

TECHNICAL DRAINAGE STUDY

Skye Canyon
Detention Basin 1
City of Las Vegas, Nevada

Job No.: OLY1401.004

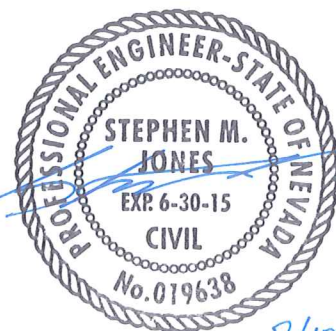
Date: September 2014

Prepared By:

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Prepared For:

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9/10/2014

Steve Jones, P.E.
NV Professional Engineer No. 19638

Assisted by: Erick Mata, EI

HYDROLOGIC CRITERIA AND DRAINAGE DESIGN MANUAL

DRAINAGE STUDY INFORMATION FORM

Name of Development: Skye Canyon Detention Basin 1 Date: September 2014
 Location of Development: a) Descriptive (Cross Streets): North/South: Puli Road
East/West: Grand Teton Drive
 b) Section: 12 Township: 19 South Range: 59 East
 c) APN: 126-12-000-001

Name of Owner/Developer: Section 12, LLC / Ninety-Five Management, LLC
 Telephone No.: 702-220-6565 Fax No.: 702-220-6566 E-mail Address: mbolduc@olympiacompanies.com
 Address: 11411 Southern Highlands Parkway, Suite 300; Las Vegas, NV 89141

Contact Person – Name: Steve Jones, P.E. Telephone No.: 702-284-5300
 *E-mail Address: sjones@shg-inc.com Fax No.: 702-284-5399
 Firm: Slater Hanifan Group
 Address: 5740 S. Arville Street, Suite 216; Las Vegas, NV 89118

Type of Land Development/Land Disturbance Process:

☐ Rezoning	☐ Subdivision Map	☐ Clearing and grading Only
☐ Parcel Map	☐ Planned Unit Development	☒ Other (Please specify below)
☐ Large Parcel Map	☐ Building Permit	☐ Roadway & Storm Drain Infrastructure

1. Total Owned Land Area: At Site: 668.9 Acres Being Developed/Disturbed: 16.7 Acres +/-

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

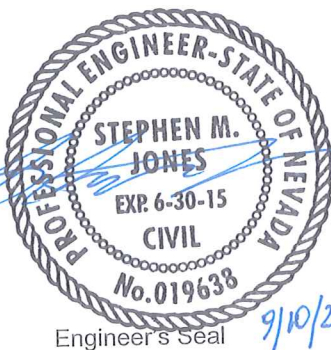
4. Proposed type of development (Residential, Commercial, Etc.): Detention Basin

5. Approximate upstream land area which drains to the subject site: 0.9 sq. miles

6. Has the site drainage been evaluated in the past? ☒ Yes** ☐ No If yes, please identify documentation: Master Drainage Study for Kyle Canyon (SHG, DS4420)

7. If known, please briefly identify the proposed discharge point(s) of runoff from the site: Existing Arroyo

8. Briefly describe your proposed schedule for the subject project: 1st of 3 planned detention basins per DS4420



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

Revision

Date

Local Entity File No.

STANDARD FORM 1

REFERENCE: SHG Job No. OLY1401.004

Updated 05/01/2008

HYDROLOGIC CRITERIA AND DRAINAGE DESIGN MANUAL

DRAINAGE SUBMITTAL CHECKLIST

Project Name: Skye Canyon Detention Basin No. 1		Map ID:
Firm Name: Slater Hanifan Group (SHG)		
Address: 5740 S. Arville St., Suite 216		
City: Las Vegas	State: Nevada	Zip: 89118
Phone Number: 702-284-5300	Fax Number: 702-284-5399	
Property Owner/Developer: Section 12, LLC / Ninety-Five Management, LLC		
Address: 11411 Southern Highlands Parkway, Suite 300		
City: Las Vegas	State: NV	Zip: 89141
Reviewed By:	Date Received:	Date Accepted for Review:

The following checklist is intended as a guide for the engineer preparing a Technical Drainage Study to submit to the local entity and Clark County Regional Flood Control District (if necessary). The listed items are the minimum information required prior to the entity performing a review. The engineer will remain responsible to ensure the Technical Drainage Study is prepared within the guidelines as set forth in the Clark County Regional Flood Control District (CCRFCDD) Hydrologic Criteria and Drainage Design Manual (MANUAL).

This document is intended as an aid in preparing Technical Drainage Studies. Each study submitted is reviewed for compliance with local and regional criteria. This form is not intended to be all inclusive and does not limit the extent of the information, calculations or exhibits which may be necessary to properly evaluate the intended land use.

If items are not applicable for the subject site, provide N/A.

I. GENERAL REQUIREMENT:

Yes	No	
X		Design Manual Standard Form 1 with the engineer's seal and signature.
X		Design Manual Standard Form 4 .
X		2 copies of the 24" x 36" Drainage Plan.
	N/A	A notarized letter from the adjacent property owner(s) allowing off-site grading or discharge.

Reference:

STANDARD FORM 2

HYDROLOGIC CRITERIA AND DRAINAGE DESIGN MANUAL

DRAINAGE SUBMITTAL CHECKLIST

II. MAPS AND EXHIBITS

Yes	No	
☒	☐	A copy of a current Flood Insurance Rate Map (FIRM) with the site delineated.
☒	☐	A copy of the current CCRFCD Master Plan Update Figure, (F-x), for Flood Control Facilities and Environmental areas with the site delineated.
☒	☐	On-site drainage basin maps for existing and proposed conditions showing the existing topography, basin boundaries, concentration points, and on-site and off-site flows in cfs.
☒	☐	Vicinity Map with local and major cross streets identified and a north arrow.
☒	☐	Off-site drainage basin maps for existing, interim and future conditions showing the existing topography, basin boundaries, concentration points, and flows in cfs.

III. DRAINAGE PLAN

	No	
☒	☐	Sheet size: 24" x 36" sealed by a registered engineer in the State of Nevada.
☒	☐	Minimum scale: 1" = 60'.
☒	☐	Project name.
☒	☐	Vicinity Map with local and major cross streets.
☒	☐	Revision box.
☒	☐	North arrow and bar scale.
☒	☐	Engineer's/consultant's address and phone number.
☒	☐	Elevation datum and benchmark.
☒	☐	Legend for symbols and abbreviations.
☒	☐	Cut/fill scarps, where applicable.
☒	☐	Street names, grades, widths.
☐	☒	Proposed future and existing spot grades for top of curbs and street crowns at lot lines, grade breaks, and along curb returns on both sides of the street.

REFERENCE:

STANDARD FORM 2

HYDROLOGIC CRITERIA AND DRAINAGE DESIGN MANUAL

DRAINAGE SUBMITTAL CHECKLIST

III. DRAINAGE PLAN (Continued)

Yes	No	
X		Existing contours encompassing the site and 100 feet beyond with spot elevations for important locations, where appropriate.
	N/A	Minimum finish floor elevations with top-of-curb elevations at upstream end of lot.
X		Proposed typical street sections.
	N/A	Streets with off-set crowns.
X		Proposed contours or spot elevations in sufficient detail to exhibit intended drainage patterns and slopes.
X		Property lines.
X		Right-of-way lines and widths, existing and proposed.
X		Existing improvements and their elevations.
X		Delineation of proposed on-site drainage basins indicating area and 10-year and 100-year storm peak flows at basin concentration points.
X		Concentration points and drainage flow direction with Q_{100} and V_{100} and D_{100} in streets.
X		Cumulative flows, velocity, and direction of flow at upstream and downstream ends of site for the 10-year and 100-year flows.
	N/A	Location and cross-section of street capacity calculations.
X		Cross-sectional detail for channels, including cutoff wall locations.
X		Existing and proposed drainage facilities, appurtenances, and connections (i.e., sidewalk, ditches, swales, storm drain systems, unimproved and improved channels, and culverts, etc.) stating size, material, shape, and slope with plan and profile and HGL calculations.
X		Existing and proposed drainage easements and widths shown with sufficient detail. A cross sectional detail must be provided that shows appropriate lining and reinforcement.
	N/A	Location and detail of existing, proposed, and future block wall openings. Minimum size is 16"x48". Wrought iron gate is required for flows > 10 cfs.
	N/A	Location and detail of flood walls illustrating depth of flow, proposed grouting height, etc.

REFERENCE:

STANDARD FORM 2

HYDROLOGIC CRITERIA AND DRAINAGE DESIGN MANUAL

DRAINAGE SUBMITTAL CHECKLIST

III. DRAINAGE PLAN (Continued)

Yes	No	
	N/A	Perimeter retaining wall locations. All existing and proposed walls (retaining screen and flood) must be shown with adjacent ground elevations. Flood Walls with 8-inch concrete masonry unit.
	N/A	Building and/or lot numbers.
X		Alignment of all existing, proposed, or future Regional Facilities adjacent to the site.
	N/A	Limits of existing floodplain based on current FIRM or best available information; limits of proposed floodplains based on best available information.
	N/A	For areas in Zone A, AE, AH, and AO, base flood elevations (BFEs) must be shown for each lot; BFEs may be listed on each lot, or in a table. Finish floor elevations must be a minimum of 18 inches above BFE.
	N/A	Appropriately elevated "humps" 6 inches above the 100-year water surface elevation at site accesses where the intent is to protect the site from the Q_{100} flows.
	N/A	Street slopes for perimeter and interior streets. The minimum slope is 0.4 percent.

IV. HYDROLOGIC ANALYSIS

Yes	No	
X		Appropriate soil information and Soils Map for existing and future conditions with subbasins and property delineated.
X		Input and output information for existing conditions from computer models (HEC-1 or TR-55). The flow routing diagram must be provided with HEC-1 models.
X		Input and output information for future conditions from computer models (HEC-1 or TR-55). The flow routing diagram must be provided with HEC-1 models.
X		Use of correct precipitation values in and around the McCarran Airport Rainfall Area.
X		A discussion in the text of the hydrologic analysis justifying subbasin boundaries and cutoffs, supporting assumptions, and calculations.
X		A summary table of storm water flows showing basin area, Q_{10} and Q_{100} for both individual basins and combined basin flows, where acceptable.
X		Copies of supporting technical information referenced from a previously approved study and a statement accepting these results.
X		On-site facilities must perpetuate flows through or around the site without significantly impacting adjacent property owners in accordance with current Nevada Drainage Law.

REFERENCE:

STANDARD FORM 2

HYDROLOGIC CRITERIA AND DRAINAGE DESIGN MANUAL

DRAINAGE SUBMITTAL CHECKLIST

V. HYDRAULIC ANALYSIS

Yes	No	
	N/A	Flow split calculations and supporting documentation or reference for the method of flow split calculations used.
	N/A	Normal depth street flow calculations and cross section diagrams for all interior and perimeter streets. Provide "d x v" products for the Q_{100} and Q_{10} flows representing the worst case for interior and all perimeter streets. $Q_{100} d \times v \leq 8$. $Q_{10} d \times v \leq 6$ and 12 foot dry lane for rights-of-way ≥ 80 feet. Calculations must be labeled by street name as indicated on the Grading Plan.
	N/A	A summary table of interior and exterior street capacity calculations showing the street name, Q_{100} flow, slope, depth of flow, velocity and depth times velocity product and streets needing to meet 12 foot dry lane criteria.
	N/A	Appropriate hydraulic calculations for block wall openings assuming a 50 percent vertical clogging factor. (Assume the lower half of the opening is plugged.)
	N/A	Appropriate hydraulic calculations at drainage easement entrance and discharge locations to set finish floor elevations. Hydraulic calculations must include submerged weir, superelevation and tee intersection losses, where appropriate.
	N/A	Provide necessary freeboard requirements to set the finished floor elevations of all proposed buildings, 2 x depth of flow or depth of flow plus 18 inches of freeboard, whichever is less. The minimum requirement is 6 inches above adjacent upstream top of curb. Buildings adjacent to drainage easements must always be provided with 18 inches of freeboard above the Q_{100} weir height or flow depth, which ever is greater.
X		A complete water surface profile analysis (HEC-2, HEC-RAS, etc.) for channel flows and FEMA Zone A flood zones.
		• Field survey data. • Input and output information. • Plotted cross-sections based on survey with proper encroachments. • A map showing the location of the cross-sections. • Analysis of both sub- and super-critical flow segments. • A summary table and a discussion of the results in the text of the report.
	N/A	Provide a 50 percent clogging factor in the capacity calculation for drop inlets.
X		Hydraulic calculations for culverts and storm drains. D-Load calculations must be provided for storm drain pipes in public rights-of-way, including headwater pool inundation.
X		The mitigation of nuisance water, both during construction and in the fully developed condition, must be addressed.

REFERENCE:

STANDARD FORM 2



CITY OF LAS VEGAS

MINIMUM DRAINAGE STUDY CRITERIA STANDARD FORM 2 CHECKLIST SUPPLEMENT

(Revised 5/18/11)

The following checklist is intended as a supplemental guide for the engineer preparing a Technical Drainage Study submittal to the City of Las Vegas. This supplement focuses on requirements specific to the City of Las Vegas. The requirements presented are in addition to the Clark County Regional Flood Control District (CCRFCD) Manual Standard Form 2. The listed items are the minimum information required prior to the City performing a review. The engineer will remain responsible to ensure the Technical Drainage Study is prepared within the guidelines as set forth in the CCRFCD Hydrologic Criteria and Drainage Design Manual (Design Manual).

An appointment must be made to preview this checklist in conjunction with CCRFCD Standard Form 2 prior to the City accepting a new drainage study for review. The engineer must contact the Flood Control Section at (702) 229-6541 to schedule a submittal appointment.

If items are not applicable for the subject site, provide N/A.

I. GENERAL REQUIREMENT		
Yes	No	
-	N/A	A notarized letter from the adjacent property owner(s) allowing off-site grading. (A copy of the letter must be received prior to final acceptance of the drainage study.)
-	N/A	Copies of all conditions of approval for development related to this property. (e.g. zoning, use permit, tentative map, etc.) Verify compliance with conditions.
X	-	An electronic copy of the complete submittal is required to be submitted with one original hard copy of the study. Electronic documents should be on a universal computer-readable digital output device replicating your submittal. An Indexed Portable Document Format (PDF) or Print Ready CAD file formats with a minimum of 300dpi are the desired formats. If figures are in color, they must be scanned in color and saved as a separate file. _____ by initial here, the engineer on record acknowledges that the electronic copy is an identical replicate of the original hard copy submitted to the City of Las Vegas.

II. GRADING PLAN INFORMATION		
Yes	No	
X	-	(1) 24" X 36" copy of the Grading Plan, (including all Detail Sheets) sealed by the engineer.
-	N/A	Proposed future and existing spot grades for top of curbs and street crowns at lot lines, grade breaks, and along curb returns on both sides of the street. Note: Proposed top of curb elevations must be provided for both sides of roadways even if only half street construction is required.
X	-	Label existing topography at a minimum 5 foot elevation interval including adjacent developments, finished floor elevations of existing buildings and top of existing curbs extending 100 feet around the perimeter of the site. (*Measured from the centerline of the adjacent roadway.)

CITY OF LAS VEGAS MINIMUM DRAINAGE STUDY CRITERIA CHECKLIST

II. GRADING PLAN INFORMATION		
Yes	No	
X	-	Proposed on-site and off-site storm drains and other flood control facilities with plan and profile sheets for public storm drains showing the class of pipe, (Class III, IV, V, etc.), design hydraulic grade line, (HGL) and 100 year storm flow. A public drainage easement must be provided over on-site storm drains conveying off-site flows. An overflow path must be provided over all storm drains.
-	N/A	All existing and "to be constructed" walls with cross-sections showing wall type, (e.g. block wall, retaining wall, flood wall, etc.), with limits clearly defined, adjacent ground elevations. Wall heights must meet current ordinances and in no case exceed 14 feet above the adjacent property.
-	N/A	Street slopes for both interior and perimeter streets. Note: The minimum slope for a roadway is 0.4 percent, a minimum 18-inch storm drain must be provided where minimum slopes cannot be met.
-	N/A	Back of lot elevations and lot drainage pattern for all lots including common lots.
-	N/A	Sites with a grade difference two feet above or below existing ground are required to have approval from City of Las Vegas Current Planning. Current Planning approval is required prior to final approval of the drainage study.
X	-	On-site facilities must perpetuate flows through or around the site without significantly impacting adjacent property owners. (The project must pass flows through the site every 600 feet where the project is blocking flow paths.)
-	N/A	This project uses a solid grouted stem wall (or approved alternate) at the back of sidewalk to provide erosion protection for landscaped areas where the depth of flow in the roadway exceeds the back of walk elevation. A corresponding cross-section detail is included.
-	N/A	Commercial and Common Lot Landscape areas are not allowed to drain over the sidewalk. The grading plans show flow lines with grades and sidewalk under drains for all landscape areas draining to the public ROW.

III. Local Entity Criteria - City of Las Vegas – Manual Section 1600		
Yes	No	
-	N/A	Concrete valley gutters are required in parking lots with slopes less than 1 percent. Slopes through cul-de-sac must be at a 1 percent minimum where flow is drained through the cul-de-sac.
X	-	Ten-foot wide public drainage easements to be privately maintained are allowed for flow less than 20 cfs. The depth of flow entering the easement must be checked using the submerged weir calculation.
-	N/A	The limits of the flood zones and the base flood elevations (BFE) must be shown on all grading plans for all developments within a Special Flood Hazard Zone A, AO, AE, etc.
-	N/A	Minimum finish floor elevation is 6 inches above highest adjacent top of curb. Finish floor calculations must include allowances for super elevations on curves and velocity head for tee intersections.
-	N/A	Finished floor elevations for buildings adjacent to public drainage easements must be a minimum of 18 inches above the Q100 weir of submerged weir elevation, whichever is greater.

CITY OF LAS VEGAS MINIMUM DRAINAGE STUDY CRITERIA CHECKLIST

III. Local Entity Criteria - City of Las Vegas – Manual Section 1600		
Yes	No	
-	N/A	Lots with "B and C Type Drainage" that drain from one lot to another through a drainage easement shall be required to install an underground nuisance drainage system or a 2-foot valley gutter. 16" x 24" minimum block wall openings are required for both options.
-	N/A	Bubblers are required across 80 foot and greater ROW streets. When flows exceed 10 cfs, bubblers larger than 18 inches will be required up to a maximum of 36". Inlets must be sized to match the pipe size provided.

- Contact the Flood Control Section regarding the drainage study review fee. These fees are payable at the time of submittal.
- The Drainage Study must be conditionally approved prior to submitting improvement plans to the Civil and Planning Development of the Department of Building and Safety for review.

This document is intended as an aid in preparing Technical Drainage Studies for the City of Las Vegas. Each study submitted is reviewed for compliance with local and regional criteria. This form is not intended to be all-inclusive and does not limit the extent of the information, calculations or exhibits which may be necessary to properly evaluate the intended land use.

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 - Exhibit B – FEMA FIRM Panel Map
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1 INTRODUCTION

1.1 Project Overview & Study Purpose

Ninety-Five Management, LLC is proposing to install a regional detention basin on the western edge of the Skye Canyon property (formerly known as Kyle Canyon). The current master plan for the 1,662 acre Skye Canyon property, plans for a series of three (3) detention basins at its western edge to cut-off and reduce offsite flows impacting future development. This technical drainage study addresses the design of *Skye Canyon Detention Basin 1* (hereafter referred to as DB1), or the basin located furthest to the south and closest to Grand Teton Drive.

The Skye Canyon property has been master planned and a *Master Drainage Study for Kyle Canyon (DS4420)* had been approved by the City of Las Vegas. The proposed DB1 has been proposed within the framework set forth by the Master Drainage Study. Therefore, it is the objective of this technical study to show conformance to the drainage patterns set forth in the Master Drainage Study.

DB1 has been planned as a regional detention basin; therefore, requirements of a regional detention basin have been utilized in the technical design of the facility and its components. Detailed hydrologic and hydraulic analyses have been utilized to design the following significant components of the facility:

- Detention/storage area;
- Inflow channels, including a collector channel extending from Grand Teton to the detention basin;
- Debris storage;
- Primary outlet structure;
- PMF overflowspillway;
- Maintenance access.

1.2 Location of Project

The project is located within Township 19 South, Range 59 East and Section 12, on APN 126-12-000-001. A location map identifying the site in relation to major streets in the vicinity has been prepared as Exhibit A, included in Appendix A.

The project is located adjacent to future Skye Canyon developable property to the north and the east, partially improved Grand Teton Drive to the south, and BLM property to the west that is designated as the Red Rock Conservation Area. It is considered within the scope of this project to dedicate flood control right-of-way required for the construction, access and footprint associated with the functioning of DB1.

1.3 FEMA Flood Zone Designation

The DB1 boundary has been delineated on current FEMA FIRM Panel Map 32003C1750E dated September 27, 2002, as Exhibit B included in Appendix A. Per the FIRM Panel, the project site is located within a FEMA designated Zone 'X', or outside the 500-year

floodplain. A Zone 'X' is located outside a FEMA designated Special Flood Hazard Area (SFHA).

1.4 CCRFCD Facility Information

The project site has been delineated on the current 2013 Clark County Regional Flood Control District (CCRFCD) Las Vegas Valley Flood Control Master Plan Update (2013 MPU, Reference 1) facility figures as Exhibit C, included in Appendix A. Per the 2013 MPU, the following CCRFCD facilities are associated with DB1 and technically addressed by this study:

- MOHU0186 – 55 ac-ft Moccasin Outfall Detention Basin #1
- MOHU0185 – 3,145 cfs PMF Spillway
- MOHU0184 – 30-inch RCP outlet
- MOSR0061 – 30-inch RCP outlet from MOHU0186 to MOSR0060.

Note that this study will technically address the removal of the necessity for MOSR0061. An overlay of the proposed DB1 footprint presented in this study compared to the anticipated regional facilities has been illustrated on Exhibit C.

Note that the above discussed alignments and facility types had been included in the 2013 *Kyle Canyon Amendment to the 2008 Las Vegas Valley Master Plan Update* (hereafter referred to as the MPU Amendment) prepared by Slater Hanifan Group, and reflected in the currently issued 2013 MPU Facilities Map represented by Exhibit C. Although the facilities identified above had been accepted by CCRFCD, the Amendment to add these facilities to the CCRFCD MPU has not been formally approved by City of Las Vegas City Council. Therefore, it is acknowledged that DB1 will not be accepted as a CCRFCD regional facility until the City officially adopts the MPU Amendment.

1.5 USACE Coordination

DB1 and its outfall are located within a U.S. Army Corps of Engineers (USACE) 404 jurisdictional wash. It is considered within the scope of this project to obtain the required 404 permit from USACE for any disturbances proposed in the jurisdictional wash.

1.6 Nevada Dam Safety Coordination

DB1 consists of a 16-ft embankment within the USACE 404 wash that impounds a total of 65 acre-ft of volume during the 100-year storm event. Therefore, the Nevada Division of Water Resources requires a submittal to obtain a dam safety permit for construction of the facility.

1.7 NV Energy Coordination

An NV Energy overhead power utility corridor is located in proximity of DB1 between its western limits and the Skye Canyon property boundary. It is considered within the scope of this project to coordinate with NV Energy to maintain appropriate access to the existing power corridor.

1.8 Referenced Documents

The *Master Drainage Study for Kyle Canyon*, prepared by Slater Hanifan Group (hereafter referred to as the SHG Master Study, Reference 8), had conceptually planned drainage improvements required for the current land plan on the property. A total of three (3) detention basins have been planned, identified on the included reference exhibit as Facilities P01W, P02W and P03W. This study proposes the technical design of Facility P01W and its associated outfall Facility P04W. The remaining two (2) detention basins P02W and P03W will be technically addressed by future drainage studies. Note that the SHG Master Study had planned for P01W (DB1) to utilize and discharge into P02W, via Facility P04AW; however, this study establishes that a second outfall from DB1 is not necessary to achieve the required volume and limit the outflow toward downstream property and facilities in the alignment of Facility P74W. Note that inflow Facilities P67W and P68W have also been technically addressed as an open channel by this study.

The SHG Master Study remains only conditionally approved and requires the following to receive full approval: BLM concurrence, NV Energy concurrence and City Council approval of the MPU Amendment. This technical study addresses these missing items in the following manner:

- BLM property is not impacted because the outfall for DB1 discharges within an arroyo that conveys the storm flows toward US-95 at approximately Brent Lane. Existing US-95 culverts perpetuate the DB1 outflow south and east with no impacts to the BLM property north of Moccasin that pertains to the condition of approval on the SHG Master Study. Therefore, BLM concurrence is not required for acceptability of DB1.
- NV Energy coordination will continue to be performed to show that the proposed limits of improvements do not adversely impact accessibility to the existing overhead power utility poles adjacent to the west of DB1. This project is anticipated to fulfill its obligation of receiving NV Energy concurrence.
- City Council approval of the MPU Amendment is not required to construct the DB1; however, it is anticipated that in the future that it will be adopted as a regional facility. Therefore, the design of the DB1 satisfies all regional detention basin criteria and should be reviewed in a manner with the plan for future regional funds for maintenance.

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 2).

2.2 Hydrologic Modeling

Modeling:

The SCS Unit Hydrograph Method (SCS Method) was utilized to determine peak flow rates. The SCS Method utilizes precipitation, drainage area, curve number and lag time parameters to determine peak flow rates. The SCS Method routine within the USACE HEC-1 Flood Hydrograph Package program was utilized to model the drainage basins analyzed by this study.

Precipitation:

The site is located outside of the McCarran Rainfall Area, per CCRFCD Manual Figure 513. The 100-year precipitation value utilized in this study's HEC-1 model has been determined as 3.00-inches utilizing CCRFCD Manual Figure 506 and Table 501. Drainage area contributing to DB1 has been determined as 0.9 square miles; therefore, a depth-area reduction factor per CCRFCD Manual Table 502 has been utilized. However, since the drainage area does not exceed 8 square miles, an SDN 3 design storm distribution referenced from Table 503 of the CCRFCD Manual is used. Note that the design of DB1 is a regional facility; therefore, only a 100-year storm event has been modeled for the purposes of this study. Relevant tables and figures from the CCRFCD Manual have been included in Appendix B.

In addition to the 100-year storm event, all regional detention basins are required to pass the probable maximum flood (PMF) event; therefore, the probable maximum precipitation (PMP) must be determined and utilized by this study. The probable maximum precipitation (PMP) has been determined as 14.1-inches following procedures outlined in the National Oceanic and Atmospheric Administration (NOAA) Hydrometeorological Report Number 49 (HMR 49, Reference 3). Inspection of the EM1110-2-1411 sequencing has been utilized to determine it closely resembles the CCRFCD SDN3 storm distribution; therefore, the SDN3 storm distribution has been utilized to compute the PMF flow in HEC-1. Relevant reference material and computations from HMR 49 has been included in Appendix B.

Curve Number:

The SCS curve number loss rate methodology was utilized to approximate infiltration for the drainage basins. Per the SCS Soil Survey of the Las Vegas Valley Area (Soil Survey, Reference 4), this study's drainage basins lie within the following soil types delineated on Exhibit D, included in Appendix A.

- Soil 155 – Cave gravelly fine sandy loam, 4 to 15 percent slopes. This soil is composed of 5% HSG 'A', 5% HSG 'B' and 90% HSG 'D'.
- Soil 191 – Dalian very cobbly fine sandy loam, 2 to 8 percent slopes. This soil is composed of 5% HSG 'A', 85% HSG 'B' and 10% HSG 'D'.
- Soil 400 – Tencee very gravelly fine sandy loam, 2 to 8 percent slopes. This soil is composed of 10% HSG 'B' and 90% HSG 'D'.

Generally the contributing watershed to DB1 is undeveloped desert land, typical of southern Nevada; therefore a curve number associated with "desert shrub – poor condition" has been selected for these areas. A portion of the ultimate condition watershed adjacent to Grand Teton Drive is planned by the current CCRFCD MPU as "very high density

residential”; therefore, a referenced MPU curve number of 96 has been selected for this area. Additionally, the DB1 is an improvement represented by a curve number associated with a “newly graded area”. Composite curve numbers for basins with multiple soil types and land uses have been computed as detailed above, and are included in Appendix B.

Lag Time:

The lag time is defined as the time measured from the center of mass of effective rainfall to the time to peak of the outflow hydrograph. The lag time is related to the time of concentration as 0.6 times the time of concentration. The time of concentration is defined as the time required for runoff to flow from the hydraulically most distant point of a basin to the outlet point of the basin. Standard Form 4, as outlined in the CCRFCD Manual, was utilized to determine the lag times for basins modeled. The lag time computations have been included in Appendix B.

2.3 Hydraulic Modeling & Criteria

Detention Basin Routing:

Detention basin routing was performed using the Modified Puls method within the USACE HEC-1 computer program. A stage-storage-discharge curve for the design configuration of DB1 and its outfall facilities has been utilized for HEC-1 to determine detention basin performance components such as peak storage, peak elevation and peak discharge. Performance curves associated with DB1 have been provided on the improvement plans to validate that regional detention criteria, per CCRFCD Manual Section 1202.1, are satisfied.

Debris Loading:

In the same manner as utilized in the SHG Master Study, debris volume inflow to DB1 during the 100-year storm event has been determined by the Modified Universal Soil Loss Equation (MUSLE) per CCRFCD Manual Equation 1307. Note that the cropping factor utilized in this study corresponds to the factor from the SHG Master Study. The total 100-year debris inflow volume has been provided in DB1 below the primary outlet structure. A debris tower has been proposed to dewater the debris storage area in less than 7 days as directed by CCRFCD detention basin criteria.

Main Inflow Channel:

The main collector channel into DB1 from Grand Teton has been designed to adhere to CCRFCD Manual Section 706 methodology utilizing Flowmaster Version 7.0 software by Heastad Methods. In addition to the hydraulic freeboard provided in the channel, an extra 1-ft of freeboard has been proposed to accommodate the sedimentation anticipated to occur from the contributing watershed. Note that maintenance access for the inflow channel has been provided at the bottom of the channel and at the top of the east bank.

Lateral Inflow Channels:

Several incised washes discharge into DB1 and the main inflow channel laterally, and have been designed to contain the inflow with no severe contractions or expansions utilizing Flowmaster Version 7.0 software by Heastad Methods. Twice the depth of flow has been

provided in these lateral channel sections and the necessary erosion protection has been provided per CCRFCD Manual Table 703.

Primary Outlet Structure:

An orifice plate on the primary outlet structure has been designed to discharge 100-year storm flows from DB1. A rating curve has been determined utilizing the orifice equation (CCRFCD Manual Equation 1202) performed in the Flowmatser Version 7.0 software by Haestad Methods. The primary outlet structure has been designed without tailwater impacts on the orifice plate opening intended to drain DB1.

PMF Overflow Spillway:

An overflow spillway has been provided to release storm flows in excess of the 100-year event in emergency conditions in the case the primary outlet structure is incapacitated. The rating curve has been determined utilizing the weir equation (CCRFCD Manual Equation 1203) performed in the Flowmatser Version 7.0 software by Haestad Methods.

The overflow spillway is located at the top of a 16-ft high embankment. Therefore a Roller Compacted Concrete (RCC) stepped structure is proposed to provide the grade difference and control the energy as the overflow spillway releases from DB1. The energy loss over the stepped spillway has been determined by a comparison of two methods, Chanson (Reference 5) and Christodolou (Reference 6) computations, with applicable reference material detailing each method included in Appendix H. The Christodolou method yielded the most conservative approach to estimating energy loss; therefore, a stilling basin and end sill has been proposed at the bottom of the stepped spillway to force a hydraulic jump.

Stilling Basins:

A total of two (2) stilling basins have been proposed in the location of proposed drops. The stilling basins have been designed utilizing methodologies found in the *USBR Hydraulic Design Manual of Stilling Basins and Energy Dissipators* (Reference 7). These methods utilize velocity, depth and Froude Number characteristics of the inflow to the stilling basin to determine conjugate depths and lengths to force the required hydraulic jump needed to dissipate the energy toward downstream conveyance. A Type III baffled stilling basin has been proposed at the downstream end of the drop from the main inflow channel into the detention storage area. A Type I natural jump stilling basin has been proposed at the downstream end of the drop from the stepped overflow spillway.

3 DESIGN FLOW RATES

3.1 Discussion of Hydrologic Analyses

A proposed and ultimate condition hydrologic analysis has been performed by this study to show that DB1 functions during either the current condition of the contributing watershed, and also the future anticipated watershed in accordance with the current CCRFCD MPU. The ultimate condition resulted in a higher contributing inflow; therefore, all design flow rates utilized in this study have been excerpted from the ultimate condition hydrologic model.

Refer to Exhibits E and F included in Appendix A for depiction of the proposed and ultimate condition hydrologic analysis, respectively. The south boundary of the contributing watershed remains consistent with the CCRFCD MPU at Grand Teton Drive in proximity to the existing overhead power utility corridor. The remainder of the contributing watershed has been delineated based on existing topography because the upstream drainage area lies within the Red Rock Conservation area and is outside the ultimate development boundary. Note that the ultimate condition produces a larger inflow to DB1 due to the anticipated “very high density residential” outlined in the CCRFCD MPU, reflected by the addition of Basin OFF7 to Exhibit F.

3.2 Summary of Design Flow Rates

As denoted above, the ultimate condition results in highest flow rates; therefore, the design of DB1 utilizes the flow rates illustrated on Exhibit F and summarized below in Table 1. Refer to Appendix C for the applicable HEC-1 analysis.

Table 1: Summary of Design Flow Rates (Ultimate Condition)		
Basin ID	Area (acres)	Q ₁₀₀ (cfs)
OFF1	260.7	403
OFF2	22.7	48
OFF3	16.6	38
OFF4	37.2	84
OFF5	164.4	236
OFF6	25.6	59
OFF7	18.0	55
ON1	16.7	47
Concentration Point ID	Area (mi ²)	Q ₁₀₀ (cfs)
CP1 (OFF1 + OFF2 + OFF3 + OFF7)	0.50	471
CP2 (OFF1 + OFF7)	0.44	420
DB1 (CP1 + OFF4 + OFF5 + OFF6 + ON1)	0.88	794
RDB1 (Detention Basin Outflow)	0.88	71

3.3 Comparison of Design Flow Rates

For comparative purposes, the design flow rates reported in this study have been evaluated against the pertinent SHG Master Study flow rates to show the study’s conformance to the master plan for the area. Refer to Table 2 for the applicable comparison.

Table 2: DB1 In/Out Flow Rate Comparison vs. SHG Master Study					
Detention Basin 1 Technical Design			SHG Master Study		
Contributing Source	Area (mi ²)	Q ₁₀₀ (cfs)	Contributing Source	Area (mi ²)	Q ₁₀₀ (cfs)
DB1 (Inflow)	0.88	794	PT1 (Inflow)	0.84	777
RDB1 (Outflow)	0.88	71	DET1 (Outflow)	0.84	146

Review of the above table shows that although the inflow drainage area and peak 100-year flow rate to DB1 has slightly increased from the concept presented in the SHG Master Study, the outflow 100-year peak flow rate has been significantly reduced. The SHG Master Study had designated that in addition to the proposed outfall into the arroyo utilized by this study, DB1 would also outlet into the 2nd of the 3 total detention basins planned at the west boundary. However, this study has re-configured DB1 to intercept an additional 0.04 square miles of contributing drainage area and also increased the storage volume from the conceptual 54.4 acre-ft to the proposed 70.9 acre-ft of volume required to no longer necessitate the 2nd outlet (SHG Master Study P04AW) into a future planned detention basin. As a result, the functionality of DB1 no longer requires DB2 to be in place to protect downstream property. Table 3 below has been provided to summarize that the proposed outlet discharge is approximately equal to the discharge (SHG Master Study P04W) conceptually approved in the SHG Master Study at the proposed outfall location.

Table 3: DB1 Outlet Comparison vs. SHG Master Study					
Detention Basin 1 Technical Design			SHG Master Study		
Proposed Outlet	Area (mi ²)	Q ₁₀₀ (cfs)	Proposed Outlet	Area (mi ²)	Q ₁₀₀ (cfs)
RDB1 (Outflow)	0.88	71	P04W (Outflow)	0.84	68

In conclusion, this table demonstrates that the removal of the 2nd outlet and the proposed re-configuration of DB1 is considered acceptable without adverse impact toward downstream property in accordance with the SHG Master Study.

4 HYDRAULIC FACILITIES

4.1 Summary of Detention Basin Design

As indicated previously, the configuration of DB1 has been modified from the conceptual design presented in the SHG Master Study. It has been expanded north to provide storage for an additional 25.6 acres of tributary area (Basin OFF6). Additionally, the storage capacity has been increased to allow for one (1) outlet pipe instead of the conceptual design of two (2) outlets. Table 4 below summarizes the critical performance parameters for DB1 technically designed by this study, compared to the conceptual design presented in the SHG Master Study. Several of the parameters summarized below are further detailed in later sections of this report.

Table 4: Summary of Detention Basin Performance Parameters			
Detention Basin 1 Technical Design		SHG Master Study Conceptual Design	
Parameter	Value	Parameter	Value
100-Yr Inflow	794 cfs	100-Yr Inflow	777 cfs
100-Yr Outflow	71 cfs	100-Yr Outflow	148 cfs
Outlet Orifice	30-inch	Outlet Orifice	(2) 30-inch RCPs
Total Storage Volume	70.9 ac-ft	Total Storage Volume	54.4 ac-ft
100-Yr Volume	65 ac-ft	100-Yr Volume	50 ac-ft
Debris Volume	5.9 ac-ft	Debris Volume	4.4 ac-ft
100-Yr Water Surface	3036.0-ft	100-Yr Water Surface	3040.7-ft
PMF Inflow	5,184 cfs	PMF Inflow	3,145 cfs
PMF Outflow	4,912 cfs	PMF Outflow	3,145 cfs
PMF Spillway Elevation	3037.0-ft	PMF Spillway Elevation	3042-ft
PMF Spillway Length	87-ft	PMF Spillway Length	200-ft
PMF Spillway Depth	7-ft	PMF Spillway Depth	3-ft

Review of the above table results in the following major differences between this study's technical design of DB1 and the previous conceptual design:

- The storage volume of DB1 has increased to allow for it to independently function without the need for a 2nd outlet pipe into the future 2nd detention basin as conceptually presented in the SHG Master Study.
- As a result of DB1 functioning independently, the PMF inflow has been re-calculated. Additionally, the PMF spillway has been positioned on the top of the major embankment into the arroyo to direct the emergency overflow into a corridor of minimal impact toward downstream property. Therefore, the PMF emergency spillway has been re-configured to accommodate a larger PMF flow and also a reduced length.

The maximum drain time per Section 1202.1 of the CCRFCD Manual is 7 days, and the preferred drain time is 24 hours. The preferred drain time is measured as the time from the end of the precipitation, or 6 hours for a SDN3 storm distribution, until the basin is drained 90 percent of design capacity. It has been determined that DB1 is 90% drained after 27 hours and 5 minutes from initial inflow, which meets the requirement for preferred drain time. This study also shows that DB1 meets the requirement for drain time and is entirely drained in approximately 2 days. The outflow hydrograph on the HEC-1 model included in Appendix C has been plotted to demonstrate the above drain times.

Exhibit G, included in Appendix A, has been prepared to demonstrate the shadow of protection for the downstream Skye Canyon master planned property resulting from the construction and functioning of DB1. All areas located within the shadow on the exhibit are subject to offsite flow rates that are intended to be captured by DB1. Note that the shadow of DB1 is no longer conditioned on the 2nd Detention Basin being in place.

A 12-ft drive-able access path has been provided to the entire perimeter of DB1, including ramps to the bottom of the basin and to the discharge of the outlet pipes and overflow spillway. Note that the existing access road for the overhead power poles has been utilized to maintain the western perimeter of the basin. The provided access originates from the public right-of-way of Grand Teton Drive and the existing power access corridor in the alignment of Shaumber Road.

Note that water quality features have not been proposed with DB1, as discussed with the City of Las Vegas. The large majority of the watershed is located within the Red Rock Conservation Area outside of the ultimate development boundary for the Las Vegas valley; therefore, the influence of development that would require water quality improvements in the basin is very limited.

Also note that 3-ft wide valley gutters have been provided on the floor of DB1 sloped at 0.5% to perpetuate low flows toward the outfall facilities.

4.2 Summary of 100-Year Outlet Facility

The following are performance parameters specific to the primary outlet structure for the 100-year storm event.

Outlet Invert Elevation = 3025.5-ft
Outlet Orifice Size = 30-inch RCP
Outlet Pipe = 36-inch RCP @ 2% slope

Note the following regarding the 100-year outlet facility:

- The outfall for the 100-year storm event has been staged above the bottom of the detention basin. The bottom elevation is 3023.0-ft and the 2.5-ft of storage below the outlet is intended as dead storage for debris collection. Further detail regarding debris storage is provided in Section 4.3 of this study.
- The outlet flow has been controlled by a 30-inch orifice plate on the outlet pipe. The outlet pipe is proposed as a 36-inch RCP in order to eliminate adverse tailwater impacts to the functionality of the 30-inch orifice opening.
- The outlet pipe discharges thru a shared headwall with the drainage pipe from the debris storage area, downstream of the overflow spillway.

4.3 Summary of Debris Storage Area

A total of 4.21 ac-ft of debris volume is required to be stored in DB1 during the 100-year storm event. Note that the proposed condition hydrologic model has been utilized to determine the debris volume because it represents the worst case sedimentation impacting DB1. During the ultimate condition, a portion of the watershed is anticipated to be developed as “very high density residential” which is anticipated to result in no additional sedimentation. Table 5 below summarizes the amount of debris estimated to impact DB1 from each individual basin comprising the offsite watershed.

Table 5: Summary of Debris Volumes	
Basin ID	Volume (ac-ft)
OFF1	2.20
OFF2	0.10
OFF3	0.09
OFF4	0.27
OFF5	1.40
OFF6	0.14

Table 5: Summary of Debris Volumes	
Basin ID	Volume (ac-ft)
<i>Total</i>	<i>4.21</i>

Note that the bottom of DB1 is intended solely for debris storage and the 100-year outlet structure is staged 2.5-ft above the bottom of the basin. The 2.5-ft of storage results in available volume of 5.86 ac-ft for the impacting debris which is greater than the 4.21-ft required as summarized by the above table; therefore, the provided debris storage is acceptable.

Since the primary outlet structure is staged above the debris storage area, a debris riser tower has been provided to provide drainage for the bottom 2.5-ft of DB1. A perforated 24-inch RCP riser structure has been provided, and computations included in Appendix G show that the perforations are adequate to dewater the debris storage area in less than 7 days as directed by CCRFCD criteria. A total of four (4) 3-inch perforations have been provided every 6-inches vertically on the tower, for a total of sixteen (16) perforations. Note that a beehive grate is provided at the top of the riser tower to allow for floating debris to fall off the tower without adverse impact.

4.4 Summary of PMF Overflow Spillway

The overflow spillway has been proposed at 3037.0-ft, or 1-ft above the 100-year water surface elevation and the PMF outflow crests over the spillway at an elevation of 3043.98-ft. The spillway has been located where the overflow passing thru DB1 will be directed into a corridor that is considered to have the most minimal impact toward future development. The overflow will be conveyed in a USACE jurisdictional wash that requires 404 permitting for disturbances in the overflow corridor. A future dam break analysis, associated with obtaining a Dam Safety Permit, will show the zone of impact for the overflow in this corridor.

A PMF outflow from DB1 of 4,912 cfs conveyed thru the 87-ft length spillway is conveyed down a 16-ft embankment into the arroyo. A RCC stepped spillway featuring a total of 8 steps (4-ft horizontal by 2-ft vertical, or 2:1 H:V sloped) has been proposed to reduce the energy from the top of the embankment to the bottom by a total ratio of 20%. The resulting velocity and Froude number at the toe of the stepped spillway is 32.1 ft/s and 4.3, respectively. The energy loss over the stepped spillway is not large enough to dissipate the energy of the PMF flow in order to minimize potential undercutting of the embankment; therefore, a 60-ft length RCC stilling basin with 3.5-ft high end sill is proposed at the toe of the stepped structure to force a hydraulic jump.

4.5 Summary of Main Inflow Channel

The main inflow channel is intended as a collector for contributing flows south of DB1, and extends from Grand Teton Drive to 1,400-ft north. As shown on Exhibits E and F, included in Appendix A, the large majority of contributing flows (Concentration Point CP2) is anticipated to collect into the main inflow channel at approximately Grand Teton Drive.

Therefore, the entire main inflow channel has been designed to convey the entire contributing flow defined at Concentration Point CP1.

The main inflow channel has been designed to limit the excess cuts and fills from existing topography; therefore, the longitudinal slope is a composite of flat and steep slopes. Note that the maximum slope does not exceed 10% along the channel bottom to ensure drive-able access to the proposed drop into DB1. Table 6 summarizes the channel hydraulics proposed and accompanying computations have been included in Appendix E.

Cross Section	Q ₁₀₀ (cfs)	Slope (%)	Flow Depth (ft)	Flow Velocity (ft/s)	Froude Number	Hydraulic Freeboard (ft) ¹	Sedimentation Freeboard (ft)	Required Channel Depth (ft)
1	471	0.5	2.43	10.03	1.33	1.34	1.0	4.77
2	471	10.0	1.08	28.63	5.35	1.73	1.0	3.81
3	471	33.3	0.52	36.09	8.81	1.73	1.0	3.25

¹ – Hydraulic Freeboard obtained from CCRFCD Manual Equation 747.

The channel geometry for Cross Sections 1 and 2 is represented by a concrete lined trapezoidal section with a 12-ft bottom width and 3:1 SS for a depth of 5-ft. The flow regime is anticipated to be stable with no hydraulic jumps as demonstrated by the above table showing supercritical flow throughout the channel. Any grading above the depth of 5-ft is to be earth lined because it is not anticipated that flows will exceed the top of concrete side slope. However, a 3-ft deep concrete cut-off wall will be provided at the top of concrete side slope to protect any undercutting that may occur from lateral flows contributing into the channel. Note that the major lateral inflows to the channel have been lined with riprap for erosion protection.

The trapezoidal channel section characterized by Cross Sections 1 and 2 transitions near the drop in grade to a concrete rectangular channel section that has also been widened to 25-ft for turnaround prior to the drop, required for the drive-able access that is present at the bottom of the channel. At the toe of the 3:1 drop from the main inflow channel to the detention basin, a Type III stilling basin is provided for energy dissipation. Note that the flow velocity in the rectangular drop, or Cross Section 3, exceeds the allowable velocity over concrete of 35 ft/s as directed by CCRFCD Manual Table 703; however, 36.09 ft/s is considered not excessive over 35 ft/s and a stilling basin designed to accommodate inflow velocities upwards of 60 ft/s per CCRFCD Manual Table 1101 is provided at the toe of the drop to protect the integrity of the concrete.

A 25-ft wide Type III stilling basin at the toe of the Cross Section 3 drop has been proposed with a 14-ft length apron with a 0.8-ft end sill. 0.5-ft width chute blocks have been provided at the toe of the drop, spaced evenly 0.5-ft apart from each other over 25-ft width, resulting in 24 chute blocks. 0.75-ft width baffle piers have been provided 4.2-ft from the toe, spaced 0.75-ft apart from each other over 25-ft width, resulting in 16 baffles. The height of the vertical wall determined to control the splash from the hydraulic jump forced by the stilling basin is 5.5-ft. Note that a 3-ft wide gap in the end sill has been provided to allow for low flows to perpetuate into the detention basin.

4.6 Summary of Lateral Inflow Channels

At each of the incised washes contributing to DB1, a lateral inflow channel has been proposed down the slope to the bottom of the basin. The lateral inflow channels have been provided for control of the inflow into DB1 to identified areas down the slope to minimize excessive maintenance concerns. The lateral inflow channels have been designed in a manner that avoids any significant contraction or expansion tailwater impacts that may result in storm flows backing up onto the offsite Red Rock Conservation area. Existing cross sections have been analyzed in each of the incised washes, refer to Exhibit E, and the proposed lateral inflow channel has been provided as the same width as existing in the wash. All lateral inflow channels have been proposed as 1-ft deep down the slope which provides minimum twice the depth of flow. Additionally, riprap armouring has been provided for slope stability and the riprap has been deepened and lengthened at the toe of slope per CCRFCD Manual Figure 705D. Table 7 below summarizes the flow depths and velocities in each of the proposed lateral inflow channels, and the associated computations have been included in Appendix F.

Table 7: Summary of Lateral Inflow Channel Hydraulic Characteristics							
Offsite Basin	Q ₁₀₀ (cfs)	Slope (%)	Flow Depth (ft)	Flow Velocity (ft/s)	Channel Width (ft)	Required Channel Depth (ft) ¹	Riprap Armouring
OFF4	84	33.3	0.33	10.04	24	0.66	Loose D ₅₀ 12-in.
OFF5	234	33.3	0.47	12.67	38	0.94	Grouted D ₅₀ 12-in.
OFF6	59	33.3	0.25	8.29	28	0.50	Loose D ₅₀ 12-in.
1 – Required Channel Depth provided as minimum twice the depth of flow.							

Note that due to the design of the main inflow channel, all lateral inflow locations discharge over the channel's concrete side slope which provides the slope stability without the need for riprap armouring or a defined channel section for containment of flow. Therefore, lateral inflow channels are not present adjacent to the main inflow channel.

5 CONCLUSIONS & RECOMMENDATIONS

1. The proposed improvements are not located within a FEMA designated SFHA.
2. This study is proposing a detention basin that is intended to be adopted as a CCRFCD regional facility. The current 2013 MPU shows DB1 identified as regional Facility MOHU 0186, its PMF overflow spillway as MOHU 0185, and its outfall as MOHU 0184. It is acknowledged that although these regional facilities added to the MPU as part of the Kyle Canyon Amendment has been accepted by CCRFCD, but they have not been formally adopted by the City of Las Vegas. As a result, DB1 is not considered a regional facility at this time, and future action by the Las Vegas City Council is required to change the classification of DB1 to a regional facility.

3. This study shows that the configuration of DB1 has changed from the concept approved in the SHG Master Study. DB1 is larger in storage volume and no longer provides a 2nd outlet into the future planned detention basin to the north. However, the outflow from DB1 in the alignment of SHG Master Study facility P04W is in conformance with the master planned drainage patterns for the area, per Table 3 in this study.
4. Application to construct DB1 requires coordination with the following agencies in addition to the City of Las Vegas:
 - **CCRFCD** – DB1 is anticipated to be adopted as a regional facility.
 - **Nevada Division of Water Resources** – A Dam Safety permit is required for the impoundment of water behind the DB1 embankment.
 - **NV Energy** – Improvements and access for DB1 within an existing overhead power utility corridor.
 - **USACE** – A permit for the proposed disturbances to the 404 jurisdictional wash encumbered by DB1 is required.
 - **Clark County Dept. of Public Works** – The Red Rock Conservation Area representing the contributing watershed to DB1 is located within unincorporated Clark County jurisdictional limits.
5. All CCRFCD standards for a regional detention basin, per CCRFCD Manual Section 1202.1, have been satisfied by DB1 and its components. Additionally, the main inflow channel satisfies the requirement for improved channels as directed by CCRFCD Manual Section 706.
6. A RCC spillway and stilling basin has been provided for the emergency overflow, intended to pass the PMF flow impacting DB1. Detailed sections regarding the installation of the RCC material has been provided on the improvement plans.
7. A Type III stilling basin has been proposed at the toe of the drop into DB1 from the main inflow channel intended to dissipate the energy so as to not adversely impact the effectiveness of the downstream basin.
8. The improvement plans for this project have been included with this study. These plans support the drainage patterns, facilities and conclusions detailed in this study.

6 REFERENCES

1. *Las Vegas Valley Flood Control Master Plan Update*. PBS&J, Louis Berger Group and Parsons Brinckerhoff, 2013.
2. *Hydrologic Criteria and Drainage Design Manual*. Clark County Regional Flood Control District, 1990.
3. *Hydrometeorological Report No. 49 – Probable Maximum Precipitation Estimates, Colorado River and Great Basin Drainages*. NOAA, National Weather Service, 1984.
4. *Soil Survey of Las Vegas Valley Area, Nevada*. U.S. Department of Agriculture, Soil Conservation Service, July 1985.

5. *Hydraulics of Skimming Flow over Stepped Channels and Spillways.* Chanson, 1994.
6. *Energy Dissipation on Stepped Spillways.* Christodolou, 1993.
7. *Engineering Monograph No. 25 - Hydraulic Design of Stilling Basins and Energy Dissipators.* U.S. Bureau of Reclamation, 1984.
8. *Master Drainage Study for Kyle Canyon;* Slater Hanifan Group, 2012.

APPENDIX A

Drainage Exhibits

Exhibit A – Location Map

Exhibit B – FEMA FIRM Panel

Exhibit C – 2013 CCRFCD MPU Facilities

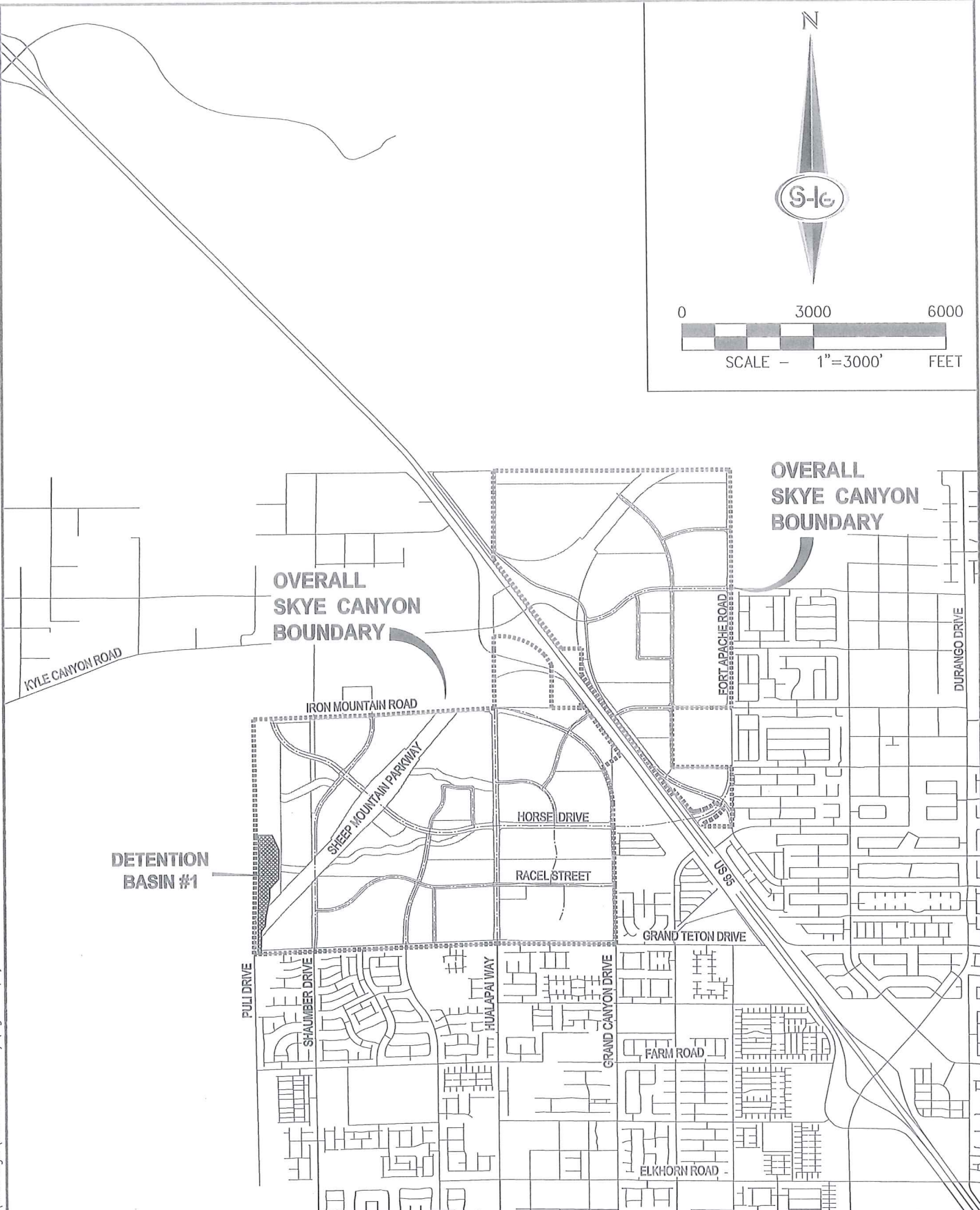
Exhibit D – Soils Map

Exhibit E – Proposed Condition Drainage Map

Exhibit F – Ultimate Condition Drainage Map

Exhibit G – Shadow of Protection Exhibit

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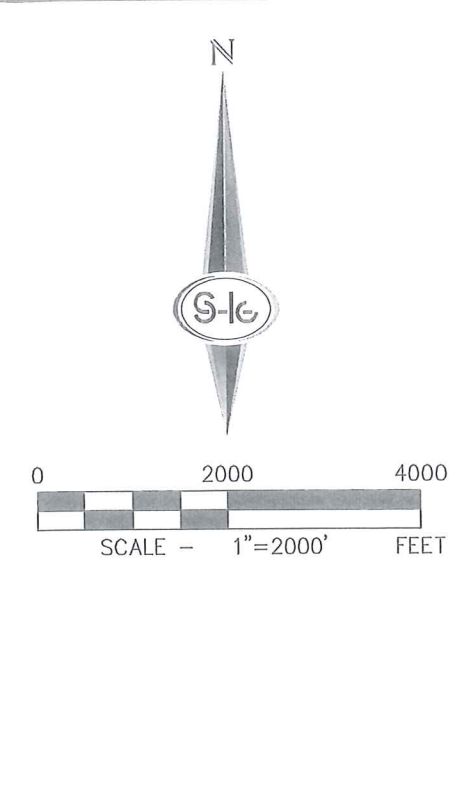


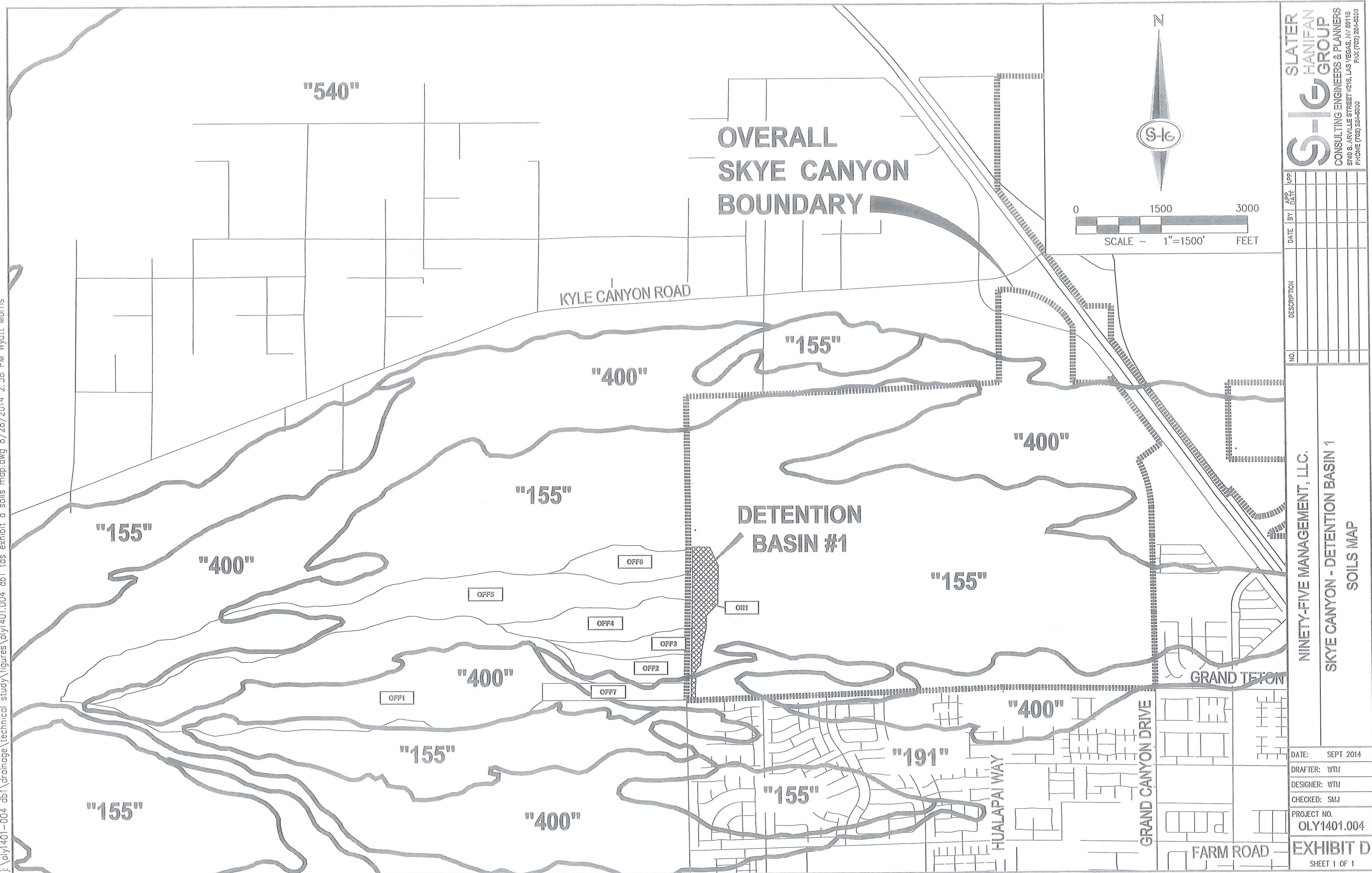
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SKYE CANYON - DETENTION BASIN 1
LOCATION MAP

DATE: SEPT 2014
DRAFTER: WTM
DESIGNER: WTM
CHECKED: SMJ

PROJECT NO.
OLY1401.004
EXHIBIT A
SHEET 1 OF 1



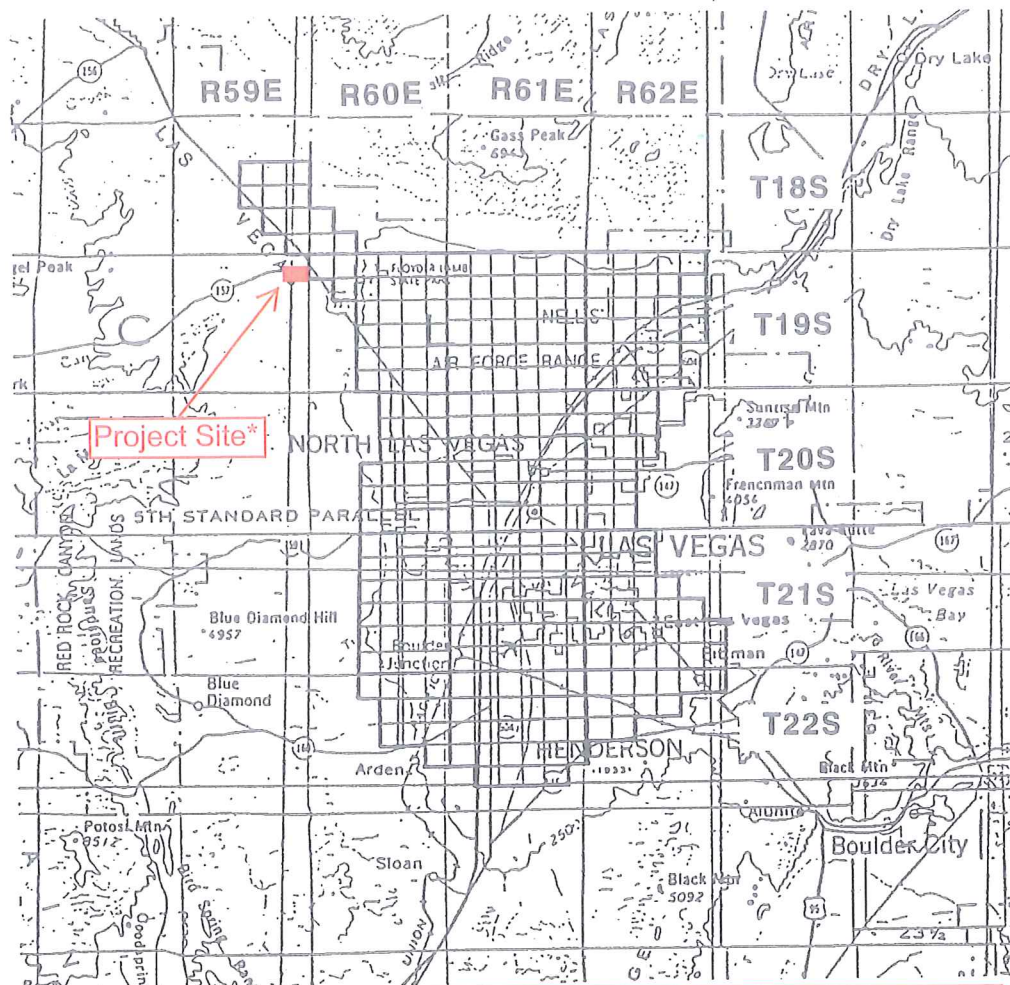


APPENDIX B

Hydrologic Data

HYDROLOGIC CRITERIA AND DRAINAGE DESIGN MANUAL

McCARRAN AIRPORT RAINFALL AREA



*Project site not located within the McCarran Rainfall area (T21-R60-S31)

TOWNSHIP	RANGE	SECTIONS	TOWNSHIP	RANGE	SECTIONS
18 South	59 East	13-15,22-26,36	20 South	62 East	4-9,16-20,29-32
18 South	60 East	30-32	21 South	60 East	1-4,9-16,21-28,33-36
19 South	60 East	1-6,8-16,21-28,33-36	21 South	61 East	ALL SECTIONS
19 South	61 East	ALL SECTIONS	21 South	62 East	4-9,15-23, 25-36
19 South	62 East	2-11,14-23,27-34	22 South	60 East	1-4,10-15,24
20 South	60 East	1-3,10-15,21-28,33-36	22 South	61 East	1-24,26-29
20 South	61 East	ALL SECTIONS	22 South	62 East	1-10,17-18

Notes:

1. Refer to Table 505 and Figure 516 Depth-Duration-Frequency values in the McCarran Airport Rainfall Area.
2. Refer to Table 506 and Figure 517 for Time-Intensity-Frequency values on the McCarran Airport Rainfall Area.

Revision	Date

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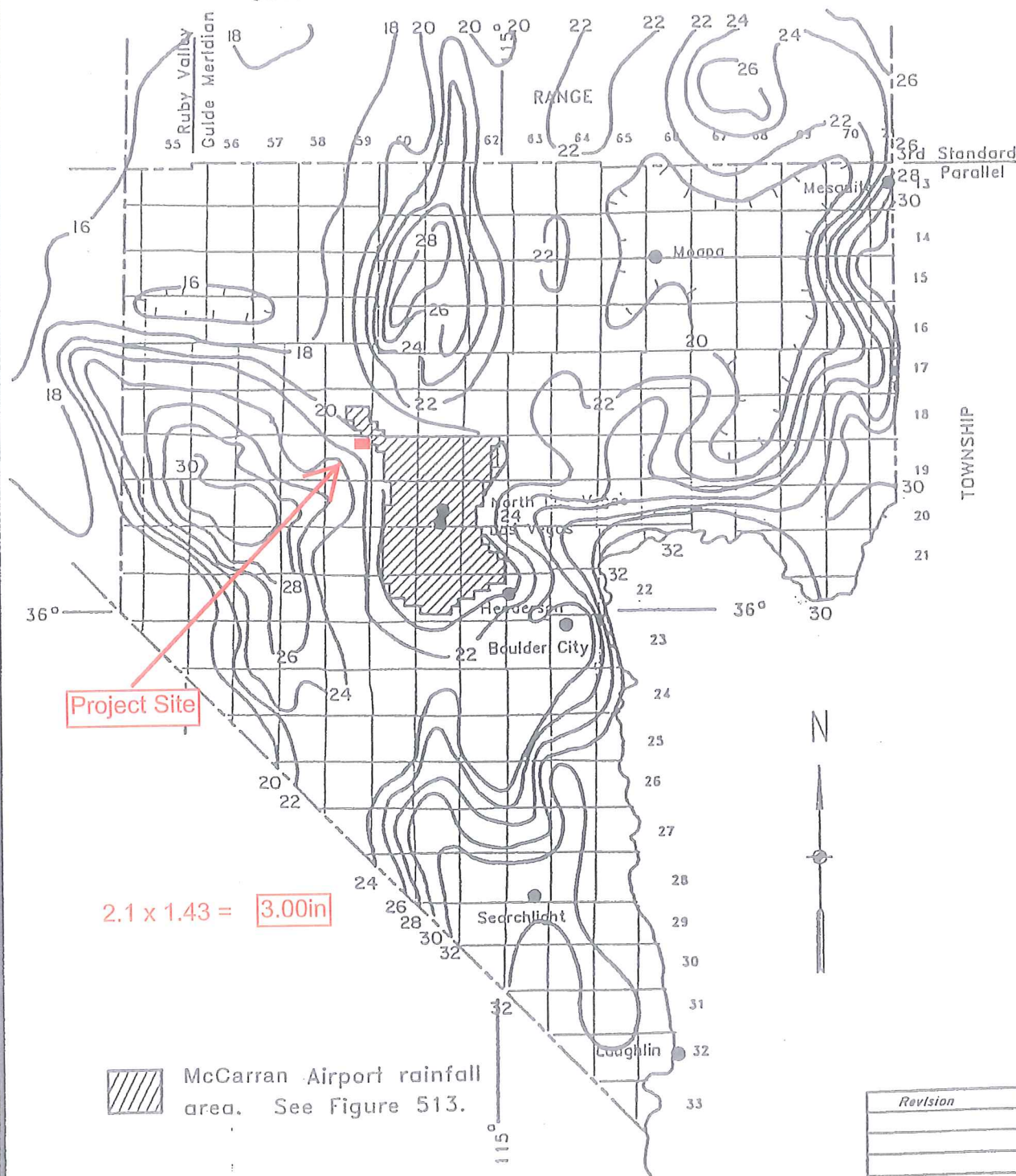
REFERENCE:

USACE, Los Angeles District, 1988

FIGURE 513

HYDROLOGIC CRITERIA AND DRAINAGE DESIGN MANUAL

RAINFALL DEPTH-DURATION-FREQUENCY 100-YEAR, 6-HOUR (DEPTHS IN TENTHS OF INCHES)



PRECIPITATION ADJUSTMENT RATIOS

<u>Recurrence Interval</u>	<u>Ratio to NOAA Atlas 2</u>
2-year	1.00
5-year	1.16
10-year	1.24
25-year	1.33
50-year	1.39
100-year	1.43

- NOTE: 1. Multiply the values obtained from the NOAA Atlas 2 by the above ratios to obtain the adjusted precipitation values.
2. NOAA Atlas 2 values for use with TR-55 shall not be adjusted by the above ratios.
3. Tables 505 and 506 require no adjustments.

<i>Revision</i>	<i>Date</i>

HYDROLOGIC CRITERIA AND DRAINAGE DESIGN MANUAL

SIX-HOUR STORM DISTRIBUTIONS

Percent of Total Storm Depth				Percent of Total Storm Depth			
Storm Time (In Minutes)	SDN3	SDN4	SDN5	Storm Time (In Minutes)	SDN3	SDN4	SDN5
0	0.0	0.0	0.0	185	32.2	37.6	43.0
5	2.0	2.0	2.0	190	35.2	41.5	47.7
10	5.7	5.8	5.9	195	40.9	46.2	51.4
15	7.0	7.5	8.0	200	49.9	53.0	56.1
20	8.7	9.9	11.0	205	59.0	61.0	63.0
25	10.8	12.6	14.4	210	71.0	71.0	71.0
30	12.4	13.7	15.0	215	74.4	73.2	72.0
35	13.0	14.5	16.0	220	78.1	75.6	73.1
40	13.0	14.9	16.8	225	81.2	78.2	75.2
45	13.0	15.1	17.1	230	81.9	79.9	77.9
50	13.0	15.5	18.0	235	83.5	81.3	79.0
55	13.0	15.6	18.2	240	85.1	82.3	79.5
60	13.0	15.9	18.7	245	85.6	83.0	80.4
65	13.3	16.2	19.0	250	86.0	83.5	81.0
70	14.0	16.9	19.7	255	86.8	84.4	82.0
75	14.2	17.2	20.2	260	87.6	85.1	82.6
80	14.8	17.9	21.0	265	88.8	86.4	84.0
85	15.8	18.9	22.0	270	91.0	88.5	85.9
90	17.2	20.1	23.0	275	92.6	90.8	88.9
95	18.1	21.1	24.1	280	93.7	92.4	91.0
100	19.0	22.0	25.0	285	95.0	94.4	93.8
105	19.7	22.8	25.9	290	97.0	96.8	96.6
110	19.9	23.2	26.5	295	97.6	97.3	97.0
115	20.0	24.0	28.0	300	98.2	97.8	97.4
120	20.1	24.6	29.0	305	98.5	98.2	97.9
125	20.4	25.2	30.0	310	98.7	98.4	98.1
130	21.4	26.0	30.5	315	98.9	98.6	98.3
135	22.9	26.9	30.9	320	99.0	98.8	98.5
140	24.1	27.6	31.0	325	99.3	99.1	98.9
145	24.9	28.3	31.7	330	99.3	99.2	99.0
150	25.1	28.6	32.1	335	99.4	99.3	99.2
155	25.6	29.2	32.7	340	99.5	99.4	99.3
160	27.0	30.2	33.3	345	99.8	99.7	99.6
165	27.8	31.2	34.6	350	99.8	99.8	99.7
170	28.1	32.1	36.1	355	99.9	99.9	99.9
175	28.3	33.2	38.1	360	100.0	100.0	100.0
180	29.5	35.2	40.8				

- Notes
1. For drainage areas less than 8 square miles in size, use SDN 3.
 2. For drainage areas greater than or equal to 8 square miles and less than 12 square miles in size, use SDN 4.
 3. For drainage areas greater than or equal to 12 square miles, use SDN 5.
 4. A graphical representation of these values is presented on Figure 515.

Revision	Date

REFERENCE:

TABLE 503

HYDROLOGIC CRITERIA AND DRAINAGE DESIGN MANUAL

SIX HOUR DEPTH-AREA REDUCTION FACTORS

Drainage Area
(Square Miles)

Six-Hour Depth-Area
Reduction Factor

0.0	1.00
0.5	0.98
1.0	0.97
2.0	0.93
4.0	0.91
6.0	0.90
8.0	0.88
10.0	0.86
20.0	0.79
30.0	0.74
50.0	0.68
100.0	0.60
150.0	0.55
200.0	0.51
300.0	0.46
400.0	0.42
500.0	0.39

- NOTES: 1. A graphical representation of these factors is presented in Figure 514.
2. Consult with the local entity and/or the CCRFCD for guidance in using the Depth-Area Reduction Factors for drainage areas greater than 200 square miles.

Revision	Date

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REFERENCE:

USACE, Los Angeles District, 1988

TABLE 502

HYDROMETEOROLOGICAL REPORT NO. 49

Probable Maximum Precipitation Estimates,
Colorado River and Great Basin Drainages

REPRINTED 1984

PROPERTY OF:
NOAA, NATIONAL WEATHER SERVICE

U.S. DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
U.S. DEPARTMENT OF ARMY
CORPS OF ENGINEERS

Silver Spring, Md.

Table 6.3A.--Local-storm PMP computation, Colorado River, Great Basin and California drainages. For drainage average depth PMP. Go to table 6.3B if areal variation is required.

Drainage INFLOW TO DBI Area 0.9 mi.² (km.²)
 Latitude 36°N Longitude 115°W Minimum Elevation 3020 ft (m)

Steps correspond to those in sec. 6.3A.

1. Average 1-hr 1-mi.² (2.6-km.²) PMP for 10.6 in. (mm)
 drainage [fig. 4.5].

2. a. Reduction for elevation. [No adjustment for elevations up to 5,000 feet (1,524 m): 5% decrease per 1,000 feet (305 m) above 5,000 feet (1,524 m)]. 100 %

b. Multiply step 1 by step 2a. 10.6 in. (mm)

3. Average 6/1-hr ratio for drainage [fig. 4.7]. 1.33

	Duration (hr)									
	1/4	1/2	3/4	1	2	3	4	5	6	
4. Durational variation for 6/1-hr ratio of step 3 [table 4.4].	<u>69.3</u>	<u>87.2</u>	<u>94.9</u>	<u>100</u>	<u>115.2</u>	<u>122.5</u>	<u>127.1</u>	<u>130.7</u>	<u>133</u>	%

5. 1-mi.² (2.6-km.²) PMP for indicated durations [step 2b X step 4]. 7.3 9.2 10.0 10.6 12.2 13.0 13.5 13.9 14.1 in. (mm)

6. Areal reduction [fig. 4.9]. 100 100 100 100 100 100 100 100 100 %

7. Areal reduced PMP [steps 5 X 6]. 7.3 9.2 10.0 10.6 12.2 13.0 13.5 13.9 14.1 in. (mm)

8. Incremental PMP [successive subtraction in step 7]. _____ in. (mm)

_____ } 15-min. increments

9. Time sequence of incremental PMP according to:

Hourly increments [table 4.7]. _____ in. (mm)

Four largest 15-min. increments [table 4.8]. _____ in. (mm)

USE IN
 PMF HEC-1
 AS PRECIP. VALUE

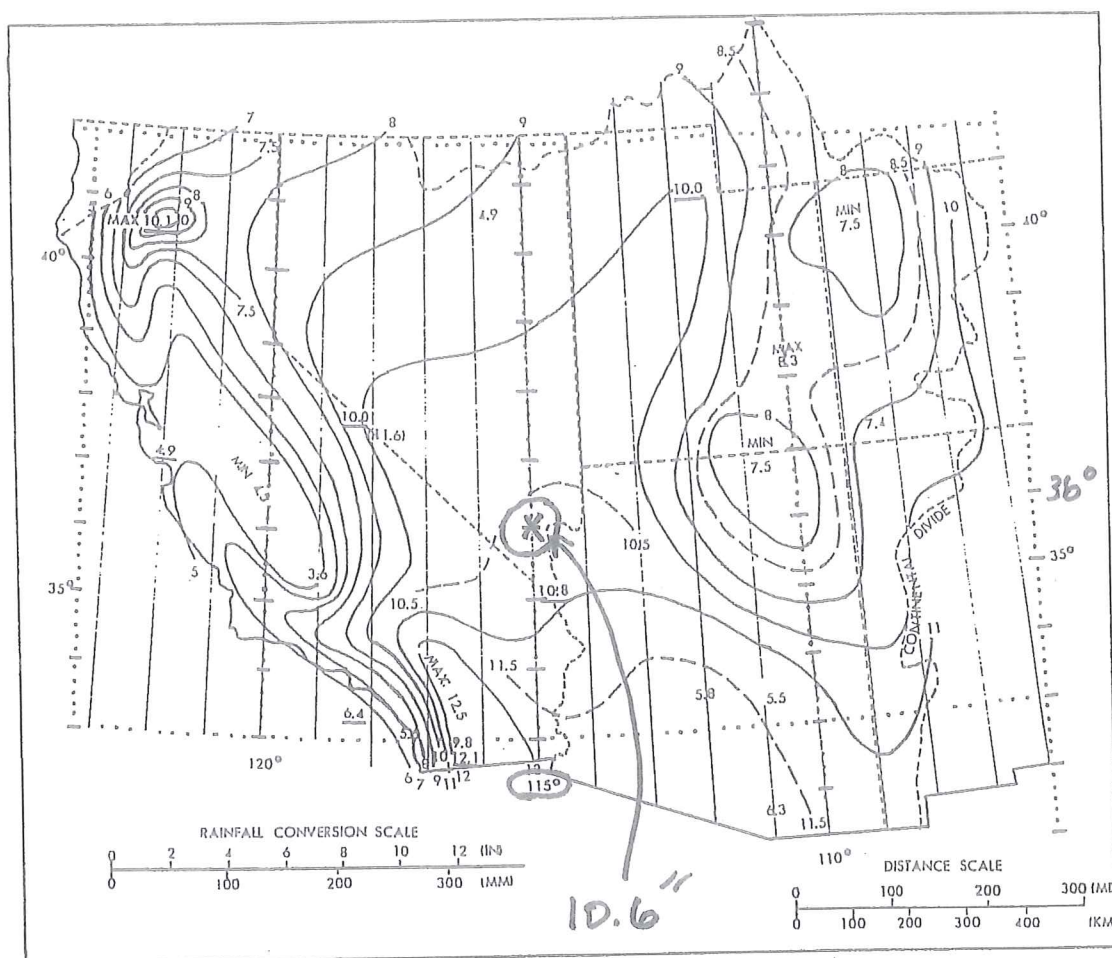


Figure 4.5--Local-storm PMP for 1 mi² (2.6 km²) 1 hr. Directly applicable for locations between sea level and 5000 ft (1524 m). Elevation adjustment must be applied for locations above 5000 ft.

events. In contrast to figure 4.4, figure 4.5 maintains a maximum between these two locations. There is no known meteorological basis for a different solution. The analysis suggests that in the northern portion of the region maximum PMP occurs between the Sierra Nevada on the west and the Wasatch range on the east.

A discrete maximum (> 10 inches, 254 mm) occurs at the north end of the Sacramento Valley in northern California because the northward-flowing moist air is increasingly channeled and forced upslope. Support for this PMP center comes from the Newton, Kennett, and Red Bluff storms (fig. 4.1). Although the analysis in this region appears to be an extension of the broad maximum through the center of the Southwestern Region, it does not indicate the direction of moist inflow. The pattern has evolved primarily as a result of attempts to tie plotted maxima into a reasonable picture while considering inflow directions, terrain effects, and moisture potential.

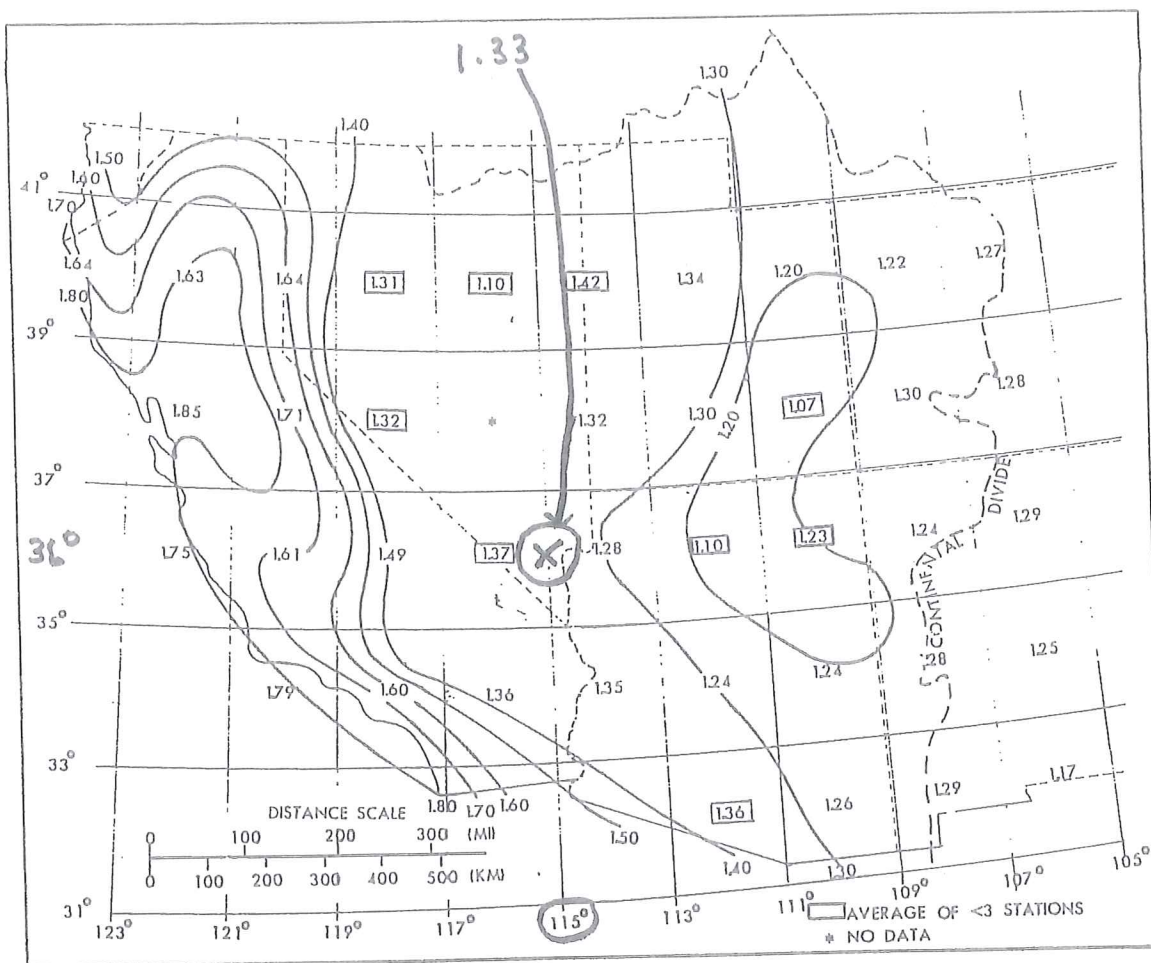


Figure 4.7.--Analysis of 6/1-hr ratios of averaged maximum station data (plotted at midpoints of a 2° latitude-longitude grid).

establish the basic depth-duration curve, then structure a variable set of depth-duration curves to cover the range of 6/1-hr ratios that are needed.

Three sets of data were considered for obtaining a base relation (see table 4.3 for depth-duration data).

a. An average of depth-duration relations from each of 17 greatest 3-hr rains from summer storms (1940-49) in Utah (U. S. Weather Bureau 1951b) and in unpublished tabulations for Nevada and Arizona (1940-63). The 3-hr amounts ranged from 1 to 3 inches (25 to 76 mm) in these events.

b. An average depth-duration relation from 14 of the most extreme short-duration storms listed in Storm Rainfall (U. S. Army, Corps of Engineers 1945-). These storms come from Eastern and Central States and have 3-hr amounts of 5 to 22 inches (127 to 559 mm).

ratios than storms with high 3/1-hr ratios. The geographical distribution of 15-min to 1-hr ratios also were inversely correlated with magnitudes of the 6/1-hr ratios of figure 4.7. For example, Los Angeles and San Diego (high 6/1-hr ratios) have low 15-min to 1-hr ratios (approximately 0.60) whereas the 15-min to 1-hr ratios in Arizona and Utah (low 6/1-hr ratios) were generally higher (approximately 0.75).

Depth-duration relations for durations less than 1 hour were then smoothed to provide a family of curves consistent with the relations determined for 1 to 6 hours, as shown in figure 4.3. Adjustment was necessary to some of the curves to provide smoother relations through the common point at 1 hour.

We believe we were justified in reducing the number of the curves shown in figure 4.3 for durations less than 1 hour, letting one curve apply to a range of 6/1-hr ratios. The corresponding curves have been indicated by letter designators, A-D, on figure 4.3. As an example, for any 6-hr amount between 115% and 135% of 1-hr, 1-mi² (2.6-km²) PMP, the associated values for durations less than 1 hour are obtained from the curve designated as "B".

Table 4.4 lists durational variations in percent of 1-hr PMP for selected 6/1-hr rain ratios. These values were interpolated from figure 4.3.

To determine 6-hr PMP for a basin, use figure 4.3 (or table 4.4) and the geographical distribution of 6/1-hr ratios given in figure 4.7.

Table 4.4.--Durational variation of 1-mi² (2.6-km²) local-storm PMP in percent of 1-hr PMP (see figure 4.3)

6/1-hr ratio	Duration (hr)								
	1/4	1/2	3/4	1	2	3	4	5	6
1.1	86	93	97	100	107	109	110	110	110
1.2	74	89	95	100	110	115	118	119	120
1.3	74	89	95	100	114	121	125	128	130
1.4	63	83	93	100	118	126	132	137	140
1.5	63	83	93	100	121	132	140	145	150
1.6	43	70	87	100	124	138	147	154	160
1.8	43	70	87	100	130	149	161	171	180
2.0	43	70	87	100	137	161	175	188	200

4.5 Depth-Area Relation

We have thus far developed local-storm PMP for an area of 1 mi² (2.6 km²). To apply PMP to a basin, we need to determine how 1-mi² (2.6-km²) PMP should decrease with increasing area. We have adopted depth-area relations based on rainfalls in the Southwest and from consideration of a model thunderstorm.

	1/4	1/2	3/4	1	2	3	4	5	6
@ 1.33	69.3	87.2	94.4	100	115.2	122.5	127.1	130.7	133

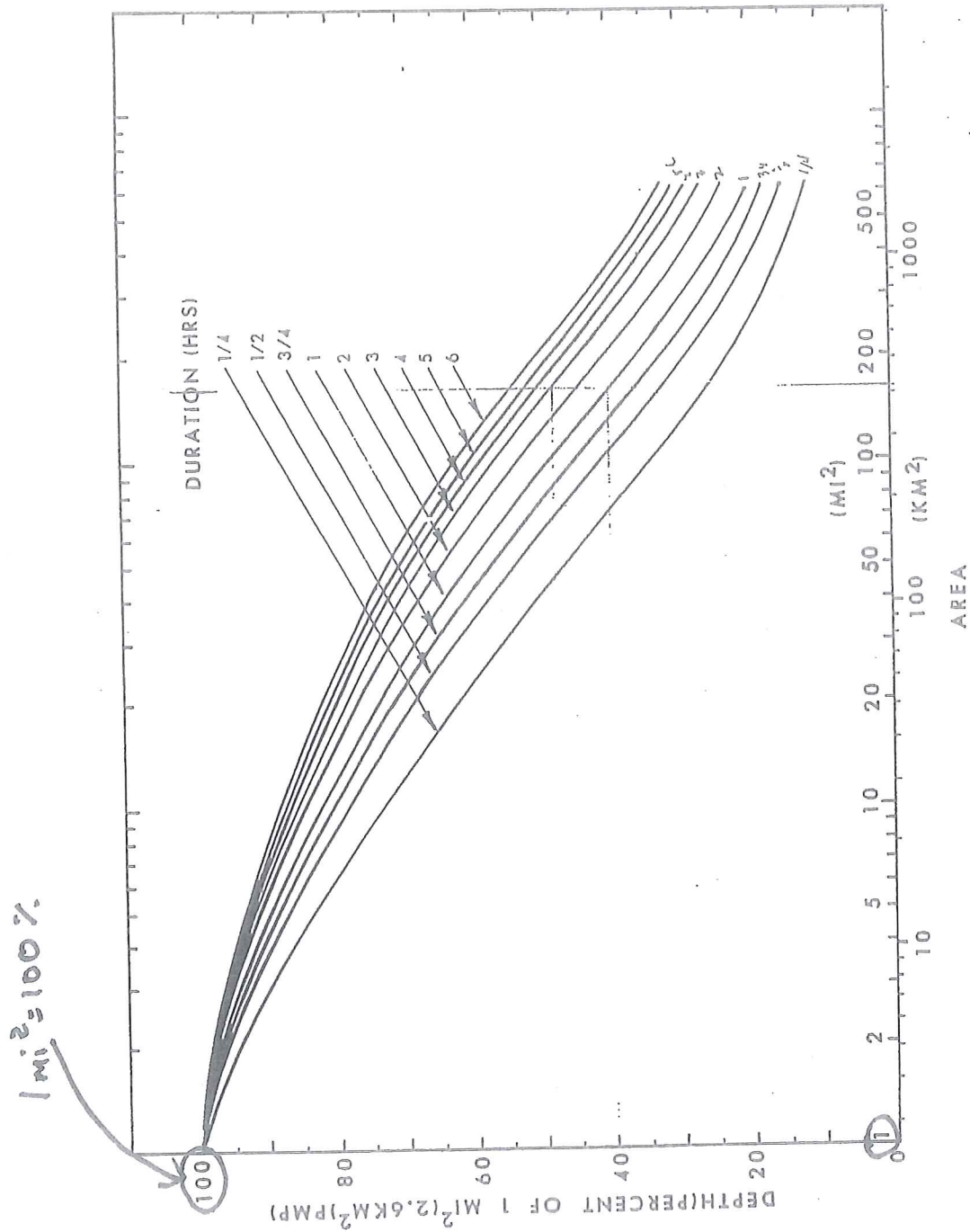
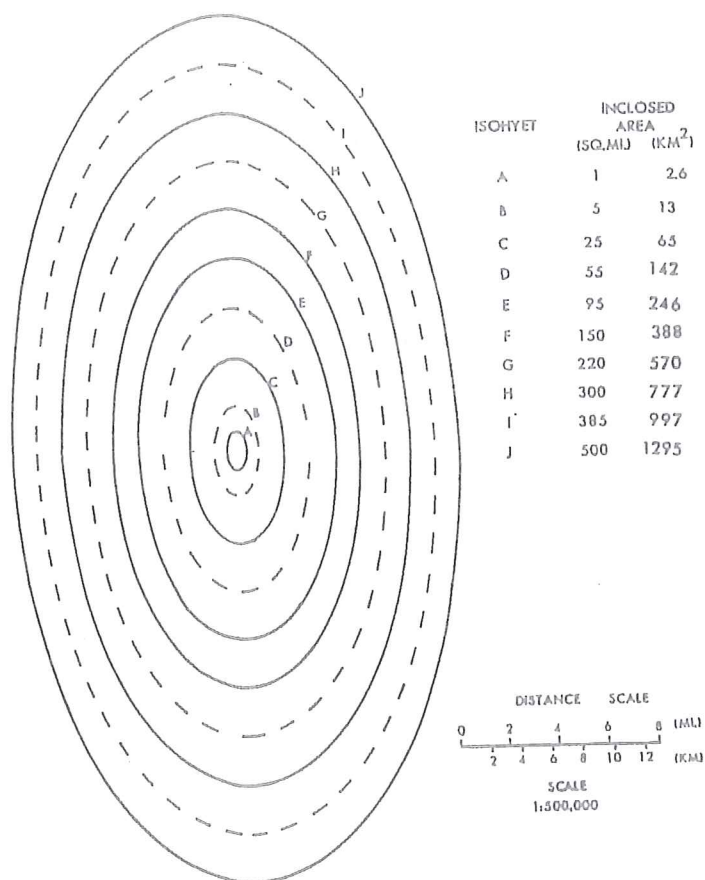


Figure 4.9: --Adopted depth-area relations for local-storm PMP.

Figure 4.10.--Idealized
local-storm isohyetal
pattern.



storm period. The sequence of hourly incremental PMP for the Southwest 6-hr thunderstorm in accord with this study is presented in column 2 of table 4.7. A small variation from this sequence is given in Engineering Manual 1110-2-1411 (U. S. Army, Corps of Engineers 1965). The latter, listed in column 3 of table 4.7, places greater incremental amounts somewhat more toward the end of the 6-hr storm period. In application, the choice of either of these distributions is left to the user since one may prove to be more critical in a specific case than the other.

Table 4.7.--Time sequence for hourly incremental PMP in 6-hr storm

Increment	HMR No. 5 ¹	EM1110-2-1411 ²
	Sequence Position	
Largest hourly amount	Third	Fourth
2nd largest	Fourth	Third
3rd largest	Second	Fifth
4th largest	Fifth	Second
5th largest	First	Last
least	Last	First

¹U. S. Weather Bureau 1947.

²U. S. Corps of Engineers 1952.



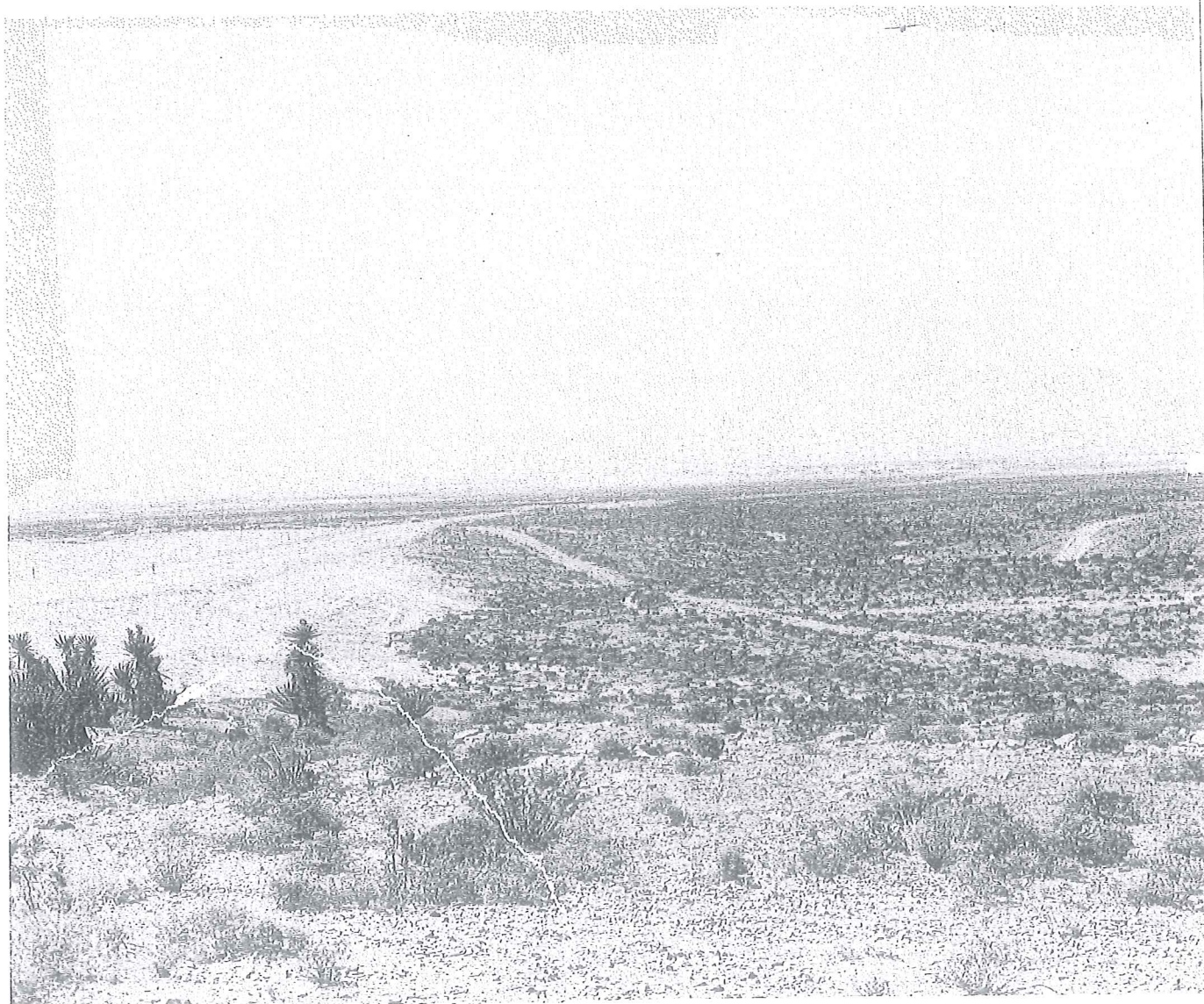
United States
Department of
Agriculture

Soil
Conservation
Service

In cooperation with
United States Department
of the Interior, Bureau
of Land Management, and
University of Nevada
Agricultural Experiment
Station

Soil Survey of Las Vegas Valley Area Nevada

Part of Clark County



This unit is limited for roads because of the depth to the indurated hardpan. Roads should be designed to minimize cuts.

This map unit is in capability subclass VII_s, nonirrigated, and in horticultural group 6.

152—Cave gravelly fine sandy loam, 0 to 4 percent slopes. This shallow, well drained soil is on erosional fan remnants. It formed in alluvium derived from various kinds of rock.

Typically, about 80 percent of the surface is covered with a desert pavement of pebbles and cobbles. The surface layer is pale brown gravelly fine sandy loam about 12 inches thick. The next layer to a depth of 36 inches is an indurated, lime-cemented hardpan. The underlying material to a depth of 60 inches or more is light brown very gravelly sandy loam. Depth to the hardpan ranges from 4 to 20 inches.

Included in this unit are about 5 percent Arizo soils, flooded, in channels, 5 percent Canutio soils on inset fans, and 5 percent Grapevine soils on side slopes of erosional fan remnants. Included areas make up about 15 percent of the total acreage. The percentage varies from one area to another.

Permeability of the Cave soil is moderate above the hardpan. Available water capacity is very low. Effective rooting depth is 4 to 20 inches. Runoff is slow, and the hazard of water erosion is slight. The hazard of soil blowing is high if the surface is disturbed.

This unit is used mainly for urban development. It is also used as habitat for desert wildlife and for recreation.

This unit is poorly suited to urban development. The main limitation is the shallow depth to the hardpan. Excavation for building sites is limited by the hardpan, and heavy equipment is needed. Special design of septic tank absorption fields is needed.

Roads should be designed to minimize cuts because of the limited depth to the hardpan.

It is difficult to establish plants in areas where the pan is exposed. Mulching and fertilizing cut areas help to establish plants. Lawn grasses, shrubs, and trees that are not sensitive to lime-induced chlorosis are well suited to use in landscaping. Annual applications of iron chelates reduce the effects of chlorosis.

Intermittent streams form the drainageways in this unit. These drainageways are subject to rare or occasional periods of high-velocity flooding. Care should be taken during urbanization to accommodate the runoff from the drainageways. If drains become plugged during a major flood, accelerated erosion and damage to roads, buildings, and other structures can occur.

This map unit is in capability subclass VII_s, nonirrigated, and in horticultural group 6.

155—Cave gravelly fine sandy loam, 4 to 15 percent slopes. This shallow, well drained soil is on

erosional fan remnants. It formed in alluvium derived from various kinds of rock.

Typically, about 70 percent of the surface is covered with a desert pavement of rock fragments and pan fragments. The surface layer is light brown gravelly fine sandy loam about 5 inches thick. The underlying material to a depth of 15 inches is light brown gravelly fine sandy loam. The next layer to a depth of 60 inches or more is an indurated, lime-cemented hardpan. Depth to the hardpan ranges from 4 to 20 inches.

Included in this unit are about 5 percent Arizo soils, flooded, in channels and 5 percent Caliza soils on side slopes of erosional fan remnants. Included areas make up about 10 percent of the total acreage. The percentage varies from one area to another.

Permeability of the Cave soil is moderate above the hardpan. Available water capacity is very low. Effective rooting depth is 4 to 20 inches. Runoff is moderate, and the hazard of water erosion is slight. The hazard of soil blowing is high if the surface is disturbed.

This unit is used as habitat for desert wildlife and for recreation.

This unit is limited for roads because of the depth to the indurated hardpan. Roads should be designed to minimize cuts. Cutting and filling can be reduced by building roads in the less sloping areas.

This map unit is in capability subclass VII_s, nonirrigated and in horticultural group 6.

160—Destazo cobbly fine sandy loam, 0 to 2 percent slopes. This very deep, well drained soil is on relict alluvial flats. It formed in alluvium derived dominantly from limestone and dolomite.

Typically, about 60 percent of the surface is covered with a desert pavement of pebbles and cobbles. The surface layer is pink cobbly fine sandy loam about 11 inches thick. The upper 29 inches of the underlying material is light brown very gravelly sandy clay loam, and the lower part to a depth of 60 inches or more is pinkish white gravelly sandy loam containing some crystalline gypsum.

Included in this unit are about 5 percent Bracken very cobbly fine sandy loam, 2 to 8 percent slopes, on side slopes of slightly higher remnants of relict alluvial flats and 10 percent Las Vegas soils on summits of slightly higher remnants of alluvial flats. Included areas make up about 15 percent of the total acreage.

Permeability of this Destazo soil is moderately slow. Available water capacity is moderate. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight. The hazard of soil blowing is moderate.

This unit is used mainly as habitat for desert wildlife and for recreation. It is also used for urban development.

This unit is well suited to the construction of dwellings.

The main limitation for septic tank absorption fields is restricted permeability. The operation of septic tank

sandy loam about 4 inches thick. The upper 7 inches of the underlying material is light yellowish brown extremely gravelly fine sandy loam, the next 6 inches is light yellowish brown very gravelly sandy loam, and the lower part to a depth of 61 inches is light yellowish brown extremely gravelly fine sandy loam. Pebbles cover 50 to 75 percent of the surface.

Included in this unit are about 5 percent Tencee soils on erosional fan remnants and 10 percent Arizo soils, flooded, in channels. Included areas make up about 15 percent of the total acreage. The percentage varies from one area to another.

Permeability of this Dalian soil is moderately rapid. Available water capacity is low. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight. The hazard of soil blowing is moderate.

This unit is used mainly as habitat for desert wildlife and for recreation. It is also used for urban development.

This unit is well suited to the construction of dwellings.

Septic tank absorption fields generally function well unless the density of housing is too high.

Roads are easily constructed and maintained.

The main limitation for lawns and landscaping is the pebbles on the surface and throughout the soil. Topsoil is needed for best results when landscaping, particularly in areas used for lawns. Lawn grasses, shrubs, and trees that are not sensitive to lime-induced chlorosis are well suited to use in landscaping. Annual applications of iron chelates reduce the effects of chlorosis.

Intermittent streams form the drainageways in this unit. These drainageways are subject to rare or occasional periods of high-velocity flooding. Care should be taken during urbanization to accommodate the runoff from the drainageways. If drains become plugged during a major flood, accelerated erosion and damage to roads, buildings, and other structures can occur.

This map unit is in capability subclasses IVs, irrigated, and VIIs, nonirrigated. It is in horticultural group 2.

191—Dalian very cobbly fine sandy loam, 2 to 8 percent slopes. This very deep, well drained soil is on fan skirts. It formed in alluvium derived dominantly from limestone and dolomite.

Typically, about 85 percent of the surface is covered with a desert pavement of rock fragments. The surface layer is light yellowish brown very cobbly fine sandy loam about 5 inches thick. The underlying material to a depth of 60 inches or more is light yellowish brown very gravelly sandy loam to extremely gravelly fine sandy loam.

Included in this unit are about 10 percent Tencee soils on erosional fan remnants and 5 percent Arizo soils, flooded, in channels. Included areas make up about 15 percent of the total acreage. The percentage varies from one area to another.

Permeability of this Dalian soil is moderately rapid. Available water capacity is low. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight. The hazard of soil blowing is moderate if the surface is disturbed. This soil is subject to rare periods of flooding during prolonged, high-intensity storms. Channeling and deposition are common along streambanks.

Most areas of this unit are used as habitat for desert wildlife and for recreation. A few areas are used for urban development.

The main limitation for construction of dwellings is the hazard of flooding. Dikes and channels that have outlets for floodwater can be used to protect buildings from flooding.

Dikes and channels that have outlets for floodwater can be used to protect onsite sewage disposal systems from flooding.

Channeling and deposition can be minimized and maintenance costs reduced by protecting roads from flooding.

The main limitations for lawns and landscaping are the cobbles and pebbles on the surface and throughout the soil. Topsoil is needed for best results when landscaping, particularly in areas used for lawns. Lawn grasses, shrubs, and trees that are not sensitive to lime-induced chlorosis are well suited to use in landscaping. Annual applications of iron chelates reduce the effects of chlorosis.

This map unit is in capability subclass VIIs, nonirrigated, and in horticultural group 2.

192—Dalian-McCullough complex, 0 to 4 percent slopes. This map unit is on fan skirts.

This unit is 55 percent Dalian very gravelly fine sandy loam, 0 to 4 percent slopes, and 35 percent McCullough very gravelly very fine sandy loam, gravelly substratum, 0 to 4 percent slopes. Both the Dalian and McCullough soils are on alluvial fan skirts. The components of this unit are so intricately intermingled that it was not practical to map them separately at the scale used.

Included in this unit are about 5 percent Las Vegas soils on basin floor remnants and 5 percent Tencee soils on erosional fan remnants. Included areas make up about 10 percent of the total acreage.

The Dalian soil is very deep and well drained. It formed in alluvium derived from various kinds of rock. Typically, about 75 percent of the surface is covered with a desert pavement of pebbles. The surface layer is light yellowish brown very gravelly fine sandy loam about 5 inches thick. The underlying material to a depth of 60 inches or more is light yellowish brown very gravelly sandy loam.

Permeability of the Dalian soil is moderately rapid. Available water capacity is low. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight. The hazard of soil blowing is

Because of the content of gypsum and other salts in the soil, salt-tolerant plants should be selected for lawns and landscaping. Because of the underlying hardpan, deep cuts should be avoided on this soil. Lawn grasses, shrubs, and trees that are not sensitive to lime-induced chlorosis are well suited to use in landscaping. Annual applications of iron chelates reduce the effects of chlorosis.

This map unit is in capability subclasses IIIs, irrigated, and VIIs, nonirrigated. It is in horticultural group 6.

390—Spring clay loam. This very deep, moderately well drained soil is on alluvial flats. It formed in gypsiferous lacustrine sediment. Slope is 0 to 2 percent.

Typically, the surface layer is pale brown clay loam about 5 inches thick. The underlying material to a depth of 60 inches or more is stratified, light brown to pink silt loam to silty clay, averaging silty clay loam, and contains many gypsum crystals.

Included in this unit are about 10 percent Land soils on alluvial flats and 5 percent Las Vegas soils on relict alluvial flats. Included areas make up about 15 percent of the total acreage.

Permeability of the Spring soil is slow. Available water capacity is high. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight. The hazard of soil blowing is high. This soil is subject to rare periods of flooding during prolonged, high-intensity storms. Channeling and deposition are common along streambanks. This soil is strongly affected by salts to a depth of 5 inches, and it is moderately affected below this depth.

This unit is used mainly for urban development. It is also used as habitat for desert wildlife and for recreation.

The main limitation for construction of dwellings is the hazard of flooding. Dikes and channels that have outlets for floodwater can be used to protect buildings from flooding. Gypsum in the soil can induce electrochemical action that corrodes concrete. This limitation can be overcome by using cement that is resistant to sulfate corrosion.

The main limitation for septic tank absorption fields is restricted permeability. Special design of septic tank absorption fields is needed. Using long absorption lines and backfilling the trench with sandy material help to compensate for the restricted permeability.

The Spring soil is limited for roads because of limited ability to support a load. Roads and streets should be designed to compensate for the instability of the soil.

The main limitation for lawns and landscaping is the excess soluble salts in the soil. Intensive management is required to reduce the salinity and maintain soil productivity. Excess salts in the soil can be flushed out by using heavy periodic applications of water. Because of the content of gypsum and other salts in the soil, salt-tolerant plants should be selected.

This map unit is in capability subclasses VIIs, irrigated, and VIIIs, nonirrigated. It is in horticultural group 4.

400—Tencee very gravelly fine sandy loam, 2 to 8 percent slopes. This shallow, well drained soil is on erosional fan remnants. It formed in alluvium derived dominantly from limestone and dolomite.

Typically, 75 percent of the surface is covered with a well developed desert pavement of pebbles. There is a dark desert varnish on the exposed surfaces of the rock fragments. The surface layer is light brown very gravelly fine sandy loam about 5 inches thick. The next layer is light brown very gravelly fine sandy loam and very gravelly sandy loam and is weakly cemented with lime to a depth of about 15 inches. An indurated, lime-cemented hardpan is at a depth of about 15 inches. Depth to the hardpan ranges from 7 to 20 inches.

Included in this unit are small areas of Dalian soils on side slopes of fan remnants and on inset fans. Included areas make up about 10 percent of the total acreage. The percentage varies from one area to another.

Permeability of the Tencee soil is moderate above the hardpan. Available water capacity is very low. Effective rooting depth is 7 to 20 inches. Runoff is medium, and the hazard of water erosion is slight. The hazard of soil blowing is moderate if the surface is disturbed.

This unit is used as habitat for desert wildlife and for recreation.

This unit is limited for roads because of the depth to the indurated hardpan. Roads should be designed to minimize cuts. Heavy equipment is needed for excavation.

This map unit is in capability subclass VIIIs, nonirrigated, and in horticultural group 6.

415—Aztec very gravelly sandy loam, 2 to 8 percent slopes. This very deep, well drained soil is on erosional fan remnants. It formed in alluvium derived from various kinds of rock.

Typically, 80 percent of the surface is covered with pebbles. The surface layer is light yellowish brown very gravelly sandy loam about 2 inches thick. The underlying material to a depth of 63 inches is stratified, light yellowish brown, light brown, and light reddish brown very gravelly sandy loam to extremely gravelly loamy coarse sand with weak, continuous gypsum cementation in some layers.

Included in this unit are about 5 percent Bracken soils on pediment remnants, 5 percent Rock outcrop on isolated ridges, and 5 percent Caliza soils on erosional fan remnants. Included areas make up about 15 percent of the total acreage. The percentage varies from one area to another.

Permeability of the Aztec soil is moderately slow. Available water capacity is low. Effective rooting depth is 60 inches or more. Runoff is medium, and the hazard of water erosion is slight. The hazard of soil blowing is high

HYDROLOGIC CRITERIA AND DRAINAGE DESIGN MANUAL

RUNOFF CURVE NUMBERS (URBAN AREAS¹)

Cover description		Curve numbers for hydrologic soil group—			
Cover type and hydrologic condition	Average percent impervious area ²	A	B	C	D
<i>Fully developed urban areas (vegetation established)</i>					
Open space (lawns, parks, golf courses, cemeteries, etc.): ³					
Poor condition (grass cover < 50%)		68	79	86	89
Fair condition (grass cover 50% to 75%)		49	69	79	84
Good condition (grass cover > 75%)		39	61	74	80
Impervious areas:					
Paved parking lots, roofs, driveways, etc. (excluding right-of-way)		98	98	98	98
Streets and roads:					
Paved; curbs and storm sewers (excluding right-of-way)		98	98	98	98
Paved; open ditches (including right-of-way)		83	89	92	93
Gravel (including right-of-way)		76	85	89	91
Dirt (including right-of-way)		72	82	87	89
Western desert urban areas:					
Natural desert landscaping (pervious areas only) ⁴ ...		63	77	85	88
Artificial desert landscaping (impervious weed barrier, desert shrub with 1- to 2-inch sand or gravel mulch and basin borders)		96	96	96	96
Urban districts:					
Commercial and business	85	89	92	94	95
Industrial	72	81	88	91	93
Residential districts by average lot size:					

See Table 602A

Developing urban areas

Newly graded areas (pervious areas only, no vegetation) ⁵	77	86	91	94
--	----	----	----	----

1 Average runoff condition, and $I_p = 0.2S$.

2 The average percent impervious area shown was used to develop the composite CN's. Other assumptions are as follows: impervious areas are directly connected to the drainage system. Impervious areas have a CN of 98, and pervious areas are considered equivalent to open space in good hydrologic condition. CN's for other combinations of conditions may be computed using Figure 603.

3 CN's shown are equivalent to those of pasture. Composite CN's may be computed for other combinations of open space cover type.

4 Composite CN's for natural desert landscaping should be computed using Figure 603 based on the impervious area percentage (CN #98) and the pervious area CN. The pervious area CN's are assumed equivalent to desert shrub in poor hydrologic condition.

5 Composite CN's to use for the design of temporary measures during grading and construction should be computed using Figure 603 based on the degree of development (impervious area percentage) and the CN's for the newly graded pervious areas.

Revision	Date

HYDROLOGIC CRITERIA AND DRAINAGE DESIGN MANUAL

RUNOFF CURVE NUMBERS (SEMIARID RANGELANDS¹)

Cover description		Curve numbers for hydrologic soil group—			
Cover type	Hydrologic condition ²	A ³	B	C	D
Herbaceous—mixture of grass, weeds, and low-growing brush, with brush the minor element.	Poor		80	87	93
	Fair		71	81	89
	Good		62	74	85
Oak-aspen—mountain brush mixture of oak brush, aspen, mountain mahogany, bitter brush, maple, and other brush.	Poor		66	74	79
	Fair		48	57	63
	Good		30	41	48
Pinyon-juniper—pinyon, juniper, or both; grass understory.	Poor		75	85	89
	Fair		58	73	80
	Good		41	61	71
Sagebrush with grass understory.	Poor		67	80	85
	Fair		51	63	70
	Good		36	47	55
Desert shrub—major plants include saltbush, greasewood, creosotebush, blackbrush, burrage, palo verde, mesquite, and cactus.	Poor	63	77	85	88
	Fair	55	72	81	86
	Good	49	68	79	84

¹Average runoff condition, and $I_n = 0.2S$.

²Poor: <30% ground cover (litter, grass, and brush overstory).

Fair: 30 to 70% ground cover.

Good: >70% ground cover.

³Curve numbers for group A have been developed only for desert shrub.

Revision	Date

Soil & Curve Number Computation

Project Name: SKYE CANYON - DETENTION BASIN 1

Date: Sep-14

File Name: OLY1401-004 TDS DB1 CNs.xlsx

By: WTM

Data:

Reference:

Soil Type & Description	A	B	C	D
155 Cave gravelly fine sandy loam, 4 to 15 percent slopes	5%	5%	0%	90%
191 Dalian very cobbly fine sandy loam, 2 to 8 percent slopes	5%	85%	0%	10%
400 Tencoe very gravelly fine sandy loam, 2 to 8 percent slopes	0%	10%	0%	90%

Exhibit G
SCS Soil Data

Land Use	A	B	C	D
Desert Shrub (poor)	63	77	85	88
Newly Graded	77	86	91	94

PROPOSED CONDITION

BASIN ID	SOIL TYPE	SUBAREA PERCENT	LAND USE	HYDROLOGIC SOIL GROUP				LAND USE CN				SUBAREA ACRES	CALCULATED CN
				A	B	C	D	A	B	C	D		
OFF1	400	51.0%	Desert Shrub (poor)	0%	10%	0%	90%	63	77	85	88	140.07	44.33
	155	44.2%	Desert Shrub (poor)	5%	5%	0%	90%	63	77	85	88	121.46	38.13
	191	4.8%	Desert Shrub (poor)	5%	85%	0%	10%	63	77	85	88	13.07	3.68
TOTAL PERCENT		100.0%					TOTAL AREA					274.60	86.14

BASIN ID	SOIL TYPE	SUBAREA PERCENT	LAND USE	HYDROLOGIC SOIL GROUP				LAND USE CN				SUBAREA ACRES	CALCULATED CN
				A	B	C	D	A	B	C	D		
OFF2	155	75.1%	Desert Shrub (poor)	5%	5%	0%	90%	63	77	85	88	20.12	64.74
	191	24.9%	Desert Shrub (poor)	5%	85%	0%	10%	63	77	85	88	6.67	19.27
TOTAL PERCENT		100.0%					TOTAL AREA					26.79	84.01

BASIN ID	SOIL TYPE	SUBAREA PERCENT	LAND USE	HYDROLOGIC SOIL GROUP				LAND USE CN				SUBAREA ACRES	CALCULATED CN
				A	B	C	D	A	B	C	D		
OFF3	155	100.0%	Desert Shrub (poor)	5%	5%	0%	90%	63	77	85	88	16.58	86.20
TOTAL PERCENT		100.0%					TOTAL AREA					16.58	86.20

BASIN ID	SOIL TYPE	SUBAREA PERCENT	LAND USE	HYDROLOGIC SOIL GROUP				LAND USE CN				SUBAREA ACRES	CALCULATED CN
				A	B	C	D	A	B	C	D		
OFF4	155	100.0%	Desert Shrub (poor)	5%	5%	0%	90%	63	77	85	88	37.19	86.20
TOTAL PERCENT		100.0%					TOTAL AREA					37.19	86.20

BASIN ID	SOIL TYPE	SUBAREA PERCENT	LAND USE	HYDROLOGIC SOIL GROUP				LAND USE CN				SUBAREA ACRES	CALCULATED CN
				A	B	C	D	A	B	C	D		
OFF5	155	63.9%	Desert Shrub (poor)	5%	5%	0%	90%	63	77	85	88	105.09	55.10
	400	36.1%	Desert Shrub (poor)	0%	10%	0%	90%	63	77	85	88	59.32	31.35
TOTAL PERCENT		100.0%					TOTAL AREA					164.41	86.45

BASIN ID	SOIL TYPE	SUBAREA PERCENT	LAND USE	HYDROLOGIC SOIL GROUP				LAND USE CN				SUBAREA ACRES	CALCULATED CN
				A	B	C	D	A	B	C	D		
OFF6	155	100.0%	Desert Shrub (poor)	5%	5%	0%	90%	63	77	85	88	25.54	86.20
TOTAL PERCENT		100.0%					TOTAL AREA					25.54	86.20

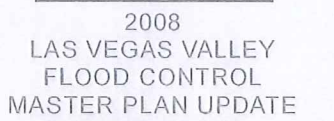
BASIN ID	SOIL TYPE	SUBAREA PERCENT	LAND USE	HYDROLOGIC SOIL GROUP				LAND USE CN				SUBAREA ACRES	CALCULATED CN
				A	B	C	D	A	B	C	D		
ON1	155	100.0%	Newly Graded	5%	5%	0%	90%	77	86	91	94	16.72	92.75
TOTAL PERCENT		100.0%					TOTAL AREA					16.72	92.75

ULTIMATE CONDITION

BASIN ID	SOIL TYPE	SUBAREA PERCENT	LAND USE	HYDROLOGIC SOIL GROUP				LAND USE CN				SUBAREA ACRES	CALCULATED CN
				A	B	C	D	A	B	C	D		
OFF1	400	51.0%	Desert Shrub (poor)	0%	10%	0%	90%	63	77	85	88	129.73	44.29
	155	47.4%	Desert Shrub (poor)	5%	5%	0%	90%	63	77	85	88	120.71	40.88
	191	1.6%	Desert Shrub (poor)	5%	85%	0%	10%	63	77	85	88	4.11	1.25
TOTAL PERCENT		100.0%	TOTAL AREA									254.55	86.41

BASIN ID	SOIL TYPE	SUBAREA PERCENT	LAND USE	HYDROLOGIC SOIL GROUP				LAND USE CN				SUBAREA ACRES	CALCULATED CN
				A	B	C	D	A	B	C	D		
OFF2	155	86.2%	Desert Shrub (poor)	5%	5%	0%	90%	63	77	85	88	19.60	74.30
	191	13.8%	Desert Shrub (poor)	5%	85%	0%	10%	63	77	85	88	3.14	10.69
TOTAL PERCENT		100.0%	TOTAL AREA									22.74	84.98

OFF7 Curve Number referenced from CCRFCD MPU



LEGEND

- ### Flood Control Facilities

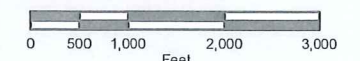
- Type Hydrologic Soil Groups

- 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* | Commercial, Retail, Casino, High Rise Condominiums |
| 10 / 20* | Light Industrial |
| 11 / 21* | Heavy Industrial |
| 12 / 22* | Schools |

* Drought Ordinance Applied



Scale: 1 inch = 2,000 feet

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

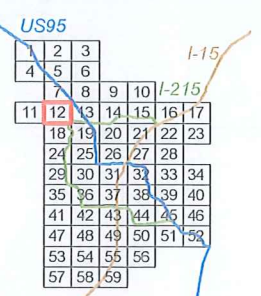


Table 4-2 Land Use Categories

Land Use Index Number	Description - Typical Land Uses	Impervious (%)	Open Landscaped Good Condition (%)	Open Desert Shrub Poor Condition <u>Natural Desert Landscaping</u> (%)
Drought Ordinance Not Applied				
1	Undeveloped Land, Open Desert	0	0	100
2	Parks, Golf Courses	5	85	10
3	Rural, 0.5-1 units per acre (uses 1 unit/acre)	20	20	60
4	Low-Density Residential, 1-2 units per acre (uses 2 units/acre)	25	40	35
5	Medium-Density Residential, 2-4 units per acre (uses 3 units/acre)	29	71	0
6	High-Density Residential, 4-8 units per acre (uses 6 units/acre)	62	38	0
7	Public Facility and Residential, 8- 12 units/acre	72	28	0
8	Very High-Density Residential, 12 units/acre or more	85	15	0
9	Commercial, Retail, Casino, High Rise Condominiums	90	10	0
10	Light Industrial	70	15	15
11	Heavy Industrial	85	8	7
12	Schools	50	50	0
13	Lakes	0	0	0
Drought Ordinance Applied				
14	Low-Density Residential, 1-2 units per acre (uses 2 units/acre)	25	20	55
15	Medium-Density Residential, 2-4 units per acre (uses 3 units/acre)	29	35	36
16	High-Density Residential, 4-8 units per acre (uses 6 units/acre)	62	19	19
17	Public Facility and Residential, 8- 12 units/acre	72	14	14
18	Very High-Density Residential, 12 units/acre or more	85	0	15
19	Commercial, Retail, Casino, High Rise Condominiums	90	0	10
20	Light Industrial	70	0	30
21	Heavy Industrial	85	0	15
22	Schools	50	30	20

The land use data used with the 2008 MPU is shown on the H-Maps of Volume 2. **Figure 4-1** shows the geographic comparison between the 2008 and 2002 MPU land use coverages in terms of percent imperviousness. The increase or decrease in impervious area represents an increase or decrease in the runoff potential for a given area.

BASIN OFF-7 REPRESENTED BY SOILS 1918 & 40D

Table 4-3. Curve Number Matrix

COMPONENTS			LAND USE CLASSIFICATION INDEX NUMBER																							
MAP #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22				
OPEN	100	10	60	35	0	0	0	0	0	15	7	0	0	55	36	19	14	15	10	30	15	20				
DESERT	0	85	20	40	71	38	28	15	10	15	8	50	0	20	35	19	14	0	0	0	0	30				
% ---->	0	5	20	25	29	62	72	85	90	70	85	50	0	25	29	62	72	85	90	70	85	50				
% ---->	0	5	20	25	29	62	72	85	90	70	85	50	0	25	29	62	72	85	90	70	85	50				
SOIL TYPE COMPOSITE CN FOR LAND USE TYPE																										
CN	CN	CN	CN	CN	CN	CN	CN	CN	CN	CN	CN	CN	CN	CN	CN	CN	CN	CN	CN	CN	CN	CN				
105	71	51	98	71.0	55.0	72.0	70.0	65.0	80.0	85.0	91.0	93.0	87.0	92.0	75.0	30.0	74.0	72.0	84.0	88.0	94.0	95.0	90.0	84.0	79.0	
107	65	42	98	65.0	47.0	67.0	64.0	58.0	77.0	82.0	90.0	92.0	85.0	91.0	70.0	30.0	69.0	67.0	81.0	86.0	93.0	95.0	88.0	93.0	75.0	
112	66	43	98	66.0	48.0	68.0	65.0	59.0	77.0	83.0	90.0	93.0	85.0	91.0	71.0	30.0	69.0	67.0	81.0	86.0	93.0	95.0	88.0	93.0	75.0	
113	66	43	98	66.0	48.0	68.0	65.0	59.0	77.0	83.0	90.0	93.0	85.0	91.0	71.0	30.0	69.0	67.0	81.0	86.0	93.0	95.0	88.0	93.0	75.0	
117	65	42	98	65.0	47.0	67.0	64.0	58.0	77.0	82.0	90.0	92.0	85.0	91.0	70.0	30.0	69.0	67.0	81.0	86.0	93.0	95.0	88.0	93.0	74.0	
120	64	40	98	64.0	45.0	66.0	63.0	57.0	76.0	82.0	89.0	92.0	84.0	91.0	69.0	30.0	68.0	65.0	81.0	85.0	93.0	95.0	88.0	93.0	74.0	
127	64	41	98	64.0	46.0	66.0	63.0	58.0	76.0	82.0	89.0	92.0	84.0	91.0	70.0	30.0	68.0	66.0	81.0	85.0	93.0	95.0	88.0	93.0	74.0	
128	64	41	98	64.0	46.0	66.0	63.0	58.0	76.0	82.0	89.0	92.0	84.0	91.0	70.0	30.0	68.0	66.0	81.0	85.0	93.0	95.0	88.0	93.0	74.0	
129	66	44	98	66.0	49.0	68.0	65.0	60.0	77.0	83.0	90.0	93.0	85.0	91.0	71.0	30.0	70.0	68.0	82.0	86.0	93.0	95.0	88.0	93.0	75.0	
130	78	63	98	78.0	66.0	79.0	77.0	73.0	85.0	88.0	93.0	95.0	90.0	94.0	81.0	30.0	80.0	79.0	88.0	90.0	95.0	96.0	92.0	95.0	84.0	
132	77	61	98	77.0	64.0	78.0	76.0	72.0	84.0	88.0	92.0	94.0	89.0	94.0	80.0	30.0	79.0	77.0	87.0	90.0	95.0	96.0	92.0	95.0	83.0	
133	79	66	98	79.0	69.0	80.0	79.0	75.0	86.0	89.0	93.0	95.0	90.0	94.0	82.0	30.0	81.0	80.0	88.0	91.0	95.0	96.0	92.0	95.0	85.0	
134	77	61	98	77.0	64.0	78.0	76.0	72.0	84.0	88.0	92.0	94.0	89.0	94.0	80.0	30.0	79.0	77.0	87.0	90.0	95.0	96.0	92.0	95.0	83.0	
140	84	72	98	84.0	75.0	84.0	83.0	80.0	88.0	91.0	94.0	95.0	92.0	95.0	85.0	30.0	85.0	84.0	90.0	92.0	96.0	97.0	94.0	96.0	87.0	
150	86	77	98	86.0	79.0	87.0	85.0	83.0	90.0	92.0	95.0	96.0	93.0	96.0	88.0	30.0	87.0	86.0	92.0	93.0	96.0	97.0	94.0	96.0	89.0	
151	87	78	98	87.0	80.0	87.0	86.0	84.0	90.0	92.0	95.0	96.0	93.0	96.0	88.0	30.0	88.0	87.0	92.0	93.0	96.0	97.0	94.0	96.0	89.0	
152	86	76	98	86.0	78.0	86.0	85.0	82.0	90.0	92.0	95.0	96.0	93.0	95.0	88.0	30.0	87.0	86.0	92.0	93.0	96.0	97.0	94.0	96.0	89.0	
155	86	77	98	86.0	79.0	87.0	85.0	83.0	90.0	92.0	95.0	96.0	93.0	95.0	88.0	30.0	87.0	86.0	92.0	93.0	96.0	97.0	94.0	96.0	89.0	
160	78	63	98	78.0	66.0	79.0	77.0	73.0	85.0	88.0	93.0	95.0	90.0	94.0	81.0	30.0	80.0	79.0	88.0	90.0	95.0	96.0	92.0	95.0	84.0	
181	79	64	98	79.0	67.0	80.0	78.0	74.0	85.0	88.0	93.0	95.0	90.0	94.0	81.0	30.0	81.0	79.0	77.0	87.0	90.0	95.0	96.0	92.0	95.0	82.0
182	77	60	98	77.0	64.0	78.0	76.0	72.0	84.0	87.0	92.0	94.0	89.0	93.0	79.0	30.0	79.0	77.0	87.0	90.0	95.0	96.0	92.0	95.0	83.0	
183	77	61	98	77.0	64.0	78.0	76.0	72.0	84.0	88.0	92.0	94.0	89.0	94.0	80.0	30.0	79.0	77.0	87.0	90.0	95.0	96.0	92.0	95.0	83.0	
184	77	61	98	77.0	64.0	78.0	76.0	72.0	84.0	88.0	92.0	94.0	89.0	94.0	80.0	30.0	79.0	77.0	87.0	90.0	95.0	96.0	92.0	95.0	83.0	
187	77	61	98	77.0	64.0	78.0	76.0	72.0	84.0	88.0	92.0	94.0	89.0	93.0	79.0	30.0	78.0	77.0	87.0	90.0	95.0	96.0	92.0	95.0	83.0	
190	76	60	98	76.0	64.0	77.0	75.0	71.0	84.0	87.0	92.0	94.0	89.0	94.0	80.0	30.0	79.0	78.0	87.0	90.0	95.0	96.0	92.0	95.0	83.0	
191	77	62	98	77.0	65.0	78.0	76.0	72.0	84.0	88.0	93.0	94.0	89.0	94.0	81.0	30.0	80.0	79.0	88.0	90.0	95.0	96.0	92.0	95.0	84.0	
192	78	63	98	78.0	66.0	79.0	77.0	73.0	85.0	88.0	93.0	95.0	90.0	94.0	80.0	30.0	80.0	79.0	88.0	90.0	95.0	96.0	92.0	95.0	83.0	
200	77	62	98	77.0	65.0	78.0	76.0	72.0	84.0	88.0	93.0	94.0	89.0	94.0	80.0	30.0	79.0	78.0	87.0	90.0	95.0	96.0	92.0	95.0	83.0	
206	77	62	98	77.0	65.0	78.0	76.0	72.0	84.0	88.0	93.0	94.0	89.0	94.0	80.0	30.0	79.0	77.0	87.0	90.0	95.0	96.0	92.0	95.0	83.0	
222	77	61	98	77.0	64.0	78.0	76.0	72.0	84.0	88.0	92.0	94.0	89.0	94.0	80.0	30.0	79.0	77.0	87.0	90.0	95.0	96.0	92.0	95.0	83.0	
236	78	62	98	78.0	65.0	79.0	77.0	73.0	85.0	88.0	93.0	94.0	89.0	94.0	80.0	30.0	79.0	77.0	87.0	90.0	95.0	96.0	92.0	95.0	83.0	
237	77	61	98	77.0	64.0	78.0	76.0	72.0	84.0	88.0	92.0	94.0	89.0	94.0	80.0	30.0	79.0	77.0	87.0	90.0	95.0	96.0	92.0	95.0	83.0	
240	87	78	98	87.0	80.0	87.0	86.0	84.0	90.0	92.0	95.0	96.0	93.0	96.0	88.0	30.0	88.0	87.0	92.0	93.0	96.0	97.0	94.0	96.0	90.0	
252	78	62	98	78.0	65.0	79.0	77.0	73.0	85.0	88.0	93.0	94.0	89.0	94.0	80.0	30.0	80.0	78.0	87.0	90.0	95.0	96.0	92.0	95.0	83.0	
255	78	62	98	78.0	65.0	79.0	77.0	73.0	85.0	88.0	93.0	94.0	89.0	94.0	80.0	30.0	80.0	78.0	87.0	90.0	95.0	96.0	92.0	95.0	83.0	
260	64	41	98	64.0	46.0	66.0	63.0	58.0	76.0	82.0	89.0	92.0	84.0	91.0	70.0	30.0	68.0	66.0	81.0	85.0	93.0	95.0	88.0	93.0	74.0	
262	69	49	98	69.0	53.0	71.0	68.0	63.0	79.0	84.0	91.0	93.0	86.0	92.0	74.0	30.0	72.0	70.0	83.0	87.0	94.0	95.0	89.0	94.0	78.0	
263	64	41	98	64.0	46.0	66.0	63.0	58.0	76.0	82.0	89.0	92.0	84.0	91.0	70.0	30.0	68.0	66.0	81.0	85.0	93.0	95.0	88.0	93.0	74.0	
264	63	39	98	63.0	44.0	65.0	62.0	56.0	76.0	81.0	89.0	92.0	84.0	91.0	69.0	30.0	67.0	65.0	80.0	85.0	93.0	95.0	88.0	93.0	73.0	
270	77	61	98	77.0	64.0	78.0	76.0	72.0	84.0	88.0	92.0	94.0	89.0	94.0	80.0	30.0	79.0	77.0	87.0	90.0	95.0	96.0	92.0	95.0	83.0	
278	77	61	98	77.0	64.0	78.0	76.0	72.0	84.0	88.0	92.0	94.0	89.0	94.0	80.0	30.0	79.0	77.0	87.0	90.0	95.0	96.0	92.0	95.0	83.0	
282	84	73	98	84.0	75.0	85.0	83																			

Table 4-3. Curve Number Matrix (Continued)

COMPONENTS			LAND USE CLASSIFICATION INDEX NUMBER																					
MAP #	OPEN	% IMP	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
DESERT	GOOD		100	10	60	35	0	0	0	0	0	15	7	0	0	55	36	19	14	15	10	30	15	20
	% --->		0	85	20	40	71	38	28	15	10	15	8	50	0	20	35	19	14	0	0	0	0	30
	% --->		0	5	20	25	29	62	72	85	90	70	85	50	0	25	29	62	72	85	90	70	85	50
			SOIL TYPE COMPOSITE CN FOR LAND USE TYPE																					
CN	ON	CN																						
341	85	74	98	85.0	76.0	85.0	84.0	81.0	89.0	91.0	94.0	96.0	92.0	95.0	86.0	86.0	85.0	91.0	93.0	96.0	97.0	94.0	96.0	88.0
360	87	82	98	87.0	83.0	88.0	88.0	87.0	92.0	94.0	96.0	96.0	94.0	96.0	90.0	89.0	88.0	93.0	94.0	96.0	97.0	95.0	96.0	91.0
380	84	73	98	84.0	75.0	85.0	83.0	80.0	89.0	91.0	94.0	96.0	92.0	95.0	86.0	85.0	84.0	91.0	93.0	96.0	97.0	94.0	96.0	88.0
390	85	74	98	85.0	76.0	85.0	84.0	81.0	89.0	91.0	94.0	96.0	92.0	95.0	86.0	85.0	84.0	91.0	93.0	96.0	97.0	94.0	96.0	88.0
400	87	78	98	87.0	80.0	87.0	86.0	84.0	90.0	92.0	95.0	96.0	93.0	96.0	88.0	88.0	87.0	92.0	94.0	96.0	97.0	95.0	96.0	90.0
415	78	62	98	78.0	65.0	79.0	77.0	72.0	84.0	88.0	93.0	94.0	90.0	94.0	80.0	80.0	78.0	87.0	90.0	95.0	96.0	92.0	95.0	83.0
417	82	72	98	82.0	74.0	83.0	82.0	80.0	88.0	91.0	94.0	95.0	92.0	95.0	85.0	84.0	83.0	90.0	92.0	96.0	96.0	93.0	96.0	87.0
418	78	62	98	78.0	65.0	79.0	77.0	72.0	84.0	88.0	93.0	94.0	90.0	94.0	80.0	80.0	78.0	87.0	90.0	95.0	96.0	92.0	95.0	83.0
419	77	62	98	77.0	65.0	78.0	76.0	72.0	84.0	88.0	92.0	94.0	89.0	94.0	80.0	79.0	77.0	87.0	90.0	95.0	96.0	92.0	95.0	83.0
430	77	61	98	77.0	64.0	78.0	76.0	71.0	84.0	87.0	92.0	94.0	89.0	93.0	79.0	78.0	77.0	87.0	90.0	95.0	96.0	91.0	95.0	82.0
440	76	60	98	76.0	64.0	77.0	75.0	71.0	84.0	87.0	92.0	94.0	89.0	93.0	79.0	78.0	77.0	87.0	90.0	95.0	96.0	91.0	95.0	82.0
450	88	80	98	88.0	82.0	88.0	87.0	85.0	91.0	93.0	95.0	96.0	94.0	96.0	89.0	89.0	88.0	93.0	94.0	96.0	97.0	94.0	96.0	89.0
481	86	77	98	86.0	79.0	87.0	85.0	83.0	90.0	92.0	95.0	96.0	93.0	95.0	88.0	88.0	87.0	92.0	94.0	96.0	97.0	94.0	96.0	89.0
484	87	79	98	87.0	81.0	88.0	87.0	85.0	91.0	93.0	95.0	96.0	94.0	96.0	89.0	89.0	88.0	93.0	94.0	96.0	97.0	94.0	96.0	89.0
500	82	69	98	82.0	72.0	83.0	81.0	77.0	87.0	90.0	94.0	95.0	91.0	95.0	84.0	83.0	82.0	89.0	92.0	96.0	96.0	93.0	95.0	86.0
501	77	61	98	77.0	64.0	78.0	76.0	72.0	84.0	88.0	92.0	94.0	89.0	94.0	80.0	79.0	77.0	87.0	90.0	95.0	96.0	91.0	95.0	82.0
502	81	68	98	81.0	71.0	82.0	80.0	77.0	87.0	90.0	94.0	95.0	91.0	95.0	84.0	83.0	82.0	89.0	92.0	96.0	96.0	93.0	95.0	86.0
505	82	70	98	82.0	73.0	83.0	81.0	78.0	87.0	90.0	94.0	95.0	91.0	95.0	84.0	83.0	82.0	89.0	92.0	96.0	96.0	93.0	95.0	86.0
510	88	82	98	88.0	83.0	89.0	88.0	87.0	92.0	94.0	96.0	96.0	94.0	96.0	90.0	89.0	89.0	93.0	94.0	97.0	97.0	95.0	96.0	91.0
540	77	62	98	77.0	65.0	78.0	76.0	72.0	84.0	88.0	93.0	94.0	89.0	94.0	80.0	79.0	78.0	87.0	90.0	95.0	96.0	92.0	95.0	83.0
542	77	62	98	77.0	65.0	78.0	76.0	72.0	84.0	88.0	93.0	94.0	89.0	94.0	80.0	79.0	78.0	87.0	90.0	95.0	96.0	92.0	95.0	83.0
545	81	68	98	81.0	71.0	82.0	80.0	77.0	87.0	90.0	94.0	95.0	91.0	95.0	84.0	83.0	81.0	89.0	91.0	95.0	96.0	93.0	95.0	86.0
600	85	74	98	85.0	76.0	85.0	84.0	81.0	89.0	91.0	94.0	96.0	92.0	95.0	86.0	86.0	85.0	91.0	93.0	96.0	97.0	94.0	96.0	88.0
605	85	74	98	85.0	76.0	85.0	84.0	81.0	89.0	91.0	94.0	96.0	92.0	95.0	86.0	86.0	85.0	91.0	93.0	96.0	97.0	94.0	96.0	88.0
610	85	74	98	85.0	76.0	85.0	84.0	81.0	89.0	91.0	94.0	96.0	92.0	95.0	86.0	86.0	85.0	91.0	93.0	96.0	97.0	94.0	96.0	88.0
615	85	74	98	85.0	76.0	85.0	84.0	81.0	89.0	91.0	94.0	96.0	92.0	95.0	86.0	86.0	85.0	91.0	93.0	96.0	97.0	94.0	96.0	88.0
630	88	80	98	88.0	82.0	88.0	87.0	85.0	91.0	93.0	95.0	96.0	94.0	96.0	89.0	89.0	88.0	93.0	94.0	97.0	97.0	95.0	97.0	91.0
635	90	90	98	90.0	90.0	92.0	92.0	92.0	95.0	96.0	97.0	97.0	96.0	97.0	94.0	92.0	92.0	95.0	96.0	97.0	97.0	96.0	97.0	94.0
640	90	90	98	90.0	90.0	92.0	92.0	92.0	95.0	96.0	97.0	97.0	96.0	97.0	94.0	92.0	92.0	95.0	96.0	97.0	97.0	96.0	97.0	94.0
645	85	74	98	85.0	76.0	85.0	84.0	81.0	89.0	91.0	94.0	96.0	92.0	95.0	86.0	86.0	85.0	91.0	93.0	96.0	97.0	94.0	96.0	88.0
999	63	39	30	63.0	41.0	52.0	45.0	36.0	33.0	33.0	31.0	31.0	36.0	33.0	35.0	30.0	50.0	45.0	38.0	36.0	35.0	33.0	40.0	35.0
1141	86	79	98	86.0	81.0	87.0	86.0	85.0	91.0	93.0	95.0	96.0	93.0	96.0	89.0	88.0	87.0	92.0	94.0	96.0	97.0	94.0	96.0	90.0
1150	63	39	98	63.0	44.0	65.0	62.0	56.0	76.0	81.0	89.0	92.0	84.0	91.0	69.0	30.0	67.0	65.0	80.0	85.0	93.0	95.0	88.0	93.0
1191	67	45	98	67.0	50.0	69.0	66.0	60.0	78.0	83.0	90.0	93.0	85.0	92.0	72.0	30.0	70.0	68.0	82.0	86.0	93.0	95.0	89.0	93.0
1200	76	60	98	76.0	64.0	77.0	75.0	71.0	84.0	87.0	92.0	94.0	89.0	93.0	79.0	30.0	78.0	77.0	87.0	90.0	95.0	96.0	91.0	84.0
1221	78	63	98	78.0	66.0	79.0	77.0	73.0	85.0	88.0	93.0	95.0	90.0	94.0	81.0	80.0	79.0	88.0	90.0	95.0	97.0	95.0	97.0	93.0
1292	89	86	98	89.0	87.0	90.0	90.0	89.0	93.0	95.0	96.0	97.0	95.0	96.0	92.0	30.0	91.0	91.0	94.0	95.0	97.0	95.0	97.0	94.0
1294	90	89	98	90.0	90.0	91.0	92.0	92.0	95.0	95.0	97.0	97.0	95.0	97.0	94.0	30.0	92.0	92.0	95.0	96.0	97.0	96.0	97.0	94.0
1311	78	63	98	78.0	66.0	79.0	77.0	73.0	85.0	88.0	93.0	95.0	90.0	94.0	81.0	80.0	79.0	88.0	90.0	95.0	96.0	92.0	95.0	84.0
1314	79	64	98	79.0	67.0	80.0	78.0	74.0	85.0	88.0	93.0	95.0	90.0	94.0	81.0	80.0	79.0	88.0	90.0	95.0	96.0	92.0	95.0	82.0
1320	88	82	98	88.0	83.0	89.0	88.0	87.0	92.0	94.0	96.0	96.0	94.0	96.0	90.0	30.0	89.0	89.0	93.0	94.0	97.0	95.0	97.0	91.0
1321	88	82	98	88.0	83.0	89.0	88.0	87.0	92.0	94.0	96.0	96.0	94.0	96.0	90.0	30.0	89.0	89.0	93.0	94.0	97.0	95.0	97.0	91.0
1322	88	81	98	88.0	83.0	89.0	88.0	86.0	92.0	93.0	95.0	96.0	94.0	96.0	90.0	30.0	89.0	89.0	93.0	94.0	97.0	95.0	97.0	91.0
1341	88	80	98	88.0																				



Date: Aug-14

STANDARD FORM 4

APPENDIX C

100-Year HEC-1 Analyses


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1*****
*
* FLOOD HYDROGRAPH PACKAGE (HEC-1)
* JUN 1998
* VERSION 4.1
*
* RUN DATE 08SEP14 TIME 15:43:36
*
*****

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PRO1.OUT

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

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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

1 HEC-1 INPUT PAGE 1

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LINE      ID.....1.....2.....3.....4.....5.....6.....7.....8.....9.....10
*DIAGRAM
1  ID      SLATER HANIFAN GROUP
2  ID      NINETY-FIVE MANAGEMENT, LLC.
3  ID      SKYE CANYON - DETENTION BASINS
4  ID      TECHNICAL DRAINAGE STUDY
5  ID      PROPOSED DRAINAGE CONDITION
6  ID
7  ID      RETURN PERIOD ----- 100-YEAR
8  ID      DISTRIBUTION ----- 6-HOUR SDN3
9  ID      PROJECT NO. ----- OLY1401.004
10 ID      FILENAME ----- PRO1.H1
11 ID      DATE ----- 08/27/14
12 ID      MODELED BY ----- WTM
13 ID
14 ID      SIX HOUR DEPTH-AREA REDUCTION FACTORS
15 ID      DRAINAGE AREA (MI^2) RATIO
16 ID      0.0-0.49 1.00
17 ID      0.5-0.99 0.98
18 ID
19 IT      5 0 0 300
20 IO      5 0 0 0
21 IN      5 0 0 0
22 JR      PREC 1.00 0.98
*
23 KK      OFF1
24 KM      EXISTING OFFSITE DRAINAGE BASIN
25 KM      DISCHARGES INTO DETENTION BASIN "DB1"
26 KO      3
27 PB      3.00
28 PC      0 0.020 0.057 0.070 0.087 0.108 0.124 0.130 0.130 0.130
29 PC      0.130 0.130 0.130 0.133 0.140 0.142 0.148 0.158 0.172 0.181
30 PC      0.190 0.197 0.199 0.200 0.201 0.204 0.214 0.229 0.241 0.249
31 PC      0.251 0.256 0.270 0.278 0.281 0.283 0.295 0.322 0.352 0.409
32 PC      0.499 0.590 0.710 0.744 0.781 0.812 0.819 0.835 0.851 0.856
33 PC      0.860 0.868 0.876 0.888 0.910 0.926 0.937 0.950 0.970 0.976
34 PC      0.982 0.985 0.987 0.989 0.990 0.993 0.993 0.994 0.995 0.998
35 PC      0.998 0.999 1
36 BA      .4291
37 LS      0 86.1
38 UD      0.420
*
39 KK      OFF2
40 KM      EXISTING OFFSITE DRAINAGE BASIN
41 KM      DISCHARGES INTO DETENTION BASIN "DB1"
42 KO      3
43 BA      .0419
44 LS      0 84.0
45 UD      0.150
*

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1 HEC-1 INPUT PAGE 2

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LINE      ID.....1.....2.....3.....4.....5.....6.....7.....8.....9.....10
*
46 KK      OFF3
47 KM      EXISTING OFFSITE DRAINAGE BASIN
48 KM      DISCHARGES INTO DETENTION BASIN "DB1"
49 KO      3
50 BA      .0259
51 LS      0 86.2
52 UD      0.112
*
53 KK      CP1
54 KM      COMBINE OFF1, OFF2, AND OFF3
55 HC      3
*
56 KK      OFF4
57 KM      EXISTING OFFSITE DRAINAGE BASIN
58 KM      DISCHARGES INTO DETENTION BASIN "DB1"
59 KO      3
60 BA      .0581
61 LS      0 86.2
62 UD      0.136
*
63 KK      OFF5
64 KM      EXISTING OFFSITE DRAINAGE BASIN
65 KM      DISCHARGES INTO DETENTION BASIN "DB1"
66 KO      3
67 BA      .2569
68 LS      0 86.5
69 UD      0.419
*
70 KK      OFF6
71 KM      EXISTING OFFSITE DRAINAGE BASIN
72 KM      DISCHARGES INTO DETENTION BASIN "DB1"
73 KO      3
74 BA      .0399
75 LS      0 86.2
76 UD      0.121
*
77 KK      ON1
78 KM      PROPOSED ONSITE DRAINAGE BASIN

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PRO1.OUT

79 BA .0261
80 LS 0 92.8
81 UD 0.116

82 KK DB1
83 KM COMBINE CP1, OFF4, OFF5, OFF6 AND ON1
84 HC 5

1 HEC-1 INPUT PAGE 3

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

85 KK RDB1
86 OUTLET = 30" ORIFICE @ INVERT ELEVATION = 3025.5-FT
87 RS 1 VOL -1
88 SV 0 7.78 13.43 19.26 58.03 96.21 132.22
89 SE 25.5 27 28 29 35 40 44
90 SQ 0 25.59 36.20 44.33 76.78 335.94 1413.68 2946.76 4825.05
91 SE 25.5 29 30 31 37 38 40 42 44

92 ZZ

1 SCHEMATIC DIAGRAM OF STREAM NETWORK

INPUT LINE (V) ROUTING (--->) DIVERSION OR PUMP FLOW
NO. (.) CONNECTOR (<---) RETURN OF DIVERTED OR PUMPED FLOW

23 OFF1
39 OFF2
46 OFF3
53 CP1.....
56 OFF4
63 OFF5
70 OFF6
77 ON1
82 DB1.....
85 RDB1

(***) RUNOFF ALSO COMPUTED AT THIS LOCATION

1 *****

* FLOOD HYDROGRAPH PACKAGE (HEC-1) *
* JUN 1998 *
* VERSION 4.1 *
* RUN DATE 08SEP14 TIME 15:43:36 *

* U.S. ARMY CORPS OF ENGINEERS *
* HYDROLOGIC ENGINEERING CENTER *
* 609 SECOND STREET *
* DAVIS, CALIFORNIA 95616 *
* (916) 756-1104 *

SLATER HANIFAN GROUP
NINETY-FIVE MANAGEMENT, LLC.
SKYE CANYON - DETENTION BASINS
TECHNICAL DRAINAGE STUDY
PROPOSED DRAINAGE CONDITION

RETURN PERIOD ----- 100-YEAR
DISTRIBUTION ----- 6-HOUR SDN3
PROJECT NO. ----- OLY1401.004
FILENAME ----- PRO1.H1
DATE ----- 08/27/14
MODELED BY ----- WTM

SIX HOUR DEPTH-AREA REDUCTION FACTORS
DRAINAGE AREA (MI^2) RATIO
0.0-0.49 1.00
0.5-0.99 0.98

20 IO OUTPUT CONTROL VARIABLES
IPRNT 5 PRINT CONTROL
IPLOT 0 PLOT CONTROL
QSCAL 0. HYDROGRAPH PLOT SCALE

IT HYDROGRAPH TIME DATA
NMIN 5 MINUTES IN COMPUTATION INTERVAL
IDATE 1 0 STARTING DATE
ITIME 0000 STARTING TIME
NQ 300 NUMBER OF HYDROGRAPH ORDINATES
NDDATE 2 0 ENDING DATE
NDTIME 0055 ENDING TIME
ICENT 19 CENTURY MARK

COMPUTATION INTERVAL .08 HOURS
TOTAL TIME BASE 24.92 HOURS

ENGLISH UNITS
DRAINAGE AREA SQUARE MILES
PRECIPITATION DEPTH INCHES
LENGTH, ELEVATION FEET
FLOW CUBIC FEET PER SECOND
STORAGE VOLUME ACRE-Feet
SURFACE AREA ACRES
TEMPERATURE DEGREES FAHRENHEIT

JP MULTI-PLAN OPTION
NPLAN 1 NUMBER OF PLANS

JR MULTI-RATIO OPTION
RATIOS OF PRECIPITATION
1.00 .98

*** **

23 KK OFF1

26 KO OUTPUT CONTROL VARIABLES
 IPRNT 3 PRINT CONTROL
 IPLOT 0 PLOT CONTROL
 QSCAL 0. HYDROGRAPH PLOT SCALE

21 IN TIME DATA FOR INPUT TIME SERIES
 JXMIN 5 TIME INTERVAL IN MINUTES
 JXDATE 1 0 STARTING DATE
 JXTIME 0 0 STARTING TIME

SUBBASIN RUNOFF DATA

36 BA SUBBASIN CHARACTERISTICS
 TAREA .43 SUBBASIN AREA

PRECIPITATION DATA

27 PB STORM 3.00 BASIN TOTAL PRECIPITATION

28 PI INCREMENTAL PRECIPITATION PATTERN
 .02 .04 .01 .02 .02 .02 .01 .00 .00 .00
 .00 .00 .00 .01 .00 .01 .01 .01 .01 .01
 .01 .00 .00 .00 .00 .01 .02 .01 .01 .00
 .01 .01 .01 .00 .00 .01 .03 .03 .06 .09
 .09 .12 .03 .04 .03 .01 .02 .02 .00 .00
 .01 .01 .01 .02 .02 .01 .01 .02 .01 .01
 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00
 .00 .00

37 LS SCS LOSS RATE
 STRTL .32 INITIAL ABSTRACTION
 CRVNR 86.10 CURVE NUMBER
 RTIMP .00 PERCENT IMPERVIOUS AREA

38 UD SCS DIMENSIONLESS UNITGRAPH
 TLAG .42 LAG

UNIT HYDROGRAPH
 27 END-OF-PERIOD ORDINATES

39.	118.	246.	379.	444.	445.	397.	330.	240.	174.
129.	98.	73.	55.	41.	30.	22.	17.	12.	9.
7.	5.	4.	3.	2.	1.	1.			

TOTAL RAINFALL = 3.00, TOTAL LOSS = 1.33, TOTAL EXCESS = 1.67

PEAK FLOW TIME 6-HR MAXIMUM AVERAGE FLOW 24.92-HR
 + (CFS) (HR) 24-HR 72-HR

+ 387. 3.83 (CFS) 77. 19. 19. 19.
 (INCHES) 1.668 1.670 1.670 1.670
 (AC-FT) 38. 38. 38. 38.

CUMULATIVE AREA = .43 SQ MI

HYDROGRAPH AT STATION OFF1
 FOR PLAN 1, RATIO = 1.00

TOTAL RAINFALL = 3.00, TOTAL LOSS = 1.33, TOTAL EXCESS = 1.67

PEAK FLOW TIME 6-HR MAXIMUM AVERAGE FLOW 24.92-HR
 + (CFS) (HR) 24-HR 72-HR

+ 387. 3.83 (CFS) 77. 19. 19. 19.
 (INCHES) 1.668 1.670 1.670 1.670
 (AC-FT) 38. 38. 38. 38.

CUMULATIVE AREA = .43 SQ MI

HYDROGRAPH AT STATION OFF1
 FOR PLAN 1, RATIO = .98

TOTAL RAINFALL = 2.94, TOTAL LOSS = 1.32, TOTAL EXCESS = 1.62

PEAK FLOW TIME 6-HR MAXIMUM AVERAGE FLOW 24.92-HR
 + (CFS) (HR) 24-HR 72-HR

+ 376. 3.83 (CFS) 75. 19. 18. 18.
 (INCHES) 1.617 1.619 1.619 1.619
 (AC-FT) 37. 37. 37. 37.

CUMULATIVE AREA = .43 SQ MI

*** **

 *
 39 KK * OFF2 *
 *

42 KO OUTPUT CONTROL VARIABLES
 IPRNT 3 PRINT CONTROL
 IPLOT 0 PLOT CONTROL
 QSCAL 0. HYDROGRAPH PLOT SCALE

SUBBASIN RUNOFF DATA

43 BA SUBBASIN CHARACTERISTICS
 TAREA .04 SUBBASIN AREA

PRECIPITATION DATA

27 PB STORM 3.00 BASIN TOTAL PRECIPITATION

28 PI INCREMENTAL PRECIPITATION PATTERN
 .02 .04 .01 .02 .02 .02 .01 .00 .00 .00
 .00 .00 .00 .01 .00 .01 .01 .01 .01 .01
 .01 .00 .00 .00 .00 .01 .02 .01 .01 .00
 .01 .01 .01 .00 .00 .01 .03 .03 .06 .09
 .09 .12 .03 .04 .03 .01 .02 .02 .00 .00
 .01 .01 .01 .02 .02 .01 .01 .02 .01 .01
 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00
 .00 .00

44 LS SCS LOSS RATE
 STRTL .38 INITIAL ABSTRACTION
 CRVNR 84.00 CURVE NUMBER
 RTIMP .00 PERCENT IMPERVIOUS AREA

45 UD SCS DIMENSIONLESS UNITGRAPH
 TLAG .15 LAG

UNIT HYDROGRAPH
11 END-OF-PERIOD ORDINATES

39. 0.	103.	91.	46.	23.	11.	6.	3.	1.	1.
TOTAL RAINFALL = 3.00, TOTAL LOSS = 1.48, TOTAL EXCESS = 1.52									
PEAK FLOW	TIME	6-HR		MAXIMUM AVERAGE FLOW		24.92-HR			
+ (CFS)	(HR)	(CFS)			24-HR	72-HR			
+ 54.	3.58		7.	2.	2.	2.			
		(INCHES)	1.516	1.516	1.516	1.516			
		(AC-FT)	3.	3.	3.	3.			
CUMULATIVE AREA = .04 SQ MI									

HYDROGRAPH AT STATION OFF2
FOR PLAN 1, RATIO = 1.00

39. 0.	103.	91.	46.	23.	11.	6.	3.	1.	1.
TOTAL RAINFALL = 3.00, TOTAL LOSS = 1.48, TOTAL EXCESS = 1.52									
PEAK FLOW	TIME	6-HR		MAXIMUM AVERAGE FLOW		24.92-HR			
+ (CFS)	(HR)	(CFS)			24-HR	72-HR			
+ 54.	3.58		7.	2.	2.	2.			
		(INCHES)	1.516	1.516	1.516	1.516			
		(AC-FT)	3.	3.	3.	3.			
CUMULATIVE AREA = .04 SQ MI									

HYDROGRAPH AT STATION OFF2
FOR PLAN 1, RATIO = .98

39. 0.	103.	91.	46.	23.	11.	6.	3.	1.	1.
TOTAL RAINFALL = 2.94, TOTAL LOSS = 1.47, TOTAL EXCESS = 1.47									
PEAK FLOW	TIME	6-HR		MAXIMUM AVERAGE FLOW		24.92-HR			
+ (CFS)	(HR)	(CFS)			24-HR	72-HR			
+ 53.	3.58		7.	2.	2.	2.			
		(INCHES)	1.467	1.467	1.467	1.467			
		(AC-FT)	3.	3.	3.	3.			
CUMULATIVE AREA = .04 SQ MI									

46 KK OFF3

49 KO OUTPUT CONTROL VARIABLES
IPRNT 3 PRINT CONTROL
IPLOT 0 PLOT CONTROL
QSCAL 0. HYDROGRAPH PLOT SCALE

SUBBASIN RUNOFF DATA

50 BA SUBBASIN CHARACTERISTICS
TAREA .03 SUBBASIN AREA

PRECIPITATION DATA

27 PB STORM 3.00 BASIN TOTAL PRECIPITATION

28 PI INCREMENTAL PRECIPITATION PATTERN

.02	.04	.01	.02	.02	.02	.01	.00	.00	.00
.00	.00	.00	.01	.00	.01	.01	.01	.01	.01
.01	.00	.00	.00	.00	.01	.02	.01	.01	.00
.01	.01	.01	.00	.00	.01	.03	.03	.06	.09
.09	.12	.03	.04	.03	.01	.02	.02	.00	.00
.01	.01	.01	.02	.02	.01	.01	.02	.01	.01
.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
.00	.00								

51 LS SCS LOSS RATE
STRTL .32 INITIAL ABSTRACTION
CRVNB 86.20 CURVE NUMBER
RTIMP .00 PERCENT IMPERVIOUS AREA

52 UD SCS DIMENSIONLESS UNITGRAPH
FLAG .11 LAG

UNIT HYDROGRAPH
9 END-OF-PERIOD ORDINATES

45.	81.	44.	18.	7.	3.	1.	0.
TOTAL RAINFALL = 3.00, TOTAL LOSS = 1.32, TOTAL EXCESS = 1.68							
PEAK FLOW	TIME	6-HR		MAXIMUM AVERAGE FLOW		24.92-HR	
+ (CFS)	(HR)	(CFS)			24-HR	72-HR	
+ 38.	3.58		5.	1.	1.	1.	
		(INCHES)	1.678	1.678	1.678	1.678	
		(AC-FT)	2.	2.	2.	2.	
CUMULATIVE AREA = .03 SQ MI							

HYDROGRAPH AT STATION OFF3
FOR PLAN 1, RATIO = 1.00

45.	81.	44.	18.	7.	3.	1.	0.
TOTAL RAINFALL = 3.00, TOTAL LOSS = 1.32, TOTAL EXCESS = 1.68							
PEAK FLOW	TIME	6-HR		MAXIMUM AVERAGE FLOW		24.92-HR	
+ (CFS)	(HR)	(CFS)			24-HR	72-HR	
+ 38.	3.58		5.	1.	1.	1.	
		(INCHES)	1.678	1.678	1.678	1.678	
		(AC-FT)	2.	2.	2.	2.	
CUMULATIVE AREA = .03 SQ MI							

HYDROGRAPH AT STATION OFF3
FOR PLAN 1, RATIO = .98

TOTAL RAINFALL = 2.94, TOTAL LOSS = 1.31, TOTAL EXCESS = 1.63

PEAK FLOW	TIME	6-HR	24-HR	72-HR	24.92-HR
(CFS)	(HR)	(CFS)			
+ 37.	3.58	5.	1.	1.	1.
		(INCHES)	(INCHES)	(INCHES)	(INCHES)
		(AC-FT)	(AC-FT)	(AC-FT)	(AC-FT)
		1.626	1.626	1.626	1.626
		2.	2.	2.	2.

CUMULATIVE AREA = .03 SQ MI

*** **

*
* OFF4
*

59 KO OUTPUT CONTROL VARIABLES
IPRNT 3 PRINT CONTROL
IPLOT 0 PLOT CONTROL
QSCAL 0. HYDROGRAPH PLOT SCALE

SUBBASIN RUNOFF DATA

60 BA SUBBASIN CHARACTERISTICS
TAREA .06 SUBBASIN AREA

PRECIPITATION DATA

27 PB STORM 3.00 BASIN TOTAL PRECIPITATION

28 PI INCREMENTAL PRECIPITATION PATTERN

.02	.04	.01	.02	.02	.02	.01	.00	.00	.00
.00	.00	.00	.01	.00	.01	.01	.01	.01	.01
.01	.00	.00	.00	.00	.01	.02	.01	.01	.00
.01	.01	.01	.00	.00	.01	.02	.03	.06	.09
.09	.12	.03	.04	.03	.01	.02	.02	.00	.00
.01	.01	.01	.02	.02	.01	.01	.02	.01	.01
.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
.00	.00								

61 LS SCS LOSS RATE
STRTL .32 INITIAL ABSTRACTION
CRVNB 86.20 CURVE NUMBER
RTIMP .00 PERCENT IMPERVIOUS AREA

62 UD SCS DIMENSIONLESS UNITGRAPH
FLAG .14 LAG

UNIT HYDROGRAPH
10 END-OF-PERIOD ORDINATES

67.	158.	123.	55.	26.	12.	6.	3.	1.	0.
TOTAL RAINFALL =	3.00	TOTAL LOSS =	1.32	TOTAL EXCESS =	1.68				
PEAK FLOW	TIME	6-HR	24-HR	72-HR	24.92-HR				
(CFS)	(HR)	(CFS)							
+ 84.	3.58	10.	3.	3.	3.				
		(INCHES)	(INCHES)	(INCHES)	(INCHES)				
		(AC-FT)	(AC-FT)	(AC-FT)	(AC-FT)				
		1.677	1.678	1.678	1.678				
		5.	5.	5.	5.				

CUMULATIVE AREA = .06 SQ MI

*** **

HYDROGRAPH AT STATION OFF4
FOR PLAN 1, RATIO = 1.00

TOTAL RAINFALL = 3.00, TOTAL LOSS = 1.32, TOTAL EXCESS = 1.68

PEAK FLOW	TIME	6-HR	24-HR	72-HR	24.92-HR
(CFS)	(HR)	(CFS)			
+ 84.	3.58	10.	3.	3.	3.
		(INCHES)	(INCHES)	(INCHES)	(INCHES)
		(AC-FT)	(AC-FT)	(AC-FT)	(AC-FT)
		1.677	1.678	1.678	1.678
		5.	5.	5.	5.

CUMULATIVE AREA = .06 SQ MI

*** **

HYDROGRAPH AT STATION OFF4
FOR PLAN 1, RATIO = .98

TOTAL RAINFALL = 2.94, TOTAL LOSS = 1.31, TOTAL EXCESS = 1.63

PEAK FLOW	TIME	6-HR	24-HR	72-HR	24.92-HR
(CFS)	(HR)	(CFS)			
+ 82.	3.58	10.	3.	2.	2.
		(INCHES)	(INCHES)	(INCHES)	(INCHES)
		(AC-FT)	(AC-FT)	(AC-FT)	(AC-FT)
		1.626	1.626	1.626	1.626
		5.	5.	5.	5.

CUMULATIVE AREA = .06 SQ MI

*** **

*
* OFF5
*

66 KO OUTPUT CONTROL VARIABLES
IPRNT 3 PRINT CONTROL
IPLOT 0 PLOT CONTROL
QSCAL 0. HYDROGRAPH PLOT SCALE

SUBBASIN RUNOFF DATA

67 BA SUBBASIN CHARACTERISTICS
TAREA .26 SUBBASIN AREA

PRECIPITATION DATA

```

PRO1.OUT

27 PB      STORM      3.00  BASIN TOTAL PRECIPITATION
28 PI      INCREMENTAL PRECIPITATION PATTERN
           .02      .04      .01      .02      .02      .02      .01      .00      .00      .00
           .00      .00      .00      .01      .00      .01      .01      .01      .01      .01
           .01      .00      .00      .00      .00      .01      .02      .03      .06      .09
           .01      .01      .01      .00      .00      .01      .02      .02      .00      .00
           .09      .12      .03      .04      .03      .01      .02      .02      .01      .01
           .01      .01      .01      .02      .02      .01      .01      .02      .01      .01
           .00      .00      .00      .00      .00      .00      .00      .00      .00      .00
           .00      .00      .00      .00      .00      .00      .00      .00      .00      .00

68 LS      SCS LOSS RATE
           STRTL      .31  INITIAL ABSTRACTION
           CRVNR      86.50  CURVE NUMBER
           RTIMP      .00  PERCENT IMPERVIOUS AREA

69 UD      SCS DIMENSIONLESS UNITGRAPH
           TLAG      .42  LAG

***

UNIT HYDROGRAPH
27 END-OF-PERIOD ORDINATES
23. 71. 148. 228. 267. 267. 238. 197. 143. 104.
77. 59. 43. 32. 24. 18. 13. 10. 7. 6.
4. 3. 2. 2. 1. 1. 0.

TOTAL RAINFALL = 3.00, TOTAL LOSS = 1.30, TOTAL EXCESS = 1.70
PEAK FLOW      TIME      6-HR      MAXIMUM AVERAGE FLOW
+ (CFS)      (HR)      (CFS)      24-HR      72-HR      24.92-HR
+ 236.      3.83      (CFS)      47.      12.      11.      11.
           (INCHES) 1.698 1.700 1.700 1.700
           (AC-FT) 23. 23. 23. 23.
CUMULATIVE AREA = .26 SQ MI

***

HYDROGRAPH AT STATION OFF5
FOR PLAN 1, RATIO = 1.00
TOTAL RAINFALL = 3.00, TOTAL LOSS = 1.30, TOTAL EXCESS = 1.70
PEAK FLOW      TIME      6-HR      MAXIMUM AVERAGE FLOW
+ (CFS)      (HR)      (CFS)      24-HR      72-HR      24.92-HR
+ 236.      3.83      (CFS)      47.      12.      11.      11.
           (INCHES) 1.698 1.700 1.700 1.700
           (AC-FT) 23. 23. 23. 23.
CUMULATIVE AREA = .26 SQ MI

***

HYDROGRAPH AT STATION OFF5
FOR PLAN 1, RATIO = .98
TOTAL RAINFALL = 2.94, TOTAL LOSS = 1.29, TOTAL EXCESS = 1.65
PEAK FLOW      TIME      6-HR      MAXIMUM AVERAGE FLOW
+ (CFS)      (HR)      (CFS)      24-HR      72-HR      24.92-HR
+ 229.      3.83      (CFS)      45.      11.      11.      11.
           (INCHES) 1.646 1.649 1.649 1.649
           (AC-FT) 23. 23. 23. 23.
CUMULATIVE AREA = .26 SQ MI

***

*****
70 KK      OFF6
*****

73 KO      OUTPUT CONTROL VARIABLES
           IPRNT      3  PRINT CONTROL
           IPLOT      0  PLOT CONTROL
           QSCAL      0.  HYDROGRAPH PLOT SCALE

SUBBASIN RUNOFF DATA
74 BA      SUBBASIN CHARACTERISTICS
           TAREA      .04  SUBBASIN AREA

PRECIPITATION DATA
27 PB      STORM      3.00  BASIN TOTAL PRECIPITATION
28 PI      INCREMENTAL PRECIPITATION PATTERN
           .02      .04      .01      .02      .02      .02      .01      .00      .00      .00
           .00      .00      .00      .01      .00      .01      .01      .01      .01      .01
           .01      .00      .00      .00      .00      .01      .02      .03      .06      .09
           .01      .01      .01      .00      .00      .01      .02      .02      .00      .00
           .09      .12      .03      .04      .03      .01      .02      .02      .01      .01
           .01      .01      .01      .02      .02      .01      .01      .02      .01      .01
           .00      .00      .00      .00      .00      .00      .00      .00      .00      .00
           .00      .00      .00      .00      .00      .00      .00      .00      .00      .00

75 LS      SCS LOSS RATE
           STRTL      .32  INITIAL ABSTRACTION
           CRVNR      86.20  CURVE NUMBER
           RTIMP      .00  PERCENT IMPERVIOUS AREA

76 UD      SCS DIMENSIONLESS UNITGRAPH
           TLAG      .12  LAG

***

UNIT HYDROGRAPH
9 END-OF-PERIOD ORDINATES
59. 119. 76. 31. 14. 6. 3. 1. 0.
TOTAL RAINFALL = 3.00, TOTAL LOSS = 1.32, TOTAL EXCESS = 1.68
PEAK FLOW      TIME      6-HR      MAXIMUM AVERAGE FLOW
+ (CFS)      (HR)      (CFS)      24-HR      72-HR      24.92-HR
+ 59.      3.58      (CFS)      7.      2.      2.      2.
           (INCHES) 1.678 1.678 1.678 1.678
           (AC-FT) 4. 4. 4. 4.

```

PRO1.OUT

CUMULATIVE AREA = .04 SQ MI

```

***          ***          ***          ***          ***
HYDROGRAPH AT STATION OFF6
FOR PLAN 1, RATIO = 1.00
TOTAL RAINFALL = 3.00, TOTAL LOSS = 1.32, TOTAL EXCESS = 1.68
PEAK FLOW      TIME      6-HR      MAXIMUM AVERAGE FLOW
+ (CFS)        (HR)              24-HR      72-HR      24.92-HR
+ 59.          3.58      (CFS)              2.          2.          2.
                        (INCHES) 1.678      1.678      1.678
                        (AC-FT)  4.          4.          4.          1.678
CUMULATIVE AREA = .04 SQ MI

```

```

***          ***          ***          ***          ***
HYDROGRAPH AT STATION OFF6
FOR PLAN 1, RATIO = .98
TOTAL RAINFALL = 2.94, TOTAL LOSS = 1.31, TOTAL EXCESS = 1.63
PEAK FLOW      TIME      6-HR      MAXIMUM AVERAGE FLOW
+ (CFS)        (HR)              24-HR      72-HR      24.92-HR
+ 57.          3.58      (CFS)              2.          2.          2.
                        (INCHES) 1.626      1.626      1.626
                        (AC-FT)  3.          3.          3.          1.626
CUMULATIVE AREA = .04 SQ MI

```

1

PEAK FLOW AND STAGE (END-OF-PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
 FLOWS IN CUBIC FEET PER SECOND, AREA IN SQUARE MILES
 TIME TO PEAK IN HOURS

OPERATION	STATION	AREA	PLAN	RATIOS APPLIED TO PRECIPITATION	
				RATIO 1 1.00	RATIO 2 .98
HYDROGRAPH AT	OFF1	.43	1 FLOW TIME	387. 3.83	376. 3.83
HYDROGRAPH AT	OFF2	.04	1 FLOW TIME	54. 3.58	53. 3.58
HYDROGRAPH AT	OFF3	.03	1 FLOW TIME	38. 3.58	37. 3.58
3 COMBINED AT	CP1	.50	1 FLOW TIME	430. 3.83	417. 3.83
HYDROGRAPH AT	OFF4	.06	1 FLOW TIME	84. 3.58	82. 3.58
HYDROGRAPH AT	OFF5	.26	1 FLOW TIME	236. 3.83	229. 3.83
HYDROGRAPH AT	OFF6	.04	1 FLOW TIME	59. 3.58	57. 3.58
HYDROGRAPH AT	ON1	.03	1 FLOW TIME	47. 3.58	46. 3.58
5 COMBINED AT	DB1	.88	1 FLOW TIME	754. 3.75	731. 3.75
ROUTED TO	RDB1	.88	1 FLOW TIME	71. 5.58	70. 5.58
				** PEAK STAGES IN FEET **	
				1 STAGE TIME	35.99 5.58
					35.72 5.58

*** NORMAL END OF HEC-1 ***


```

1*****
*
* FLOOD HYDROGRAPH PACKAGE (HEC-1)
* JUN 1998
* VERSION 4.1
*
* RUN DATE 08SEP14 TIME 15:44:54
*
*****

```

ULT1.OUT

```

*****
*
* U.S. ARMY CORPS OF ENGINEERS
* HYDROLOGIC ENGINEERING CENTER
* 609 SECOND STREET
* DAVIS, CALIFORNIA 95616
* (916) 756-1104
*
*****

```

```

      X   X  XXXXXXX XXXXX      X
      X   X  X      X      X
      X   X  X      X      XX
      XXXXXX XXXX  X      XXXXX  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

1 HEC-1 INPUT PAGE 1

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LINE      ID.....1.....2.....3.....4.....5.....6.....7.....8.....9.....10
*DIAGRAM
1      ID      SLATER HANIFAN GROUP
2      ID      NINETY-FIVE MANAGEMENT, LLC.
3      ID      SKYE CANYON - DETENTION BASINS
4      ID      TECHNICAL DRAINAGE STUDY
5      ID      ULTIMATE DRAINAGE CONDITION
6      ID
7      ID      RETURN PERIOD ----- 100-YEAR
8      ID      DISTRIBUTION ----- 6-HOUR SDN3
9      ID      PROJECT NO. ----- OLY1401.004
10     ID      FILENAME ----- ULT1.H1
11     ID      DATE ----- 08/19/14
12     ID      MODELED BY ----- WTM
13     ID
14     ID      SIX HOUR DEPTH-AREA REDUCTION FACTORS
15     ID      DRAINAGE AREA (MI^2)      RATIO
16     ID      0.0-0.49      1.00
17     ID      0.5-0.99      0.98
18     ID
19     IT      5      0      0      500
20     IO      5      0      0
21     IN      5      0      0
22     JR      PREC      1.00      0.98
*
23     KK      OFF1
24     KM      EXISTING OFFSITE DRAINAGE BASIN
25     KM      DISCHARGES INTO DETENTION BASIN "DB1"
26     PB      3.00
27     PC      0      0.020      0.057      0.070      0.087      0.108      0.124      0.130      0.130      0.130
28     PC      0.130      0.130      0.130      0.133      0.140      0.142      0.148      0.158      0.172      0.181
29     PC      0.190      0.197      0.199      0.200      0.201      0.204      0.214      0.229      0.241      0.249
30     PC      0.251      0.256      0.270      0.278      0.281      0.283      0.295      0.322      0.352      0.409
31     PC      0.499      0.590      0.710      0.744      0.781      0.812      0.819      0.835      0.851      0.856
32     PC      0.860      0.868      0.876      0.888      0.910      0.926      0.937      0.950      0.970      0.976
33     PC      0.982      0.985      0.987      0.989      0.990      0.993      0.993      0.994      0.995      0.998
34     PC      0.998      0.999      1
35     BA      .4073
36     LS      0      86.4
37     UD      0.356
*
38     KK      OFF7
39     KM      FUTURE DEVELOPED OFFSITE DRAINAGE BASIN
40     KM      DISCHARGES INTO DETENTION BASIN "DB1"
41     BA      .0281
42     LS      0      96.0
43     UD      0.118
*

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1 HEC-1 INPUT PAGE 2

```

LINE      ID.....1.....2.....3.....4.....5.....6.....7.....8.....9.....10
*
44     KK      CP2
45     KM      COMBINE OFF1, OFF7
46     HC      2
*
47     KK      OFF2
48     KM      EXISTING OFFSITE DRAINAGE BASIN
49     KM      DISCHARGES INTO DETENTION BASIN "DB1"
50     BA      .0355
51     LS      0      85.0
52     UD      0.148
*
53     KK      OFF3
54     KM      EXISTING OFFSITE DRAINAGE BASIN
55     KM      DISCHARGES INTO DETENTION BASIN "DB1"
56     BA      .0259
57     LS      0      86.2
58     UD      0.112
*
59     KK      CP1
60     KM      COMBINE CP2, OFF2, AND OFF3
61     HC      3
*
62     KK      OFF4
63     KM      EXISTING OFFSITE DRAINAGE BASIN
64     KM      DISCHARGES INTO DETENTION BASIN "DB1"
65     BA      .0581
66     LS      0      86.2
67     UD      0.136
*
68     KK      OFF5
69     KM      EXISTING OFFSITE DRAINAGE BASIN
70     KM      DISCHARGES INTO DETENTION BASIN "DB1"
71     BA      .2569
72     LS      0      86.5
73     UD      0.419
*
74     KK      OFF6
75     KM      EXISTING OFFSITE DRAINAGE BASIN
76     KM      DISCHARGES INTO DETENTION BASIN "DB1"

```

77 BA .0399
78 LS 0 86.2
79 UD 0.121
*

HEC-1 INPUT

PAGE 3

1

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

80 KK ON1
81 KM PROPOSED ONSITE DRAINAGE BASIN
82 BA .0261
83 LS 0 92.8
84 UD 0.116
*

85 KK DB1
86 KM COMBINE CP1, OFF4, OFF5, OFF6 AND ON1
87 KO 1
88 HC 5
*

89 KK RDB1
90 KM OUTLET = 30" ORIFICE @ INVERT ELEVATION = 3025.5-FT
91 KO 1
92 RS 1 VOL -1
93 SV 0 7.78 13.43 19.26 58.03 96.21 132.22
94 SE 25.5 27 28 29 35 40 44
95 SQ 0 25.59 36.20 44.33 76.78 335.94 1413.68 2946.76 4825.05
96 SE 25.5 29 30 31 37 38 40 42 44
*
97 ZZ

1

SCHEMATIC DIAGRAM OF STREAM NETWORK

INPUT LINE (V) ROUTING (--->) DIVERSION OR PUMP FLOW
NO. (.) CONNECTOR (<---) RETURN OF DIVERTED OR PUMPED FLOW

```

23 OFF1
.
.
38 OFF7
.
.
44 CP2.....
.
.
47 OFF2
.
.
53 OFF3
.
.
59 CP1.....
.
.
62 OFF4
.
.
68 OFF5
.
.
74 OFF6
.
.
80 ON1
.
.
85 DB1.....
V
V
89 RDB1

```

(***) RUNOFF ALSO COMPUTED AT THIS LOCATION

* FLOOD HYDROGRAPH PACKAGE (HEC-1) *
* JUN 1998 *
* VERSION 4.1 *
* RUN DATE 08SEP14 TIME 15:44:54 *
* *****

* U.S. ARMY CORPS OF ENGINEERS *
* HYDROLOGIC ENGINEERING CENTER *
* 609 SECOND STREET *
* DAVIS, CALIFORNIA 95616 *
* (916) 756-1104 *
* *****

SLATER HANIFAN GROUP
NINETY-FIVE MANAGEMENT, LLC.
SKYE CANYON - DETENTION BASINS
TECHNICAL DRAINAGE STUDY
ULTIMATE DRAINAGE CONDITION

RETURN PERIOD ----- 100-YEAR
DISTRIBUTION ----- 6-HOUR SDN3
PROJECT NO. ----- OLY1401.004
FILENAME ----- ULT1.H1
DATE ----- 08/19/14
MODELED BY ----- WTM

SIX HOUR DEPTH-AREA REDUCTION FACTORS
DRAINAGE AREA (MI^2) RATIO
0.0-0.49 1.00
0.5-0.99 0.98

20 IO OUTPUT CONTROL VARIABLES
IPRNT 5 PRINT CONTROL
IPLOT 0 PLOT CONTROL
QSCAL 0. HYDROGRAPH PLOT SCALE

IT HYDROGRAPH TIME DATA
NMIN 5 MINUTES IN COMPUTATION INTERVAL
IDATE 1 0 STARTING DATE
ITIME 0000 STARTING TIME
NQ 500 NUMBER OF HYDROGRAPH ORDINATES
NDDATE 2 0 ENDING DATE
NDTIME 1735 ENDING TIME
ICENT 19 CENTURY MARK

COMPUTATION INTERVAL .08 HOURS
TOTAL TIME BASE 41.58 HOURS

ENGLISH UNITS
DRAINAGE AREA SQUARE MILES
PRECIPITATION DEPTH INCHES
LENGTH, ELEVATION FEET
FLOW CUBIC FEET PER SECOND
STORAGE VOLUME ACRE-Feet
SURFACE AREA ACRES
TEMPERATURE DEGREES FAHRENHEIT

JP MULTI-PLAN OPTION
NPLAN 1 NUMBER OF PLANS

JR MULTI-RATIO OPTION
RATIOS OF PRECIPITATION
1.00 .98

ULT1.OUT

85 KK DB1

87 KO OUTPUT CONTROL VARIABLES
IPRNT 1 PRINT CONTROL
IPLOT 0 PLOT CONTROL
QSCAL 0. HYDROGRAPH PLOT SCALE

88 HC HYDROGRAPH COMBINATION
ICOMP 5 NUMBER OF HYDROGRAPHS TO COMBINE

HYDROGRAPH AT STATION DB1
SUM OF 5 HYDROGRAPHS
PLAN 1, RATIO = 1.00

DA MON HRMN ORD				FLOW	DA MON HRMN ORD				FLOW	DA MON HRMN ORD				FLOW	DA MON HRMN ORD				FLOW
				*					*					*					*
1	0000	1	0.	*	1	1025	126	0.	*	1	2050	251	0.	*	2	0715	376	0.	*
1	0005	2	0.	*	1	1030	127	0.	*	1	2055	252	0.	*	2	0720	377	0.	*
1	0010	3	1.	*	1	1035	128	0.	*	1	2100	253	0.	*	2	0725	378	0.	*
1	0015	4	2.	*	1	1040	129	0.	*	1	2105	254	0.	*	2	0730	379	0.	*
1	0020	5	4.	*	1	1045	130	0.	*	1	2110	255	0.	*	2	0735	380	0.	*
1	0025	6	6.	*	1	1050	131	0.	*	1	2115	256	0.	*	2	0740	381	0.	*
1	0030	7	9.	*	1	1055	132	0.	*	1	2120	257	0.	*	2	0745	382	0.	*
1	0035	8	10.	*	1	1100	133	0.	*	1	2125	258	0.	*	2	0750	383	0.	*
1	0040	9	8.	*	1	1105	134	0.	*	1	2130	259	0.	*	2	0755	384	0.	*
1	0045	10	5.	*	1	1110	135	0.	*	1	2135	260	0.	*	2	0800	385	0.	*
1	0050	11	4.	*	1	1115	136	0.	*	1	2140	261	0.	*	2	0805	386	0.	*
1	0055	12	4.	*	1	1120	137	0.	*	1	2145	262	0.	*	2	0810	387	0.	*
1	0100	13	2.	*	1	1125	138	0.	*	1	2150	263	0.	*	2	0815	388	0.	*
1	0105	14	3.	*	1	1130	139	0.	*	1	2155	264	0.	*	2	0820	389	0.	*
1	0110	15	4.	*	1	1135	140	0.	*	1	2200	265	0.	*	2	0825	390	0.	*
1	0115	16	6.	*	1	1140	141	0.	*	1	2205	266	0.	*	2	0830	391	0.	*
1	0120	17	7.	*	1	1145	142	0.	*	1	2210	267	0.	*	2	0835	392	0.	*
1	0125	18	11.	*	1	1150	143	0.	*	1	2215	268	0.	*	2	0840	393	0.	*
1	0130	19	17.	*	1	1155	144	0.	*	1	2220	269	0.	*	2	0845	394	0.	*
1	0135	20	24.	*	1	1200	145	0.	*	1	2225	270	0.	*	2	0850	395	0.	*
1	0140	21	29.	*	1	1205	146	0.	*	1	2230	271	0.	*	2	0855	396	0.	*
1	0145	22	33.	*	1	1210	147	0.	*	1	2235	272	0.	*	2	0900	397	0.	*
1	0150	23	34.	*	1	1215	148	0.	*	1	2240	273	0.	*	2	0905	398	0.	*
1	0155	24	31.	*	1	1220	149	0.	*	1	2245	274	0.	*	2	0910	399	0.	*
1	0200	25	28.	*	1	1225	150	0.	*	1	2250	275	0.	*	2	0915	400	0.	*
1	0205	26	25.	*	1	1230	151	0.	*	1	2255	276	0.	*	2	0920	401	0.	*
1	0210	27	26.	*	1	1235	152	0.	*	1	2300	277	0.	*	2	0925	402	0.	*
1	0215	28	34.	*	1	1240	153	0.	*	1	2305	278	0.	*	2	0930	403	0.	*
1	0220	29	44.	*	1	1245	154	0.	*	1	2310	279	0.	*	2	0935	404	0.	*
1	0225	30	51.	*	1	1250	155	0.	*	1	2315	280	0.	*	2	0940	405	0.	*
1	0230	31	53.	*	1	1255	156	0.	*	1	2320	281	0.	*	2	0945	406	0.	*
1	0235	32	51.	*	1	1300	157	0.	*	1	2325	282	0.	*	2	0950	407	0.	*
1	0240	33	56.	*	1	1305	158	0.	*	1	2330	283	0.	*	2	0955	408	0.	*
1	0245	34	63.	*	1	1310	159	0.	*	1	2335	284	0.	*	2	1000	409	0.	*
1	0250	35	63.	*	1	1315	160	0.	*	1	2340	285	0.	*	2	1005	410	0.	*
1	0255	36	57.	*	1	1320	161	0.	*	1	2345	286	0.	*	2	1010	411	0.	*
1	0300	37	58.	*	1	1325	162	0.	*	1	2350	287	0.	*	2	1015	412	0.	*
1	0305	38	75.	*	1	1330	163	0.	*	1	2355	288	0.	*	2	1020	413	0.	*
1	0310	39	107.	*	1	1335	164	0.	*	2	0000	289	0.	*	2	1025	414	0.	*
1	0315	40	163.	*	1	1340	165	0.	*	2	0005	290	0.	*	2	1030	415	0.	*
1	0320	41	273.	*	1	1345	166	0.	*	2	0010	291	0.	*	2	1035	416	0.	*
1	0325	42	428.	*	1	1350	167	0.	*	2	0015	292	0.	*	2	1040	417	0.	*
1	0330	43	618.	*	1	1355	168	0.	*	2	0020	293	0.	*	2	1045	418	0.	*
1	0335	44	764.	*	1	1400	169	0.	*	2	0025	294	0.	*	2	1050	419	0.	*
1	0340	45	807.	*	1	1405	170	0.	*	2	0030	295	0.	*	2	1055	420	0.	*
1	0345	46	817.	*	1	1410	171	0.	*	2	0035	296	0.	*	2	1100	421	0.	*
1	0350	47	780.	*	1	1415	172	0.	*	2	0040	297	0.	*	2	1105	422	0.	*
1	0355	48	698.	*	1	1420	173	0.	*	2	0045	298	0.	*	2	1110	423	0.	*
1	0400	49	612.	*	1	1425	174	0.	*	2	0050	299	0.	*	2	1115	424	0.	*
1	0405	50	519.	*	1	1430	175	0.	*	2	0055	300	0.	*	2	1120	425	0.	*
1	0410	51	425.	*	1	1435	176	0.	*	2	0100	301	0.	*	2	1125	426	0.	*
1	0415	52	349.	*	1	1440	177	0.	*	2	0105	302	0.	*	2	1130	427	0.	*
1	0420	53	292.	*	1	1445	178	0.	*	2	0110	303	0.	*	2	1135	428	0.	*
1	0425	54	254.	*	1	1450	179	0.	*	2	0115	304	0.	*	2	1140	429	0.	*
1	0430	55	240.	*	1	1455	180	0.	*	2	0120	305	0.	*	2	1145	430	0.	*
1	0435	56	242.	*	1	1500	181	0.	*	2	0125	306	0.	*	2	1150	431	0.	*
1	0440	57	240.	*	1	1505	182	0.	*	2	0130	307	0.	*	2	1155	432	0.	*
1	0445	58	237.	*	1	1510	183	0.	*	2	0135	308	0.	*	2	1200	433	0.	*
1	0450	59	245.	*	1	1515	184	0.	*	2	0140	309	0.	*	2	1205	434	0.	*
1	0455	60	248.	*	1	1520	185	0.	*	2	0145	310	0.	*	2	1210	435	0.	*
1	0500	61	232.	*	1	1525	186	0.	*	2	0150	311	0.	*	2	1215	436	0.	*
1	0505	62	209.	*	1	1530	187	0.	*	2	0155	312	0.	*	2	1220	437	0.	*
1	0510	63	182.	*	1	1535	188	0.	*	2	0200	313	0.	*	2	1225	438	0.	*
1	0515	64	155.	*	1	1540	189	0.	*	2	0205	314	0.	*	2	1230	439	0.	*
1	0520	65	128.	*	1	1545	190	0.	*	2	0210	315	0.	*	2	1235	440	0.	*
1	0525	66	104.	*	1	1550	191	0.	*	2	0215	316	0.	*	2	1240	441	0.	*
1	0530	67	85.	*	1	1555	192	0.	*	2	0220	317	0.	*	2	1245	442	0.	*
1	0535	68	67.	*	1	1600	193	0.	*	2	0225	318	0.	*	2	1250	443	0.	*
1	0540	69	54.	*	1	1605	194	0.	*	2	0230	319	0.	*	2	1255	444	0.	*
1	0545	70	47.	*	1	1610	195	0.	*	2	0235	320	0.	*	2	1300	445	0.	*
1	0550	71	41.	*	1	1615	196	0.	*	2	0240	321	0.	*	2	1305	446	0.	*
1	0555	72	34.	*	1	1620	197	0.	*	2	0245	322	0.	*	2	1310	447	0.	*
1	0600	73	30.	*	1	1625	198	0.	*	2	0250	323	0.	*	2	1315	448	0.	*
1	0605	74	26.	*	1	1630	199	0.	*	2	0255	324	0.	*	2	1320	449	0.	*
1	0610	75	21.	*	1	1635	200	0.	*	2	0300	325	0.	*	2	1325	450	0.	*
1	0615	76	17.	*	1	1640	201	0.	*	2	0305	326	0.	*	2	1330	451	0.	*
1	0620	77	13.	*	1	1645	202	0.	*	2	0310	327	0.	*	2	1335	452	0.	*
1	0625	78	10.	*	1	1650	203	0.	*	2	0315	328	0.	*	2	1340	453	0.	*
1	0630	79	7.	*	1	1655	204	0.	*	2	0320	329	0.	*	2	1345	454	0.	*
1	0635	80	5.	*	1	1700	205	0.	*	2	0325	330	0.						

1	0830	103	0.	*	1	1855	228	0.	*	2	0520	353	0.	*	2	1545	478	0.
1	0835	104	0.	*	1	1900	229	0.	*	2	0525	354	0.	*	2	1550	479	0.
1	0840	105	0.	*	1	1905	230	0.	*	2	0530	355	0.	*	2	1555	480	0.
1	0845	106	0.	*	1	1910	231	0.	*	2	0535	356	0.	*	2	1600	481	0.
1	0850	107	0.	*	1	1915	232	0.	*	2	0540	357	0.	*	2	1605	482	0.
1	0855	108	0.	*	1	1920	233	0.	*	2	0545	358	0.	*	2	1610	483	0.
1	0900	109	0.	*	1	1925	234	0.	*	2	0550	359	0.	*	2	1615	484	0.
1	0905	110	0.	*	1	1930	235	0.	*	2	0555	360	0.	*	2	1620	485	0.
1	0910	111	0.	*	1	1935	236	0.	*	2	0600	361	0.	*	2	1625	486	0.
1	0915	112	0.	*	1	1940	237	0.	*	2	0605	362	0.	*	2	1630	487	0.
1	0920	113	0.	*	1	1945	238	0.	*	2	0610	363	0.	*	2	1635	488	0.
1	0925	114	0.	*	1	1950	239	0.	*	2	0615	364	0.	*	2	1640	489	0.
1	0930	115	0.	*	1	1955	240	0.	*	2	0620	365	0.	*	2	1645	490	0.
1	0935	116	0.	*	1	2000	241	0.	*	2	0625	366	0.	*	2	1650	491	0.
1	0940	117	0.	*	1	2005	242	0.	*	2	0630	367	0.	*	2	1655	492	0.
1	0945	118	0.	*	1	2010	243	0.	*	2	0635	368	0.	*	2	1700	493	0.
1	0950	119	0.	*	1	2015	244	0.	*	2	0640	369	0.	*	2	1705	494	0.
1	0955	120	0.	*	1	2020	245	0.	*	2	0645	370	0.	*	2	1710	495	0.
1	1000	121	0.	*	1	2025	246	0.	*	2	0650	371	0.	*	2	1715	496	0.
1	1005	122	0.	*	1	2030	247	0.	*	2	0655	372	0.	*	2	1720	497	0.
1	1010	123	0.	*	1	2035	248	0.	*	2	0700	373	0.	*	2	1725	498	0.
1	1015	124	0.	*	1	2040	249	0.	*	2	0705	374	0.	*	2	1730	499	0.
1	1020	125	0.	*	1	2045	250	0.	*	2	0710	375	0.	*	2	1735	500	0.

PEAK FLOW	TIME		MAXIMUM AVERAGE FLOW	
+	(CFS)	(HR)	6-HR	24-HR
+	817.	3.75	163.	41.
			1.727	1.732
		(INCHES)	81.	81.
		(AC-FT)		
			CUMULATIVE AREA = .88 SQ MI	

HYDROGRAPH AT STATION DB1			
SUM OF 5 HYDROGRAPHS			
PLAN 1, RATIO = .98			

DA	MON	HRMN	ORD	FLOW	DA	MON	HRMN	ORD	FLOW	DA	MON	HRMN	ORD	FLOW	DA	MON	HRMN	ORD	FLOW
1	0000	1	0.	*	1	1025	126	0.	*	1	2050	251	0.	*	2	0715	376	0.	*
1	0005	2	0.	*	1	1030	127	0.	*	1	2055	252	0.	*	2	0720	377	0.	*
1	0010	3	1.	*	1	1035	128	0.	*	1	2100	253	0.	*	2	0725	378	0.	*
1	0015	4	2.	*	1	1040	129	0.	*	1	2105	254	0.	*	2	0730	379	0.	*
1	0020	5	3.	*	1	1045	130	0.	*	1	2110	255	0.	*	2	0735	380	0.	*
1	0025	6	6.	*	1	1050	131	0.	*	1	2115	256	0.	*	2	0740	381	0.	*
1	0030	7	9.	*	1	1055	132	0.	*	1	2120	257	0.	*	2	0745	382	0.	*
1	0035	8	9.	*	1	1100	133	0.	*	1	2125	258	0.	*	2	0750	383	0.	*
1	0040	9	7.	*	1	1105	134	0.	*	1	2130	259	0.	*	2	0755	384	0.	*
1	0045	10	5.	*	1	1110	135	0.	*	1	2135	260	0.	*	2	0800	385	0.	*
1	0050	11	3.	*	1	1115	136	0.	*	1	2140	261	0.	*	2	0805	386	0.	*
1	0055	12	3.	*	1	1120	137	0.	*	1	2145	262	0.	*	2	0810	387	0.	*
1	0100	13	2.	*	1	1125	138	0.	*	1	2150	263	0.	*	2	0815	388	0.	*
1	0105	14	2.	*	1	1130	139	0.	*	1	2155	264	0.	*	2	0820	389	0.	*
1	0110	15	4.	*	1	1135	140	0.	*	1	2200	265	0.	*	2	0825	390	0.	*
1	0115	16	4.	*	1	1140	141	0.	*	1	2205	266	0.	*	2	0830	391	0.	*
1	0120	17	7.	*	1	1145	142	0.	*	1	2210	267	0.	*	2	0835	392	0.	*
1	0125	18	10.	*	1	1150	143	0.	*	1	2215	268	0.	*	2	0840	393	0.	*
1	0130	19	16.	*	1	1155	144	0.	*	1	2220	269	0.	*	2	0845	394	0.	*
1	0135	20	23.	*	1	1200	145	0.	*	1	2225	270	0.	*	2	0850	395	0.	*
1	0140	21	27.	*	1	1205	146	0.	*	1	2230	271	0.	*	2	0855	396	0.	*
1	0145	22	31.	*	1	1210	147	0.	*	1	2235	272	0.	*	2	0900	397	0.	*
1	0150	23	32.	*	1	1215	148	0.	*	1	2240	273	0.	*	2	0905	398	0.	*
1	0155	24	29.	*	1	1220	149	0.	*	1	2245	274	0.	*	2	0910	399	0.	*
1	0200	25	26.	*	1	1225	150	0.	*	1	2250	275	0.	*	2	0915	400	0.	*
1	0205	26	23.	*	1	1230	151	0.	*	1	2255	276	0.	*	2	0920	401	0.	*
1	0210	27	24.	*	1	1235	152	0.	*	1	2300	277	0.	*	2	0925	402	0.	*
1	0215	28	32.	*	1	1240	153	0.	*	1	2305	278	0.	*	2	0930	403	0.	*
1	0220	29	42.	*	1	1245	154	0.	*	1	2310	279	0.	*	2	0935	404	0.	*
1	0225	30	49.	*	1	1250	155	0.	*	1	2315	280	0.	*	2	0940	405	0.	*
1	0230	31	50.	*	1	1255	156	0.	*	1	2320	281	0.	*	2	0945	406	0.	*
1	0235	32	49.	*	1	1300	157	0.	*	1	2325	282	0.	*	2	0950	407	0.	*
1	0240	33	54.	*	1	1305	158	0.	*	1	2330	283	0.	*	2	0955	408	0.	*
1	0245	34	60.	*	1	1310	159	0.	*	1	2335	284	0.	*	2	1000	409	0.	*
1	0250	35	60.	*	1	1315	160	0.	*	1	2340	285	0.	*	2	1005	410	0.	*
1	0255	36	55.	*	1	1320	161	0.	*	1	2345	286	0.	*	2	1010	411	0.	*
1	0300	37	55.	*	1	1325	162	0.	*	1	2350	287	0.	*	2	1015	412	0.	*
1	0305	38	72.	*	1	1330	163	0.	*	1	2355	288	0.	*	2	1020	413	0.	*
1	0310	39	103.	*	1	1335	164	0.	*	2	0000	289	0.	*	2	1025	414	0.	*
1	0315	40	158.	*	1	1340	165	0.	*	2	0005	290	0.	*	2	1030	415	0.	*
1	0320	41	264.	*	1	1345	166	0.	*	2	0010	291	0.	*	2	1035	416	0.	*
1	0325	42	414.	*	1	1350	167	0.	*	2	0015	292	0.	*	2	1040	417	0.	*
1	0330	43	599.	*	1	1355	168	0.	*	2	0020	293	0.	*	2	1045	418	0.	*
1	0335	44	741.	*	1	1400	169	0.	*	2	0025	294	0.	*	2	1050	419	0.	*
1	0340	45	784.	*	1	1405	170	0.	*	2	0030	295	0.	*	2	1055	420	0.	*
1	0345	46	794.	*	1	1410	171	0.	*	2	0035	296	0.	*	2	1100	421	0.	*
1	0350	47	758.	*	1	1415	172	0.	*	2	0040	297	0.	*	2	1105	422	0.	*
1	0355	48	678.	*	1	1420	173	0.	*	2	0045	298	0.	*	2	1110	423	0.	*
1	0400	49	595.	*	1	1425	174	0.	*	2	0050	299	0.	*	2	1115	424	0.	*
1	0405	50	505.	*	1	1430	175	0.	*	2	0055	300	0.	*	2	1120	425	0.	*
1	0410	51	414.	*	1	1435	176	0.	*	2	0100	301	0.	*	2	1125	426	0.	*
1	0415	52	339.	*	1	1440	177	0.	*	2	0105	302	0.	*	2	1130	427	0.	*
1	0420	53	284.	*	1	1445	178	0.	*	2	0110	303	0.	*	2	1135	428	0.	*
1	0425	54	247.	*	1	1450	179	0.	*	2	0115	304	0.	*	2	1140	429	0.	*
1	0430	55	233.	*	1	1455	180	0.	*	2	0120	305	0.	*	2	1145	430	0.	*
1	0435	56	235.	*	1	1500	181	0.	*	2	0125	306	0.	*	2	1150	431	0.	*
1	0440	57	234.	*	1	1505	182	0.	*	2	0130	307	0.	*	2	1155	432	0.	*
1	0445	58	231.	*	1	1510	183	0.	*	2	0135	308	0.	*	2	1200	433	0.	*
1	0450	59	239.	*	1	1515	184	0.	*	2	0140	309	0.	*	2	1205	434	0.	*
1	0455	60	242.	*	1	1520	185	0.	*	2	0145	310	0.	*	2	1210	435	0.	*
1	0500	61	226.	*	1	1525	186	0.	*	2	0150	311	0.	*	2	1215	436	0.	*
1	0505	62	204.	*	1	1530	187	0.	*	2	0155	312	0.	*	2	1220	437	0.	*
1	0510	63	178.	*	1	1535	188	0.	*	2	0200	313	0.	*	2	1225	438	0.	*
1	0515	64	151.	*	1	1540	189	0.	*	2	0205	314	0.	*	2	1230	439	0.	*
1	0520	65	124.	*	1	1545	190	0.	*	2	0210	315	0.	*	2	1235	440	0.	*
1	0525	66	101.	*	1	1550	191	0.	*	2	0215	316	0.	*	2	1240	441	0.	*
1	0530	67	82.	*	1	1555	192	0.	*	2	0220	317	0.	*	2	1245	442	0.	*
1	0535	68	65.	*	1	1600	193	0.	*	2	0225	318	0.	*	2	1250	443	0.	*
1	0540	69	53.	*	1	1605	194	0.	*	2	0230	319	0.	*	2	1255	444	0.	*
1	0545	70	40.	*	1	1610	195	0.	*	2	0235	320	0.	*	2	1300	445	0.	*
1	0550	71	34.	*	1	1615	196	0.	*	2	0240	321	0.	*	2	1305	446	0.	*
1	0555	72	29.	*	1	1620	197	0.	*	2	0245	322	0.	*	2	1310	447	0.	*
1	0600	73	39.	*	1	1625	198	0.	*	2	0250	323	0.	*	2	1315	448	0.	*
1	0605	74	26.	*	1	1630	199	0.	*	2	0255	324	0.	*	2	1320	449	0.	*
1	0610	75	21.	*	1	1635	200	0.	*	2	0300	325	0.	*	2	1325	450	0.	*
1	0615	76	17.	*	1	1640	201	0.	*	2	0305	326	0.	*	2	1330	451	0.	*
1	0620	77	13.	*	1	1645	202	0.	*	2	0310	327	0.	*	2	1335	452	0.	*
1	0625	78	10.	*	1	1650	203	0.	*	2	0315	328	0.	*	2	1340	453	0.	*
1	0630	79	7.	*	1	1655	204	0.	*	2	0320	329	0.	*	2	1345	454	0.	*
1	0635	80	5.	*	1	1700	205	0.	*	2	0325	330	0.	*	2	1350	455	0.	*
1	0640	81	3.	*	1	1705	206	0.	*	2	0330	331	0.	*	2	1355	456	0.	*
1	0645	82	3.	*	1	1710	207	0.	*	2	0335	332	0.	*	2	1400	457	0.	*
1	0650	83	1.	*	1	1715	208	0.	*	2	0340	333	0.	*	2	1405	458	0.	*
1	0655	84	1.	*	1	1720	209	0.	*	2	0345	334	0.	*	2	1410	459	0.	*
1	0700	85	1.	*	1	1725	210	0.	*	2	0350	335	0.	*	2	1415	460	0.	*
1	0705	86	0.	*	1	1730	211	0.	*	2	0355	336	0.	*	2	1420	461	0.	*
1	0710	87	0.	*	1	1735	212	0.	*	2	0400	337	0.	*	2	1425	462	0.	*
1	0715	88	0.	*	1	1740	213	0.	*	2	0405	338	0.	*	2	1430	463	0.	*
1	0720	89	0.	*	1	1745	214	0.	*	2	0410	339	0.	*	2	1435	464	0.	*
1	0725	90	0.	*	1	1750	215	0.	*	2	0415	340	0.	*	2	1440	465	0.	*

ULT1.GUT													
1	0730	91	0.	*	1	1755	216	0.	*	2	0420	341	0.
1	0735	92	0.	*	1	1800	217	0.	*	2	0425	342	0.
1	0740	93	0.	*	1	1805	218	0.	*	2	0430	343	0.
1	0745	94	0.	*	1	1810	219	0.	*	2	0435	344	0.
1	0750	95	0.	*	1	1815	220	0.	*	2	0440	345	0.
1	0755	96	0.	*	1	1820	221	0.	*	2	0445	346	0.
1	0800	97	0.	*	1	1825	222	0.	*	2	0450	347	0.
1	0805	98	0.	*	1	1830	223	0.	*	2	0455	348	0.
1	0810	99	0.	*	1	1835	224	0.	*	2	0500	349	0.
1	0815	100	0.	*	1	1845	225	0.	*	2	0505	350	0.
1	0820	101	0.	*	1	1840	226	0.	*	2	0510	351	0.
1	0825	102	0.	*	1	1850	227	0.	*	2	0515	352	0.
1	0830	103	0.	*	1	1855	228	0.	*	2	0520	353	0.
1	0835	104	0.	*	1	1900	229	0.	*	2	0525	354	0.
1	0840	105	0.	*	1	1905	230	0.	*	2	0530	355	0.
1	0845	106	0.	*	1	1910	231	0.	*	2	0535	356	0.
1	0850	107	0.	*	1	1915	232	0.	*	2	0540	357	0.
1	0855	108	0.	*	1	1920	233	0.	*	2	0545	358	0.
1	0900	109	0.	*	1	1925	234	0.	*	2	0550	359	0.
1	0905	110	0.	*	1	1930	235	0.	*	2	0555	360	0.
1	0910	111	0.	*	1	1935	236	0.	*	2	0600	361	0.
1	0915	112	0.	*	1	1940	237	0.	*	2	0605	362	0.
1	0920	113	0.	*	1	1945	238	0.	*	2	0610	363	0.
1	0925	114	0.	*	1	1950	239	0.	*	2	0615	364	0.
1	0930	115	0.	*	1	1955	240	0.	*	2	0620	365	0.
1	0935	116	0.	*	1	2000	241	0.	*	2	0625	366	0.
1	0940	117	0.	*	1	2005	242	0.	*	2	0630	367	0.
1	0945	118	0.	*	1	2010	243	0.	*	2	0635	368	0.
1	0950	119	0.	*	1	2015	244	0.	*	2	0640	369	0.
1	0955	120	0.	*	1	2020	245	0.	*	2	0645	370	0.
1	1000	121	0.	*	1	2025	246	0.	*	2	0650	371	0.
1	1005	122	0.	*	1	2030	247	0.	*	2	0655	372	0.
1	1010	123	0.	*	1	2035	248	0.	*	2	0700	373	0.
1	1015	124	0.	*	1	2040	249	0.	*	2	0705	374	0.
1	1020	125	0.	*	1	2045	250	0.	*	2	0710	375	0.

PEAK FLOW		TIME	MAXIMUM AVERAGE FLOW			
+ (CFS)		(HR)	6-HR	24-HR	72-HR	41.58-HR
+ 794.		3.75	158.	40.	23.	23.
		(INCHES)	1.675	1.680	1.680	1.680
		(AC-FT)	78.	79.	79.	79.
		CUMULATIVE AREA =	.88 SQ MI			

89 KK RDB1 *

91 KO OUTPUT CONTROL VARIABLES
IPRNT 1 PRINT CONTROL
IPLOT 0 PLOT CONTROL
QSCAL 0 HYDROGRAPH PLOT SCALE

HYDROGRAPH ROUTING DATA

92 RS		STORAGE ROUTING	1	NUMBER OF SUBREACHES	
		NSTPS	VOL	TYPE OF INITIAL CONDITION	
		ITYP	-1.00	INITIAL CONDITION	
		RSVRIC	.00	WORKING R AND D COEFFICIENT	
		X			
93 SV	STORAGE	.0	7.8	13.4	19.3
94 SE	ELEVATION	25.50	27.00	28.00	29.00
95 SQ	DISCHARGE	0.	26.	36.	44.
96 SE	ELEVATION	25.50	29.00	30.00	31.00

COMPUTED STORAGE-OUTFLOW-ELEVATION DATA

STORAGE	.00	7.78	13.43	19.26	25.72	32.18	58.03	73.30	80.94	96.21
OUTFLOW	.00	10.97	18.28	25.59	36.20	44.33	65.96	76.78	335.94	1413.68
ELEVATION	25.50	27.00	28.00	29.00	30.00	31.00	35.00	37.00	38.00	40.00
STORAGE	114.21	132.22								
OUTFLOW	2946.76	4825.05								
ELEVATION	42.00	44.00								

HYDROGRAPH AT STATION RDB1
PLAN 1, RATIO = 1.00

DA	MON	HRMN	ORD	OUTFLOW	STORAGE	STAGE	DA	MON	HRMN	ORD	OUTFLOW	STORAGE	STAGE
1	0000	1	0.	.0	25.5	*	1	1355	168	42.	30.2	30.7	2
1	0005	2	0.	.0	25.5	*	1	1400	169	42.	30.0	30.7	2
1	0010	3	0.	.0	25.5	*	1	1405	170	41.	29.7	30.6	2
1	0015	4	0.	.0	25.5	*	1	1410	171	41.	29.4	30.6	2
1	0020	5	0.	.0	25.5	*	1	1415	172	40.	29.1	30.5	2
1	0025	6	0.	.1	25.5	*	1	1420	173	40.	28.8	30.5	2
1	0030	7	0.	.1	25.5	*	1	1425	174	40.	28.6	30.4	2
1	0035	8	0.	.2	25.5	*	1	1430	175	39.	28.3	30.4	2
1	0040	9	0.	.3	25.5	*	1	1435	176	39.	28.0	30.4	2
1	0045	10	0.	.3	25.5	*	1	1440	177	39.	27.7	30.3	2
1	0050	11	0.	.3	25.5	*	1	1445	178	38.	27.5	30.3	2
1	0055	12	0.	.3	25.5	*	1	1450	179	38.	27.2	30.2	2
1	0100	13	0.	.3	25.5	*	1	1455	180	38.	26.7	30.2	2
1	0105	14	1.	.4	25.5	*	1	1500	181	37.	26.4	30.1	2
1	0110	15	1.	.4	25.5	*	1	1505	182	37.	26.2	30.1	2
1	0115	16	1.	.4	25.5	*	1	1510	183	37.	25.9	30.0	2
1	0120	17	1.	.5	25.5	*	1	1515	184	36.	25.7	30.0	2
1	0125	18	1.	.5	25.5	*	1	1520	185	36.	25.4	30.0	2
1	0130	19	1.	.6	25.5	*	1	1525	186	36.	25.2	29.9	2
1	0135	20	1.	.7	25.5	*	1	1530	187	35.	24.9	29.9	2
1	0140	21	1.	.9	25.5	*	1	1535	188	35.	24.7	29.8	2
1	0145	22	2.	1.1	25.7	*	1	1540	189	34.	24.5	29.8	2
1	0150	23	2.	1.3	25.8	*	1	1545	190	34.	24.2	29.8	2
1	0155	24	2.	1.5	25.8	*	1	1550	191	34.	24.0	29.7	2
1	0200	25	2.	1.7	25.8	*	1	1555	192	33.	23.8	29.7	2
1	0205	26	3.	1.9	25.9	*	1	1600	193	33.	23.5	29.7	2
1	0210	27	3.	2.0	25.9	*	1	1605	194	32.	23.3	29.6	2
1	0215	28	3.	2.2	25.9	*	1	1610	195	32.	23.1	29.6	2
1	0220	29	3.	2.5	26.0	*	1	1615	196	32.	22.9	29.6	2
1	0225	30	4.	2.8	26.1	*	1	1620	197	31.	22.7	29.5	2
1	0230	31	4.	3.1	26.2	*	1	1625	198	31.	22.5	29.5	2
1	0235	32	5.	3.4	26.2	*	1	1630	199	30.	22.2	29.5	2
1	0240	33	5.	3.8	26.3	*	1	1635	200	30.	22.0	29.4	2
1	0245	34	6.	4.1	26.3	*	1	1640	201	30.	21.8	29.4	2
1	0250	35	6.	4.5	26.4	*	1	1645	202	30.			

										ULT1.OUT									
1	0255	36	7.	4.9	26.4	*	1	1650	203	29.	21.6	29.4	*	2	0645	370	6.	4.4	26.4
1	0300	37	7.	5.2	26.5	*	1	1655	204	29.	21.4	29.3	*	2	0650	371	6.	4.4	26.3
1	0305	38	8.	5.6	26.6	*	1	1700	205	29.	21.2	29.3	*	2	0655	372	6.	4.3	26.3
1	0310	39	9.	6.2	26.7	*	1	1705	206	28.	21.0	29.3	*	2	0700	373	6.	4.3	26.3
1	0315	40	10.	7.1	26.9	*	1	1710	207	28.	20.8	29.2	*	2	0705	374	6.	4.2	26.3
1	0320	41	12.	8.5	27.1	*	1	1715	208	28.	20.6	29.2	*	2	0710	375	6.	4.1	26.3
1	0325	42	15.	10.8	27.5	*	1	1720	209	28.	20.4	29.2	*	2	0715	376	6.	4.1	26.3
1	0330	43	19.	14.3	28.2	*	1	1725	210	27.	20.3	29.2	*	2	0720	377	6.	4.1	26.3
1	0335	44	25.	18.9	28.9	*	1	1730	211	27.	20.1	29.1	*	2	0725	378	6.	4.1	26.3
1	0340	45	34.	24.1	29.8	*	1	1735	212	27.	19.9	29.1	*	2	0730	379	6.	4.0	26.3
1	0345	46	41.	29.5	30.6	*	1	1740	213	26.	19.7	29.1	*	2	0735	380	6.	4.0	26.3
1	0350	47	46.	34.7	31.4	*	1	1745	214	26.	19.5	29.0	*	2	0740	381	6.	3.9	26.3
1	0355	48	50.	39.4	32.1	*	1	1750	215	25.	19.3	29.0	*	2	0745	382	5.	3.9	26.2
1	0400	49	54.	43.6	32.8	*	1	1755	216	25.	19.2	29.0	*	2	0750	383	5.	3.9	26.2
1	0405	50	57.	47.1	33.3	*	1	1800	217	25.	19.0	29.0	*	2	0755	384	5.	3.8	26.2
1	0410	51	59.	49.9	33.7	*	1	1805	218	25.	18.8	28.9	*	2	0800	385	5.	3.8	26.2
1	0415	52	61.	52.2	34.1	*	1	1810	219	25.	18.7	28.9	*	2	0805	386	5.	3.7	26.2
1	0420	53	63.	54.0	34.4	*	1	1815	220	25.	18.5	28.9	*	2	0810	387	5.	3.7	26.2
1	0425	54	64.	55.4	34.6	*	1	1820	221	24.	18.3	28.8	*	2	0815	388	5.	3.6	26.2
1	0430	55	65.	56.7	34.8	*	1	1825	222	24.	18.1	28.8	*	2	0820	389	5.	3.6	26.2
1	0435	56	66.	57.9	35.0	*	1	1830	223	24.	17.8	28.8	*	2	0825	390	5.	3.6	26.2
1	0440	57	67.	59.1	35.3	*	1	1835	224	24.	17.7	28.7	*	2	0830	391	5.	3.6	26.2
1	0445	58	68.	60.3	35.5	*	1	1840	225	24.	17.5	28.7	*	2	0835	392	5.	3.5	26.2
1	0450	59	68.	61.5	35.4	*	1	1845	226	23.	17.3	28.7	*	2	0840	393	5.	3.5	26.2
1	0455	60	69.	62.7	35.6	*	1	1850	227	23.	17.2	28.6	*	2	0845	394	5.	3.5	26.2
1	0500	61	70.	63.9	35.8	*	1	1855	228	23.	17.0	28.6	*	2	0850	395	5.	3.4	26.2
1	0505	62	71.	64.9	35.9	*	1	1900	229	23.	16.9	28.6	*	2	0855	396	5.	3.4	26.2
1	0510	63	71.	65.8	36.0	*	1	1905	230	22.	16.7	28.6	*	2	0900	397	5.	3.4	26.1
1	0515	64	72.	66.4	36.1	*	1	1910	231	22.	16.5	28.5	*	2	0905	398	5.	3.4	26.1
1	0520	65	72.	66.9	36.2	*	1	1915	232	22.	16.4	28.5	*	2	0910	399	5.	3.3	26.1
1	0525	66	72.	67.2	36.2	*	1	1920	233	22.	16.2	28.5	*	2	0915	400	5.	3.3	26.1
1	0530	67	73.	67.3	36.2	*	1	1925	234	22.	16.1	28.5	*	2	0920	401	5.	3.2	26.1
1	0535	68	73.	67.4	36.2	*	1	1930	235	21.	15.9	28.4	*	2	0925	402	5.	3.2	26.1
1	0540	69	73.	67.5	36.2	*	1	1935	236	21.	15.8	28.4	*	2	0930	403	5.	3.2	26.1
1	0545	70	72.	67.1	36.2	*	1	1940	237	21.	15.7	28.4	*	2	0935	404	4.	3.2	26.1
1	0550	71	72.	66.9	36.2	*	1	1945	238	21.	15.5	28.4	*	2	0940	405	4.	3.1	26.1
1	0555	72	72.	66.7	36.1	*	1	1950	239	21.	15.4	28.4	*	2	0945	406	4.	3.1	26.1
1	0600	73	72.	66.4	36.1	*	1	1955	240	21.	15.2	28.3	*	2	0950	407	4.	3.1	26.1
1	0605	74	72.	66.1	36.1	*	1	2000	241	21.	15.1	28.3	*	2	0955	408	4.	3.0	26.1
1	0610	75	71.	65.8	36.0	*	1	2005	242	20.	14.9	28.3	*	2	1000	409	4.	3.0	26.1
1	0615	76	71.	65.4	36.0	*	1	2010	243	20.	14.8	28.2	*	2	1005	410	4.	3.0	26.1
1	0620	77	71.	65.0	35.9	*	1	2015	244	20.	14.7	28.2	*	2	1010	411	4.	2.9	26.1
1	0625	78	71.	64.6	35.9	*	1	2020	245	20.	14.5	28.2	*	2	1015	412	4.	2.9	26.1
1	0630	79	70.	64.2	35.8	*	1	2025	246	19.	14.4	28.2	*	2	1020	413	4.	2.9	26.1
1	0635	80	70.	63.8	35.8	*	1	2030	247	19.	14.3	28.1	*	2	1025	414	4.	2.9	26.1
1	0640	81	70.	63.3	35.7	*	1	2035	248	19.	14.1	28.1	*	2	1030	415	4.	2.8	26.0
1	0645	82	69.	62.9	35.6	*	1	2040	249	19.	14.0	28.1	*	2	1035	416	4.	2.8	26.0
1	0650	83	69.	62.4	35.6	*	1	2045	250	19.	13.9	28.1	*	2	1040	417	4.	2.8	26.0
1	0655	84	69.	61.9	35.5	*	1	2050	251	19.	13.7	28.1	*	2	1045	418	4.	2.7	26.0
1	0700	85	68.	61.5	35.5	*	1	2055	252	19.	13.6	28.0	*	2	1050	419	4.	2.7	26.0
1	0705	86	68.	61.0	35.4	*	1	2100	253	19.	13.5	28.0	*	2	1055	420	4.	2.7	26.0
1	0710	87	68.	60.6	35.3	*	1	2105	254	18.	13.4	28.0	*	2	1100	421	4.	2.7	26.0
1	0715	88	67.	60.1	35.3	*	1	2110	255	18.	13.2	27.9	*	2	1105	422	4.	2.6	26.0
1	0720	89	67.	59.6	35.2	*	1	2115	256	18.	13.1	27.9	*	2	1110	423	4.	2.6	26.0
1	0725	90	67.	59.2	35.1	*	1	2120	257	18.	13.0	27.9	*	2	1115	424	4.	2.6	26.0
1	0730	91	66.	58.7	35.0	*	1	2125	258	18.	12.9	27.9	*	2	1120	425	4.	2.6	26.0
1	0735	92	66.	58.3	35.0	*	1	2130	259	18.	12.7	27.9	*	2	1125	426	4.	2.6	26.0
1	0740	93	66.	57.8	35.0	*	1	2135	260	17.	12.6	27.9	*	2	1130	427	4.	2.5	26.0
1	0745	94	65.	57.4	34.9	*	1	2140	261	17.	12.5	27.8	*	2	1135	428	4.	2.5	26.0
1	0750	95	65.	56.9	34.8	*	1	2145	262	17.	12.4	27.8	*	2	1140	429	4.	2.5	26.0
1	0755	96	65.	56.5	34.8	*	1	2150	263	17.	12.3	27.8	*	2	1145	430	3.	2.5	26.0
1	0800	97	64.	56.0	34.7	*	1	2155	264	17.	12.2	27.8	*	2	1150	431	3.	2.4	26.0
1	0805	98	64.	55.6	34.6	*	1	2200	265	17.	12.0	27.8	*	2	1155	432	3.	2.4	26.0
1	0810	99	64.	55.1	34.6	*	1	2205	266	16.	11.9	27.7	*	2	1200	433	3.	2.4	26.0
1	0815	100	63.	54.7	34.5	*	1	2210	267	16.	11.8	27.7	*	2	1205	434	3.	2.4	26.0
1	0820	101	63.	54.3	34.4	*	1	2215	268	16.	11.7	27.7	*	2	1210	435	3.	2.3	25.9
1	0825	102	62.	53.8	34.4	*	1	2220	269	16.	11.6	27.7	*	2	1215	436	3.	2.3	25.9
1	0830	103	62.	53.4	34.3	*	1	2225	270	16.	11.5	27.7	*	2	1220	437	3.	2.3	25.9
1	0835	104	62.	53.0	34.2	*	1	2230	271	16.	11.4	27.6	*	2	1225	438	3.	2.3	25.9
1	0840	105	61.	52.6	34.2	*	1	2235	272	16.	11.3	27.6	*	2	1230	439	3.	2.2	25.9
1	0845	106	61.	52.1	34.1	*	1	2240	273	15.	11.2	27.6	*	2	1235	440	3.	2.2	25.9
1	0850	107	60.	51.7	34.0	*	1	2245	274	15.	11.1	27.6	*	2	1240	441	3.	2.2	25.9
1	0855	108	60.	51.3	34.0	*	1	2250	275	15.	11.0	27.6	*	2	1245	442	3.	2.2	25.9
1	0900	109	60.	50.9	33.9	*	1	2255	276	15.	10.8	27.5	*	2	1250	443	3.	2.2	25.9
1	0905	110	60.	50.5	33.8	*	1	2300	277	15.	10.7	27.5	*	2	1255	444	3.	2.1	25.9
1	0910	111	59.	50.1	33.8	*	1	2305	278	15.	10.6	27.5	*	2	1300	445	3.	2.1	25.9
1	0915	112	59.	49.7	33.7	*	1	2310	279	15.	10.5	27.5	*	2	1305	446	3.	2.1	25.9
1	0920	113	59.	49.2	33.6	*	1	2315	280	15.	10.4	27.5	*	2	1310	447	3.	2.1	25.9
1	0925	114	58.	48.8	33.5	*	1	2320	281										

ULT1.OUT

+	(CFS)	(HR)	(CFS)	65.	37.	23.	23.
+	73.	5.58	(INCHES)	.693	1.576	1.706	1.706
			(AC-FT)	32.	74.	80.	80.
PEAK STORAGE	TIME			6-HR	MAXIMUM AVERAGE 24-HR	STORAGE 72-HR	41.58-HR
+	(AC-FT)	(HR)		58.	30.	19.	19.
	67.	5.58					
PEAK STAGE	TIME			6-HR	MAXIMUM AVERAGE 24-HR	STAGE 72-HR	41.58-HR
+	(FEET)	(HR)		34.91	30.59	28.68	28.68
	36.22	5.58					
CUMULATIVE AREA =				.88 SQ MI			

 HYDROGRAPH AT STATION RDB1
 PLAN 1, RATIO = .98

* *										* *													
DA	MON	HR	MIN	ORD	OUTFLOW	STORAGE	STAGE	DA	MON	HR	MIN	ORD	OUTFLOW	STORAGE	STAGE	DA	MON	HR	MIN	ORD	OUTFLOW	STORAGE	STAGE
1	40	0000	1	0.	0.	0	25.5	1	1355	168	40.	29.0	30.5	2	0350	335	8.	6.0	26.6				
1	0005	2	0.	0.	0	25.5	1	1400	169	40.	28.8	30.5	2	0355	336	8.	5.9	26.6					
1	0010	3	0.	0.	0	25.5	1	1405	170	40.	28.5	30.4	2	0400	337	8.	5.8	26.6					
1	0015	4	0.	0.	0	25.5	1	1410	171	39.	28.2	30.4	2	0405	338	8.	5.7	26.6					
1	0020	5	0.	0.	0	25.5	1	1415	172	39.	27.9	30.3	2	0410	339	8.	5.7	26.6					
1	0025	6	0.	0.	0	25.5	1	1420	173	39.	27.7	30.3	2	0415	340	8.	5.7	26.6					
1	0030	7	0.	0.	0	25.5	1	1425	174	38.	27.4	30.2	2	0420	341	8.	5.6	26.6					
1	0035	8	0.	0.	0	25.5	1	1430	175	38.	27.1	30.2	2	0425	342	8.	5.6	26.6					
1	0040	9	0.	0.	0	25.5	1	1435	176	38.	26.9	30.2	2	0430	343	8.	5.5	26.6					
1	0045	10	0.	0.	0	25.6	1	1440	177	37.	26.6	30.1	2	0435	344	8.	5.5	26.6					
1	0050	11	0.	0.	0	25.6	1	1445	178	37.	26.4	30.1	2	0440	345	8.	5.4	26.5					
1	0055	12	0.	0.	0	25.6	1	1450	179	37.	26.1	30.1	2	0445	346	7.	5.3	26.5					
1	0100	13	0.	0.	0	25.6	1	1455	180	36.	25.9	30.0	2	0450	347	7.	5.2	26.5					
1	0105	14	0.	0.	0	25.6	1	1500	181	36.	25.6	30.0	2	0455	348	7.	5.2	26.5					
1	0110	15	0.	0.	0	25.6	1	1505	182	36.	25.4	29.9	2	0500	349	7.	5.1	26.5					
1	0115	16	0.	0.	0	25.6	1	1510	183	35.	25.1	29.9	2	0505	350	7.	5.1	26.5					
1	0120	17	1.	0.	0	25.6	1	1515	184	35.	24.9	29.9	2	0510	351	7.	5.0	26.5					
1	0125	18	1.	0.	0	25.6	1	1520	185	34.	24.6	29.8	2	0515	352	7.	5.0	26.5					
1	0130	19	1.	0.	0	25.6	1	1525	186	34.	24.4	29.8	2	0520	353	7.	5.0	26.5					
1	0135	20	1.	0.	0	25.6	1	1530	187	34.	24.2	29.8	2	0525	354	7.	4.9	26.4					
1	0140	21	1.	0.	0	25.7	1	1535	188	33.	23.9	29.7	2	0530	355	7.	4.9	26.4					
1	0145	22	1.	0.	0	25.7	1	1540	189	33.	23.7	29.7	2	0535	356	7.	4.8	26.4					
1	0150	23	2.	1.	0	25.7	1	1545	190	33.	23.5	29.7	2	0540	357	7.	4.8	26.4					
1	0155	24	2.	1.	0	25.8	1	1550	191	32.	23.3	29.6	2	0545	358	7.	4.7	26.4					
1	0200	25	2.	1.	0	25.8	1	1555	192	32.	23.0	29.6	2	0550	359	7.	4.7	26.4					
1	0205	26	2.	1.	0	25.8	1	1600	193	31.	22.8	29.6	2	0555	360	7.	4.7	26.4					
1	0210	27	3.	1.	0	25.9	1	1605	194	31.	22.6	29.5	2	0600	361	7.	4.6	26.4					
1	0215	28	3.	1.	0	25.9	1	1610	195	31.	22.4	29.5	2	0605	362	6.	4.6	26.4					
1	0220	29	3.	1.	0	25.9	1	1615	196	30.	22.2	29.5	2	0610	363	6.	4.5	26.4					
1	0225	30	4.	1.	0	26.0	1	1620	197	30.	22.0	29.4	2	0615	364	6.	4.5	26.4					
1	0230	31	4.	1.	0	26.1	1	1625	198	30.	21.8	29.4	2	0620	365	6.	4.5	26.4					
1	0235	32	5.	1.	0	26.1	1	1630	199	29.	21.6	29.4	2	0625	366	6.	4.4	26.4					
1	0240	33	5.	1.	0	26.2	1	1635	200	29.	21.4	29.3	2	0630	367	6.	4.4	26.4					
1	0245	34	6.	1.	0	26.3	1	1640	201	29.	21.2	29.3	2	0635	368	6.	4.3	26.3					
1	0250	35	6.	1.	0	26.3	1	1645	202	28.	21.0	29.2	2	0640	369	6.	4.3	26.3					
1	0255	36	7.	1.	0	26.4	1	1650	203	28.	20.8	29.2	2	0645	370	6.	4.2	26.3					
1	0300	37	7.	1.	0	26.5	1	1655	204	28.	20.6	29.2	2	0650	371	6.	4.2	26.3					
1	0305	38	8.	1.	0	26.5	1	1700	205	27.	20.4	29.2	2	0655	372	6.	4.2	26.3					
1	0310	39	8.	1.	0	26.6	1	1705	206	27.	20.2	29.1	2	0700	373	6.	4.1	26.3					
1	0315	40	10.	1.	0	26.8	1	1710	207	27.	20.0	29.1	2	0705	374	6.	4.1	26.3					
1	0320	41	11.	1.	0	27.1	1	1715	208	27.	19.8	29.1	2	0710	375	6.	4.0	26.3					
1	0325	42	14.	1.	0	27.5	1	1720	209	26.	19.7	29.1	2	0715	376	6.	4.0	26.3					
1	0330	43	19.	1.	0	28.1	1	1725	210	26.	19.5	29.0	2	0720	377	6.	4.0	26.3					
1	0335	44	24.	1.	0	28.8	1	1730	211	26.	19.3	29.0	2	0725	378	6.	3.9	26.2					
1	0340	45	32.	1.	0	29.6	1	1735	212	25.	19.1	29.0	2	0730	379	5.	3.8	26.2					
1	0345	46	40.	1.	0	28.5	1	1740	213	25.	19.0	28.9	2	0735	380	5.	3.8	26.2					
1	0350	47	45.	1.	0	31.2	1	1745	214	25.	18.8	28.9	2	0740	381	5.	3.8	26.2					
1	0355	48	49.	1.	0	31.9	1	1750	215	25.	18.6	28.9	2	0745	382	5.	3.8	26.2					
1	0400	49	53.	1.	0	32.5	1	1755	216	25.	18.4	28.9	2	0750	383	5.	3.7	26.2					
1	0405	50	56.	1.	0	33.1	1	1800	217	24.	18.3	28.8	2	0755	384	5.	3.7	26.2					
1	0410	51	58.	1.	0	34.3	1	1805	218	24.	18.1	28.8	2	0800	385	5.	3.6	26.2					
1	0415	52	60.	1.	0	35.0	1	1810	219	24.	17.9	28.8	2	0805	386	5.	3.6	26.2					
1	0420	53	61.	1.	0	34.1	1	1815	220	24.	17.8	28.7	2	0810	387	5.	3.6	26.2					
1	0425	54	62.	1.	0	34.3	1	1820	221	24.	17.6	28.7	2	0815	388	5.	3.6	26.2					
1	0430	55	63.	1.	0	34.5	1	1825	222	23.	17.5	28.7	2	0820	389	5.	3.5	26.2					
1	0435	56	64.	1.	0	34.7	1	1830	223	23.	17.3	28.7	2	0825	390	5.	3.5	26.2					
1	0440	57	65.	1.	0	34.9	1	1835	224	23.	17.1	28.6	2	0830	391	5.	3.4	26.2					
1	0445	58	66.	1.	0	35.0	1	1840	225	23.	17.0	28.6	2	0835	392	5.	3.4	26.2					
1	0450	59	67.	1.	0	35.2	1	1845	226	23.	16.8	28.6	2	0840	393	5.	3.4	26.2					
1	0455	60	68.	1.	0	35.4	1	1850	227	22.	16.7	28.6	2	0845	394	5.	3.4	26.2					
1	0500	61	69.	1.	0	35.5	1	1855	228	22.	16.5	28.5	2	0850	395	5.	3.3	26.1					
1	0505	62	69.	1.	0	35.6	1	1900	229	22.	16.4	28.5	2	0855	396	5.	3.3	26.1					
1	0510	63	70.	1.	0	35.7	1	1905	230	22.	16.2	28.5	2	0900	397	5.	3.3	26.1					
1	0515	64	70.	1.	0	35.8	1	1910	231	22.	16.1	28.5	2	0905	398	5.	3.2	26.1					
1	0520	65	71.	1.	0	35.9	1	1915	232	21.	15.9	28.4	2	0910	399	5.	3.2	26.1					
1	0525	66	71.	1.	0	35.9	1	1920	233	21.	15.8	28.4	2	0915	400	4.	3.1	26.1					
1	0530	67	71.	1.	0	35.9	1	1925	234	21.	15.6	28.4	2	0920	401	4.	3.1	26.1					
1	0535	68	71.	1.	0	35.9	1	1930	235	21.	15.5	28.4	2	0925	402	4.	3.1	26.1					
1	0540	69	71.	1.	0	35.9	1	1935	236	21.	15.3	28.3	2	0930	403	4.	3.1	26.1					
1	0545	70	71.	1.	0	35.9	1	1940	237	20.	15.2	28.3	2	0935	404	4.	3.0	26.1					
1	0550	71	71.	1.	0	35.9	1	1945	238														

														ULT1.OUT					
1	0905	110	58.	48.7	33.6	*	1	2300	277	14.	10.4	27.5	*	2	1255	444	3.	2.1	25.9
1	0910	111	58.	48.3	33.5	*	1	2305	278	14.	10.3	27.5	*	2	1300	445	3.	2.0	25.9
1	0915	112	58.	47.9	33.4	*	1	2310	279	14.	10.2	27.4	*	2	1305	446	3.	2.0	25.9
1	0920	113	57.	47.6	33.4	*	1	2315	280	14.	10.1	27.4	*	2	1310	447	3.	2.0	25.9
1	0925	114	57.	47.2	33.3	*	1	2320	281	14.	10.0	27.4	*	2	1315	448	3.	2.0	25.9
1	0930	115	57.	46.8	33.3	*	1	2325	282	14.	9.9	27.4	*	2	1320	449	3.	2.0	25.9
1	0935	116	56.	46.4	33.2	*	1	2330	283	14.	9.9	27.4	*	2	1325	450	3.	2.0	25.9
1	0940	117	56.	46.0	33.1	*	1	2335	284	14.	9.8	27.3	*	2	1330	451	3.	1.9	25.9
1	0945	118	56.	45.6	33.1	*	1	2340	285	13.	9.7	27.3	*	2	1335	452	3.	1.9	25.9
1	0950	119	55.	45.2	33.0	*	1	2345	286	13.	9.6	27.3	*	2	1340	453	3.	1.9	25.9
1	0955	120	55.	44.8	33.0	*	1	2350	287	13.	9.5	27.3	*	2	1345	454	3.	1.9	25.9
1	1000	121	55.	44.5	32.9	*	1	2355	288	13.	9.4	27.3	*	2	1350	455	3.	1.8	25.9
1	1005	122	54.	44.1	32.8	*	2	0000	289	13.	9.3	27.3	*	2	1355	456	3.	1.8	25.9
1	1010	123	54.	43.7	32.8	*	2	0005	290	13.	9.2	27.3	*	2	1400	457	3.	1.8	25.8
1	1015	124	54.	43.4	32.7	*	2	0010	291	13.	9.1	27.2	*	2	1405	458	3.	1.8	25.8
1	1020	125	53.	43.0	32.7	*	2	0015	292	12.	9.0	27.2	*	2	1410	459	3.	1.8	25.8
1	1025	126	53.	42.6	32.6	*	2	0020	293	12.	8.9	27.2	*	2	1415	460	2.	1.8	25.8
1	1030	127	53.	42.3	32.6	*	2	0025	294	12.	8.8	27.2	*	2	1420	461	2.	1.7	25.8
1	1035	128	52.	41.9	32.5	*	2	0030	295	12.	8.7	27.2	*	2	1425	462	2.	1.7	25.8
1	1040	129	52.	41.5	32.4	*	2	0035	296	12.	8.6	27.2	*	2	1430	463	2.	1.7	25.8
1	1045	130	52.	41.2	32.4	*	2	0040	297	12.	8.5	27.1	*	2	1435	464	2.	1.7	25.8
1	1050	131	52.	40.8	32.3	*	2	0045	298	12.	8.4	27.1	*	2	1440	465	2.	1.7	25.8
1	1055	132	51.	40.5	32.2	*	2	0050	299	12.	8.3	27.1	*	2	1445	466	2.	1.7	25.8
1	1100	133	51.	40.1	32.2	*	2	0055	300	12.	8.2	27.1	*	2	1450	467	2.	1.7	25.8
1	1105	134	51.	39.8	32.2	*	2	0100	301	12.	8.1	27.1	*	2	1455	468	2.	1.6	25.8
1	1110	135	50.	39.4	32.1	*	2	0105	302	12.	8.0	27.1	*	2	1500	469	2.	1.6	25.8
1	1115	136	50.	39.1	32.1	*	2	0110	303	11.	8.1	27.1	*	2	1505	470	2.	1.6	25.8
1	1120	137	50.	38.7	32.0	*	2	0115	304	11.	8.1	27.0	*	2	1510	471	2.	1.6	25.8
1	1125	138	50.	38.4	32.0	*	2	0120	305	11.	8.0	27.0	*	2	1515	472	2.	1.6	25.8
1	1130	139	49.	38.0	31.9	*	2	0125	306	11.	7.9	27.0	*	2	1520	473	2.	1.5	25.8
1	1135	140	49.	37.7	31.9	*	2	0130	307	11.	7.8	27.0	*	2	1525	474	2.	1.5	25.8
1	1140	141	49.	37.4	31.8	*	2	0135	308	11.	7.7	27.0	*	2	1530	475	2.	1.5	25.8
1	1145	142	48.	37.0	31.8	*	2	0140	309	11.	7.6	27.0	*	2	1535	476	2.	1.5	25.8
1	1150	143	48.	36.7	31.7	*	2	0145	310	11.	7.5	27.0	*	2	1540	477	2.	1.5	25.8
1	1155	144	48.	36.4	31.6	*	2	0150	311	11.	7.4	26.9	*	2	1545	478	2.	1.5	25.8
1	1200	145	48.	36.0	31.6	*	2	0155	312	11.	7.4	26.9	*	2	1550	479	2.	1.5	25.8
1	1205	146	47.	35.7	31.5	*	2	0200	313	10.	7.3	26.9	*	2	1555	480	2.	1.4	25.8
1	1210	147	47.	35.4	31.5	*	2	0205	314	10.	7.2	26.9	*	2	1600	481	2.	1.4	25.8
1	1215	148	47.	35.1	31.4	*	2	0210	315	10.	7.2	26.9	*	2	1605	482	2.	1.4	25.8
1	1220	149	46.	34.7	31.4	*	2	0215	316	10.	7.1	26.9	*	2	1610	483	2.	1.4	25.8
1	1225	150	46.	34.4	31.3	*	2	0220	317	10.	7.0	26.9	*	2	1615	484	2.	1.4	25.8
1	1230	151	46.	34.1	31.3	*	2	0225	318	10.	7.0	26.9	*	2	1620	485	2.	1.4	25.8
1	1235	152	46.	33.8	31.2	*	2	0230	319	10.	6.9	26.8	*	2	1625	486	2.	1.4	25.8
1	1240	153	45.	33.5	31.2	*	2	0235	320	10.	6.8	26.8	*	2	1630	487	2.	1.3	25.8
1	1245	154	45.	33.2	31.2	*	2	0240	321	10.	6.8	26.8	*	2	1635	488	2.	1.3	25.8
1	1250	155	45.	32.9	31.1	*	2	0245	322	10.	6.7	26.8	*	2	1640	489	2.	1.3	25.8
1	1255	156	45.	32.5	31.1	*	2	0250	323	9.	6.6	26.8	*	2	1645	490	2.	1.3	25.8
1	1300	157	44.	32.2	31.0	*	2	0255	324	9.	6.6	26.8	*	2	1650	491	2.	1.3	25.8
1	1305	158	44.	31.9	31.0	*	2	0300	325	9.	6.5	26.8	*	2	1655	492	2.	1.3	25.8
1	1310	159	44.	31.6	30.9	*	2	0305	326	9.	6.4	26.7	*	2	1700	493	2.	1.3	25.7
1	1315	160	43.	31.3	30.9	*	2	0310	327	9.	6.4	26.7	*	2	1705	494	2.	1.3	25.7
1	1320	161	43.	31.0	30.8	*	2	0315	328	9.	6.3	26.7	*	2	1710	495	2.	1.2	25.7
1	1325	162	43.	30.7	30.8	*	2	0320	329	9.	6.3	26.7	*	2	1715	496	2.	1.2	25.7
1	1330	163	42.	30.5	30.7	*	2	0325	330	9.	6.2	26.7	*	2	1720	497	2.	1.2	25.7
1	1335	164	42.	30.2	30.7	*	2	0330	331	9.	6.1	26.7	*	2	1725	498	2.	1.2	25.7
1	1340	165	41.	29.9	30.6	*	2	0335	332	9.	6.1	26.7	*	2	1730	499	2.	1.2	25.7
1	1345	166	41.	29.6	30.6	*	2	0340	333	9.	6.1	26.7	*	2	1735	500	2.	1.2	25.7
1	1350	167	41.	29.3	30.6	*	2	0345	334	8.	6.0	26.7	*	2					

PEAK FLOW	TIME		6-HR	MAXIMUM AVERAGE FLOW	24-HR	72-HR	41.58-HR
+	(CFS)	(HR)					
+	71.	5.58	(CFS)	64.	36.	23.	23.
			(INCHES)	.678	1.531	1.655	1.655
			(AC-FT)	32.	72.	77.	77.
PEAK STORAGE	TIME		6-HR	MAXIMUM AVERAGE STORAGE	24-HR	72-HR	41.58-HR
+	(AC-FT)	(HR)					
+	65.	5.58		56.	29.	18.	18.
PEAK STAGE	TIME		6-HR	MAXIMUM AVERAGE STAGE	24-HR	72-HR	41.58-HR
+	(FEET)	(HR)					
+	35.95	5.58		34.64	30.43	28.57	28.57
CUMULATIVE AREA =				.88 SQ MI			

1

PEAK FLOW AND STAGE (END-OF-PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND, AREA IN SQUARE MILES
TIME TO PEAK IN HOURS

OPERATION	STATION	AREA	PLAN	RATIOS APPLIED TO PRECIPITATION	
				RATIO 1	RATIO 2
				1.00	.98
HYDROGRAPH AT					
+	OFF1	.41	1 FLOW	403.	391.
			TIME	3.75	3.75
HYDROGRAPH AT					
+	OFF7	.03	1 FLOW	55.	54.
			TIME	3.50	3.50
2 COMBINED AT					
+	CP2	.44	1 FLOW	432.	420.
			TIME	3.75	3.75
HYDROGRAPH AT					
+	OFF2	.04	1 FLOW	48.	47.
			TIME	3.58	3.58
HYDROGRAPH AT					
+	OFF3	.03	1 FLOW	38.	37.
			TIME	3.58	3.58
3 COMBINED AT					
+	CP1	.50	1 FLOW	485.	471.
			TIME	3.75	3.75
HYDROGRAPH AT					
+	OFF4	.06	1 FLOW	84.	82.
			TIME	3.58	3.58
HYDROGRAPH AT					
+	OFF5	.26	1 FLOW	236.	229.
			TIME	3.83	3.83
HYDROGRAPH AT					
+	OFF6	.04	1 FLOW	59.	57.
			TIME	3.58	3.58
HYDROGRAPH AT					
+	ON1	.03	1 FLOW	47.	46.
			TIME	3.58	3.58
5 COMBINED AT					
+	DB1	.88	1 FLOW	817.	794.
			TIME	3.75	3.75
ROUTED TO					

						ULT1.OUT
+	RDB1	.88	1	FLOW	73.	71.
				TIME	5.58	5.58
			**	PEAK STAGES	IN FEET	**
			1	STAGE	36.22	35.95
				TIME	5.58	5.58

*** NORMAL END OF HEC-1 ***

1*****
* FLOOD HYDROGRAPH PACKAGE (HEC-1)
* JUN 1998
* VERSION 4.1
* RUN DATE 29AUG14 TIME 12:16:29

PMF.OUT

* U.S. ARMY CORPS OF ENGINEERS
* HYDROLOGIC ENGINEERING CENTER
* 609 SECOND STREET
* DAVIS, CALIFORNIA 95616
* (916) 756-1104

```

      X   X   XXXXXX   XXXXX   X
      X   X   X   X   X   X   XX
      X   X   X   X   X   X   X
      XXXXXX   XXXX   X   XXXXX   X
      X   X   X   X   X   X   X
      X   X   XXXXXX   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, DSSWRITE STAGE FREQUENCY,
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
ID SLATER HANIFAN GROUP
ID NINETY-FIVE MANAGEMENT, LLC.
ID SKYE CANYON - DETENTION BASINS
ID TECHNICAL DRAINAGE STUDY
ID PMF DRAINAGE CONDITION
ID
ID RETURN PERIOD ----- 100-YEAR
ID DISTRIBUTION ----- 6-HOUR SDN3
ID PROJECT NO. ----- OLY1401.004
ID FILENAME ----- PMF.H1
ID DATE ----- 08/22/14
ID MODELED BY ----- WTM
ID
ID SIX HOUR DEPTH-AREA REDUCTION FACTORS
ID DRAINAGE AREA (MIA2) RATIO
ID 0.0-0.49 1.00
ID 0.5-0.99 0.98
ID
ID
ID IT 5 0 0 500
ID TO 5 0 0
ID IN 5 0 0
ID JR PREC 1.00 0.98
*

23 KK OFF1
24 KM EXISTING OFFSITE DRAINAGE BASIN
25 KM DISCHARGES INTO DETENTION BASIN "DB1"
26 PB 14.1
27 PC 0 0.020 0.057 0.070 0.087 0.108 0.124 0.130 0.130 0.130
28 PC 0.130 0.130 0.130 0.130 0.133 0.140 0.142 0.148 0.158 0.172
29 PC 0.190 0.197 0.199 0.200 0.201 0.204 0.214 0.229 0.241 0.249
30 PC 0.251 0.256 0.270 0.278 0.281 0.283 0.295 0.322 0.352 0.409
31 PC 0.499 0.590 0.710 0.744 0.781 0.812 0.819 0.835 0.851 0.856
32 PC 0.860 0.868 0.876 0.888 0.910 0.926 0.937 0.950 0.970 0.976
33 PC 0.982 0.985 0.987 0.989 0.990 0.993 0.993 0.994 0.995 0.998
34 PC 0.998 0.999 1
35 BA .4073
36 LS 0 86.4
37 UD 0.356
*

38 KK OFF7
39 KM FUTURE DEVELOPED OFFSITE DRAINAGE BASIN
40 KM DISCHARGES INTO DETENTION BASIN "DB1"
41 BA .0281
42 LS 0 96.0
43 UD 0.118
*

1 HEC-1 INPUT PAGE 2

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

44 KK CP2
45 KM COMBINE OFF1, OFF7
46 HC 2
*

47 KK OFF2
48 KM EXISTING OFFSITE DRAINAGE BASIN
49 KM DISCHARGES INTO DETENTION BASIN "DB1"
50 BA .0355
51 LS 0 85.0
52 UD 0.148
*

53 KK OFF3
54 KM EXISTING OFFSITE DRAINAGE BASIN
55 KM DISCHARGES INTO DETENTION BASIN "DB1"
56 BA .0259
57 LS 0 86.2
58 UD 0.112
*

59 KK CP1
60 KM COMBINE CP2, OFF2, AND OFF3
61 HC 3
*

62 KK OFF4
63 KM EXISTING OFFSITE DRAINAGE BASIN
64 KM DISCHARGES INTO DETENTION BASIN "DB1"
65 BA .0581
66 LS 0 86.2
67 UD 0.136
*

68 KK OFF5
69 KM EXISTING OFFSITE DRAINAGE BASIN
70 KM DISCHARGES INTO DETENTION BASIN "DB1"
71 BA .2569
72 LS 0 86.5
73 UD 0.419
*

74 KK OFF6
75 KM EXISTING OFFSITE DRAINAGE BASIN
76 KM DISCHARGES INTO DETENTION BASIN "DB1"

77 BA .0399
78 LS 0 86.2
79 UD 0.121

1

HEC-1 INPUT

PAGE 3

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

80 KK ON1
81 KM PROPOSED ONSITE DRAINAGE BASIN
82 BA .0261
83 LS 0 92.8
84 UD 0.116

85 KK DB1
86 KM COMBINE CP1, OFF4, OFF5, OFF6 AND ON1
87 KO 1
88 HC 5

89 KK RDB1
90 KM OUTLET = 30" ORIFICE @ INVERT ELEVATION = 3025.5-FT
91 KO 1
92 RS 1
93 SV 0 7.78 13.43 19.26 58.03 96.21 132.22
94 SE 25.5 27 28 29 35 40 44
95 SQ 0 25.59 36.20 44.33 76.78 341.94 1444.86 3013.84 4936.17
96 SE 25.5 29 30 31 37 38 40 42 44

97 ZZ

1

SCHEMATIC DIAGRAM OF STREAM NETWORK

INPUT LINE (V) ROUTING (--->) DIVERSION OR PUMP FLOW
NO. (.) CONNECTOR (<---) RETURN OF DIVERTED OR PUMPED FLOW

23 OFF1
38 OFF7
44 CP2.....
47 OFF2
53 OFF3
59 CP1.....
62 OFF4
68 OFF5
74 OFF6
80 ON1
85 DB1.....
89 RDB1

(***) RUNOFF ALSO COMPUTED AT THIS LOCATION

* FLOOD HYDROGRAPH PACKAGE (HEC-1) *
* JUN 1998 *
* VERSION 4.1 *
* RUN DATE 29AUG14 TIME 12:16:29 *

* U.S. ARMY CORPS OF ENGINEERS *
* HYDROLOGIC ENGINEERING CENTER *
* 609 SECOND STREET *
* DAVIS, CALIFORNIA 95616 *
* (916) 756-1104 *

SLATER HANIFAN GROUP
NINETY-FIVE MANAGEMENT, LLC.
SKYE CANYON - DETENTION BASINS
TECHNICAL DRAINAGE STUDY
PMF DRAINAGE CONDITION

RETURN PERIOD ----- 100-YEAR
DISTRIBUTION ----- 6-HOUR SDN3
PROJECT NO. ----- OLY1401.004
FILENAME ----- PMF.H1
DATE ----- 08/22/14
MODELED BY ----- WTM

SIX HOUR DEPTH-AREA REDUCTION FACTORS
DRAINAGE AREA (MI^2) RATIO
0.0-0.49 1.00
0.5-0.99 0.98

20 IO OUTPUT CONTROL VARIABLES
IPRNT 5 PRINT CONTROL
IPLOT 0 PLOT CONTROL
QSCAL 0. HYDROGRAPH PLOT SCALE

IT HYDROGRAPH TIME DATA
NMIN 5 MINUTES IN COMPUTATION INTERVAL
IDATE 1 0 STARTING DATE
ITIME 0000 STARTING TIME
NQ 500 NUMBER OF HYDROGRAPH ORDINATES
NDDATE 2 0 ENDING DATE
NDTIME 1735 ENDING TIME
ICENT 19 CENTURY MARK

COMPUTATION INTERVAL .08 HOURS
TOTAL TIME BASE 41.58 HOURS

ENGLISH UNITS
DRAINAGE AREA SQUARE MILES
PRECIPITATION DEPTH INCHES
LENGTH, ELEVATION FEET
FLOW CUBIC FEET PER SECOND
STORAGE VOLUME ACRE-Feet
SURFACE AREA ACRES
TEMPERATURE DEGREES FAHRENHEIT

JP MULTI-PLAN OPTION
NPLAN 1 NUMBER OF PLANS

JR

MULTI-RATIO OPTION
RATIOS OF PRECIPITATION
1.00 .98

PMF.OUT

85 KK DB1
*****87 KO OUTPUT CONTROL VARIABLES
IPRNT 1 PRINT CONTROL
IPLOT 0 PLOT CONTROL
QSCAL 0. HYDROGRAPH PLOT SCALE88 HC HYDROGRAPH COMBINATION
ICOMP 5 NUMBER OF HYDROGRAPHS TO COMBINE

HYDROGRAPH AT STATION DB1
SUM OF 5 HYDROGRAPHS
PLAN 1, RATIO = 1.00

DA	MON	HRMN	ORD	FLOW	DA	MON	HRMN	ORD	FLOW	DA	MON	HRMN	ORD	FLOW	DA	MON	HRMN	ORD	FLOW
1	0000	1	0.	*	1	1025	126	0.	*	1	2050	251	0.	*	2	0715	376	0.	*
1	0005	2	4.	*	1	1030	127	0.	*	1	2055	252	0.	*	2	0720	377	0.	*
1	0010	3	67.	*	1	1035	128	0.	*	1	2100	253	0.	*	2	0725	378	0.	*
1	0015	4	172.	*	1	1040	129	0.	*	1	2105	254	0.	*	2	0730	379	0.	*
1	0020	5	264.	*	1	1045	130	0.	*	1	2110	255	0.	*	2	0735	380	0.	*
1	0025	6	394.	*	1	1050	131	0.	*	1	2115	256	0.	*	2	0740	381	0.	*
1	0030	7	542.	*	1	1055	132	0.	*	1	2120	257	0.	*	2	0745	382	0.	*
1	0035	8	623.	*	1	1100	133	0.	*	1	2125	258	0.	*	2	0750	383	0.	*
1	0040	9	624.	*	1	1105	134	0.	*	1	2130	259	0.	*	2	0755	384	0.	*
1	0045	10	565.	*	1	1110	135	0.	*	1	2135	260	0.	*	2	0800	385	0.	*
1	0050	11	488.	*	1	1115	136	0.	*	1	2140	261	0.	*	2	0805	386	0.	*
1	0055	12	400.	*	1	1120	137	0.	*	1	2145	262	0.	*	2	0810	387	0.	*
1	0100	13	308.	*	1	1125	138	0.	*	1	2150	263	0.	*	2	0815	388	0.	*
1	0105	14	239.	*	1	1130	139	0.	*	1	2155	264	0.	*	2	0820	389	0.	*
1	0110	15	220.	*	1	1135	140	0.	*	1	2200	265	0.	*	2	0825	390	0.	*
1	0115	16	221.	*	1	1140	141	0.	*	1	2205	266	0.	*	2	0830	391	0.	*
1	0120	17	227.	*	1	1145	142	0.	*	1	2210	267	0.	*	2	0835	392	0.	*
1	0125	18	276.	*	1	1150	143	0.	*	1	2215	268	0.	*	2	0840	393	0.	*
1	0130	19	371.	*	1	1155	144	0.	*	1	2220	269	0.	*	2	0845	394	0.	*
1	0135	20	467.	*	1	1200	145	0.	*	1	2225	270	0.	*	2	0850	395	0.	*
1	0140	21	533.	*	1	1205	146	0.	*	1	2230	271	0.	*	2	0855	396	0.	*
1	0145	22	579.	*	1	1210	147	0.	*	1	2235	272	0.	*	2	0900	397	0.	*
1	0150	23	583.	*	1	1215	148	0.	*	1	2240	273	0.	*	2	0905	398	0.	*
1	0155	24	539.	*	1	1220	149	0.	*	1	2245	274	0.	*	2	0910	399	0.	*
1	0200	25	473.	*	1	1225	150	0.	*	1	2250	275	0.	*	2	0915	400	0.	*
1	0205	26	410.	*	1	1230	151	0.	*	1	2255	276	0.	*	2	0920	401	0.	*
1	0210	27	393.	*	1	1235	152	0.	*	1	2300	277	0.	*	2	0925	402	0.	*
1	0215	28	450.	*	1	1240	153	0.	*	1	2305	278	0.	*	2	0930	403	0.	*
1	0220	29	540.	*	1	1245	154	0.	*	1	2310	279	0.	*	2	0935	404	0.	*
1	0225	30	607.	*	1	1250	155	0.	*	1	2315	280	0.	*	2	0940	405	0.	*
1	0230	31	623.	*	1	1255	156	0.	*	1	2320	281	0.	*	2	0945	406	0.	*
1	0235	32	608.	*	1	1300	157	0.	*	1	2325	282	0.	*	2	0950	407	0.	*
1	0240	33	637.	*	1	1305	158	0.	*	1	2330	283	0.	*	2	0955	408	0.	*
1	0245	34	682.	*	1	1310	159	0.	*	1	2335	284	0.	*	2	1000	409	0.	*
1	0250	35	664.	*	1	1315	160	0.	*	1	2340	285	0.	*	2	1005	410	0.	*
1	0255	36	604.	*	1	1320	161	0.	*	1	2345	286	0.	*	2	1010	411	0.	*
1	0300	37	589.	*	1	1325	162	0.	*	1	2350	287	0.	*	2	1015	412	0.	*
1	0305	38	713.	*	1	1330	163	0.	*	1	2355	288	0.	*	2	1020	413	0.	*
1	0310	39	956.	*	1	1335	164	0.	*	2	0000	289	0.	*	2	1025	414	0.	*
1	0315	40	1362.	*	1	1340	165	0.	*	2	0005	290	0.	*	2	1030	415	0.	*
1	0320	41	2114.	*	1	1345	166	0.	*	2	0010	291	0.	*	2	1035	416	0.	*
1	0325	42	3110.	*	1	1350	167	0.	*	2	0015	292	0.	*	2	1040	417	0.	*
1	0330	43	4258.	*	1	1355	168	0.	*	2	0020	293	0.	*	2	1045	418	0.	*
1	0335	44	5096.	*	1	1400	169	0.	*	2	0025	294	0.	*	2	1050	419	0.	*
1	0340	45	5296.	*	1	1405	170	0.	*	2	0030	295	0.	*	2	1055	420	0.	*
1	0345	46	5265.	*	1	1410	171	0.	*	2	0035	296	0.	*	2	1100	421	0.	*
1	0350	47	4944.	*	1	1415	172	0.	*	2	0040	297	0.	*	2	1105	422	0.	*
1	0355	48	4362.	*	1	1420	173	0.	*	2	0045	298	0.	*	2	1110	423	0.	*
1	0400	49	3771.	*	1	1425	174	0.	*	2	0050	299	0.	*	2	1115	424	0.	*
1	0405	50	3160.	*	1	1430	175	0.	*	2	0055	300	0.	*	2	1120	425	0.	*
1	0410	51	2566.	*	1	1435	176	0.	*	2	0100	301	0.	*	2	1125	426	0.	*
1	0415	52	2087.	*	1	1440	177	0.	*	2	0105	302	0.	*	2	1130	427	0.	*
1	0420	53	1731.	*	1	1445	178	0.	*	2	0110	303	0.	*	2	1135	428	0.	*
1	0425	54	1485.	*	1	1450	179	0.	*	2	0115	304	0.	*	2	1140	429	0.	*
1	0430	55	1381.	*	1	1455	180	0.	*	2	0120	305	0.	*	2	1145	430	0.	*
1	0435	56	1372.	*	1	1500	181	0.	*	2	0125	306	0.	*	2	1150	431	0.	*
1	0440	57	1350.	*	1	1505	182	0.	*	2	0130	307	0.	*	2	1155	432	0.	*
1	0445	58	1325.	*	1	1510	183	0.	*	2	0135	308	0.	*	2	1200	433	0.	*
1	0450	59	1357.	*	1	1515	184	0.	*	2	0140	309	0.	*	2	1205	434	0.	*
1	0455	60	1363.	*	1	1520	185	0.	*	2	0145	310	0.	*	2	1210	435	0.	*
1	0500	61	1272.	*	1	1525	186	0.	*	2	0150	311	0.	*	2	1215	436	0.	*
1	0505	62	1145.	*	1	1530	187	0.	*	2	0155	312	0.	*	2	1220	437	0.	*
1	0510	63	997.	*	1	1535	188	0.	*	2	0200	313	0.	*	2	1225	438	0.	*
1	0515	64	844.	*	1	1540	189	0.	*	2	0205	314	0.	*	2	1230	439	0.	*
1	0520	65	696.	*	1	1545	190	0.	*	2	0210	315	0.	*	2	1235	440	0.	*
1	0525	66	566.	*	1	1550	191	0.	*	2	0215	316	0.	*	2	1240	441	0.	*
1	0530	67	459.	*	1	1555	192	0.	*	2	0220	317	0.	*	2	1245	442	0.	*
1	0535	68	364.	*	1	1600	193	0.	*	2	0225	318	0.	*	2	1250	443	0.	*
1	0540	69	293.	*	1	1605	194	0.	*	2	0230	319	0.	*	2	1255	444	0.	*
1	0545	70	252.	*	1	1610	195	0.	*	2	0235	320	0.	*	2	1300	445	0.	*
1	0550	71	221.	*	1	1615	196	0.	*	2	0240	321	0.	*	2	1305	446	0.	*
1	0555	72	186.	*	1	1620	197	0.	*	2	0245	322	0.	*	2	1310	447	0.	*
1	0600	73	162.	*	1	1625	198	0.	*	2	0250	323	0.	*	2	1315	448	0.	*
1	0605	74	141.	*	1	1630	199	0.	*	2	0255	324	0.	*	2	1320	449	0.	*
1	0610	75	116.	*	1	1635	200	0.	*	2	0300	325	0.	*	2	1325	450	0.	*
1	0615	76	93.	*	1	1640	201	0.	*	2	0305	326	0.	*	2	1330	451	0.	*
1	0620	77	72.	*	1	1645	202	0.	*	2	0310	327	0.	*	2	1335	452	0.	*
1	0625	78	54.	*	1	1650	203	0.	*	2	0315	328	0.	*	2	1340	453	0.	*
1	0630	79	40.	*	1	1655	204	0.	*	2	0320	329	0.	*	2	1345	454	0.	*
1	0635	80	29.	*	1	1700	205	0.	*	2	0325	330	0.	*	2	1350	455	0.	*
1	0640	81	20.	*	1	1705	206	0.	*	2	0330	331	0.	*	2	1355	456	0.	*
1	0645	82	14.	*	1	1710	207	0.	*	2	0335	332	0.	*	2	1400	457	0.	*
1	0650	83	10.	*	1	1715	208	0.	*	2	0340	333	0.	*	2	1405	458	0.	*
1	0655	84	7.	*	1	1720	209	0.	*	2	0345	334	0.	*	2	1410	459	0.	*
1	0700	85	5.	*	1	1725	210	0.	*	2	0350	335	0.	*	2	1415	460	0.	*
1	0705	86	4.	*	1	1730	211	0.	*	2	0355	336	0.	*	2	1420	46		

										PMF.OUT									
1	0830	103	0.	*	1	1855	228	0.	*	2	0520	353	0.	*	2	1545	478	0.	
1	0835	104	0.	*	1	1900	229	0.	*	2	0525	354	0.	*	2	1550	479	0.	
1	0840	105	0.	*	1	1905	230	0.	*	2	0530	355	0.	*	2	1555	480	0.	
1	0845	106	0.	*	1	1910	231	0.	*	2	0535	356	0.	*	2	1600	481	0.	
1	0850	107	0.	*	1	1915	232	0.	*	2	0540	357	0.	*	2	1605	482	0.	
1	0855	108	0.	*	1	1920	233	0.	*	2	0545	358	0.	*	2	1610	483	0.	
1	0900	109	0.	*	1	1925	234	0.	*	2	0550	359	0.	*	2	1615	484	0.	
1	0905	110	0.	*	1	1930	235	0.	*	2	0555	360	0.	*	2	1620	485	0.	
1	0910	111	0.	*	1	1935	236	0.	*	2	0600	361	0.	*	2	1625	486	0.	
1	0915	112	0.	*	1	1940	237	0.	*	2	0605	362	0.	*	2	1630	487	0.	
1	0920	113	0.	*	1	1945	238	0.	*	2	0610	363	0.	*	2	1635	488	0.	
1	0925	114	0.	*	1	1950	239	0.	*	2	0615	364	0.	*	2	1640	489	0.	
1	0930	115	0.	*	1	1955	240	0.	*	2	0620	365	0.	*	2	1645	490	0.	
1	0935	116	0.	*	1	2000	241	0.	*	2	0625	366	0.	*	2	1650	491	0.	
1	0940	117	0.	*	1	2005	242	0.	*	2	0630	367	0.	*	2	1655	492	0.	
1	0945	118	0.	*	1	2010	243	0.	*	2	0635	368	0.	*	2	1700	493	0.	
1	0950	119	0.	*	1	2015	244	0.	*	2	0640	369	0.	*	2	1705	494	0.	
1	0955	120	0.	*	1	2020	245	0.	*	2	0645	370	0.	*	2	1710	495	0.	
1	1000	121	0.	*	1	2025	246	0.	*	2	0650	371	0.	*	2	1715	496	0.	
1	1005	122	0.	*	1	2030	247	0.	*	2	0655	372	0.	*	2	1720	497	0.	
1	1010	123	0.	*	1	2035	248	0.	*	2	0700	373	0.	*	2	1725	498	0.	
1	1015	124	0.	*	1	2040	249	0.	*	2	0705	374	0.	*	2	1730	499	0.	
1	1020	125	0.	*	1	2045	250	0.	*	2	0710	375	0.	*	2	1735	500	0.	

PEAK FLOW TIME 6-HR MAXIMUM AVERAGE FLOW 41.58-HR
+ (CFS) (HR) (CFS) 1167. 293. 169. 169.
+ 5296. 3.67 (INCHES) 12.363 12.429 12.429 12.429
(AC-FT) 579. 582. 582. 582.
CUMULATIVE AREA = .88 SQ MI

HYDROGRAPH AT STATION DB1
SUM OF 5 HYDROGRAPHS
PLAN 1, RATIO = .98

DA	MON	HRMN	ORD	FLOW	DA	MON	HRMN	ORD	FLOW	DA	MON	HRMN	ORD	FLOW	DA	MON	HRMN	ORD	FLOW
1	0000	1	0.	*	1	1025	126	0.	*	1	2050	251	0.	*	2	0715	376	0.	*
1	0005	2	3.	*	1	1030	127	0.	*	1	2055	252	0.	*	2	0720	377	0.	*
1	0010	3	64.	*	1	1035	128	0.	*	1	2100	253	0.	*	2	0725	378	0.	*
1	0015	4	165.	*	1	1040	129	0.	*	1	2105	254	0.	*	2	0730	379	0.	*
1	0020	5	253.	*	1	1045	130	0.	*	1	2110	255	0.	*	2	0735	380	0.	*
1	0025	6	379.	*	1	1050	131	0.	*	1	2115	256	0.	*	2	0740	381	0.	*
1	0030	7	522.	*	1	1055	132	0.	*	1	2120	257	0.	*	2	0745	382	0.	*
1	0035	8	606.	*	1	1100	133	0.	*	1	2125	258	0.	*	2	0750	383	0.	*
1	0040	9	602.	*	1	1105	134	0.	*	1	2130	259	0.	*	2	0755	384	0.	*
1	0045	10	546.	*	1	1110	135	0.	*	1	2135	260	0.	*	2	0800	385	0.	*
1	0050	11	472.	*	1	1115	136	0.	*	1	2140	261	0.	*	2	0805	386	0.	*
1	0055	12	387.	*	1	1120	137	0.	*	1	2145	262	0.	*	2	0810	387	0.	*
1	0100	13	298.	*	1	1125	138	0.	*	1	2150	263	0.	*	2	0815	388	0.	*
1	0105	14	231.	*	1	1130	139	0.	*	1	2155	264	0.	*	2	0820	389	0.	*
1	0110	15	213.	*	1	1135	140	0.	*	1	2200	265	0.	*	2	0825	390	0.	*
1	0115	16	215.	*	1	1140	141	0.	*	1	2205	266	0.	*	2	0830	391	0.	*
1	0120	17	221.	*	1	1145	142	0.	*	1	2210	267	0.	*	2	0835	392	0.	*
1	0125	18	268.	*	1	1150	143	0.	*	1	2215	268	0.	*	2	0840	393	0.	*
1	0130	19	361.	*	1	1155	144	0.	*	1	2220	269	0.	*	2	0845	394	0.	*
1	0135	20	455.	*	1	1200	145	0.	*	1	2225	270	0.	*	2	0850	395	0.	*
1	0140	21	519.	*	1	1205	146	0.	*	1	2230	271	0.	*	2	0855	396	0.	*
1	0145	22	564.	*	1	1210	147	0.	*	1	2235	272	0.	*	2	0900	397	0.	*
1	0150	23	568.	*	1	1215	148	0.	*	1	2240	273	0.	*	2	0905	398	0.	*
1	0155	24	525.	*	1	1220	149	0.	*	1	2245	274	0.	*	2	0910	399	0.	*
1	0200	25	461.	*	1	1225	150	0.	*	1	2250	275	0.	*	2	0915	400	0.	*
1	0205	26	400.	*	1	1230	151	0.	*	1	2255	276	0.	*	2	0920	401	0.	*
1	0210	27	383.	*	1	1235	152	0.	*	1	2300	277	0.	*	2	0925	402	0.	*
1	0215	28	439.	*	1	1240	153	0.	*	1	2305	278	0.	*	2	0930	403	0.	*
1	0220	29	527.	*	1	1245	154	0.	*	1	2310	279	0.	*	2	0935	404	0.	*
1	0225	30	593.	*	1	1250	155	0.	*	1	2315	280	0.	*	2	0940	405	0.	*
1	0230	31	608.	*	1	1255	156	0.	*	1	2320	281	0.	*	2	0945	406	0.	*
1	0235	32	593.	*	1	1300	157	0.	*	1	2325	282	0.	*	2	0950	407	0.	*
1	0240	33	622.	*	1	1305	158	0.	*	1	2330	283	0.	*	2	0955	408	0.	*
1	0245	34	666.	*	1	1310	159	0.	*	1	2335	284	0.	*	2	1000	409	0.	*
1	0250	35	648.	*	1	1315	160	0.	*	1	2340	285	0.	*	2	1005	410	0.	*
1	0255	36	590.	*	1	1320	161	0.	*	1	2345	286	0.	*	2	1010	411	0.	*
1	0300	37	576.	*	1	1325	162	0.	*	1	2350	287	0.	*	2	1015	412	0.	*
1	0305	38	697.	*	1	1330	163	0.	*	1	2355	288	0.	*	2	1020	413	0.	*
1	0310	39	934.	*	1	1335	164	0.	*	2	0000	289	0.	*	2	1025	414	0.	*
1	0315	40	1332.	*	1	1340	165	0.	*	2	0005	290	0.	*	2	1030	415	0.	*
1	0320	41	2067.	*	1	1345	166	0.	*	2	0010	291	0.	*	2	1035	416	0.	*
1	0325	42	3042.	*	1	1350	167	0.	*	2	0015	292	0.	*	2	1040	417	0.	*
1	0330	43	4167.	*	1	1355	168	0.	*	2	0020	293	0.	*	2	1045	418	0.	*
1	0335	44	4987.	*	1	1400	169	0.	*	2	0025	294	0.	*	2	1050	419	0.	*
1	0340	45	5184.	*	1	1405	170	0.	*	2	0030	295	0.	*	2	1055	420	0.	*
1	0345	46	5153.	*	1	1410	171	0.	*	2	0035	296	0.	*	2	1100	421	0.	*
1	0350	47	4840.	*	1	1415	172	0.	*	2	0040	297	0.	*	2	1105	422	0.	*
1	0355	48	4271.	*	1	1420	173	0.	*	2	0045	298	0.	*	2	1110	423	0.	*
1	0400	49	3692.	*	1	1425	174	0.	*	2	0050	299	0.	*	2	1115	424	0.	*
1	0405	50	3094.	*	1	1430	175	0.	*	2	0055	300	0.	*	2	1120	425	0.	*
1	0410	51	2512.	*	1	1435	176	0.	*	2	0100	301	0.	*	2	1125	426	0.	*
1	0415	52	2044.	*	1	1440	177	0.	*	2	0105	302	0.	*	2	1130	427	0.	*
1	0420	53	1695.	*	1	1445	178	0.	*	2	0110	303	0.	*	2	1135	428	0.	*
1	0425	54	1454.	*	1	1450	179	0.	*	2	0115	304	0.	*	2	1140	429	0.	*
1	0430	55	1352.	*	1	1455	180	0.	*	2	0120	305	0.	*	2	1145	430	0.	*
1	0435	56	1343.	*	1	1500	181	0.	*	2	0125	306	0.	*	2	1150	431	0.	*
1	0440	57	1322.	*	1	1505	182	0.	*	2	0130	307	0.	*	2	1155	432	0.	*
1	0445	58	1298.	*	1	1510	183	0.	*	2	0135	308	0.	*	2	1200	433	0.	*
1	0450	59	1329.	*	1	1515	184	0.	*	2	0140	309	0.	*	2	1205	434	0.	*
1	0455	60	1335.	*	1	1520	185	0.	*	2	0145	310	0.	*	2	1210	435	0.	*
1	0500	61	1246.	*	1	1525	186	0.	*	2	0150	311	0.	*	2	1215	436	0.	*
1	0505	62	1122.	*	1	1530	187	0.	*	2	0155	312	0.	*	2	1220	437	0.	*
1	0510	63	976.	*	1	1535	188	0.	*	2	0200	313	0.	*	2	1225	438	0.	*
1	0515	64	827.	*	1	1540	189	0.	*	2	0205	314	0.	*	2	1230	439	0.	*
1	0520	65	682.	*	1	1545	190	0.	*	2	0210	315	0.	*	2	1235	440	0.	*
1	0525	66	554.	*	1	1550	191	0.	*	2	0215	316	0.	*	2	1240	441	0.	*
1	0530	67	450.	*	1	1555	192	0.	*	2	0220	317	0.	*	2	1245	442	0.	*
1	0535	68	357.	*	1	1600	193	0.	*	2	0225	318	0.	*	2	1250	443	0.	*
1	0540	69	287.	*	1	1605	194	0.	*	2	0230	319	0.	*	2	1255	444	0.	*
1	0545	70	247.	*	1	1610	195	0.	*	2	0235	320	0.	*	2	1300	445	0.	*
1	0550	71	216.	*	1	1615	196	0.	*	2	0240	321	0.	*	2	1305	446	0.	*
1	0555	72	182.	*	1	1620	197	0.	*	2	0245	322	0.	*	2	1310	447	0.	*
1	0600	73	159.	*	1	1625	198	0.	*	2	0250	323	0.	*	2	1315	448	0.	*
1	0605	74	138.	*	1	1630	199	0.	*	2	0255	324	0.	*	2	1320	449	0.	*
1	0610	75	113.	*	1	1635	200	0.	*	2	0300	325	0.	*	2	1325	450	0.	*
1	0615	76	91.	*	1	1640	201	0.	*	2	0305	326	0.	*	2	1330	451	0.	*
1	0620	77	70.	*	1	1645	202	0.	*	2	0310	327	0.	*	2	1335	452	0.	*
1	0625	78	53.	*	1	1650	203	0.	*	2	0315	328	0.	*	2	1340	453	0.	*
1	0630	79	39.	*	1	1655	204	0.	*	2	0320	329	0.	*	2	1345	454	0.	*
1	0635	80	28.	*	1	1700	205	0.	*	2	0325	330	0.	*	2	1350	455	0.	*
1	0640	81	20.	*	1	1705	206	0.	*	2	0330	331	0.	*	2	1355	456	0.	*
1	0645	82	14.	*	1	1710	207	0.	*	2	0335	332	0.	*	2	1400	457	0.	*
1	0650	83	10.	*	1	1715	208	0.	*	2	0340	333	0.	*	2	1405	458	0.	*
1	0655	84	7.	*	1	1720	209	0.	*	2	0345	334	0.	*	2	1410	459	0.	*
1	0700	85	5.	*	1	1725	210	0.	*	2	0350	335	0.	*	2	1415	460	0.	*
1	0705	86	4.	*	1	1730	211	0.	*	2	0355	336	0.	*	2	1420	461	0.	*
1	0710	87	3.	*	1	1735	212	0.	*	2	0400	337	0.	*	2	1425	462	0.	*
1	0715	88	2.	*	1	1740	213	0.	*	2	0405	338	0.	*	2	1430	463	0.	*
1	0720	89	1.	*	1	1745	214	0.	*	2	0410	339	0.	*	2	1435	464	0.	*
1	0725	90	1.	*	1	1750	215	0.	*	2									

															PMF.OUT									
1	0730	91	1.	*	1	1755	216	0.	*	2	0420	341	0.	*	2	1445	466	0.						
1	0735	92	0.	*	1	1800	217	0.	*	2	0425	342	0.	*	2	1450	467	0.						
1	0740	93	0.	*	1	1805	218	0.	*	2	0430	343	0.	*	2	1455	468	0.						
1	0745	94	0.	*	1	1810	219	0.	*	2	0435	344	0.	*	2	1500	469	0.						
1	0750	95	0.	*	1	1815	220	0.	*	2	0440	345	0.	*	2	1505	470	0.						
1	0755	96	0.	*	1	1820	221	0.	*	2	0445	346	0.	*	2	1510	471	0.						
1	0800	97	0.	*	1	1825	222	0.	*	2	0450	347	0.	*	2	1515	472	0.						
1	0805	98	0.	*	1	1830	223	0.	*	2	0455	348	0.	*	2	1520	473	0.						
1	0810	99	0.	*	1	1835	224	0.	*	2	0500	349	0.	*	2	1525	474	0.						
1	0815	100	0.	*	1	1840	225	0.	*	2	0505	350	0.	*	2	1530	475	0.						
1	0820	101	0.	*	1	1845	226	0.	*	2	0510	351	0.	*	2	1535	476	0.						
1	0825	102	0.	*	1	1850	227	0.	*	2	0515	352	0.	*	2	1540	477	0.						
1	0830	103	0.	*	1	1855	228	0.	*	2	0520	353	0.	*	2	1545	478	0.						
1	0835	104	0.	*	1	1900	229	0.	*	2	0525	354	0.	*	2	1550	479	0.						
1	0840	105	0.	*	1	1905	230	0.	*	2	0530	355	0.	*	2	1555	480	0.						
1	0845	106	0.	*	1	1910	231	0.	*	2	0535	356	0.	*	2	1600	481	0.						
1	0850	107	0.	*	1	1915	232	0.	*	2	0540	357	0.	*	2	1605	482	0.						
1	0855	108	0.	*	1	1920	233	0.	*	2	0545	358	0.	*	2	1610	483	0.						
1	0900	109	0.	*	1	1925	234	0.	*	2	0550	359	0.	*	2	1615	484	0.						
1	0905	110	0.	*	1	1930	235	0.	*	2	0555	360	0.	*	2	1620	485	0.						
1	0910	111	0.	*	1	1935	236	0.	*	2	0600	361	0.	*	2	1625	486	0.						
1	0915	112	0.	*	1	1940	237	0.	*	2	0605	362	0.	*	2	1630	487	0.						
1	0920	113	0.	*	1	1945	238	0.	*	2	0610	363	0.	*	2	1635	488	0.						
1	0925	114	0.	*	1	1950	239	0.	*	2	0615	364	0.	*	2	1640	489	0.						
1	0930	115	0.	*	1	1955	240	0.	*	2	0620	365	0.	*	2	1645	490	0.						
1	0935	116	0.	*	1	2000	241	0.	*	2	0625	366	0.	*	2	1650	491	0.						
1	0940	117	0.	*	1	2005	242	0.	*	2	0630	367	0.	*	2	1655	492	0.						
1	0945	118	0.	*	1	2010	243	0.	*	2	0635	368	0.	*	2	1700	493	0.						
1	0950	119	0.	*	1	2015	244	0.	*	2	0640	369	0.	*	2	1705	494	0.						
1	0955	120	0.	*	1	2020	245	0.	*	2	0645	370	0.	*	2	1710	495	0.						
1	1000	121	0.	*	1	2025	246	0.	*	2	0650	371	0.	*	2	1715	496	0.						
1	1005	122	0.	*	1	2030	247	0.	*	2	0655	372	0.	*	2	1720	497	0.						
1	1010	123	0.	*	1	2035	248	0.	*	2	0700	373	0.	*	2	1725	498	0.						
1	1015	124	0.	*	1	2040	249	0.	*	2	0705	374	0.	*	2	1730	499	0.						
1	1020	125	0.	*	1	2045	250	0.	*	2	0710	375	0.	*	2	1735	500	0.						

PEAK FLOW	TIME	6-HR	MAXIMUM	AVERAGE FLOW	41.58-HR
(CFS)	(HR)	(CFS)	24-HR	72-HR	
5184.	3.67	1141.	287.	166.	166.
		(INCHES)	12.085	12.150	12.150
		(AC-FT)	566.	569.	569.
CUMULATIVE AREA =			.88 SQ MI		

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COMPUTED STORAGE-OUTFLOW-ELEVATION DATA											
STORAGE	.00	7.78	13.43	19.26	25.72	32.18	58.03	73.30	80.94	96.21	
OUTFLOW	.00	10.97	18.28	25.59	36.20	44.33	65.96	76.78	341.94	1444.86	
ELEVATION	25.50	27.00	28.00	29.00	30.00	31.00	35.00	37.00	38.00	40.00	
STORAGE	114.21	132.22									
OUTFLOW	3013.84	4936.17									
ELEVATION	42.00	44.00									

WARNING --- ROUTED OUTFLOW (5020.) IS GREATER THAN MAXIMUM OUTFLOW (4936.) IN STORAGE-OUTFLOW TABLE

HYDROGRAPH AT STATION RDB1																				
PLAN 1, RATIO = 1.00																				

DA	MON	HRMN	ORD	OUTFLOW	STORAGE	STAGE	DA	MON	HRMN	ORD	OUTFLOW	STORAGE	STAGE	DA	MON	HRMN	ORD	OUTFLOW	STORAGE	STAGE

1	0000	1	0.	.0	25.5	*	1	1355	168	48.	36.8	31.7	*	2	0350	335	11.	7.6	27.0	
1	0005	2	0.	.0	25.5	*	1	1400	169	48.	36.5	31.7	*	2	0355	336	11.	7.5	27.0	
1	0010	3	0.	.3	25.5	*	1	1405	170	48.	36.1	31.6	*	2	0400	337	11.	7.5	26.9	
1	0015	4	2.	1.1	25.7	*	1	1410	171	47.	35.8	31.6	*	2	0405	338	10.	7.4	26.9	
1	0020	5	4.	2.6	26.0	*	1	1415	172	47.	35.5	31.5	*	2	0410	339	10.	7.3	26.9	
1	0025	6	7.	4.8	26.4	*	1	1420	173	47.	35.2	31.5	*	2	0415	340	10.	7.3	26.9	
1	0030	7	11.	7.9	27.0	*	1	1425	174	47.	34.9	31.4	*	2	0420	341	10.	7.2	26.9	
1	0035	8	16.	11.9	27.7	*	1	1430	175	46.	34.5	31.4	*	2	0425	342	10.	7.1	26.9	
1	0040	9	22.	16.1	28.5	*	1	1435	176	46.	34.2	31.3	*	2	0430	343	10.	7.1	26.9	
1	0045	10	27.	20.0	29.1	*	1	1440	177	46.	33.9	31.3	*	2	0435	344	10.	7.0	26.8	
1	0050	11	32.	23.4	29.6	*	1	1445	178	46.	33.6	31.2	*	2	0440	345	10.	6.9	26.8	
1	0055	12	37.	26.2	30.1	*	1	1450	179	45.	33.3	31.2	*	2	0445	346	10.	6.8	26.8	
1	0100	13	40.	28.4	30.4	*	1	1455	180	45.	33.0	31.1	*	2	0450	347	10.	6.8	26.8	
1	0105	14	42.	30.0	30.7	*	1	1500	181	45.	32.7	31.1	*	2	0455	348	9.	6.7	26.8	
1	0110	15	43.	31.3	30.9	*	1	1505	182	44.	32.3	31.0	*	2	0500	349	9.	6.7	26.8	
1	0115	16	45.	32.5	31.2	*	1	1510	183	44.	32.0	31.0	*	2	0505	350	9.	6.6	26.8	
1	0120	17	46.	33.8	31.5	*	1	1515	184	44.	31.7	30.9	*	2	0510	351	9.	6.5	26.8	
1	0125	18	47.	35.2	31.8	*	1	1520	185	43.	31.4	30.9	*	2	0515	352	9.	6.5	26.8	
1	0130	19	48.	37.1	31.8	*	1	1525	186	43.	31.1	30.8	*	2	0520	353	9.	6.4	26.8	
1	0135	20	51.	39.6	32.1	*	1	1530	187	43.	30.8	30.8	*	2	0525	354	9.	6.3	26.8	
1	0140	21	53.	42.7	32.6	*	1	1535	188	42.	30.6	30.7	*	2	0530	355	9.	6.3	26.8	
1	0145	22	56.	46.2	33.2	*	1	1540	189	42.	30.3	30.7	*	2	0535	356	9.	6.2	26.8	
1	0150	23	59.	49.8	33.7	*	1	1545	190	42.	30.0	30.6	*	2	0540	357	9.	6.2	26.8	
1	0155	24	62.	53.2	34.3	*	1	1550	191	41.	29.7	30.7	*	2	0545	358	9.	6.1	26.8	
1	0200	25	64.	56.3	34.7	*	1	1555	192	41.	29.4	30.6	*	2	0550	359	9.	6.0	26.8	
1	0205	26	67.	58.9	35.1	*	1	1600	193	40.	29.1	30.5	*	2	0555	360	8.	6.0	26.8	
1	0210	27	68.	61.2	35.4	*	1	1605	194	40.	28.8	30.5	*	2	0600	361	8.	5.9	26.8	
1	0215	28	70.	63.6	35.7	*	1	1610	195	40.	28.6	30.4	*	2	0605	362	8.	5.9	26.8	
1	0220	29	72.	66.5	36.1	*	1	1615	196	39.	28.3	30.4	*	2	0610	363	8.	5.8	26.8	
1	0225	30	74.	70.0	36.6	*	1	1620	197	39.	28.0	30.4	*	2	0615	364	8.	5.7	26.8	
1	0230	31	88.	73.6	37.0	*	1	1625	198	39.	27.8	30.3	*	2	0620	365	8.	5.7	26.8	
1	0235	32	201.	76.9	37.5	*	1	1630	199	38.	27.5	30.3	*	2	0625	366	8.	5.6	26.8	
1	0240	33	291.	79.5	37.8	*	1	1635	200	38.	27.2	30.2	*	2	0630	367	8.	5.6	26.8	

1	0245	34	394.	81.7	38.1	*	1	1640	201	38.	27.0	30.2	*	2	0635	368	8.	5.5	26.6
1	0250	35	505.	83.2	38.3	*	1	1645	202	37.	26.7	30.2	*	2	0640	369	8.	5.5	26.6
1	0255	36	556.	83.9	38.4	*	1	1650	203	37.	26.5	30.1	*	2	0645	370	8.	5.4	26.5
1	0300	37	573.	84.1	38.4	*	1	1655	204	37.	26.2	30.1	*	2	0650	371	8.	5.4	26.5
1	0305	38	604.	84.6	38.5	*	1	1700	205	36.	25.9	30.0	*	2	0655	372	7.	5.3	26.5
1	0310	39	696.	85.8	38.6	*	1	1705	206	36.	25.7	30.0	*	2	0700	373	7.	5.3	26.5
1	0315	40	880.	88.4	39.0	*	1	1710	207	36.	25.5	30.0	*	2	0705	374	7.	5.2	26.5
1	0320	41	1222.	93.1	39.6	*	1	1715	208	35.	25.2	29.9	*	2	0710	375	7.	5.1	26.5
1	0325	42	1828.	100.6	40.1	*	1	1720	209	35.	25.0	29.9	*	2	0715	376	7.	5.1	26.5
1	0330	43	2685.	110.4	41.6	*	1	1725	210	35.	24.7	29.8	*	2	0720	377	7.	5.1	26.5
1	0335	44	3702.	120.7	42.7	*	1	1730	211	34.	24.5	29.8	*	2	0725	378	7.	5.0	26.5
1	0340	45	4505.	128.2	43.6	*	1	1735	212	34.	24.3	29.8	*	2	0730	379	7.	4.9	26.4
1	0345	46	4922.	132.1	44.0	*	1	1740	213	33.	24.0	29.7	*	2	0735	380	7.	4.9	26.4
1	0350	47	5020.	133.0	44.1	*	1	1750	215	33.	23.6	29.7	*	2	0745	382	7.	4.8	26.4
1	0355	48	4823.	127.4	43.5	*	1	1755	216	32.	23.3	29.6	*	2	0750	383	7.	4.8	26.4
1	0400	49	4416.	122.6	42.9	*	1	1800	217	32.	23.1	29.6	*	2	0755	384	7.	4.7	26.4
1	0405	50	3905.	122.6	42.9	*	1	1805	218	32.	22.9	29.6	*	2	0800	385	7.	4.7	26.4
1	0410	51	3345.	117.3	42.3	*	1	1810	219	31.	22.7	29.5	*	2	0805	386	7.	4.6	26.4
1	0415	52	2828.	112.1	41.8	*	1	1815	220	31.	22.5	29.5	*	2	0810	387	6.	4.6	26.4
1	0420	53	2404.	107.2	41.2	*	1	1820	221	31.	22.3	29.5	*	2	0815	388	6.	4.6	26.4
1	0425	54	2036.	103.0	40.8	*	1	1825	222	30.	22.1	29.4	*	2	0820	389	6.	4.5	26.4
1	0430	55	1758.	99.8	40.4	*	1	1830	223	30.	21.8	29.4	*	2	0825	390	6.	4.5	26.4
1	0435	56	1582.	97.8	40.2	*	1	1835	224	30.	21.6	29.4	*	2	0830	391	6.	4.4	26.4
1	0440	57	1480.	96.6	40.0	*	1	1840	225	29.	21.4	29.3	*	2	0835	392	6.	4.4	26.3
1	0445	58	1418.	95.8	40.0	*	1	1845	226	29.	21.2	29.3	*	2	0840	393	6.	4.3	26.3
1	0450	59	1387.	95.4	39.9	*	1	1850	227	29.	21.0	29.3	*	2	0845	394	6.	4.3	26.3
1	0455	60	1377.	95.3	39.9	*	1	1855	228	28.	20.8	29.2	*	2	0850	395	6.	4.2	26.3
1	0500	61	1353.	94.9	39.8	*	1	1900	229	28.	20.7	29.2	*	2	0855	396	6.	4.2	26.3
1	0505	62	1296.	94.1	39.7	*	1	1905	230	28.	20.5	29.2	*	2	0900	397	6.	4.1	26.3
1	0510	63	1206.	92.9	39.6	*	1	1910	231	27.	20.3	29.2	*	2	0905	398	6.	4.1	26.3
1	0515	64	1092.	91.3	39.4	*	1	1915	232	27.	20.1	29.1	*	2	0910	399	6.	4.1	26.3
1	0520	65	964.	89.6	39.1	*	1	1920	233	27.	19.9	29.1	*	2	0915	400	6.	4.1	26.3
1	0525	66	831.	87.7	38.9	*	1	1925	234	26.	19.7	29.1	*	2	0920	401	6.	4.0	26.3
1	0530	67	704.	86.0	38.7	*	1	1930	235	26.	19.5	29.0	*	2	0925	402	6.	3.9	26.3
1	0535	68	588.	84.3	38.4	*	1	1935	236	26.	19.4	29.0	*	2	0930	403	5.	3.9	26.3
1	0540	69	485.	82.9	38.3	*	1	1940	237	25.	19.2	29.0	*	2	0935	404	5.	3.9	26.3
1	0545	70	400.	81.7	38.1	*	1	1945	238	25.	19.0	29.0	*	2	0940	405	5.	3.9	26.2
1	0550	71	338.	80.8	38.0	*	1	1950	239	25.	18.8	28.9	*	2	0945	406	5.	3.8	26.2
1	0555	72	309.	80.0	37.9	*	1	1955	240	25.	18.7	28.9	*	2	0950	407	5.	3.8	26.2
1	0600	73	280.	79.2	37.8	*	1	2000	241	25.	18.5	28.8	*	2	0955	408	5.	3.7	26.2
1	0605	74	253.	78.4	37.7	*	1	2005	242	24.	18.3	28.8	*	2	1000	409	5.	3.7	26.2
1	0610	75	226.	77.6	37.6	*	1	2010	243	24.	18.2	28.8	*	2	1005	410	5.	3.7	26.2
1	0615	76	200.	76.9	37.5	*	1	2015	244	24.	18.0	28.8	*	2	1010	411	5.	3.6	26.2
1	0620	77	175.	76.1	37.4	*	1	2020	245	24.	17.8	28.8	*	2	1015	412	5.	3.6	26.2
1	0625	78	151.	75.4	37.3	*	1	2025	246	24.	17.7	28.7	*	2	1020	413	5.	3.6	26.2
1	0630	79	129.	74.8	37.2	*	1	2030	247	23.	17.5	28.7	*	2	1025	414	5.	3.5	26.2
1	0635	80	109.	74.2	37.1	*	1	2035	248	23.	17.3	28.7	*	2	1030	415	5.	3.5	26.2
1	0640	81	91.	73.7	37.0	*	1	2040	249	23.	17.2	28.6	*	2	1035	416	5.	3.5	26.2
1	0645	82	77.	73.2	37.0	*	1	2045	250	23.	17.0	28.6	*	2	1040	417	5.	3.4	26.2
1	0650	83	76.	72.8	36.9	*	1	2050	251	23.	16.9	28.6	*	2	1045	418	5.	3.4	26.1
1	0655	84	76.	72.3	36.9	*	1	2055	252	22.	16.7	28.6	*	2	1050	419	5.	3.3	26.1
1	0700	85	76.	71.9	36.8	*	1	2100	253	22.	16.6	28.5	*	2	1055	420	5.	3.3	26.1
1	0705	86	75.	71.4	36.7	*	1	2105	254	22.	16.4	28.5	*	2	1100	421	5.	3.3	26.1
1	0710	87	75.	70.9	36.7	*	1	2110	255	22.	16.3	28.5	*	2	1105	422	5.	3.3	26.1
1	0715	88	74.	70.4	36.6	*	1	2115	256	22.	16.1	28.5	*	2	1110	423	5.	3.2	26.1
1	0720	89	74.	69.9	36.6	*	1	2120	257	21.	16.0	28.4	*	2	1115	424	4.	3.2	26.1
1	0725	90	74.	69.4	36.5	*	1	2125	258	21.	15.8	28.4	*	2	1120	425	4.	3.1	26.1
1	0730	91	74.	68.9	36.4	*	1	2130	259	21.	15.7	28.4	*	2	1125	426	4.	3.1	26.1
1	0735	92	73.	68.4	36.4	*	1	2135	260	21.	15.5	28.4	*	2	1130	427	4.	3.1	26.1
1	0740	93	73.	67.9	36.3	*	1	2140	261	21.	15.4	28.3	*	2	1135	428	4.	3.1	26.1
1	0745	94	73.	67.4	36.2	*	1	2145	262	21.	15.2	28.3	*	2	1140	429	4.	3.1	26.1
1	0750	95	72.	66.9	36.2	*	1	2150	263	20.	15.1	28.3	*	2	1145	430	4.	3.0	26.1
1	0755	96	72.	66.4	36.1	*	1	2155	264	20.	15.0	28.3	*	2	1150	431	4.	3.0	26.1
1	0800	97	72.	65.9	36.0	*	1	2200	265	20.	14.8	28.2	*	2	1155	432	4.	3.0	26.1
1	0805	98	71.	65.4	36.0	*	1	2205	266	20.	14.7	28.2	*	2	1200	433	4.	2.9	26.1
1	0810	99	71.	64.9	35.9	*	1	2210	267	20.	14.5	28.2	*	2	1205	434	4.	2.9	26.1
1	0815	100	70.	64.4	35.8	*	1	2215	268	20.	14.4	28.2	*	2	1210	435	4.	2.9	26.1
1	0820	101	70.	63.9	35.8	*	1	2220	269	19.	14.3	28.1	*	2	1215	436	4.	2.9	26.1
1	0825	102	70.	63.4	35.7	*	1	2225	270	19.	14.1	28.1	*	2	1220	437	4.	2.8	26.0
1	0830	103	69.	63.0	35.6	*	1	2230	271	19.	14.0	28.1	*	2	1225	438	4.	2.8	26.0
1	0835	104	69.	62.5	35.5	*	1	2235	272	19.	13.9	28.1	*	2	1230	439	4.	2.8	26.0
1	0840	105	69.	62.0	35.5	*	1	2240	273	19.	13.8	28.1	*	2	1235	440	4.	2.7	26.0
1	0845	106	68.	61.5	35.5	*	1	2245	274	19.	13.6	28.0	*	2	1240	441	4.	2.7	26.0
1	0850	107	68.	61.1	35.4	*	1	2250	275	18.	13.5	28.0	*	2	1245	442	4.	2.7	26.0
1	0855	108	68.	60.6	35.3	*	1	2255	276	18.	13.4	28.0	*	2	1250	443	4.	2.7	26.0
1	0900	109	67.	60.1	35.3	*	1	2300	277	18.	13.2	28.0	*	2	1255	444	4.	2.6	26.0
1	0905	110	67.	59.7	35.2	*	1	2305	278	18.	13.1	27.9	*	2	1300	445	4.	2.6	26.0
1	0910	111	67.	59.2	35.2	*	1	2310	279	18.	13.0	27.9	*	2	1305	446	4.	2.6	26.0
1	0915	112	66.	58.8	35.1	*	1	2315	280	18.	12.9	27.9	*	2	1310	447	4.	2.6	26.0
1	09																		

PEAK FLOW	TIME		6-HR	MAXIMUM AVERAGE FLOW	72-HR	41.58-HR
+	(CFS)	(HR)		24-HR		
+	5020.	3.83	(CFS)	1030.	288.	169.
			(INCHES)	10,909	12,188	12,397
			(AC-FT)	511.	571.	580.
PEAK STORAGE	TIME		6-HR	MAXIMUM AVERAGE STORAGE	72-HR	41.58-HR
+	(AC-FT)	(HR)		24-HR		
+	133.	3.83		86.	45.	28.
PEAK STAGE	TIME		6-HR	MAXIMUM AVERAGE STAGE	72-HR	41.58-HR
+	(FEET)	(HR)		24-HR		
+	44.09	3.83		38.63	32.85	30.13

CUMULATIVE AREA = .88 SQ MI

HYDROGRAPH AT STATION RDB1
PLAN 1, RATIO = .98

DA	MON	HRMN	ORD	OUTFLOW	STORAGE	STAGE	DA	MON	HRMN	ORD	OUTFLOW	STORAGE	STAGE	DA	MON	HRMN	ORD	OUTFLOW	STORAGE	STAGE
1	0000	1	0.	0.	.0	25.5	*	1	1355	168	48.	36.8	31.7	*	2	0350	335	11.	7.6	27.0
1	0005	2	0.	0.	0.	25.5	*	1	1400	169	48.	36.4	31.7	*	2	0355	336	11.	7.5	27.0
1	0010	3	0.	0.	.2	25.5	*	1	1405	170	48.	36.1	31.6	*	2	0400	337	11.	7.5	26.9
1	0015	4	1.	1.0	25.7	*	1	1410	171	47.	35.8	31.6	*	2	0405	338	10.	7.4	26.9	
1	0020	5	3.	2.4	26.0	*	1	1415	172	47.	35.5	31.5	*	2	0410	339	10.	7.3	26.9	
1	0025	6	6.	4.6	26.4	*	1	1420	173	47.	35.1	31.5	*	2	0415	340	10.	7.3	26.9	
1	0030	7	11.	7.6	27.0	*	1	1425	174	47.	34.8	31.4	*	2	0420	341	10.	7.2	26.9	
1	0035	8	16.	11.4	27.6	*	1	1430	175	46.	34.5	31.4	*	2	0425	342	10.	7.1	26.9	
1	0040	9	21.	15.5	28.3	*	1	1435	176	46.	34.2	31.3	*	2	0430	343	10.	7.0	26.8	
1	0045	10	26.	19.3	29.0	*	1	1440	177	46.	33.9	31.3	*	2	0435	344	10.	6.9	26.8	
1	0050	11	31.	22.6	29.5	*	1	1445	178	45.	33.6	31.2	*	2	0440	345	10.	6.8	26.8	
1	0055	12	35.	25.3	29.9	*	1	1450	179	45.	33.2	31.2	*	2	0445	346	10.	6.8	26.8	
1	0100	13	38.	27.4	30.3	*	1	1455	180	45.	32.9	31.1	*	2	0450	347	10.	6.8	26.8	
1	0105	14	40.	28.9	30.5	*	1	1500	181	45.	32.6	31.1	*	2	0455	348	9.	6.7	26.8	
1	0110	15	42.	30.2	30.7	*	1	1505	182	44.	32.3	31.0	*	2	0500	349	9.	6.6	26.8	
1	0115	16	43.	31.4	30.9	*	1	1510	183	44.	32.0	31.0	*	2	0505	350	9.	6.6	26.8	
1	0120	17	45.	32.6	31.1	*	1	1515	184	44.	31.7	30.9	*	2	0510	351	9.	6.5	26.8	
1	0125	18	46.	33.9	31.3	*	1	1520	185	43.	31.4	30.9	*	2	0515	352	9.	6.5	26.7	
1	0130	19	47.	35.8	31.6	*	1	1525	186	43.	31.1	30.8	*	2	0520	353	9.	6.4	26.7	
1	0135	20	49.	38.3	31.9	*	1	1530	187	43.	30.8	30.8	*	2	0525	354	9.	6.3	26.7	
1	0140	21	52.	41.3	32.4	*	1	1535	188	42.	30.5	30.7	*	2	0530	355	9.	6.2	26.7	
1	0145	22	55.	44.6	32.9	*	1	1540	189	42.	30.2	30.7	*	2	0535	356	9.	6.2	26.7	
1	0150	23	58.	48.1	33.5	*	1	1545	190	42.	29.9	30.7	*	2	0540	357	9.	6.1	26.7	
1	0155	24	60.	51.5	34.0	*	1	1550	191	41.	29.7	30.6	*	2	0545	358	9.	6.1	26.7	
1	0200	25	63.	54.5	34.4	*	1	1555	192	41.	29.4	30.6	*	2	0550	359	9.	6.0	26.7	
1	0205	26	65.	57.0	34.8	*	1	1600	193	40.	29.1	30.5	*	2	0555	360	8.	6.0	26.7	
1	0210	27	67.	59.2	35.2	*	1	1605	194	40.	28.8	30.5	*	2	0600	361	8.	5.9	26.6	
1	0215	28	68.	61.6	35.5	*	1	1610	195	40.	28.5	30.5	*	2	0605	362	8.	5.9	26.6	
1	0220	29	71.	64.4	35.8	*	1	1615	196	40.	28.3	30.4	*	2	0610	363	8.	5.8	26.6	
1	0225	30	73.	67.8	36.3	*	1	1620	197	39.	28.0	30.4	*	2	0615	364	8.	5.7	26.6	
1	0230	31	75.	71.4	36.8	*	1	1625	198	39.	27.7	30.3	*	2	0620	365	8.	5.7	26.6	
1	0235	32	131.	74.9	37.2	*	1	1630	199	38.	27.5	30.3	*	2	0625	366	8.	5.6	26.6	
1	0240	33	233.	77.8	37.6	*	1	1635	200	38.	27.2	30.2	*	2	0630	367	8.	5.6	26.6	
1	0245	34	321.	80.3	37.9	*	1	1640	201	38.	26.9	30.1	*	2	0635	368	8.	5.5	26.6	
1	0250	35	436.	82.2	38.2	*	1	1645	202	37.	26.7	30.1	*	2	0640	369	8.	5.5	26.6	
1	0255	36	509.	83.3	38.3	*	1	1650	203	37.	26.4	30.1	*	2	0645	370	8.	5.4	26.5	
1	0300	37	538.	83.7	38.4	*	1	1655	204	37.	26.2	30.1	*	2	0650	371	8.	5.4	26.5	
1	0305	38	577.	84.2	38.4	*	1	1700	205	36.	25.9	30.0	*	2	0655	372	7.	5.3	26.5	
1	0310	39	672.	85.5	38.6	*	1	1705	206	36.	25.7	30.0	*	2	0700	373	7.	5.2	26.5	
1	0315	40	856.	88.1	38.9	*	1	1710	207	36.	25.4	30.0	*	2	0705	374	7.	5.2	26.5	
1	0320	41	1192.	88.1	38.9	*	1	1715	208	35.	25.2	29.9	*	2	0710	375	7.	5.1	26.5	
1	0325	42	1781.	100.1	40.4	*	1	1720	209	35.	24.9	29.9	*	2	0715	376	7.	5.1	26.5	
1	0330	43	2623.	109.7	41.5	*	1	1725	210	35.	24.7	29.8	*	2	0720	377	7.	5.1	26.5	
1	0335	44	3609.	119.8	42.6	*	1	1730	211	34.	24.5	29.8	*	2	0725	378	7.	5.0	26.5	
1	0340	45	4403.	127.2	43.4	*	1	1735	212	34.	24.2	29.8	*	2	0730	379	7.	4.9	26.4	
1	0345	46	4815.	131.1	43.9	*	1	1740	213	33.	24.0	29.7	*	2	0735	380	7.	4.9	26.4	
1	0350	47	4912.	132.0	44.0	*	1	1745	214	33.	23.8	29.7	*	2	0740	381	7.	4.9	26.4	
1	0355	48	4720.	130.2	43.8	*	1	1750	215	33.	23.5	29.7	*	2	0745	382	7.	4.8	26.4	
1	0400	49	4323.	126.5	43.4	*	1	1755	216	32.	23.3	29.6	*	2	0750	383	7.	4.8	26.4	
1	0405	50	3823.	121.8	42.8	*	1	1800	217	32.	23.1	29.6	*	2	0755	384	7.	4.7	26.4	
1	0410	51	3275.	116.7	42.3	*	1	1805	218	32.	22.9	29.6	*	2	0800	385	7.	4.7	26.4	
1	0415	52	2778.	111.5	41.7	*	1	1810	219	31.	22.7	29.5	*	2	0805	386	7.	4.6	26.4	
1	0420	53	2359.	106.7	41.2	*	1	1815	220	31.	22.5	29.5	*	2	0810	387	6.	4.6	26.4	
1	0425	54	1997.	102.5	40.7	*	1	1820	221	30.	22.2	29.5	*	2	0815	388	6.	4.6	26.4	
1	0430	55	1723.	99.4	40.4	*	1	1825	222	30.	22.0	29.4	*	2	0820	389	6.	4.5	26.4	
1	0435	56	1550.	97.4	40.1	*	1	1830	223	30.	21.8	29.4	*	2	0825	390	6.	4.4	26.4	
1	0440	57	1450.	96.3	40.0	*	1	1835	224	29.	21.6	29.4	*	2	0830	391	6.	4.4	26.3	
1	0445	58	1393.	95.5	39.9	*	1	1840	225	29.	21.4	29.3	*	2	0835	392	6.	4.4	26.3	
1	0450	59	1361.	95.1	39.8	*	1	1845	226	29.	21.2	29.3	*	2	0840	393	6.	4.3	26.3	
1	0455	60	1350.	94.9	39.8	*	1	1850	227	28.	21.0	29.3	*	2	0845	394	6.	4.3	26.3	
1	0500	61	1326.	94.6	39.8	*	1	1855	228	28.	20.8	29.2	*	2	0850	395	6.	4.3	26.3	
1	0505	62	1270.	93.8	39.7	*	1	1900	229	28.	20.6	29.2	*	2	0855	396	6.	4.2	26.3	
1	0510	63	1182.	92.6	39.5	*	1	1905	230	28.	20.4	29.2	*	2	0900	397	6.	4.2	26.3	
1	0515	64	1070.	91.0	39.3	*	1	1910	231	27.	20.3	29.2	*	2	0905	398	6.	4.1	26.3	
1	0520	65	944.	89.3	39.1	*	1	1915	232	27.	20.1	29.1	*	2	0910	399	6.	4.1	26.3	
1	0525	66	814.	87.5	38.9	*	1	1920	233	27.	19.9	29.1	*	2	0915	400	6.	4.1	26.3	
1	0530	67	690.	85.8	38.6	*	1	1925	234	26.	19.7	29.1	*	2	0920	401	6.	4.0	26.3	
1	0535	68	576.	84.2	38.4	*	1	1930	235	26.	19.5	29.0	*	2	0925	402	6.	3.9	26.3	
1	0540	69	475.	82.8	38.2	*	1	1935	236	26.	19.3	29.0	*	2	0930	403	5.	3.9	26.3	
1	0545	70	392.	81.6	38.1	*	1	1940	237	25.	19.2	29.0	*	2	0935	404	5.	3.9	26.3	
1	0550	71	335.	80.7	38.0	*	1	1945	238	25.	19.0	29.0	*	2	0940	405	5.	3.9	26.2	
1	0555	72	306.	79.9	37.9	*	1	1950	239	25.	18.8	28.9	*	2	0945	406	5.	3.8	26.2	
1	0600	73	277.	79.1	37.8	*	1	1955	240	25.	18.7	28.9	*	2	0950	407	5.	3.8	26.2	
1	0605	74	249.																	

1	0855	108	68.	60.6	35.3	*	1	2250	275	18.	PMF.OUT	13.5	28.0	*	2	1245	442	4.	2.7	26.0
1	0900	109	67.	60.1	35.3	*	1	2255	276	18.	13.4	28.0	*	2	1250	443	4.	2.7	26.0	
1	0905	110	67.	59.6	35.2	*	1	2300	277	18.	13.2	28.0	*	2	1255	444	4.	2.6	26.0	
1	0910	111	67.	59.2	35.1	*	1	2305	278	18.	13.1	27.9	*	2	1300	445	4.	2.6	26.0	
1	0915	112	66.	58.7	35.1	*	1	2310	279	18.	13.0	27.9	*	2	1305	446	4.	2.6	26.0	
1	0920	113	66.	58.3	35.0	*	1	2315	280	18.	12.9	27.9	*	2	1310	447	4.	2.6	26.0	
1	0925	114	66.	57.8	35.0	*	1	2320	281	17.	12.7	27.9	*	2	1315	448	4.	2.6	26.0	
1	0930	115	65.	57.3	34.9	*	1	2325	282	17.	12.6	27.9	*	2	1320	449	4.	2.5	26.0	
1	0935	116	65.	56.9	34.8	*	1	2330	283	17.	12.5	27.8	*	2	1325	450	4.	2.5	26.0	
1	0940	117	65.	56.5	34.8	*	1	2335	284	17.	12.4	27.8	*	2	1330	451	3.	2.5	26.0	
1	0945	118	64.	56.0	34.7	*	1	2340	285	17.	12.3	27.8	*	2	1335	452	3.	2.4	26.0	
1	0950	119	64.	55.6	34.6	*	1	2345	286	17.	12.2	27.8	*	2	1340	453	3.	2.4	26.0	
1	0955	120	64.	55.1	34.6	*	1	2350	287	16.	12.0	27.8	*	2	1345	454	3.	2.4	26.0	
1	1000	121	63.	54.7	34.5	*	1	2355	288	16.	11.9	27.7	*	2	1350	455	3.	2.4	26.0	
1	1005	122	63.	54.3	34.4	*	2	0000	289	16.	11.8	27.7	*	2	1355	456	3.	2.4	26.0	
1	1010	123	62.	53.8	34.3	*	2	0005	290	16.	11.7	27.7	*	2	1400	457	3.	2.3	25.9	
1	1015	124	62.	53.4	34.3	*	2	0010	291	16.	11.6	27.7	*	2	1405	458	3.	2.3	25.9	
1	1020	125	62.	53.0	34.2	*	2	0015	292	16.	11.5	27.7	*	2	1410	459	3.	2.3	25.9	
1	1025	126	61.	52.5	34.2	*	2	0020	293	16.	11.4	27.6	*	2	1415	460	3.	2.3	25.9	
1	1030	127	61.	52.1	34.1	*	2	0025	294	15.	11.3	27.6	*	2	1420	461	3.	2.2	25.9	
1	1035	128	61.	51.7	34.0	*	2	0030	295	15.	11.2	27.6	*	2	1425	462	3.	2.2	25.9	
1	1040	129	60.	51.3	34.0	*	2	0035	296	15.	11.1	27.6	*	2	1430	463	3.	2.2	25.9	
1	1045	130	60.	50.9	33.9	*	2	0040	297	15.	11.0	27.6	*	2	1435	464	3.	2.2	25.9	
1	1050	131	60.	50.5	33.8	*	2	0045	298	15.	10.9	27.5	*	2	1440	465	3.	2.2	25.9	
1	1055	132	59.	50.1	33.8	*	2	0050	299	15.	10.8	27.5	*	2	1445	466	3.	2.1	25.9	
1	1100	133	59.	49.6	33.7	*	2	0055	300	15.	10.7	27.5	*	2	1450	467	3.	2.1	25.9	
1	1105	134	59.	49.2	33.6	*	2	0100	301	15.	10.6	27.5	*	2	1455	468	3.	2.1	25.9	
1	1110	135	58.	48.8	33.6	*	2	0105	302	14.	10.5	27.5	*	2	1500	469	3.	2.1	25.9	
1	1115	136	58.	48.4	33.5	*	2	0110	303	14.	10.4	27.5	*	2	1505	470	3.	2.1	25.9	
1	1120	137	58.	48.0	33.5	*	2	0115	304	14.	10.3	27.4	*	2	1510	471	3.	2.0	25.9	
1	1125	138	57.	47.6	33.4	*	2	0120	305	14.	10.2	27.4	*	2	1515	472	3.	2.0	25.9	
1	1130	139	57.	47.3	33.3	*	2	0125	306	14.	10.1	27.4	*	2	1520	473	3.	2.0	25.9	
1	1135	140	57.	46.9	33.3	*	2	0130	307	14.	10.0	27.4	*	2	1525	474	3.	2.0	25.9	
1	1140	141	56.	46.5	33.2	*	2	0135	308	14.	9.9	27.4	*	2	1530	475	3.	2.0	25.9	
1	1145	142	56.	46.1	33.2	*	2	0140	309	14.	9.8	27.4	*	2	1535	476	3.	1.9	25.9	
1	1150	143	56.	45.7	33.1	*	2	0145	310	13.	9.7	27.3	*	2	1540	477	3.	1.9	25.9	
1	1155	144	55.	45.3	33.0	*	2	0150	311	13.	9.6	27.3	*	2	1545	478	3.	1.9	25.9	
1	1200	145	55.	44.9	33.0	*	2	0155	312	13.	9.5	27.3	*	2	1550	479	3.	1.9	25.9	
1	1205	146	54.	44.6	32.9	*	2	0200	313	13.	9.4	27.3	*	2	1555	480	3.	1.9	25.9	
1	1210	147	54.	44.2	32.9	*	2	0205	314	13.	9.3	27.3	*	2	1600	481	3.	1.8	25.9	
1	1215	148	54.	43.8	32.8	*	2	0210	315	13.	9.2	27.3	*	2	1605	482	3.	1.8	25.9	
1	1220	149	54.	43.4	32.7	*	2	0215	316	13.	9.1	27.2	*	2	1610	483	3.	1.8	25.8	
1	1225	150	53.	43.1	32.7	*	2	0220	317	13.	9.0	27.2	*	2	1615	484	3.	1.8	25.8	
1	1230	151	53.	42.7	32.6	*	2	0225	318	13.	8.9	27.2	*	2	1620	485	3.	1.8	25.8	
1	1235	152	53.	42.3	32.6	*	2	0230	319	12.	8.8	27.2	*	2	1625	486	2.	1.8	25.8	
1	1240	153	53.	42.0	32.5	*	2	0235	320	12.	8.7	27.2	*	2	1630	487	2.	1.7	25.8	
1	1245	154	52.	41.6	32.5	*	2	0240	321	12.	8.7	27.2	*	2	1635	488	2.	1.7	25.8	
1	1250	155	52.	41.3	32.4	*	2	0245	322	12.	8.6	27.2	*	2	1640	489	2.	1.7	25.8	
1	1255	156	52.	40.9	32.3	*	2	0250	323	12.	8.6	27.1	*	2	1645	490	2.	1.7	25.8	
1	1300	157	51.	40.5	32.3	*	2	0255	324	12.	8.5	27.1	*	2	1650	491	2.	1.7	25.8	
1	1305	158	51.	40.2	32.2	*	2	0300	325	12.	8.4	27.1	*	2	1655	492	2.	1.7	25.8	
1	1310	159	51.	39.8	32.2	*	2	0305	326	12.	8.3	27.1	*	2	1700	493	2.	1.6	25.8	
1	1315	160	50.	39.5	32.1	*	2	0310	327	11.	8.2	27.1	*	2	1705	494	2.	1.6	25.8	
1	1320	161	50.	39.1	32.1	*	2	0315	328	11.	8.1	27.1	*	2	1710	495	2.	1.6	25.8	
1	1325	162	50.	38.8	32.0	*	2	0320	329	11.	8.1	27.1	*	2	1715	496	2.	1.6	25.8	
1	1330	163	50.	38.5	32.0	*	2	0325	330	11.	8.0	27.0	*	2	1720	497	2.	1.6	25.8	
1	1335	164	49.	38.1	31.9	*	2	0330	331	11.	7.9	27.0	*	2	1725	498	2.	1.6	25.8	
1	1340	165	49.	37.8	31.9	*	2	0335	332	11.	7.8	27.0	*	2	1730	499	2.	1.5	25.8	
1	1345	166	49.	37.4	31.8	*	2	0340	333	11.	7.8	27.0	*	2	1735	500	2.	1.5	25.8	
1	1350	167	48.	37.1	31.8	*	2	0345	334	11.	7.7	27.0	*	2						

PEAK FLOW	TIME	6-HR	MAXIMUM AVERAGE FLOW	41.58-HR
(CFS)	(HR)		24-HR	72-HR
+	4912.	3.83	1004.	165.
			10,635	12,118
			498.	567.
PEAK STORAGE	TIME	6-HR	MAXIMUM AVERAGE STORAGE	41.58-HR
(AC-FT)	(HR)		24-HR	72-HR
+	132.	3.83	86.	28.
PEAK STAGE	TIME	6-HR	MAXIMUM AVERAGE STAGE	41.58-HR
(FEET)	(HR)		24-HR	72-HR
+	43.98	3.83	38.57	30.11
CUMULATIVE AREA = .88 SQ MI				

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PEAK FLOW AND STAGE (END-OF-PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND, AREA IN SQUARE MILES
TIME TO PEAK IN HOURS

OPERATION	STATION	AREA	PLAN	RATIOS APPLIED TO PRECIPITATION	
				RATIO 1	RATIO 2
				1.00	.98
HYDROGRAPH AT	OFF1	.41	1 FLOW	2662.	2605.
+			TIME	3.75	3.75
HYDROGRAPH AT	OFF7	.03	1 FLOW	271.	266.
+			TIME	3.50	3.50
2 COMBINED AT	CP2	.44	1 FLOW	2804.	2745.
+			TIME	3.75	3.75
HYDROGRAPH AT	OFF2	.04	1 FLOW	323.	316.
+			TIME	3.58	3.58
HYDROGRAPH AT	OFF3	.03	1 FLOW	247.	241.
+			TIME	3.50	3.50
3 COMBINED AT	CP1	.50	1 FLOW	3128.	3062.
+			TIME	3.75	3.75
HYDROGRAPH AT	OFF4	.06	1 FLOW	538.	526.
+			TIME	3.58	3.58
HYDROGRAPH AT	OFF5	.26	1 FLOW	1549.	1516.
+			TIME	3.83	3.83
HYDROGRAPH AT	OFF6	.04	1 FLOW	370.	363.
+			TIME	3.58	3.58
HYDROGRAPH AT	ON1	.03	1 FLOW	252.	246.
+			TIME	3.50	3.50
5 COMBINED AT	DB1	.88	1 FLOW	5296.	5184.
+			TIME	3.67	3.67

PMF.OUT

ROUTED TO	RDB1	.88	1	FLOW	5020.	4912.
+				TIME	3.83	3.83
			**	PEAK STAGES IN FEET		**
			1	STAGE	44.09	43.98
				TIME	3.83	3.83

*** NORMAL END OF HEC-1 ***

APPENDIX D

Debris Loading MUSLE Computations

TABLE 14.--PHYSICAL AND CHEMICAL PROPERTIES OF SOILS--Continued

Soil name and map symbol	Depth	Clay	Permeability	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Erosion factors		Wind erodibility group
								K	T	
	In	Pct	In/hr	In/in	pH	Mmhos/cm				
140----- Casaga	0-1 1-21 21-41 41-60	20-30 27-35 27-35 8-18	0.2-0.6 0.06-0.2 0.2-0.6 2.0-6.0	0.08-0.10 0.19-0.21 0.08-0.11 0.06-0.10	>8.4 >8.4 >8.4 7.4-9.0	8-16 4-8 4-8 8-16	Moderate----- Moderate----- Moderate----- Low-----	0.10 0.32 0.17 0.10	5	7
150----- Cave	0-6 6-60	10-20 ---	0.6-2.0 ---	0.06-0.10 ---	7.4-8.4 ---	<2 ---	Low----- ---	0.10 ---	1	5
151----- Cave	0-5 5-11 11-60	3-8 10-20 ---	6.0-20 0.6-2.0 ---	0.09-0.11 0.07-0.12 ---	7.9-8.4 7.9-8.4 ---	2-4 2-4 ---	Low----- Low----- ---	0.17 0.24 ---	1	2
152----- Cave	0-12 12-36 36-60	10-20 --- 2-5	0.6-2.0 --- 2.0-6.0	0.07-0.12 --- 0.04-0.06	7.9-8.4 --- 7.9-8.4	2-4 --- <4	Low----- --- Low-----	0.20 --- 0.10	1	4L
155----- Cave	0-15 15-60	10-20 ---	0.6-2.0 ---	0.07-0.12 ---	7.9-8.4 ---	2-4 ---	Low----- ---	0.20	1	4L
160----- Destazo	0-11 11-40 40-60	8-18 20-35 15-20	2.0-6.0 0.2-0.6 2.0-6.0	0.10-0.12 0.05-0.10 0.09-0.11	7.9-8.4 7.9-8.4 7.9-8.4	<4 <4 <4	Low----- Low----- Low-----	0.17 0.10 0.17	5	8
181*: Caliza	0-2 2-14 14-60	4-10 3-8 2-8	2.0-6.0 2.0-6.0 6.0-20	0.05-0.08 0.05-0.09 0.03-0.07	7.9-8.4 7.9-8.4 7.9-8.4	<2 <2 <2	Low----- Low----- Low-----	0.05 0.10 0.05	5	6
Pittman-----	0-2 2-23 23-32 32-50 50-60	5-15 2-12 --- --- 0-5	6.0-20 6.0-20 --- --- 6.0-20	0.04-0.08 0.04-0.08 --- --- 0.03-0.06	7.4-8.4 7.9-8.4 --- --- 7.4-8.4	<2 <2 --- --- <8	Low----- Low----- --- --- Low-----	0.10 0.17 --- --- 0.05	2	8
182*: Caliza	0-2 2-14 14-60	4-10 3-8 2-8	2.0-6.0 2.0-6.0 6.0-20	0.05-0.08 0.05-0.09 0.03-0.07	7.9-8.4 7.9-8.4 7.9-8.4	<2 <2 <2	Low----- Low----- Low-----	0.05 0.10 0.05	5	6
Pittman-----	0-2 2-23 23-32 32-50 50-60	5-15 2-12 --- --- 0-5	6.0-20 6.0-20 --- --- 6.0-20	0.04-0.06 0.04-0.08 --- --- 0.03-0.06	7.4-8.4 7.9-8.4 --- --- 7.4-8.4	<2 <2 --- --- <8	Low----- Low----- --- --- Low-----	0.10 0.17 --- --- 0.05	2	8
Arizo-----	0-8 8-60	2-8 0-5	6.0-20 >20	0.04-0.06 0.04-0.06	7.4-9.0 7.4-9.0	<2 <2	Low----- Low-----	0.15 0.10	5	4
183----- Caliza	0-3 3-60	2-6 2-8	6.0-20 2.0-6.0	0.04-0.07 0.03-0.07	7.9-8.4 7.9-8.4	<2 <2	Low----- Low-----	0.05 0.05	5	5
184----- Caliza	0-3 3-16 16-60	5-10 5-10 3-8	2.0-6.0 2.0-6.0 6.0-20	0.05-0.07 0.05-0.08 0.03-0.06	7.9-8.4 7.9-8.4 7.9-8.4	<2 <2 <2	Low----- Low----- Low-----	0.10 0.05 0.10	5	5
187----- Caliza	0-2 2-14 14-60	4-10 3-8 2-8	2.0-6.0 2.0-6.0 6.0-20	0.05-0.08 0.05-0.09 0.03-0.07	7.9-8.4 7.9-8.4 7.9-8.4	<2 <2 <2	Low----- Low----- Low-----	0.05 0.10 0.05	5	6
190----- Dalian	0-4 4-61	5-10 3-12	2.0-6.0 2.0-6.0	0.05-0.09 0.05-0.09	7.9-8.4 7.9-8.4	<2 <2	Low----- Low-----	0.15 0.15	5	5
191----- Dalian	0-5 5-60	5-10 3-12	2.0-6.0 2.0-6.0	0.05-0.09 0.05-0.09	7.9-8.4 7.9-8.4	<2 <2	Low----- Low-----	0.15 0.15	5	8
192*: Dalian	0-5 5-60	5-10 3-12	2.0-6.0 2.0-6.0	0.05-0.09 0.05-0.09	7.9-8.4 7.9-8.4	<2 <2	Low----- Low-----	0.15 0.15	5	5

See footnote at end of table.

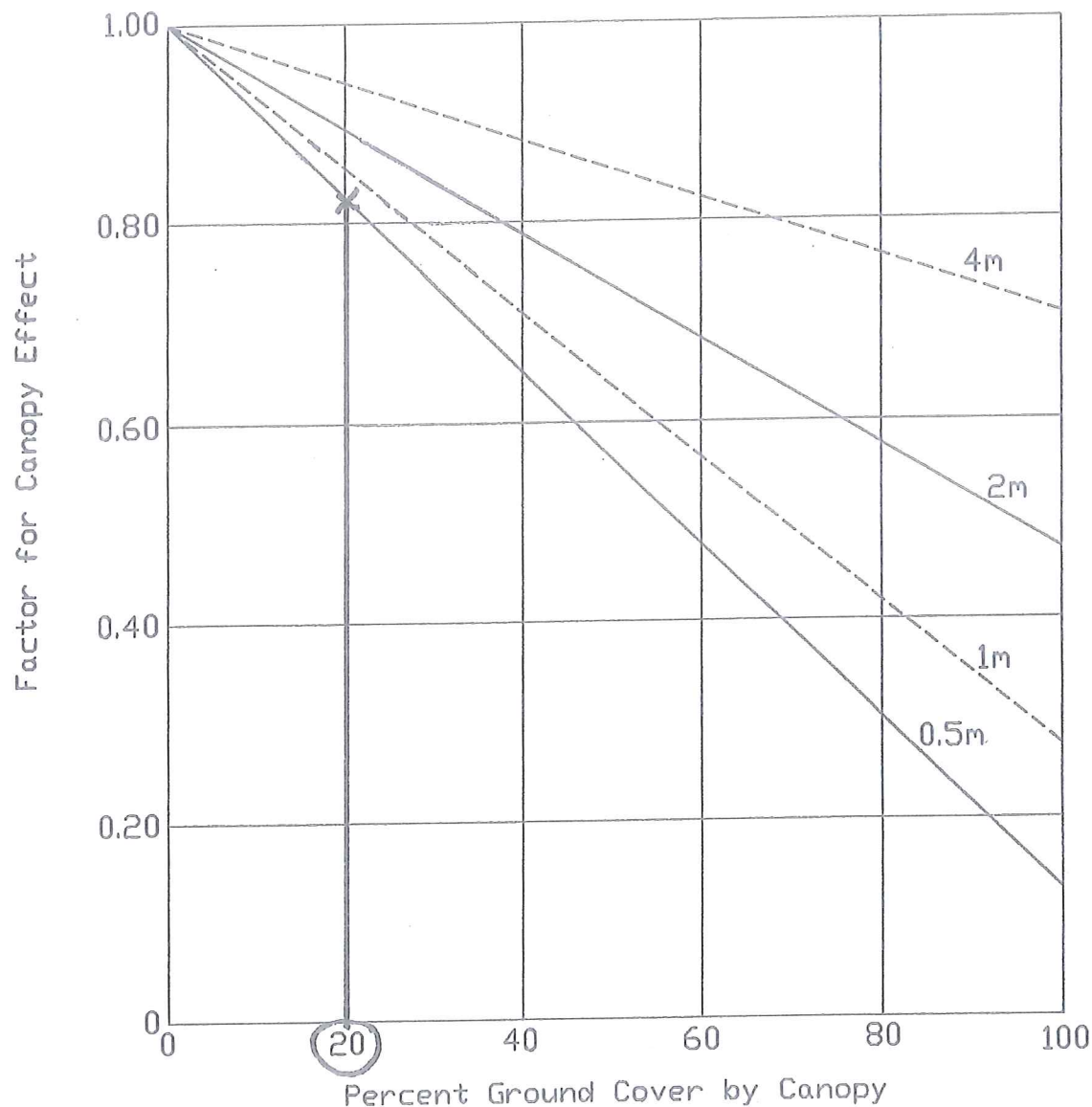
TABLE 14.---PHYSICAL AND CHEMICAL PROPERTIES OF SOILS---Continued

Soil name and map symbol	Depth	Clay	Permeability	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Erosion factors		Wind erodibility group
								K	T	
	In	Pct	In/hr	In/in	pH	Mmhos/cm				
400----- Tencee	0-5 5-15 15-60	10-20 10-20 ---	2.0-6.0 0.6-2.0 ---	0.05-0.07 0.05-0.08 ---	7.9-8.4 7.9-8.4 ---	<2 <2 ---	Low----- Low----- ---	0.15 0.15 ---	1	8
415----- Aztec	0-2 2-30 30-60	6-12 3-15 ---	2.0-6.0 0.2-0.6 ---	0.06-0.08 0.06-0.08 ---	7.4-9.0 7.4-9.0 ---	<2 4-8 ---	Low----- Low----- ---	0.10 0.15 ---	5	6
417*: Aztec	0-4 4-30 30-60	6-12 3-15 ---	2.0-6.0 0.2-0.6 ---	0.06-0.08 0.06-0.08 ---	7.4-9.0 7.4-9.0 ---	<2 4-8 ---	Low----- Low----- ---	0.10 0.15 ---	5	6
Rock outcrop.										
418*: Aztec	0-4 4-30 30-60	3-12 3-15 ---	2.0-20 0.2-0.6 ---	0.06-0.10 0.06-0.08 ---	7.4-9.0 7.4-9.0 ---	<2 4-8 ---	Low----- Low----- ---	0.17 0.15 ---	5	3
Nickel-----	0-9 9-23 23-45 45	4-12 6-15 2-10 ---	2.0-6.0 0.2-0.6 2.0-6.0 ---	0.06-0.10 0.04-0.07 0.04-0.08 ---	7.9-9.0 7.9-9.0 7.9-9.0 ---	<2 <2 <2 ---	Low----- Low----- Low----- ---	0.15 0.05 0.05 ---	5	4
Knob Hill-----	0-7 7-23 23-37 37-60	3-8 3-10 3-10 3-8	6.0-20 2.0-6.0 2.0-6.0 6.0-20	0.06-0.08 0.06-0.08 0.06-0.08 0.05-0.07	7.9-8.4 7.9-8.4 7.9-9.0 7.9-9.0	<2 <2 <4 <4	Low----- Low----- Low----- Low-----	0.17 0.17 0.17 0.17	5	2
419*: Aztec	0-4 4-60	3-12 3-15	2.0-20 0.2-0.6	0.06-0.10 0.06-0.08	7.4-9.0 7.4-9.0	<2 4-8	Low----- Low-----	0.17 0.15	5	3
Bracken-----	0-1 1-60	4-10 ---	2.0-6.0 ---	0.06-0.11 ---	7.4-8.4 ---	<2 ---	Low----- ---	0.10 ---	4	6
430----- Knob Hill	0-7 7-23 23-37 37-60	3-8 3-10 3-10 3-8	6.0-20 2.0-6.0 2.0-6.0 6.0-20	0.06-0.08 0.06-0.08 0.06-0.08 0.05-0.07	7.9-8.4 7.9-8.4 7.9-9.0 7.9-9.0	<2 <2 <4 <4	Low----- Low----- Low----- Low-----	0.17 0.17 0.17 0.17	5	2
440----- Nickel	0-9 9-23 23-45 45	4-12 6-15 2-10 ---	2.0-6.0 0.2-0.6 2.0-6.0 ---	0.04-0.08 0.04-0.07 0.04-0.08 ---	7.9-9.0 7.9-9.0 7.9-9.0 ---	<2 <2 <2 ---	Low----- Low----- Low----- ---	0.10 0.05 0.05 ---	5	5
450----- Cave Variant	0-2 2-11 11-29 29-40 40-60	7-15 7-18 ---	2.0-6.0 2.0-6.0 ---	0.06-0.09 0.04-0.08 ---	7.9-8.4 7.9-8.4 ---	<2 <2 ---	Low----- Low----- ---	0.17 0.17 ---	1	5
	11-29 29-40 40-60	12-30 5-10 ---	0.6-2.0 2.0-6.0 ---	0.10-0.14 0.05-0.09 ---	7.9-8.4 7.4-7.8 ---	8-16 8-16 ---	Moderate----- Low----- ---	0.24 0.15 ---		
481----- Hobog	0-4 4-13 13	1-5 12-25 ---	6.0-20 0.6-2.0 ---	0.08-0.10 0.04-0.06 ---	7.4-8.4 7.4-9.0 ---	<2 <2 ---	Low----- Low----- ---	0.17 0.20 ---	1	2
484----- Hobog	0-9 9-15 15	9-21 9-21 ---	0.6-2.0 0.6-2.0 ---	0.04-0.06 0.04-0.06 ---	7.4-9.0 7.4-9.0 ---	<2 <2 ---	Low----- Low----- ---	0.10 0.17 ---	1	8
500*: Canutio	0-4 4-43 43	5-12 5-10 ---	2.0-6.0 2.0-6.0 ---	0.05-0.08 0.04-0.08 ---	7.4-8.4 7.4-8.4 ---	<2 <2 ---	Low----- Low----- ---	0.10 0.10 ---	3	8
Akela-----	0-3 3-11 11-60	5-12 6-10 ---	0.6-2.0 0.6-2.0 ---	0.04-0.09 0.04-0.09 ---	7.4-8.4 7.4-8.4 ---	<2 <2 ---	Low----- Low----- ---	0.17 0.17 ---	1	5

See footnote at end of table.

INFLUENCE OF VEGETAL CANOPY (C_v)

$$C_v = 0.82$$



ESTIMATED 20% GROUND COVER @ 0.5m HIGH CANOPY
 PER TABLE 602 4 OF 4 DESERT SHRUB - POOR CONDITION
 (< 30% GROUND COVER)

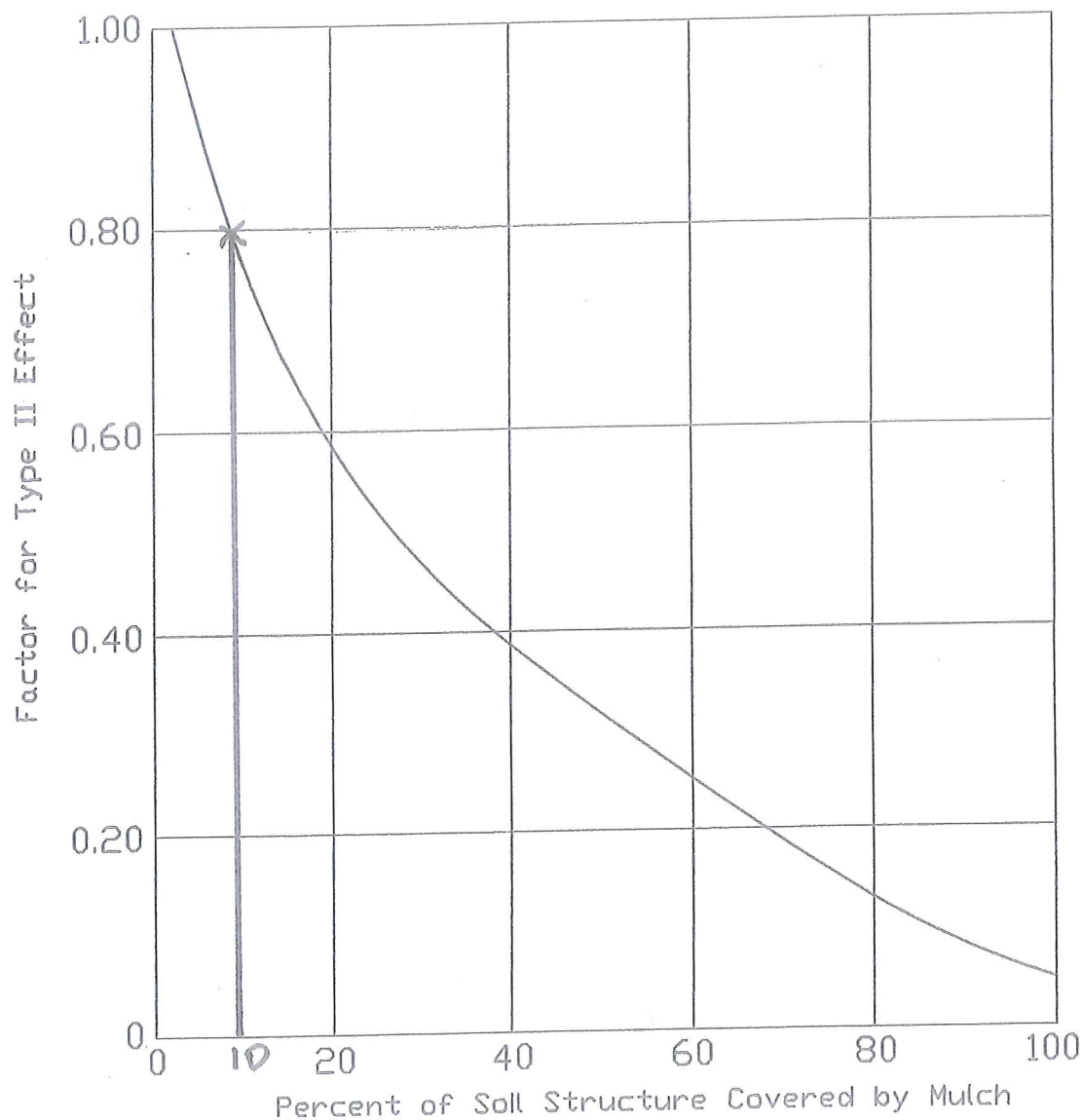
Revision	Date

REFERENCE: A Soil-Erodibility Nomograph
 for Farmland and Construction Sites, 1971

FIGURE 1303b

EFFECT OF PLANT RESIDUES OR CLOSE-GROWING STEMS AT THE SOIL SURFACE (C_{11})

$$C_{11} = 0.80$$



ESTIMATED 10% MULCH

Revision	Date

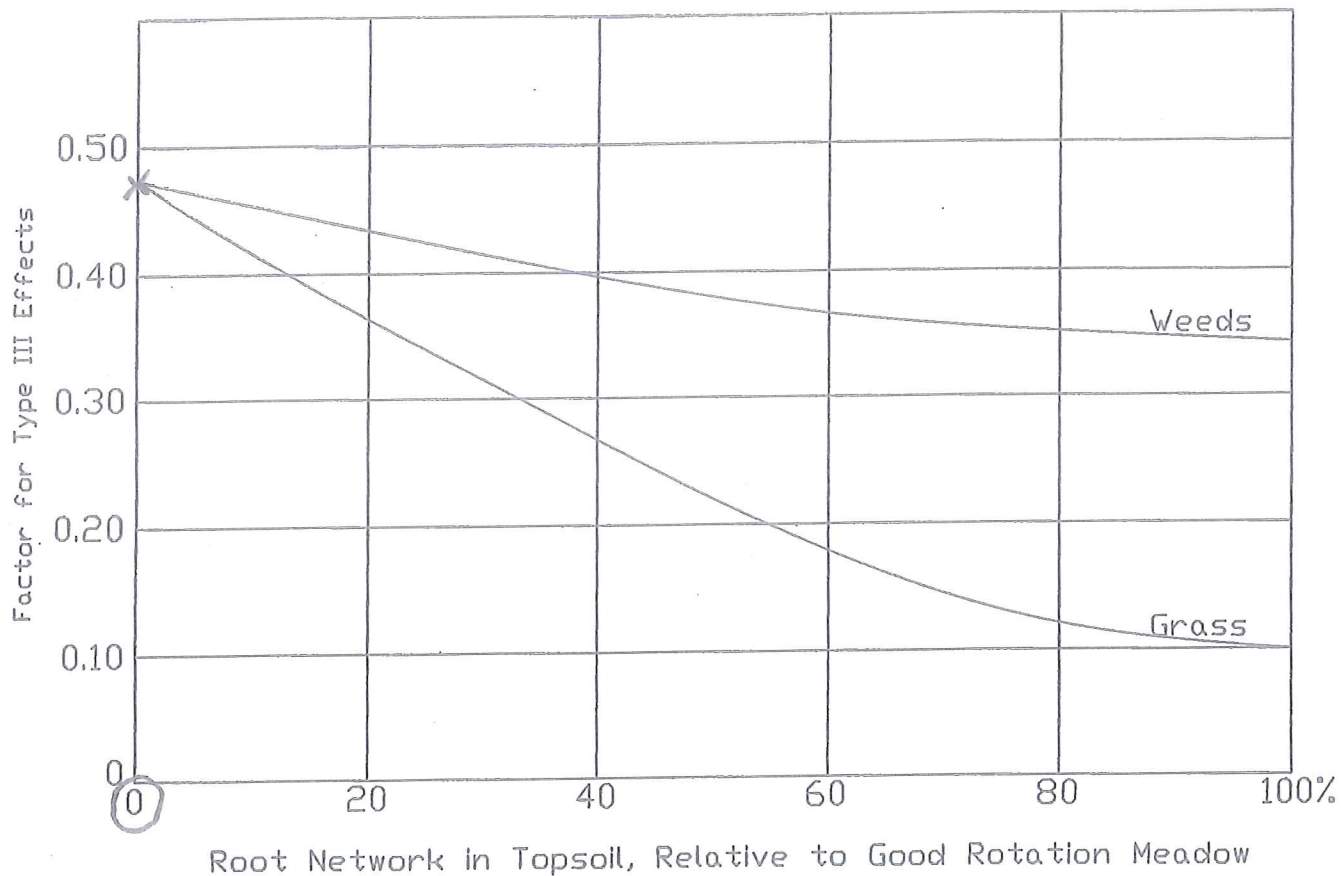
REFERENCE: Estimating the Cover and Management Factor for Undisturbed Areas, 1972

FIGURE 1303c

HYDROLOGIC CRITERIA AND DRAINAGE DESIGN MANUAL

TYPE III EFFECTS ON UNDISTURBED LAND AREAS (C_{III})

$$C_{III} = 0.48$$

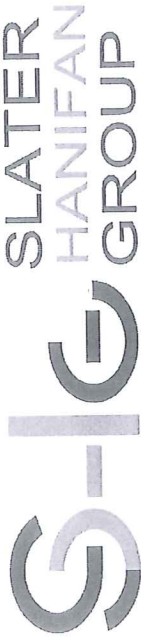


0% ROOTS IN TOP SOIL, NO TREES

Revision	Date

REFERENCE: Estimating the Cover and Management Factor for Undisturbed Areas, 1972

FIGURE 1303d



CONSULTING ENGINEERS & PLANNERS

Modified Universal Soil Loss Equation

BY: SMJ
DATE: 8/7/2014

$$Y_s = 95(VQ_p)^{0.56} K(LS)CP$$

Eqn. 1307

Basin/Concentration Point =

OFF1

Runoff Volume (V) =

38 ac-ft

(From HEC-1)

Peak Flow (Q_p) =

387 cfs

(From HEC-1)

Soil Erodibility Factor (K) =

0.172

(See Composite K Calcs)

Topographic Factor (LS) =

$$LS = (X_r)^{0.5} (0.0076 + 0.53S_0 + 7.6S_0^2)$$

Eqn. 1303

Runoff Length (X_r) =

11804 ft

(From Standard Form 4)

Runoff Slope (S₀) =

0.0359 ft/ft

(From Standard Form 4)

Cropping Management Factor (C) =

0.31

Eqn. 1304

Canopy Cover (C_i) =

0.82

Fig. 1303b

Mulch/Vegetation on Soil Surface (C_{ii}) =

0.80

Fig. 1303c

Tillage and Land Use (C_{iii}) =

0.48

Fig. 1303d

Conservation Practice Factor (P) =

1.0

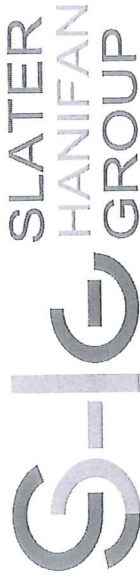
$$C = C_i C_{ii} C_{iii}$$

Sediment Yield (Y_s) =

4393.63902 tons

Sediment Volume =

2.20 ac-ft



CONSULTING ENGINEERS & PLANNERS

Soil Erodibility Factor Calculations

BY: SMJ
DATE: 8/7/2014

Basin/Concentration Point = OFF1

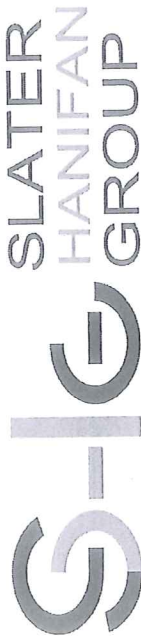
Soil Type 1 Breakdown = 44.2% %
Soil Type 2 Breakdown = 4.8% %
Soil Type 3 Breakdown = 51.0% %

Soil Type 1 Erosion Factor (K_w) = 0.20
Soil Type 2 Erosion Factor (K_w) = 0.15
Soil Type 3 Erosion Factor (K_w) = 0.15

Soil Type 155 (From Soils Exhibit)
Soil Type 191 (From Soils Exhibit)
Soil Type 400 (From Soils Exhibit)

Soil Type 155 (From Soil Properties)
Soil Type 191 (From Soil Properties)
Soil Type 400 (From Soil Properties)

Composite Soil Erodibility Factor (K) = 0.172



CONSULTING ENGINEERS & PLANNERS

Modified Universal Soil Loss Equation

BY: SMJ
DATE: 8/7/2014

$$Y_s = 95(VQ_p)^{0.56} K(LS)CP$$

Eqn. 1307

Basin/Concentration Point =

OFF2

Runoff Volume (V) =

3 ac-ft

(From HEC-1)

Peak Flow (Q_p) =

54 cfs

(From HEC-1)

Soil Erodibility Factor (K) =

0.188

(See Composite K Calcs)

Topographic Factor (LS) =

$$LS = (X_r)^{0.5} (0.0076 + 0.53S_0 + 7.6S_0^2)$$

2.06

Eqn. 1303

Runoff Length (X_r) =

2754 ft

(From Standard Form 4)

Runoff Slope (S₀) =

0.0385 ft/ft

(From Standard Form 4)

Cropping Management Factor (C) =

0.31

Eqn. 1304

Canopy Cover (C_i) =

0.82

Fig. 1303b

Mulch/Vegetation on Soil Surface (C_{ii}) =

0.80

Fig. 1303c

Tillage and Land Use (C_{iii}) =

0.48

Fig. 1303d

Conservation Practice Factor (P) =

1.0

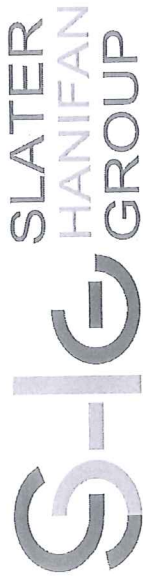
$$C = C_i C_{ii} C_{iii}$$

Sediment Yield (Y_s) =

199.690835 tons

Sediment Volume =

0.10 ac-ft



CONSULTING ENGINEERS & PLANNERS

Soil Erodibility Factor Calculations

BY: SMJ
DATE: 8/7/2014

Basin/Concentration Point = OFF2

Soil Type 1 Breakdown = 75.1% %
Soil Type 2 Breakdown = 24.9% %

Soil Type 1 Erosion Factor (K_w) = 0.20
Soil Type 2 Erosion Factor (K_w) = 0.15

Soil Type 155 (From Soils Exhibit)
Soil Type 191 (From Soils Exhibit)

Soil Type 155 (From Soil Properties)
Soil Type 191 (From Soil Properties)

Composite Soil Erodibility Factor (K) = 0.188



CONSULTING ENGINEERS & PLANNERS

Modified Universal Soil Loss Equation

BY: SMJ
DATE: 8/7/2014

Eqn. 1307

$$Y_s = 95(VQ_P)^{0.56} K(LS)CP$$

Basin/Concentration Point =

OFF3

Runoff Volume (V) =

2

ac-ft

Peak Flow (Q_P) =

38

cfs

Soil Erodibility Factor (K) =

0.200

Topographic Factor (LS) =

2.70

ft

Runoff Length (X_r) =

2647

ft

Runoff Slope (S₀) =

0.0495

ft/ft

Cropping Management Factor (C) =

0.31

Canopy Cover (C_I) =

0.82

Mulch/Vegetation on Soil Surface (C_{II}) =

0.80

Tillage and Land Use (C_{III}) =

0.48

Conservation Practice Factor (P) =

1.0

(From HEC-1)

(From HEC-1)

(See Composite K Calcs)

Eqn. 1303

(From Standard Form 4)

(From Standard Form 4)

Eqn. 1304

Fig. 1303b

Fig. 1303c

Fig. 1303d

$$LS = (X_r)^{0.5} (0.0076 + 0.53S_0 + 7.6S_0^2)$$

$$C = C_I C_{II} C_{III}$$

Sediment Yield (Y_s) =

182.529844 tons

Sediment Volume =

0.09 ac-ft



Soil Erodibility Factor Calculations

BY: SMJ
DATE: 8/7/2014

Basin/Concentration Point = OFF3

Soil Type 1 Breakdown = 100.0% %

Soil Type 1 Erosion Factor (K_w) = 0.20

Soil Type 155 (From Soils Exhibit)

Soil Type 155 (From Soil Properties)

Composite Soil Erodibility Factor (K) = 0.200



CONSULTING ENGINEERS & PLANNERS

Modified Universal Soil Loss Equation

BY: SMJ
DATE: 8/7/2014

$$Y_s = 95(VQ_p)^{0.56} K(LS)C_p$$

Eqn. 1307

Basin/Concentration Point =

OFF4

Runoff Volume (V) =

5 ac-ft

(From HEC-1)

Peak Flow (Q_p) =

84 cfs

(From HEC-1)

Soil Erodibility Factor (K) =

0.200

(See Composite K Calcs)

Topographic Factor (LS) =

3.08

$$LS = (X_r)^{0.5} (0.0076 + 0.53S_0 + 7.6S_0^2)$$

Eqn. 1303

Runoff Length (X_r) =

3522 ft

(From Standard Form 4)

Runoff Slope (S₀) =

0.0491 ft/ft

(From Standard Form 4)

Cropping Management Factor (C) =

0.31

$$C = C_I C_{II} C_{III}$$

Eqn. 1304

Canopy Cover (C_I) =

0.82

Fig. 1303b

Mulch/Vegetation on Soil Surface (C_{II}) =

0.80

Fig. 1303c

Tillage and Land Use (C_{III}) =

0.48

Fig. 1303d

Conservation Practice Factor (P) =

1.0

Sediment Yield (Y_s) =

543.072749 tons

Sediment Volume =

0.27 ac-ft

Soil Erodibility Factor Calculations

BY: SMJ
DATE: 8/7/2014

Basin/Concentration Point = OFF4

Soil Type 1 Breakdown = 100.0% %

Soil Type 1 Erosion Factor (K_w) = 0.20

Soil Type 155 (From Soils Exhibit)

Soil Type 155 (From Soil Properties)

Composite Soil Erodibility Factor (K) = 0.200

BY: SMJ
DATE: 8/7/2014

Eqn. 1307

$$Y_s = 95(VQ_p)^{0.56} K(LS) CP$$

Basin/Concentration Point =

OFF5

Runoff Volume (V) =

23 ac-ft

(From HEC-1)

Peak Flow (Q_p) =

236 cfs

(From HEC-1)

Soil Erodibility Factor (K) =

0.182

(See Composite K Calcs)

Topographic Factor (LS) =

4.18

$$LS = (X_r)^{0.5} (0.0076 + 0.53S_0 + 7.6S_0^2)$$

Eqn. 1303

Runoff Length (X_r) =

12337 ft

(From Standard Form 4)

Runoff Slope (S₀) =

0.037 ft/ft

(From Standard Form 4)

Cropping Management Factor (C) =

0.31

Eqn. 1304

Canopy Cover (C_I) =

0.82

Fig. 1303b

Mulch/Vegetation on Soil Surface (C_{II}) =

0.80

Fig. 1303c

Tillage and Land Use (C_{III}) =

0.48

Fig. 1303d

Conservation Practice Factor (P) =

1.0

$$C = C_I C_{II} C_{III}$$

Sediment Yield (Y_s) =

2806.58353 tons

Sediment Volume =

1.40 ac-ft

Soil Erodibility Factor Calculations

BY: SMJ
DATE: 8/7/2014

Basin/Concentration Point = OFF5

Soil Type 1 Breakdown = 63.9% %
Soil Type 2 Breakdown = 36.1% %

Soil Type 1 Erosion Factor (K_w) = 0.20
Soil Type 2 Erosion Factor (K_w) = 0.15

Soil Type 155 (From Soils Exhibit)
Soil Type 400 (From Soils Exhibit)

Soil Type 155 (From Soil Properties)
Soil Type 400 (From Soil Properties)

Composite Soil Erodibility Factor (K) = 0.182

Modified Universal Soil Loss Equation

BY: SMJ
DATE: 8/7/2014

Eqn. 1307

$$Y_s = 95(VQ_p)^{0.56} K(LS) C_P$$

Basin/Concentration Point =

OFF6

Runoff Volume (V) =

4

ac-ft

Peak Flow (Q_p) =

59

cfs

Soil Erodibility Factor (K) =

0.200

(From HEC-1)

(From HEC-1)

(See Composite K Calcs)

Topographic Factor (LS) =

2.23

$$LS = (X_r)^{0.5} (0.0076 + 0.53S_0 + 7.6S_0^2)$$

Eqn. 1303

(From Standard Form 4)

(From Standard Form 4)

Runoff Length (X_r) =

2341

ft

Runoff Slope (S₀) =

0.0444

ft/ft

Cropping Management Factor (C) =

0.31

$$C = C_I C_{II} C_{III}$$

Eqn. 1304

Canopy Cover (C_I) =

0.82

Fig. 1303b

Mulch/Vegetation on Soil Surface (C_{II}) =

0.80

Fig. 1303c

Tillage and Land Use (C_{III}) =

0.48

Fig. 1303d

Conservation Practice Factor (P) =

1.0

Sediment Yield (Y_s) =

284.620427

tons

Sediment Volume =

0.14

ac-ft



Soil Erodibility Factor Calculations

BY: SMJ
DATE: 8/7/2014

Basin/Concentration Point = OFF6

Soil Type 1 Breakdown = 100.0% %

Soil Type 1 Erosion Factor (K_w) = 0.20

Soil Type 155 (From Soils Exhibit)

Soil Type 155 (From Soil Properties)

Composite Soil Erodibility Factor (K) = 0.200

APPENDIX E

Main Inflow Channel Hydraulic Computations

Typical Cross Section 1

Worksheet for Trapezoidal Channel

Project Description	
Worksheet	CP1 Inflow Channel @ 0.5%
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data	
Mannings Coefficient	0.015
Channel Slope	0.50 %
Left Side Slope	3.00 H : V
Right Side Slope	3.00 H : V
Bottom Width	12.00 ft
Discharge	471.00 cfs

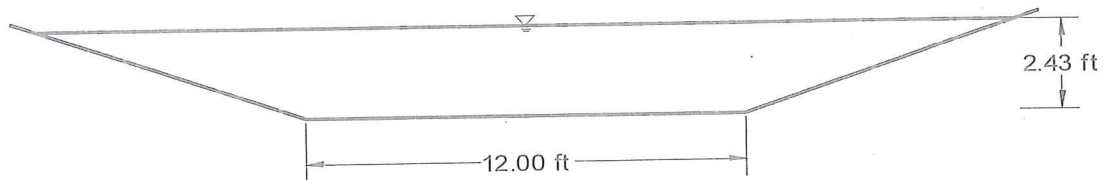
Results	
Depth	2.43 ft
Flow Area	46.9 ft ²
Wetted Perimeter	27.39 ft
Top Width	26.60 ft
Critical Depth	2.85 ft
Critical Slope	0.27 %
Velocity	10.03 ft/s
Velocity Head	1.56 ft
Specific Energy	4.00 ft
Froude Number	1.33
Flow Type	Supercritical

Notes: CP1 = 471 cfs

Typical Cross Section 1 Cross Section for Trapezoidal Channel

Project Description	
Worksheet	CP1 Inflow Channel @ 0.5%
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Section Data	
Mannings Coefficient	0.015
Channel Slope	0.50 %
Depth	2.43 ft
Left Side Slope	3.00 H : V
Right Side Slope	3.00 H : V
Bottom Width	12.00 ft
Discharge	471.00 cfs



V:1
H:1
NTS

Typical Cross Section 2

Worksheet for Trapezoidal Channel

Project Description	
Worksheet	CP1 Inflow Channel @ 10.0%
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data	
Mannings Coefficient	0.015
Channel Slope	10.00 %
Left Side Slope	3.00 H : V
Right Side Slope	3.00 H : V
Bottom Width	12.00 ft
Discharge	471.00 cfs

Results	
Depth	1.08 ft
Flow Area	16.5 ft ²
Wetted Perimeter	18.83 ft
Top Width	18.48 ft
Critical Depth	2.85 ft
Critical Slope	0.27 %
Velocity	28.63 ft/s
Velocity Head	12.74 ft
Specific Energy	13.82 ft
Froude Number	5.35
Flow Type	Supercritical

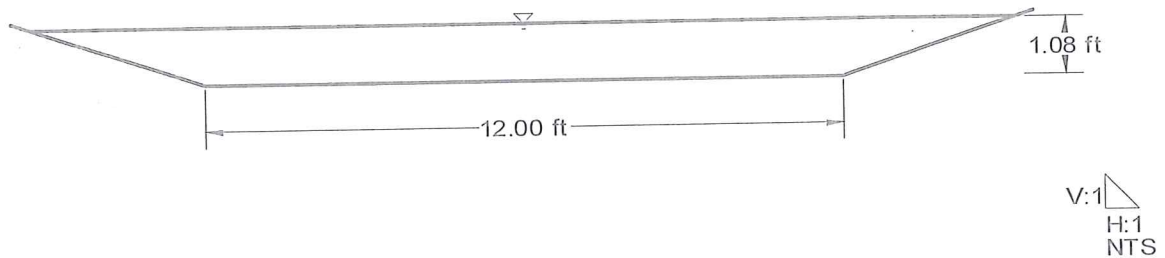
Notes: CP1 = 471 cfs

Typical Cross Section 2

Cross Section for Trapezoidal Channel

Project Description	
Worksheet	CP1 Inflow Channel @ 10.0%
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Section Data	
Mannings Coefficient	0.015
Channel Slope	10.00 %
Depth	1.08 ft
Left Side Slope	3.00 H : V
Right Side Slope	3.00 H : V
Bottom Width	12.00 ft
Discharge	471.00 cfs



Cross Section 3

Worksheet for Rectangular Channel

Project Description	
Worksheet	Drop Flume (DB1)
Flow Element	Rectangular Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data	
Mannings Coefficient	0.015
Channel Slope	33.30 %
Bottom Width	25.00 ft
Discharge	471.00 cfs

Results	
Depth	0.52 ft
Flow Area	13.1 ft ²
Wetted Perimeter	26.04 ft
Top Width	25.00 ft
Critical Depth	2.23 ft
Critical Slope	0.31 %
Velocity	36.09 ft/s
Velocity Head	20.24 ft
Specific Energy	20.76 ft
Froude Number	8.81
Flow Type	Supercritical

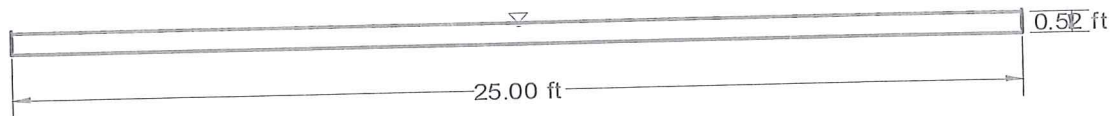
Notes: CP1 = 471 cfs

Cross Section 3

Cross Section for Rectangular Channel

Project Description	
Worksheet	Drop Flume (DB1)
Flow Element	Rectangular Channel
Method	Manning's Formula
Solve For	Channel Depth

Section Data	
Mannings Coefficient	0.015
Channel Slope	33.30 %
Depth	0.52 ft
Bottom Width	25.00 ft
Discharge	471.00 cfs



V:1
H:1
NTS

CHANNEL DROP AND ENERGY DISSIPATION STRUCTURES

STRUCTURE	1 UPSTREAM FLOW CLASS	2 MAXIMUM ALLOWED DROP HEIGHT (FEET)	3 MAXIMUM ALLOWED FLOW RATE (CFS/FT)	4 MAXIMUM ALLOWED INFLOW VELOCITY (FPS)	5 APRON ENTRANCE FROUDE NO. (FR)	6 MAXIMUM APRON ENTRANCE VELOCITY (FPS)	7 REQUIRED CROSS- SECTION GEOMETRY	8 REFERENCE FIGURE NUMBER
SLOPING RIPRAP DROP	SUB.	3	35	7	-	-	TRAP.	1102
VERTICAL RIPRAP DROP	SUB.	3	35	7	-	-	TRAP.	1103
GABION DROP	SUB.	10	35	-	-	-	TRAP. OR RECT.	1104- 1106
STRAIGHT DROP	SUB.	8	-	-	-	-	RECT.	1107
BAFFLED APRON (USBR TYPE IX)	SUB.	-	60	12	-	-	RECT.	1108
SHORT STILLING BASIN (USBR TYPE III)	SUB. OR SUPER	-	-	-	>4.5	60	RECT.	1110
LOW FROUDE NUMBER BASIN (USBR TYPE IV)	SUB. OR SUPER	-	-	-	2.5 TO 4.5	-	RECT.	1111
BAFFLED OUTLET (USBR TYPE VI)	SUB. OR SUPER	NA	-	30	NA	NA	NA	1112

COLUMN DESCRIPTIONS:

1. SUB. = SUBCRITICAL ($F_r < 0.86$)
SUPER = SUPERCRITICAL ($F_r > 1.13$)
2. DROP HEIGHT MEASURED FROM BOTTOM OF UPSTREAM CHANNEL TO BOTTOM OF DOWNSTREAM CHANNEL.
3. FLOW RATE = NORMAL DEPTH (Y_n) MULTIPLIED BY NORMAL VELOCITY (V_n).
4. INFLOW VELOCITY = UPSTREAM NORMAL CHANNEL VELOCITY.
5. FROUDE NUMBER FOR FLOW CONDITIONS AT ENTRANCE TO STRUCTURE APRON.
6. VELOCITY FOR FLOW CONDITIONS AT ENTRANCE TO STRUCTURE APRON.
7. CROSS-SECTION OF CHUTE AND STILLING BASIN.
8. REFERENCE TO FIGURES IN THIS MANUAL.

NOTE: Tail water (TW) is measured from invert of basin to water surface in channel immediately downstream of end sill.

Revised	Date

DROP STRUCTURE COMPUTATIONS

DESIGN PROCEDURE:

STEP 1: DETERMINE INLET FLOW HYDRAULIC FLOW PROPERTIES (SEE FLOW MASTER SECTION 3)

n-value = 0.015

bottom width = 25 feet

Q = 471 cfs

slope = 3:1

depth, $D_1 = 0.52$ ft

velocity, $V_1 = 36.09$ fps > OK; < 60 fps

Froude No., $F_1 = 8.81$ > OK; > 4.5

Flow Type = supercritical

STEP 2: DETERMINE CONJUGATE DEPTH, D_2 (SEE FIGURE 11)

$D_2/D_1 = 10.0$

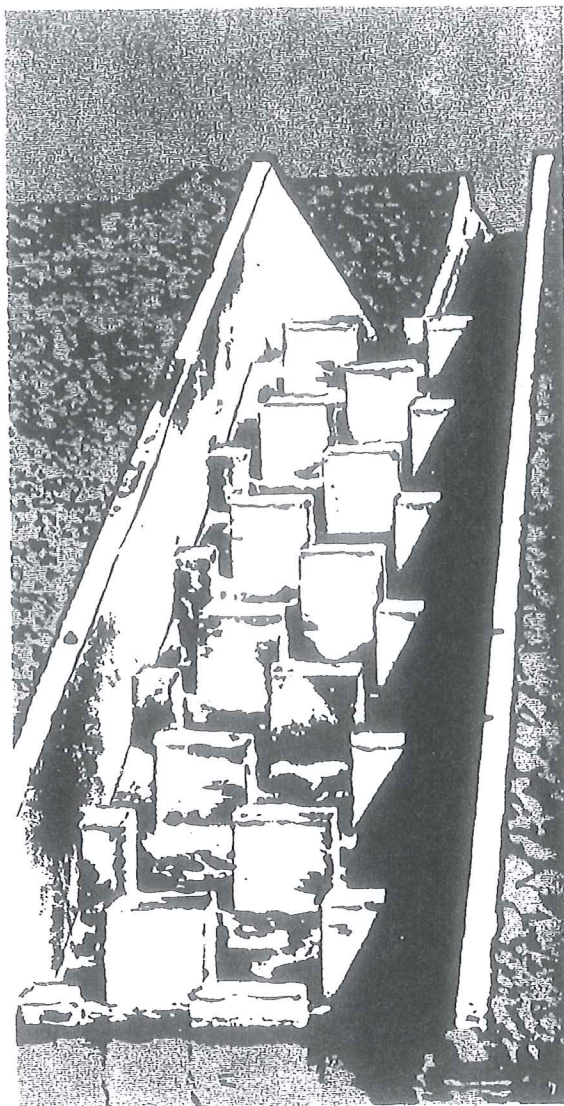
$D_2 = 5.2$ ft

STEP 3: DETERMINE LENGTH OF JUMP, L (SEE FIGURE 12)

$L/D_2 = 2.7$

$L = 14.0$ ft > Therefore, minimum apron length is 14.0 ft.

A WATER RESOURCES TECHNICAL PUBLICATION
ENGINEERING MONOGRAPH No. 25



Hydraulic Design of Stilling Basins and Energy Dissipators

UNITED STATES DEPARTMENT
OF THE INTERIOR
BUREAU OF RECLAMATION

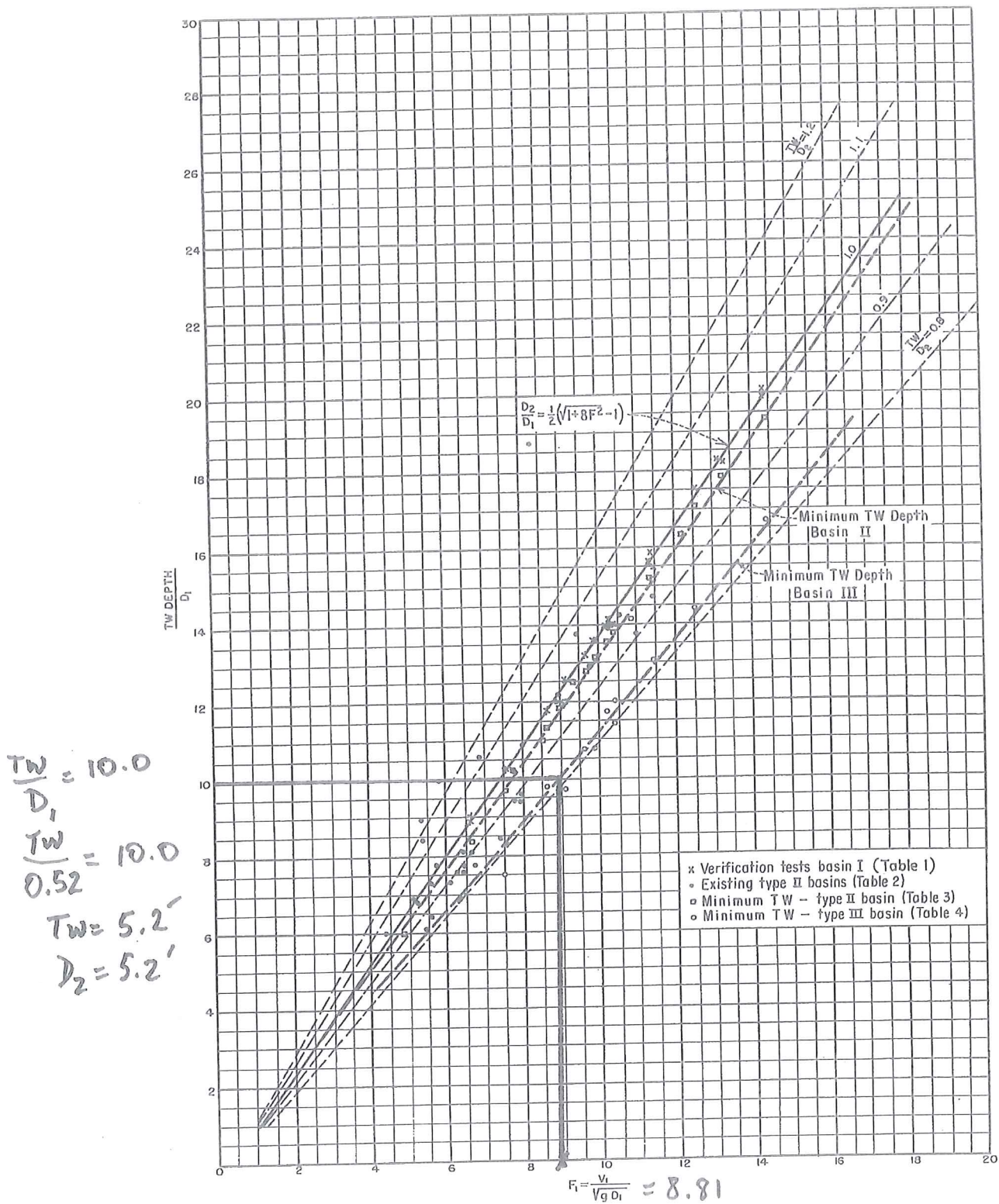


FIGURE 11.—Minimum tail water depths (Basins I, II, and III).

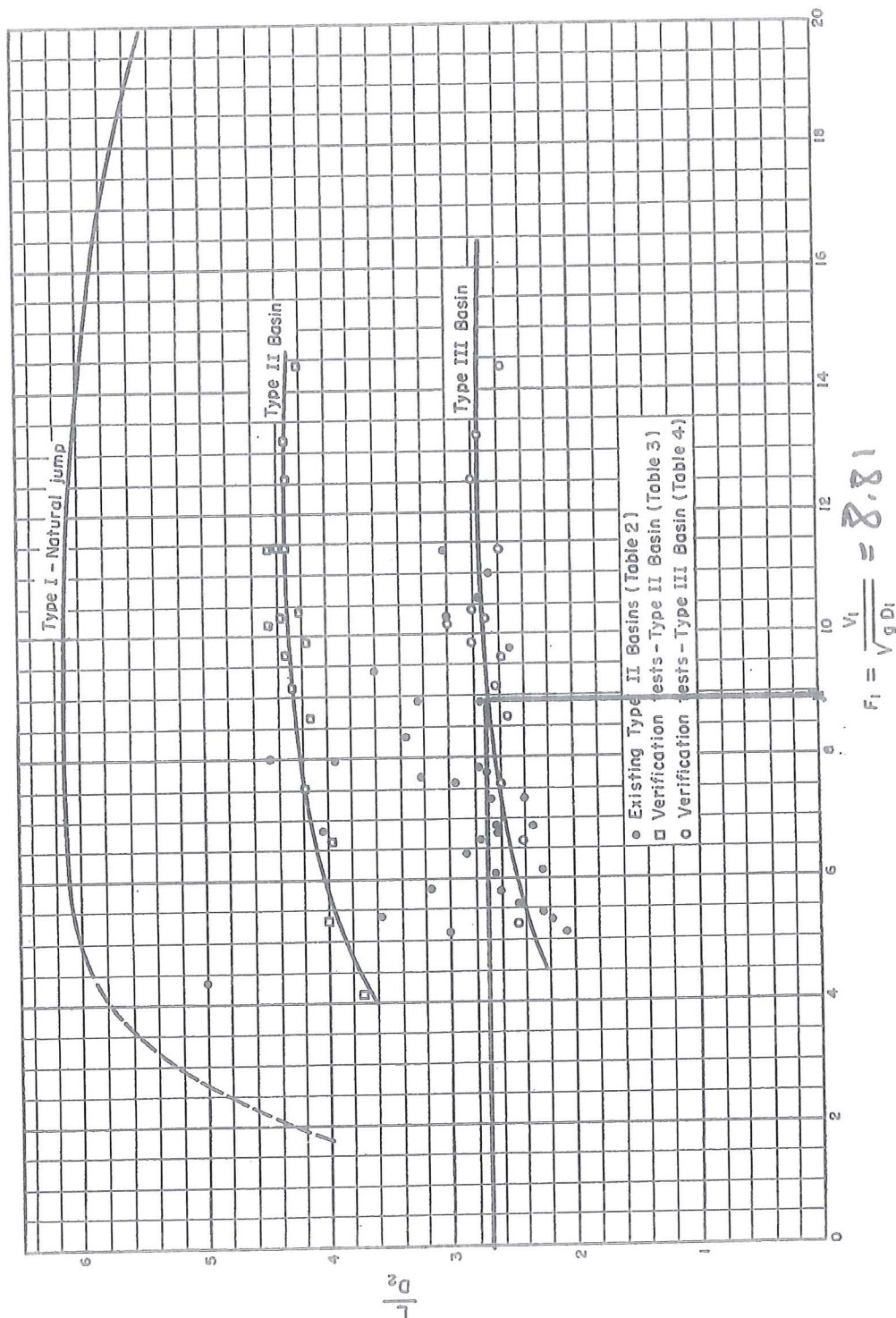
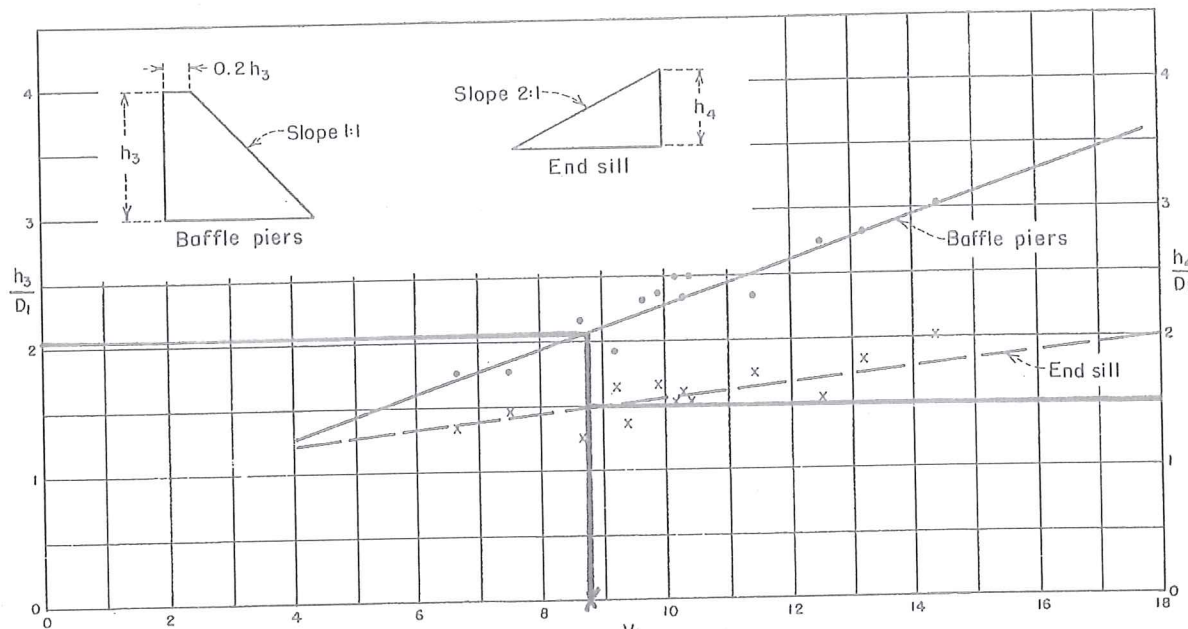


FIGURE 12.—Length of jump on horizontal floor (Basins I, II, and III).



$$\frac{h_3}{D_1} = 2.0 \Rightarrow h_3 = 1.0'$$

$$F_1 = \frac{V_1}{\sqrt{g D_1}} = 8.81$$

$$\frac{h_4}{D_1} = 1.5 \Rightarrow h_4 = 0.8'$$

FIGURE 18.—Height of baffle piers and end sill (Basin III).

ducing eddies which in turn aid in the dissipation of energy. Small chamfers on the pier edges of the type used to obtain better forming of the concrete may be used.

End sill. The height of the solid end sill is also shown to vary with the Froude number, although there is nothing critical about this dimension. The heights of the sills used in the verification tests are shown in Columns 27 and 28 of Table 4. The height of the end sill in terms of D_1 is plotted with respect to the Froude number and shown as the lower line in Figure 18. A slope of 2:1 was used throughout the tests since previous sill experiments indicated that minimum wave heights and erosion could be expected with this slope.

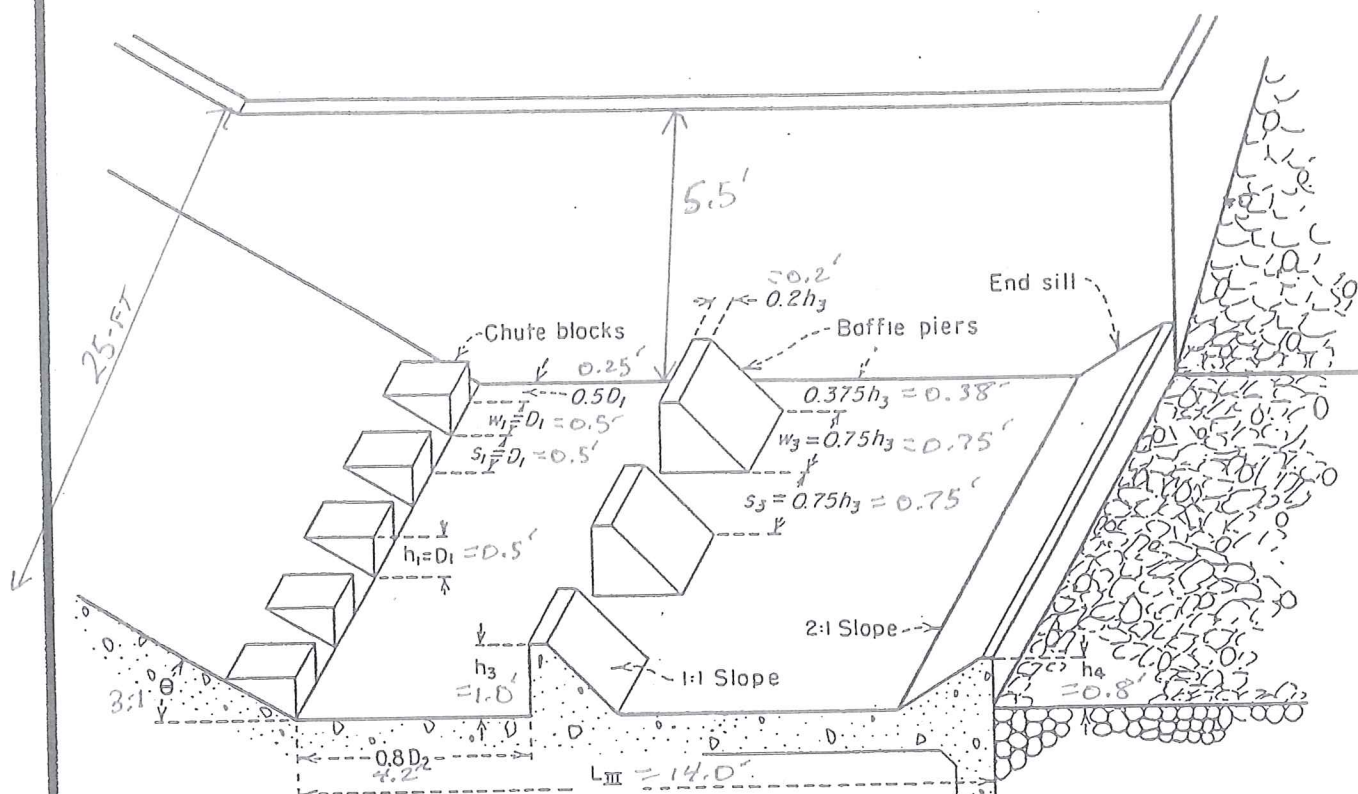
Tail water depth. As in the case of Basin II, full conjugate depth, measured above the apron, is also recommended for Basin III. There are several reasons for this: First, the best operation for this stilling basin occurs at full conjugate tail water depth; second, if less than the conjugate depth is used, the surface velocities leaving the pool are high, the jump action is impaired, and there is greater chance for scour downstream; and third, if the baffle blocks erode with time, the

additional tail water depth will serve to lengthen the interval between repairs. On the other hand, there is no hydraulic advantage in using greater than the conjugate depth, as the action in the pool will show little or no improvement. The same precautions should be considered when determining the tail water for Basin III that were discussed for Basin II.

The margin of safety for Basin III varies from 15 to 18 percent depending on the value of the Froude number, as can be observed by the dashed line labeled "Minimum Tail Water Depth—Basin III," in Figure 11. The points, from which the line was drawn, were obtained from the verification tests, Columns 10 and 14, Table 4. Again, this line does not represent complete jump sweep-out, but rather the tail water depth at which the front of the jump moves away from the chute blocks. In this position the jump is not fully developed and the stilling basin does not perform properly. In special cases it may be necessary to encroach on this wide margin of safety; however, it is not advisable as a general rule for the reasons stated above.

Length of basin. The length of Basin III, which is related to the Froude number, can be

SHORT STILLING BASIN (USBR TYPE III)



$$\begin{aligned} D_1 &= 0.5' \\ D_2 &= 5.2' \\ L &= 14.0' \\ h_3 &= 1.0' \\ h_4 &= 0.8' \end{aligned}$$

NOTE: See Figure 1109 for design data

Revision	Date

WRC
ENGINEERING

REFERENCE: "Hydraulic Design of Stilling Basins and Energy Dissipators", EM25 BR, January 1978

FIGURE 1110

APPENDIX F

Lateral Inflow Channel Hydraulic Computations

MAXIMUM PERMISSIBLE MEAN CHANNEL VELOCITIES

Material / Lining
**Maximum Permissible
Mean Velocity
(fps)**

Natural and Improved Unlined Channels

Fine sand, colloidal.....	1.50
Sandy loam, noncolloidal.....	1.75
Silt loam, noncolloidal.....	2.00
Alluvial silts, noncolloidal.....	2.00
Ordinary firm loam.....	2.50
Volcanic ash.....	2.50
Stiff clay, vary colloidal.....	3.75
Alluvial silts, colloidal.....	3.75
Shales and hardpans.....	6.00
Fine gravel.....	2.50
Graded loam to cobbles when noncolloidal.....	3.75
Graded silts to cobbles when colloidal.....	4.00
Coarse gravel, noncolloidal.....	4.00
Cobbles and shingles.....	5.00
Sandy silt.....	2.00
Silty clay.....	2.50
Clay.....	6.00
Poor sedimentary rock.....	10.0

Fully Lined Channels

Unreinforced vegetation.....	5.0
Loose riprap.....	10.0
Grouted riprap.....	15.0
Gabions.....	15.0
Soil-Cement.....	15.0
Concrete.....	35.0

- NOTES: 1. For composite lined channels, use the lowest of the maximum mean velocities for the materials used in the composite lining.
2. Deviations from the above values are only allowed with appropriate engineering analysis and/or suitable agreements for maintenance responsibilities.

Revision	Date

OFF4 Existing Wash Worksheet for Irregular Channel

Project Description	
Worksheet	OFF4 Existing Wash
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data	
Channel Slope	4.12 %
Discharge	84.00 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	0.035
Water Surface Elevation	3,037.48 ft
Elevation Range	3,036.30 to 3,068.70
Flow Area	14.0 ft ²
Wetted Perimeter	23.90 ft
Top Width	23.71 ft
Actual Depth	1.18 ft
Critical Elevation	3,037.64 ft
Critical Slope	2.06 %
Velocity	6.02 ft/s
Velocity Head	0.56 ft
Specific Energy	3,038.04 ft
Froude Number	1.38
Flow Type	Supercritical

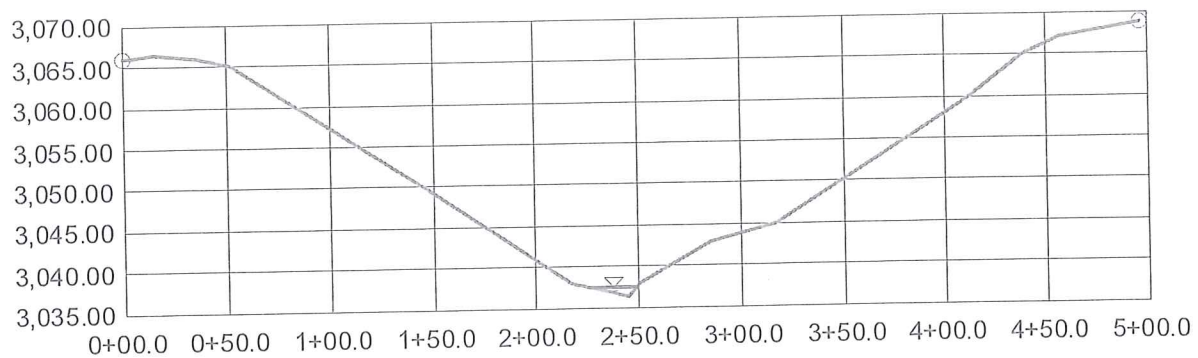
Roughness Segments		
Start Station	End Station	Mannings Coefficient
0+00.0	4+96.6	0.035

Natural Channel Points	
Station (ft)	Elevation (ft)
0+00.0	3,065.90
0+15.0	3,066.30
0+35.1	3,066.00
0+51.2	3,065.00
1+44.3	3,050.00
2+16.8	3,038.00
2+44.8	3,036.30
2+51.1	3,038.00
2+85.1	3,043.00
3+17.2	3,045.00
4+11.7	3,060.00
4+38.5	3,065.00
4+57.0	3,067.00
4+96.6	3,068.70

OFF4 Existing Wash Cross Section for Irregular Channel

Project Description	
Worksheet	OFF4 Existing Wash
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Channel Depth

Section Data	
Mannings Coefficient	0.035
Channel Slope	4.12 %
Water Surface Elevation	3,037.48 ft
Elevation Range	3,036.30 to 3,068.70
Discharge	84.00 cfs



V:4.0
H:1
NTS

OFF4 Lateral Inflow Channel

Worksheet for Trapezoidal Channel

Project Description	
Worksheet	OFF4 Inflow Channel (DB1)
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data	
Mannings Coefficient	0.040
Channel Slope	33.33 %
Left Side Slope	3.00 H : V
Right Side Slope	3.00 H : V
Bottom Width	24.00 ft
Discharge	84.00 cfs

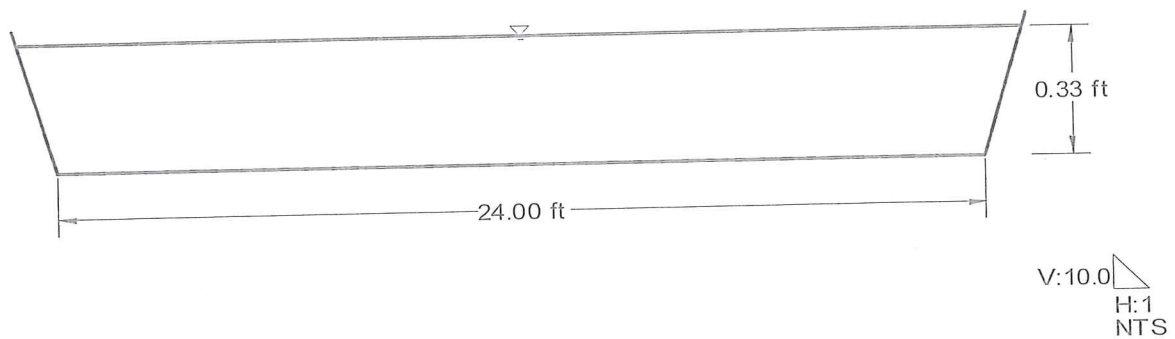
Results	
Depth	0.33 ft
Flow Area	8.4 ft ²
Wetted Perimeter	26.12 ft
Top Width	26.01 ft
Critical Depth	0.70 ft
Critical Slope	2.72 %
Velocity	10.04 ft/s
Velocity Head	1.57 ft
Specific Energy	1.90 ft
Froude Number	3.12
Flow Type	Supercritical

OFF4 Lateral Inflow Channel

Cross Section for Trapezoidal Channel

Project Description	
Worksheet	OFF4 Inflow Channel (DB1)
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Section Data	
Mannings Coefficient	0.040
Channel Slope	33.33 %
Depth	0.33 ft
Left Side Slope	3.00 H : V
Right Side Slope	3.00 H : V
Bottom Width	24.00 ft
Discharge	84.00 cfs



OFF5 Existing Wash

Worksheet for Irregular Channel

Project Description

Worksheet	OFF5 Existing Wash
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data

Channel Slope	3.40 %
Discharge	236.00 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	0.035
Water Surface Elevation	3,048.67 ft
Elevation Range	3,047.30 to 3,065.90
Flow Area	32.9 ft ²
Wetted Perimeter	37.55 ft
Top Width	37.37 ft
Actual Depth	1.37 ft
Critical Elevation	3,048.88 ft
Critical Slope	1.78 %
Velocity	7.17 ft/s
Velocity Head	0.80 ft
Specific Energy	3,049.47 ft
Froude Number	1.35
Flow Type	Supercritical

Roughness Segments

Start Station	End Station	Mannings Coefficient
0+00.0	5+76.6	0.035

Natural Channel Points

Station (ft)	Elevation (ft)
0+00.0	3,061.90
0+82.6	3,064.00
1+20.5	3,064.50
1+60.0	3,064.00
2+26.5	3,061.00
2+57.2	3,051.00
2+60.0	3,050.80
2+62.3	3,051.00
2+75.3	3,052.60
2+83.8	3,052.00
3+00.5	3,048.00
3+25.5	3,047.30
3+58.5	3,052.00
3+81.3	3,062.00

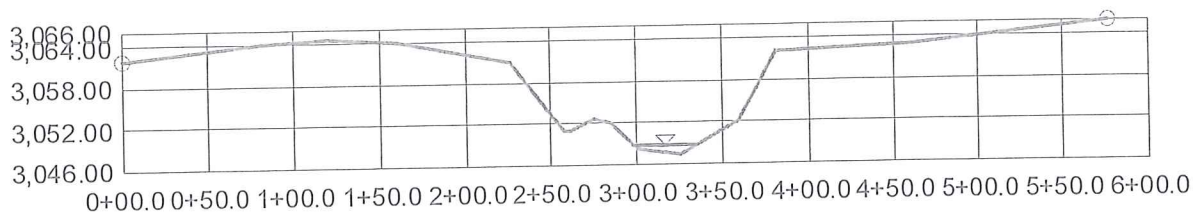
OFF5 Existing Wash
Worksheet for Irregular Channel

Natural Channel Points	
Station (ft)	Elevation (ft)
4+60.8	3,063.00
5+76.6	3,065.90

OFF5 Existing Wash Cross Section for Irregular Channel

Project Description	
Worksheet	OFF5 Existing Wash
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Channel Depth

Section Data	
Mannings Coefficient	0.035
Channel Slope	3.40 %
Water Surface Elevation	3,048.67 ft
Elevation Range	3,047.30 to 3,065.90
Discharge	236.00 cfs



V:4.0
H:1
NTS

OFF5 Lateral Inflow Channel

Worksheet for Trapezoidal Channel

Project Description	
Worksheet	OFF5 Inflow Channel (DB1)
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data	
Mannings Coefficient	0.040
Channel Slope	33.33 %
Left Side Slope	3.00 H : V
Right Side Slope	3.00 H : V
Bottom Width	38.00 ft
Discharge	236.00 cfs

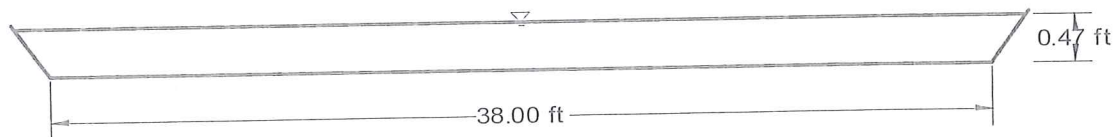
Results	
Depth	0.47 ft
Flow Area	18.6 ft ²
Wetted Perimeter	40.99 ft
Top Width	40.83 ft
Critical Depth	1.03 ft
Critical Slope	2.39 %
Velocity	12.67 ft/s
Velocity Head	2.50 ft
Specific Energy	2.97 ft
Froude Number	3.31
Flow Type	Supercritical

OFF5 Lateral Inflow Channel

Cross Section for Trapezoidal Channel

Project Description	
Worksheet	OFF5 Inflow Channel (DB1)
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Section Data	
Mannings Coefficient	0.040
Channel Slope	33.33 %
Depth	0.47 ft
Left Side Slope	3.00 H : V
Right Side Slope	3.00 H : V
Bottom Width	38.00 ft
Discharge	236.00 cfs



V:4.0
H:1
NTS

OFF6 Existing Wash

Worksheet for Irregular Channel

Project Description	
Worksheet	OFF6 Existing Wash
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data	
Channel Slope	3.37 %
Discharge	59.00 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	0.035
Water Surface Elevation	3,050.12 ft
Elevation Range	3,049.30 to 3,061.90
Flow Area	12.8 ft ²
Wetted Perimeter	28.30 ft
Top Width	28.23 ft
Actual Depth	0.82 ft
Critical Elevation	3,050.18 ft
Critical Slope	2.25 %
Velocity	4.60 ft/s
Velocity Head	0.33 ft
Specific Energy	3,050.45 ft
Froude Number	1.20
Flow Type	Supercritical

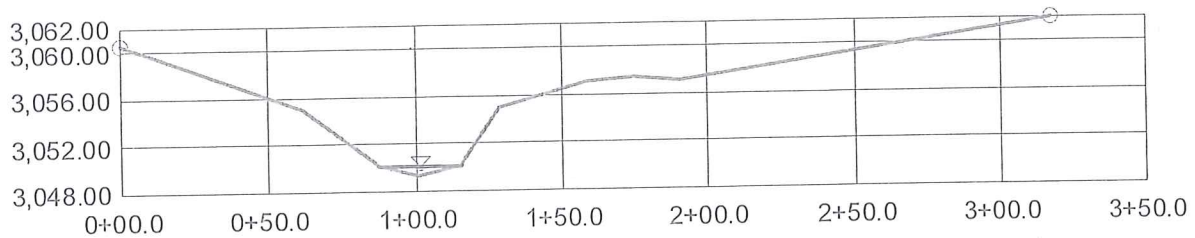
Roughness Segments		
Start Station	End Station	Mannings Coefficient
0+00.0	3+17.4	0.035

Natural Channel Points	
Station (ft)	Elevation (ft)
0+00.0	3,060.50
0+61.8	3,055.00
0+87.8	3,050.00
1+00.3	3,049.30
1+15.1	3,050.00
1+28.8	3,055.00
1+59.1	3,057.00
1+75.0	3,057.40
1+90.6	3,057.10
3+17.4	3,061.90

OFF6 Existing Wash **Cross Section for Irregular Channel**

Project Description	
Worksheet	OFF6 Existing Wash
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Channel Depth

Section Data	
Mannings Coefficient	0.035
Channel Slope	3.37 %
Water Surface Elevation	3,050.12 ft
Elevation Range	3,049.30 to 3,061.90
Discharge	59.00 cfs



V:4.0
H:1
NTS

OFF6 Lateral Inflow Channel

Worksheet for Trapezoidal Channel

Project Description	
Worksheet	OFF6 Inflow Channel (DB1)
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data	
Mannings Coefficient	0.040
Channel Slope	33.33 %
Left Side Slope	3.00 H : V
Right Side Slope	3.00 H : V
Bottom Width	28.00 ft
Discharge	59.00 cfs

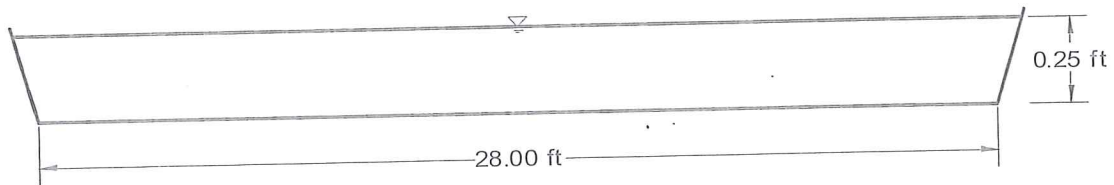
Results	
Depth	0.25 ft
Flow Area	7.1 ft ²
Wetted Perimeter	29.57 ft
Top Width	29.49 ft
Critical Depth	0.51 ft
Critical Slope	2.99 %
Velocity	8.29 ft/s
Velocity Head	1.07 ft
Specific Energy	1.32 ft
Froude Number	2.97
Flow Type	Supercritical

OFF6 Lateral Inflow Channel

Cross Section for Trapezoidal Channel

Project Description	
Worksheet	OFF6 Inflow Channel (DB1)
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Section Data	
Mannings Coefficient	0.040
Channel Slope	33.33 %
Depth	0.25 ft
Left Side Slope	3.00 H : V
Right Side Slope	3.00 H : V
Bottom Width	28.00 ft
Discharge	59.00 cfs



V:10.0
H:1
NTS

APPENDIX G

Discharge Curves

30-inch Orifice Discharge Curve Rating Table for Circular Orifice

Project Description	
Worksheet	Outfall
Type	Circular Orifice
Solve For	Discharge

Input Data	
Centroid Elevation	3,026.75 ft
Tailwater Elevation	3,028.00 ft
Discharge Coefficient	0.65
Diameter	30.0 in

Attribute	Minimum	Maximum	Increment
Headwater Elevation (ft)	3,026.00	3,044.00	1.00

Headwater Elevation (ft)	Discharge (cfs)	Velocity (ft/s)
3,026.00	N/A	N/A
3,027.00	N/A	N/A
3,028.00	N/A	N/A
3,029.00	25.59	5.21
3,030.00	36.20	7.37
3,031.00	44.33	9.03
3,032.00	51.19	10.43
3,033.00	57.23	11.66
3,034.00	62.69	12.77
3,035.00	67.72	13.80
3,036.00	72.39	14.75
3,037.00	76.78	15.64
3,038.00	80.94	16.49
3,039.00	84.89	17.29
3,040.00	88.66	18.06
3,041.00	92.28	18.80
3,042.00	95.77	19.51
3,043.00	99.13	20.19
3,044.00	102.38	20.86

36-inch RCP Outflow Pipe Worksheet for Circular Channel

Project Description	
Worksheet	Outflow Pipe
Flow Element	Circular Channel
Method	Manning's Formula
Solve For	Full Flow Diameter

Input Data	
Mannings Coefficient	0.013
Channel Slope	2.00 %
Discharge	71.00 cfs

Results	
Depth	2.70 ft
Diameter	32.4 in
Flow Area	5.7 ft ²
Wetted Perimeter	11.00 ft
Top Width	0.00 ft
Critical Depth	2.57 ft
Percent Full	100.0 %
Critical Slope	1.74 %
Velocity	12.43 ft/s
Velocity Head	2.40 ft
Specific Energy	5.10 ft
Froude Number	0.00
Maximum Discharge	76.38 cfs
Discharge Full	71.00 cfs
Slope Full	2.00 %
Flow Type	N/A

Notes: Outflow Pipe is large enough to not result in backwater impacts to orifice plate outlet from DB1.

PMF Overflow Spillway Discharge Curve

Rating Table for Generic Weir

Project Description	
Worksheet	PMF Spillway - Weir
Type	Generic Weir
Solve For	Discharge

Input Data	
Crest Elevation	3,037.00 ft
Discharge Coefficient	3.00 US
Crest Length	87.00 ft

Attribute	Minimum	Maximum	Increment
Headwater Elevation (ft)	3,037.00	3,044.00	1.00

Headwater Elevation (ft)	Discharge (cfs)	Velocity (ft/s)
3,037.00	N/A	N/A
3,038.00	261.00	3.00
3,039.00	738.22	4.24
3,040.00	1,356.20	5.20
3,041.00	2,088.00	6.00
3,042.00	2,918.07	6.71
3,043.00	3,835.90	7.35
3,044.00	4,833.79	7.94

Debris Tower Orifice Calculator Rating Table for Circular Orifice

Project Description	
Worksheet	Debris Tower
Type	Circular Orifice
Solve For	Discharge

Input Data	
Centroid Elevation	3,023.12 ft
Tailwater Elevation	3,023.00 ft
Discharge Coefficient	0.65
Diameter	3.0 in

Attribute	Minimum	Maximum	Increment
Headwater Elevation (ft)	3,023.00	3,025.50	0.50

Headwater Elevation (ft)	Discharge (cfs)	Velocity (ft/s)
3,023.00	N/A	N/A
3,023.50	0.16	3.21
3,024.00	0.24	4.89
3,024.50	0.30	6.13
3,025.00	0.35	7.15
3,025.50	0.39	8.04

MULTIPLY Q BY 4 PERFORATIONS @ EACH STAGE (6").

Elevation vs. Discharge Calculation

Project: Skye Canyon Detention Basin No. 1
Date: 8/26/2014

(1) Elevation (Feet)	Row 1 4- 3" Dia. (cfs)	Row 2 4- 3" Dia. (cfs)	Row 3 4- 3" Dia. (cfs)	Row 4 4- 3" Dia. (cfs)	Row 5 Beehive Grate (cfs)	Q Total (cfs)
3023.0	0.00	0.00	0.00	0.00	0.00	0.00
3023.5	0.64	0.00	0.00	0.00	0.00	0.64
3024.0	0.96	0.64	0.00	0.00	0.00	1.60
3024.5	1.20	0.96	0.64	0.00	0.00	2.80
3025.0	1.40	1.20	0.96	0.64	0.00	4.20
3025.5	1.56	1.40	1.20	0.96	4.10	9.22

Dewatering Time Calculation

Project: Skye Canyon Detention Basin No. 1
Date: 8/26/2014

(1) Elevation (Feet)	Storage Volume (Cu. Ft.)	Difference in Storage Volumes	(4) Discharge (cfs)	Average Discharge (cfs)	(6) Time (Hrs.)	(7) Accumulated Time (Hrs.)
3025.5	162159	0	9.22	0.00	0.00	0.00
3025.0	120608	41551	4.20	4.20	2.75	2.75
3024.5	76670	43938	2.80	3.50	3.49	6.24
3024.0	32731	43939	1.60	2.20	5.55	11.78
3023.5	16366	16365	0.64	1.12	4.06	15.84
3023.0	0	16366	0.00	0.32	14.21	30.05

Debris storage area drains in 30 hours which is less than maximum allowed 7 days.
Debris Tower Acceptable.

APPENDIX H

Emergency PMF Spillway RCC Design Energy Computations

Chanson - Energy Reduction Step Computation

Project Name: Skye Canyon Detention Basin No. 1

Date: 8/19/2014

File Name: OLY1401-004 TDS RCC Spillway Energy Calc.xlsx

By: SMJ

1. Using the energy reduction equation in Sturm - Open Channel Hydraulics (Section 6.4 Stepped Spillways, pages 213-215)

$$\Delta H/H = 1 - [(C_f^{1/3} \cos \theta + 0.5 C_f^{-2/3}) / (1.5 + H_{dam} / y_c)]$$

ΔH = Energy head dissipated, ft

H = Total Head, ft

H_{dam} = Height from the toe of the spillway to the crest, ft

$$C_f = f / (8 \sin \theta)$$

f = friction factor

$$\theta = \tan^{-1} (h/l)$$

h = height of the step, ft

l = length of the step, ft

2. Using the critical depth (rectangular) equation in Lindeburg (page 19-17)

$$y_c = [(Q^2) / (g w^3)]^{1/3}$$

Q = Flow rate, cfs

g = gravity, ft/sec²

w = width, ft

3. Applying Steps 1 and 2

Known: $Q = 4,912$ cfs
 $g = 32.2$ ft/s²
 $w = 87$ ft
 $H_{dam} = 16$ ft
 $f = 1$

Solve for: $y_c = 4.63$ ft

Solve for:

h/l (assumed)	θ (rads)	θ (deg)	C_f	$C_f^{1/3}$	$\cos \theta$ (rads)	$C_f^{-2/3}$	$\Delta H/H$
0.01	0.010	0.573	12.501	2.321	1.000	0.186	0.513
0.02	0.020	1.146	6.251	1.842	1.000	0.295	0.599
0.03	0.030	1.719	4.169	1.609	1.000	0.386	0.637
0.05	0.050	2.864	2.503	1.358	0.999	0.542	0.672
0.10	0.100	5.713	1.256	1.079	0.995	0.859	0.697
0.15	0.149	8.535	0.843	0.945	0.989	1.121	0.699
0.20	0.197	11.316	0.637	0.861	0.981	1.350	0.694
0.25	0.245	14.043	0.515	0.802	0.970	1.556	0.686
0.30	0.291	16.708	0.435	0.758	0.958	1.742	0.678
0.35	0.337	19.300	0.378	0.723	0.944	1.912	0.670
0.40	0.381	21.812	0.337	0.696	0.928	2.067	0.661
0.45	0.423	24.240	0.305	0.673	0.912	2.209	0.654
0.50	0.464	26.579	0.280	0.654	0.894	2.339	0.646
0.55	0.503	28.825	0.259	0.638	0.876	2.459	0.639
0.60	0.540	30.979	0.243	0.624	0.857	2.568	0.633
0.65	0.576	33.041	0.229	0.612	0.838	2.669	0.627
0.70	0.611	35.010	0.218	0.602	0.819	2.761	0.622
0.75	0.644	36.889	0.208	0.593	0.800	2.846	0.617
0.80	0.675	38.679	0.200	0.585	0.781	2.923	0.613
0.85	0.704	40.385	0.193	0.578	0.762	2.994	0.609

0.90	0.733	42.009	0.187	0.572	0.743	3.060	0.606
0.95	0.760	43.553	0.181	0.566	0.725	3.120	0.603
1.00	0.785	45.023	0.177	0.561	0.707	3.175	0.600
1.25	0.896	51.366	0.160	0.543	0.625	3.392	0.590
1.50	0.983	56.338	0.150	0.532	0.555	3.539	0.584
1.75	1.052	60.286	0.144	0.524	0.496	3.640	0.580
2.00	1.107	63.467	0.140	0.519	0.447	3.713	0.579
2.25	1.153	66.071	0.137	0.515	0.406	3.767	0.578
2.50	1.190	68.233	0.135	0.513	0.371	3.807	0.578
2.75	1.222	70.052	0.133	0.510	0.342	3.838	0.578
3.00	1.249	71.601	0.132	0.509	0.316	3.862	0.578
3.25	1.272	72.934	0.131	0.508	0.294	3.881	0.579
3.50	1.292	74.092	0.130	0.507	0.275	3.897	0.579
3.75	1.310	75.107	0.129	0.506	0.258	3.909	0.580
4.00	1.326	76.002	0.129	0.505	0.243	3.920	0.580
4.25	1.340	76.798	0.128	0.505	0.229	3.929	0.581
4.50	1.352	77.510	0.128	0.504	0.217	3.936	0.581
4.75	1.363	78.151	0.128	0.504	0.206	3.943	0.582
5.00	1.373	78.730	0.127	0.503	0.196	3.948	0.582
5.25	1.383	79.256	0.127	0.503	0.187	3.953	0.582
5.50	1.391	79.736	0.127	0.503	0.179	3.957	0.583
5.75	1.399	80.175	0.127	0.502	0.171	3.960	0.583
6.00	1.406	80.579	0.127	0.502	0.164	3.964	0.584
6.25	1.412	80.951	0.127	0.502	0.158	3.966	0.584
6.50	1.418	81.295	0.126	0.502	0.152	3.969	0.584
6.75	1.424	81.614	0.126	0.502	0.147	3.971	0.585
7.00	1.429	81.911	0.126	0.502	0.141	3.973	0.585
7.25	1.434	82.188	0.126	0.502	0.137	3.975	0.585
7.50	1.438	82.447	0.126	0.501	0.132	3.977	0.586
7.75	1.442	82.690	0.126	0.501	0.128	3.978	0.586
8.00	1.446	82.917	0.126	0.501	0.124	3.979	0.586
8.25	1.450	83.131	0.126	0.501	0.120	3.981	0.586
8.50	1.454	83.332	0.126	0.501	0.117	3.982	0.587
8.75	1.457	83.523	0.126	0.501	0.114	3.983	0.587
9.00	1.460	83.702	0.126	0.501	0.110	3.984	0.587
9.25	1.463	83.872	0.126	0.501	0.107	3.985	0.587
9.50	1.466	84.034	0.126	0.501	0.105	3.985	0.588
9.75	1.469	84.187	0.126	0.501	0.102	3.986	0.588
10.00	1.471	84.332	0.126	0.501	0.100	3.987	0.588

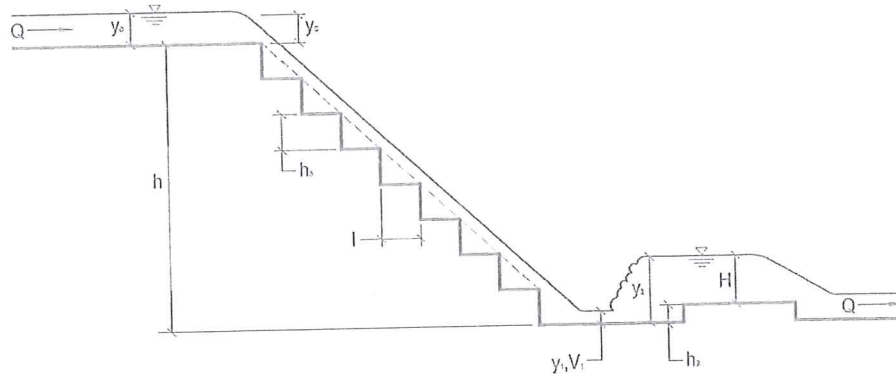
4. Findings of Step 3 and Results

From the computations of Step 3, the maximum reduction we can obtain is approximately 69.9%
The corresponding h/l ratio is 0.15

Per CCRFCD, the preferred height of a step is 2.0 ft
Per CCRFCD, the preferred slope is 2:1; therefore, the length of the step is 4.0 ft

The resulting h/l ratio is 0.50
Number of steps, $N = H_{\text{dam}}/h$ 8

From the table and chart, the corresponding energy reduction is 64.6%



1. Identify known parameters

Known:

Flow rate, Q =	4,912	cfs
Gravity, g =	32.2	ft/s ²
Width of spillway, w =	87	ft
Height of spillway, h =	16	ft
Number of Steps, N =	8	
Height of step, h _s =	2	ft
Length of step, l =	4	ft

2. Using the critical depth (rectangular) equation in Lindeburg (page 19-17)

$$y_c = \left[\frac{Q^2}{gw^3} \right]^{1/3}$$

Q = Flow rate, cfs
g = gravity, ft/sec²
w = width of spillway, ft

Solve for: $y_c = 4.63 \text{ ft}$

3. Determining the energy at the top of stepped structure

$$H_0 = h + y_o + (V_o^2 / 2g)$$

$$= h + y_c + (V_c^2 / 2g)$$

$$= h + y_c + (Q^2 / 2gw^3 y_c^2)$$

Q = Flow rate, cfs
g = gravity, ft/sec²
w = width, ft
h = height of spillway, ft
y_c = critical flow depth, ft

Solve for: $H_0 = 22.94 \text{ ft}$

4. Determining the energy at the toe of stepped structure

$$H_1 = H_0 - \Delta H$$

$$= y_1 + (V_1^2 / 2g)$$

$$= y_1 + (Q^2 / 2gw^2y_1^2)$$

Q = Flow rate, cfs
g = gravity, ft/sec²
w = width, ft
y₁ = flow depth at the toe of stepped structure

Use the percentages from both the Energy Reduction and Christodoulou Methods to see which controls.

(See Energy Reduction)	(Use Christodoulou, Fig 4)
	l/h _s = 2.0 y _c /h _s = 2.3 If y _c /(Nh _s) = 0.29 Check 1, is l/h _s ≥ 0.7 yes Check 2, is l/h _s ≤ 2.5 yes Check 3, is y _c /h _s ≤ 4.5 yes Check 4, is y _c /Nh _s ≤ 0.5 yes Is the Christodoulou Method, Fig 4 valid?: yes ΔH = 20.0% Then H ₁ = 18.351
ΔH = 64.6% Then H ₁ = 8.120	
Solve for: y ₁ = 7.15 ft	Solve for: y ₁ = 1.73 ft

$$V_1 = Q / (wy_1)$$

V₁ = velocity at the toe of stepped structure
y₁ = flow depth at the toe of stepped structure
w = width of spillway, ft
Q = Flow rate, cfs

(Energy Reduction)	(Christodoulou)
Solve for: V ₁ = 7.90	Solve for: V ₁ = 32.64

$$F_{r1} = V_1 / (gy_1)^{0.5}$$

F_{r1} = Froude Number at the toe of stepped structure
g = gravity, ft/sec²
y₁ = flow depth at the toe of stepped structure

(Energy Reduction)	(Christodoulou)
Solve for: F _{r1} = 0.52	Solve for: F _{r1} = 4.37

5. Determining the height of block to force a hydraulic jump

Broad-crested weir

$$Q = CLH^{3/2}$$

Q = Flow rate, cfs
C = Weir coefficient
L = width of spillway, ft
H = Weir depth, ft

C = 3.30
L = w = 87 ft

Solve for: H = 6.64 ft

Conjugate depth for a hydraulic jump

$$y_2 = (y_1 / 2) \left((1 + 8F_{r1}^2)^{0.5} - 1 \right)$$

y_2 = flow depth at the hydraulic jump
 y_1 = flow depth at the toe of stepped structure
 F_{r1} = Froude Number at the toe of stepped structure

(Energy Reduction)	(Christodoulou)
Solve for: $y_2 = 2.79$ ft	Solve for: $y_2 = 9.87$ ft

Required tailwater depth to force a hydraulic jump

$$h_B = y_2 - H$$

y_2 = flow depth at the hydraulic jump
 h_B = Height of block, ft
 H = Weir depth, ft

(Energy Reduction)	(Christodoulou)
If $\Delta H = 64.6\%$ Solve for: $h_B = -3.9$ ft	If $\Delta H = 20.0\%$ Solve for: $h_B = 3.23$ ft

Conclusion:
 Use Christodoulou Equation. End Sill Height is 3.5-ft (h_B). 10-ft (y_2) depth provided in stilling basin for hydraulic jump depth.

Use: $h_B = 3.5$ ft

6. Determining the length of the stilling basin

Length of Free Jump can be obtained from USBR EM25 Figure 12 (1983)

Controlling Method = Christodoulou

$F_{r1} = 4.37$

$y_2 = 9.87$

Then $L_B/y_2 = 5.900$

Solve for: Length of stilling basin, $L_B = 58.22$ ft

Conclusion:
 The design length of the stilling basin is 60-ft.

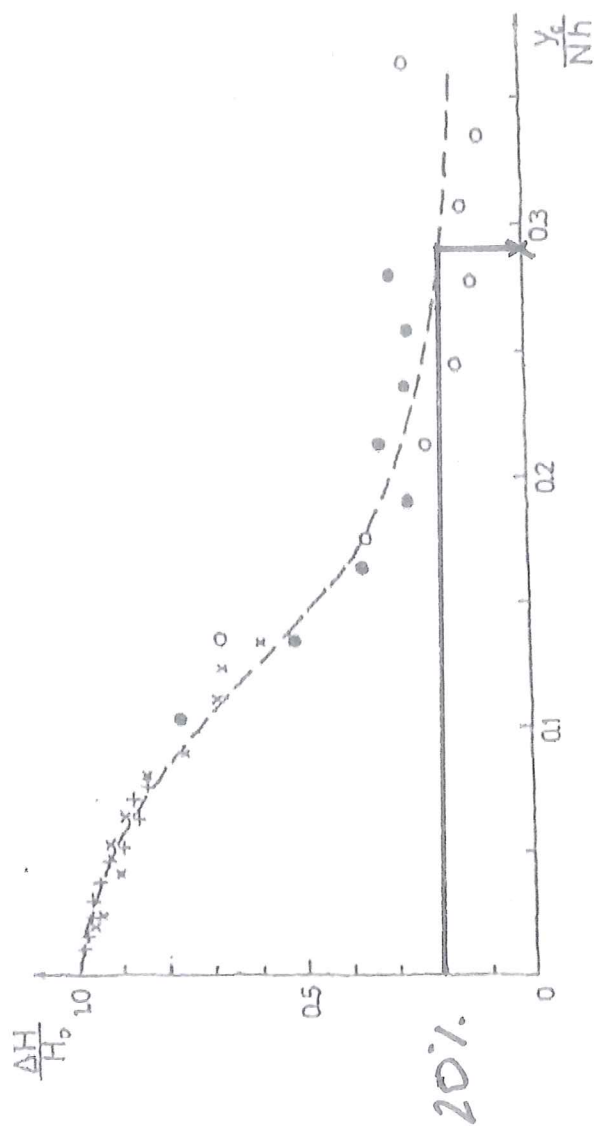


FIG. 4. Dependence of $\Delta H/H_0$ on γ_c/Nh

$$\frac{\gamma_c}{Nh} = \frac{4.63}{(8)(2)} = 0.29$$

$$\gamma_c = 4.63$$

$$N = 8 \text{ STEPS}$$

$$h = 2\text{-FT HIGH STEP}$$

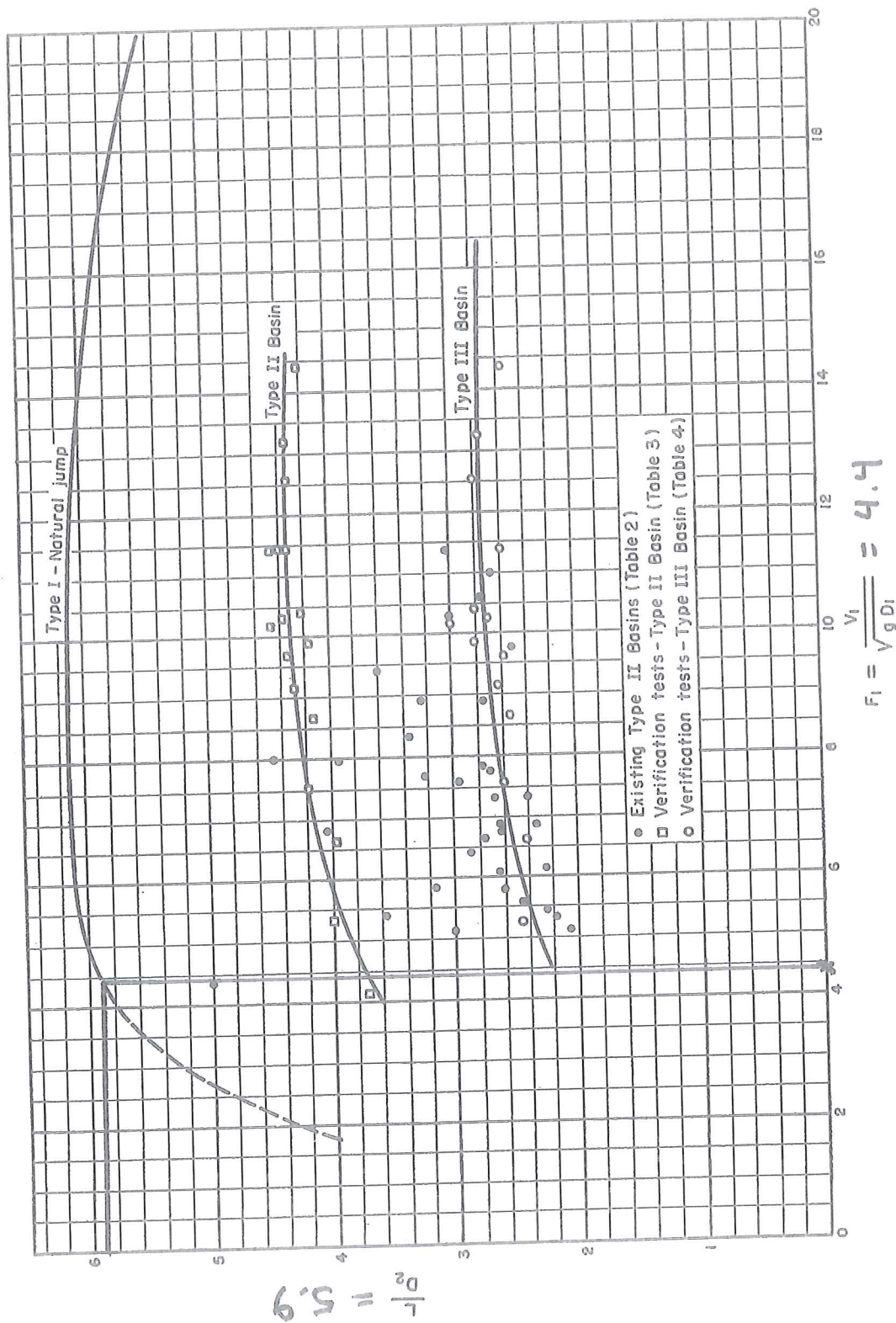


FIGURE 12.—Length of jump on horizontal floor (Basins I, II, and III).

known from prototype experience, the required value of L/h can be determined from Equation 6.8 for the desired air concentration. Then, from the relationship given by Equation 6.7 from physical model studies or numerical analysis of the jet trajectory for a given ramp geometry, the required underpressure Δp_a can be determined for the specified value of L/h and the known value of the Froude number. Finally, the air delivery system can be designed to provide the air flow rate with the specified pressure drop.

The value of k in Equation 6.8 has been determined to be 0.033 from the Foz do Areia prototype spillway tests (de S. Pinto 1988), but it can vary for different flow conditions and different ramp geometries. What is required is a model study with a relatively large scale (1:10 to 1:15) to eliminate Reynolds number and Weber number effects and so determine specific design values of k .

6.4 STEPPED SPILLWAYS

Stepped spillways have been used extensively around the world since antiquity, but they became very popular in the past few decades with the advent of roller-compacted concrete (RCC) and gabion construction of dams (Chanson 1994a). They provide good surface aeration but also increase the energy dissipation in the flow down the spillway in comparison to a smooth spillway. This latter feature of stepped spillways may reduce the cost of the downstream stilling basin.

Stepped spillways can operate either in a nappe flow regime or a skimming flow regime. In nappe flow, which tends to occur at lower discharges on flatter spillways, the flow consists of a series of jets that strike the floor of the succeeding steps. Each jet usually is followed by a partial hydraulic jump. In skimming flow, the jets move smoothly without breakup across the steps, which act as a series of roughness elements. A recirculating vortex forms on each step in which energy dissipates. The skimming flow regime is shown in Figure 6.8. Rajaratnam (1990) suggested that the onset of skimming flow occurs for values of y_c/h exceeding 0.8,

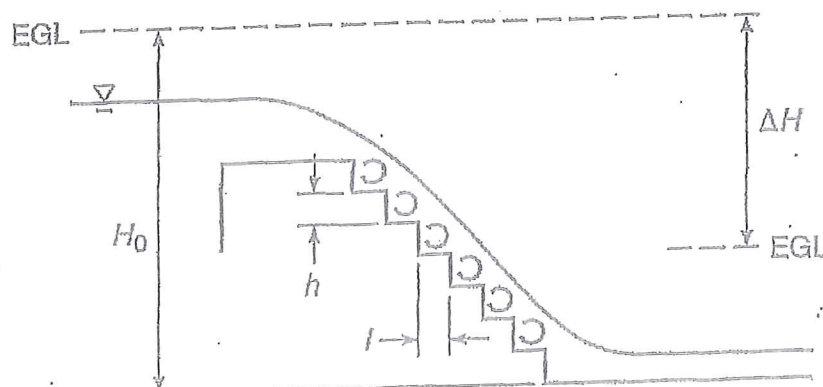


FIGURE 6.8
Definition sketch of a stepped spillway.

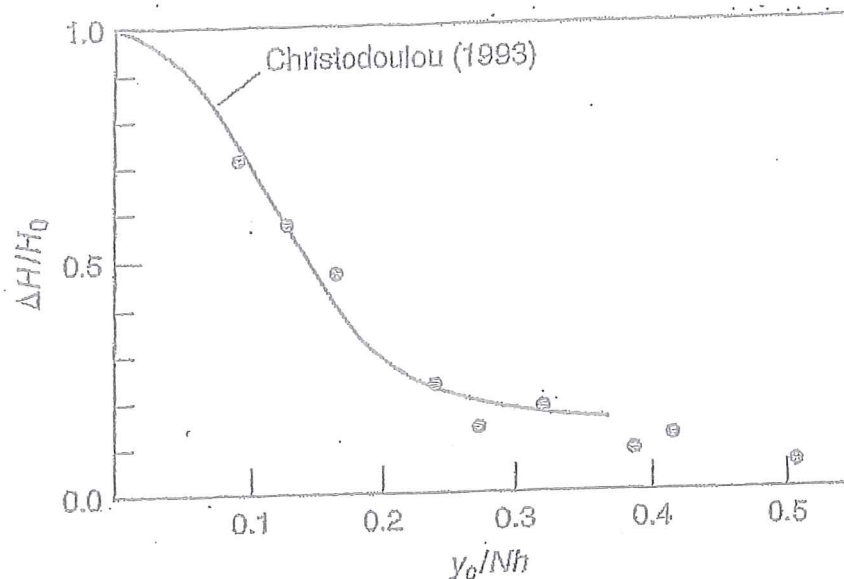


FIGURE 6.9

Model study results for head loss on a stepped spillway in skimming flow with N steps (Rice and Kadavy 1996). (Source: C. E. Rice and K. C. Kadavy, "Model Study of a Roller Compacted Concrete Stepped Spillway," *J. Hydr. Engrg.*, © 1996, ASCE. Reproduced by permission of ASCE.)

where y_c is the critical depth for the flow on the spillway and h is the height of an individual step.

The amount of energy dissipation that occurs on a stepped spillway for skimming flow is one of the primary design variables. Christodoulou (1993) suggested that the energy head dissipated, ΔH , in ratio to the total head, H_0 , upstream of the dam relative to the toe is related to y_c/Nh , in which y_c = critical depth; N = number of steps; and h = the height of each step, as shown in Figure 6.9. Rice and Kadavy (1996) have confirmed the validity of Figure 6.9 for a physical model of the Salado Creek spillway in Texas. Based on their data points, the Christodoulou curve in Figure 6.9 is valid for l/h values in the range of 0.7 to 2.5, $y_c/h \leq 4.5$, and $y_c/Nh \leq 0.5$.

Chanson (1994b) analyzed experimental data for stepped spillways from a large number of investigators and compared the results for relative energy loss with an analytical formulation for uniform flow conditions given by

$$\frac{\Delta H}{H_0} = 1 - \frac{C_f^{1/3} \cos \theta + 0.5 C_f^{-2/3}}{1.5 + \frac{H_{dam}}{y_c}} \quad (6.9)$$

in which $C_f = f/(8 \sin \theta)$; f = friction factor; $\theta = \tan^{-1}(h/l)$; H_{dam} = dam crest height above the toe; and y_c = critical flow depth. He found reasonable agreement with the experimental results, considering the degree of scatter, using $f = 1.0$ (non-aerated flow) and $\theta = 52^\circ$ over a very wide range of H_{dam}/y_c from approximately 2 to 90. Usually, $H_{dam} = Nh$, so Equation 6.9 corresponds with the variables of Fig-

ure 6.9 except that it covers a wider range in y_c/Nh . Equation 6.9 must be used with care because of the uncertainty in the friction factor due to the effects of aeration.

Stepped spillways offer the advantage of enhanced air entrainment as well as energy dissipation. Chanson (1994b) shows that the inception of air entrainment occurs in a shorter distance on a stepped spillway than on a smooth spillway because of the more rapid rate of boundary-layer growth. However, the equilibrium air concentration is similar on stepped and smooth spillways and primarily is a function of slope. For more details on the design of stepped spillways, refer to the comprehensive treatment of the subject by Chanson (1994b).

6.5

CULVERTS

Culverts seem to be simple hydraulic structures but in fact are among the most complicated because of the wide variety of flow conditions that can occur in them. Flow can be gradually varied or rapidly varied and also a function of time. A culvert can flow full, in which case it operates under pressure-flow conditions as in pipe flow, or it can flow partly full, as an open channel. The open channel flow can be supercritical or subcritical, and its analysis may include computation of a gradually varied flow profile or a hydraulic jump. Culverts flow full when the outlet is submerged due to high tailwater but also may flow full for a very high headwater with the outlet unsubmerged. In both full and partly full flow, the submergence of the inlet or outlet is an important criterion in determining the type of flow that occurs. Perhaps the most important distinguishing characteristic of a culvert flow is whether it is under inlet or outlet control. In the case of inlet control, the head-discharge relation is determined entirely by the inlet geometry, including the inlet area, edge rounding, and shape. Tailwater conditions are immaterial for inlet control. In outlet control, on the other hand, the head-discharge relation is affected not only by the inlet but also by the barrel roughness, length, slope, shape, and area as well as the tailwater elevation. These influences on inlet and outlet control are summarized in Table 6-1. Inlet control generally occurs for short, steep culverts with a free outlet, while outlet control prevails for long, rough-barreled culverts with high tailwater conditions.

Culvert design usually is based on the selection of a design discharge determined from frequency analysis. Interstate highway culverts, for example, may be designed to carry the 100 year peak discharge. The culvert is sized to limit the headwater resulting from the design discharge to a specified value to prevent overtopping the highway embankment. Once the design culvert size is determined, its performance may be analyzed over a wide range of discharges, including discharges that overtop the embankment. This analysis can be summarized by a plot of the complete head-discharge relation, called the *performance curve*. This step is important to accurately determine whether the culvert operates under inlet or outlet control for the design discharge. The design process is based on a selected peak discharge in steady flow, and a conservative approach is taken in which both inlet

ENERGY DISSIPATION ON STEPPED SPILLWAYS

By George C. Christodoulou,¹ Member, ASCE

ABSTRACT: Potentially high energy dissipation on stepped overflow spillways would imply a significant reduction of the size of downstream stilling basins. The amount of energy loss on such spillways under skimming-flow conditions is examined experimentally for structures with a moderate number of steps and a width-to-height ratio equal to 0.7. The experimental results, supported by dimensional considerations, indicate that the most important parameters governing energy dissipation are the ratio of the critical depth of flow passing over the spillway to the step height y_c/h , and the number of steps N . Dissipation is highest for the small values of y_c/h tested, near unity, and decreases with increasing y_c/h ; for a certain y_c/h the dissipation increases with N . The results are compared to those of earlier investigations referring to a large number of steps. For commonly used ranges of the step dimensions, a general relation is established between the energy loss and the parameter y_c/h , which may be useful in practical applications.

INTRODUCTION

Usually, the crest of overflow spillways follows the standard shapes that were determined after extensive experiments at the U.S. Waterways Experiment Station (Chow 1959). The flow accelerates along the downstream face and high velocities are attained at the spillway toe, so that stilling basins or other types of energy dissipators need to be provided. Some concrete gravity dams and the associated spillways are being constructed with a stepwise profile by application of rollcrete technology [e.g., Hollingworth and Drayts (1986); Bouyge et al. (1988)]. However, the performance of stepped spillways is not well known. Limited experimental research in the past (Young 1982; Sorensen 1985) has suggested that considerable energy dissipation may take place on the stepped surface of the spillway, and, consequently, the stilling basin might be severely reduced in size or even eliminated. Rajaratnam (1990) proposed a theoretical estimate for the energy loss due to the steps, assuming the establishment of uniform skimming flow. This assumption would imply a high spillway with many steps—a requirement that may not be typical of stepped structure. Peyras et al. (1992) presented experimental results for small gabion weirs with a flat crest and up to seven steps. According to these results, the relative energy dissipation decreases with increasing flowrate and also depends on the slope of the downstream face. The objective of the present paper is to further assess the energy loss characteristics of stepped spillways by means of laboratory experiments.

EXPERIMENTS

The experiments were conducted at the Applied Hydraulics Laboratory of the National Technical University of Athens. The spillway tested had the form shown in Fig. 1, in which all dimensions are given in centimeters. The

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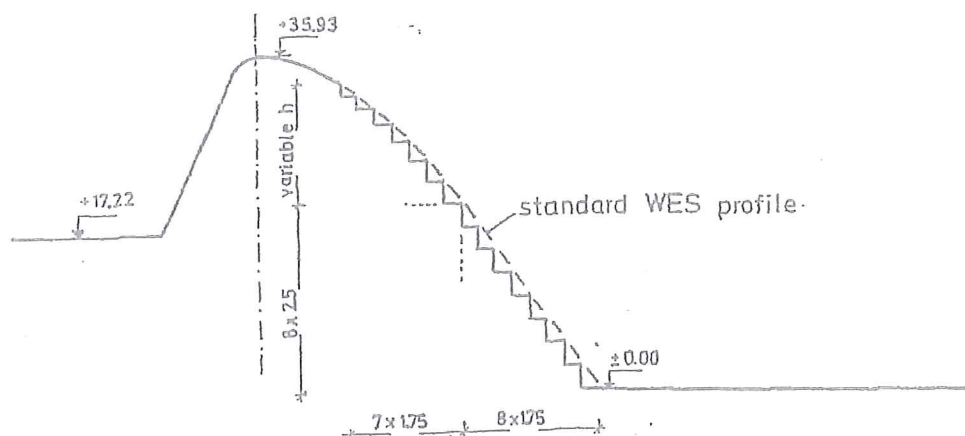


FIG. 1. Side View of Spillway Tested (Dimensions in cm)

steps are designed so that the envelope of their tips, indicated by the broken line, follows the standard Waterways Experiment Station (WES) profile up to a constant slope of 1:0.7 (55° angle to the horizontal). There are seven steps on the curved part of the spillway face with variable height-to-width ratios, and eight steps on the straight part with constant width $l = 1.75$ cm and height $h = 2.50$ cm ($l/h = 0.7$). The spillway was made of wood, and epoxy coated to avoid warping. It was placed in a laboratory flume 10 m long and 0.5 m wide, which was connected upstream to a 2.0 m $\times$ 1.5 m supply reservoir through an elliptical transition. Beyond the toe of the spillway, the flume had a bottom slope of 0.04, and there was no downstream control, so that supercritical flow was maintained without formation of a hydraulic jump.

Eight experimental runs were carried out, with discharges ranging between 10 L/s and 45 L/s. The measurement of discharge Q was performed by means of a carbon-tetrachloride differential manometer installed on the main supply line of the laboratory. In each run, the vertical water depth was measured at the brink of the 10th and the 13th step by means of a point gage mounted on an aluminum frame so that it could be moved longitudinally and transversely over any point on the spillway. The gage was equipped with a vernier, readable to within 0.1 mm. However, minor irregularities of the water surface, due primarily to the influence of the side walls, render an overall accuracy on the order of 0.1 cm. The depth was recorded at three points across each step (at $B/4, B/2, 3B/4$, where B is the flume width), and the arithmetic mean of the three values was considered as the vertical depth d over the respective step. The water level was measured on the flume axis 1 m upstream of the crest. Based on the preceding measurements, the head loss was calculated as discussed in the following section.

ANALYSIS OF RESULTS

Referring to the notation shown in Fig. 2, the total head loss up to a certain step is expressed by

$$\Delta H = H_0 - H \quad \dots \dots \dots (1)$$

where $H = y \cos \theta + (V^2/2g)$ = head on the step under consideration; $H_0 = \Delta z + Y + (V_0^2/2g)$ = head upstream of the spillway relative to the same datum; $V = Q/(yB)$ = local mean velocity; and $V_0 = Q/(YB)$ = approach velocity.

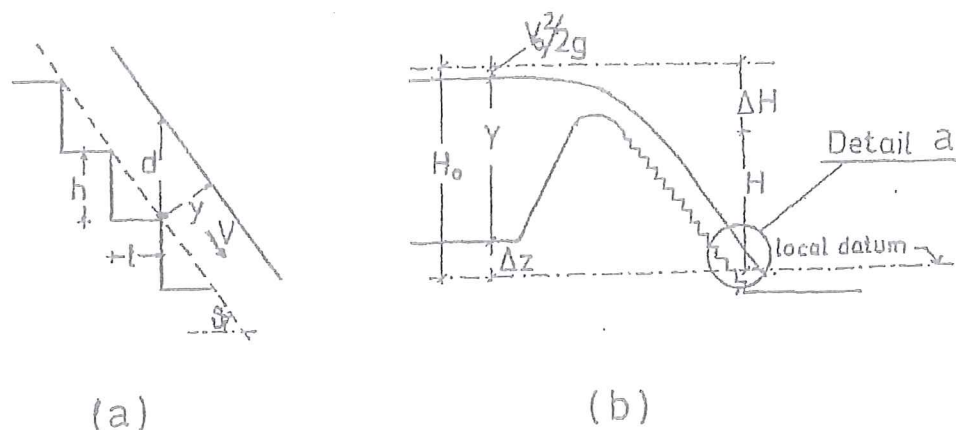


FIG. 2. Notation Sketches

Provided $B \gg y$, the head loss should be primarily dependent on the number of steps N , the geometry of the steps (h, l), and the discharge Q ; the latter may be expressed equivalently by the critical depth $y_c = \sqrt[3]{(Q/B)^2/g}$. Simple dimensional analysis leads to the relation

$$\frac{\Delta H}{h_0} = f\left(N, \frac{y_c}{h}, \frac{l}{h}\right) \quad (2)$$

In the present experiments, the ratio of l/h was 0.7. This value is close to the practically applied values of 0.78 (Sorensen 1985), 0.60–0.62 (Hollingworth and Druyts 1988), and 0.75 (Bouyge et al. 1988). The importance of the parameter y_c/h was suggested earlier by Rajaratnam (1990). He determined that for $y_c/h > 0.8$, skimming flow is expected to occur over a stepped spillway, whereas for smaller values of y_c/h , there is a nappe-flow regime, i.e., the flow from each step hits the step below as a falling jet. According to observations on gabion weirs by Peyras et al. (1992), isolated nappe flow occurs at very small flow rates, in the range of $y_c/h < 0.5$, and partial nappe flow occurs at somewhat higher discharges. Although the nappe-flow conditions are evidently most efficient in terms of energy dissipation, they are not likely to be sought in practice, due to the anticipated considerable damage of the stepped structure.

The theoretical description of flow over a spillway is not simple, even for the conventional form without the steps. The flow accelerates down the slope, and a boundary layer develops starting at the crest. After fully developed flow is established, the entrainment of air due to high velocities may lead to considerable flow bulking. In attempting to estimate the energy loss due to the steps, Rajaratnam (1990) adopted the assumption of uniform skimming flow, and derived the following expression for the effective roughness coefficient c_f of the stepped surface:

$$c_f = \frac{2y_0^3 g \sin \theta}{\left(\frac{Q}{B}\right)^2} \quad (3)$$

where y_0 = (uniform) depth normal to the flow direction. Rajaratnam reported values of c_f for stepped structures ranging between 0.05 and 0.18. For the stepped spillway tested by Sorensen (1985), Rajaratnam calculated values of c_f in the range 0.11 ÷ 0.20, with an average of 0.18.

TABLE 1. Summary of Experimental Data

Q (L/s) (1)	d (cm) (2)	Y (cm) (3)	V (cm/s) (4)	H (cm) (5)	H_0 (cm) (6)	$\Delta H/H_0$ (7)	c_f (8)	Y_c/h (9)
(a) Step No. 13								
10	2.82	1.62	124	8.82	38.02	0.768	0.171	1.34
15	2.77	1.59	188	18.93	39.26	0.518	0.072	1.75
20	3.20	1.83	218	25.41	40.41	0.372	0.062	2.12
25	3.65	2.09	239	30.30	41.43	0.268	0.059	2.45
30	4.57	2.62	229	28.25	42.38	0.333	0.080	2.78
35	5.02	2.89	242	31.53	43.22	0.270	0.080	3.07
40	5.69	3.26	245	32.45	44.00	0.265	0.087	3.35
45	6.55	3.76	240	31.46	45.17	0.303	0.105	3.64
(b) Step No. 10								
10	2.67	1.53	132	9.74	30.27	0.678	0.048	1.34
15	2.68	1.54	195	20.30	31.51	0.355	0.065	1.75
20	3.18	1.82	220	25.69	32.66	0.214	0.061	2.12
25	3.75	2.15	232	28.74	33.68	0.147	0.064	2.45
30	4.34	2.49	241	31.05	34.63	0.104	0.069	2.78
35	5.12	2.93	239	30.76	35.47	0.133	0.083	3.07
40	5.59	3.21	248	33.21	36.25	0.084	0.084	3.35
45	7.09	4.07	222	27.35	37.42	0.266	0.133	3.64

Table 1 summarizes the present experimental results for the 10th and the 13th step. The experimental range of y_c/h clearly belongs to the skimming-flow regime. It is seen that for each y_c/h the relative head loss is higher at the 13th step, close to the spillway toe. There is high energy dissipation for small y_c/h , apparently due to the more pronounced effect of the steps for small water depths relative to the step size. In fact, the presence of the steps may be considered as a macroroughness of the boundary, at a scale much larger than the usual wall roughness. The values of c_f calculated by (3) are also shown in Table 1; although not strictly uniform, the observed local depth is used for the sake of comparison. Their average value is 0.089 at the 13th step and 0.076 at the 10th step. These are within the expected range, but less than half the value corresponding to Sorensen's experiments.

According to Rajaratnam (1990), for a large number of identical steps and for a high Froude number, the theoretical energy loss at the spillway toe is 88% of the energy present without the steps. Sorensen (1985) reported a 84% kinetic energy dissipation up to the toe for the maximum discharge passing over a model spillway of 58 steps. However, the present results, obtained for a much smaller number of steps, indicate significantly lower energy losses. A plot of the present data of $\Delta H/H_0$ versus y_c/h is shown in Fig. 3. On the same figure the respective results of Sorensen are presented, as calculated from his original data. The effect of the number of steps N is evident, since at any specific y_c/h the relative energy loss increases with the number of steps; in fact the importance of N is more pronounced at higher y_c/h . Fig. 4 illustrates the dependence of $\Delta H/H_0$ on the parameter y_c/Nh . The data points suggest a single experimental curve, indicated by the broken line. Clearly, a stepped spillway is most effective for energy dissipation when y_c/Nh is small or when the discharge is small. For a certain discharge, the dissipation decreases with increasing Nh , which roughly equals the total

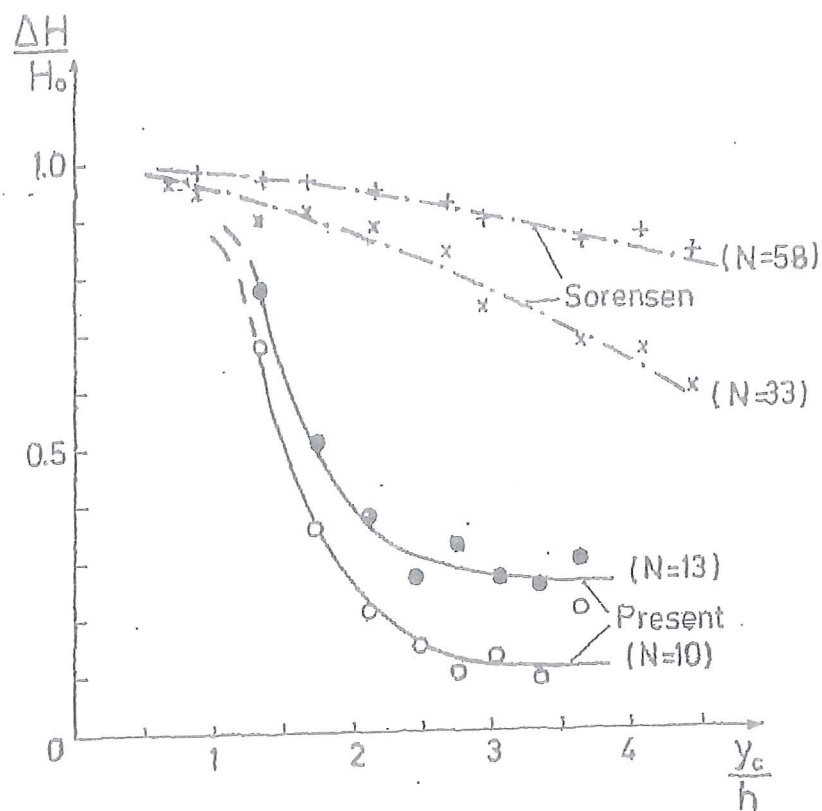


FIG. 3. Variation of Relative Head Loss $\Delta H/H_0$ with y_c/h and N

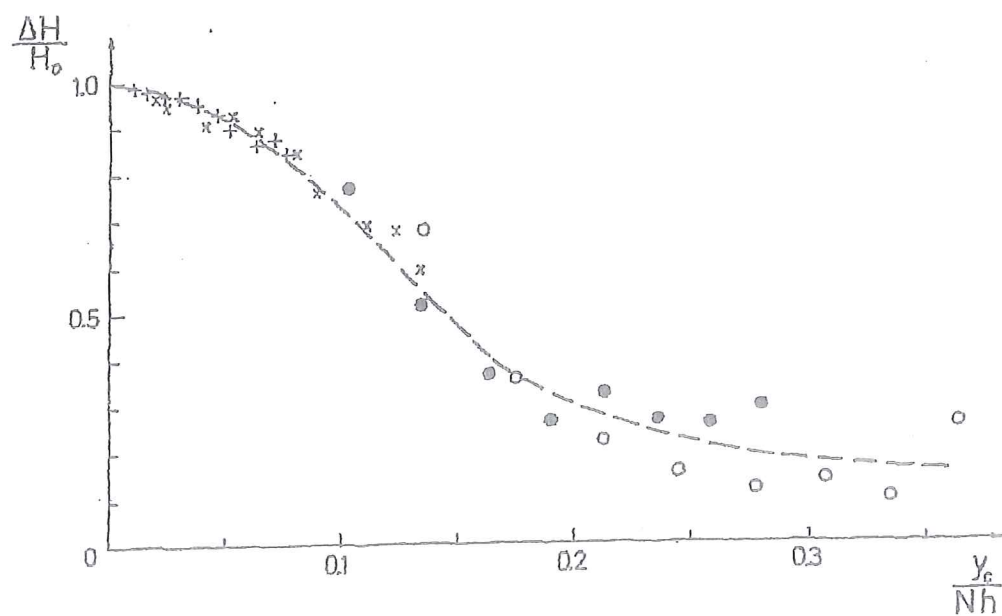


FIG. 4. Dependence of $\Delta H/H_0$ on y_c/Nh

height of the spillway. This somewhat unexpected dependence on the total height holds provided that the values of y_c/h and l/h are within the ranges tested. (This dependence obviously cannot be generalized for any step size.) With the stated limitations, the experimental curve of Fig. 4 may be used in design practice for straightforward preliminary estimates of the energy loss.

CONCLUSIONS

Experiments on a moderately sized stepped spillway indicate that the energy dissipation may be significantly less than suggested by earlier studies based on the establishment of uniform flow on high spillways. It is found that the energy loss due to the steps depends primarily on the ratio y_c/h , where y_c is the critical depth of flow passing over the spillway, and h is the step height, as well as on the number of steps N . For small values of y_c/h near unity, i.e., near the limit of skimming flow, the stepped surface is very effective in dissipating energy. For higher values of y_c/h , the effect of N becomes appreciable: at a certain y_c/h , the relative energy loss increases with N . The present and previous experimental results can be combined in a single experimental curve expressing the relative energy loss in terms of the parameter y_c/Nh for the commonly used values of l/h close to 0.7 and y_c/h in the range of 1–4.

ACKNOWLEDGMENTS

Partial financial support for this study was provided by the Public Power Corporation of Greece. Experimental measurements were taken by the students H. Tsiodra and G. Halari.

APPENDIX I. REFERENCES

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APPENDIX II. NOTATION

The following symbols are used in this paper:

- B = flume width;
 c_f = effective roughness coefficient;
 d = vertical depth of flow over brink of step;
 f = function;

g = acceleration due to gravity;
 H = local energy head, above chosen step;
 H_0 = upstream head, referred to step elevation;
 h = step height;
 l = step width;
 N = number of steps from crest to chosen level;
 Q = discharge;
 V = local mean velocity;
 V_0 = approach velocity;
 Y = upstream depth;
 y = depth of flow normal to spillway slope;
 y_c = critical depth;
 y_0 = uniform depth;
 $\Delta H = H_0 - H$;
 Δz = elevation difference between chosen step and bottom of flume in front of spillway; and
 θ = angle of downstream face of spillway to horizontal [Fig. 2(a)].

APPENDIX I

Reference Material

Master Drainage Study for Kyle Canyon, by SHG

CITY OF LAS VEGAS INTER-OFFICE MEMORANDUM			DATE: September 19, 2012
TO: Land Development Services Department of Public Works			FROM: Oh Sang Kwon, P.E. Flood Control Section Department of Public Works
SUBJECT: Drainage Study for: Kyle Canyon Master Drainage Study			COPIES TO:
Cross Streets:	Fort Apache Road & Moccasin Road		Slater Hanifan Group
File Number:	F:\Depot\DSMemos\DS4420F.doc		Wachovia Bank / Carwin Advisors
Parcel Number:	125-06-001-001		Bart Anderson, P.E., DevCo
Zoning Action:			Randy Fultz
FEMA Flood Zone	YES	NO X	CCPW, CCRFCD
Proposed Storm Drain	YES X	NO	NDOT; NV Energy
			PB America, Inc.

HISTORY	DATE RECEIVED	DATE REVIEWED	COMMENTS	REVIEW FEES	FEES PAID Transaction #
1 st Submittal	6/22/2010	7/13/2010	Not Approved	\$1,000.00	147216: \$1000
2 nd Submittal	9/17/2010	10/4/2010	Not Approved	\$400.00	153788: \$400
3 rd Submittal	10/15/2011	11/14/2011	Not Approved	\$400.00	153788: \$400
4 th Submittal	2/13/2012	3/1/2012	Conditional Approval	\$400.00	274196: \$400
CCRFCD	5/23/2012	5/24/2012	Concurrence Recv'd	N/C	N/C
5 th Submittal NDOT Comments	9/10/2012	9/19/2012	See Comments Below	N/C	N/C
TOTAL FEES (LDDRS):				\$2,200.00	****

REMARKS:**5th Submittal: Responses to NDOT Comments**

Update to original Kyle Canyon Master Drainage Study (DS4091). Site layout has been changed.

The Master Drainage Study for the subject project has been reviewed and:

	is approved subject to conformance to all City standards and the following conditions:
	must be resubmitted or supplemented including the following:
	is conditionally approved subject to Clark County Regional Flood Control District concurrence.
X	is conditionally approved subject to Clark County Department of Public Works concurrence.
X	is conditionally approved subject to Nevada Department of Transportation concurrence.
X	is conditionally approved subject to BLM concurrence/approval.

The following comments are repeated until they are complete:

- Please note that the traffic study must be approved prior to final approval of the Master Drainage Study. If the street layout does not match the Master Drainage study, an update to the Master Drainage Study must be submitted to address the changes.

2. The Kyle Canyon Master Drainage Study is proposing to revise the hydrology and facilities identified in the *Clark County Regional Flood Control District's (CCRFCD) 2008 Las Vegas Valley Flood Control Master Plan Update*. A Master Plan Amendment (MPA) must be submitted to the City of Las Vegas for approval. The City of Las Vegas will coordinate the MPA submittal to CCRFCD for approval. The Master Developer will be responsible for preparing all submittals needed for CCRFCD along with any and all presentations. The MPU must be approved by CCRFCD prior to the final approval of the Master Drainage Study.
3. Per a meeting held in August 18, 2011 between the developer and the *City of Las Vegas*, it was agreed that NV Energy's approval of any proposed drainage facilities within their access easements (such as the proposed detention basins) must be obtained prior to the final approval of the Master Drainage Study. Please provide documentation for such approval or acknowledgment.
4. Please note that any future technical drainage study submittals that differ from the Master Drainage Study (ie. Changes in pods, infrastructure, flows etc.) will require an update to the Master Drainage Study and this update must be approved by the *City of Las Vegas Flood Control Section* prior to final approval of technical drainage study.
5. The proposed detention basins will require coordination with the State of Nevada, Division of Water Resources Dam Safety and will require the State's approval prior to permitting.
6. Please obtain necessary 404 permits from Army Corps of Engineers and provide a copy of the permit to Flood Control prior to issuance of the grading permit. The contact information for Army Corps of Engineers is listed below:

Patricia L. McQueary
Chief, USACE S. George Regulatory Office
US Army Corps of Engineers
321 North Mall Drive
Suite L-101
St. George, UT 84790

(435) 986-3979 (Office)
(435) 986-3981 (FAX)
Patricia.L.McQueary@usace.army.mil

7. Please note that the proposed 100-year flood protection facilities identified on Exhibit F must be constructed by the Master Developer as a part of the master planned infrastructure. Technical drainage studies are required for each phase of the master planned infrastructure improvements. The technical drainage studies for the infrastructure improvements may be submitted with conditional approval of this Master Drainage Study. However, final approval for the Master Drainage Study must be obtained prior to conditional approval of the infrastructure drainage studies.
8. Technical drainage studies are required for each of the POD's. The technical drainage studies for the POD's may not be submitted until the conditional approval of the pertinent infrastructure drainage study is obtained. Final approval for the infrastructure drainage study must be obtained prior to conditional approval of the impacted POD drainage studies.
9. Building permits for the homes within the individual POD's will not be issued until construction of the street and flood control infrastructure around the POD is substantially complete or interim protection is provided per the approved technical drainage study.
10. The site is adjacent to Clark County jurisdictional boundaries. The engineer must coordinate the Master Drainage Study with *Clark County Public Works Department (CCPW)* and incorporate any concerns for boundary conditions. CCPW concurrence is required prior to final acceptance of the Master Drainage Study.

11. The project proposed to construct facilities and/or increase flows within *Nevada Department of Transportation* (NDOT) right-of-way. Therefore, NDOT concurrence is required prior to final approval of the Master Drainage Study.
12. The project proposed to discharge flows onto and proposed facilities within U.S. Bureau of Land Management (BLM) property. Therefore, BLM concurrence is required prior to final approval of the Master Drainage Study.
13. The proposed berm/levee along Moccasin Road will require approval from *Federal Emergency Management Agency* (FEMA) in the future. The proposed berm/levee must be designed to meet the minimum requirements set by FEMA and CCRFCD by a future technical drainage study.
14. The design of debris basins at all major culvert entrances to limit the amount of sediment and debris entering the storm drain facilities will be required in a future infrastructure study.
15. Please note that all detention basins must be designed per CCRFCD criteria including a low flow facility around the detention basin. Also, include new water quality feature per Storm Water Management Plan.
16. Please note that all proposed interim facilities must be maintained by the master developer.
17. Provide a legal description of the proposed detention basins prior to recordation of the parent final map.
18. Coordinate the proposed drainage facilities with *Sheep Mountain Parkway* project. Please contact Greg McDermott, P.E., at 702-229-2143 to coordinate the proposed drainage facilities.

NOTE: Any future changes to the proposed design (or design assumptions) as outlined in the approved master drainage study and attached preliminary grading plan which affect drainage must be addressed in a Drainage Study Amendment and accepted by the *City of Las Vegas Flood Control Section*. Additionally, conditional acceptance of a drainage study is valid for a period of one (1) year. If the proposed construction has not been completed in that time period, the *City of Las Vegas* reserves the right to require additional conditions and/or submission and acceptance of a complete drainage study update prior to further construction of a project.

NOTE: Please be advised that all land surface area disturbances over 1 acre or any area adjacent to a water way must submit to the Nevada Division of Environmental Protection a "Notice of Intent" to discharge that certifies a stormwater pollution prevention plan has been developed and is maintained on site; for inclusion in the Stormwater General Permit No. NVR100000. A phased construction unit in a contiguous subdivision is considered under construction until all stripped or disturbed surface areas have been covered by paving, building construction or planting. For more information, including forms and applications see <http://ndep.nv.gov/bwpc/storm01.htm> or call (775) 687-9429.

In an effort to increase administrative efficiency, the City of Las Vegas Public Works Department requires all soil reports, drainage studies and traffic impact analysis submittals to be accompanied by an electronic copy of the submittal. Electronic documents must be submitted with one original hard copy of the study. Electronic documents should be on a universal computer-readable digital output replicating your submittal to be used for archival or display purposes. This may be more than one file if necessary. An Indexed Portable Document Format (PDF) or Print Ready CAD file formats with a minimum of 300dpi are the desired formats, but provided it is a high quality digitized replication of the submittal, other formats may be acceptable. If figures are in color, they must be scanned in color and saved as a separate file. The new submittal requirement is effective on July 1, 2011. If there are any questions regarding these new requirements, please contact Oh Sang Kwon in the Flood Section at (702) 229-2177 or Rick Schroder in Traffic Engineering at (702) 229-6327.

END OF REMARKS
osk

T/R/S: T19S/R60E/6 & 7
AREA G-6, 7, & F-12

APPENDIX J

Improvement Plans