RECLAMATION DISTRICT NO. 1601
TWITCHELL ISLAND
BOARD OF TRUSTEES MEETING
TUESDAY, SEPTEMBER 15, 2026
9:00 AM
ENGINEER'S REPORT

I. TW-24-1.0 - SJ RIVER SETBACK LEVEE, REACH 6 PHASE 1

A. Project status:

a) Dutra Construction Co. is wrapping up with all-weather road cleanup and Aggregate Base placement, and they expect to be completely finished with work by the September. We are working with Dutra to transfer work to KSN for the QSP (SWPPP) responsibilities to save some cost.

b) KSN is continuing to survey the settlement plates for the immediate future (albeit less frequently). Once we are comfortable with the rate of settlement, we will as-built survey the entire site and use that as the basis for our Phase 2 levee design. We're hoping to minimize significant increases to Phase 2 fill quantities by waiting a bit before we do our as-built survey. KSN will still be able to continue with the Phase 2 levee design and anticipates to having Phase 2 levee construction out to bid and bids received by Thanksgiving.

c) It's anticipated the total change orders will be on the order of $600k. KSN is still working with Dutra to develop a credit for the final site stabilization (i.e., hydro mulch), so that $600k may be further reduced.

PCO No.	Description	Actual CO 1 Amount	Estimated CO 2 Amount
2A	Additional Type 1 fill in lieu of Type 2 fill	+$604,240	
2B	Credit for Type 2 fill		-$500,000
3	Additional Type 1 fill to stabilize the toe of the berm	+$352,302	
4	Partial deduction of toe road		-$80,000
5	Repair to East End Wetlands irrigation pipe		+$220,000
		+$956,542	**-$360,000**

B. Continual monitoring and surveying of levee crown crack at Station 501+50 indicates minimal horizontal and vertical movement.

C. DWR Real Estate Division is coordinating with PG&E regarding the power pole relocation easement.

EXHIBIT A: Progress Payment No. 4 excerpt.

EXHIBIT B: Contract Change Order No. 1.

EXHIBIT C: Field photos from KSN Daily Field Reports (DFR's)

II. NEW PROPOSITION 218 ASSESSMENT AND ENGINEERS REPORT

A. Review KSN's 2026 Drainage Analysis. This technical memorandum serves to outline the findings of the 2026 drainage analysis conducted for Reclamation District No. 1601 – Twitchell Island (District). The objective of this analysis was to quantify the various components of water discharged from the District terminal pump station, encompassing runoff from rainfall, irrigation, and levee seepage. These findings are intended to provide critical input for the District's Proposition 218 Assessment.

EXHIBIT D: KSN's 2026 Drainage Analysis

Exhibit A

KJELDSEN SINNOCK NEUDECK
CIVIL ENGINEERS & LAND SURVEYORS

Progress Pay Estimate
No. 4

PROJECT: 1110-1071-10
San Joaquin River Setback Levee
Reach 6 - Phase 1

DATE: 9/8/2026

CONTRACTOR: The Dutra Group

CONTRACT ID: 1601-12-18-25-03

CONTRACT TIME:

Original Time	154 days
Notice to Proceed Date	4/30/2026
Original Completion Date	10/1/2026
Approved Time Extensions	0 days
Revised Completion Date	10/1/2026
Work Completed Through	8/31/2026
Elapsed Time	123 days
Percent Time Elapsed	79.9%

CONTRACT COST:

Original Contract Price	$5,595,434.00
Approved Change Orders	$956,541.80
Percent Change Orders	17.1%
Revised Contract Price	$6,551,975.80
Amount Complete to Date	$5,506,994.63
Percent Complete	84.1%

CURRENT PAYMENT SUMMARY:

DESCRIPTION	TOTAL EARNINGS	*LESS 5% RETENTION*	*LESS DEDUCTIONS*	NET EARNINGS
To Date	$5,506,994.63	($275,349.73)	$0.00	$5,231,644.90
Previous	$4,159,805.03	($207,990.25)	$0.00	$3,951,814.78
Current	$1,347,189.60	($67,359.48)	$0.00	$1,279,830.12
		Net Payment Due This Invoice:		**$1,279,830.12**

OVERALL PAYMENT SUMMARY:

NO.	WORK COMPLETED THROUGH	TOTAL EARNINGS	*LESS 5% RETENTION*	*LESS DEDUCTIONS*	NET EARNINGS
1	5/31/2026	$408,710.15	($20,435.51)	$0.00	$388,274.64
2	6/30/2026	$2,108,941.13	($105,447.06)	$0.00	$2,003,494.07
3	7/31/2026	$1,642,153.75	($82,107.69)	$0.00	$1,560,046.06
4	8/31/2026	$1,347,189.60	($67,359.48)	$0.00	$1,279,830.12
	TOTALS:	**$5,506,994.63**	**($275,349.73)**	**$0.00**	**$5,231,644.90**

NOTES:

SUPPORTING DOCUMENTATION
- The Dutra Group Invoice No. 2122522-004 dated 9/4/26.

RECOMMENDED FOR PAYMENT
KSN, Inc.

BY:
Daniel Vitoria, PE
Resident Engineer

KJELDSEN SINNOCK NEUDECK
CIVIL ENGINEERS & LAND SURVEYORS

Progress Pay Estimate
No. 4

PROJECT: 1110-1071-10
San Joaquin River Setback Levee
Reach 6 - Phase 1

DATE: 9/8/2026

CONTRACTOR: The Dutra Group

CONTRACT ID: 1601-12-18-25-03

ITEM NO.	ITEM DESCRIPTION	UNIT	CONTRACT QTY	CONTRACT UNIT PRICE	CONTRACT AMOUNT	TOTAL ESTIMATE TO DATE QTY	TOTAL ESTIMATE TO DATE %	TOTAL ESTIMATE TO DATE AMOUNT	PREVIOUS ESTIMATE QTY	PREVIOUS ESTIMATE %	PREVIOUS ESTIMATE AMOUNT	CURRENT ESTIMATE QTY	CURRENT ESTIMATE %	CURRENT ESTIMATE AMOUNT
ORIGINAL CONTRACT					**$5,595,434.00**		**81.32%**	**$4,550,452.83**		**74.34%**	**$4,159,805.03**		**6.98%**	**$390,647.80**
SCHEDULE 1: BASE BID					**$1,940,114.00**		**46.14%**	**$895,132.83**		**45.92%**	**$890,982.83**		**0.21%**	**$4,150.00**
1	Mobilization	LS	1	$44,000.00	$44,000.00		100.00%	$44,000.00		100.00%	$44,000.00			
2	SWPPP	LS	1	$246,903.00	$246,903.00		60.00%	$148,141.80		60.00%	$148,141.80			
3	Demolition	LS	1	$7,490.00	$7,490.00		100.00%	$7,490.00		100.00%	$7,490.00			
4	Clearing and Grubbing	LS	1	$100,000.00	$100,000.00		100.00%	$100,000.00		100.00%	$100,000.00			
5	Toe Road Preparation	SY	5,800	$5.45	$31,610.00									
6	Geogrid	SY	5,800	$6.95	$40,310.00									
7	Aggregate Base at Toe Road	TN	1,900	$42.50	$80,750.00									
8	Toe Ditch	LF	1,200	$8.30	$9,960.00	700	58.33%	$5,810.00	200.00	16.67%	$1,660.00	500.00	41.67%	$4,150.00
9	Temporary Irrigation Facilities	LS	1	$114,000.00	$114,000.00		100.00%	$114,000.00		100.00%	$114,000.00			
10	Berm Embankment Fill	CY	43,800	$17.10	$748,980.00	8,139.80	18.58%	$139,190.58	8,139.80	18.58%	$139,190.58			
11	Settlement Plates and Instrumentation	LS	1	$354,211.00	$354,211.00		95.00%	$336,500.45		95.00%	$336,500.45			
12	District Access Road Regrading	SY	39,500	$0.20	$7,900.00									
13	Aggregate Base at District Access Road	TN	4,400	$35.00	$154,000.00									
SCHEDULE 2: MARINE-BASED LEVEE FILL DELIVERY					**$3,655,320.00**		**100.00%**	**$3,655,320.00**		**89.43%**	**$3,268,822.20**		**10.57%**	**$386,497.80**
1	Levee Embankment Fill	TN	220,200	$16.60	$3,655,320.00	220,200.00	100.00%	$3,655,320.00	196,917.00	89.43%	$3,268,822.20	23,283.00	10.57%	$386,497.80
CHANGE ORDERS					**$956,541.80**		**100.00%**	**$956,541.80**		**0.00%**	**$0.00**		**100.00%**	**$956,541.80**
CO 001	**Levee Embankment Fill - Material Reconciliation**				**$956,541.80**		**100.00%**	**$956,541.80**		**0.00%**	**$0.00**		**100.00%**	**$956,541.80**
001-1	Levee Embankment Fill	TN	57,623	$16.60	$956,541.80	57,623.0	100.00%	$956,541.80				57,623.0	100.00%	$956,541.80
TOTALS:					**$6,551,975.80**		**84.05%**	**$5,506,994.63**		**63.49%**	**$4,159,805.03**		**20.56%**	**$1,347,189.60**

2122522-004 dated 9/4/26.

THE DUTRA GROUP
PROGRESS PAYMENT No. 004

Submitted To:
KSN Inc. Civil Engineers & Land Surveyors

Attention:
Erik Almaas
KSN Inc. Civil Engineers & Land Surveyors
711 N. Pershing Avenue
Stockton, CA 95203
(916) 403-5900

Client Contract: 1601-12-18-25-03
Project Name: San Joaquin River Setback Levee, Reach 6 - Ph 1
Work Location: Twitchell Island, CA

Invoice No: 2122522-004
Bill Date: 09/04/26
Terms: NET 30 DAYS
Dutra Project No.: 2122522
Dutra Customer No.:

For Period Beginning: 8/1/2026
For Period Ending: 8/31/2026

Bid Item	Description of Work	Contract Quantity	Unit Price	UOM	Contract Amount	This Period Qty	This Period Total $	Previous Period Qty	Previous Period Total $	Total To Date Qty	Total To Date Total $
	BASE BID										
1	MOBILIZATION	1.00	$ 44,000.00	LS	$ 44,000.00		$ -	1.00	$ 44,000.00	1.00	$ 44,000.00
2	SWPPP	1.00	$ 246,903.00	LS	$ 246,903.00		$ -	0.60	$ 148,141.80	0.60	$ 148,141.80
3	DEMOLITION	1.00	$ 7,490.00	LS	$ 7,490.00		$ -	1.00	$ 7,490.00	1.00	$ 7,490.00
4	CLEARING & GRUBBING	1.00	$ 100,000.00	LS	$ 100,000.00		$ -	1.00	$ 100,000.00	1.00	$ 100,000.00
5	TOE ROAD PREPARATION	5,800.00	$ 5.45	SY	$ 31,610.00		$ -	0.00	$ -	0.00	$ -
6	GEOGRID	5,800.00	$ 6.95	SY	$ 40,310.00		$ -	0.00	$ -	0.00	$ -
7	AGGREGATE BASE @ TOE ROAD	1,900.00	$ 42.50	TN	$ 80,750.00		$ -	0.00	$ -	0.00	$ -
8	TOE DITCH	1,200.00	$ 8.30	LF	$ 9,960.00	500.00	$ 4,150.00	200.00	$ 1,660.00	700.00	$ 5,810.00
9	TEMP IRRIGATION FACILITIES	1.00	$ 114,000.00	LS	$ 114,000.00		$ -	1.00	$ 114,000.00	1.00	$ 114,000.00
10	BERM ENBANKMENT FILL	43,800.00	$ 17.10	CY	$ 748,980.00		$ -	8139.80	$ 139,190.58	8,139.80	$ 139,190.58
11	SETTLEMENT PLATES & INSTRUMMENTATION	1.00	$ 354,211.00	LS	$ 354,211.00		$ -	0.95	$ 336,500.45	0.95	$ 336,500.45
12	DISTRICT ACESS ROAD REGRADING	39,500.00	$ 0.20	SY	$ 7,900.00		$ -	0.00	$ -	0.00	$ -
13	AGGREGATE BASE @ DISTRICT ACCESS RD	4,400.00	$ 35.00	TN	$ 154,000.00		$ -	0.00	$ -	0.00	$ -
	BID ALRERNATE No. 2										
1	LEVEE ENBANKMENT FILL	220,200.00	$ 16.60	TN	$ 3,655,320.00	23283.00	$ 386,497.80	196917.00	$ 3,268,822.20	220,200.00	$ 3,655,320.00
	PCOs										
	LEVEE ENBANKMENT FILL	57,623.00	$ 16.60	TN	$ 956,541.80	57623.00	$ 956,541.80			57,623.00	$ 956,541.80
	6" Pumps	1.00	$ -	T&M	$ -		$ -		$ -	0.00	$ -
	PIP Pipe Repair	1.00	$ -	T&M	$ -		$ -		$ -	0.00	$ -
				Total Gross Earnings:	$6,551,975.80		$1,347,189.60		$4,159,805.03		$5,506,994.63
				Retention 5%:			$67,359.48		$207,990.25		$275,349.73
										Previous Payments:	$3,951,814.78
										Net Due:	**$1,279,830.12**

Gonzalo Melendez
Signature

Gonzalo Melendez, Project Manager
Name, Title

9/4/2026
Date

FOR USE BY BILLING OFFICE ONLY
DATE RECEIVED:
EVALUATION DATE:
CONSTRUCTIVE APPROVAL & ACCEPTANCE:

REMARKS:

Exhibit B

Change Order
No. 01

Date of Issuance:	September 4, 2026	Effective Date:	September 4, 2026		
Project:	RD1601 Setback Levee R6 Ph1	Owner:	Reclamation District 1601	Owner's Contract No.:	1601-12-18-25-03
Contract: Agreement Form 00 52 00		Date of Contract: December 18, 2025			
Contractor: The Dutra Group		Engineer's Project Number: 1110-1071-01			

The Contract Documents are modified as follows upon execution of this Change Order:

Change Order No. 1 accounts for additional materials, equipment, and labor as required for the construction of additional project features and final reconciliation of placed material quantities.

Attachments (list documents supporting change):

Please see attached Attachment to Change Order No. 1.

CHANGE IN CONTRACT PRICE:

Original Contract Price:
$ 5,595,434.00

Increase from previously approved Change Orders No. None
$ 0.00

Contract Price prior to this Change Order:
$ 5,595,434.00

Increase/Decrease of this Change Order:
$ 956,541.80

Contract Price incorporating this Change Order
$ 6,551,975.80

CHANGE IN CONTRACT TIMES:

Original Contract Time: Deadline
Substantial Completion: 10/1/2026
Ready for final payment: 10/15/2026

Increase from previously approved Change Orders:
Substantial Completion: N/A
Ready for final payment: N/A

Contract Times prior to this Change Order:
Substantial Completion: 10/1/2026
Ready for final payment: 10/15/2026

Increase of this Change Order:
Substantial Completion: 0 Days
Ready for final payment: 0 Days

Contract Times with all approved Change Orders:
Substantial Completion: 10/1/2026
Ready for final payment: 10/15/2026

RECOMMENDED:	ACCEPTED:	ACCEPTED:
By:	By:	By:
Daniel Vitoria, KSN	Gonzalo Melendez, The Dutra Group	Barry Sgarrela, RD 1601
Date: 9/4/2026	Date:	Date:

JOB NO. 1110-1071

ATTACHMENT TO CHANGE ORDER NO. 1

SAN JOAQUIN RIVER SETBACK LEVEE PROJECT
REACH 6 – PHASE 1
SACRAMENTO COUNTY, CALIFORNIA

CONSTRUCTION MILESTONES:

Original Completion Date: 10/1/26
Revised Completion Date: 10/1/26

DESCRIPTION OF CHANGES:

Material Reconciliation – This change order includes the final quantity count for levee embankment fill.

Parties agree that a payment of $956,541.80, as detailed in Table 1, shall cover all costs for the additional work described above.

PCO No.	DESCRIPTION	CONTRACT QTY	ACTUAL FINAL QTY	QTY DIFF.	UNIT PRICE	TOTAL PRICE
002	Replace Type 2 Berm Fill for Type 1 Levee Embankment Fill	220,200 tons	256,600 tons	+36,400 tons	$16.60/ton	$ 604,240.00
003	Toe Road Stabilization with Type 1 Levee Embankment Fill	220,200 tons	241,423 tons	+21,223 tons	$16.60/ton	$ 352,301.80
					TOTAL	**$ 956,541.80**

Exhibit C


CAT
325


TEAM
SAFETY


Tensar InterAx
Tensar Corporation, LLC
Suite 500
Made in the USA
Tensar and InterAx are
registered trademarks
made in USA
WEAR GLOVES


A321

Exhibit D

KJELDSEN SINNOCK NEUDECK
CIVIL ENGINEERS & LAND SURVEYORS

Christopher H. Neudeck, P.E
Neal T. Colwell, P.E.
Barry O'Regan, P.E., CFM
Jeffrey A. Mueller, P.E.

1110-1100
08-300

August 24, 2026

To: Reclamation District No 1601 – Twitchell Island

Subject: 2026 Drainage Analysis

Project: Twitchell Island Drainage Analysis

From: Christopher H. Neudeck, P.E., District Engineer

Introduction

Objective

This technical memorandum serves to outline the findings of the 2026 drainage analysis conducted for Reclamation District No. 1601 – Twitchell Island (District). The objective of this analysis was to quantify the various components of water discharged from the District terminal pump station, encompassing runoff from rainfall, irrigation, and levee seepage. These findings are intended to provide critical input for the District's Proposition 218 Assessment.

Background

The District is located at the southern border of Sacramento County and is northwest of the City of Stockton and southeast of the town of Rio Vista. The District is bounded by Sevenmile Slough to the north, west and east, Threemile Slough to the west, and San Joaquin River to the south. (See Figure 1 below). The interior of the District is approximately 3,560 acres in area. The District is responsible for maintaining the levee system and drainage facilities that provide flood protection for primarily agricultural land and infrastructure. The District boundary and study area for this analysis is the internal drainage area of the District (as shown in Figure 1).

A network of interior irrigation and drainage ditches divide the District into subareas that drain to the District's single terminal pump station. In addition to the interior irrigation and drainage ditch network, toe ditches adjacent to the levees collect seepage water and convey the water to the interior drainage network. The pump station, located along the south District levee adjacent to the San Joaquin River, contains three 100 horsepower pumps that have a combined flow rate of approximately 30,000 gallons per minute.[1] The pumps are controlled by a level sensing float system that automatically starts and stops the pumps at predetermined water levels. The pump station location is shown in Figures 1 and 2 below.

[1] The flow rates listed are based on pump performance during conditions at the time of the pump test. These conditions are assumed to be indicative of normal operations of the pump station. Pump capacities for any pump with a given motor vary, depending on the total dynamic head, impeller size, and efficiency.

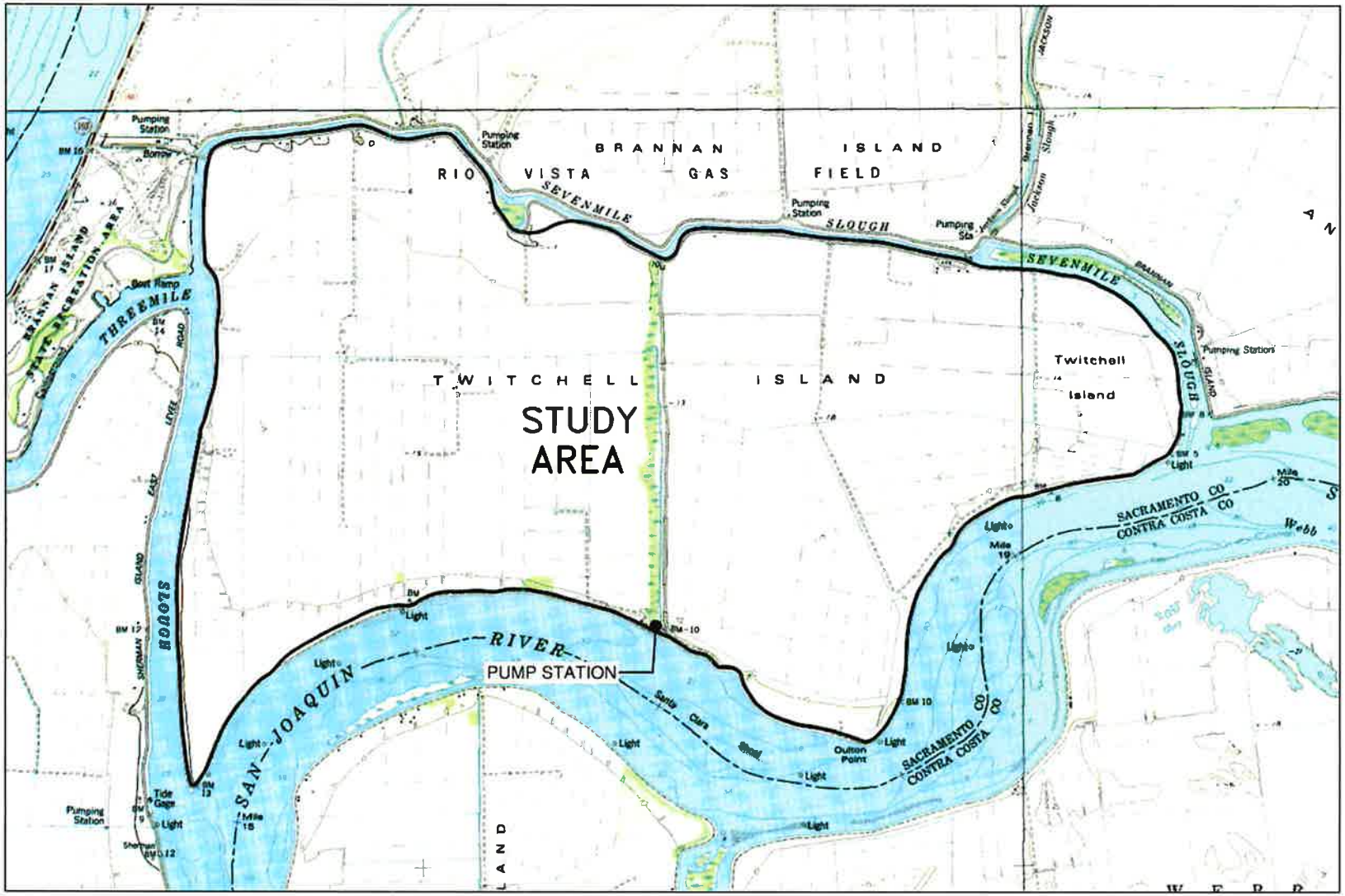

Figure 1 - Study Area

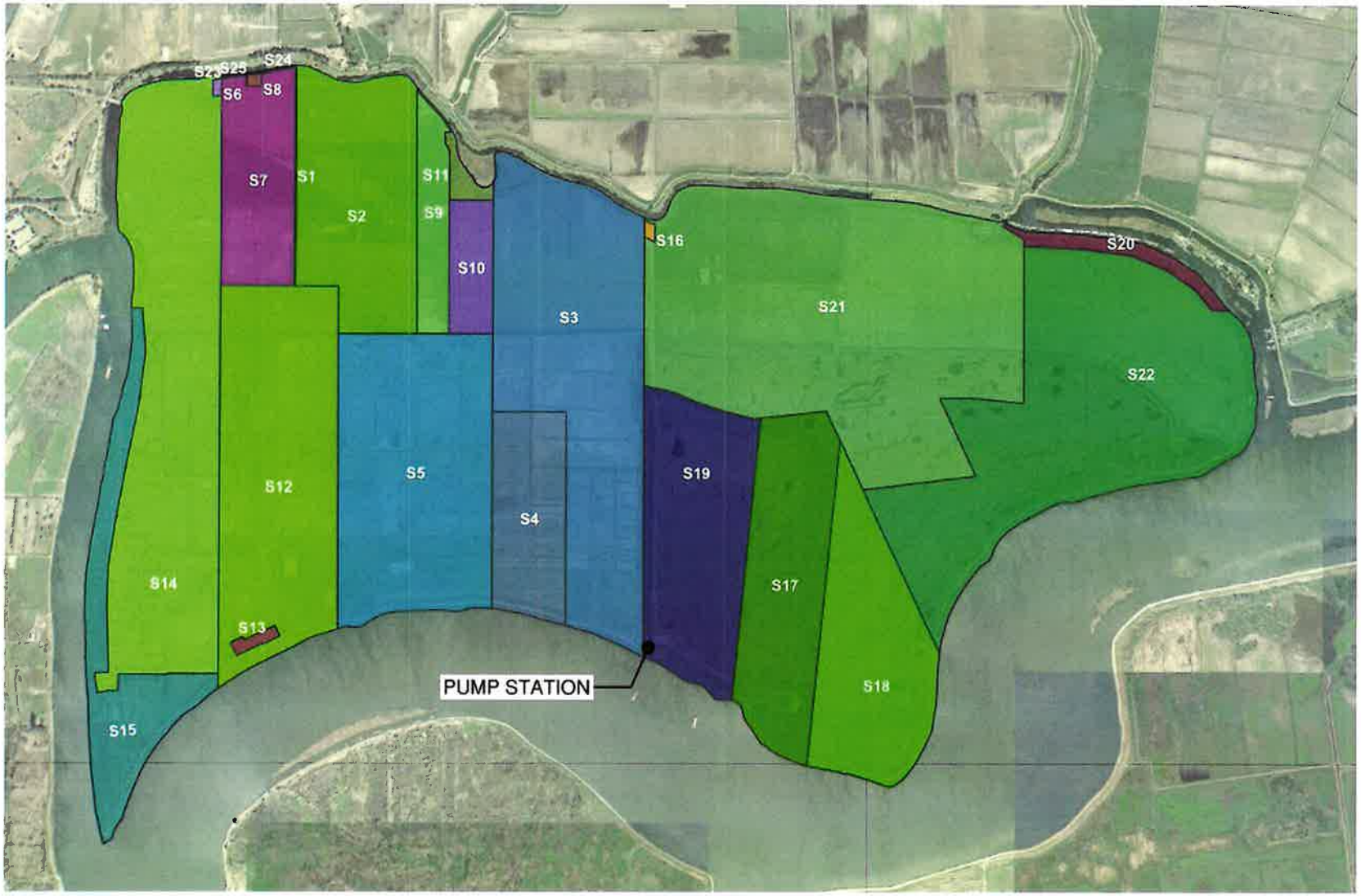

Figure 2 – District Drainage Parcels

Analysis Methods & Results

Methods used to estimate runoff from rainfall, irrigation, and seepage for the District are summarized below. Rainfall runoff was estimated based on a 10-day duration design storm with a 2-year recurrence interval and modeled via Geographic Information System (GIS) software and the Environmental Protection Agency Storm Water Management Model (EPA SWMM) software. The modeled design storm was used to develop a precipitation runoff coefficient for each parcel based on the relationship between modeled surface runoff and total precipitation. These parcel-specific runoff coefficients were subsequently applied to the average annual precipitation depth for the Sacramento area from 2015 through 2025 to estimate representative annual precipitation runoff volumes for the District. Irrigation runoff was estimated for the agricultural drainage subareas using a consumptive use model implemented in a Microsoft Excel spreadsheet, and for habitat subareas based on historic diversion practices. Levee seepage was estimated using a conservative seepage rate based on soil properties from a prior study and subsequently applied to riverine levee sections.

Precipitation Runoff

A precipitation analysis was conducted using a 10-day duration design storm with a 2-year recurrence interval. The selection of the storm duration and recurrence interval was based on recommendations provided in the City and County of Sacramento Drainage Manual, Volume 2 – Hydrology Standards, which identifies long-duration storm types as appropriate for volume-based hydrologic analyses. Long-duration storms include 36-hour, 5-day, and 10-day storm events and are intended to represent multiple precipitation events occurring over the selected duration. These storm types are used when the total volume of runoff generated over an extended period of time is more significant to the analysis than the peak discharge rate. For this analysis, the temporal distribution of the 10-day, 2-year design storm was obtained from the Drainage Manual and is included in Appendix A. The total precipitation depth for the selected design storm and study area was obtained from the National Oceanic and Atmospheric Administration (NOAA) National Weather Service (NWS) Precipitation Frequency Data Server (PFDS) and is provided in Appendix A. The total precipitation depth used for the 10-day, 2-year design storm in this analysis was 4.12 inches. A summary of the design storm is presented in Table 1 below.

Table 1 - Summary of Design Storm

Storm Duration	Recurrence Interval	Precipitation Depth
10-day	2 Years	4.12 inches

Average annual precipitation for the Sacramento area was estimated using annual precipitation records for calendar years 2015 through 2025 obtained from the NOAA NWS NOWData database. The resulting average annual precipitation depth of 17-inches for Twitchell Island was used as the representative annual precipitation depth for this analysis. Annual precipitation records are provided in Appendix A.

Soil Data

A determination of the general soil characteristics was necessary for the completion of this analysis. General soils information for the District was obtained from the Web Soil Survey, a website operated by the United States Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS). Available data for the District includes soil classifications, and values for hydraulic conductivity, suction

head, and initial deficit, all of which were used to model the precipitation runoff. Additionally, land cover and urban imperviousness data produced by the National Land Cover Database (NLCD) in 2024 was obtained through the Multi-Resolution Land Characteristics Consortium for use in this analysis.

Hydrologic Modeling

In order to calculate the excess runoff from each District parcel, precipitation, soil data, spatial extents and other data were preprocessed in Quantum Geographic Information System (QGIS) software for the development of an EPA SWMM model. The pre-processing of input data consisted of extracting needed input values (e.g. precipitation depth, subarea acreage, land cover) and developing the input files for the EPA SWMM model. QGIS provides a plug-in that automates a large portion of the spatial analyses and development of the EPA SWMM input files. Outputs from the QGIS plug-in were checked and verified for accuracy by KSN engineers.

The modeling software used to calculate the excess precipitation runoff volume was EPA SWMM version 5.2. The study area was analyzed for the selected design storm. Infiltration losses were calculated using the modified Green-Ampt method on a subarea basis. This method estimates infiltration into the soil based on soil hydraulic conductivity, suction head, and the available soil moisture deficit as rainfall progresses. A detailed breakdown of input parameters and output results are presented in Appendix A which summarizes the precipitation runoff analysis, detailing the input parameters such as precipitation depth, soil data, and acreage, as well as the corresponding runoff estimates and runoff coefficients by parcel.

For each parcel, the average annual precipitation depth of 17-inches was converted to a total annual precipitation volume based on parcel acreage. The parcel-specific runoff coefficient developed from the EPA SWMM model design-storm analysis was applied to the annual precipitation depth to estimate average annual precipitation runoff. The annual runoff estimates for all parcels were summed to estimate the total average annual precipitation runoff volume for the District.

This approach assumes that the runoff fraction calculated from the 10-day, 2-year design storm provides a representative relationship between precipitation and runoff for purposes of estimating annual drainage volumes. The annual calculation is therefore intended as a planning-level estimate of average annual precipitation runoff and does not represent a continuous simulation of individual precipitation events occurring throughout a year.

It should be noted that the purpose of the precipitation analysis was to quantify the total volume of precipitation runoff from the various portions of the District. Routing of the runoff was not examined as a part of this analysis because all excess runoff is assumed to be evacuated from the District via the pump station. Evaporation was not considered in the runoff estimates because evaporation would be expected to be minimal during the rainfall event itself, and the resulting runoff is typically evacuated promptly following the event. Since significant evaporation primarily affects water that remains exposed for longer durations, its effect on the short-term runoff events evaluated in this study was considered negligible.

Results

A summary of the precipitation runoff results from the analysis is presented in Table 2 below and further detailed in Appendix A.

Table 2 - Summary of Precipitation Runoff Results

	Volume (acre-feet)
Total Precipitation	5,035.6
Evaporation Loss	-
Infiltration Loss & Final Storage	4,357.1
Surface Runoff	678.5

The total precipitation over the District drainage areas was estimated at 5,035.6 acre-feet which results in approximately 678.8 acre-feet of runoff. The runoff for each parcel varies depending on the soil properties, size, and imperviousness as indicated in the provided runoff summary table.

Irrigation Runoff

The majority of the District is undeveloped land with crop, pasture, and habitat areas irrigated via water from adjacent waterways using irrigation siphons. The District has a total of 22 irrigation siphons at various locations along the levee with varying diameters and flow rates. The existing siphons along the District are not metered and time of usage is not documented, which presents challenges in the methods available to estimate total irrigation water diversion.

The irrigation runoff for the District was estimated using a consumptive-use-based excel spreadsheet historically utilized for water diversion reporting within the central and south delta regions. Inputs to the spreadsheet include acreage of agricultural areas and crop/use type. The analysis was subsequently refined to improve the estimate of irrigation runoff generated by habitat areas shown in Figure 3.

For these areas, irrigation diversions were estimated using a diversion rate per acre derived from the documented operation and use of the siphon serving the habitat area. The estimated habitat-area diversion volume was then incorporated into the overall irrigation runoff calculation for the District. For this analysis, the specific use of each area for agricultural, livestock, or habitat purposes were obtained from the District. These uses were then utilized to compute consumptive water use, expressed in acre-feet per year, for one acre of each crop type.

Standard agricultural practices typically involve diverting an additional 40 to 60 percent of water to accommodate infiltration, runoff, and evaporation during irrigation. The difference in total estimated diversion and total estimated consumptive use by crops results in a potential irrigation runoff. Table 3 below summarizes the total diversion, consumptive use, and potential runoff based on one acre of each crop type.

Figure 3 - Twitchell Island Habitat Areas

Table 3 – Total Annual per Acre Diversion, Consumptive Use, and Potential Runoff by Use Type

Crop/ Land Use Type	Annual Volume (acre-feet/acre)		
	Total Diversion	Consumptive Use	Potential Runoff
Alflafa/Pasture	6.62	4.14	2.48
Corn	4.40	2.75	1.65
Idle	0.98	0.61	0.37
Habitat	11.60-14.27[(a)]	2.36	9.24-11.91
Rice	5.92	3.70	2.22
Trees	6.16	3.85	2.31

(a) Diversion per acre of Habitat land use type based on documented six months per year operation of existing siphons serving existing habitat areas on Twitchell Island as shown in Figure 3.

Results

A summary of the estimated irrigation diversion, consumptive use, and runoff for each drainage area is presented in Table 4 and Appendix B. Appendix B contains a detailed summary of the irrigation runoff analysis, including the acreages of agricultural areas, crop types, and the historical water diversion data used in the calculations. The appendix also includes the resulting runoff estimates by subarea. The total estimated runoff from irrigation was 13,411.7 acre-feet per year.

Table 4 - Summary of Irrigation Runoff Results

Total Area (acres)	Total Irrigation Diversion (acre-feet/year)	Total Crop Consumptive Use (acre-feet/year)	Total Irrigation Runoff (acre-feet/year)
3,341.0	24,356.7	10,944.9	13,411.7

Seepage Volume

Seepage from the exterior levee surrounding the District was also considered in this analysis. Seepage is the movement of water through or beneath an embankment typically caused by a difference in water elevation (static head) between the water side and landside of the embankment. Levee seepage is collected by ditches at the toe of the levee and routed via the drainage ditches to the discharge pump station.

Seepage rates utilized for the District's levee were estimated using existing soil properties presented in the GEI Consultants Geotechnical Investigation and Evaluation Report dated January 2009, and subsequently applied in this study. The estimate considered both through-seepage through the levee embankment and under-seepage beneath the levee toe area. Based on the available information and conservative assumptions for drainage analysis purposes, a seepage rate of 3.3 gallons per hour per foot of levee was adopted for levee reaches adjacent to the river and contributing to the drainage ditch system. Lengths of District levee used in seepage estimates are presented in Table 5 below.

Table 5 - District Levee Lengths for Seepage Estimates

Start Station	Stop Station	Length (ft)
0+00	203+00	20,300
214+00	622+55	40,855

(a) District levee segment between station 203+00 and 214+00 was omitted from seepage calculation. This portion of levee is setback from the adjacent water way (Seven Mile Slough).

Results

A summary of the total estimated levee seepage area is presented in Table 6 and Appendix C. Appendix C summarizes the seepage analysis for the levee system, detailing the seepage rates applied, levee lengths by section, and the resulting seepage volume estimate for the District. The total estimated seepage produced along the entire District levee is 5,425.8 acre-feet per year.

Table 6 - Total Estimated Seepage by Area

	Levee Seepage (acre-feet/year)
Station 0+00 to Station 203+00	1,801.1
Station 214+00 to Station 622+55	3,624.7
Total	5,425.8

Conclusion

This drainage analysis provides a comprehensive assessment of the water volumes conveyed to the District's pump station. The study estimated water volume contributions from various sources including storm runoff, irrigation, and levee seepage. The total water volume from each of these sources is summarized in Table 7 below.

Table 7 - Summary of Total Estimated Water Volume to District Pump Stations

Source	Total Runoff	Unit
Precipitation Runoff	678.5	acre-feet/year
Irrigation Runoff	13,411.7	acre-feet/year
Levee Seepage	5,425.8	acre-feet/year

The analysis revealed that the average annual precipitation runoff is 678.5 acre-feet. Irrigation activities contribute an estimated annual runoff of 13,411.7 acre-feet and levee seepage, based on conservative estimates, adds 5,425.8 acre-feet per year.

By quantifying the various sources of water inflow, this analysis estimates water quantities by source to inform the District's Proposition 218 Assessment, ensuring sustainable, equitable, and efficient allocation of resources for flood protection and drainage maintenance. The District can utilize this information to prioritize infrastructure improvements, optimize pump station operations, and implement targeted interventions to manage the diverse water sources affecting the area.

Appendix A

Summary of Precipitation Runoff Analysis

RD1601 TWITCHELL ISLAND
DRAINAGE ANALYSIS MODEL RESULTS - 2YEAR 10DAY STORM
EPA STORM WATER MANAGEMENT MODEL - VERSION 5.2 (Build 5.2.4)

Analysis Options

Flow Units	CFS
Process Models:	
Rainfall/Runoff	YES
RDII	NO
Snowmelt	NO
Groundwater	NO
Flow Routing	NO
Water Quality	NO
Infiltration Method	MODIFIED_GREEN_AMPT
Starting Date	1/1/2026 0:00
Ending Date	1/11/2026 1:00
Antecedent Dry Days	0
Report Time Step	0:15:00
Wet Time Step	0:05:00
Dry Time Step	1:00:00

Runoff Quantity Continuity	Volume(ac-ft)	Depth(in)
Total Precipitation	1220.38	4.12
Evaporation Loss	0	0
Infiltration Loss	1052.20	3.55
Surface Runoff	140.14	0.47
Final Storage	28.05	0.10
Continuity Error (%)	0.0%	

Flow Routing Continuity	Volume(ac-ft)	Volume(10^6 gal)
Dry Weather Inflow	0	0
Wet Weather Inflow	140.14	45.67
Groundwater Inflow	0	0
RDII Inflow	0	0
External Inflow	0	0
External Outflow	140.14	45.67
Flooding Loss	0	0
Evaporation Loss	0	0
Exfiltration Loss	0	0
Initial Stored Volume	0	0
Final Stored Volume	0	0
Continuity Error (%)	0	0

RD1601 TWITCHELL ISLAND
DRAINAGE ANALYSIS MODEL RESULTS - 2YEAR 10DAY STORM

Runoff Summary

		Input Parameters				
APN	Area Number	Area (acres)	Percent Impervious	Suction Head (in)	Hydraulic Conductivity	Initial Deficit
157-0130-003	S1	1.73	1.39%	11.22	0.025	0.117
157-0130-004	S2	196.98	0.27%	11.34	0.022	0.115
157-0130-006	S3	348.72	2.24%	9.84	0.067	0.141
157-0130-007	S4	100.49	1.52%	9.19	0.103	0.156
157-0130-008	S5	291.43	2.02%	10.63	0.093	0.137
157-0130-011	S6	1.00	14.10%	10.44	0.025	0.126
157-0130-017	S7	104.52	0.35%	10.53	0.033	0.127
157-0130-018	S8	1.17	5.50%	8.27	0.040	0.154
157-0130-020	S9	48.70	0.73%	11.03	0.025	0.119
157-0130-022	S10	40.00	0.09%	10.50	0.030	0.127
157-0130-023	S11	8.11	0.57%	8.27	0.040	0.154
157-0130-024	S12	291.63	0.32%	9.19	0.103	0.156
157-0130-025	S13	4.08	0.00%	12.60	0.010	0.097
157-0130-026	S14	386.41	0.94%	8.92	0.045	0.148
157-0130-027	S15	110.24	0.25%	11.16	0.020	0.116
157-0140-004	S16	1.17	6.83%	8.27	0.040	0.154
157-0140-009	S17	178.64	0.21%	8.66	0.166	0.175
157-0140-010	S18	182.34	0.14%	9.65	0.108	0.153
157-0140-011	S19	195.11	3.26%	9.32	0.113	0.158
157-0140-015	S20	19.05	4.79%	10.44	0.025	0.126
157-0140-020	S21	585.12	0.32%	9.11	0.099	0.157
157-0140-021	S22	457.92	0.02%	10.20	0.091	0.142
157-0130-015	S23	-	-	-	-	-
157-0130-016	S24	-	-	-	-	-
157-0130-019	S25	-	-	-	-	-

RD1601 TWITCHELL ISLAND
DRAINAGE ANALYSIS MODEL RESULT

Runoff Summary

		Output Parameters				
APN	Area Number	Total Precip. (in)	Total Infiltration (in)	Total Runoff (in)	Total Runoff (ac-ft)	Runoff Coefficient
157-0130-003	S1	4.12	3.06	0.97	0.15	0.23
157-0130-004	S2	4.12	3.19	0.81	12.80	0.20
157-0130-006	S3	4.12	3.40	0.65	8.16	0.16
157-0130-007	S4	4.12	3.47	0.58	3.56	0.14
157-0130-008	S5	4.12	3.21	0.77	8.87	0.19
157-0130-011	S6	4.12	2.61	1.42	0.12	0.34
157-0130-017	S7	4.12	3.46	0.60	7.61	0.15
157-0130-018	S8	4.12	3.42	0.70	0.06	0.17
157-0130-020	S9	4.12	3.18	0.84	3.77	0.20
157-0130-022	S10	4.12	3.37	0.68	2.98	0.17
157-0130-023	S11	4.12	3.62	0.51	0.34	0.12
157-0130-024	S12	4.12	3.61	0.43	16.14	0.11
157-0130-025	S13	4.12	2.64	1.28	0.43	0.31
157-0130-026	S14	4.12	3.52	0.52	23.51	0.13
157-0130-027	S15	4.12	3.07	0.90	6.94	0.22
157-0140-004	S16	4.12	3.37	0.75	0.06	0.18
157-0140-009	S17	4.12	3.77	0.31	2.58	0.07
157-0140-010	S18	4.12	3.67	0.42	2.42	0.10
157-0140-011	S19	4.12	3.73	0.38	2.98	0.09
157-0140-015	S20	4.12	2.97	1.05	1.78	0.25
157-0140-020	S21	4.12	3.74	0.35	19.70	0.08
157-0140-021	S22	4.12	3.35	0.66	15.16	0.16
157-0130-015	S23	-	-	-	-	-
157-0130-016	S24	-	-	-	-	-
157-0130-019	S25	-	-	-	-	-
				TOTAL =	140.12	

RD1601 TWITCHELL ISLAND
DRAINAGE ANALYSIS - AVERAGE ANNUAL PRECIPITATION RUNOFF

Runoff Summary

APN	Area Number	Area (acres)	Runoff Coefficient	Annual Precipitation (in)	Total Runoff (in)	Total Runoff (ac-ft)
157-0130-003	S1	1.73	0.23	17.00	3.98	0.57
157-0130-004	S2	196.98	0.20	17.00	3.33	54.58
157-0130-006	S3	348.72	0.16	17.00	2.70	78.38
157-0130-007	S4	100.49	0.14	17.00	2.39	19.98
157-0130-008	S5	291.43	0.19	17.00	3.17	77.07
157-0130-011	S6	1.00	0.34	17.00	5.84	0.49
157-0130-017	S7	104.52	0.15	17.00	2.48	21.62
157-0130-018	S8	1.17	0.17	17.00	2.87	0.28
157-0130-020	S9	48.70	0.20	17.00	3.46	14.06
157-0130-022	S10	40.00	0.17	17.00	2.81	9.35
157-0130-023	S11	8.11	0.12	17.00	2.08	1.41
157-0130-024	S12	291.63	0.11	17.00	1.79	43.52
157-0130-025	S13	4.08	0.31	17.00	5.29	1.80
157-0130-026	S14	386.41	0.13	17.00	2.15	69.25
157-0130-027	S15	110.24	0.22	17.00	3.73	34.31
157-0140-004	S16	1.17	0.18	17.00	3.08	0.30
157-0140-009	S17	178.64	0.07	17.00	1.27	18.93
157-0140-010	S18	182.34	0.10	17.00	1.73	26.35
157-0140-011	S19	195.11	0.09	17.00	1.59	25.89
157-0140-015	S20	19.05	0.25	17.00	4.33	6.87
157-0140-020	S21	585.12	0.08	17.00	1.42	69.27
157-0140-021	S22	457.92	0.16	17.00	2.73	104.25
157-0130-015	S23	-	-	-	-	-
157-0130-016	S24	-	-	-	-	-
157-0130-019	S25	-	-	-	-	-
					TOTAL =	678.50

Long-Duration Storms (Cont.)

Table 4-8. 10-Day Long-Duration Storm Precipitation as a Percent of Total Storm Depth

Hou	%	Hour	%	Hour	%	Hour	%	Hour	%	Hour	%
1	0.30	41	0.50	81	0.00	121	0.00	161	0.00	201	0.00
2	1.10	42	0.70	82	0.00	122	0.00	162	0.00	202	0.00
3	2.70	43	0.90	83	0.00	123	0.00	163	0.00	203	0.00
4	1.50	44	1.30	84	0.00	124	0.00	164	0.00	204	0.00
5	0.50	45	3.00	85	0.00	125	0.00	165	0.00	205	0.00
6	0.30	46	1.90	86	0.00	126	0.00	166	0.00	206	0.00
7	0.10	47	1.00	87	0.00	127	0.00	167	0.00	207	0.00
8	0.00	48	0.80	88	0.00	128	0.00	168	0.00	208	0.00
9	0.00	49	0.60	89	0.00	129	0.10	169	0.00	209	0.00
10	0.00	50	0.50	90	0.00	130	0.10	170	0.00	210	0.00
11	0.00	51	0.40	91	0.00	131	0.20	171	0.00	211	0.00
12	0.00	52	0.30	92	0.00	132	0.20	172	0.00	212	0.00
13	0.00	53	0.20	93	0.00	133	0.20	173	0.00	213	0.00
14	0.00	54	0.10	94	0.10	134	0.30	174	0.00	214	0.00
15	0.00	55	0.00	95	0.20	135	0.50	175	0.00	215	0.00
16	0.00	56	0.00	96	0.30	136	0.60	176	0.00	216	0.00
17	0.00	57	0.00	97	0.40	137	0.70	177	0.00	217	0.00
18	0.00	58	0.00	98	0.50	138	0.90	178	0.00	218	0.00
19	0.00	59	0.00	99	0.60	139	1.00	179	0.00	219	0.00
20	0.00	60	0.00	100	0.70	140	1.10	180	0.00	220	0.00
21	0.00	61	0.00	101	0.90	141	1.30	181	0.10	221	0.00
22	0.00	62	0.00	102	1.50	142	1.40	182	0.20	222	0.00
23	0.00	63	0.00	103	5.30	143	1.60	183	0.30	223	0.00
24	0.00	64	0.00	104	2.20	144	1.70	184	0.40	224	0.00
25	0.00	65	0.00	105	1.00	145	1.80	185	0.50	225	0.00
26	0.00	66	0.00	106	0.80	146	1.90	186	0.70	226	0.00
27	0.00	67	0.00	107	0.60	147	2.10	187	0.90	227	0.00
28	0.00	68	0.00	108	0.50	148	1.50	188	1.30	228	0.00
29	0.00	69	0.00	109	0.40	149	1.20	189	3.90	229	0.00
30	0.00	70	0.00	110	0.30	150	0.90	190	2.00	230	0.10
31	0.00	71	0.00	111	0.30	151	3.10	191	1.00	231	0.20
32	0.00	72	0.00	112	0.20	152	3.90	192	0.80	232	0.50
33	0.00	73	0.00	113	0.20	153	6.70	193	0.70	233	0.70
34	0.00	74	0.00	114	0.10	154	3.30	194	0.60	234	1.00
35	0.00	75	0.00	115	0.10	155	0.50	195	0.50	235	2.90
36	0.00	76	0.00	116	0.00	156	0.30	196	0.40	236	1.60
37	0.00	77	0.00	117	0.00	157	0.20	197	0.30	237	0.80
38	0.10	78	0.00	118	0.00	158	0.10	198	0.20	238	0.60
39	0.20	79	0.00	119	0.00	159	0.10	199	0.10	239	0.40
40	0.30	80	0.00	120	0.00	160	0.10	200	0.00	240	0.20

NOAA Atlas 14, Volume 6, Version 2
Location name: Isleton, California, USA*
Latitude: 38.1059°, Longitude: -121.647°
Elevation: -16 ft**
* source: ESRI Maps
** source: USGS

POINT PRECIPITATION FREQUENCY ESTIMATES

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

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

PF tabular

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

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.095 (0.085-0.107)	0.117 (0.104-0.132)	0.148 (0.132-0.168)	0.177 (0.156-0.203)	0.220 (0.185-0.265)	0.258 (0.211-0.320)	0.301 (0.237-0.386)	0.350 (0.266-0.467)	0.426 (0.305-0.600)	0.492 (0.337-0.727)
10-min	0.137 (0.122-0.154)	0.167 (0.150-0.189)	0.212 (0.189-0.241)	0.253 (0.223-0.290)	0.316 (0.265-0.380)	0.370 (0.302-0.459)	0.432 (0.340-0.553)	0.502 (0.381-0.669)	0.610 (0.437-0.860)	0.705 (0.483-1.04)
15-min	0.165 (0.148-0.186)	0.202 (0.181-0.228)	0.257 (0.229-0.291)	0.306 (0.270-0.351)	0.382 (0.321-0.459)	0.448 (0.365-0.555)	0.522 (0.412-0.669)	0.607 (0.461-0.809)	0.738 (0.529-1.04)	0.853 (0.584-1.26)
30-min	0.228 (0.204-0.257)	0.279 (0.250-0.315)	0.354 (0.316-0.402)	0.423 (0.372-0.485)	0.527 (0.443-0.634)	0.618 (0.504-0.766)	0.721 (0.568-0.924)	0.839 (0.636-1.12)	1.02 (0.730-1.44)	1.18 (0.806-1.74)
60-min	0.321 (0.287-0.361)	0.392 (0.351-0.443)	0.498 (0.444-0.564)	0.594 (0.523-0.681)	0.741 (0.623-0.891)	0.869 (0.709-1.08)	1.01 (0.799-1.30)	1.18 (0.894-1.57)	1.43 (1.03-2.02)	1.66 (1.13-2.44)
2-hr	0.466 (0.417-0.525)	0.568 (0.508-0.641)	0.716 (0.638-0.811)	0.847 (0.746-0.971)	1.04 (0.877-1.26)	1.21 (0.988-1.50)	1.40 (1.10-1.79)	1.60 (1.22-2.14)	1.91 (1.37-2.70)	2.18 (1.49-3.22)
3-hr	0.581 (0.520-0.654)	0.708 (0.634-0.800)	0.890 (0.793-1.01)	1.05 (0.925-1.20)	1.29 (1.08-1.55)	1.48 (1.21-1.84)	1.70 (1.34-2.18)	1.94 (1.48-2.59)	2.30 (1.65-3.25)	2.61 (1.78-3.85)
6-hr	0.820 (0.735-0.924)	1.00 (0.898-1.13)	1.26 (1.12-1.43)	1.48 (1.30-1.70)	1.80 (1.51-2.16)	2.06 (1.68-2.55)	2.35 (1.85-3.01)	2.66 (2.02-3.54)	3.11 (2.23-4.39)	3.49 (2.39-5.16)
12-hr	1.10 (0.982-1.24)	1.35 (1.21-1.53)	1.71 (1.52-1.93)	2.01 (1.77-2.30)	2.44 (2.05-2.93)	2.79 (2.28-3.46)	3.16 (2.49-4.05)	3.57 (2.70-4.75)	4.15 (2.97-5.85)	4.63 (3.17-6.83)
24-hr	1.48 (1.37-1.63)	1.85 (1.72-2.04)	2.36 (2.17-2.60)	2.77 (2.54-3.09)	3.36 (2.99-3.86)	3.83 (3.34-4.48)	4.32 (3.68-5.16)	4.83 (4.02-5.93)	5.56 (4.45-7.08)	6.14 (4.77-8.08)
2-day	1.90 (1.76-2.09)	2.40 (2.22-2.65)	3.05 (2.82-3.37)	3.58 (3.28-3.98)	4.29 (3.82-4.93)	4.84 (4.22-5.66)	5.39 (4.60-6.45)	5.96 (4.95-7.31)	6.72 (5.38-8.56)	7.31 (5.67-9.61)
3-day	2.18 (2.02-2.40)	2.77 (2.56-3.05)	3.52 (3.24-3.89)	4.11 (3.77-4.58)	4.91 (4.36-5.63)	5.50 (4.80-6.44)	6.10 (5.20-7.29)	6.70 (5.57-8.22)	7.49 (6.00-9.54)	8.09 (6.28-10.6)
4-day	2.38 (2.20-2.62)	3.02 (2.79-3.33)	3.83 (3.54-4.24)	4.48 (4.10-4.98)	5.32 (4.73-6.11)	5.96 (5.20-6.97)	6.58 (5.61-7.87)	7.21 (5.99-8.84)	8.03 (6.43-10.2)	8.65 (6.71-11.4)
7-day	2.90 (2.69-3.20)	3.67 (3.40-4.05)	4.65 (4.29-5.14)	5.42 (4.97-6.04)	6.44 (5.72-7.39)	7.19 (6.27-8.41)	7.93 (6.77-9.49)	8.68 (7.22-10.6)	9.66 (7.73-12.3)	10.4 (8.06-13.7)
10-day	3.26 (3.02-3.60)	4.12 (3.82-4.55)	5.21 (4.81-5.76)	6.07 (5.56-6.76)	7.20 (6.40-8.26)	8.03 (7.01-9.40)	8.86 (7.56-10.6)	9.68 (8.05-11.9)	10.8 (8.61-13.7)	11.6 (8.96-15.2)
20-day	4.23 (3.92-4.66)	5.37 (4.97-5.93)	6.79 (6.27-7.51)	7.89 (7.23-8.78)	9.30 (8.27-10.7)	10.3 (9.01-12.1)	11.3 (9.67-13.6)	12.3 (10.2-15.1)	13.6 (10.9-17.3)	14.5 (11.2-19.1)
30-day	5.04 (4.67-5.55)	6.40 (5.93-7.06)	8.08 (7.46-8.93)	9.36 (8.58-10.4)	11.0 (9.77-12.6)	12.2 (10.6-14.2)	13.3 (11.3-15.9)	14.4 (11.9-17.6)	15.7 (12.6-20.1)	16.7 (13.0-22.0)
45-day	6.16 (5.71-6.79)	7.83 (7.24-8.63)	9.83 (9.07-10.9)	11.3 (10.4-12.6)	13.2 (11.8-15.2)	14.6 (12.7-17.0)	15.8 (13.5-18.9)	17.0 (14.2-20.9)	18.5 (14.8-23.6)	19.6 (15.2-25.8)
60-day	7.38 (6.84-8.14)	9.34 (8.64-10.3)	11.7 (10.8-12.9)	13.4 (12.3-14.9)	15.5 (13.8-17.8)	17.0 (14.9-19.9)	18.4 (15.7-22.0)	19.8 (16.4-24.2)	21.4 (17.1-27.2)	22.5 (17.5-29.6)

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

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

Please refer to NOAA Atlas 14 document for more information.

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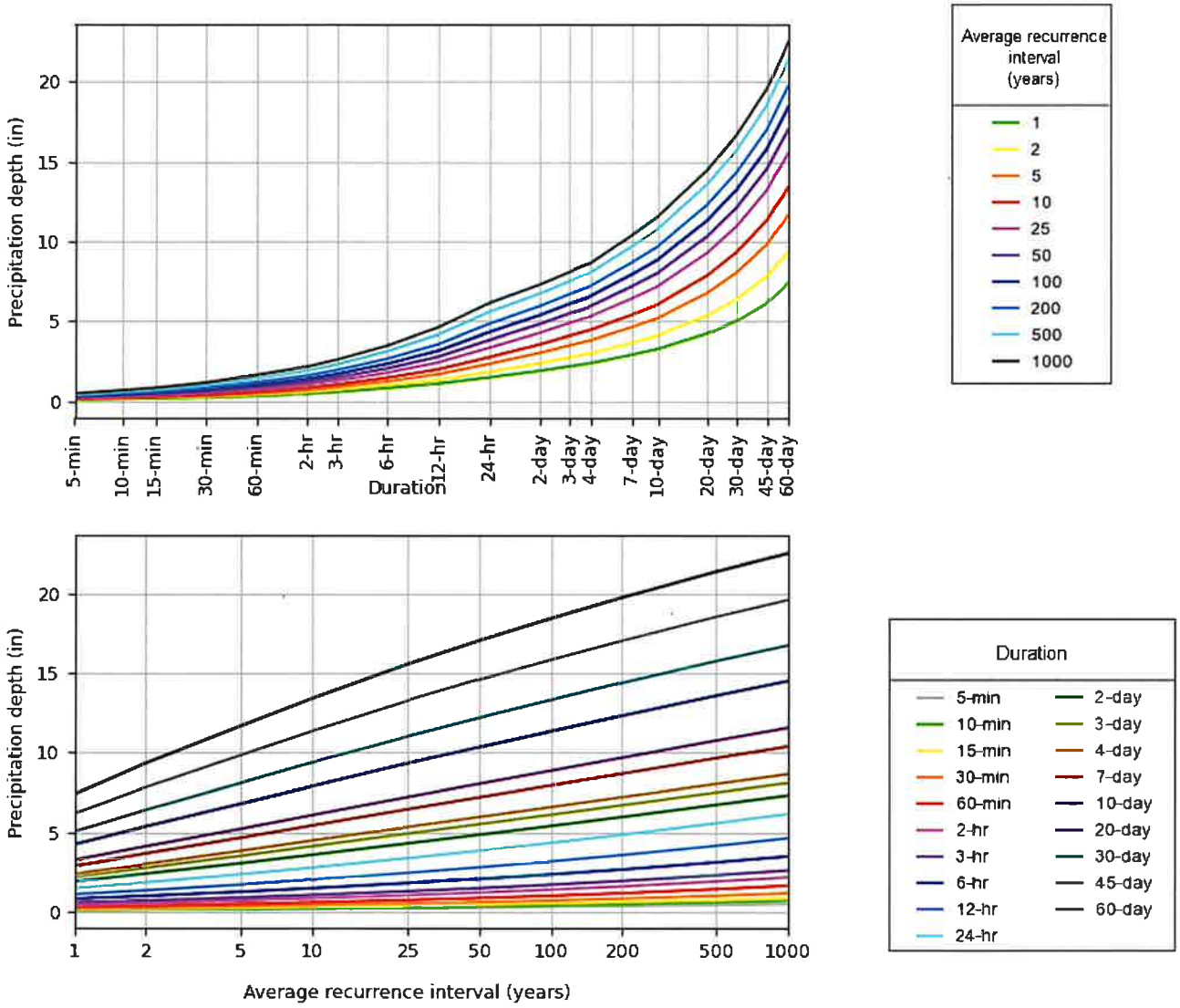
PF graphical

PDS-based depth-duration-frequency (DDF) curves
Latitude: 38.1059°, Longitude: -121.6470°



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Created (GMT): Thu Aug 6 17:40:38 2026

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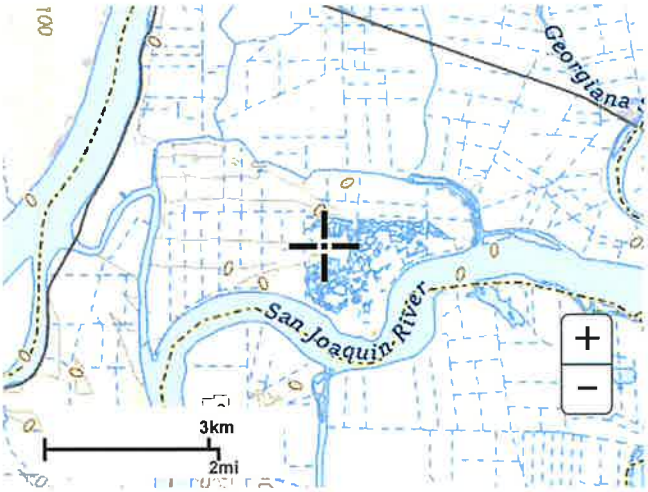
Maps & aerials

Small scale terrain



Large scale terrain

Large scale map

Large scale aerial

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Monthly Total Precipitation for Sacramento Area, CA (ThreadEx)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
2015	T	2.82	0.22	1.85	0.07	0.07	T	T	0.04	0.12	1.57	1.75	8.51
2016	5.44	0.82	5.07	1.03	0.39	T	0.00	0.00	T	4.72	1.12	3.61	22.20
2017	9.92	8.25	2.38	2.93	0.05	0.10	T	0.00	T	0.15	2.13	0.14	26.05
2018	5.20	0.60	5.14	2.00	0.60	0.00	0.00	0.00	0.00	0.04	2.47	2.37	18.42
2019	4.22	7.84	3.76	0.77	3.17	T	0.00	0.00	0.12	0.00	0.65	4.35	24.88
2020	1.14	T	1.57	1.68	0.32	T	0.00	0.02	0.00	0.00	0.54	1.54	6.81
2021	2.50	0.90	1.06	0.01	0.01	0.00	0.00	0.00	0.05	6.71	0.68	6.98	18.90
2022	0.05	T	1.38	0.64	0.01	0.09	T	0.00	0.28	0.00	0.95	7.79	11.19
2023	M	2.62	5.04	0.15	0.25	T	0.00	T	0.08	0.60	0.36	4.69	M
2024	3.53	4.63	1.62	1.60	0.57	0.00	0.00	0.03	T	0.25	3.53	3.53	19.29
2025	0.45	4.41	1.39	0.19	0.04	0.00	0.00	0.00	0.02	1.88	3.18	2.21	13.77
Mean	0.25	2.93	2.00	1.17	0.50	0.02	T	0.00	0.05	1.32	1.50	3.1	17.00
Max	9.92 2017	8.25 2017	5.14 2018	2.93 2017	3.17 2019	0.10 2017	T 2022	0.03 2024	0.28 2022	6.71 2021	3.53 2024	7.79 2022	26.05 2017
Min	T 2015	T 2022	0.22 2015	0.01 2021	0.01 2022	0.00 2025	0.00 2025	0.00 2025	0.00 2020	0.00 2022	0.36 2023	0.14 2017	6.81 2020

Appendix B

Summary of Irrigation Runoff Analysis

RD1601 TWITCHELL ISLAND
DRAINAGE ANALYSIS

Annual Irrigation Runoff Summary

Tract No.	APN	Crop/Use Type	Acres	Habitat Acres	Revised Acres	Irrigated Acres*
1	157-0130-026	Alfalfa, Corn, Rice	422.509		422.509	377.4
2	157-0130-027	Alfalfa, Rice	117		117	80.5
3	157-0130-011	Alfalfa	0.951		0.951	0.7
4	157-0130-015	-	0.566		0.566	-
5	157-0130-019	-	0.41		0.41	-
6	157-0130-016	-	0.741		0.741	-
7	157-0130-018	Alfalfa	1.07		1.07	1.1
8	157-0130-014	-	0.01		0.01	-
9	157-0130-017	Alfalfa, Corn	102.45		102.45	104.2
10	157-0130-004	Alfalfa, Corn	200.55		200.55	193.7
11	157-0130-024	Corn, Rice	302.96		302.96	283.6
12	157-0130-020	Alfalfa, Corn	47.75	0.82	46.93	44.0
12a	157-0130-020	Habitat			0.82	0.8
13	157-0130-022	Rice	40	21.1	18.9	19.1
13b	157-0130-022	Habitat			21.1	20.1
14	157-0130-008	Rice	300.85		300.85	285.9
15a	157-0130-006	Rice	357.98	25.97	332.01	305.2
15b	157-0130-006	Habitat			25.97	26.0
16	157-0130-007	Rice	102		102	98.3
17	157-0140-004	Alfalfa	1		1	0.5
18a	157-0140-020	Alfalfa	578.47	209.4	369.07	340.0
18b	157-0140-020	Habitat			209.4	206.8
19a	157-0140-011	Alfalfa, Rice	181.5	140.8	40.7	19.2
19b	157-0140-011	Habitat			140.8	158.1
20a	157-0140-009	Alfalfa	186	121.1	64.9	22.0
20b	157-0140-009	Habitat			121.1	152.7
21a	157-0140-010	Alfalfa	181.5	111.3	70.2	61.6
21b	157-0140-010	Habitat			111.3	112.3
22	157-0140-015	Alfalfa	20		20	0.5
23	157-0130-003	Alfalfa, Corn	1.74		1.74	1.7
24	157-0130-023	Alfalfa	10.52		10.52	2.9
25	157-0130-023	-	0.36		0.36	-
26	157-0130-025	Rice	4.04		4.04	4.1
27a	157-0140-021	Alfalfa	471.96	182.3	289.66	236.1
27b	157-0140-021	Habitat			182.3	182.0
			3,634.89	**812.79**	**3,634.89**	**3,341.01**

* Irrigated acreage used to estimate irrigation diversion represents the estimated portion of each parcel that receives irrigation and excludes areas within the assessed parcel acreage that are believed to be non-irrigated.

RD1601 TWITCHELL ISLAND
DRAINAGE ANALYSIS

Annual Irrigation Runoff Summary

Tract No.	APN	Crop/Use Type	Total Irrigation Diversion (ac-ft/year)	Total Crop Consumptive Use (ac-ft/year)	Total Irrigation Runoff (ac-ft/year)
1	157-0130-026	Alfalfa, Corn, Rice	2,494.17	1,558.86	935.31
2	157-0130-027	Alfalfa, Rice	533.22	333.26	199.96
3	157-0130-011	Alfalfa	4.69	2.93	1.76
4	157-0130-015	-	-	-	-
5	157-0130-019	-	-	-	-
6	157-0130-016	-	-	-	-
7	157-0130-018	Alfalfa	7.24	4.52	2.71
8	157-0130-014	-	-	-	-
9	157-0130-017	Alfalfa, Corn	536.38	335.24	201.14
10	157-0130-004	Alfalfa, Corn	962.26	601.41	360.85
11	157-0130-024	Corn, Rice	1,621.83	1,013.64	608.18
12	157-0130-020	Alfalfa, Corn	194.66	121.66	73.00
12a	157-0130-020	Habitat	11.76	1.95	9.82
13	157-0130-022	Rice	117.46	73.41	44.05
13b	157-0130-022	Habitat	286.71	47.43	239.28
14	157-0130-008	Rice	1,692.66	1,057.91	634.75
15a	157-0130-006	Rice	1,833.35	1,145.84	687.50
15b	157-0130-006	Habitat	370.52	61.30	309.23
16	157-0130-007	Rice	581.90	363.69	218.21
17	157-0140-004	Alfalfa	3.04	1.90	1.14
18a	157-0140-020	Alfalfa	2,249.51	1,405.95	843.57
18b	157-0140-020	Habitat	2,398.72	488.01	1,910.70
19a	157-0140-011	Alfalfa, Rice	93.57	58.48	35.09
19b	157-0140-011	Habitat	1,834.52	373.23	1,461.29
20a	157-0140-009	Alfalfa	106.09	66.30	39.78
20b	157-0140-009	Habitat	1,771.88	360.49	1,411.39
21a	157-0140-010	Alfalfa	218.42	136.51	81.91
21b	157-0140-010	Habitat	1,302.18	264.93	1,037.25
22	157-0140-015	Alfalfa	3.60	2.25	1.35
23	157-0130-003	Alfalfa, Corn	8.71	5.44	3.27
24	157-0130-023	Alfalfa	18.94	11.84	7.10
25	157-0130-023	-	-	-	-
26	157-0130-025	Rice	24.13	15.08	9.05
27a	157-0140-021	Alfalfa	963.02	601.89	361.13
27b	157-0140-021	Habitat	2,111.57	429.60	1,681.98
			24,356.7	**10,944.9**	**13,411.7**

Appendix C

Summary of Seepage Runoff Analysis

RD1601 TWITCHELL ISLAND
DRAINAGE ANALYSIS

Levee Seepage Summary

Assumptions:
- Seepage estimated based on hydraulic conductivity and hydraulic gradient obtained from GEI Consultants Geotechnical Investigation and Evaluation Report dated January 2009.
- Averages of hydraulic conductivity used for each soil type to estimate levee through-seepage and under-seepage.
- Darcy's Law was applied with a hydrulic gradient of 0.20 and flow width of 5 feet for through-seepage and 80 feet for under-seepage.
- Constant seepage flow rate year round.
- Seepage is captured by the toe ditches and routed to the pump station.

Total Estimated Levee Seepage for Pump Station Service Area

Start Station	Stop Station	Length	Seepage Rate (gal/hr/ft)	Total Seepage (ac-ft/year)
0+00	203+00	20,300	3.3	1,801.0
214+00	622+55	40,855	3.3	3,624.7
			TOTAL =	5,425.8