	3.0	0.0	2692.25	0.00	57.00	0.00

THE ABOVE ELEMENT CONTAINED AN INVERT ELEV WHICH WAS NOT GREATER THAN THE PREVIOUS INVERT ELEV -WARNING
THE ABOVE ELEMENT CONTAINED AN INVERT ELEV WHICH WAS NOT GREATER THAN THE PREVIOUS INVERT ELEV -WARNING

ELEMENT NO 6 IS A REACH

	STATION	INVERT	SECT	N	RADIUS	ANGLE	ANG PT	MAN H
U/S DATA	-3385.00	2694.43	7	0.015	0.00	0.00	0.00	0

ELEMENT NO 7 IS A REACH

	STATION	INVERT	SECT	N	RADIUS	ANGLE	ANG PT	MAN H
U/S DATA	-3375.00	2694.72	7	0.015	0.00	0.00	0.00	0

ELEMENT NO 8 IS A REACH

	STATION	INVERT	SECT	N	RADIUS	ANGLE	ANG PT	MAN H
U/S DATA	-3290.00	2699.82	7	0.015	0.00	0.00	0.00	0

ELEMENT NO 9 IS A REACH

	STATION	INVERT	SECT	N	RADIUS	ANGLE	ANG PT	MAN H
U/S DATA	-3289.07	2699.85	7	0.015	0.00	0.00	0.00	0

ELEMENT NO 10 IS A JUNCTION

	STATION	INVERT	SECT	LAT-1	LAT-2	N	Q3	Q4	INVERT-3	INVERT-4	PHI 3	PHI 4
U/S DATA	-3289.06	2699.85	7	30	0	0.015	64.0	0.0	2702.35	0.00	90.00	0.00

THE ABOVE ELEMENT CONTAINED AN INVERT ELEV WHICH WAS NOT GREATER THAN THE PREVIOUS INVERT ELEV -WARNING
THE ABOVE ELEMENT CONTAINED AN INVERT ELEV WHICH WAS NOT GREATER THAN THE PREVIOUS INVERT ELEV -WARNING

F 0 5 1 5 P PAGE NO 3

WATER SURFACE PROFILE - ELEMENT CARD LISTING

ELEMENT NO 11 IS A REACH

	STATION	INVERT	SECT	N	RADIUS	ANGLE	ANG PT	MAN H
U/S DATA	-3236.85	2701.78	7	0.015	0.00	0.00	0.00	0

ELEMENT NO 12 IS A JUNCTION

	STATION	INVERT	SECT	LAT-1	LAT-2	N	Q3	Q4	INVERT-3	INVERT-4	PHI 3	PHI 4
U/S DATA	-3236.84	2701.78	7	18	0	0.015	1.5	0.0	2705.28	0.00	60.00	0.00

THE ABOVE ELEMENT CONTAINED AN INVERT ELEV WHICH WAS NOT GREATER THAN THE PREVIOUS INVERT ELEV -WARNING
THE ABOVE ELEMENT CONTAINED AN INVERT ELEV WHICH WAS NOT GREATER THAN THE PREVIOUS INVERT ELEV -WARNING

ELEMENT NO 13 IS A REACH

	STATION	INVERT	SECT	N	RADIUS	ANGLE	ANG PT	MAN H
U/S DATA	-2819.78	2717.19	7	0.015	0.00	0.00	0.00	0

ELEMENT NO 14 IS A JUNCTION

	STATION	INVERT	SECT	LAT-1	LAT-2	N	Q3	Q4	INVERT-3	INVERT-4	PHI 3	PHI 4
U/S DATA	-2819.77	2717.19	7	18	0	0.015	1.5	0.0	2720.69	0.00	49.00	0.00

THE ABOVE ELEMENT CONTAINED AN INVERT ELEV WHICH WAS NOT GREATER THAN THE PREVIOUS INVERT ELEV -WARNING
THE ABOVE ELEMENT CONTAINED AN INVERT ELEV WHICH WAS NOT GREATER THAN THE PREVIOUS INVERT ELEV -WARNING

ELEMENT NO 15 IS A REACH

	STATION	INVERT	SECT	N	RADIUS	ANGLE	ANG PT	MAN H
U/S DATA	-2040.01	2745.99	7	0.015	0.00	0.00	0.00	0

ELEMENT NO 16 IS A JUNCTION

	STATION	INVERT	SECT	LAT-1	LAT-2	N	Q3	Q4	INVERT-3	INVERT-4	PHI 3	PHI 4
U/S DATA	-2040.00	2745.99	7	42	0	0.015	67.0	0.0	2745.99	0.00	45.00	0.00

THE ABOVE ELEMENT CONTAINED AN INVERT ELEV WHICH WAS NOT GREATER THAN THE PREVIOUS INVERT ELEV -WARNING
THE ABOVE ELEMENT CONTAINED AN INVERT ELEV WHICH WAS NOT GREATER THAN THE PREVIOUS INVERT ELEV -WARNING

ELEMENT NO 17 IS A REACH

	STATION	INVERT	SECT	N	RADIUS	ANGLE	ANG PT	MAN H
U/S DATA	-1942.92	2749.58	7	0.015	0.00	0.00	0.00	0

ELEMENT NO 18 IS A JUNCTION

	STATION	INVERT	SECT	LAT-1	LAT-2	N	Q3	Q4	INVERT-3	INVERT-4	PHI 3	PHI 4
U/S DATA	-1942.91	2749.58	7	18	24	0.015	8.0	37.0	2753.08	2752.58	45.00	45.00

THE ABOVE ELEMENT CONTAINED AN INVERT ELEV WHICH WAS NOT GREATER THAN THE PREVIOUS INVERT ELEV -WARNING
THE ABOVE ELEMENT CONTAINED AN INVERT ELEV WHICH WAS NOT GREATER THAN THE PREVIOUS INVERT ELEV -WARNING ♀

WATER SURFACE PROFILE - ELEMENT CARD LISTING

ELEMENT NO 19 IS A REACH

	STATION	INVERT	SECT	N	RADIUS	ANGLE	ANG PT	MAN H
U/S DATA	-1885.00	2751.72	7	0.015	0.00	0.00	0.00	0

ELEMENT NO 20 IS A SYSTEM HEADWORKS

	STATION	INVERT	SECT	W S ELEV
U/S DATA	-1885.00	2751.72	7	0.00

NO EDIT ERRORS ENCOUNTERED-COMPUTATION IS NOW BEGINNING
** WARNING NO. 2 ** - WATER SURFACE ELEVATION GIVEN IS LESS THAN OR EQUALS INVERT ELEVATION IN HDWKDS, W.S.ELEV = INV + DC ♀

WATER SURFACE PROFILE LISTING

SLATER HANIFAN GROUP, 08-24-2012
CITY OF LAS VEGAS, RANCHO RD SYSTEM - ELKHORN (FT APACHE TO GRAND CANYON)
CLV1201.000, 30% PRE-DESIGN DRAINAGE REPORT, MAINLINE

STATION	INVERT ELEV	DEPTH OF FLOW	W.S. ELEV	Q	VEL	VEL HEAD	ENERGY GRD.EL.	SUPER ELEV	CRITICAL DEPTH	HGT/ DIA	BASE/ ID NO.	ZL	NO PIER	AVBPR
L/ELEM	SO					SF AVE	HF		NORM DEPTH			ZR		
-4346.68	2667.20	4.369	2671.569	791.5	25.88	10.401	2681.970	0.00	5.000	5.00	7.00	0.00	0	0.00
160.52	0.02834					.028037	4.50		4.357			0.00		
-4186.16	2671.75	4.382	2676.132	791.5	25.80	10.340	2686.472	0.00	5.000	5.00	7.00	0.00	0	0.00
JUNCT STR	0.00000					.028124	0.00					0.00		
-4186.15	2671.75	4.348	2676.098	789.0	25.92	10.435	2686.533	0.00	5.000	5.00	7.00	0.00	0	0.00
149.09	0.02832					.028318	4.22		4.348			0.00		
-4037.06	2675.97	4.348	2680.320	789.0	25.92	10.435	2690.755	0.00	5.000	5.00	7.00	0.00	0	0.00
451.18	0.02832					.029532	13.32		4.348			0.00		
-3585.88	2688.75	4.213	2692.963	789.0	26.76	11.117	2704.080	0.00	5.000	5.00	7.00	0.00	0	0.00
JUNCT STR	0.00000					.030992	0.00					0.00		
-3585.87	2688.75	4.175	2692.925	786.0	26.90	11.233	2704.158	0.00	5.000	5.00	7.00	0.00	0	0.00
28.83	0.02828					.031442	0.91		4.337			0.00		
-3557.04	2689.57	4.154	2693.719	786.0	27.03	11.346	2705.065	0.00	5.000	5.00	7.00	0.00	0	0.00
172.04	0.02828					.033748	5.81		4.337			0.00		
-3385.00	2694.43	3.961	2698.391	786.0	28.35	12.480	2710.871	0.00	5.000	5.00	7.00	0.00	0	0.00
10.00	0.02900					.036008	0.36		4.296			0.00		
-3375.00	2694.72	3.948	2698.668	786.0	28.44	12.563	2711.231	0.00	5.000	5.00	7.00	0.00	0	0.00
34.23	0.06000					.034198	1.17		3.263			0.00		
-3340.77	2696.77	4.125	2700.899	786.0	27.22	11.505	2712.404	0.00	5.000	5.00	7.00	0.00	0	0.00
28.48	0.06000					.030349	0.86		3.263			0.00		
-3312.29	2698.48	4.326	2702.809	786.0	25.95	10.459	2713.268	0.00	5.000	5.00	7.00	0.00	0	0.00
22.29	0.06000					.026816	0.60		3.263			0.00		♀

WATER SURFACE PROFILE LISTING

SLATER HANIFAN GROUP, 08-24-2012
CITY OF LAS VEGAS, RANCHO RD SYSTEM - ELKHORN (FT APACHE TO GRAND CANYON)
CLV1201.000, 30% PRE-DESIGN DRAINAGE REPORT, MAINLINE

STATION	INVERT ELEV	DEPTH OF FLOW	W.S. ELEV	Q	VEL	VEL HEAD	ENERGY GRD.EL.	SUPER ELEV	CRITICAL DEPTH	HGT/ DIA	BASE/ ID NO.	ZL	NO PIER	AVBPR
L/ELEM	SO					SF AVE	HF		NORM DEPTH			ZR		
-3290.00	2699.82	4.538	2704.358	786.0	24.75	9.509	2713.867	0.00	5.000	5.00	7.00	0.00	0	0.00
0.93	0.03226					.025152	0.02		4.124			0.00		
-3289.07	2699.85	4.539	2704.389	786.0	24.74	9.501	2713.890	0.00	5.000	5.00	7.00	0.00	0	0.00
JUNCT STR	0.00000					.030939	0.00					0.00		

-3289.06	2699.85	3.679	2703.529	722.0	28.03	12.202	2715.731	0.00	5.000		5.00	7.00	0.00	0	0.00
52.21	0.03697					.036707	1.92			3.671			0.00		
-3236.85	2701.78	3.682	2705.462	722.0	28.01	12.186	2717.648	0.00	5.000		5.00	7.00	0.00	0	0.00
JUNCT STR	0.00000					.036809	0.00						0.00		
-3236.84	2701.78	3.666	2705.446	720.5	28.08	12.241	2717.687	0.00	5.000		5.00	7.00	0.00	0	0.00
2.72	0.03695					.036942	0.10			3.666			0.00		
-3234.12	2701.88	3.666	2705.547	720.5	28.08	12.241	2717.788	0.00	5.000		5.00	7.00	0.00	0	0.00
414.34	0.03695					.036678	15.20			3.666			0.00		
-2819.78	2717.19	3.686	2720.876	720.5	27.92	12.108	2732.984	0.00	5.000		5.00	7.00	0.00	0	0.00
JUNCT STR	0.00000					.036541	0.00						0.00		
-2819.77	2717.19	3.671	2720.861	719.0	27.98	12.159	2733.020	0.00	5.000		5.00	7.00	0.00	0	0.00
343.39	0.03693					.035587	12.22			3.660			0.00		
-2476.38	2729.87	3.756	2733.629	719.0	27.35	11.613	2745.242	0.00	5.000		5.00	7.00	0.00	0	0.00
195.39	0.03693					.032469	6.34			3.660			0.00		
-2280.99	2737.09	3.939	2741.029	719.0	26.08	10.558	2751.587	0.00	5.000		5.00	7.00	0.00	0	0.00
92.62	0.03693					.028647	2.65			3.660			0.00		
-2188.37	2740.51	4.131	2744.642	719.0	24.86	9.598	2754.240	0.00	5.000		5.00	7.00	0.00	0	0.00
57.64	0.03693					.025294	1.46			3.660			0.00		

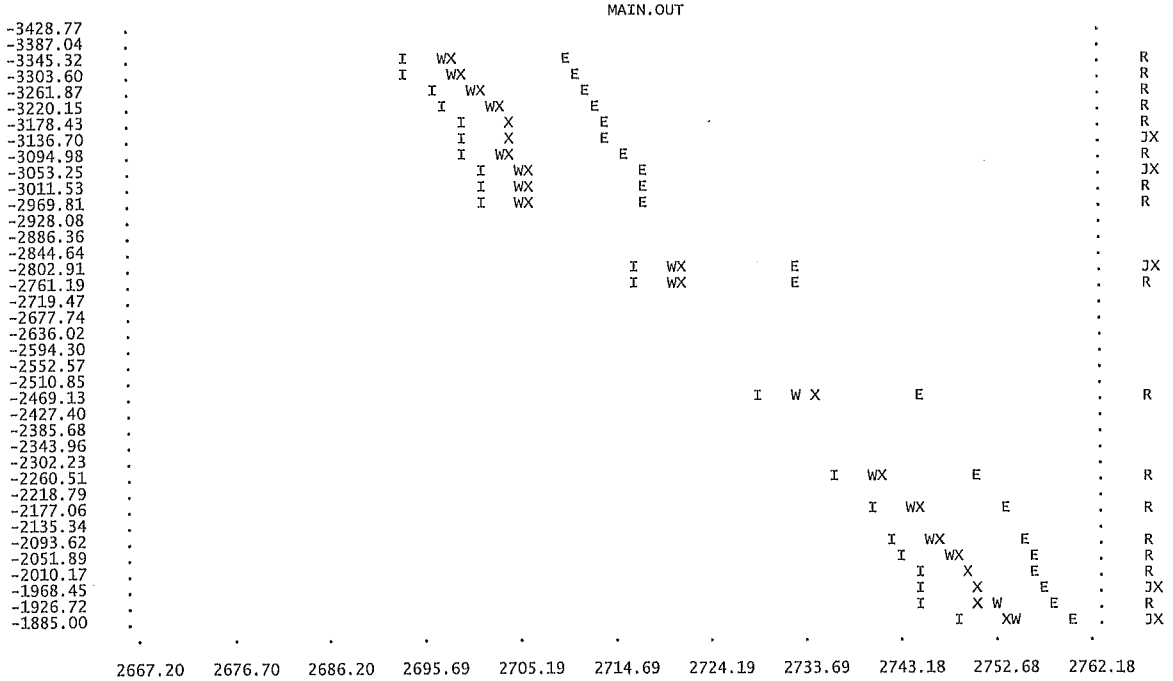
WATER SURFACE PROFILE LISTING

SLATER HANIFAN GROUP, 08-24-2012
CITY OF LAS VEGAS, RANCHO RD SYSTEM - ELKHORN (FT APACHE TO GRAND CANYON)
CLV1201.000, 30% PRE-DESIGN DRAINAGE REPORT, MAINLINE

STATION	INVERT ELEV	DEPTH OF FLOW	W.S. ELEV	Q	VEL	VEL HEAD	ENERGY GRD.EL.	SUPER ELEV	CRITICAL DEPTH		HGT/ DIA	BASE/ ID NO.	ZL	NO PIER	AVBPR
L/ELEM	SO					SF AVE	HF			NORM DEPTH			ZR		
-2130.73	2742.64	4.333	2746.972	719.0	23.71	8.726	2755.698	0.00	5.000		5.00	7.00	0.00	0	0.00
39.89	0.03693					.022351	0.89			3.660			0.00		
-2090.84	2744.11	4.545	2748.658	719.0	22.60	7.932	2756.590	0.00	5.000		5.00	7.00	0.00	0	0.00
29.08	0.03693					.019764	0.57			3.660			0.00		
-2061.76	2745.19	4.766	2749.953	719.0	21.55	7.211	2757.164	0.00	5.000		5.00	7.00	0.00	0	0.00
21.75	0.03693					.022592	0.49			3.660			0.00		
-2040.01	2745.99	5.000	2750.990	719.0	20.69	6.648	2757.638	0.00	5.000		5.00	7.00	0.00	0	0.00
JUNCT STR	0.00000					.024264	0.00						0.00		
-2040.00	2745.99	7.068	2753.058	652.0	18.76	5.466	2758.524	0.00	5.000		5.00	7.00	0.00	0	0.00
97.08	0.03698					.021898	2.13			3.400			0.00		
-1942.92	2749.58	5.604	2755.184	652.0	18.76	5.466	2760.650	0.00	5.000		5.00	7.00	0.00	0	0.00
JUNCT STR	0.00000					.020439	0.00						0.00		
-1942.91	2749.58	6.763	2756.343	607.0	17.47	4.738	2761.081	0.00	5.000		5.00	7.00	0.00	0	0.00
57.91	0.03695					.018980	1.10			3.224			0.00		
-1885.00	2751.72	5.722	2757.442	607.0	17.47	4.738	2762.180	0.00	5.000		5.00	7.00	0.00	0	0.00

SLATER HANIFAN GROUP, 08-24-2012
CITY OF LAS VEGAS, RANCHO RD SYSTEM - ELKHORN (FT APACHE TO GRAND CANYON)
CLV1201.000, 30% PRE-DESIGN DRAINAGE REPORT, MAINLINE

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-4346.68    .I  WX        E                                                .  R
-4304.96    .                                                              .
-4263.23    .                                                              .
-4221.51    .                                                              .
-4179.79    .   I   WX        E                                            .  JX
-4138.06    .   I   WX        E                                            .  R
-4096.34    .                                                              .
-4054.62    .                                                              .
-4012.89    .       I   WX        E                                        .  R
-3971.17    .                                                              .
-3929.45    .                                                              .
-3887.72    .                                                              .
-3846.00    .                                                              .
-3804.28    .                                                              .
-3762.55    .                                                              .
-3720.83    .                                                              .
-3679.11    .                                                              .
-3637.38    .                                                              .
-3595.66    .                                                              .
-3553.94    .                   I   X         E                            .  JX
-3512.21    .                   I   X         E                            .  R
-3470.49    .                    I  WX         E                           .  R
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N O T E S
1. GLOSSARY
   I = INVERT ELEVATION
   C = CRITICAL DEPTH
   W = WATER SURFACE ELEVATION
   H = HEIGHT OF CHANNEL
   E = ENERGY GRADE LINE
   X = CURVES CROSSING OVER
   B = BRIDGE ENTRANCE OR EXIT
   Y = WALL ENTRANCE OR EXIT
2. STATIONS FOR POINTS AT A JUMP MAY NOT BE PLOTTED EXACTLY.

Lateral Full Flow Capacity Computations

18" RCP
Rating Table for Circular Channel

Project Description	
Worksheet	18" RCP
Flow Element	Circular Channel
Method	Manning's Formula
Solve For	Full Flow Capacity

Input Data	
Mannings Coefficient	0.013
Diameter	18.0 in

Attribute	Minimum	Maximum	Increment
Channel Slope (%)	0.5000	8.5000	0.5000

Channel Slope (%)	Discharge (cfs)	Depth (ft)	Velocity (ft/s)	Flow Area (ft^2)	Wetted Perimeter (ft)	Top Width (ft)
0.5000	7.43	1.50	4.20	1.8	4.71	0.00
1.0000	10.50	1.50	5.94	1.8	4.71	0.00
1.5000	12.86	1.50	7.28	1.8	4.71	0.00
2.0000	14.85	1.50	8.41	1.8	4.71	0.00
2.5000	16.61	1.50	9.40	1.8	4.71	0.00
3.0000	18.19	1.50	10.30	1.8	4.71	0.00
3.5000	19.65	1.50	11.12	1.8	4.71	0.00
4.0000	21.01	1.50	11.89	1.8	4.71	0.00
4.5000	22.28	1.50	12.61	1.8	4.71	0.00
5.0000	23.49	1.50	13.29	1.8	4.71	0.00
5.5000	24.63	1.50	13.94	1.8	4.71	0.00
6.0000	25.73	1.50	14.56	1.8	4.71	0.00
6.5000	26.78	1.50	15.15	1.8	4.71	0.00
7.0000	27.79	1.50	15.73	1.8	4.71	0.00
7.5000	28.77	1.50	16.28	1.8	4.71	0.00
8.0000	29.71	1.50	16.81	1.8	4.71	0.00
8.5000	30.62	1.50	17.33	1.8	4.71	0.00

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24" RCP
Rating Table for Circular Channel

Project Description	
Worksheet	24" RCP
Flow Element	Circular Channel
Method	Manning's Formula
Solve For	Full Flow Capacity

Input Data	
Mannings Coefficient	0.013
Diameter	24.0 in

Attribute	Minimum	Maximum	Increment
Channel Slope (%)	0.5000	8.5000	0.5000

Channel Slope (%)	Discharge (cfs)	Depth (ft)	Velocity (ft/s)	Flow Area (ft^2)	Wetted Perimeter (ft)	Top Width (ft)
0.5000	16.00	2.00	5.09	3.1	6.28	0.00
1.0000	22.62	2.00	7.20	3.1	6.28	0.00
1.5000	27.71	2.00	8.82	3.1	6.28	0.00
2.0000	31.99	2.00	10.18	3.1	6.28	0.00
2.5000	35.77	2.00	11.39	3.1	6.28	0.00
3.0000	39.18	2.00	12.47	3.1	6.28	0.00
3.5000	42.32	2.00	13.47	3.1	6.28	0.00
4.0000	45.24	2.00	14.40	3.1	6.28	0.00
4.5000	47.99	2.00	15.27	3.1	6.28	0.00
5.0000	50.58	2.00	16.10	3.1	6.28	0.00
5.5000	53.05	2.00	16.89	3.1	6.28	0.00
6.0000	55.41	2.00	17.64	3.1	6.28	0.00
6.5000	57.67	2.00	18.36	3.1	6.28	0.00
7.0000	59.85	2.00	19.05	3.1	6.28	0.00
7.5000	61.95	2.00	19.72	3.1	6.28	0.00
8.0000	63.98	2.00	20.37	3.1	6.28	0.00
8.5000	65.95	2.00	20.99	3.1	6.28	0.00

30" RCP
Rating Table for Circular Channel

Project Description	
Worksheet	30" RCP
Flow Element	Circular Channel
Method	Manning's Formula
Solve For	Full Flow Capacity

Input Data	
Mannings Coefficient	0.013
Diameter	24.0 in

Attribute	Minimum	Maximum	Increment
Channel Slope (%)	0.5000	8.5000	0.5000

Channel Slope (%)	Discharge (cfs)	Depth (ft)	Velocity (ft/s)	Flow Area (ft^2)	Wetted Perimeter (ft)	Top Width (ft)
0.5000	16.00	2.00	5.09	3.1	6.28	0.00
1.0000	22.62	2.00	7.20	3.1	6.28	0.00
1.5000	27.71	2.00	8.82	3.1	6.28	0.00
2.0000	31.99	2.00	10.18	3.1	6.28	0.00
2.5000	35.77	2.00	11.39	3.1	6.28	0.00
3.0000	39.18	2.00	12.47	3.1	6.28	0.00
3.5000	42.32	2.00	13.47	3.1	6.28	0.00
4.0000	45.24	2.00	14.40	3.1	6.28	0.00
4.5000	47.99	2.00	15.27	3.1	6.28	0.00
5.0000	50.58	2.00	16.10	3.1	6.28	0.00
5.5000	53.05	2.00	16.89	3.1	6.28	0.00
6.0000	55.41	2.00	17.64	3.1	6.28	0.00
6.5000	57.67	2.00	18.36	3.1	6.28	0.00
7.0000	59.85	2.00	19.05	3.1	6.28	0.00
7.5000	61.95	2.00	19.72	3.1	6.28	0.00
8.0000	63.98	2.00	20.37	3.1	6.28	0.00
8.5000	65.95	2.00	20.99	3.1	6.28	0.00

42" RCP
Rating Table for Circular Channel

Project Description	
Worksheet	42" RCP
Flow Element	Circular Channel
Method	Manning's Formula
Solve For	Full Flow Capacity

Input Data	
Mannings Coefficient	0.013
Diameter	24.0 in

Attribute	Minimum	Maximum	Increment
Channel Slope (%)	0.5000	8.5000	0.5000

Channel Slope (%)	Discharge (cfs)	Depth (ft)	Velocity (ft/s)	Flow Area (ft^2)	Wetted Perimeter (ft)	Top Width (ft)
0.5000	16.00	2.00	5.09	3.1	6.28	0.00
1.0000	22.62	2.00	7.20	3.1	6.28	0.00
1.5000	27.71	2.00	8.82	3.1	6.28	0.00
2.0000	31.99	2.00	10.18	3.1	6.28	0.00
2.5000	35.77	2.00	11.39	3.1	6.28	0.00
3.0000	39.18	2.00	12.47	3.1	6.28	0.00
3.5000	42.32	2.00	13.47	3.1	6.28	0.00
4.0000	45.24	2.00	14.40	3.1	6.28	0.00
4.5000	47.99	2.00	15.27	3.1	6.28	0.00
5.0000	50.58	2.00	16.10	3.1	6.28	0.00
5.5000	53.05	2.00	16.89	3.1	6.28	0.00
6.0000	55.41	2.00	17.64	3.1	6.28	0.00
6.5000	57.67	2.00	18.36	3.1	6.28	0.00
7.0000	59.85	2.00	19.05	3.1	6.28	0.00
7.5000	61.95	2.00	19.72	3.1	6.28	0.00
8.0000	63.98	2.00	20.37	3.1	6.28	0.00
8.5000	65.95	2.00	20.99	3.1	6.28	0.00

APPENDIX E

Reference Material

Rancho-Fort Apache Storm Drain, LBG

DRAFT FINAL DESIGN REPORT

RANCHO-FORT APACHE STORM DRAIN

PREPARED FOR:

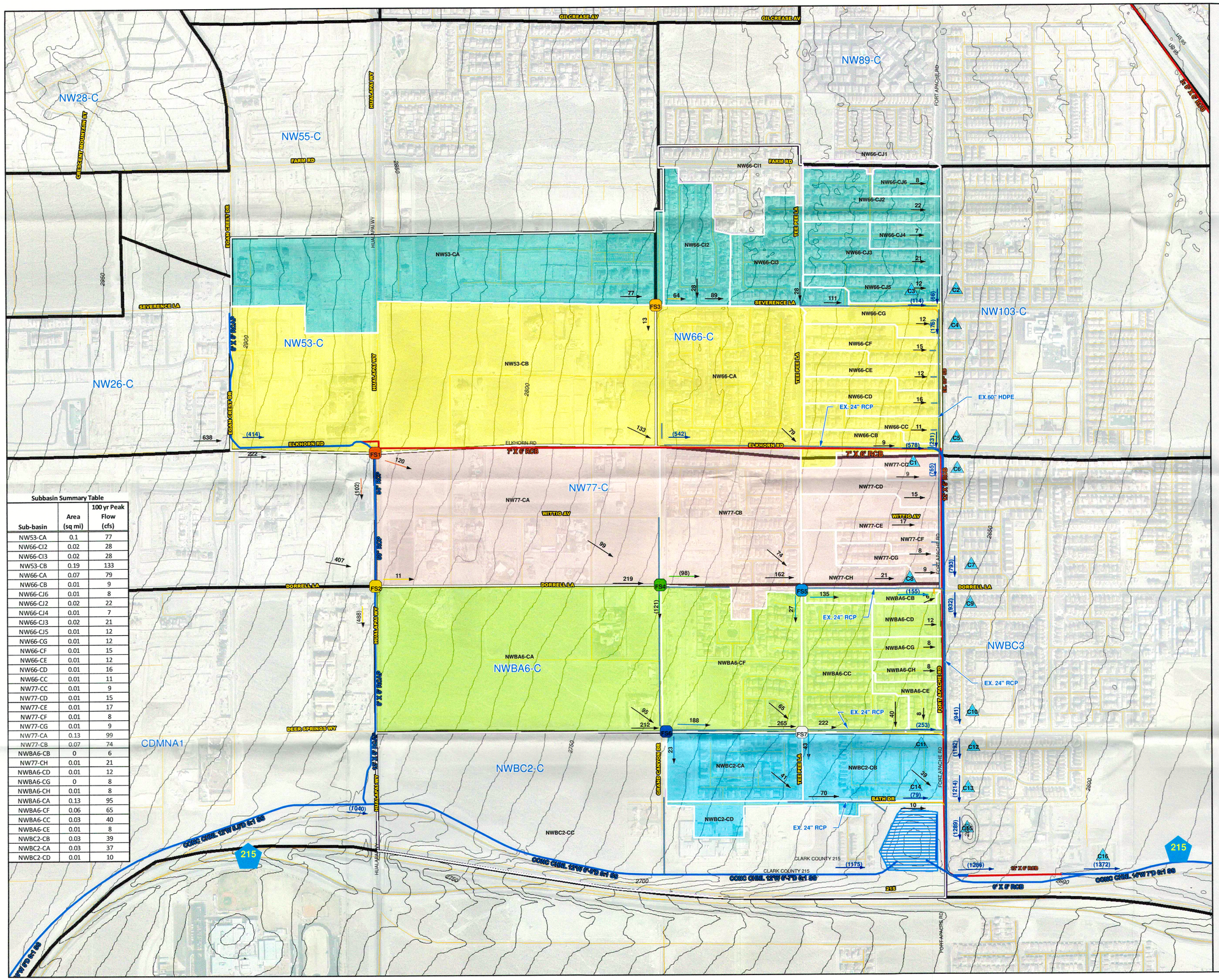
CITY OF LAS VEGAS
DEPARTMENT OF PUBLIC WORKS
333 NORTH RANCHO
LAS VEGAS, NV 89101

PREPARED BY:

THE LOUIS BERGER GROUP, INC.
500 E. AMIGO COURT, SUITE 100
LAS VEGAS, NV 89119

July 2012

Rancho - Fort Apache Storm Drain



Legend

- (xxx) Storm Drain Flow (cfs)
- Street Flow (cfs)
- LBG Subbasin
- MPU Basins
- Severence Watershed
- Elkhorn Watershed
- Deer Springs Watershed
- Echelon Watershed
- Dorrell Watershed
- Fort Apache Detention Basin
- Existing Regional Facilities
- Proposed Regional Facilities
- Proposed Local Facilities
- Local Facilities
- 10 Foot Contours
- CP1 Concentration Point
- FS1 Flow Split

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

Subbasin Summary Table

Sub-basin	Area (sq mi)	100 yr Peak Flow (cfs)
NW53-CA	0.1	77
NW66-CI2	0.02	28
NW66-CI3	0.02	28
NW53-CB	0.19	133
NW66-CA	0.07	79
NW66-CB	0.01	9
NW66-CJ6	0.01	8
NW66-CJ2	0.02	22
NW66-CJ4	0.01	7
NW66-CJ3	0.02	21
NW66-CJ5	0.01	12
NW66-CG	0.01	12
NW66-CF	0.01	15
NW66-CE	0.01	12
NW66-CD	0.01	16
NW66-CC	0.01	11
NW77-CC	0.01	9
NW77-CD	0.01	15
NW77-CE	0.01	17
NW77-CF	0.01	8
NW77-CG	0.01	9
NW77-CA	0.13	99
NW77-CB	0.07	74
NWBA6-CB	0	6
NW77-CH	0.01	21
NWBA6-CD	0.01	12
NWBA6-CG	0	8
NWBA6-CH	0.01	8
NWBA6-CA	0.13	95
NWBA6-CF	0.06	65
NWBA6-CC	0.03	40
NWBA6-CE	0.01	8
NWBC2-CB	0.03	39
NWBC2-CA	0.03	37
NWBC2-CD	0.01	10

Flow Split Summary Table

Number	HEC-1 Node	Area (sq mi)
FS1	DCFB-C	0.93
FS2	DBA3-C	0.84
FS3	SEV	0.10
FS4	GC-DRINT	0.64
FS5	DORTP	0.71
FS6	CFTELB	1.32
FS7	DSTP	1.22

Concentration Point Summary Table

Number	HEC-1 Node	Area (sq mi)	Facility	100-yr Peak Flow (cfs)
C1	C66-CB	0.93	Ft Apache Storm Drain	608
C2	C66CJ5	0.06	Ex. 60" HDPE Storm Drain	66
C3	DSEV	0.15	Severence Lateral	114
C4	CFA&SV	0.21	Ex. 60" HDPE Storm Drain	176
C5	CRC66CC	0.26	Severence / Ft Apache 5'x5' RCB	231
C6	CFTELKS	1.04	Ft Apache Storm Drain	765
C7	CNW77-CG	1.08	Ft Apache Storm Drain	793
C8	CPT2A	0.72	Dorrell	155
C9	CBA6-CB	1.29	Ft Apache Storm Drain	932
C10	CBA6-CD	1.31	Ft Apache Storm Drain	941
C11	CBA6-CE	1.26	Deer Springs Lateral	253
C12	CPT1A	1.87	Ft Apache Storm Drain	1192
C13	FTAP	1.90	Ft Apache Storm Drain	1214
C14	CP-EPL	1.26	Echelon Lateral	79
C15	FTAP2	1.94	Ft Apache Storm Drain	1289
C16	CFADB	2.63	Freeway Channel	1372

Rancho - Fort Apache Storm Drain
Future Conditions Hydrology

```
1*****************************************
*                                       *
*   FLOOD HYDROGRAPH PACKAGE  (HEC-1)   *
*             JUN  1998                 *
*           VERSION 4.1                 *
*                                       *
*  RUN DATE   22JUN12  TIME  09:57:07   *
*                                       *
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*****************************************
*                                       *
*    U.S. ARMY CORPS OF ENGINEERS       *
*    HYDROLOGIC ENGINEERING CENTER      *
*          609 SECOND STREET            *
*       DAVIS, CALIFORNIA 95616         *
*           (916) 756-1104              *
*                                       *
*****************************************
```

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X     X  X        X     X        XX
X     X  X        X              X
XXXXXXX  XXXX     X        XXXXX  X
X     X  X        X              X
X     X  X        X     X        X
X     X  XXXXXXX   XXXXX         XXX
```

THIS PROGRAM REPLACES ALL PREVIOUS VERSIONS OF HEC-1 KNOWN AS HEC1 (JAN 73), HEC1GS, HEC1DB, AND HEC1KW.

THE DEFINITIONS OF VARIABLES -RTIMP- AND -RTIOR- HAVE CHANGED FROM THOSE USED WITH THE 1973-STYLE INPUT STRUCTURE.
THE DEFINITION OF -AMSKK- ON RM-CARD WAS CHANGED WITH REVISIONS DATED 28 SEP 81. THIS IS THE FORTRAN77 VERSION
NEW OPTIONS: DAMBREAK OUTFLOW SUBMERGENCE , SINGLE EVENT DAMAGE CALCULATION, DSS:WRITE STAGE FREQUENCY,
DSS:READ TIME SERIES AT DESIRED CALCULATION INTERVAL LOSS RATE:GREEN AND AMPT INFILTRATION
KINEMATIC WAVE: NEW FINITE DIFFERENCE ALGORITHM


```
          LINE          ID.....1.....2.....3.....4.....5.....6.....7.....8.....9.....10
                        *DIAGRAM
*** FREE ***
             1          ID    CLARK COUNTY REGIONAL FLOOD CONTROL DISTRICT 2008 MASTER PLAN UPDATE
             2          ID    UPPER AND LOWER NORTHERN LAS VEGAS WASH WATERSHEDS
             3          ID    RECOMMENDED DRAINAGE SYSTEM WITH ULTIMATE DEVELOPMENT
             4          ID    INPUT FILE = WEST8.DAT
             5          ID    INPUT FILE DATE = MAY 2008
             6          ID    DESIGN STORM = 100-YEAR 6-HOUR STORM
             7          ID    STORM DISTRIBUTION = SDN3
             8          ID    MODELED BY PBS&J (KRYSTLE PEMBERTON, E.I., CFM)
             9          ID    CHECKED BY PBS&J (HARSHAL B. DESAI, P.E., CFM)
            10          ID    STORM CENTERING = WEST TRIBUTARY
            11          ID    DOWNSTREAM OF THE UPPER LAS VEGAS WASH DETENTION BASIN TO THE MOST
            12          ID    DOWNSTREAM POINT IN THE LOWER NORTHERN LAS VEGAS WASH WATERSHED
            13          ID
            14          ID    REFERENCED HYDROLOGIC MODELS:
            15          ID    REVISED FINAL DESIGN REPORT FOR THE RANCHO DETENTION BASIN
            16          ID    PHASE II (VTN 2006)
            17          ID    RESPONSE TO COMMENTS ON THE CONCEPTUAL DRAINAGE STUDY FOR
            18          ID    NORTH LAS VEGAS 600-ACRE SITE (GC WALLACE 2006)
            19          ID    SECOND RESPONSE TO COMMENTS OF THE CONCEPTUAL DRAINAGE STUDY
            20          ID    FOR NORTH LAS VEGAS 2074-ACRE SITE (GC WALLACE 2006)
            21          ID    BASIN MAPS FOR SUPPLEMENT #2 TO ADDENDUM #2 TO THE MASTER
            22          ID    DRAINAGE STUDY FOR CLIFF'S EDGE/ PROVIDENCE (VTN 2004)
            23          ID    MASTER DRAINAGE STUDY FOR KYLE CANYON (GC WALLACE 2006)
            24          ID    TECHNICAL DRAINAGE STUDY FOR GRAND TETON DRIVE STROM DRAIN
            25          ID    AND AREA 1 ROADWAY IMPROVEMENTS  (GC WALLACE 2006)
            26          ID    90% FINAL DESIGN REPORT FOR RANCHO ROAD SYSTEM - EL CAMPO
            27          ID    GRANDE STORM DRAIN PROJECT (PBS&J 2007)
            28          ID    MPA FOR RACEL STREET COLLECTOR (LOUIS BERGER JANUARY 2007)
            29          ID    HYDROLOGIC MODEL FOR FLOYD LAMB NORTH AND SOUTH ENVIRONMENTAL
            30          ID    ENHANCEMENT AREAS (LOUIS BERGER  DECEMBER 7, 2007)
            31          ID
            32          ID    UPDATED BY THE LOUIS BERGER GROUP INC FOR THE RANCHO-FORT
            33          ID    APACHE STORM DRAIN PROJECT.  MODEL WAS NOT TRUNCATED IN ORDER TO
            34          ID    VERFITY THAT THE RANCHO DETENTION BASIN (RCHODB) WAS NOT AFFECTED.
            35          ID    INPUT FILE = FASD.DAT
            36          ID    INPUT FILE DATE = JUNE 2012
            37          ID    MODELED BY LBG (RUFIN INOS, E.I. AND FRED RETZLAFF, P.E.)
            38          ID    CHECKED BY LBG (JEFFREY, S DOUGLAS, P.E., CFM)
            39          ID
            40          ID
            41          ID    JR CARDS CONTAIN DARFS BASED ON THE FOLLOWING VALUES:
            42          ID
            43          ID    AREA (SQUARE MILES)           DARF
            44          ID          0 - 0.5                 0.99
            45          ID          0.5 - 1                 0.975
            46          ID          1 - 2                   0.95
            47          ID          2 - 3                   0.925
            48          ID          3 - 4                   0.915
            49          ID          4 - 5                   0.908
            50          ID          5 - 6                   0.903
            51          ID          6 - 7                   0.895
            52          ID          7 - 8                   0.885
            53          ID
```



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          LINE          ID.....1.....2.....3.....4.....5.....6.....7.....8.....9.....10
            54          IT       5       0       0     200
            55          IO       5       0       0
            56          IN       5       0       0
            57          JR    PREC    0.99   0.975    0.95   0.925   0.915   0.908   0.903   0.895   0.885
                        *
            58          KK  NW62-S
            59          BA   0.208
            60          PB    2.77
            61          PC   0.000   0.020   0.057   0.070   0.087   0.108   0.124   0.130   0.130   0.130
            62          PC   0.130   0.130   0.130   0.133   0.140   0.142   0.148   0.158   0.172   0.181
```

```
1*****************************************
*                                       *
*   FLOOD HYDROGRAPH PACKAGE  (HEC-1)   *
*             JUN   1998                *
*           VERSION 4.1                 *
*                                       *
*  RUN DATE   22JUN12  TIME  09:57:07   *
*                                       *
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*    HYDROLOGIC ENGINEERING CENTER      *
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*       DAVIS, CALIFORNIA 95616         *
*           (916) 756-1104              *
*                                       *
*****************************************
```

```
X     X  XXXXXXX  XXXXX          X
X     X  X       X     X        XX
X     X  X       X              X
XXXXXXX  XXXX    X        XXXXX  X
X     X  X       X              X
X     X  X       X     X        X
X     X  XXXXXXX  XXXXX         XXX
```

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DSS:READ TIME SERIES AT DESIRED CALCULATION INTERVAL LOSS RATE:GREEN AND AMPT INFILTRATION
KINEMATIC WAVE: NEW FINITE DIFFERENCE ALGORITHM

1 HEC-1 INPUT PAGE 1

```
          LINE      ID.....1.....2.....3.....4.....5.....6.....7.....8.....9.....10
                    *DIAGRAM
 *** FREE ***
             1      ID    CLARK COUNTY REGIONAL FLOOD CONTROL DISTRICT 2008 MASTER PLAN UPDATE
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             5      ID    INPUT FILE DATE = MAY 2008
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            11      ID    DOWNSTREAM OF THE UPPER LAS VEGAS WASH DETENTION BASIN TO THE MOST
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            18      ID    NORTH LAS VEGAS 600-ACRE SITE (GC WALLACE 2006)
            19      ID    SECOND RESPONSE TO COMMENTS OF THE CONCEPTUAL DRAINAGE STUDY
            20      ID    FOR NORTH LAS VEGAS 2074-ACRE SITE (GC WALLACE 2006)
            21      ID    BASIN MAPS FOR SUPPLEMENT #2 TO ADDENDUM #2 TO THE MASTER
            22      ID    DRAINAGE STUDY FOR CLIFF'S EDGE/ PROVIDENCE (VTN 2004)
            23      ID    MASTER DRAINAGE STUDY FOR KYLE CANYON (GC WALLACE 2006)
            24      ID    TECHNICAL DRAINAGE STUDY FOR GRAND TETON DRIVE STROM DRAIN
            25      ID    AND AREA 1 ROADWAY IMPROVEMENTS  (GC WALLACE 2006)
            26      ID    90% FINAL DESIGN REPORT FOR RANCHO ROAD SYSTEM - EL CAMPO
            27      ID    GRANDE STORM DRAIN PROJECT (PBS&J 2007)
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            29      ID    HYDROLOGIC MODEL FOR FLOYD LAMB NORTH AND SOUTH ENVIRONMENTAL
            30      ID    ENHANCEMENT AREAS (LOUIS BERGER  DECEMBER 7, 2007)
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            38      ID    CHECKED BY LBG (JEFFREY, S DOUGLAS, P.E., CFM)
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            40      ID
            41      ID    JR CARDS CONTAIN DARFS BASED ON THE FOLLOWING VALUES:
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            43      ID    AREA (SQUARE MILES)           DARF
            44      ID          0 - 0.5                 0.99
            45      ID          0.5 - 1                 0.975
            46      ID          1 - 2                   0.95
            47      ID          2 - 3                   0.925
            48      ID          3 - 4                   0.915
            49      ID          4 - 5                   0.908
            50      ID          5 - 6                   0.903
            51      ID          6 - 7                   0.895
            52      ID          7 - 8                   0.885
            53      ID
```

1 HEC-1 INPUT PAGE 2

```
          LINE      ID.....1.....2.....3.....4.....5.....6.....7.....8.....9.....10
            54      IT       5       0       0     200
            55      IO       5       0       0
            56      IN       5       0       0
            57      JR    PREC    0.99   0.975    0.95   0.925   0.915   0.908   0.903   0.895   0.885
                    *
            58      KK  NW62-S
            59      BA   0.208
            60      PB    2.77
            61      PC   0.000   0.020   0.057   0.070   0.087   0.108   0.124   0.130   0.130   0.130
            62      PC   0.130   0.130   0.130   0.133   0.140   0.142   0.148   0.158   0.172   0.181
```

```
                *
1215            KK  NW27-C
1216            BA   0.148
1217            PB    3.06
1218            LS       0    90.0
1219            UD   0.234
                *

1220            KK  RN27-C
1221            KM  ROUTE NW27-C TO CNW26-C
1222            KM  FACILITY = ELKHORN AND HUALAPAI
1223            KM  FACILITY ID-MILE = EKHU 0023
1224            KM  LINING = RCAP
1225            RD    2300   0.009   0.015       0    TRAP       8       0
                *
```



```
LINE            ID.......1.......2.......3.......4.......5.......6.......7.......8.......9.....10

1226            KK  NW26-C
1227            BA   0.367
1228            PB    3.09
1229            LS       0    90.3
1230            UD   0.325
                *

1231            KK CNW26-C
1232            KM  COMBINE NW26-C AND RN27-C
1233            HC       2
                *

1234            KK  RN26-C
1235            KM  ROUTE CN26-C TO DNW26-C
1236            KM  FACILITY = ELKHORN AND HUALAPAI
1237            KM  FACILITY ID-MILE = EKHU 0000,0001,0003,0020
1238            KM  LINING = RCAP
1239            RD    1250   0.036   0.015       0    TRAP       6       0
                *

1240            KK DNW26-C
1241            KM  190 CFS IN FACILITY AND 132 CFS SURFACE FLOW
1242            KM  GO SOUTH ON HUALAPAI AND REMAINING FLOW GOES EAST
1243            KM  PER "SUPPLEMENT #2 TO ADDENDUM #2 TO THE TDS FOR
1244            KM  CLIFFS EDGE" PREPARED BY VTN (FIGURE 5-N AND 5-S)
1245            KM  THE FLOW GOING SOUTH WAS REDUCED BY 100 CFS TO
1246            KM  KEEP THE FORT APACHE DB FROM OVERTOPPING
1247            DTDOUTFLOW
1248            DI       0     222     500    1000    5000
1249            DQ       0       0     278     778    4778
                *

1250            KK  RC26-C
1251            KM  ROUTE DNW26-C TO CBA3-C
1252            KM  FACILITY = BELTWAY CHANNEL - HUALAPAI
1253            KM  FACILITY ID-MILE = BCHU 0054,0042,0040
1254            KM  LINING = RCP
1255            RD    1445   0.014   0.013       0    CIRC       5       0
                *

1256            KK  DC26-C
1257            KM  DIVERT 120 CFS FROM RC26-C TO NW77-C
1258            KM  IN PROPOSED LOCAL FACILITY AND STREETS
1259            KM  REMAINING FLOW ROUTED TO CDMNA1
1260            KM  REFERENCED FROM "REVISED FINAL DESIGN REPORT -
1261            KM  RANCHO DETENTION BASIN PHASE II" PREPARED BY VTN (JUNE 2006)
1262            KM  REFERENCE NODE: DCE3
1263            DT DNW77-C
1264            DI       0     120     150     200     500    1000    5000
1265            DQ       0     120     120     120     120     120     120
                *
```



```
LINE            ID.......1.......2.......3.......4.......5.......6.......7.......8.......9.....10

1266            KK NWBA3-C
1267            BA   0.327
1268            PB    3.11
1269            LS       0    89.7
1270            UD   0.313
                *

1271            KK  CBA3-C
1272            KM  COMBINE NWBA3-C AND DC26-C
1273            KM  DORRELL AND HUALAPAI
1274            HC       2
                *

1275            KKRDWBA3-C
1276            KM  ROUTE CBA3-C TO CMNA1
1277            KM  FACILITY = BELTWAY CHANNEL - HUALAPAI
1278            KM  FACILITY ID-MILE = BCHU 0017
1279            KM  LINING = RCAP
1280            RD    1360   0.013   0.015       0    TRAP       8       0
                *

1281            KK  DBA3-C
1282            KM  DIVERT 11 CFS FROM RDWBA3-C TO NWBA6-C
1283            KM  REMAINING FLOW COMBINES AT CMNA1
1284            KM  REFERENCED FROM "REVISED FINAL DESIGN REPORT -
1285            KM  RANCHO DETENTION BASIN PHASE II" PREPARED BY VTN (JUNE 2006)
1286            KM  REFERENCE NODE: DCE4
1287            DTDNWBA6-C
1288            DI       0      11      50     100     500    1000
1289            DQ       0      11      11      11      11      11
                *
```

```
1290          KKR2WBA3-C
1291          KM  ROUTE DBA3-C TO CMNA1
1292          KM  FACILITY = BELTWAY CHANNEL - HUALAPAI
1293          KM  FACILITY ID-MILE = BCHU 0000
1294          KM  LINING = RCAP
1295          RD     853   0.011   0.015       0    TRAP      12       0
              *

1296          KK  CDMNA1
1297          BA   0.481
1298          PB    3.12
1299          LS       0     90.8
1300          UD   0.344
              *

1301          KK   CMNA1
1302          KM  COMBINE CDMNA1 AND R2WBA3-C
1303          KM  RANCHO ROAD SYSTEM-BELTWAY @ HUALAPAI WAY
1304          HC       2
              *
```



```
LINE          ID.....1.....2.....3.....4.....5.....6.....7.....8.....9.....10

1305          KK  RCMNA1
1306          KM  ROUTE CMNA1 TO FADBIN
1307          KM  FACILITY = RANCHO ROAD SYSTEM - BELTWAY
1308          KM  FACILITY # = RCBC 0096,0051,0048,0012,0009,0007
1309          KM  LINING = CONCRETE
1310          RD    5160   0.034   0.015       0    TRAP      12       0
              *

1311          KKNWBC2-CC
1312          BA   0.206
1313          PB    3.03
1314          LS       0     79.4
1315          UD   0.268
              *

1316          KK FADBIN1
1317          KM  COMBINE RCMNA1 AND NWBC2-C
1318          HC       2
              *

1319          KKDFADBIN1
1320          KM   DIVERT OUT FLOW INTO DETENTION BASIN.  RETRIVE AFTER
1321          KM   FLOW SPLIT AT GRAND CANYON AND DEER SPRINGS IS CALCULATED.
1322          DT   DFADB
1323          DI       0  9000.1
1324          DQ       0  9000.0
              *

1325          KK NW53-CA
1326          BA   0.103
1327          PB    2.85
1328          LS       0     79.1
1329          UD   0.252
              *

1330          KK     SEV
1331          KM   FLOW SPLIT AT SEVERENCE & GRAND CANYON
1332          KM   REMAINING FLOW GOES EAST ON SEVERENCE
1333          KM   PIMA COUNTY METHOD
1334          DT    DSGC
1335          DI       0      50     100     150     200     250     350     500     750
1336          DQ       0       9      16      23      29      38      60      80     129
              *
              *
              *
              * ***************
              * NEW BASIN
              * ***************
              *
```



```
LINE          ID.....1.....2.....3.....4.....5.....6.....7.....8.....9.....10

1337          KKNW66-CI2
1338          BA   0.024
1339          PB    2.85
1340          LS       0     84.0
1341          UD   0.162
              *

1342          KK    CCI2
1343          HC       2
              *
              *
              * ***************
              * NEW BASIN
              * ***************
              *

1344          KKNW66-CI3
1345          BA   0.024
1346          PB    2.85
1347          LS       0     84.1
1348          UD   0.163
              *

1349          KK    CCI3
1350          HC       2
              *

1351          KK     SGC
```

```
1352          KM   FLOW AT INTERSECTION OF TEE PEE AND SEVERANCE
1353          KM   NO FLOW SPLIT, ALL FLOW CONTINUES EAST ALONG
1354          KM   SEVERANCE.
1355          DT    DSEV
1356          DI       0  3000.1
1357          DQ       0  3000.0
              *

1358          KKDOUTFLOW
1359          KM   RETIREVE DOUTFLOW FLOWING EAST ON ELKHORN
1360          DRDOUTFLOW
              *

1361          KKRDOUTFLW
1362          KM   ROUTE DOUTFLOW TO CNW53-C
1363          KM   FACILITY = RANCHO ROAD SYSTEM - BELTWAY
1364          KM   FACILITY # = RCHB 0295
1365          KM   LINING = RCB
1366          RD    2925   0.033   0.015       0    TRAP       7       0
              *
              * ***************
              * REVISE BASIN
              * ***************
              *
```



```
LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

1367          KK NW53-CB
1368          BA   0.188
1369          PB    2.85
1370          LS       0    79.3
1371          UD   0.292
              *

1372          KK    DSGC
1373          KM   RETRIEVE DSGC FLOWING SOUTH ON GRAND CANYON
1374          DR    DSGC
              *

1375          KK CNW53-C
1376          KM   COMBINE FLOWS AT ELKHORN AND GRAND CANYON
1377          HC       4
              *

1378          KKRCNW53-C
1379          KM   ROUTE CNW53-C TO CNW66-C
1380          KM   ROUTE ELK AND GC TO ELK AND FT APACHE
1381          KM   FACILITY = RANCHO ROAD SYSTEM - BELTWAY
1382          KM   FACILITY # = RCHB 0295
1383          KM   LINING = RCB
1384          RD    2600   0.033   0.015       0    TRAP       7       0
              *

1385          KK NW66-CA
1386          BA   0.067
1387          PB    2.91
1388          LS       0    84.0
1389          UD   0.166
              *

1390          KK NW66-CB
1391          BA   0.010
1392          PB    2.91
1393          LS       0    77.5
1394          UD   0.129
              *

1395          KK  C66-CB
1396          KM   FLOW IN RCHB 0295 JUST WEST OF INTERSECTION
1397          KM   OF ELKHORN AND FORT APACHE
1398          HC       3
              *

1399          KKNW66-CJ6
1400          BA   0.006
1401          PB    2.85
1402          LS       0    84.0
1403          UD   0.101
              *
```



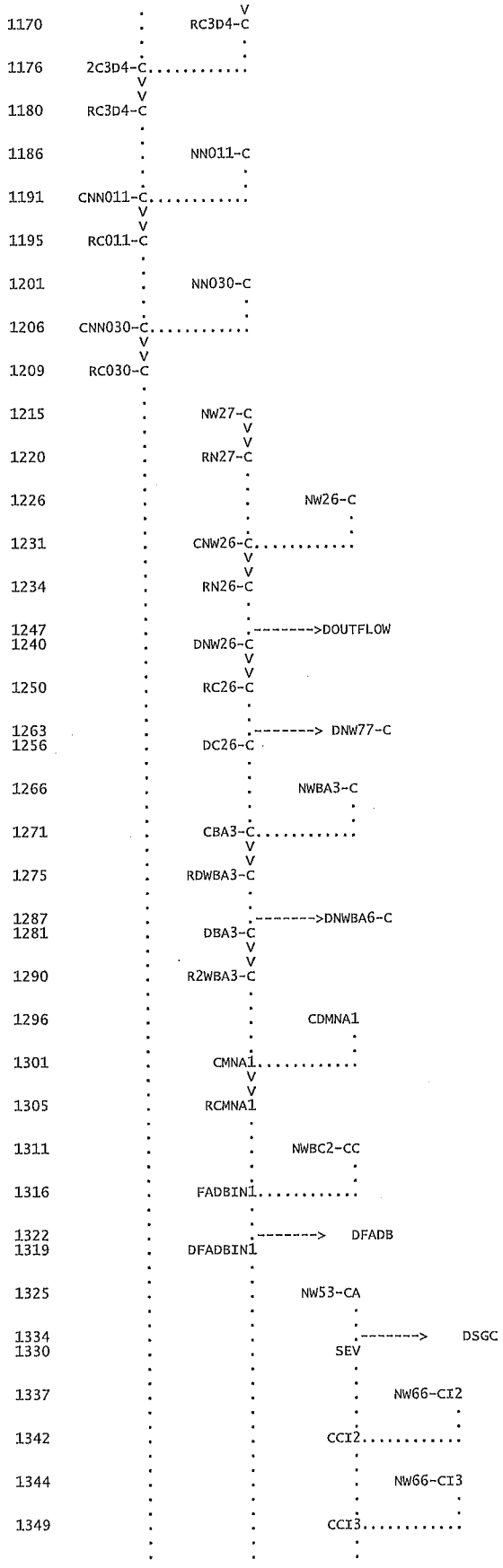
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LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

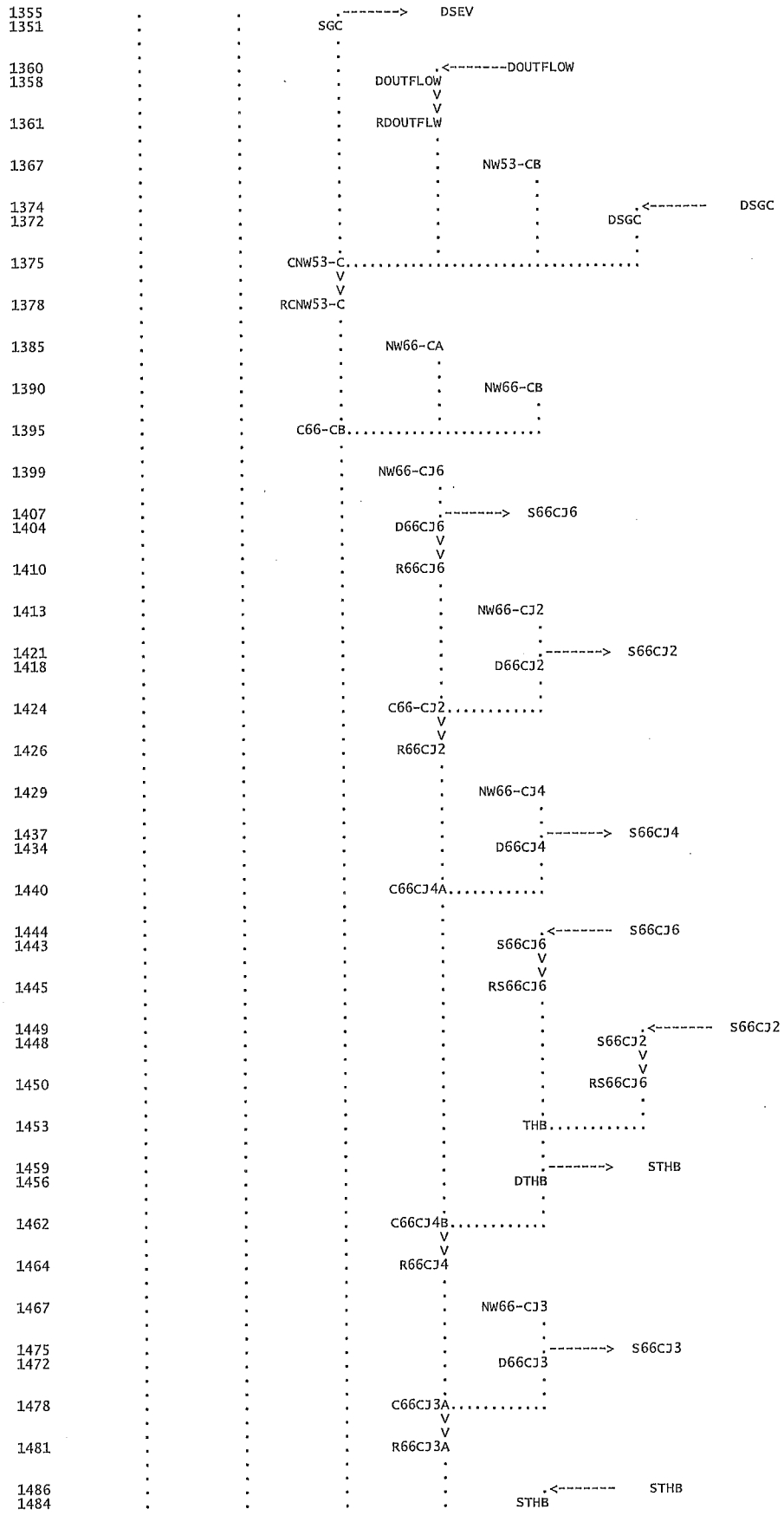
1404          KK  D66CJ6
1405          KM   PART OF FLOW GOES INTO 60" STORM DRAIN
1406          KM   THE REMAINDER TRAVELS IN THE STREET SOUTH ON FT APACHE
1407          DT  S66CJ6
1408          DI       0       4    1004
1409          DQ       0       0    1000
              *

1410          KK  R66CJ6
1411          KM   ROUTE STORM DRAIN FLOWS TO GOLD LAKE AVE
1412          RD     243  0.0050   0.013       0    CIRC       5       0
              *

1413          KKNW66-CJ2
1414          BA   0.018
1415          PB    2.85
1416          LS       0    84.0
1417          UD   0.128
              *

1418          KK  D66CJ2
1419          KM   PART OF FLOW GOES INTO 60" STORM DRAIN
```


1170
RC3D4-C
1176
2C3D4-C
1180
RC3D4-C
1186
NN011-C
1191
CNN011-C
1195
RC011-C
1201
NN030-C
1206
CNN030-C
1209
RC030-C
1215
NW27-C
1220
RN27-C
1226
NW26-C
1231
CNW26-C
1234
RN26-C
1247
1240
DNW26-C
1250
RC26-C
1263
1256
DC26-C
1266
NWBA3-C
1271
CBA3-C
1275
RDWBA3-C
1287
1281
DBA3-C
1290
R2WBA3-C
1296
CDMNA1
1301
CMNA1
1305
RCMNA1
1311
NWBC2-CC
1316
FADBIN1
1322
1319
DFADBIN1
1325
NW53-CA
1334
1330
SEV
1337
NW66-CI2
1342
CCI2
1344
NW66-CI3
1349
CCI3
DOUTFLOW
DNW77-C
DNWBA6-C
DFADB
DSGC


1355
1351
SGC
DSEV
1360
1358
DOUTFLOW
DOUTFLOW
1361
RDOUTFLW
1367
NW53-CB
1374
1372
DSGC
DSGC
1375
CNW53-C
1378
RCNW53-C
1385
NW66-CA
1390
NW66-CB
1395
C66-CB
1399
NW66-CJ6
1407
1404
D66CJ6
S66CJ6
1410
R66CJ6
1413
NW66-CJ2
1421
1418
D66CJ2
S66CJ2
1424
C66-CJ2
1426
R66CJ2
1429
NW66-CJ4
1437
1434
D66CJ4
S66CJ4
1440
C66CJ4A
1444
1443
S66CJ6
S66CJ6
1445
RS66CJ6
1449
1448
S66CJ2
S66CJ2
1450
RS66CJ6
1453
THB
1459
1456
DTHB
STHB
1462
C66CJ4B
1464
R66CJ4
1467
NW66-CJ3
1475
1472
D66CJ3
S66CJ3
1478
C66CJ3A
1481
R66CJ3A
1486
1484
STHB
STHB

+	RC3C2-C	11.29	1	FLOW	3918.	3813.	3635.	3458.	3392.	3341.	3308.	3250.	3183.
				TIME	4.08	4.08	4.08	4.08	4.08	4.08	4.08	4.08	4.08
HYDROGRAPH AT													
+	NW3D4-C	.26	1	FLOW	222.	217.	209.	201.	198.	196.	194.	192.	188.
				TIME	3.83	3.83	3.83	3.83	3.83	3.83	3.83	3.83	3.83
2 COMBINED AT													
+	CNW3D4-C	11.55	1	FLOW	4095.	3985.	3801.	3618.	3549.	3497.	3463.	3403.	3334.
				TIME	4.08	4.08	4.08	4.08	4.08	4.08	4.08	4.08	4.08
ROUTED TO													
+	RC3D4-C	11.55	1	FLOW	4087.	3975.	3792.	3606.	3537.	3485.	3449.	3390.	3320.
				TIME	4.08	4.08	4.08	4.08	4.08	4.08	4.08	4.08	4.08
2 COMBINED AT													
+	2C3D4-C	17.99	1	FLOW	9324.	9087.	8731.	8321.	8166.	8075.	7996.	7868.	7709.
				TIME	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00
ROUTED TO													
+	RC3D4-C	17.99	1	FLOW	9261.	9024.	8655.	8240.	8087.	7991.	7908.	7783.	7616.
				TIME	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00
HYDROGRAPH AT													
+	NN011-C	.27	1	FLOW	366.	359.	347.	336.	331.	328.	326.	322.	318.
				TIME	3.67	3.67	3.67	3.67	3.67	3.67	3.67	3.67	3.67
2 COMBINED AT													
+	CNN011-C	18.26	1	FLOW	9411.	9171.	8798.	8379.	8224.	8127.	8043.	7916.	7747.
				TIME	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00
ROUTED TO													
+	RC011-C	18.26	1	FLOW	9323.	9083.	8712.	8296.	8141.	8048.	7985.	7854.	7714.
				TIME	4.00	4.00	4.00	4.08	4.08	4.08	4.08	4.08	4.08
HYDROGRAPH AT													
+	NN030-C	.29	1	FLOW	319.	313.	302.	291.	287.	284.	282.	278.	274.
				TIME	3.75	3.75	3.75	3.75	3.75	3.75	3.75	3.75	3.75
2 COMBINED AT													
+	CNN030-C	18.55	1	FLOW	9517.	9273.	8896.	8470.	8294.	8194.	8125.	7992.	7850.
				TIME	4.00	4.00	4.00	4.00	4.00	4.00	4.08	4.08	4.08
ROUTED TO													
+	RC030-C	18.55	1	FLOW	9453.	9211.	8829.	8439.	8281.	8186.	8122.	7988.	7842.
				TIME	4.00	4.00	4.08	4.08	4.08	4.08	4.08	4.08	4.08
HYDROGRAPH AT													
+	NW27-C	.15	1	FLOW	207.	203.	196.	189.	186.	185.	183.	181.	178.
				TIME	3.67	3.67	3.67	3.67	3.67	3.67	3.67	3.67	3.67
ROUTED TO													
+	RN27-C	.15	1	FLOW	203.	199.	193.	185.	183.	181.	179.	178.	175.
				TIME	3.67	3.67	3.67	3.67	3.67	3.67	3.67	3.67	3.67
HYDROGRAPH AT													
+	NW26-C	.37	1	FLOW	456.	447.	432.	417.	411.	407.	404.	399.	393.
				TIME	3.75	3.75	3.75	3.75	3.75	3.75	3.75	3.75	3.75
2 COMBINED AT													
+	CNW26-C	.51	1	FLOW	650.	638.	617.	596.	587.	582.	577.	571.	562.
				TIME	3.75	3.75	3.75	3.75	3.75	3.75	3.75	3.75	3.75
ROUTED TO													
+	RN26-C	.51	1	FLOW	649.	636.	616.	595.	586.	581.	576.	570.	560.
				TIME	3.75	3.75	3.75	3.75	3.75	3.75	3.75	3.75	3.75
DIVERSION TO													
+	DOUTFLOW	.51	1	FLOW	427.	414.	394.	373.	364.	359.	354.	348.	338.
				TIME	3.75	3.75	3.75	3.75	3.75	3.75	3.75	3.75	3.75
HYDROGRAPH AT													
+	DNW26-C	.51	1	FLOW	222.	222.	222.	222.	222.	222.	222.	222.	222.
				TIME	3.42	3.42	3.42	3.42	3.50	3.50	3.50	3.50	3.50
ROUTED TO													
+	RC26-C	.51	1	FLOW	222.	222.	222.	222.	222.	222.	222.	222.	222.
				TIME	3.50	3.50	3.50	3.50	3.58	3.58	3.58	3.58	3.58
DIVERSION TO													
+	DNW77-C	.51	1	FLOW	120.	120.	120.	120.	120.	120.	120.	120.	120.
				TIME	3.33	3.33	3.33	3.33	3.42	3.42	3.42	3.42	3.42
HYDROGRAPH AT													
+	DC26-C	.51	1	FLOW	102.	102.	102.	102.	102.	102.	102.	102.	102.
				TIME	3.50	3.50	3.50	3.50	3.58	3.58	3.58	3.58	3.58
HYDROGRAPH AT													
+	NWBA3-C	.33	1	FLOW	407.	399.	386.	372.	367.	363.	360.	356.	351.
				TIME	3.75	3.75	3.75	3.75	3.75	3.75	3.75	3.75	3.75
2 COMBINED AT													
+	CBA3-C	.84	1	FLOW	509.	501.	488.	474.	469.	465.	462.	458.	453.
				TIME	3.75	3.75	3.75	3.75	3.75	3.75	3.75	3.75	3.75
ROUTED TO													
+	RDWBA3-C	.84	1	FLOW	507.	499.	486.	472.	467.	463.	460.	456.	451.
				TIME	3.75	3.75	3.75	3.75	3.75	3.75	3.75	3.75	3.75
DIVERSION TO													
+	DNWBA6-C	.84	1	FLOW	11.	11.	11.	11.	11.	11.	11.	11.	11.
				TIME	1.58	1.58	1.67	1.67	1.67	1.67	1.67	1.67	1.67
HYDROGRAPH AT													
+	DBA3-C	.84	1	FLOW	496.	488.	475.	461.	456.	452.	449.	445.	440.
				TIME	3.75	3.75	3.75	3.75	3.75	3.75	3.75	3.75	3.75
ROUTED TO													

+	R2WBA3-C	.84	1	FLOW	494.	486.	473.	459.	454.	450.	447.	443.	438.
				TIME	3.75	3.75	3.75	3.75	3.75	3.75	3.75	3.75	3.75
HYDROGRAPH AT													
+	CDMNA1	.48	1	FLOW	598.	587.	567.	548.	540.	535.	531.	525.	517.
				TIME	3.75	3.75	3.75	3.75	3.75	3.75	3.75	3.75	3.75
2 COMBINED AT													
+	CMNA1	1.32	1	FLOW	1093.	1073.	1040.	1007.	994.	985.	978.	968.	955.
				TIME	3.75	3.75	3.75	3.75	3.75	3.75	3.75	3.75	3.75
ROUTED TO													
+	RCMNA1	1.32	1	FLOW	1071.	1052.	1018.	987.	974.	965.	959.	948.	937.
				TIME	3.75	3.75	3.75	3.75	3.83	3.75	3.83	3.83	3.83
HYDROGRAPH AT													
+	NWBC2-CC	.21	1	FLOW	169.	164.	157.	149.	146.	144.	143.	140.	137.
				TIME	3.75	3.75	3.75	3.75	3.75	3.75	3.75	3.75	3.75
2 COMBINED AT													
+	FADBIN1	1.53	1	FLOW	1240.	1217.	1175.	1137.	1119.	1110.	1101.	1087.	1072.
				TIME	3.75	3.75	3.75	3.75	3.75	3.75	3.75	3.75	3.75
DIVERSION TO													
+	DFADB	1.53	1	FLOW	1240.	1217.	1175.	1137.	1119.	1110.	1101.	1087.	1072.
				TIME	3.75	3.75	3.75	3.75	3.75	3.75	3.75	3.75	3.75
HYDROGRAPH AT													
+	DFADBIN1	1.53	1	FLOW	0.	0.	0.	0.	0.	0.	0.	0.	0.
				TIME	3.75	3.75	3.67	3.75	3.67	3.75	3.75	3.75	3.75
HYDROGRAPH AT													
+	NW53-CA	.10	1	FLOW	77.	75.	71.	67.	66.	65.	64.	63.	61.
				TIME	3.67	3.67	3.67	3.67	3.67	3.67	3.67	3.67	3.67
DIVERSION TO													
+	DSGC	.10	1	FLOW	13.	12.	12.	11.	11.	11.	11.	11.	11.
				TIME	3.67	3.67	3.67	3.67	3.67	3.67	3.67	3.67	3.67
HYDROGRAPH AT													
+	SEV	.10	1	FLOW	64.	62.	59.	56.	55.	54.	53.	52.	51.
				TIME	3.67	3.67	3.67	3.67	3.67	3.67	3.67	3.67	3.67
HYDROGRAPH AT													
+	NW66-CI2	.02	1	FLOW	28.	27.	26.	25.	24.	24.	24.	23.	23.
				TIME	3.58	3.58	3.58	3.58	3.58	3.58	3.58	3.58	3.58
2 COMBINED AT													
+	CCI2	.13	1	FLOW	89.	86.	82.	78.	76.	75.	74.	73.	71.
				TIME	3.67	3.67	3.67	3.67	3.67	3.67	3.67	3.67	3.67
HYDROGRAPH AT													
+	NW66-CI3	.02	1	FLOW	28.	27.	26.	25.	24.	24.	24.	23.	23.
				TIME	3.58	3.58	3.58	3.58	3.58	3.58	3.58	3.58	3.58
2 COMBINED AT													
+	CCI3	.15	1	FLOW	114.	110.	105.	100.	98.	97.	96.	94.	92.
				TIME	3.67	3.67	3.67	3.67	3.67	3.67	3.67	3.67	3.67
DIVERSION TO													
+	DSEV	.15	1	FLOW	114.	110.	105.	100.	98.	97.	96.	94.	92.
				TIME	3.67	3.67	3.67	3.67	3.67	3.67	3.67	3.67	3.67
HYDROGRAPH AT													
+	SGC	.15	1	FLOW	0.	0.	0.	0.	0.	0.	0.	0.	0.
				TIME	3.50	3.50	3.58	3.58	3.58	3.58	3.58	3.58	3.58
HYDROGRAPH AT													
+	DOUTFLOW	.00	1	FLOW	427.	414.	394.	373.	364.	359.	354.	348.	338.
				TIME	3.75	3.75	3.75	3.75	3.75	3.75	3.75	3.75	3.75
ROUTED TO													
+	RDOUTFLW	.00	1	FLOW	425.	412.	391.	370.	361.	355.	350.	344.	335.
				TIME	3.75	3.75	3.75	3.75	3.75	3.75	3.75	3.75	3.75
HYDROGRAPH AT													
+	NW53-CB	.19	1	FLOW	133.	130.	123.	117.	115.	113.	112.	110.	107.
				TIME	3.75	3.75	3.75	3.75	3.75	3.75	3.75	3.75	3.75
HYDROGRAPH AT													
+	DSGC	.00	1	FLOW	13.	12.	12.	11.	11.	11.	11.	11.	11.
				TIME	3.67	3.67	3.67	3.67	3.67	3.67	3.67	3.67	3.67
4 COMBINED AT													
+	CNW53-C	.34	1	FLOW	571.	554.	526.	498.	487.	479.	473.	465.	453.
				TIME	3.75	3.75	3.75	3.75	3.75	3.75	3.75	3.75	3.75
ROUTED TO													
+	RCNW53-C	.34	1	FLOW	564.	546.	519.	491.	480.	471.	465.	458.	446.
				TIME	3.75	3.75	3.75	3.75	3.75	3.75	3.75	3.75	3.75
HYDROGRAPH AT													
+	NW66-CA	.07	1	FLOW	79.	77.	74.	70.	69.	68.	68.	67.	65.
				TIME	3.58	3.58	3.58	3.58	3.58	3.58	3.58	3.58	3.58
HYDROGRAPH AT													
+	NW66-CB	.01	1	FLOW	9.	9.	9.	8.	8.	8.	8.	8.	7.
				TIME	3.58	3.58	3.58	3.58	3.58	3.58	3.58	3.58	3.58
3 COMBINED AT													
+	C66-CB	.42	1	FLOW	627.	608.	578.	548.	536.	527.	520.	512.	499.
				TIME	3.75	3.75	3.75	3.75	3.75	3.75	3.75	3.75	3.75
HYDROGRAPH AT													
+	NW66-CJ6	.01	1	FLOW	8.	7.	7.	7.	7.	7.	6.	6.	6.
				TIME	3.50	3.50	3.50	3.50	3.50	3.50	3.50	3.50	3.50
DIVERSION TO													

DEPARTMENT OF PUBLIC WORKS

Mayor:
CAROLYN G. GOODMAN

City Council:
STAVROS S. ANTHONY (Mayor Pro-Tem)
BOB BEERS
STEVE WOLFSON
BOB COFFIN
RICKI Y. BARLOW
STEVEN D. ROSS

City Manager:
ELIZABETH N. FRETWELL

Director of Public Works:
JORGE CERVANTES, P.E., P.T.O.E.

City Engineer:
DAVID N. BOWERS, P.E., P.T.O.E.

RANCHO-FORT APACHE STORM DRAIN

Funded By:
CLARK COUNTY REGIONAL FLOOD CONTROL DISTRICT
AND
CITY OF LAS VEGAS

Reviewed By:

CLV CITY ENGINEER — DATE

CLV PROJECT MANAGER — DATE

CLV CITY TRAFFIC ENGINEER — DATE

CLARK COUNTY REGIONAL FLOOD CONTROL DISTRICT — DATE

CLARK COUNTY PUBLIC WORKS — DATE

REGIONAL TRANSPORTATION COMMISSION OF SOUTHERN NEVADA — DATE

SOUTHWEST GAS CORPORATION — DATE

CENTURYLINK — DATE
THE AFFIXED CENTURYLINK NEVADA APPROVAL DOES NOT ASSUME OR GUARANTEE LIABILITY FOR KNOWN OR UNKNOWN CONFLICTS WITH EXISTING OR PROPOSED IMPROVEMENTS. RESOLUTION OF ANY CONFLICT WILL BE ACCOMPLISHED PURSUANT TO LOCAL ORDINANCES, NEVADA REVISED STATUTES AND/OR PUBLIC UTILITY COMMISSION STANDARD REGULATIONS.

COX COMMUNICATIONS LAS VEGAS, INC. — DATE

NV ENERGY – DISTRIBUTION — DATE
NV ENERGY ACKNOWLEDGES THAT WE HAVE RECEIVED YOUR PLANS AND WILL PROVIDE SERVICE TO ALL ELECTRICAL NEEDS ASSOCIATED WITH THIS PROJECT. NV ENERGY RESERVES THE RIGHT TO ADDRESS ANY EXISTING OR FUTURE CONFLICTS ONCE THE FINAL DESIGN IS COMPLETED. THE NEW SERVICE AND THE RESOLUTION OF ANY CONFLICTS WILL BE ACCOMPLISHED PURSUANT TO THE NEVADA PUBLIC UTILITY COMMISSION'S RULES AND REGULATIONS.

NV ENERGY – TRANSMISSION — DATE

APPROVED FOR CONSTRUCTION

LAS VEGAS VALLEY WATER DISTRICT ENGINEERING SERVICES MANAGER
DATE: PROJECT# LVVWD_#
SHEETS: SHEETS

THE SIGNATURE ABOVE ACKNOWLEDGES THAT THE UTILITY COMPANY REPRESENTATIVE HAS REVIEWED THE PLANS, AND THAT TO THE BEST OF HIS OR HER KNOWLEDGE THE UTILITY LINES ARE SHOWN IN THE CORRECT LOCATIONS AND ARE THE CORRECT SIZES. WHILE SUCH DATA HAS BEEN COLLECTED WITH REASONABLE CARE, THERE IS NO EXPRESSED OR IMPLIED GUARANTEE THAT THE LOCATIONS ARE EXACT. THE CONTRACTOR SHALL BEAR THE RESPONSIBILITY OF OBTAINING THE ACTUAL FIELD LOCATIONS.

THE SIGNATURE ABOVE FURTHER ACKNOWLEDGES THAT THE UTILITY COMPANY DOES NOT ANTICIPATE CONSTRUCTION OR MAINTENANCE IN THE PROJECT AREA FOR FIVE (5) YEARS IN CONFORMANCE WITH THE CLV NO-CUT POLICY.

CLV BID NO. XX.XXXX.XX

BY | DESCRIPTION | No. | DATE

RANCHO - FORT APACHE STORM DRAIN

WA# | DESIGN BY: JSD | SCALE(V): AS SHOWN | DATE: | SCALE(H): AS SHOWN | FIELD BOOK #:

THE Louis Berger Group, INC.
500 E. Amigo Court, Suite 100 Voice: 702-736-6632
Las Vegas, Nevada 89119 Fax: 702-736-0704

70% DESIGN SUBMITTAL 7/11/2012 - NOT FOR CONSTRUCTION

DEPARTMENT OF PUBLIC WORKS

PROJECT: RANCHO-FORT APACHE STORM DRAIN

SHEET TITLE: COVER SHEET

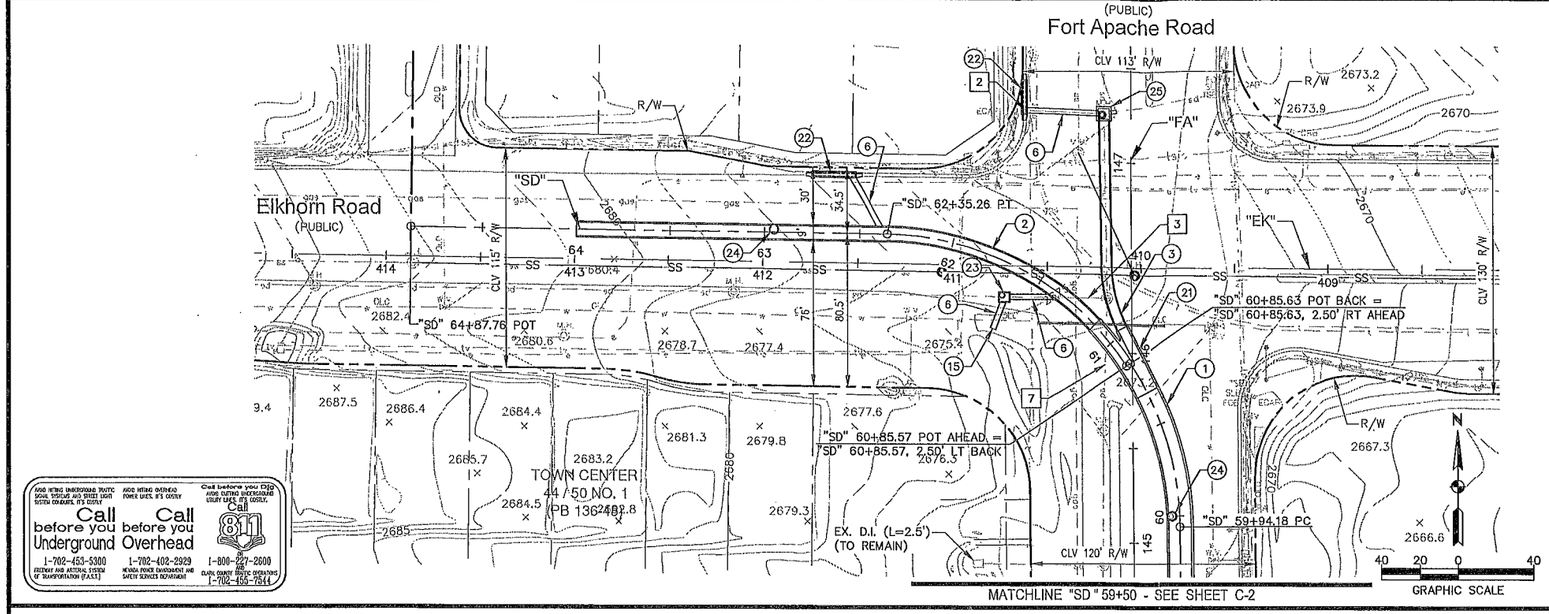
70% PRELIMINARY SUBMITTAL 7/11/12 NOT FOR CONSTRUCTION

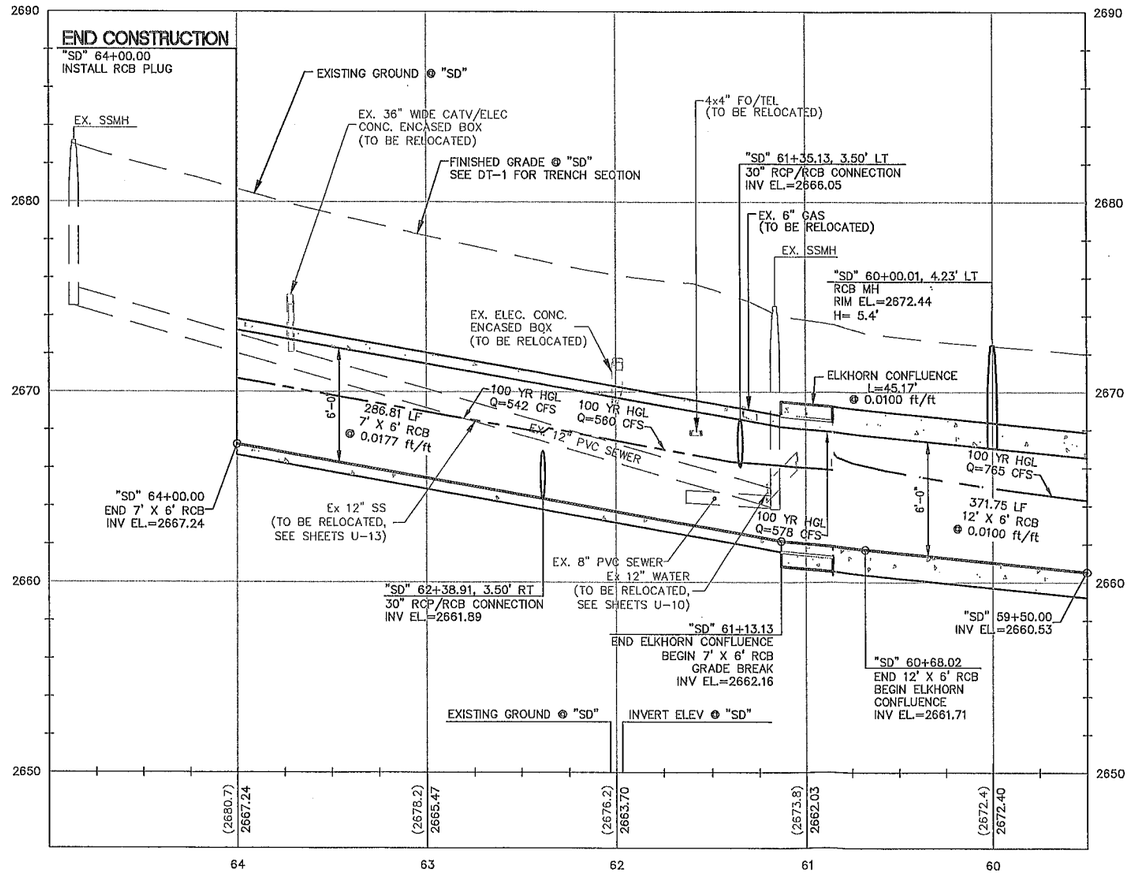
SHEET: G-1 1 OF 69

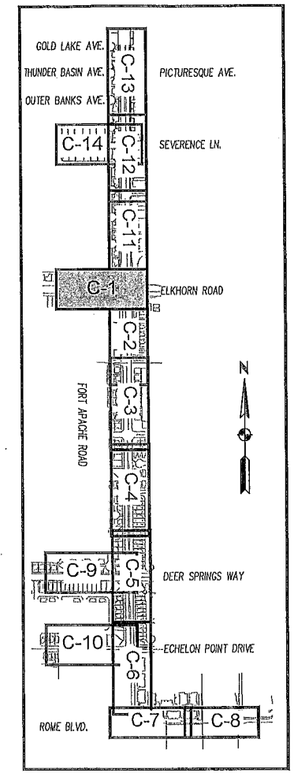
CLV DRAWING NO: 327V150

H#36802

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SHEET KEY

REMOVAL ITEMS:

1	REMOVE EX. MANHOLE.	7	REMOVE EX. 60" RCP.
2	REMOVE EX. DROP INLET.	8	REMOVE EX. 15" RCP.
3	REMOVE EX. 18" RCP.	9	REMOVE EX. 24" CMP.
4	REMOVE EX. 24" RCP.	10	REMOVE EX. 49"x32" CHEC.
5	REMOVE EX. 30" RCP.	10	REMOVE EXISTING RIPRAP
6	REMOVE EX. 36" RCP.		

CONSTRUCTION ITEMS:

(1)	"SD" 60+68.02 TO "SD" 59+50.00	INSTALL 12' X 6' RCB
(2)	"SD" 64+00.00 TO "SD" 61+35.13	INSTALL 7' X 6' RCB
(3)	"SD" 61+02.17, 9.95 RT TO "SD" 61+61.42, 92.92 RT	INSTALL 5' X 5' RCB
(6)	"SD" 62+54.97, 31.43 RT TO "SD" 62+38.91, 3.50 RT "SD" 61+59.68, 34.52 LT TO "SD" 61+62.44, 16.74 LT "SD" 61+62.44, 16.74 LT TO "SD" 61+35.13, 3.50' LT	INSTALL 30" RCP
(15)	"SD" 61+59.68, 34.52 LT	INSTALL 30" RCP PLUG
(21)	"SD" 61+13.13 TO "SD" 60+68.02	CONSTRUCT ELKHORN CONFLUENCE
(22)	"SD" 61+87.28, 77.29'RT "SD" 62+54.97, 31.43'RT	CONSTRUCT TYPE "DM" DI
(23)	"SD" 61+62.44, 16.74'LT	CONSTRUCT TYPE III MH
(24)	"SD" 60+00.01, 4.23' LT	CONSTRUCT RCB MH
(25)	"SD" 61+61.42, 92.92'RT	CONSTRUCT NDOT TYPE IV MH

NOTES:

1. SEE SHEETS CP-1 THROUGH CP-4 FOR HORIZONTAL CONTROL PLANS.
2. SEE SHEETS U-11 THROUGH U-12 FOR WATERLINE RELOCATION PLANS.
3. SEE SHEETS U-12 THROUGH U-16 FOR SEWERLINE RELOCATION PLANS.
4. SEE SHEETS LP-1 THOUGHT LP-5 FOR STORM DRAIN LATERAL PROFILES.

70% DESIGN SUBMITTAL 7/11/2012 - NOT FOR CONSTRUCTION

No.	DATE	DESCRIPTION	BY

RANCHO - FORT APACHE STORM DRAIN

THE Louis Berger Group, INC.
500 E. Amigo Court, Suite 100 Voice: 702-736-6632
Las Vegas, Nevada 89119 Fax: 702-736-0704

SCALE(H): AS SHOWN | SCALE(V): AS SHOWN | TM#
FIELD BOOK #: | DATE: | DESIGN BY: JSD

CITY OF LAS VEGAS NEVADA

DEPARTMENT OF PUBLIC WORKS
PROJECT: RANCHO-FORT APACHE STORM DRAIN
SHEET TITLE: PLAN AND PROFILE "SD" 59+50 TO "SD" 64+87.82

70% PRELIMINARY SUBMITTAL 7/11/12
NOT FOR CONSTRUCTION

SHEET: C-1
9 OF 69
CLV DRAWING NO: 327V150

H#36802

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Master Drainage Study for Cliff's Edge, VTN

3/2/04
DS 3404
$400
F-13

ADDENDUM #2 TO THE MASTER DRAINAGE STUDY

FOR

CLIFF'S EDGE

CITY OF LAS VEGAS, NEVADA
W.O. # 5969

Prepared for:

FOCUS COMMERCIAL GROUP

Submitted to:

PUBLIC WORKS DEPT.
CITY OF LAS VEGAS, NEVADA

