February 8, 2018

Mr. Mark Norton, PE, LEED AP, ENV SP
Water Resources & Planning Manager
Santa Ana Watershed Project Authority
11615 Sterling Ave.
Riverside, CA 92503

Re: Request for Budget Amendment for Consulting Services for Santa Ana River Waste Load Allocation Model Update

Dear Mark:

GEOSCIENCE Support Services, Inc. (GEOSCIENCE) submitted a draft budget amendment on January 5, 2018 in response to comments received on the Santa Ana River Waste Load Allocation Model (WLAM) draft Technical Memorandums (TMs) No. 1 and 2 from Orange County Water District (OCWD; dated October 12, 2017), Santa Ana Watershed Project Authority (SAWPA; dated October 13, 2017), Inland Empire Utilities Agency/Chino Basin Watermaster (IEUA/CBWM; dated October 18, 2017), and Risk Sciences (dated November 29, 2017). In addition, the Santa Ana Regional Water Quality Control Board provided further comments during a conference call. Comments received in response to the draft TMs are provided as Attachment A for reference. GEOSCIENCE presented the proposed budget amendment at the January 18, 2018 Basin Management Plan (BMP) Task Force meeting. Following the meeting, Eastern Municipal Water District (EMWD) provided comments on the proposed budget amendment (received January 31, 2018). This budget amendment request incorporates these comments as well.

GEOSCIENCE has already addressed some of the comments received on draft TMs No. 1 and 2 (see Attachment B for presentation slides from the November 16, 2017 Task Force meeting) and plans to address all remaining comments. We feel that incorporating the comments will greatly add to the finished product and defensibility of the WLAM, but some of the requests are beyond the original project scope of work. Per your request, GEOSCIENCE has prepared this proposed budget amendment which outlines the extra work and budget required to address these out-of-scope items, a budget reduction to account for work the Task Force has decided not to pursue, and an updated project schedule to accommodate the extra work. The extra work, if approved, will be performed through 10

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new subtasks. A breakdown by task for the additional, out-of-scope services and budget reduction is presented on attached Table 1 and described below.

1.0 PROPOSED ADDITIONAL SCOPE OF WORK

Task 1 – Update the Data Used in the Waste Load Allocation Model (WLAM)

Two (2) new subtasks are planned to cover the proposed out-of-scope work for Task 1, as follows:

Subtask 1h: Update and Consolidate Flow Data from Additional Discharge Sources Identified in the WLAM

During the November 16, 2017 Task Force meeting and in the comments from Risk Sciences (comments 3 through 7) additional discharge locations were discussed, which were not included in previous versions of the WLAM. These point sources include:

- Discharge from San Bernardino's geothermal plant to Warm Creek, and
- Wet-weather discharges of secondary effluent by the Cities of San Bernardino and Colton directly to the Santa Ana River.

Discharge from the Arlington Desalter to Temescal Creek was also identified during the process of evaluating additional potential flow sources. These flows are not yet included in the HSPF WLAM update because no mention was made of them in the previous WLAM reports. However, it was recently determined from a reexamination of the original model files that they were actually included in previous versions. They will therefore be included in the HSPF WLAM update.

Collectively, these additional discharges may help improve discrepancies between model-estimated and observed flow and water quality in these areas of the model. Flow data from these various discharge sources will be compiled and updated in the model input files. All supplementary flow data will be subjected to a QA/QC process to identify potential errors, outliers, and duplicate data.

Subtask 1i: Create Plots and Database Files of Model Input Data (to be included as appendices)

This subtask is proposed in response to comments from IEUA/CBWM (comment numbers 7 and 8) and OCWD (comment re: Section 2.3.8). All model input for the model calibration period (WY2007-2016) will be compiled into database files (i.e., Excel files) to be included as part of the finalized TM No. 1. Plots of model input will also be generated and included as appendices.

Task 2 – Update and Recalibrate the WLAM

Seven (7) new subtasks are planned to cover the proposed out-of-scope work for Task 2, as follows:

Subtask 2h: Create an Impoundment for the Prado Wetlands to Account for Evapotranspiration and Changes in Water Quality

It was suggested at the November 16, 2017 Task Force meeting and in comments received (OCWD comment re: Section 2.3.10.2, Risk Sciences comment numbers 11 and 12, and SAWPA comment number 6) to refine how the model handles the Prado Wetlands. Treating this area as a discrete impoundment would help the model account for seasonal evapotranspiration of water that is diverted to the wetlands and impacts on TDS and TIN concentrations. Changes in flow and water quality from the Prado Wetlands will therefore be handled outside of the HSPF model with a spreadsheet mass balance model and used as additional model input for recalibration.

Subtask 2i: Re-Estimate Stream Flow in Major Stream Segments after Incorporating Additional Discharge Data

After supplementary flow data from additional discharge sources (proposed Subtask 1h) and evapotranspiration at the Prado Wetlands (proposed Subtask 2h) are updated, the model will need to be recalibrated so that it accurately and reliably predicts daily and monthly stream flow at the USGS gauging stations used as calibration targets.

Subtask 2j: Re-Estimate Concentration of TDS in Major Stream Segments after Incorporating Additional Discharge Data and Effects of the Prado Wetlands

The HSPF WLAM has three components: a flow component, and two water quality components for TDS and TIN. Calibration is first conducted for the flow component. The calibrated flow is then used to calibrate TDS and TIN, independently. Therefore, even though the HSPF WLAM is represented by one model file, three separate steps are required for its calibration.

Changes to TDS as the result of incorporating additional discharges (proposed Subtask 1h) and the effects from the Prado Wetlands (proposed Subtask 2h) will be used as additional model input for the recalibration. The concentration of TDS in major stream segments will be re-estimated following incorporation of this additional data.

Subtask 2k: Re-Estimate Concentration of TIN in Major Stream Segments after Incorporating Additional Discharge Data and Effects of the Prado Wetlands

Changes to TIN as the result of incorporating additional discharges (proposed Subtask 1h) and the effects from the Prado Wetlands (proposed Subtask 2h) will be used as additional model input for the recalibration. The concentration of TIN in major stream segments will be re-estimated following incorporation of this additional data.

Subtask 2l: Tabulate the Differences between WLAM Versions

Based on comments received from Risk Sciences (comment numbers 9, 27, and 29 through 31), we propose this subtask to clarify the differences between the 2002 WLAM, 2015 WLAM (Scenario 8) and 2017 HSPF WLAM versions. Key similarities and differences will be tabulated and discussed in detail, including but not limited to:

- Land use data,
- Precipitation data,
- Gage data,
- Number of model subareas,
- Publicly owned treatment works (POTW) data,
- Soil data,
- Evaporation stations,
- Nitrogen reaction coefficients,
- Calibration period,
- Calibration criteria (e.g., R^2, RSME, etc.),
- Methods used to account for rising groundwater and related water quality, and
- Methods used to account for flow at key locations (e.g., San Timoteo, Chino Creek at Schaefer Ave., Temescal Creek, etc).

In addition, we will prepare and present the results of the initial side-by-side analyses of the 2015 (Scenario 8) WLAM vs. the HSPF WLAM that was performed at the outset of this effort (Risk Sciences comment number 13).

Subtask 2m: Tabulate the Average Mass Balance (by Source) for Flow, TDS, and TIN in Each Major Stream Segment

While the WLAM already provides a mass balance from “combined” sources (Subtasks 2a through 2d), we will prepare a separate tabular summary of the average mass balance (by source) for flow, TDS, and TIN in each major stream segment. This additional work will facilitate future peer review requirements of the Regional Water Quality Control Board. Tables will be prepared for each major stream segment to summarize the flow and water quality for each contributing source (e.g., individual POTW discharges, surface runoff, rising groundwater, water transfers, etc.), as shown below. Reported values will be calculated based on the flow-weighted annualized average.

Example Mass Balance (by Source) for Reach 3 & 4 of the Santa Ana River overlying the Riverside-A GMZ

SOURCE	FLOW *(ac-ft./yr. & % of total)*	TDS *(tons/yr. & % of total)*	TIN *(tons/yr. & % of total)*
Rialto POTW			
RIX POTW			
Surface Runoff			
Rising Groundwater			
Water Transfers			
Other (specify)			
TOTAL	**xxx (100%)**	**yyy (100%)**	**zzz (100%)**

Example Mass Balance (by Source) for Reach 3 of the Santa Ana River overlying the Chino-South GMZ

SOURCE	FLOW *(ac-ft./yr. & % of total)*	TDS *(tons/yr. & % of total)*	TIN *(tons/yr. & % of total)*
Rialto POTW			
RIX POTW			
City of Riverside POTW			
Surface Runoff			
Rising Groundwater			
Water Transfers			
Other (specify)			
TOTAL	**xxx (100%)**	**yyy (100%)**	**zzz (100%)**

Subtask 2n: Conduct Formal Outlier Analysis for Areas of High Model Over/Underestimation (i.e., greater than two orders of magnitude)

Per Risk Science's comment number 28, we propose to conduct a formal outlier analysis for those data points where the model estimates differ from observed values by more than two orders of magnitude. This analysis will focus on extreme deviations which would likely have the greatest impact on R^2 values, and identifying possible reasons for the deviation.

The purpose of conducting the QA/QC process for Task 1g (original scope of work) was to identify any outliers in the raw data to help determine if any data reporting errors exist, prior to model input. This type of data analysis is standard practice for modeling efforts. However, the outlier analysis being proposed for Subtask 2n involves a different kind of calibration performance evaluation than was completed as part of the original scope of work. It involves looking at model calibration output and analyzing the effect of large outlier residuals (observed data minus model-simulated data) on model calibration performance criteria (e.g., R^2).

Task 9 – Draft Task Reports, Draft and Final Report

As indicated in the RFP and the original proposal, only one set of draft task reports was anticipated for Tasks 1 through 6 (TM Nos. 1-6). Comments from SAWPA and the Task Force on the individual draft task TMs would then be included in the overall "Draft Study Report", which would reflect a compilation of the draft reports and incorporation of any comments received from SAWPA and the Task Force. Upon acceptance of all comments, a "Final Study Report" would be prepared. However, the Task Force indicated in the November 16, 2017 Peer Review Workshop that they would like to see another draft of TM No. 2 for an opportunity to provide further comments to be incorporated in the Draft Study Report. The issuance of a second draft of any of the individual Task TMs was not assumed as part of the original cost estimate for Task 9.

Therefore, following the addition of supplementary flow and water quality data compiled under the proposed subtasks for Task 1, and subsequent model recalibration and additional analyses conducted under the proposed subtasks for Task 2, all results will be summarized in another draft task report for Task 2 (TM No. 2). This draft TM No. 2 will be provided to SAWPA and members of the Task Force for review. The results will also be discussed at the Task Force meeting, and any comments received will be incorporated into the final report.

2.0 PROPOSED BUDGET REDUCTION

During the course of this project, the Task Force decided to forego Task 4 (Develop WLAM for Managed Recharge in Percolation Basins). This decision also affects the budget for Task 9, which included a Draft TM No. 4 summarizing the results of Task 4. The budget for Task 4 and portion of Task 9 related to Task 4 is therefore available for redistribution to any other proposed work the Task Force decides to pursue. However, GEOSCIENCE already spent $3,696.25 in the effort of attaining data regarding agricultural spreading in percolation basins prior to the Task's cancellation. This work included a trip to the Water Board to review stormwater runoff management plans for dairies in the model area, documentation of locations of existing dairy waste storage ponds, and the collection of related information. The amount remaining for this task is $18,133.75 [$18,133.75 = $16,070 (Task 4) + $5,760 (Draft TM No. 4 in Task 9) – $3,696.25 (Billed for Task 4)].

3.0 PROPOSED BUDGET AMENDMENT

The estimated cost of the additional subtasks and budget reduction for the work associated with Task 4 is detailed in Table 1 and summarized below.

Proposed Budget for Out-of-Scope Work and Cancelled Task

TASK		Total Additional Hours	Total Additional Cost
Out-of-Scope Work			
1h	Update and Consolidate Flow Data from Additional Discharge Sources Identified in the WLAM	18	$2,400
1i	Create Plots and Database Files of Model Input Data (to be included as appendices)	17	$2,200
2h	Create an Impoundment for the Prado Wetlands to Account for Evapotranspiration and Changes in Water Quality	41	$6,485
2i	Re-Estimate Stream Flow in Major Stream Segments after Incorporating Additional Discharge Data	26	$3,400
2j	Re-Estimate Concentration of TDS in Major Stream Segments after Incorporating Additional Discharge Data and Effects of the Prado Wetlands	26	$3,400
2k	Re-Estimate Concentration of TIN in Major Stream Segments after Incorporating Additional Discharge Data and Effects of the Prado Wetlands	26	$3,400
2l	Tabulate the Differences between WLAM Versions	42	$7,370
2m	Tabulate the Average Mass Balance (by Source) for Flow, TDS, and TIN in Each Major Stream Segment	28	$3,800
2n	Conduct Formal Outlier Analyses for Areas of High Model Over/Underestimation (i.e., greater than two orders of magnitude)	18	$2,400
9.0	Prepare Second Draft Task Report for Task 2 Documenting the Results of Task 2	51	$7,245
	Out-of-Scope Subtotal	**293**	**$42,100**
Budget Reduction			
4.0	Remove Costs for Task 4 (minus $3,696.25 for work already completed)	0	$(12,374)
9.0	Remove Costs for Draft Task Report for Task 4 Documenting the Results of Task 4	0	$(5,760)
	Reduction Subtotal	**0**	**$(18,134)**
	TOTAL	**293**	**$23,966**

Budget Amendment Summary

TASK		Total Additional Hours	Total Additional Cost	Prior Approved Budget	Total Project Budget
1.0	Update the Data Used in the Waste Load Allocation Model (WLAM)	35	$4,600	$25,665	$30,265
2.0	Update and Recalibrate the WLAM	207	$30,255	$59,255	$89,510
3.0	Evaluate Waste Load Allocation Scenarios for Major Stream Segments	0	-	$33,150	$33,150
4.0	Task 4 - Develop WLAM for Managed Recharge in Percolation Basins	0	$(12,374)	$16,070	$3,696
5.0	Task 5 - Estimate Off-Channel Recharge From Natural Precipitation	0	-	$6,385	$6,385
6.0	Task 6 - Run the WLAM in Retrospective Mode, Using Historical Discharge Data, to Estimate the Quantity and Quality of Recharge that Actually Occurred	0	-	$8,290	$8,290
7.0	Task 7 - Compile the WLAM into a Run-Time Software Simulation Package	0	-	$17,340	$17,340
9.0	Task 9 - Draft Task Reports, Draft and Final Report	51	$1,485	$45,005	$46,490
10.0	Task 10 - Monthly Project Meetings	0	-	$35,640	$35,640
11.0	Task 11 - Pilot Evaluation of the Doppler Data Compared to Precipitation Gauge Data	0	-	$3,000	$3,000
	TOTAL	**293**	**$23,966**	**$249,800**	**$273,766**

Our existing contract amount is $249,800. The requested cost for this contract amendment is **$23,966**, which would increase the total contract amount to **$273,766**. This includes the cost of the additional out-of-scope work ($42,100) and budget reduction from cancelling Task 4 ($18,134). The budget for Tasks 3, 5 through 7, 10, and 11, which cover running model scenarios, preparing simulation packages, attending progress meetings, and evaluating precipitation datasets, are still in place and do not require additional budget or changes in budget.

4.0 REVISED PROJECT SCHEDULE

The revised project schedule to incorporate the out-of-scope work is presented on Table 2. Despite the additional time that will be required to address the additional work outlined in this proposed budget amendment, we anticipate finishing this project by the originally scheduled completion date of the end of September 2018.

We appreciate the opportunity to provide our services on this important project. If you have any questions, please call us at (909) 451-6650.

Sincerely,

Dennis E. Williams, Ph.D., PG, CHG
President

Johnson Yeh, Ph.D., PG, CHG
Principal/Groundwater Modeler

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TABLES

GEOSCIENCE

Table 1

ADDITIONAL COST ESTIMATE FOR CONSULTING SERVICES

Santa Ana River Waste Load Allocation Model Update

Task		Description	ADDITIONAL COST										Prior Approved Budget	Total Project Budget
			Principal Hydrologist	Senior Geohydrologist	Project Geohydrologist	Staff Geohydrologist	Graphics	Clerical	Total Hours	Labor Cost	Reimbursable Expenses [1]	Additional Cost		
		Hourly Rate:	$285	$200	$165	$125	$110	$95						
1.0		**Update the Data Used in the Waste Load Allocation Model (WLAM)**												
	1a	Update Relevant Land Use Maps for the Region							0	$ -		$ -	$ 4,520	$ 4,520
	1b	Update the Stormwater Management Facility Maps							0	$ -		$ -	$ 4,520	$ 4,520
	1c	Update the Historical Precipitation Data for the Region							0	$ -		$ -	$ 2,530	$ 2,530
	1d	Review and Confirm the Operating Assumptions for Seven Oaks Dam and Prado Dam							0	$ -		$ -	$ 2,020	$ 2,020
	1e	Update and Consolidate the Flow Data Used in the WLAM							0	$ -		$ -	$ 3,530	$ 3,530
	1f	Update and Consolidate the Water Quality Data Used in the WLAM							0	$ -		$ -	$ 3,530	$ 3,530
	1g	Perform a Systematic QA/QC Review of All Data							0	$ -		$ -	$ 5,015	$ 5,015
	1h	Update and Consilidate Flow Data from Additional Discharge Sources Identified in the WLAM		2		16			18	$ 2,400		$ 2,400	$ -	$ 2,400
	1i	Create Plots and Database Files of Model Input Data (to be included as appendices)		1		16			17	$ 2,200		$ 2,200	$ -	$ 2,200
		Task 1.0 Subtotal Hours and Costs	**0**	**3**	**0**	**32**	**0**	**0**	**35**	**$ 4,600**	**$ -**	**$ 4,600**	**$ 25,665**	**$ 30,265**
2.0		**Update and Recalibrate the WLAM**												
	2a	Update the Estimate of Surface Water Runoff to Major Stream Segments							0	$ -		$ -	$ 24,800	$ 24,800
	2b	Update the Estimate of Stream Flow in Major Stream Segments							0	$ -		$ -	$ 10,685	$ 10,685
	2c	Update the Estimated Concentration of TDS in Major Stream Segments							0	$ -		$ -	$ 10,685	$ 10,685
	2d	Update the Estimated Concentration of TIN in Major Stream Segments							0	$ -		$ -	$ 5,885	$ 5,885
	2e	Estimate the Volume of Stream Flow Recharging from Each Major Stream Segment to the Underlying Groundwater Management Zone							0	$ -		$ -	$ 2,400	$ 2,400
	2f	Estimate the Average Daily Concentration and Mass of TDS Recharging from Each Major Stream Segment to the Underlying Groundwater Management Zone							0	$ -		$ -	$ 2,400	$ 2,400
	2g	Estimate the Average Daily Concentration and Mass of TIN Recharging from Each Major Stream Segment to the Underlying Groundwater Management Zone							0	$ -		$ -	$ 2,400	$ 2,400
	2h	Create an Impoundment for the Prado Wetlands to Account for Evapotranspiration and Changes in Water Quality	1	16		24			41	$ 6,485		$ 6,485	$ -	$ 6,485
	2i	Re-Estimate Stream Flow in Major Stream Segments after Incorporating Additional Discharge Data		2		24			26	$ 3,400		$ 3,400	$ -	$ 3,400
	2j	Re-Estimate Concentration of TDS in Major Stream Segments after Incorporating Additional Discharge Data and Effects of the Prado Wetlands		2		24			26	$ 3,400		$ 3,400	$ -	$ 3,400
	2k	Re-Estimate Concentration of TIN in Major Stream Segments after Incorporating Additional Discharge Data and Effects of the Prado Wetlands		2		24			26	$ 3,400		$ 3,400	$ -	$ 3,400
	2l	Tabulate the Differences between WLAM Versions	2	24		16			42	$ 7,370		$ 7,370	$ -	$ 7,370
	2m	Tabulate the Average Mass Balance (by Source) for Flow, TDS, and TIN in Each Major Stream Segment		4		24			28	$ 3,800		$ 3,800	$ -	$ 3,800
	2n	Conduct Formal Outlier Analyses for Areas of High Model Over/Underestimation (i.e., greater than two orders of magnitude)		2		16			18	$ 2,400		$ 2,400	$ -	$ 2,400
		Task 2.0 Subtotal Hours and Costs	**3**	**52**	**0**	**152**	**0**	**0**	**207**	**$ 30,255**	**$ -**	**$ 30,255**	**$ 59,255**	**$ 89,510**
3.0		**Evaluate Waste Load Allocation Scenarios for Major Stream Segments**												
	3a	Specify the Range of Probable Discharge Conditions							0	$ -		$ -	$ 6,720	$ 6,720
	3b	Use WLAM to Analyze Six Scenarios							0	$ -		$ -	$ 15,040	$ 15,040
	3c	Report Results of the WLAM Scenario Analyses							0	$ -		$ -	$ 11,390	$ 11,390
		Task 3.0 Subtotal Hours and Costs	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**$ -**	**$ -**	**$ -**	**$ 33,150**	**$ 33,150**
4.0		**Develop WLAM for Managed Recharge in Percolation Basins**												
	4a	Identify the Percolation Ponds and Recharge Basins to be Evaluated							0	$ -		$ -	$ 3,720	$ 3,720
	4b	Characterize the Volume and Quality of Water Recharged to Groundwater							0	$ -		$ -	$ 6,720	$ 6,720
	4c	Summarize the Results of Task 4b by Groundwater Management Zone							0	$ -		$ -	$ 2,815	$ 2,815
	4d	Integrate Results from Task 4c with the Results from Task 3c							0	$ -		$ -	$ 2,815	$ 2,815
		Remove Costs for Task 4 (minus $3,696.25 for work already completed)							-	$ -		$ (12,374)	$ -	$ (12,374)
		Task 4.0 Subtotal Hours and Costs	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**$ -**	**$ -**	**$ (12,374)**	**$ 16,070**	**$ 3,696**

Table 1

ADDITIONAL COST ESTIMATE FOR CONSULTING SERVICES

Santa Ana River Waste Load Allocation Model Update

Task	Description	ADDITIONAL COST										Prior Approved Budget	Total Project Budget
		Principal Hydrologist	Senior Geohydrologist	Project Geohydrologist	Staff Geohydrologist	Graphics	Clerical	Total Hours	Labor Cost	Reimbursable Expenses [1]	Additional Cost		
	Hourly Rate:	$285	$200	$165	$125	$110	$95						
5.0	**Estimate Off-Channel Recharge from Natural Precipitation**												
	Estimate the Volume and Quality of Natural Rainfall that Percolates to The Underlying Groundwater Basin							0	$ -		$ -	$ 6,385	$ 6,385
	Task 5.0 Subtotal Hours and Costs	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**$ -**	**$ -**	**$ -**	**$ 6,385**	**$ 6,385**
6.0	**Run the WLAM in Retrospective Mode, Using Historical Discharge Data, to Estimate the Quantity and Quality of Recharge that Actually Occurred**												
	Run the Most Current Version of the WLAM Produced in the RFP Task 2 After It Has Been Finalized (Calibrated and Validated) to Estimate the Actual Volume and Quality of Water Recharged to the Six GMZ's Named in Task 5 for the 12-Year Period Commencing in January of 2005 and Ending in December of 2016.							0	$ -		$ -	$ 6,385	$ 6,385
	Prepare a Summary Comparing the Estimated Actual Values to the WLAM Projects for the Same GMZs.							0	$ -		$ -	$ 1,905	$ 1,905
	Task 6.0 Subtotal Hours and Costs	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**$ -**	**$ -**	**$ -**	**$ 8,290**	**$ 8,290**
7.0	**Compile the WLAM into a Run-Time Software Simulation Package**												
	Develop a Simple Windows-Based Graphical User Interface for the WLAM	The proposed WinHSPF computer code is a Windows-Based Graphic User Interface						0	$ -		$ -	$ -	$ -
	Prepare a Standardized Input File Specifying the Key Input Variables for Each Wastewater Discharge							0	$ -		$ -	$ 6,600	$ 6,600
	Prepare a User Manual* and Training for up to 15 Staff Members on How to Analyze Scenarios, Run and Retrieve Results From the WLAM.							0	$ -		$ -	$ 6,480	$ 6,480
	Prepare and Submit Model Documentation Suitable for Peer Review							0	$ -		$ -	$ 4,260	$ 4,260
	Task 7.0 Subtotal Hours and Costs	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**$ -**	**$ -**	**$ -**	**$ 17,340**	**$ 17,340**
9.0	**Draft Task Reports, Draft and Final Report**												
	Prepare Draft Task Report for Task 1 Documenting the Results of Task 1							0	$ -		$ -	$ 4,380	$ 4,380
	Prepare Draft Task Report for Task 2 Documenting the Results of Task 2							0	$ -		$ -	$ 9,680	$ 9,680
	Prepare Second Draft Task Report for Task 2 Documenting the Results of Task 2	2	8		32	8	1	51	$ 7,145	$ 100	$ 7,245	$ -	$ 7,245
	Prepare Draft Task Report for Task 3 Documenting the Results of Task 3							0	$ -		$ -	$ 5,760	$ 5,760
	Prepare Draft Task Report for Task 4 Documenting the Results of Task 4							0	$ -		$ -	$ 5,760	$ 5,760
	Remove Costs for Draft Task Report for Task 4 Documenting the Results of Task 4							-	$ -		$ (5,760)	$ -	$ (5,760)
	Prepare Draft Task Report for Task 5 Documenting the Results of Task 5							0	$ -		$ -	$ 3,440	$ 3,440
	Prepare Draft Task Report for Task 6 Documenting the Results of Task 6							0	$ -		$ -	$ 3,440	$ 3,440
	Prepare a Draft Study Report, Reflecting a Compilation of the Draft Reports and Addressing All Comments Received from SAWPA and Members of the Task Force on the Previous Drafts							0	$ -		$ -	$ 8,720	$ 8,720
	Prepare a Final Study Report in Electronic Format for Distribution to SAWPA							0	$ -		$ -	$ 3,825	$ 3,825
	Task 9.0 Subtotal Hours and Costs	**2**	**8**	**0**	**32**	**8**	**1**	**51**	**$ 7,145**	**$ 100**	**$ 1,485**	**$ 45,005**	**$ 46,490**
10.0	**Monthly Project Meetings**												
	Prepare For and Participate in up-to-18 Half-Day Monthly Meetings Where GSSI will Describe Project Status and/or Present Draft and Final Results to the BMPTF and/or Regional or State Water Boards							0	$ -		$ -	$ 35,640	$ 35,640
	Task 10.0 Subtotal Hours and Costs	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**$ -**	**$ -**	**$ -**	**$ 35,640**	**$ 35,640**
11.0	**Pilot Evaluation of the Doppler Data Compared to Precipitation Gauge Data**												
	Pilot Evaluation of the Doppler Data Compared to Precipitation Gauge Data							0	$ -		$ -	$ 3,000	$ 3,000
	Task 11.0 Subtotal Hours and Costs	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**$ -**	**$ -**	**$ -**	**$ 3,000**	**$ 3,000**
	TOTAL HOURS AND COST:	**5**	**63**	**0**	**216**	**8**	**1**	**293**	**$ 42,000**	**$ 100**	**$ 23,966**	**$ 249,800**	**$ 273,766**

Note

[1] Reimbursable expenses include report reproduction.

Santa Ana Watershed Project Authority

Request for Budget Amendment for Consulting Services for Santa Ana River Waste Load Allocation Model Update

Table 2

REVISED PROJECT SCHEDULE

Task		Description	Jan-17	Feb-17	Mar-17	Apr-17	May-17	Jun-17	Jul-17	Aug-17	Sep-17	Oct-17	Nov-17	Dec-17	Jan-18	Feb-18	Mar-18	Apr-18	May-18	Jun-18	Jul-18	Aug-18	Sep-18
1		**Update the Data Used in the Waste Load Allocation Model (WLAM)**																					
	1a	Update Relevant Land Use Maps for the Region																					
	1b	Update the Stormwater Management Facility Maps																					
	1c	Update the Historical Precipitation Data for the Region																					
	1d	Review and Confirm the Operating Assumptions for Seven Oaks Dam and Prado Dam																					
	1e	Update and Consolidate the Flow Data Used in the WLAM																					
	1f	Update and Consolidate the Water Quality Data Used in the WLAM																					
	1g	Perform a Systematic QA/QC Review of All Data																					
	1h	Update and Consolidate Flow Data from Additional Discharge Sources Identified in the WLAM																					
	1i	Augment TIN Water Quality Data																					
	1j	Create Plots and Database Files of Model Input Data (to be included as appendices)																					
2		**Update and Recalibrate the WLAM**																					
	2a	Update the Estimate of Surface Water Runoff to Major Stream Segments																					
	2b	Update the Estimate of Stream Flow in Major Stream Segments																					
	2c	Update the Estimated Concentration of TDS in Major Stream Segments																					
	2d	Update the Estimated Concentration of TIN in Major Stream Segments																					
	2e	Estimate the Volume of Stream Flow Recharging from Each Major Stream Segment to the Underlying Groundwater Management Zone																					
	2f	Estimate the Average Daily Concentration and Mass of TDS Recharging from Each Major Stream Segment to the Underlying Groundwater Management Zone																					
	2g	Estimate the Average Daily Concentration and Mass of TIN Recharging from Each Major Stream Segment to the Underlying Groundwater Management Zone																					
	2h	Create an Impoundment for the Prado Wetlands to Account for Evapotranspiration and Changes in Water Quality																					
	2i	Re-Estimate Stream Flow in Major Stream Segments after Incorporating Additional Discharge Data																					
	2j	Re-Estimate Concentration of TDS in Major Stream Segments after Incorporating Additional Discharge Data and Effects of the Prado Wetlands																					
	2k	Re-Estimate Concentration of TIN in Major Stream Segments after Incorporating Additional Discharge Data and Effects of the Prado Wetlands																					
	2l	Tabulate the Differences between WLAM Versions																					
	2m	Tabulate the Average Mass Balance (by Source) for Flow, TDS, and TIN in Each Major Stream Segment																					
	2n	Conduct Formal Outlier Analyses for Areas of High Model Over/Underestimation (i.e., greater than two orders of magnitude)																					
3		**Evaluate Waste Load Allocation Scenarios for Major Stream Segments**																					
	3a	Specify the Range of Probable Discharge Conditions																					
	3b	Use WLAM to Analyze Six Scenarios																					
	3c	Report Results of the WLAM Scenario Analyses																					
4		**Develop WLAM for Managed Recharge in Percolation Basins**																					
	4a	Identify the Percolation Ponds and Recharge Basins to be Evaluated																					
	4b	Characterize the Volume and Quality of Water Recharged to Groundwater																					
	4c	Summarize the Results of Task 4b by Groundwater Management Zone																					
	4d	Integrate Results from Task 4c with the Results from Task 3c																					
5		**Estimate Off-Channel Recharge from Natural Precipitation**																					
		Estimate the Volume and Quality of Natural Rainfall that Percolates to The Underlying Groundwater Basin																					
6		**Run the WLAM in Retrospective Mode, Using Historical Discharge Data, to Estimate the Quantity and Quality of Recharge that Actually Occurred**																					
		Run the Most Current Version of the WLAM Produced in the RFP Task 2 After It Has Been Finalized (Calibrated and Validated) to Estimate the Actual Volume and Quality of Water Recharged to the Six GMZ's Named in Task 5 for the 12-Year Period Commencing in January of 2005 and Ending in December of 2016.																					
		Prepare a Summary Comparing the Estimated Actual Values to the WLAM Projects for the Same GMZs.																					
7		**Compile the WLAM into a Run-Time Software Simulation Package**																					
		Develop a Simple Windows-Based Graphical User Interface for the WLAM	The proposed WinHSPF computer code is a Windows-Based Graphic User Interphase																				
		Prepare a Standardized Input File Specifying the Key Input Variables for Each Wastewater Discharge																					
		Prepare a User Manual and Training for up to 15 Staff Members on How to Analyze Scenarios, Run and Retrieve Results From the WLAM.																					
		Prepare and Submit Model Documentation Suitable for Peer Review	TO BE DETERMINED																				

Santa Ana Watershed Project Authority

Request for Budget Amendment for Consulting Services for Santa Ana River Waste Load Allocation Model Update

Table 2

REVISED PROJECT SCHEDULE

Task	Description	Jan-17	Feb-17	Mar-17	Apr-17	May-17	Jun-17	Jul-17	Aug-17	Sep-17	Oct-17	Nov-17	Dec-17	Jan-18	Feb-18	Mar-18	Apr-18	May-18	Jun-18	Jul-18	Aug-18	Sep-18
9	**Draft Task Reports, Draft and Final Report**																					
	Prepare Draft Task Report for Task 1 Documenting the Results of Task 1																					
	Prepare Draft Task Report for Task 2 Documenting the Results of Task 2																					
	Prepare Draft Task Report for Task 3 Documenting the Results of Task 3																					
	Prepare Draft Task Report for Task 4 Documenting the Results of Task 4																					
	Prepare Draft Task Report for Task 5 Documenting the Results of Task 5																					
	Prepare Draft Task Report for Task 6 Documenting the Results of Task 6																					
	Prepare a Draft Study Report, Reflecting a Compilation of the Draft Reports and Addressing All Comments Received from SAWPA and Members of the Task Force on the																					
	Prepare a Final Study Report in Electronic Format for Distribution to SAWPA																					
10	**Monthly Project Meetings**																					
	Prepare For and Participate in Half-Day Monthly Meetings Where GSSI will Describe Project Status and/or Present Draft and Final Results to the BMPTF and/or Regional or																					
11	**Pilot evaluation of the Doppler Data Compared to Precipitation Gauge Data**																					
	Pilot evaluation of the Doppler Data Compared to Precipitation Gauge Data																					

Previous GEOSCIENCE Working Period

Revised GEOSCIENCE Working Period

Deliverable Date

Meeting / Workshop

Note

* The dates of the Regional and State Water Board hearings have not yet been determined

ATTACHMENT A

Comments Received on Technical Memoranda Nos. 1 and 2

GEOSCIENCE

OCWD Comments on draft TM-1 and TM-2 dated September 19, 2017

(TM's prepared for SAWPA by Geoscience for the Santa Ana River Waste Load Allocation Model Update)

TM-1 'Data Collection' comments

- Figure 6 includes 'underground pipe' – some of these features are not part of the channel system but are imported water pipelines – it does not seem relevant to include them in Figure 6

TM-2 'WLAM Update and Recalibration' comments

- Section 2.2, Watershed Model Development – it is not clear if the stormwater runoff in the green shaded area in Figure 5 is accounted for in the model. The green shaded area includes flow that would be conveyed to the SAR through the Carbon Diversion Channel, Fletcher Channel, and some other small tributaries to the SAR that are located between OCWD's Imperial Highway inflatable dam and Santiago Creek. OCWD's Recharge Facilities Model does not simulate runoff in the green shaded area. Please provide more discussion of the modeling of stormwater runoff in the green shaded area in Figure 5.
- For Figure 5, please add a legend for the symbols
- Section 2.3.8, Wastewater Discharge – add a table showing the wastewater discharge for each facility per year
- Section 2.3.8, Wastewater Discharge – is there no discharge by Eastern MWD at their discharge point to Temescal Creek?
- A water budget summary table should be included – among other items, the table should list total runoff, total wastewater discharge, total unmanaged streambed infiltration, total managed infiltration (such as OCWD managed infiltration, and other agencies if it can be accounted for), total evapotranspiration, rising groundwater at Riverside Narrows, rising groundwater in Prado Basin, and total outflow at the downstream model boundary; the table should list the above terms by year; the table should be used to demonstrate that all the water in the system is accounted for from a mass balance perspective on an annual basis.
- Section 2.3.9, Rising Groundwater – text should be added to describing how the rising groundwater rate was estimated at the two locations; reference is made in the text to Figure 10, but it is not clear from Figure 10 where the rising groundwater is specified; please include additional features on Figure 10 to specify where rising groundwater is defined in the model;
- Section 2.3.10.2, OCWD Wetlands – the TIN of effluent from the OCWD Prado Wetlands should be varied seasonally – the winter time nitrate removal rate is lower than the summer time

removal rate. For May-October, a TIN effluent of 1 mg/L is appropriate; for November-April, 4 mg/L is appropriate.

- Section 3.3, Streamflow Calibration Results – the R^2 values should be included in the table on page 15.

- Section 3.3, Streamflow Calibration Results – in the table on page 15, the monthly streamflow calibration is listed as 'very good' for both the 2008 WLAM and the WLAM Update for the Prado Inflow – in looking at Figure 31, the 2008 WLAM calibration result is noticeably better than the WLAM Update – since (1) Prado Dam is where runoff in the upper Santa Ana Watershed collects before flowing to the lower Santa Ana Watershed, (2) Water Quality Objectives are identified for Reach 2 and 3 in the Regional Board's Basin Plan, and (3) Reaches 2 and 3 are demarcated at Prado Dam, additional attention should be given to the WLAM Update calibration results at Prado Dam. OCWD is not yet ready to use the WLAM Update for assessing future conditions until more evaluation is given to the calibration shown in Figure 31.

- Section 3.3, Streamflow Calibration Results – it would be helpful to have more discussion of the parameters that were changed for calibration – for example, discussion could be added to explain the degree to which each parameter was changed, and whether it was changed throughout the model or in certain areas; this should be added to Section 3.3, or an earlier section.

- Section 3.3, Streamflow Calibration Results – the daily streamflow calibration for the WLAM Update is listed as 'poor' for the SAR at Santa Ana – the reason for the poor calibration should be described in greater detail.

- Section 3.4, TDS and TIN Calibration – the table showing the residuals on page 16 should also include the residuals calculated on a percentage basis.

- Section 3.4, TDS and TIN Calibration – the evaluation of the flow calibration uses the methodology of Donigian (2002) to categorize the calibration performance; is there a similar methodology for the calibration of TDS and TIN that can be used to categorize the residuals?

- Section 3.4, TDS and TIN Calibration – it would be helpful to have more discussion of the parameters that were changed for calibration – for example, discussion could be added to explain the degree to which each parameter was changed, and whether it was changed throughout the model or in certain areas; a brief amount of text is already included for the nitrogen reaction rate coefficients, but discussion should be added for the other parameters that were changed.

- General document formatting comment – the tables that are imbedded in the text are not numbered (for example, there is no table number for the table on page 16); these tables are some of the most important tables in the document and will be referred to frequently; these tables should be numbered for ease of reference.

Santa Ana Watershed Project Authority

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District

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Bernardino
Valley
Municipal
Water
District

Inland
Empire
Utilities
Agency

October 13, 2017

Johnson Yeh
Geoscience Support Service, Inc.
P.O. Box 220
Claremont, CA 91711

Re: TM 1 & 2 Review Comments

Dear Johnson,

SAWPA staff has reviewed the draft Technical Memorandum Reports 1 - Data Collection & 2 – WLAM Update and Recalibration. Our comments are as follows:

TM #1

1) Page 2. Please change acronym for Riverside County Flood Control and Water Conservation District to (RCFCWCD) as is their normal protocol.
2) Overall, the report appears to be very brief and summarized citing the sources of data collection that are largely reflected in the original proposal and scope. We recommend additional information be added to this TM about the "process of data collection" particularly for data from the public owned treatment works. The data collection form should be included as an appendix with explanation as to why and how data will be used in the model. Concerns had been raised about some data collection associated with the recharge basins and how this will be incorporated into the new WLAM update.
3) Some discussion of how data collected will be entered into the HSPF platform for later use would be helpful.

TM #2

1) Page 1. This TM has a significant number of acronyms associated with model components, see page 10, so it is recommended to have a list of acronyms and abbreviations. I may have missed them but many do not appear to be defined at all.
2) Page 2. The last paragraph on this page needs further explanation. It is unclear from these sentences whether reference to "the model update" is referring to just the 2008 WLAM model or/and the new model using HSPF.
3) Page 3. Last Line. Change "compressive" to "comprehensive".

4) Page 8. 1st paragraph. It seems very odd to be using an ET station labeled "Los Angeles County Public Works (LACPW) station at Puddingstone Dam" which is outside the Santa Ana River Watershed should be used. There are multiple ET sites in the Santa Ana River Watershed that have been established by water agencies to support the development of water budgets. Please confirm accuracy of ET and whether use of more local ET stations is warranted.
5) Page 10. Please explain what "nitrogen reaction rate coefficients" are. Are these the same thing as nitrogen loss coefficients?
6) Page 11. The statement that the OCWD wetlands are used to treat all the effluent of WRCWRA plant seems too simplistic and not entirely accurate. Please expound. Devoting just three sentences about the OCWD wetlands and how impacts the WLAM seems overly brief and summarized. More detail is warranted. For example, though the wetlands is effective in nitrogen removal, evaporation through the wetlands would increase the TDS concentrations. Is this negligible? Please discuss why this particular nitrogen loss mechanism is addressed by the model why other nitrogen loss uptakes such as vegetation are not.
7) Page 12 & 15. The first sentence states that the calibration is a trial and error process until a "reasonable" match is met between model simulation and actual flows. However, some calibration results indicate a rating of Poor with the new WLAM model. Please explain why a "Poor" R2 level is considered a "reasonable" or "satisfactory" match. Please explain.

If you have any questions regarding these comments, please contact me at 951-354-4221.

Sincerely,

Mark R Norton

Mark R. Norton P.E
Water Resources & Planning Mgr

IEUA AND CBWM COMMENTS ON THE WASTELOAD ALLOCATION MODEL (WLAM), TM-1 AND TM-2

To: SAWPA Basin Monitoring Program Task Force, Geoscience
From: Inland Empire Utilities Agency (IEUA) and Chino Basin Watermaster (CBWM)
Date: October 17, 2017
Subject: Review of the Wasteload Allocation Model (WLAM), *TM-1 Data Colleciton*, and *TM-2 WLAM Update & Recalibration* prepared by Geoscience, September 19, 2017

The following set of comments are categorized as general comments and specific comments. The general comments are meant to communicate our overall concerns and recommendations to the Basin Monitoring Program Task Force (BMP TF) and Geoscience. The specific comments are those relating to each individual technical memorandum. These comments include references to the report page, section number, and/or figures in question.

GENERAL COMMENTS:

1. TM-1 does not provide sufficient information or details to ensure a high-level of reliability in the process (TM-1 specific comments are provided below). TM-1 was not provided to the BMP TF for review and approval prior to the development of TM-2, as prescribed in the RFP. Although this may have initially saved time, data collection and validation is essential to producing accurate modeling results.

2. Model appears to rely on a national database for several of its parameters. It is recommended that local data use be maximized and supplemented with national database parameters. More details are provided in TM-2 comments below.

TM-1 COMMENTS:

1. Please provide summary tables that list the monitoring stations where data was collected, the period of record, and identify the missing and/or questionable data. The report states that the data was collected and QAQC'd. Please provide details and documentation of the process and identification of data eliminated from the analysis.

2. Page 1, Paragraph 1. The text states that Geoscience was retained to "update, calibrate and apply the Wasteload Allocation Model (WLAM)…". It is our understanding that Geoscience was going to be developing and implementing a whole new model platform (HSPF) for the wasteload allocation analysis, not updating the old model. Please clarify.

3. Page 3, Section 2.3 and Figure 8. Will reducing the precipitation data coverage from 43 stations to 19 have an impact on the model results? Can you provide a table that summarizes the stations considered, including the names, data provider, the period of record available from the station, if the station was eliminated or is new, and if any data gaps exist for the calibration period of record for the final selected 19 stations. Can you show the spatial location of the 24 stations eliminated from the analysis and call out the five new stations on Figure 8? Were NEXRAD gridded precipitation estimates collected and evaluated and if not, why?

4. Page 3, Section 2.3, Second Paragraph. Why was the PRISM data used for calculating the precipitation adjustment factors only for the period of record through 2010? This excludes the recent drought period. What is the potential impact of not extending this record through at least 2015?

5. Page 3, Section 2.4. Please provide a table that lists and summarizes the characteristics of the stormwater management facilities that reduce discharge to the Santa Ana River.

6. Page 3, Section 2.5. Please provide a table that summarizes the stations, including the names, data provider, the period of record available from the station, and if any data gaps exist for the calibration period of record.

7. Page 3, Section 2.6. How was the streamflow data determined to be reliable? Can you provide a table that summarizes the stations, including the names, data provider/source, the data type (USGS gage vs. wastewater discharge point), the period of record available from the station, and if any data gaps exist for the calibration period of record? For the POTW discharges, can you please provide time-history charts for the agencies to review and QA/QC?

8. Page 4, Section 2.7. Please expand this section to clearly describe the information collected. At a minimum, a table of stations for which data was collected, including the names, data provider/source, the data type available (TIN, TDS, or both), the period of record available from the station, and the number of TIN and/or TDS observations available in the calibration period. For the POTW discharges, can you please provide time-history charts for the agencies to review and QA/QC?

9. Page 4, Section 3.0. Please expand this section to provide more information about how data was reviewed, and describe if/which data was eliminated from the analysis and why.

10. In 2010, the 2008 WLAM analysis had to be updated to include revised operating rules for Seven Oaks Dam. This memo does not describe the operating rules for Seven Oaks, San Antonio and the many stormwater recharge projects in the watershed. Please explain if this information was collected, and if, so how it will be used in the model.

11. Figure 1. It appears the figure depicts an incorrect shapefile of management zone boundaries – the layer does not include the revised Prado Basin and Chino North boundaries incorporated in a 2012 Basin Plan Amendment (R8-2012-0002).

TM-2 COMMENTS:

1. The work described in the RFP as Tasks 2e (stream flow volume from major stream segments), 2f (concentration and mass of TDS recharging from major streams), and 2g (concentration and mass of TIN recharging from major streams) was not reported in TM-2.

2. Precipitation: The TM should compare the spatial/temporal estimates of precipitation to the gridded NEXRAD estimates on an annual basis to demonstrate that the recommended method of assigning precipitation estimate to the sub watershed is reliable and the best alternative. There is significant variability across the watershed year to year, and using a thirty-year average isohyetal map may not be the appropriate representation. There are gridded radar-based precipitation estimates that can be used to estimate precipitation on the watershed on daily and sub-daily time steps. These

datasets may be more accurate than estimating based on a 30-year average annual isohyetal map. The comparison and recommendation of estimating precipitation should be provided in the TM for the task force's review and concurrence.

3. Evapotranspiration (ET): A regression is developed based on the statement that ET is a function of elevation. Solar radiation, wind, temperature, and humidity may vary with elevation at any point in time but elevation cannot be used to predict their individual values. The TM developed regression equations without discussing alternative approaches. The text uses "ET" and "evaporation" interchangeably– this should be corrected. There are two CIMIS stations in the upper watershed and one in the lower watershed with potential ET estimates based on solar radiation, temperature, humidity and wind – and not elevation. The TM does not provide a clear relationship between ET and elevation. The TM does not address why the CIMIS stations were not used and the scientific basis for the regression equations. It would be instructive for the TM to present elevation vs ET estimates from the various CIMIS stations in the southern California area and see how closely it matches the ET estimates used in the work documented in the TM. The TM reports the use of evaporation pans for four stations that were used to develop the regression equations. It is our understanding that only two of those stations have pan evaporation data during the entire calibration period. One station has no data during the calibration period, please clarify.

4. Rising Groundwater: There was no demonstrated attempt to develop rising groundwater estimates upstream of the Riverside Narrows or at Prado Dam. Attempting to mimic rising water by reducing streambed infiltration may not be the best or most accurate alternative. The impact of rising water on TDS concentration is very significant at the Riverside Narrows and at Prado Dam. The rising water contributions and their associated TDS and nitrogen concentrations can be estimated from available data. Please describe the alternatives of how to accurately address rising groundwater.

5. General Comment. Both the Wildermuth Environmental, Inc. (WEI) and Geoscience modeling work are referenced throughout the report – in text and exhibits. Both are referred to as the WLAM. A timeframe is generally used to distinguish between the two models, but not consistently. The WEI model is interchangeably referred to as WLAM, 2008 WLAM, existing 2008 WLAM, R4 model, and R4 computer code. The Geoscience work is referred to as WLAM, "this WLAM", "updated WLAM", "WLAM update". For clarity, we recommend using a single unique name for each and using those consistently throughout to improve clarity for the reader.

6. Page 1, Paragraph 1. The text states that Geoscience was retained to "update, calibrate and apply the Wasteload Allocation Model (WLAM)…". It is our understanding that Geoscience was going to be developing and implementing a whole new model platform (HSPF) for the Waste Load Allocation analysis, not updating the old model. Please clarify.

7. Page 2, Paragraph 3. The R4 model was never applied by WEI for the wasteload allocation work; and R4 was developed prior to 2008.

8. Page 2, Paragraph 4. Please clarify if the WEI version of the WLAM was updated and recalibrated, or if a new model was constructed and calibrated for this study.

9. Page 3, Section 2.1.1, Paragraph 1. The comparison to R4 is incorrect. It should be compared to the 2008 WLAM.

10. Page 4, Section 2.2, Paragraph 3. Beyond this brief paragraph, there is no other discussion of the RFM or presentation of modeling showing interaction or its result of OCWD recharge basins.

11. Page 4, Section 2.3, Last sentence. This may be misleading. TM-1 very generally describes the data collection process, but does not provide or present the data for anything other than land use and soil types.

12. Page 5 and Table 1. Soil group and infiltration rate. Infiltration rate values are significantly lower compared to the values recommended in the HSPF user guide. The procedure to estimate initial infiltration rate should be discussed in detail. Table 1 should include an infiltration index, as well as initial and final calibrated infiltration rates for each sub-watershed.

13. Page 7 – Inset Table on Land Use % Pervious. The pervious area percentages presented in this table may not be representative of the development in the Santa Ana River watershed. Most of the development that has occurred between the 1980s and 2010 were at higher densities than prior 1980. This means a simple national average reported by Aqua Terra may not be representative in the Santa Ana River watershed. Please provide additional clarification to demonstrate the applicability of information in the table.

14. Page 7, Section 2.3.4. The method used to estimate daily precipitation may not be appropriate. Given that there is significant variability across the watershed from year to year, it may be more appropriate to use an annual isohyetal map for each year in the calibration period instead of using a 30-year average isohyetal map. There are gridded radar-based precipitation estimates that can be used to estimate precipitation on the watershed on daily and sub-daily time steps. Please provide a comparison of a subset of your sub-watershed estimates to the gridded NEXRAD estimates to demonstrate this method is reliable and the best alternative.

15. Page 9. Section 2.3.6. Seven Oaks Dam outflow was used as boundary inflow. Please explain how will the future Seven Oaks Dam operation will be handled.

16. Page 9, Section 2.3.7. There is no mention of the stormwater diversions to spreading basins or how they were used. Please explain if/how these diversions were included in the model. If they were not included, please explain. Also, there is no information in TM-1 or TM-2 describing the stream system characteristics, just that they were considered and their associated properties were developed from a national database. Please describe how urban storm drainage system data were used.

17. Page 9, Section 2.3.8. This section describes the non-tributary discharge from POTWs. Please explain if this is comprehensive in including other non-tributary discharges, and how they are accounted for in the model.

18. Page 9/10, Section 2.3.9. Please clarify the approach to modeling rising groundwater. Our understanding is that the model parameters are adjusted to mimic rising water by reducing streambed infiltration. If this is the case, what will be the resulting impact to the estimation of TDS and TIN in streambed infiltration and surface flow downstream of the rising water areas? The impact of rising water on TDS concentration is significant at Prado Dam and for this reason, this method may not be appropriate.

19. Page 12, Section 3.1, Paragraph 2. Please explain why the calibration period of WY 2007 through WY 2016 was selected. Why not a longer calibration period?

20. Page 13, Section 3.3/3.4 (Figures 15 through 32). Please provide clarity on the purpose of comparing the old (2008 WLAM) and new model (2017 WLAM-HSPF) calibration results in these figures if each calibration effort is based on completely different calibration time periods/data sets?

21. Page 16, Inset Table. The residual values for TDS seem misleading given the large range in positive and negative residuals seen in Figures 51 through 53. Please provide a table that compares the measured versus modeled data and the residual calculations more explicitly.

22. The mean residual error approach used to evaluate the calibration for TIN and TDS is unclear. Please provide further explanation of how the quality of the calibration was assessed. Review of TM-2 Figures 51 and 52 show that there are large positive and negative values and the resulting near zero residuals is caused by compensatory errors that cancel each other out. The residual error does explain systematic error.

23. We recommend that a peer review be conducted prior to using the model for planning or wasteload allocation scenarios evaluation. Due to the comments above, and the fact that the WLAM is 1) Being updated with substantially different information and methods, and 2) Being moved to a new model platform, it is recommended that the model undergo a peer review. A peer review at this critical juncture will provide the modeler and the BMP TF with a defensible foundation, and build confidence in this significant modeling effort. It is critical that the new WLAM replicate the functionality and accuracy of the most recent WLAM.

// END COMMENTS //

Requested Revisions to Technical Memorandum #2: WLAM Update and Recalibration

1) Please describe how dam operations (7 Oaks & Prado) are handled when calibrating the flow model. Need to note that ACOE does not always follow their own formal operating rules for the dams and that there is no way to predict these deviations in the WLAM. This is especially important for the 2010-11 wet season.

2) Please describe in greater detail the flow and water quality data provided by the POTWs. Was this data assumed to be QA/QC'd by the provider or did Geosciences do additional QA/QC on the data? Did POTWs provide daily data for TIN & TDS or were the monthly averages assigned to all days in each month?

3) There are significant discharges from the San Bernardino's geothermal plant to Warm Creek. These do not appear to be accounted for in the model calibration and may explain some of the discrepancy at this station.

4) Discharges from Eastern Municipal Water District are not depicted on several figures including: Fig. 12, Fig. 35 & Fig. 43 (and there may be others). EMWD is also not listed among the POTW discharges described in Section 2.3.8 on pg. 9 of the report.

5) On occasion, under certain extreme wet weather conditions, the Cities of San Bernardino and Colton may discharge directly to the river rather than sending secondary effluent to RIX for filtration. Although rare, these discharges may be confounding the calibration. Please check with POTWs for more details regarding these events.

6) Historically, SBVMWD has operated a dewatering discharge of approximately 6.3 cfs. This does not appear to be accounted for in the calibration. Please check with Valley District to determine if the discharge is still occurring.

7) Historically, there was up to 7.9 cfs of discharge from the Arlington Desalter. This does not appear to be accounted for in the calibration and may explain some of the discrepancy at Temescal Creek. Please check with SAWPA to better characterize these flows.

8) Please indicate whether salinity data was originally provided as TDS (mg/L) or Electrical Conductivity (uS/cm) and what conversion factor was used to translate between these different measurement units.

9) Please prepare a table summarizing key similarities and differences between the 2002 WLAM, the 2015 WLAM (Scenario 8) and the 2017 WLAM including, but not limited to, the following categories: land use data, precipitation data, gauge data, number of sub-areas, POTW data, soil data, evaporation stations, nitrogen reaction coefficients, calibration period, calibration endpoints (R2, RMSE, other), etc.

10) Please describe why Geosciences elected to estimate local rainfall using the Prism contours rather than the Thiessen Polygon approach used in the previous WLAM.

11) The new and prior WLAM presume that TIN concentration in water leaving the Prado Wetlands (operated by OCWD) is 1 mg/L (see pg. 13). Do we have data to defend that conclusion? If so, it should be cited in a reference. Perhaps OCWD has better data with higher resolution under a wider variety of input conditions. This may improve the TIN calibration at Prado Dam.

12) The WLAM should probably be revised to treat the Prado Wetlands as a discrete impoundment so that the model can better account for the minor evapotranspiration losses that occur for river flows diverted through those ponds. This will probably improve the TDS and flow calibration at Prado Dam.

13) Please provide a new subsection describing the side-by-side analyses of the 2015 (Scenario 8) WLAM vs. the HSPF model for the upper Santa Ana Watershed that Geosciences performed at the outset of this effort.

14) For all tables showing the relative percent error between modeled and observed scores, please add a footnote indicating how the percent error was calculated and whether a negative valence indicates that the model is over- or under-estimating in relation to the measured value.

15) Please add text explaining that the HSPF model is used to calculate precipitation runoff in Reach 2 of the Santa Ana River (see green area in Fig. 5). OCWD's RFM model is only used as an accounting tool to track diversions and recharges not to estimate runoff from adjacent land areas.

16) Please add text explaining that variance at very low flows may be partially explained by sensitivity and precision of the gages at their detection limits (e.g. 0.1 cfs - 1.0 cfs). See Fig. 26 for example.

17) IUEA's RP-2 treatment plant was decommissioned in about 2002. The loss of perennial flows probably altered the subsequent streambed percolation rates in Chino Creek. This may explain some of the calibration problems at this station.

18) Figure 22 and Figure 33 are entitled: "Inflow to Prado." This is somewhat confusing. Since the USGS gage is located below Prado Dam (in Reach 2 of the SAR), is this really referring to "Outflow from Prado?"

19) Neither the old nor the new WLAM explicitly account for dry weather urban runoff caused by return flows from landscape or crop irrigation. At some times and places such flows can be quite large. In addition, there is a long-term declining trend in such flows in response to conservation efforts. If there is no way to account for these flows, then the text should acknowledge their existence and indicate that this may explain some of the discrepancy between measured and observed values particularly in dry weather, low flow conditions.

20) Figures 51 thru 56 present daily water quality data. Similar graphs should be prepared showing the relationships based on monthly averages.

21) Please describe how the new WLAM accounts for diversion of dry weather flows and stormwater flows to off-channel recharge basins (esp. in San Bernardino County).

22) Please provide a more detailed explanation of the decision criteria used to include or exclude data from rainfall gaging stations. Why did Geosciences use far fewer precipitation stations than were used in the previous WLAM (see Section 2.3.4 on pg. 7 of the report)?

23) It appears that there are very little TIN data available at most gaging stations. It may be possible to augment this dataset by computing a synthetic TIN value by summing the value of Ammonia + Nitrate + Nitrite. Nitrite is not critical to this computation as the concentration is usually very small.

24) Please describe what TIN and TDS concentrations were assumed for mountain runoff and wet weather urban runoff and dry weather urban runoff? What was the scientific basis for these assumed values? Please provide relevant reference citations.

25) Please add text explaining the unavoidable discrepancies associated with delays between the rainfall event and when the runoff reaches a gage. For example, rainfall that begins late at night one day and flow gage data that spikes the following day. This is why the monthly data generally calibrates better than the daily data. Add text noting that, given the primary use of the WLAM (e.g. to protect groundwater quality), calibration to a monthly time step is more than adequate to implement Basin Plan objectives (note: groundwater objectives are calculated as a 20-year average and recharge compliance is computed using a 10-year average). It should also be noted that we rarely have accurate daily data for some non-tributary discharges (e.g. OC-59 deliveries of SPW)

26) Please add text describing the significant channel improvements that have been made to San Timoteo Creek over the last 10 years and note the impact this has on the model calibration. See Fig. 33. Note: San Timoteo is misspelled as "San Temoteo" in numerous places throughout the document.

27) Please provide a more detailed description of the precise methods used to account for the amount of flow, and related water quality of those flows, for rising groundwater at the Riverside Narrows and at Prado Dam. Compare and contrast the method(s) used by Geosciences to that used in the previous WLAM. Discuss Pros and Cons of both methods and, in particular, how the different methods may affect subsequent calculations required by the RFP-SOW for this project (e.g. Task 3b: volume and quality of water recharging to each individual aquifer through streambed percolation from each surface segment of the river).

28) It may be appropriate to do some formal outlier analysis for those data points where the model estimates and the observed values differ by more than two orders of magnitude (see, for example, Figures 32, 35, 36 & 41). Such discrepancies seem quite large even if the overall average relative percent difference is small. Large differences in both directions tend to cancel each other out and give the illusion that the overall error is small when it is not. This analysis should focus on only the most extreme deviations which would have the greatest adverse effect on R2 values. For example, in Figure 37, there seem to be several instances where the model predicts flows in the 0.1 to 1.0 cfs range but the measured flows range from 10 to 100 cfs. This may be an example of where the model cannot account for excess irrigation runoff in the Arlington orchard area that ultimately drains to Temescal Creek.

29) Please provide a detailed forensic analysis of how the prior WLAM was able to achieve an acceptable R2 value at San Timoteo when the new WLAM did not.

30) Please provide a detailed forensic analysis of how the prior WLAM was able to achieve an acceptable R2 value at Chino Creek (Schaefer Ave.) when the new WLAM did not. Figure 20 appears to indicate that the old WLAM established a minimum flow and truncated all model estimates below that threshold.

31) Please provide a detailed forensic analysis of how the prior WLAM was able to achieve an acceptable R2 value at Temescal Creek when the new WLAM did not. Figure 15 appears to indicate that the old WLAM established a minimum flow value and truncated all model estimates below that threshold.

32) Please provide a reference citation for the "Standards and Guidelines" for calibrating HSPF models that is described on page 3 of the report.

33) Please provide a more detailed explanation of the steps used to perform a QA/QC review of the flow data, TIN data and TDS data used to populate the new WLAM. Please add text indicating that Geosciences did not re-evaluate prior data that had already been QA/QC'd as part of the 2015-Scenario #8 WLAM prepared by WEI. Only new data collected after 2012 was QA/QC'd by Geosciences.

34) Please provide a reference citation for the source of data used to describe characteristics of the storm channels in Figure 11. All three counties were required to submit GIS layers and an Access Database describing the flood control channels to the Regional Board as part of the 2012 Basin Plan amendment for bacteria standards.

35) Please add USGS Gage number, Lat/Long coordinates, and period of record to the list of stations shown on page 12 of the report.

36) Please add actual R2 values to each cell in the table shown on page 15 of the report.

37) Please add text emphasizing the new WLAM used a different calibration period (WY2006-2016) then the 2002 WLAM (WY1999-2006) or the 2015-Scenario #8 WLAM (WY1995-2006). The computed R2 values for the two older WLAM should not be compared directly to the R2 values for the new WLAM. Rather, the older R2 values were computed solely to determine what has been previously considered acceptable level of model performance.

38) Please provide a footnote to the last sentence on page 3 of the report describing the website address where the HSPF software and user manual can be downloaded.

39) Please provide additional description and explanation of "GoldSim" where that model is first discussed on page 4 of the report.

40) The report should add text explaining that the prior WLAM also did not attempt to optimize the water quality predictions by maximizing R2 or minimizing RMSE because there wasn't enough data to do so.

41) Please add a section at the beginning of the report describing the chronology of WLAM development. It is important to distinguish the WLAM that was developed in 2002 (approved by the Regional Board in 2004) from the updates that were developed in 2008-9 and finalized (as Scenario #8) in 2015. Only the 2002 version was actually approved by the Regional Board. While the 2008-2015 versions were submitted to Regional Board staff for review, they were never agendized for formal Regional Board approval. In addition, the nomenclature for referring to all of the various WLAM versions needs to be standardized throughout the report.

ATTACHMENT B

Presentation Slides from November 16, 2017 Task Force Meeting

GEOSCIENCE

Santa Ana River Wasteload Allocation Model Update

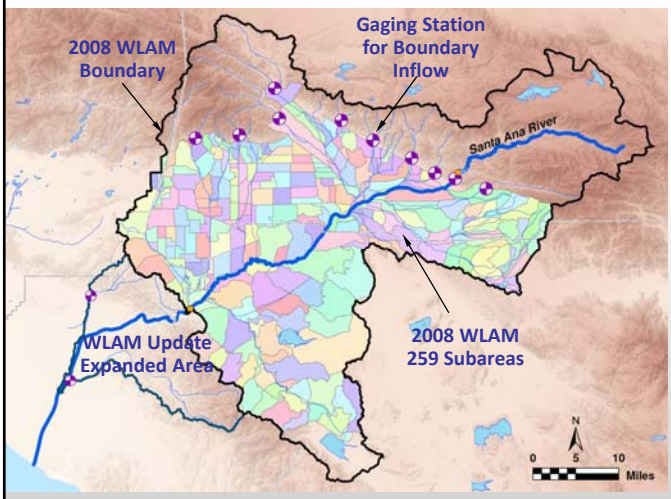
BASIN MONITORING PROGRAM TASK FORCE

November 16, 2017

GEOSCIENCE

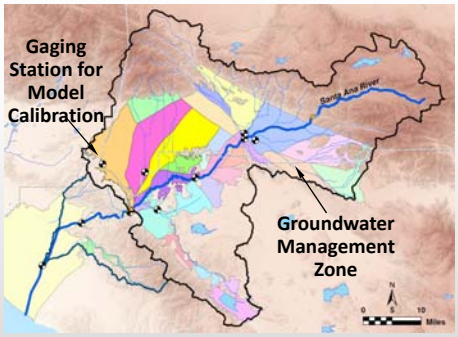
SAR WLAM
Scope of Work Review

Task 1 – Update the Data Used in the Waste Load Allocation Model (WLAM)



- Task 1a: Update relevant land use maps for the region
- Task 1b: Update the stormwater management facility maps
- Task 1c: Update the historical precipitation data for the region
- Task 1d: Review and confirm the operating assumptions for Seven Oaks Dam and Prado Dam
- Task 1e: Update and consolidate the flow data used in the WLAM
- Task 1f: Update and consolidate the water quality data used in the WLAM
- Task 1g: Perform a systematic QA/QC review of all data

Task 2 – Update and Recalibrate the WLAM



- Task 2a: Update the estimate of surface water runoff to major stream segments
- Task 2b: Update the estimate of stream flow in major streams segments
- Task 2c: Update the estimated concentration of TDS in major stream segments
- Task 2d: Update the estimated concentration of TIN in major stream segments
- Task 2e: Estimate the volume of streamflow recharging from each major stream segment to the underlying groundwater management zone
- Task 2f: Estimate the average daily concentration and mass of TDS recharging from each major stream segment to the underlying groundwater management zone
- Task 2f: Estimate the average daily concentration and mass of TIN recharging from each major stream segment to the underlying groundwater management zone

2008 WLAM

Algorithm of 2008 WLAM

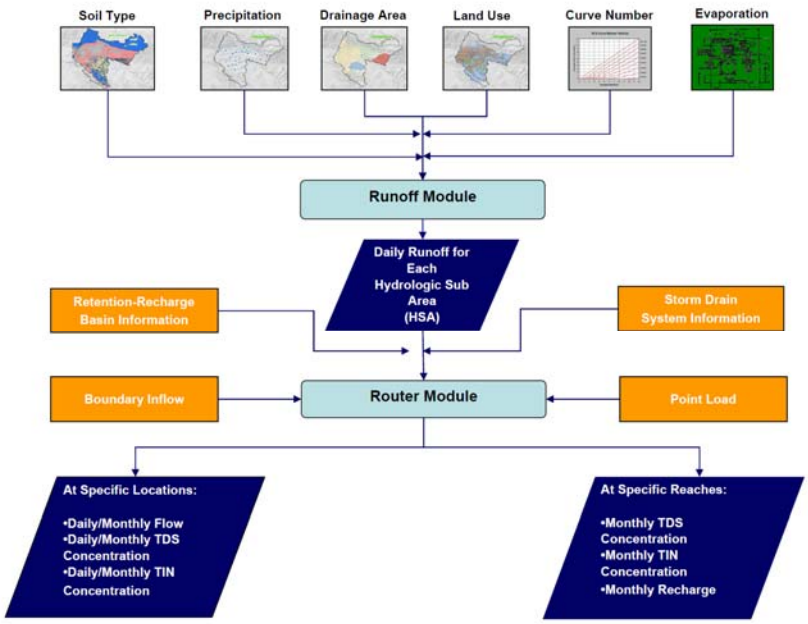


Figure 2-1
Organization of the Wasteload Allocation Model

Source: WEI 2009

Rainfall Runoff Process – 2008 WLAM

$$P = Q + F + Ia \quad (1)$$

$$I_a = 0.2S \quad (2)$$

$$Q = \frac{(P-0.2S)^2}{P+0.8\,S} \quad (3)$$

$$CN = \frac{1000}{10+S} \quad (4)$$

$$CN_1 = \frac{CN_2}{2.27-0.0125*CN_2} \quad (5)$$

$$CN_3 = \frac{CN_2}{0.44+0.0055*CN_2} \quad (6)$$

$$CN\,(t) = (CN_3 - CN_1) * \frac{\mathrm{SM}(t)}{\mathrm{SM}_{max}} + CN_1 \quad (7)$$

P = Daily Precipitation

Q = Runoff

F = Retention after runoff begins

I_a = Initial Abstraction

S = Potential retention after runoff begins

CN = Curve Number

CN_1 = Curve Number for AMC I (the lowest runoff potential)

CN_2 = Curve Number for AMC II (the average conditions)

CN_3 = Curve Number for AMC III (the highest runoff potential)

CN(t) = Curve number at a given day

SM(t) = Soil moisture at a given day

SM_{max} = Maximum allowable soil moisture

2008 WLAM Initial Curve Number

Table 2-7
Hydrologic Properties of Each Land Use Type

WEI Land Use Code	Land Use Type	Percent Impervious	AMC	Curve Number Soil Type A	B	C	D
1	Low Density Residential	30	2	32	56	69	75
2	Medium Density Residential	50	2	32	56	69	75
3	High Density Residential	75	2	32	56	69	75
4	Commercial	90	2	32	56	69	75
5	Industrial	90	2	32	56	69	75
6	Orchards and Vineyards	2	2	39	62	75	81
7	Irrigated Cropland and Improved Pasture Land, Golf course	2	2	53	70	80	85
8	Parks, schools	80	2	39	61	74	80
9	Dairy, poultry, horse ranch, etc	0	2	1	1	1	1
10	Impervious	100	2	98	98	98	98
11	Undeveloped	2	2	78	86	91	93
12	Native/mountain	2	2	47	67	78	83

AMC - Antecedent moisture condition

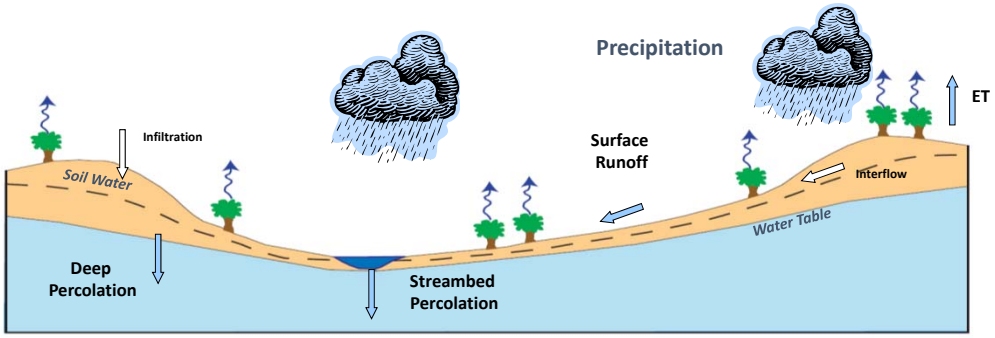
Source: WEI 2009

Table 2-1
SCS Method Curve Numbers[1,2]

Cover Type[3]	Quality of Cover[4]	Soil Group A	B	C	D
Natural Covers					
Barren (Rockland, eroded and graded land)		78	86	91	93
Chaparral, Broadleaf (Manzanita, ceanothus and scrub oak)	Poor	53	70	80	85
	Fair	40	63	75	81
	Good	31	57	71	78
Chaparral, Narrowleaf (Chamise and redshank)	Poor	71	82	88	91
	Fair	55	72	81	86
Grass, Annual or Perennial	Poor	67	78	86	89
	Fair	50	69	79	84
	Good	38	61	74	80
Meadows or Cienegas (Areas with seasonally high water table, principal vegetation is sod forming grass)	Poor	63	77	85	88
	Fair	51	70	80	84
	Good	30	58	72	78
Open Brush (Soft wood shrubs - buckwheat, sage, etc.)	Poor	62	76	84	88
	Fair	46	66	77	83
	Good	41	63	75	81
Woodland (Coniferous or broadleaf trees predominate. Canopy is at least 50 percent)	Poor	45	66	77	83
	Fair	36	60	73	79
	Good	28	55	70	77
Woodland, Grass (Coniferous or broadleaf trees with a canopy density from 20 to 50 percent)	Poor	57	73	82	86
	Fair	44	65	77	82
	Good	33	58	72	79
Urban Covers					
Residential or Commercial Landscaping (Lawn, shrubs, etc.)	Good	32	56	69	75
Turf (Irrigated and mowed grass)	Poor	58	74	83	87
	Fair	44	65	77	82
	Good	33	58	72	79
Agricultural Covers					
Fallow (Land plowed but not tilled or seeded		76	85	90	92
Legumes, Close Seeded (Alfalfa, sweetclover, timothy, etc.)	Poor	66	77	85	89
	Good	58	72	81	85
Orchards, Evergreen (Citrus, avocados, etc.)	Poor	57	73	82	86
	Fair	44	65	77	82
	Good	33	58	72	79
Pasture, Dry land (Annual grasses)	Poor	67	78		89
	Fair	50	69	79	84
	Good	38	61	74	80
Pasture, Irrigated (Legumes and perennial grasses)	Poor	58	74	83	87
	Fair	44	65	77	82
	Good	33	58	72	79
Row Crops (Field crops - tomatoes, sugar beets, etc.)	Poor	72	81	88	91
	Good	67	78	85	89
Small grain (Wheat, oats, barley, etc.)	Poor	65	76	84	88
	Good	63	75	83	87

2017 WLAM HSPF

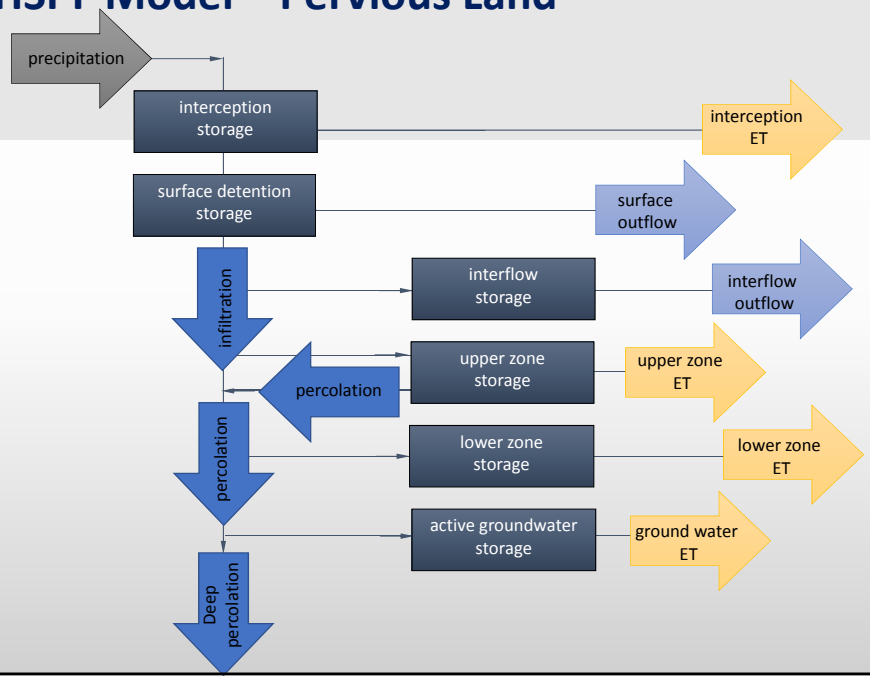
Hydrologic Simulation Program – Fortran (HSPF)



- Evolved from Stanford Watershed Model
- Comprehensive & Physically Based,
- Simulates ALL Water Cycle Components & Water Quality,
- Supported & Maintained by Federal Agencies (EPA & USGS),
- Established Standard Guidelines and Calibration Performance Criteria,
- Windows-Based Interface with Powerful Pre- & Post- Processors, and
- Software is Free.

Stanford Watershed Model Developed in 1950' and 1960'

Algorithm of HSPF Model – Pervious Land*



HSPF — Established Calibration Standard & Guidelines

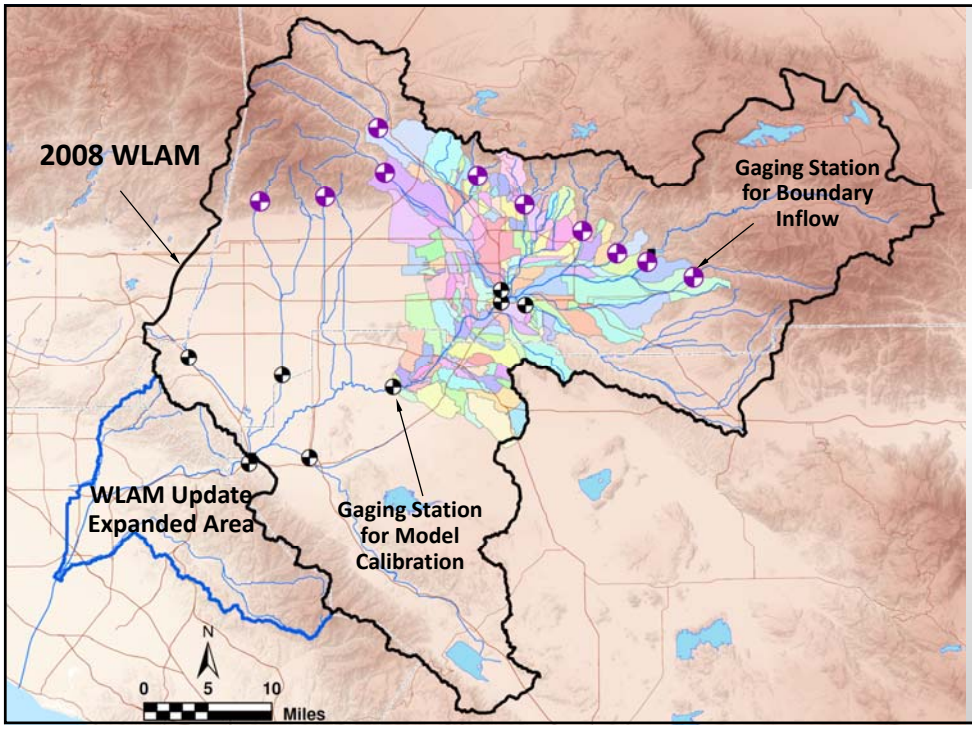
United States Environmental Protection Agency | Office of Water 4305 | EPA-823-R00-012 July 2000

EPA BASINS Technical Note 6

Estimating Hydrology and Hydraulic Parameters for HSPF

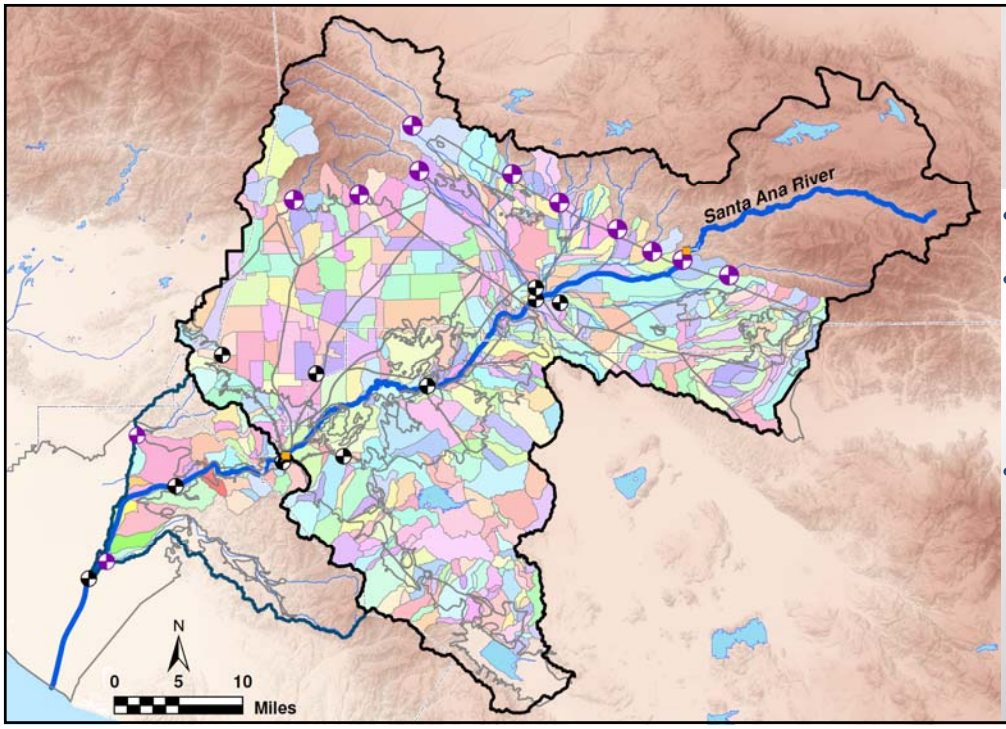
HSPF HYDROLOGY PARAMETERS AND VALUE RANGES

			RANGE OF VALUES					
NAME	DEFINITION	UNITS	TYPICAL		POSSIBLE		FUNCTION OF ...	COMMENT
			MIN	MAX	MIN	MAX		
PWAT - PARM2								
FOREST	Fraction forest cover	none	0.0	0.50	0.0	0.95	Forest cover	Only impact when SNOW is active
LZSN	Lower Zone Nominal Soil Moisture Storage	inches	3.0	8.0	2.0	15.0	Soils, climate	**Calibration**
INFILT	Index to Infiltration Capacity	in/hr	0.01	0.25	0.001	0.50	Soils, land use	**Calibration**, divides surface and subsurface flow
LSUR	Length of overland flow	feet	200	500	100	700	Topography	Estimate from high resolution topo maps or GIS
SLSUR	Slope of overland flow plane	ft/ft	0.01	0.15	0.001	0.30	Topography	Estimate from high resolution topo maps or GIS
KVARY	Variable groundwater recession	1/inches	0.0	3.0	0.0	5.0	Baseflow recession variation	Used when recession rate varies with GW levels
AGWRC	Base groundwater recession	none	0.92	0.99	0.85	0.999	Baseflow recession	**Calibration**



Initial Steps of Model Update

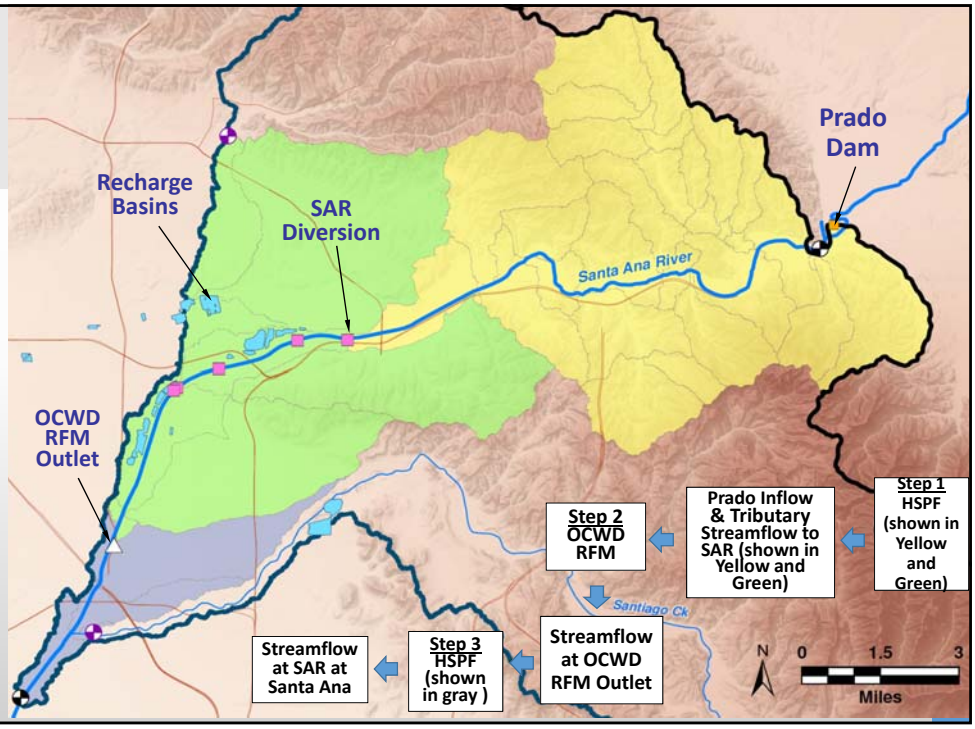
1. Compare results for the period WY 1995 to 2006
2. Update both models and compare the modeling results for the period from WY 2007 to 2016



Model Development

- 564 subareas were delineated
- Each subarea consists of
  - Stream segment,
  - Pervious land area, and
  - Impervious land area.
- They were delineated based on:
  - Topography
  - Drainage Patterns
  - Types of stream channels, and
  - Location of gaging stations and recharge basins

Coupling Process of HSPF and OCWD Recharge Facilities Model (RFM)



Status Update at the Basin Monitoring Program Task Force Meetings

- **Provide status update for Task 1 and Task 2 at six Task Force meetings:**
  - **March 22, 2017;**
  - **April 19, 2017;**
  - **May 15, 2017;**
  - **June 16, 2017;**
  - **August 16, 2017; and**
  - **September 19, 2017.**

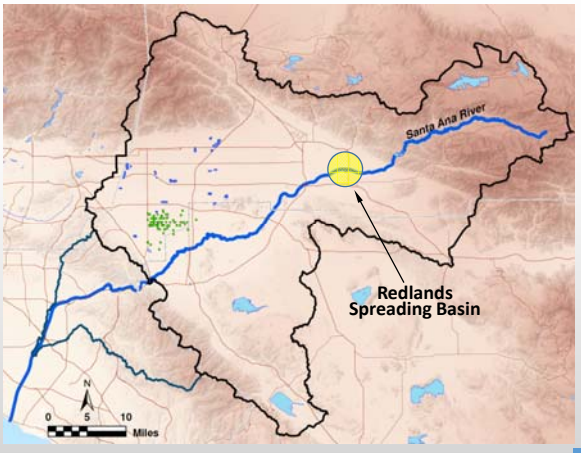
Task 3 – Evaluate Waste Load Allocation Scenarios for Major Stream Segments

- **Task 3a: Specify the range of probable conditions**
- **Task 3b: Use WLAM to analyze six scenarios**
- **Task 3c: Report the results of the WLAM scenario analysis**

Scenario	Hydrology	Land Use	Maximum Discharge (Zero Recycled)	Planned Recycled / Discharge)	50% of Planned Recycled
A	WY 1950-2016	2012	X		
B				X	
C					X
D		General Plan (2040)	X		
E				X	
F					X

Task 4 – Develop WLAM for Managed Recharge in Percolation Basins

- **Task 4a: Identify the percolation ponds and recharge basins to be evaluated**
- **Task 4b: Characterize the volume and quality of water recharged to groundwater**
- **Task 4c: Summarize the results of Task 4b by groundwater management zone**
- **Task 4d: Integrate results from Task 4c with the results from Task 3c**



Tasks 5 through 11

- Task 5: Estimate off-channel recharge from natural precipitation
- Task 6: Run the WLAM in retrospective mode, using historical discharge data, to estimate the quantity & quality of recharge that actually occurred
- Task 7: Compile the WLAM into a run-time software simulation package
- Task 8: Supplemental scenario analyses (Removed)
- Task 9: Draft task reports, draft & final report
- Task 10: Monthly project meetings
- Task 11: Pilot evaluation of the Doppler data compared to precipitation gauge data

Response to Comments on TM No. 1

Response to Comments on TM No. 1 from SAWPA

Comments on Draft TM No. 1 from SAWPA – Comment No. 1

No.	Section	Pg.	Comment	GEOSCIENCE Response
1	2	2	Please change acronym for Riverside County Flood Control and Water Conservation District to (RCFCWCD) as is their normal protocol.	Change will be made.

Comments on Draft TM No. 1 from SAWPA – Comment No. 2

No.	Section	Pg.	Comment	GEOSCIENCE Response
2	General	-	Overall, the report appears to be very brief and summarized citing the sources of data collection that are largely reflected in the original proposal and scope. We recommend additional information be added to this TM about the "process of data collection" particularly for data from the public owned treatment works. The data collection form should be included as an appendix with explanation as to why and how data will be used in the model. Concerns had been raised about some data collection associated with the recharge basins and how this will be incorporated into the new WLAM update.	Additional explanation will be added and raw data will be provided as appendices. In addition, addressing the remaining comments should satisfy this comment as well.

Comments on Draft TM No. 1 from SAWPA – Comment No. 3

No.	Section	Pg.	Comment	GEOSCIENCE Response
3	General	-	Some discussion of how data collected will be entered into the HSPF platform for later would be helpful	Additional explanation will be added.

Response to Comments on TM No. 1 from OCWD

Comments on Draft TM No. 1 from OCWD – Comment No. 1

No.	Section	Pg.	Comment	GEOSCIENCE Response
1	Figures	Figure 6	Figure 6 includes 'underground pipe' – some of these features are not part of the channel system but are imported water pipelines – it does not seem relevant to include them in Figure 6	Feature will be removed from Figure.

Response to Comments on TM No. 1 from IEUA and Chino Basin Watermaster

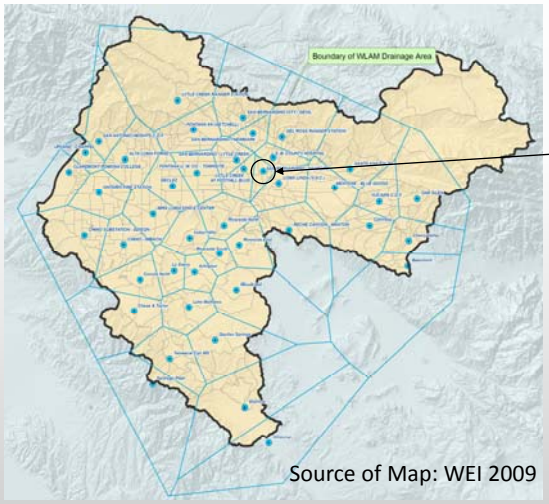
Comments on Draft TM No. 1 from IEUA and Chino Basin Watermaster – General Comment No. 1

No.	Section	Pg.	Comment	GEOSCIENCE Response
G-1	General	-	TM-1 does not provide sufficient information or details to ensure a high-level of reliability in the process (TM-1 specific comments are provided below). TM-1 was not provided to the BMP TF for review and approval prior to the development of TM-2, as prescribed in the RFP. Although this may have initially saved time, data collection and validation is essential to producing accurate modeling results.	Comment noted and is addressed through responses to comments below.

Comments on Draft TM No. 1 from IEUA and Chino Basin Watermaster – Comment No. 1

No.	Section	Pg.	Comment	GEOSCIENCE Response
1	General	-	Please provide summary tables that list the monitoring stations where data was collected, the period of record, and identify the missing and/or questionable data. The report states that the data was collected and QAQC'd. Please provide details and documentation of the process and identification of data eliminated from the analysis.	Tables will be provided as described in the response to individual comments below. In addition, further explanation regarding QA/QC will be included. In general, the QA/QC process involved plotting data, identifying extreme outliers, comparing the data with those from surrounding or nearby stations, and verifying questionable values.

Example of QA/QC Process



Source of Map: WEI 2009

Date	2287 / 2286AUTO Precipitation
12/27/2014	0.62
12/28/2014	1.85
12/29/2014	0.49
12/30/2014	1.65
12/31/2014	0.02
1/1/2015	2.01
1/2/2015	0.01
1/3/2015	0
1/4/2015	0
1/5/2015	0
1/6/2015	0
1/7/2015	3.01
1/8/2015	24.29
1/9/2015	45.76
1/10/2015	0.39
1/11/2015	0.17
1/12/2015	0.67
1/13/2015	0
1/14/2015	0
1/15/2015	0
1/16/2015	0.08
1/17/2015	0

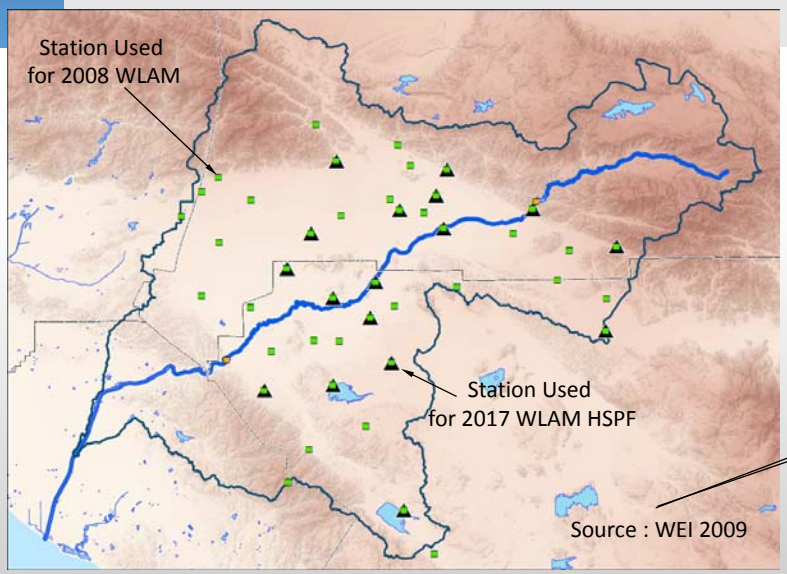
Comments on Draft TM No. 1 from IEUA and Chino Basin Watermaster – Comment No. 2

No.	Section	Pg.	Comment	GEOSCIENCE Response
2	1.1	1	Page 1, Paragraph 1. The text states that Geoscience was retained to "update, calibrate and apply the Wasteload Allocation Model (WLAM)...". It is our understanding that Geoscience was going to be developing and implementing a whole new model platform (HSPF) for the wasteload allocation analysis, not updating the old model. Please clarify.	The "update" refers to the update of modeled data (e.g., streamflow, precipitation, land use, etc.) for the recent calibration period using 2012 land use. Text will be clarified.

Comments on Draft TM No. 1 from IEUA and Chino Basin Watermaster – Comment No. 3

No.	Section	Pg.	Comment	GEOSCIENCE Response
3	2.3	3	Page 3, Section 2.3 and Figure 8. Will reducing the precipitation data coverage from 43 stations to 19 have an impact on the model results? Can you provide a table that summarizes the stations considered, including the names, data provider, the period of record available from the station, if the station was eliminated or is new, and if any data gaps exist for the calibration period of record for the final selected 19 stations. Can you show the spatial location of the 24 stations eliminated from the analysis and call out the five new stations on Figure 8? Were NEXRAD gridded precipitation estimates collected and evaluated and if not, why?	While precipitation data was collected from all 43 stations, only the 19 stations with most complete coverage were used for the model calibration. Reducing the precipitation coverage from 43 stations to 19 will not have an impact on the calibration results. A table will be added summarizing precipitation station details. A comparison of NEXRAD precipitation and the recorded precipitation used for model calibration will be performed as part of Task 11.

Precipitation Stations Used for WLAM



Station Number	Station Name	WEI (2009)		County Data	
		Start	End	Start	End
1021AUTO	Mira Loma Space Center	1943	2006	1966	2016
1026	Ontario Fire Station	1934	2006	1933	2002
2071	San Bernardino City - Devil	1928	2006	1927	2007
2159AUTO	Lytle Creek At Foothill Boulevard	1948	2006	1979	2016
2166	San Bernardino City - Newmark	1928	2006	1927	2007
2198	San Bernardino City - Lytle Creek	1927	2006	1926	2007
3014AUTO	Oak Glen	1946	2006	1945	2016
3273	Loma Linda (V.G.C.)	1893	2006	1892	2016
1079	Chino - Imbach	1929	2006	1928	1987
1085	San Antonio Heights C.D.F.	1944	2006	1943	2002
3129	Yucaipa C.D.F.	1951	2006	1950	1980
1034	Claremont Pomona College	1896	2006	1895	1989
1067	Chino Substation - Edison	1927	2006	1927	1982
1175	Alta Loma Forney	1956	2006	1955	1984
2005B	Declez	1943	2006	1977	2016
2009A	Reche Canyon - Manton	1919	2006	1918	1995
2015AUTO	Del Rosa Ranger Station	1943	2006	1957	2016
2017AUTO	Fontana 5N (Getchell)	1958	2006	1957	2016
2037AUTO	Lytle Creek Ranger Station	1958	2006	1957	2003
2146AUTO	San Bernardino County Hospital	1985	2006	1984	2016
2194	Fontana Union Water Company -	1926	2006	1925	2004
2286AUTO	San Bernardino City - Hanford	1930	2006	1974	2016
3162AUTO	Santa Ana P.H. #3	1980	2006	1979	2016
1019AAUTO	Upland - Chapel	1960	2006	1959	1993
3058	Mentone - Blue Goose	1928	2006	1927	1980
13	Beaumont	1929	2006	1940	2016
35	Chase & Taylor	1930	2006	1967	2016
67	Elsinore	1887	2006	1958	2016
75	Temescal Cyn Ws	1905	2006	1905	1999
177	Riverside East	1925	2006	1924	2009
178	Riverside North	1925	2006	1962	2016
179	Riverside South	1881	2006	1975	2016
246	Wildomar	1907	2006	2002	2016
7	Arlington	1963	2006	1962	1996
31	Calimesa	1958	2006	1957	2016
36	Cherry Valley	1956	2006	1955	2012
44	Corona North	1956	2006	1950	2001
100	La Sierra	1905	2006	1955	1996
102	Lake Mathews	1905	2006	1961	2016
202	Santiago Peak	1950	2006	1998	2003
250	Woodcrest	1956	2006	1955	2016
71	Gavilan Springs	1978	2006	1977	1997
265	Indian Hills	1956	2006	1986	2016

Comments on Draft TM No. 1 from IEUA and Chino Basin Watermaster – Comment No. 4

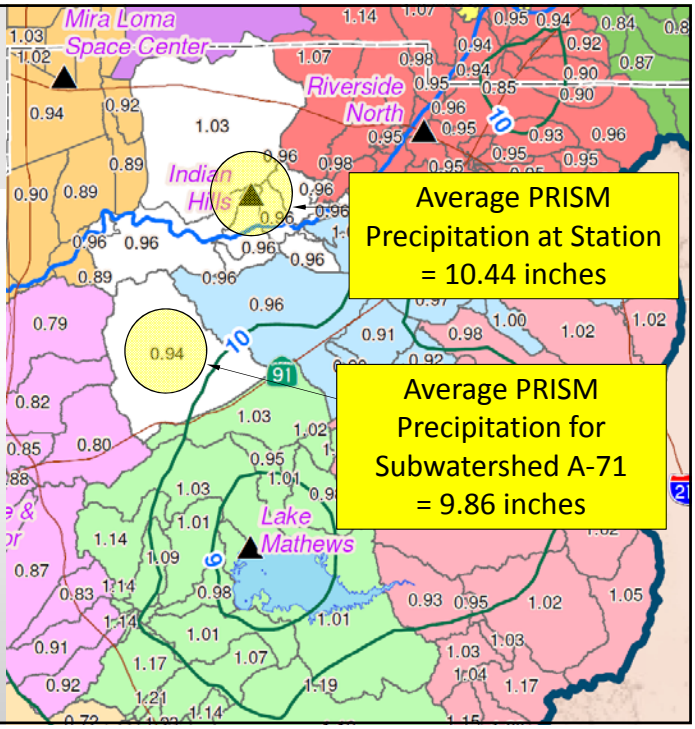
No.	Section	Pg.	Comment	GEOSCIENCE Response
4	2.3	3	Page 3, Section 2.3, Second Paragraph. Why was the PRISM data used for calculating the precipitation adjustment factors only for the period of record through 2010? This excludes the recent drought period. What is the potential impact of not extending this record through at least 2015?	The PRISM data is a 30-year average, which includes dry, wet, and average conditions. The PRISM gridded historical average annual precipitation data from 1981 through 2010 represents the most recently available data set, which was published in 2015. The precipitation adjustment factors are used to assign daily precipitation data from precipitation stations across the watershed area to the individual subwatersheds delineated in the HSPF model. This is an industry standard approach. Since actual precipitation is used as model input, wet and dry periods (including the recent drought) will be reflected.

Precipitation Adjustment Factors

Precipitation Adjustment Factor for A-71
= 9.86 in / 10.44 in = 0.94%

Example of Application of Daily Precipitation at A-71:

[1] Date	[2] Indian Hills (recorded)	[3]=[2]x0.94 A-71 (applied)
3/6/16	0.04 in	0.038 in
3/7/16	0.21 in	0.19 in
3/8/16	0.42 in	0.39 in
3/9/16	0	0
3/10/16	0	0
3/11/16	0.01 in	0.009 in
3/12/16	0.32 in	0.30 in
3/13/16	0.31 in	0.29 in
3/14/16	0	0



Comments on Draft TM No. 1 from IEUA and Chino Basin Watermaster – Comment No. 5

No.	Section	Pg.	Comment	GEOSCIENCE Response
5	2.4	3	Page 3, Section 2.4. Please provide a table that lists and summarizes the characteristics of the stormwater management facilities that reduce discharge to the Santa Ana River.	Information on stormwater management facilities will be provided.

Comments on Draft TM No. 1 from IEUA and Chino Basin Watermaster – Comment No. 6

No.	Section	Pg.	Comment	GEOSCIENCE Response
6	2.5	3	Page 3, Section 2.5. Please provide a table that summarizes the stations, including the names, data provider, the period of record available from the station, and if any data gaps exist for the calibration period of record.	Table will be provided and ET data will be included as an appendix.

Comments on Draft TM No. 1 from IEUA and Chino Basin Watermaster – Comment No. 7

No.	Section	Pg.	Comment	GEOSCIENCE Response
7	2.6	3	Page 3, Section 2.6. How was the streamflow data determined to be reliable? Can you provide a table that summarizes the stations, including the names, data provider/source, the data type (USGS gage vs. wastewater discharge point), the period of record available from the station, and if any data gaps exist for the calibration period of record? For the POTW discharges, can you please provide time-history charts for the agencies to review and QA/QC?	Table will be provided and raw data will be included in appendices.

Comments on Draft TM No. 1 from IEUA and Chino Basin Watermaster – Comment No. 8

No.	Section	Pg.	Comment	GEOSCIENCE Response
8	2.7	4	Page 4, Section 2.7. Please expand this section to clearly describe the information collected. At a minimum, a table of stations for which data was collected, including the names, data provider/source, the data type available (TIN, TDS, or both), the period of record available from the station, and the number of TIN and/or TDS observations available in the calibration period. For the POTW discharges, can you please provide time-history charts for the agencies to review and QA/QC?	Table will be provided and raw data will be included in appendices.

Comments on Draft TM No. 1 from IEUA and Chino Basin Watermaster – Comment No. 9

No.	Section	Pg.	Comment	GEOSCIENCE Response
9	3.0	4	Page 4, Section 3.0. Please expand this section to provide more information about how data was reviewed, and describe if/which data was eliminated from the analysis and why.	Additional information will be added.

Comments on Draft TM No. 1 from IEUA and Chino Basin Watermaster – Comment No. 10

No.	Section	Pg.	Comment	GEOSCIENCE Response
10			In 2010, the 2008 WLAM analysis had to be updated to include revised operating rules for Seven Oaks Dam. This memo does not describe the operating rules for Seven Oaks, San Antonio and the many stormwater recharge projects in the watershed. Please explain if this information was collected, and if, so how it will be used in the model.	Based on conversations with Valley District, the existing control manual is the underlying assumption for now. Explanation of Seven Oaks data will be added.

Comments on Draft TM No. 1 from IEUA and Chino Basin Watermaster – Comment No. 11

No.	Section	Pg.	Comment	GEOSCIENCE Response
11	Figures	Figure 1	Figure 1. It appears the figure depicts an incorrect shapefile of management zone boundaries – the layer does not include the revised Prado Basin and Chino North boundaries incorporated in a 2012 Basin Plan Amendment (R8-2012-0002).	Figure will be revised.

Response to Comments on TM No. 2

Response to Comments on TM No. 2 from SAWPA

Comments on Draft TM No. 2 from SAWPA – Comment No. 1

No.	Section	Pg.	Comment	GEOSCIENCE Response
1	1.1	1	Page 1. This TM has a significant number of acronyms associated with model components, see page 10, so it is recommended to have a list of acronyms and abbreviations. I may have missed them but many do not appear to be defined at all.	List of acronyms/abbreviations will be added.

Comments on Draft TM No. 2 from SAWPA – Comment No. 2

No.	Section	Pg.	Comment	GEOSCIENCE Response
2	1.2	2	Page 2. The last paragraph on this page needs further explanation. It is unclear from these sentences whether reference to "the model update" is referring to just the 2008 WLAM model or/and the new model using HSPF.	Reference to the various models will be clarified. The WEI model will be called the “2008 WLAM” (or “2004 WLAM”, where appropriate) and the GEOSCIENCE model will be referred to as “2017 WLAM HSPF”.

Comments on Draft TM No. 2 from SAWPA – Comment No. 3

No.	Section	Pg.	Comment	GEOSCIENCE Response
3	2.1.1	3	Page 3. Last line. Change "compressive" to "comprehensive".	Text will be corrected.

Comments on Draft TM No. 2 from SAWPA – Comment No. 4

No.	Section	Pg.	Comment	GEOSCIENCE Response
4	2.3.5	8	Page 8. 1st paragraph. It seems very odd to be using an ET station labeled "Los Angeles County Public Works (LACPW) station at Puddingstone Dam" which is outside the Santa Ana River Watershed should be used. There are multiple ET sites in the Santa Ana River Watershed that have been established by water agencies to support the development of water budgets. Please confirm accuracy of ET and whether use of more local ET stations is warranted.	The Puddingstone Dam station was the ET station used in the 2008 WLAM. In the current 2017 WLAM HSPF model, three additional ET stations were incorporated.

Comments on Draft TM No. 2 from SAWPA – Comment No. 5

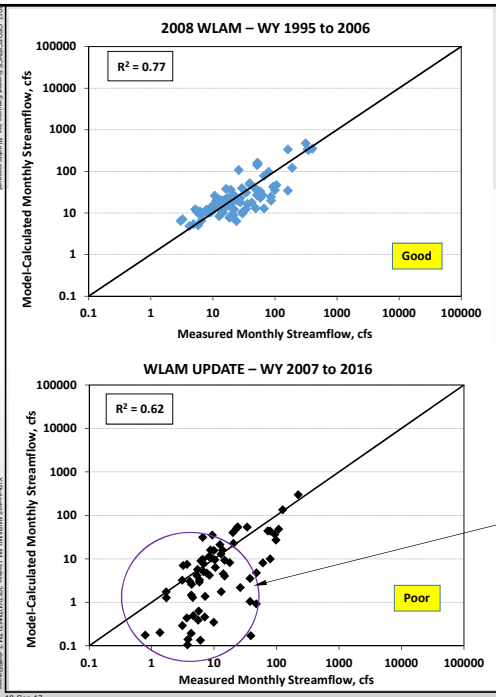
No.	Section	Pg.	Comment	GEOSCIENCE Response
5	2.3.10.1	10	Page 10. Please explain what "nitrogen reaction rate coefficients" are. Are these the same thing as nitrogen loss coefficients?	The nitrogen reaction rate coefficient is the same as the nitrogen loss coefficient. This will be clarified in the text.

Comments on Draft TM No. 2 from SAWPA – Comment No. 6

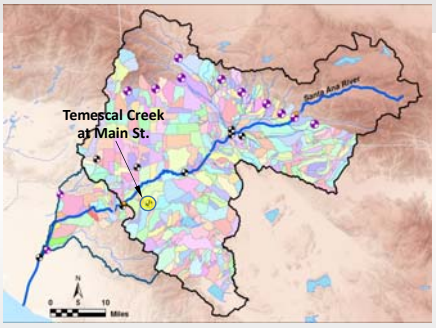
No.	Section	Pg.	Comment	GEOSCIENCE Response
6	2.3.10.2	11	Page 11. The statement that the OCWD wetlands were used to treat all the effluent of WRCWRA plant seems too simplistic and not entirely accurate. Please expound. Devoting just three sentences about the OCWD wetlands and how impacts the WLAM seems overly brief and summarized. More detail is warranted. For example, though the wetlands is effective in nitrogen removal, evaporation through the wetlands would increase the TDS concentrations. Is this negligible? Please discuss why this particular nitrogen loss mechanism is addressed by the model why other nitrogen loss uptakes such as vegetation are not.	Additional explanation will be added.

Comments on Draft TM No. 2 from SAWPA – Comment No. 7

No.	Section	Pg.	Comment	GEOSCIENCE Response
7	3	12, 15	Page 12 & 15. The first sentence states that the calibration is a trial and error process until a "reasonable" match is met between model simulation and actual flows. However, some calibration results indicate a rating of Poor with the new WLAM model. Please explain why a "Poor" R2 level is considered a "reasonable" or "satisfactory" match. Please explain.	The poor calibration for monthly streamflow at Temescal Ck at Main Street has been addressed. The poor calibration for daily streamflow at Santa Ana River at Santa Ana is a product of the modeling process. Flow at this location is largely from the OCWD recharge facilities model, which simulated Prado Dam operations. Actual releases from Prado may be different, which causes a discrepancy between the modeled and observed streamflow at this location. Additional explanation to this effect will be added.



Draft TM 2 Figure 46

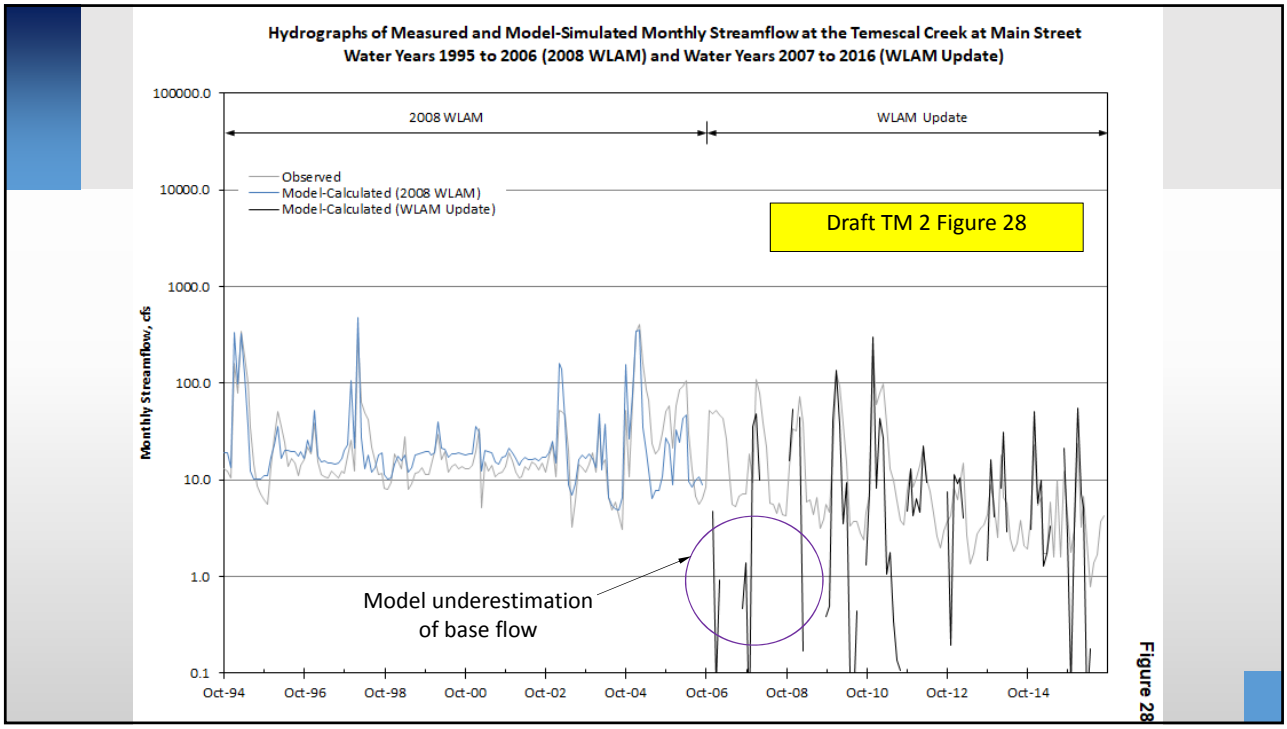


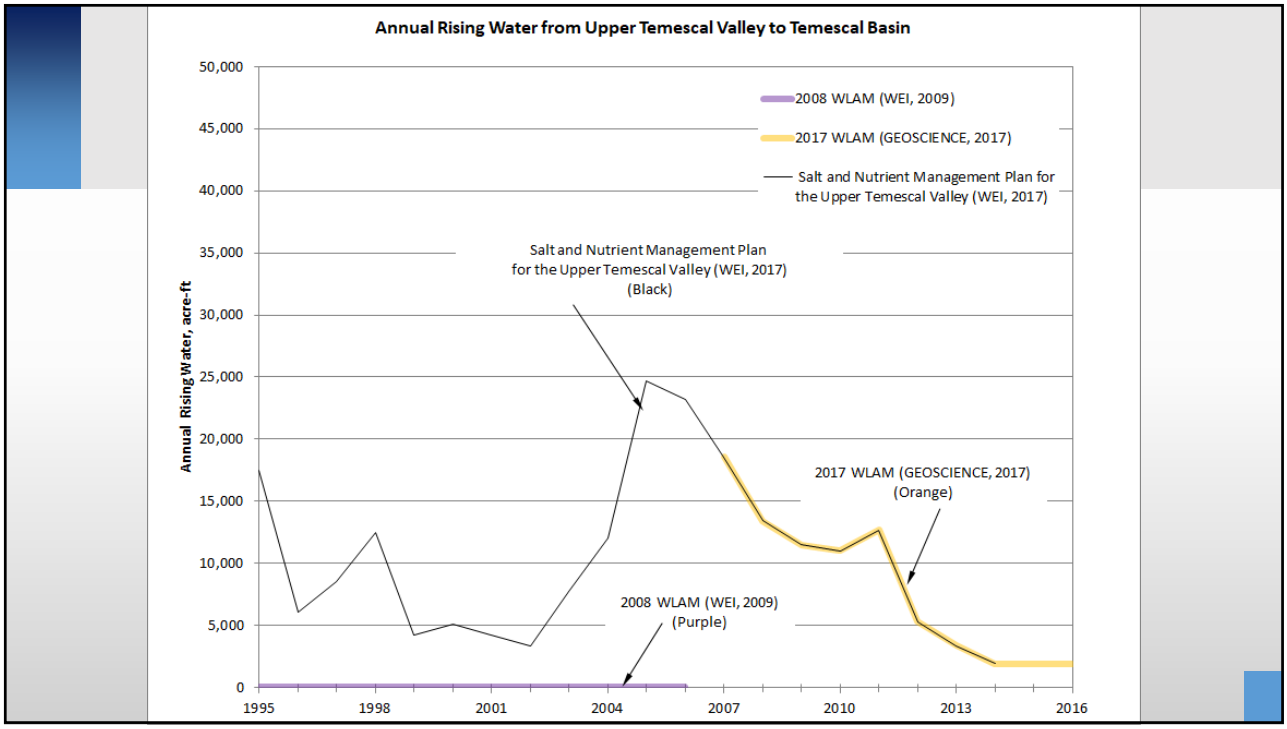
Model underestimation of base flow with poor calibration performance

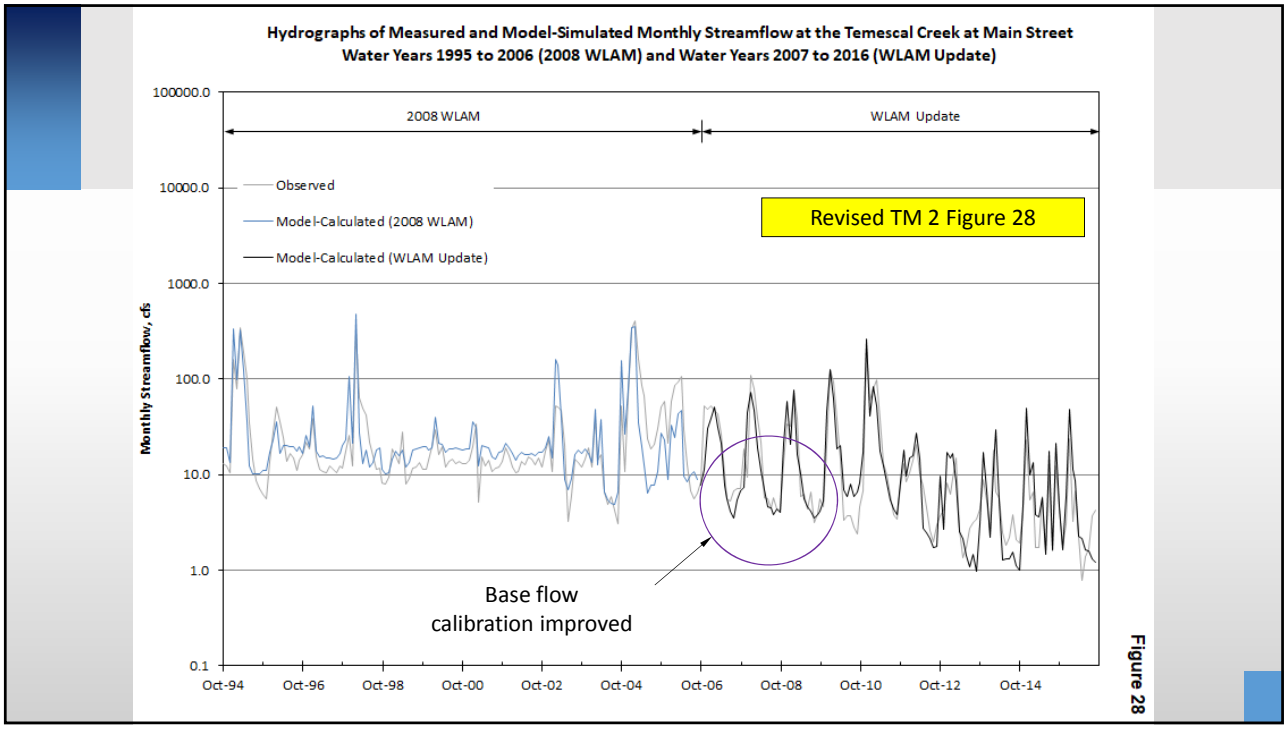
SCATTERPLOTS OF MEASURED AND MODEL-SIMULATED MONTHLY STREAMFLOW AT THE TEMESCAL CREEK AT MAIN STREET WATER YEARS 1995 TO 2006 (2008 WLAM) AND WATER YEARS 2007 TO 2016 (WLAM UPDATE)

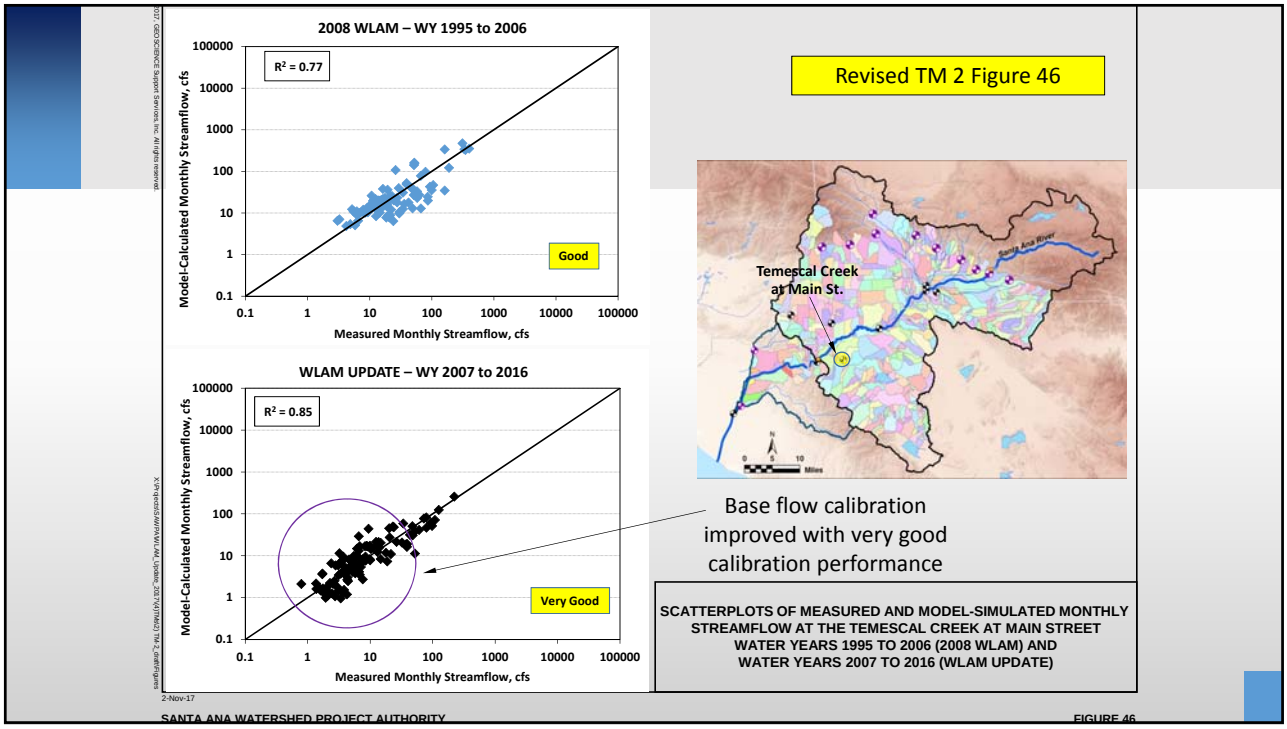
SANTA ANA WATERSHED PROJECT AUTHORITY

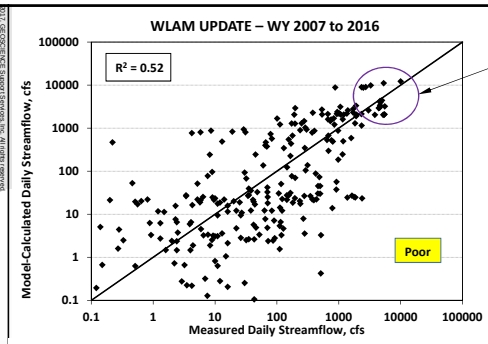
FIGURE 46


Hydrographs of Measured and Model-Simulated Monthly Streamflow at the Temescal Creek at Main Street
Water Years 1995 to 2006 (2008 WLAM) and Water Years 2007 to 2016 (WLAM Update)
2008 WLAM
WLAM Update
Observed
Model-Calculated (2008 WLAM)
Model-Calculated (WLAM Update)
Draft TM 2 Figure 28
Monthly Streamflow, cfs
100000.0
10000.0
1000.0
100.0
10.0
1.0
0.1
Model underestimation of base flow
Oct-94
Oct-96
Oct-98
Oct-00
Oct-02
Oct-04
Oct-06
Oct-08
Oct-10
Oct-12
Oct-14
Figure 28

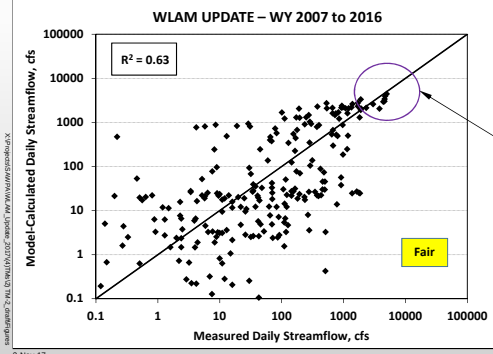

Annual Rising Water from Upper Temescal Valley to Temescal Basin
2008 WLAM (WEI, 2009)
2017 WLAM (GEOSCIENCE, 2017)
Salt and Nutrient Management Plan for the Upper Temescal Valley (WEI, 2017)
Salt and Nutrient Management Plan for the Upper Temescal Valley (WEI, 2017) (Black)
2017 WLAM (GEOSCIENCE, 2017) (Orange)
2008 WLAM (WEI, 2009) (Purple)
Annual Rising Water, acre-ft
50,000
45,000
40,000
35,000
30,000
25,000
20,000
15,000
10,000
5,000
0
1995
1998
2001
2004
2007
2010
2013
2016

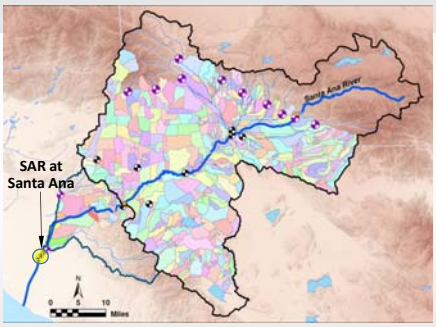

Hydrographs of Measured and Model-Simulated Monthly Streamflow at the Temescal Creek at Main Street
Water Years 1995 to 2006 (2008 WLAM) and Water Years 2007 to 2016 (WLAM Update)
2008 WLAM
WLAM Update
Observed
Model-Calculated (2008 WLAM)
Model-Calculated (WLAM Update)
Revised TM 2 Figure 28
Monthly Streamflow, cfs
100000.0
10000.0
1000.0
100.0
10.0
1.0
0.1
Oct-94
Oct-96
Oct-98
Oct-00
Oct-02
Oct-04
Oct-06
Oct-08
Oct-10
Oct-12
Oct-14
Base flow
calibration improved
Figure 28


2008 WLAM – WY 1995 to 2006
R² = 0.77
Good
Model-Calculated Monthly Streamflow, cfs
Measured Monthly Streamflow, cfs
WLAM UPDATE – WY 2007 to 2016
R² = 0.85
Very Good
Model-Calculated Monthly Streamflow, cfs
Measured Monthly Streamflow, cfs
Revised TM 2 Figure 46
Temescal Creek
at Main St.
Santa Ana River
Base flow calibration
improved with very good
calibration performance
SCATTERPLOTS OF MEASURED AND MODEL-SIMULATED MONTHLY
STREAMFLOW AT THE TEMESCAL CREEK AT MAIN STREET
WATER YEARS 1995 TO 2006 (2008 WLAM) AND
WATER YEARS 2007 TO 2016 (WLAM UPDATE)
2-Nov-17
SANTA ANA WATERSHED PROJECT AUTHORITY
FIGURE 46



Model overestimates flow in December 2010 and underestimates flow in January 2011





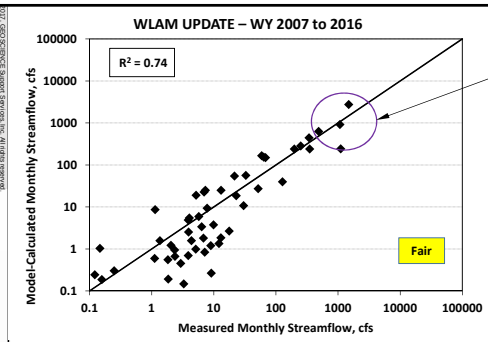
Calibration improved after data between December 19, 2010 and January 11, 2011 were removed

SCATTERPLOTS OF MEASURED AND MODEL-SIMULATED DAILY STREAMFLOW AT THE SANTA ANA RIVER AT SANTA ANA WATER YEARS 2007 TO 2016 (WLAM UPDATE)

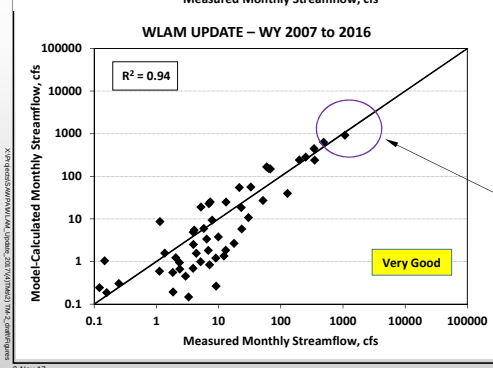
2-Nov-17

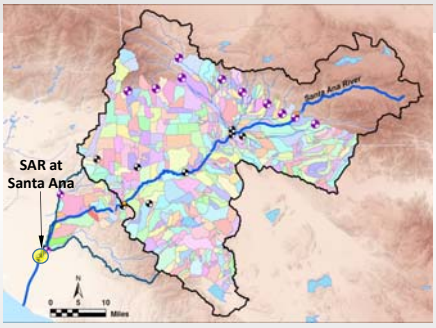
SANTA ANA WATERSHED PROJECT AUTHORITY

FIGURE 50



Model overestimates flow in December 2010 and underestimates flow in January 2011





Calibration improved after data between December 19, 2010 and January 12, 2011 were removed

SCATTERPLOTS OF MEASURED AND MODEL-SIMULATED MONTHLY STREAMFLOW AT THE SANTA ANA RIVER AT SANTA ANA WATER YEARS 2007 TO 2016 (WLAM UPDATE)

2-Nov-17

SANTA ANA WATERSHED PROJECT AUTHORITY

FIGURE 50

Response to Comments on TM No. 2 from RWQCB

Comments on Draft TM No. 2 from RWQCB – Comment No. 1

No.	Section	Pg.	Comment	GEOSCIENCE Response
1	2.3.10.2	11	Add reference for TIN in effluent from OCWD wetlands.	Reference will be added.

Comments on Draft TM No. 2 from RWQCB – Comment No. 2

No.	Section	Pg.	Comment	GEOSCIENCE Response
2	3.1	12	Add the degree of accuracy for streamflow data for each gaging station used for model calibration.	Additional information will be added.

Degree of Accuracy for Streamflow Data

Station Name	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
San Timoteo Creek near Loma Linda	Poor	Poor	Fair	Poor	Poor	Poor	Poor	Fair	Fair	Fair
Santa Ana River at E Street	Poor	Poor	Poor	Poor	Poor	Poor	Poor	Poor	Poor	Poor
Santa Ana River at MWD Crossing	Good - Fair	Fair - Poor	Fair - Poor	Fair - Poor	Poor	Poor	Poor	Poor	Poor	Poor
Temescal Creek at Main Street	Fair - Poor	Fair - Poor	Fair - Poor	Fair - Poor	Fair - Poor	Fair - Poor	Fair - Poor	Fair - Poor	Fair - Poor	Fair - Poor
Chino Creek at Schaefer Avenue	Fair - Poor	Fair - Poor	Fair	Fair	Good	Good	Good	Good - Fair	Good - Fair	Good - Fair
Cucamonga Creek near Mira Loma	Fair	Poor	Poor	Fair - Poor	Fair - Poor	Fair - Poor	Fair - Poor	Fair - Poor	Fair - Poor	Fair - Poor
Santa Ana River Below Prado Dam	Fair - Poor	Fair - Poor	Good - Poor	Good	Fair	Fair	Fair	Good	Good	Good
Warm Creek near San Bernardino	Fair - Poor	Good - Poor	Good	Good - Poor	Good - Poor	Good	Fair - Poor	Good - Poor	Good - Poor	Good - Poor
Santa Ana River at Santa Ana	Fair	Fair	Poor	Fair	Poor	Poor	Poor	Poor	Poor	Poor

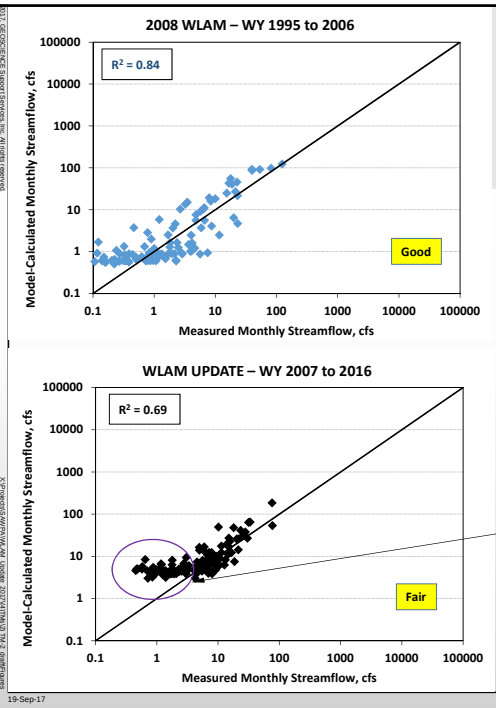
"Good" indicates that about 95 percent of the daily discharges are within 10 percent of the true value;
"Fair" indicates that about 95 percent of the daily discharges are within 15 percent of the true value;
"Poor" indicates that daily discharges have less than "fair" accuracy.

Comments on Draft TM No. 2 from RWQCB – Comment No. 3

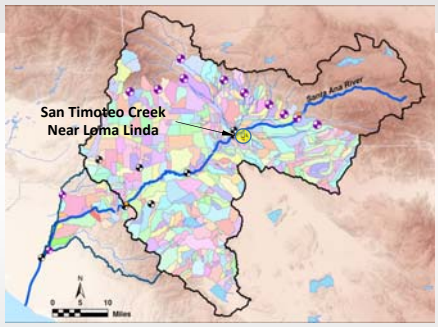
No.	Section	Pg.	Comment	GEOSCIENCE Response
3	3.1	12	Provide explanation on why only three gaging stations were used for the TDS/TIN calibration.	The 2008 WLAM used the gaging stations at Santa Ana River at MWD Crossing and Santa Ana River below Prado Dam for the TDS/TIN calibration, due to data availability. These same stations were utilized in the 2017 WLAM HSPF version, but an additional gage was added (Santa Ana River at Imperial Highway near Anaheim) due to the extension of the model into Orange County.

Comments on Draft TM No. 2 from RWQCB – Comment No. 4

No.	Section	Pg.	Comment	GEOSCIENCE Response
4	3.3	15	Provide an explanation for the reduction in model performance between the 2008 WLAM (R4) and the WLAM Update (HSPF) seen at the San Timoteo Creek near Loma Linda and Temescal Creek at Main Street gaging stations.	Model will be refined to improve model calibration.



Draft TM 2 Figure 42



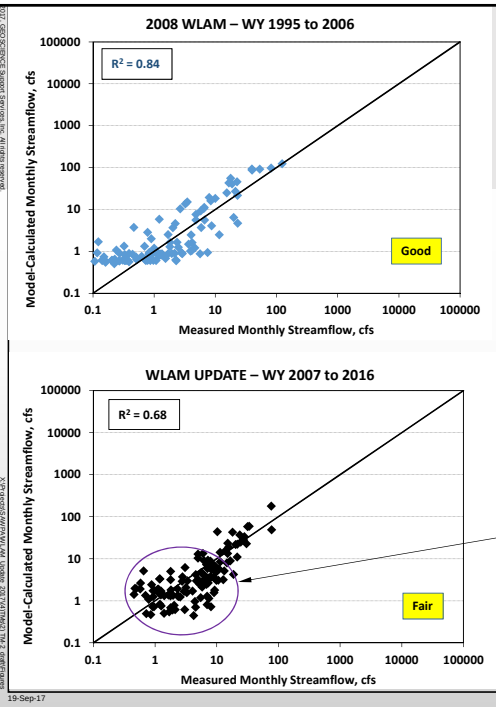
Model overestimates streamflow

SCATTERPLOTS OF MEASURED AND MODEL-SIMULATED MONTHLY STREAMFLOW AT THE SAN TEMOTEO CREEK NEAR LOMA LINDA
WATER YEARS 1995 TO 2006 (2008 WLAM) AND
WATER YEARS 2007 TO 2016 (WLAM UPDATE)

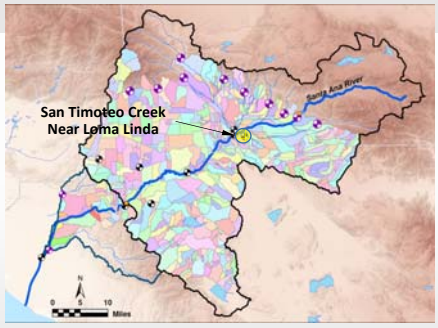
19-Sep-17

SANTA ANA WATERSHED PROJECT AUTHORITY

FIGURE 42



Revised TM 2 Figure 42



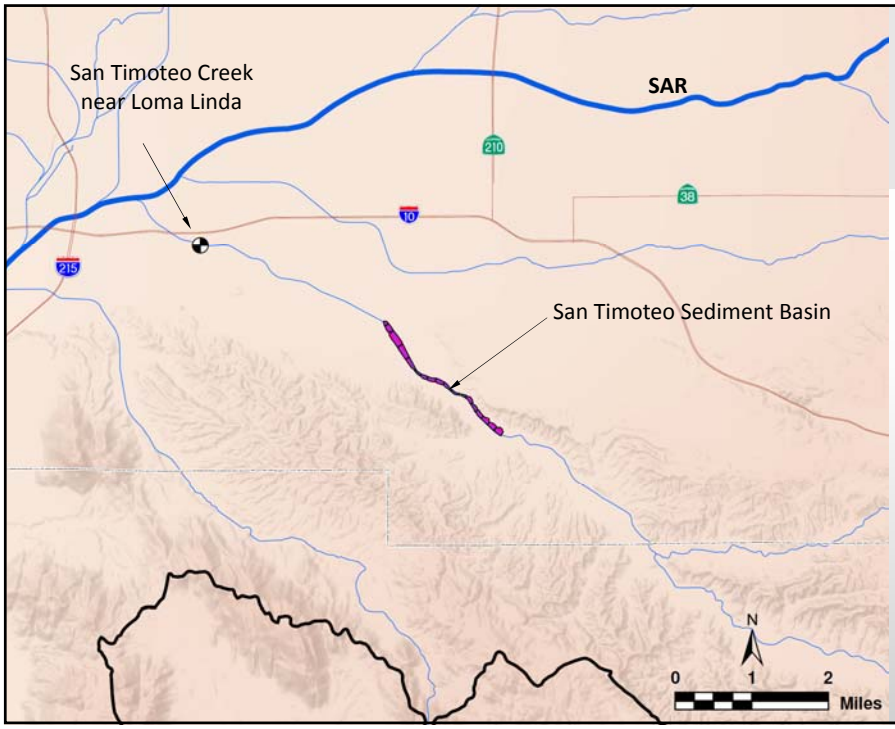
Baseflow calibration improved slightly. However, R^2 was not improved

SCATTERPLOTS OF MEASURED AND MODEL-SIMULATED MONTHLY STREAMFLOW AT THE SAN TEMOTEO CREEK NEAR LOMA LINDA
WATER YEARS 1995 TO 2006 (2008 WLAM) AND
WATER YEARS 2007 TO 2016 (WLAM UPDATE)

19-Sep-17

SANTA ANA WATERSHED PROJECT AUTHORITY

FIGURE 42



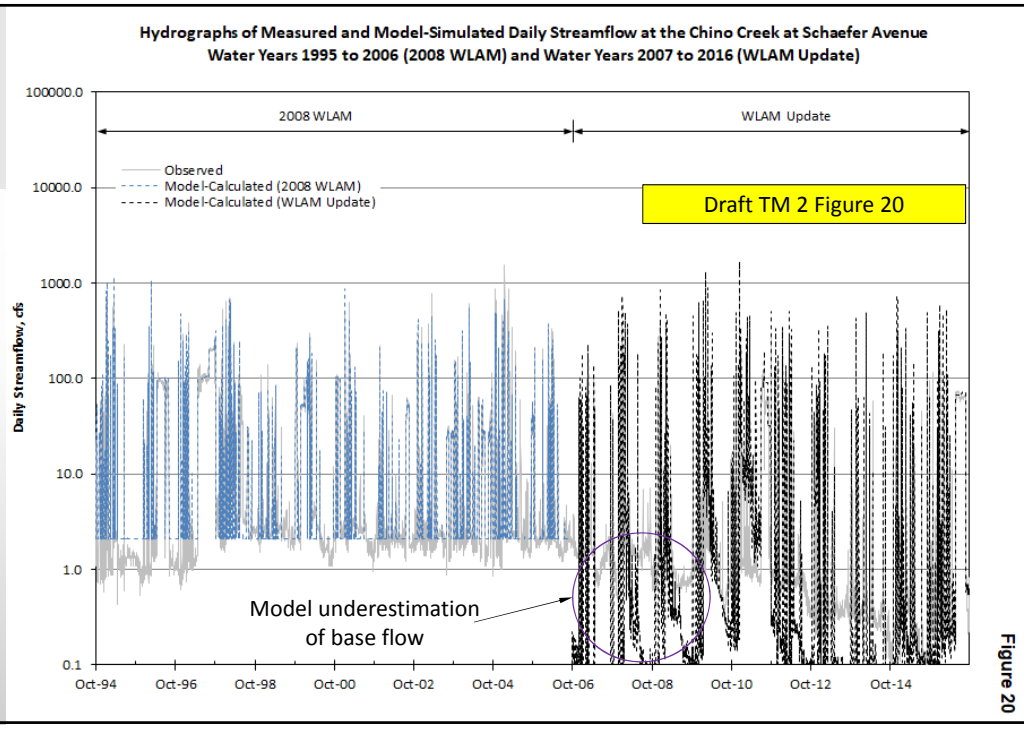
San Timoteo Sediment Basin

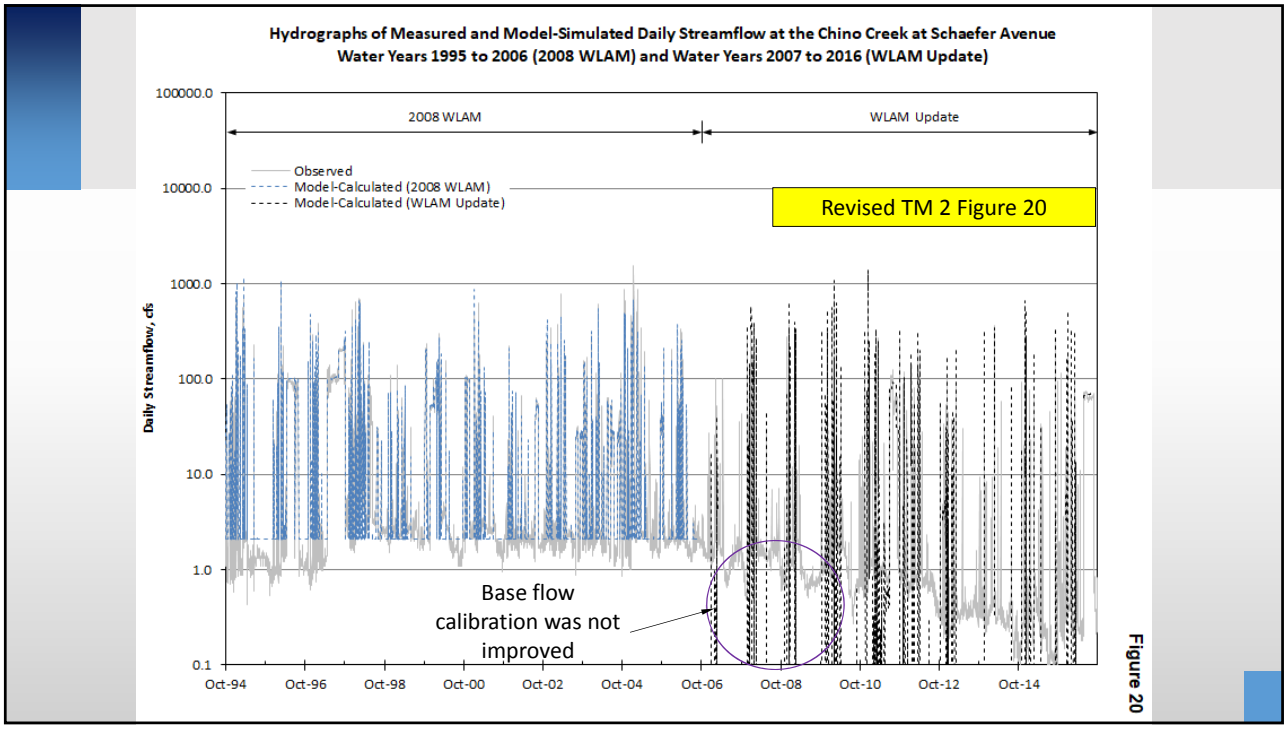
Comments on Draft TM No. 2 from RWQCB – Comment No. 5

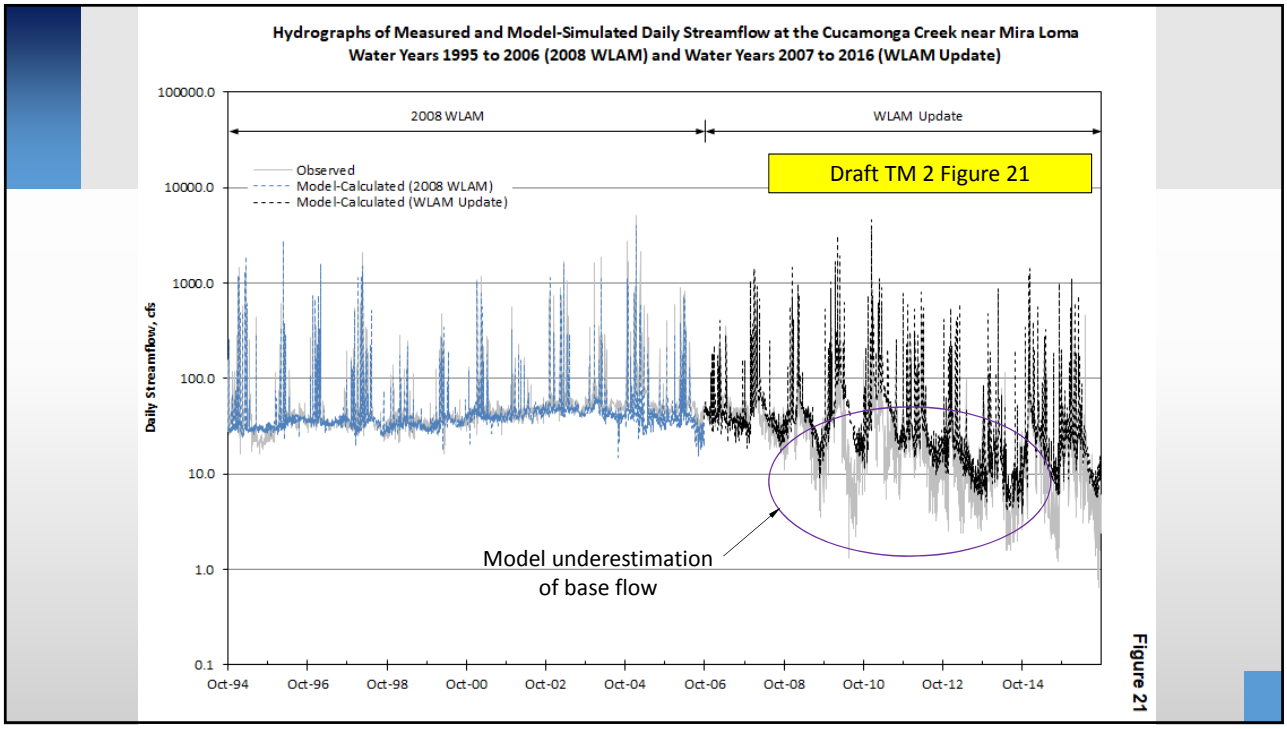
No.	Section	Pg.	Comment	GEOSCIENCE Response
5	3.3	15	Provide an explanation for the poor model performance at the Santa Ana River at Santa Ana gaging station.	The 2008 WLAM used the gaging stations at Santa Ana River at MWD Crossing and Santa Ana River below Prado Dam for the TDS/TIN calibration, due to data availability. These same stations were utilized in the 2017 WLAM HSPF version, but an additional gage was added (Santa Ana River at Imperial Highway near Anaheim) due to the extension of the model into Orange County.

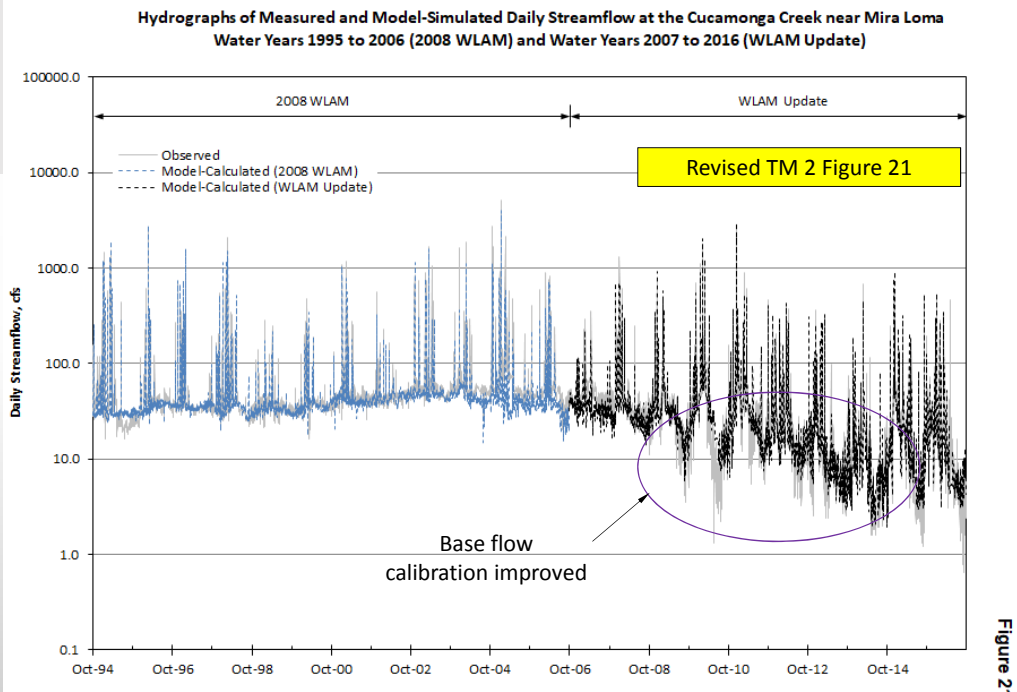
Comments on Draft TM No. 2 from RWQCB – Comment No. 6

No.	Section	Pg.	Comment	GEOSCIENCE Response
6	General	-	Revisit areas where the model is over/underestimating streamflow and may need improvement (e.g., Figures 20, 21, 24, and 28).	Underperforming areas will be revisited.



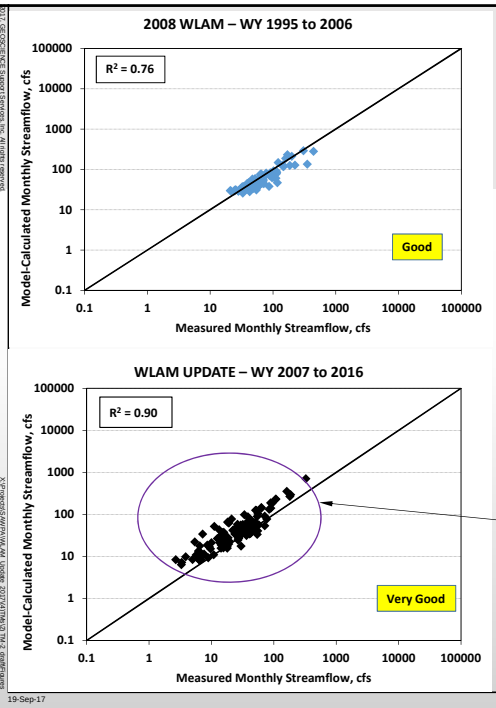

Hydrographs of Measured and Model-Simulated Daily Streamflow at the Chino Creek at Schaefer Avenue
Water Years 1995 to 2006 (2008 WLAM) and Water Years 2007 to 2016 (WLAM Update)
2008 WLAM
WLAM Update
Observed
Model-Calculated (2008 WLAM)
Model-Calculated (WLAM Update)
Revised TM 2 Figure 20
Daily Streamflow, cfs
100000.0
10000.0
1000.0
100.0
10.0
1.0
0.1
Oct-94
Oct-96
Oct-98
Oct-00
Oct-02
Oct-04
Oct-06
Oct-08
Oct-10
Oct-12
Oct-14
Base flow calibration was not improved
Figure 20


Hydrographs of Measured and Model-Simulated Daily Streamflow at the Cucamonga Creek near Mira Loma
Water Years 1995 to 2006 (2008 WLAM) and Water Years 2007 to 2016 (WLAM Update)
2008 WLAM
WLAM Update
Observed
Model-Calculated (2008 WLAM)
Model-Calculated (WLAM Update)
Draft TM 2 Figure 21
Daily Streamflow, cfs
100000.0
10000.0
1000.0
100.0
10.0
1.0
0.1
Oct-94
Oct-96
Oct-98
Oct-00
Oct-02
Oct-04
Oct-06
Oct-08
Oct-10
Oct-12
Oct-14
Model underestimation of base flow
Figure 21

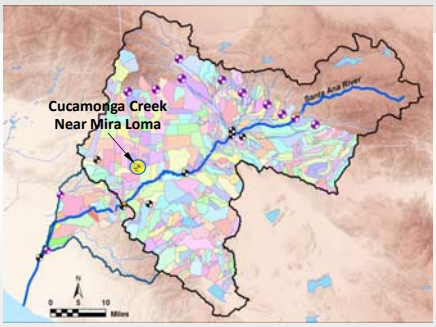


Comments on Draft TM No. 2 from RWQCB – Comment No. 7

No.	Section	Pg.	Comment	GEOSCIENCE Response
7	Figures	Figure 48	According to the scatter plot shown on Figure 48, the model appears to consistently overestimate streamflow. Please address.	Overestimation was addressed.



Draft TM 2 Figure 48



Model overestimates streamflow consistently

SCATTERPLOTS OF MEASURED AND MODEL-SIMULATED MONTHLY STREAMFLOW AT THE CUCAMONGA CREEK NEAR MIRA LOMA WATER YEARS 1995 TO 2006 (2008 WLAM) AND WATER YEARS 2007 TO 2016 (WLAM UPDATE)

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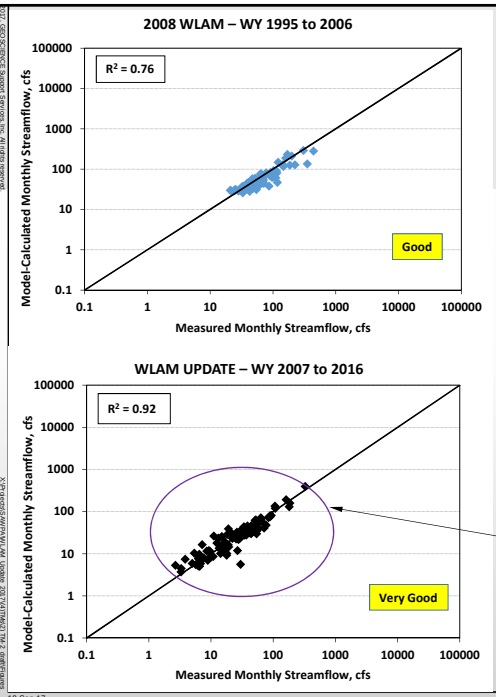
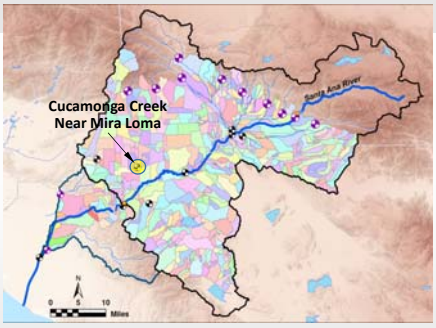
FIGURE 48



Revised TM 2 Figure 48



Overestimation of streamflow improved

SCATTERPLOTS OF MEASURED AND MODEL-SIMULATED MONTHLY STREAMFLOW AT THE CUCAMONGA CREEK NEAR MIRA LOMA WATER YEARS 1995 TO 2006 (2008 WLAM) AND WATER YEARS 2007 TO 2016 (WLAM UPDATE)

19-Sep-17

SANTA ANA WATERSHED PROJECT AUTHORITY

FIGURE 48

Response to Comments on TM No. 2 from OCWD

Comments on Draft TM No. 2 from OCWD – Comment No. 1

No.	Section	Pg.	Comment	GEOSCIENCE Response
1	2.2	4	Section 2.2, Watershed Model Development – it is not clear if the stormwater runoff in the green shaded area in Figure 5 is accounted for in the model. The green shaded area includes flow that would be conveyed to the SAR through the Carbon Diversion Channel, Fletcher Channel, and some other small tributaries to the SAR that are located between OCWD's Imperial Highway inflatable dam and Santiago Creek. OCWD's Recharge Facilities Model does not simulate runoff in the green shaded area. Please provide more discussion of the modeling of stormwater runoff in the green shaded area in Figure 5.	The area shaded in green is accounted for in the model. Explanation will be added.

Comments on Draft TM No. 2 from OCWD – Comment No. 2

No.	Section	Pg.	Comment	GEOSCIENCE Response
2	Figures	Figure 2	For Figure 5, please add a legend for the symbols	Legend will be added.

Comments on Draft TM No. 2 from OCWD – Comment No. 3

No.	Section	Pg.	Comment	GEOSCIENCE Response
3	2.3.8	9	Section 2.3.8, Wastewater Discharge – add a table showing the wastewater discharge for each facility per year	Discharge data will be provided as an appendix.

Comments on Draft TM No. 2 from OCWD – Comment No. 4

No.	Section	Pg.	Comment	GEOSCIENCE Response
4	2.3.8	9	Section 2.3.8, Wastewater Discharge – is there no discharge by Eastern MWD at their discharge point to Temescal Creek?	Non-tributary discharge from Eastern Municipal Water District and OC-59 will be added to the text.

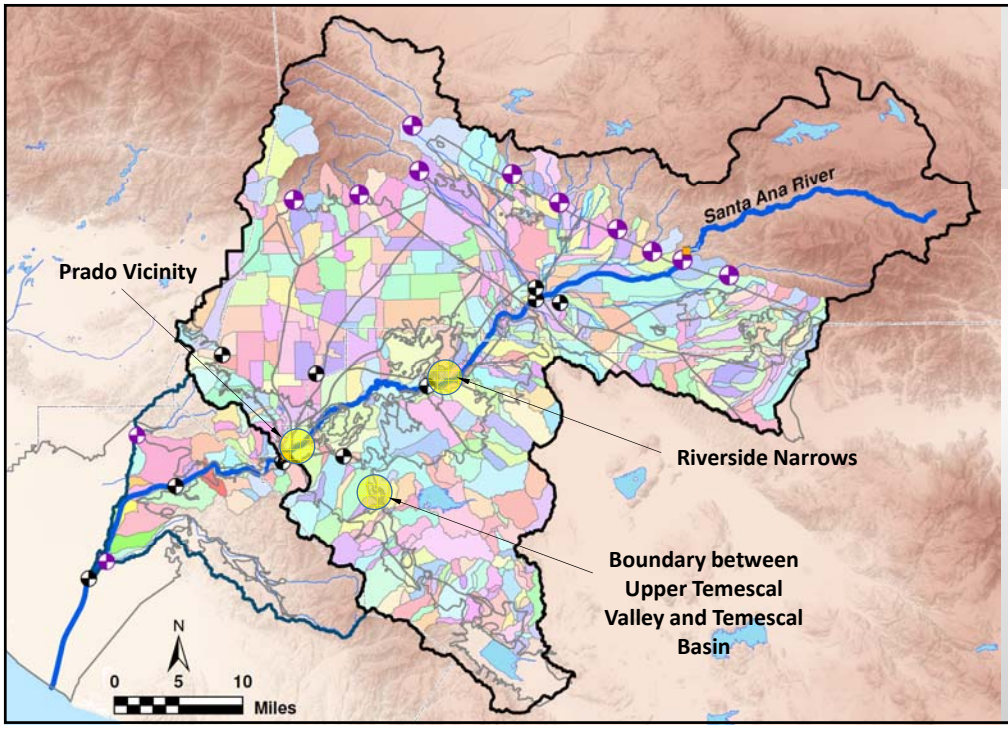
Comments on Draft TM No. 2 from OCWD – Comment No. 5

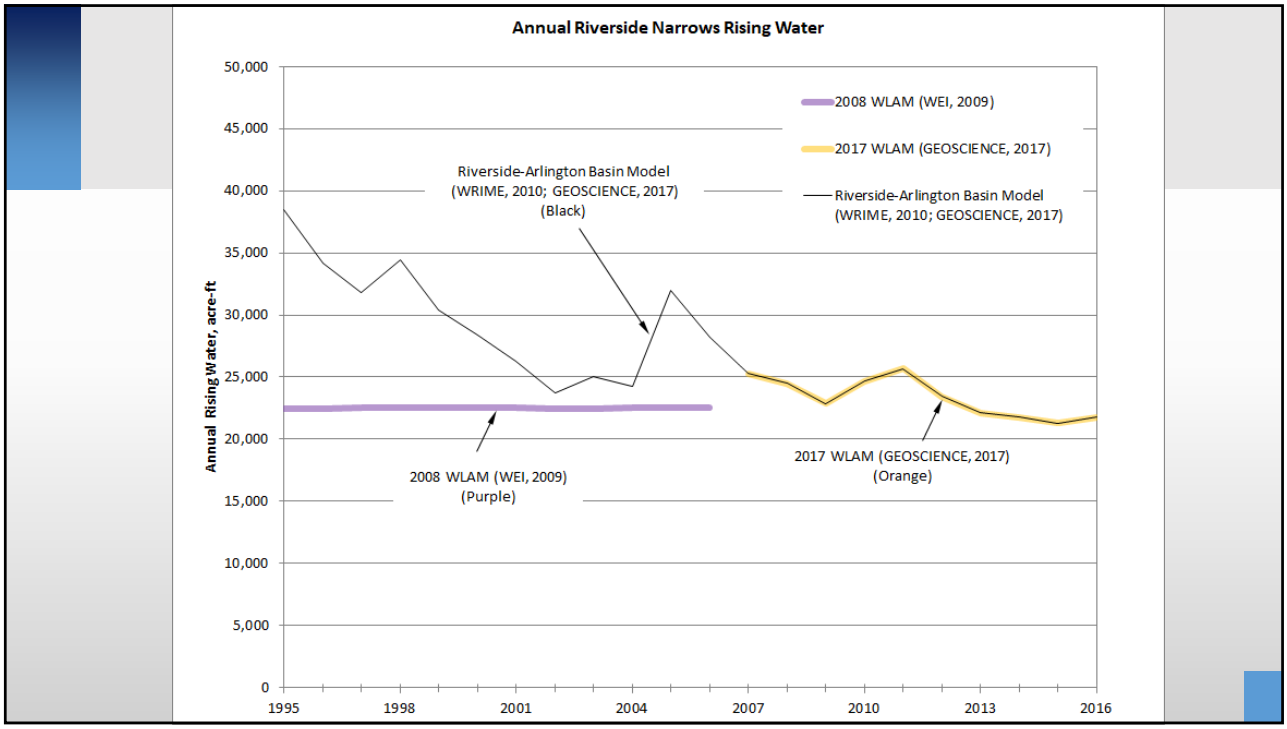
No.	Section	Pg.	Comment	GEOSCIENCE Response
5	General	-	A water budget summary table should be included – among other items, the table should list total runoff, total wastewater discharge, total unmanaged streambed infiltration, total managed infiltration (such as OCWD managed infiltration, and other agencies if it can be accounted for), total evapotranspiration, rising groundwater at Riverside Narrows, rising groundwater in Prado Basin, and total outflow at the downstream model boundary; the table should list the above terms by year; the table should be used to demonstrate that all the water in the system is accounted for from a mass balance perspective on an annual basis.	A water budget table will be added.

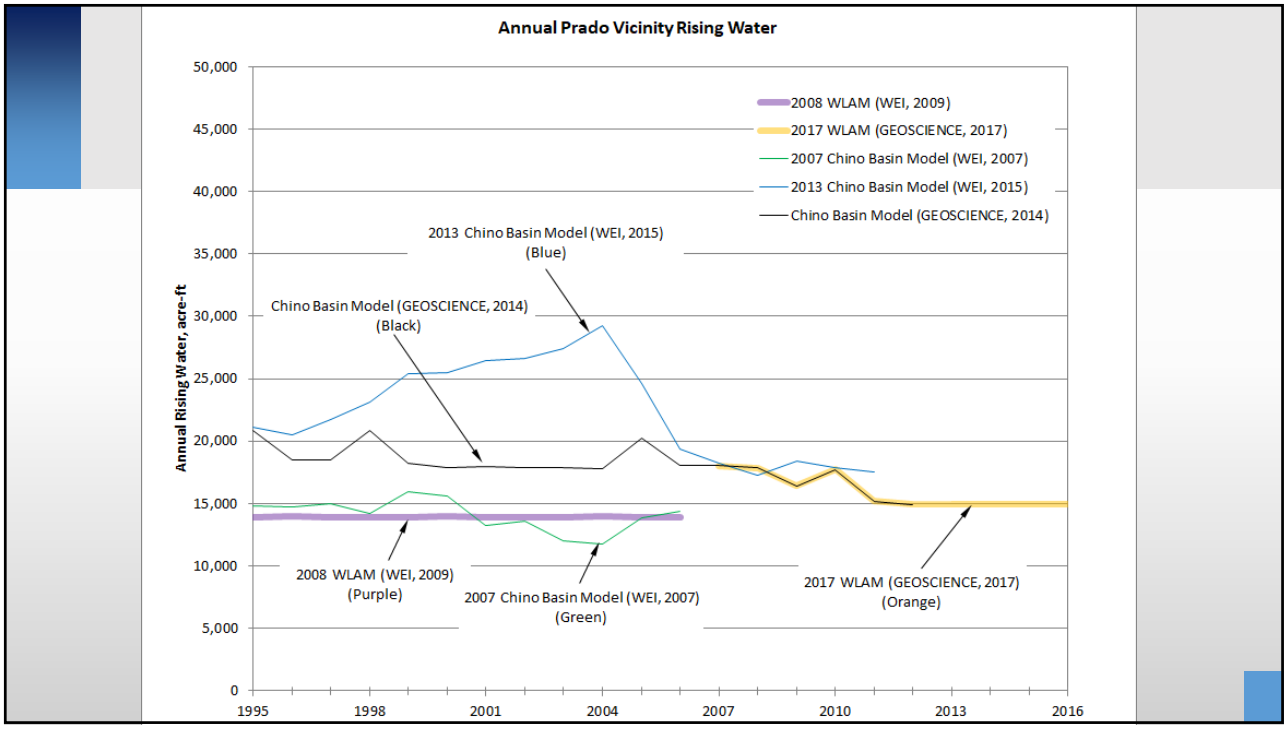
Comments on Draft TM No. 2 from OCWD – Comment No. 6

No.	Section	Pg.	Comment	GEOSCIENCE Response
6	2.3.9	10	Section 2.3.9, Rising Groundwater – text should be added to describing how the rising groundwater rate was estimated at the two locations; reference is made in the text to Figure 10, but it is not clear from Figure 10 where the rising groundwater is specified; please include additional features on Figure 10 to specify where rising groundwater is defined in the model;	Explanation will be added.

Location of Rising Water




Annual Riverside Narrows Rising Water
Annual Rising Water, acre-ft
50,000
45,000
40,000
35,000
30,000
25,000
20,000
15,000
10,000
5,000
0
1995
1998
2001
2004
2007
2010
2013
2016
2008 WLAM (WEI, 2009)
2017 WLAM (GEOSCIENCE, 2017)
Riverside-Arlington Basin Model (WRIME, 2010; GEOSCIENCE, 2017)
Riverside-Arlington Basin Model (WRIME, 2010; GEOSCIENCE, 2017) (Black)
2008 WLAM (WEI, 2009) (Purple)
2017 WLAM (GEOSCIENCE, 2017) (Orange)


Annual Prado Vicinity Rising Water
Annual Rising Water, acre-ft
50,000
45,000
40,000
35,000
30,000
25,000
20,000
15,000
10,000
5,000
0
1995
1998
2001
2004
2007
2010
2013
2016
2008 WLAM (WEI, 2009)
2017 WLAM (GEOSCIENCE, 2017)
2007 Chino Basin Model (WEI, 2007)
2013 Chino Basin Model (WEI, 2015)
Chino Basin Model (GEOSCIENCE, 2014)
2013 Chino Basin Model (WEI, 2015) (Blue)
Chino Basin Model (GEOSCIENCE, 2014) (Black)
2008 WLAM (WEI, 2009) (Purple)
2007 Chino Basin Model (WEI, 2007) (Green)
2017 WLAM (GEOSCIENCE, 2017) (Orange)

TDS and TIN Concentrations for Rising Water

Rising Water Area	2008 WLAM WY 1995-2006		2017 WLAM HSPF WY 2007-2016	
	TDS Concentration	TIN Concentration	TDS Concentration	TIN Concentration
	mg/L	mg/L	mg/L	mg/L
Riverside Narrows	900	11	790	10
Prado Vicinity	1,100	11	1,160	7
Upper Temescal Valley to Temescal Basin	NA	NA	770	6

Comments on Draft TM No. 2 from OCWD – Comment No. 7

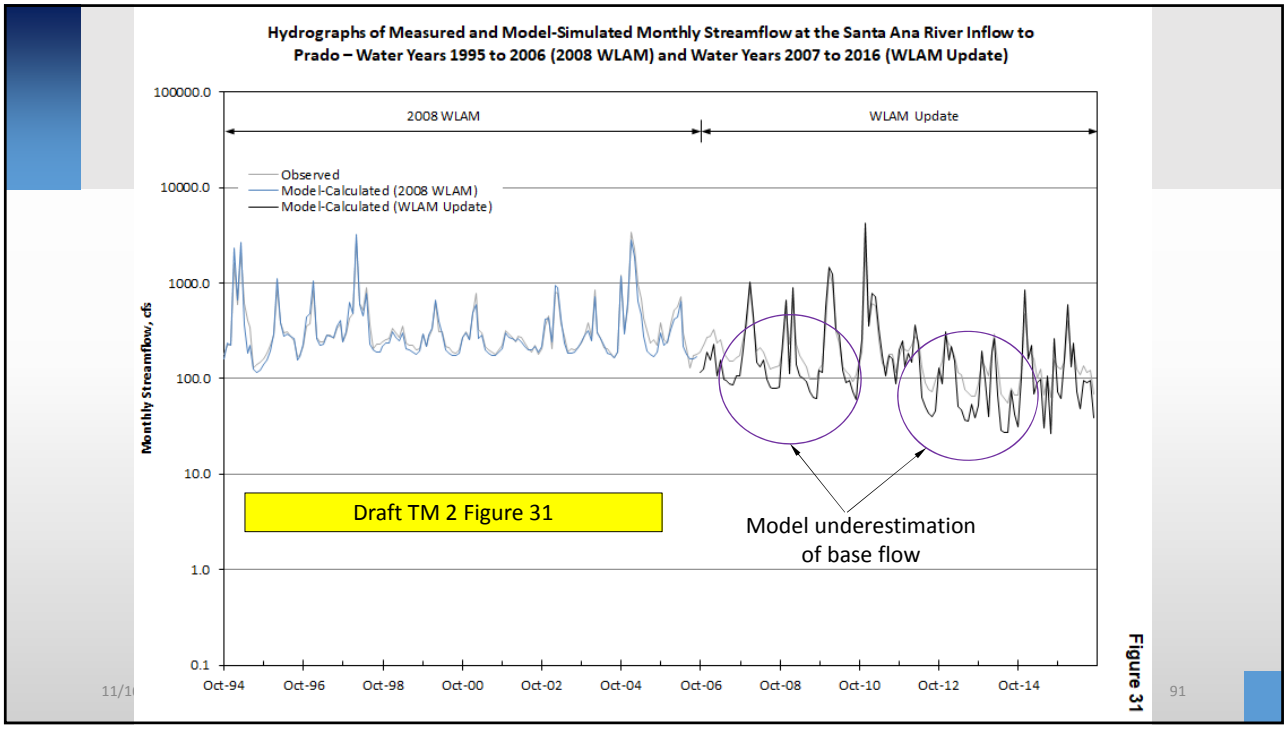
No.	Section	Pg.	Comment	GEOSCIENCE Response
7	2.3.10.2	10	Section 2.3.10.2, OCWD Wetlands – the TIN of effluent from the OCWD Prado Wetlands should be varied seasonally – the winter time nitrate removal rate is lower than the summer time removal rate. For May-October, a TIN effluent of 1 mg/L is appropriate; for November-April, 4 mg/L is appropriate.	Model will be revised to incorporate this comment.

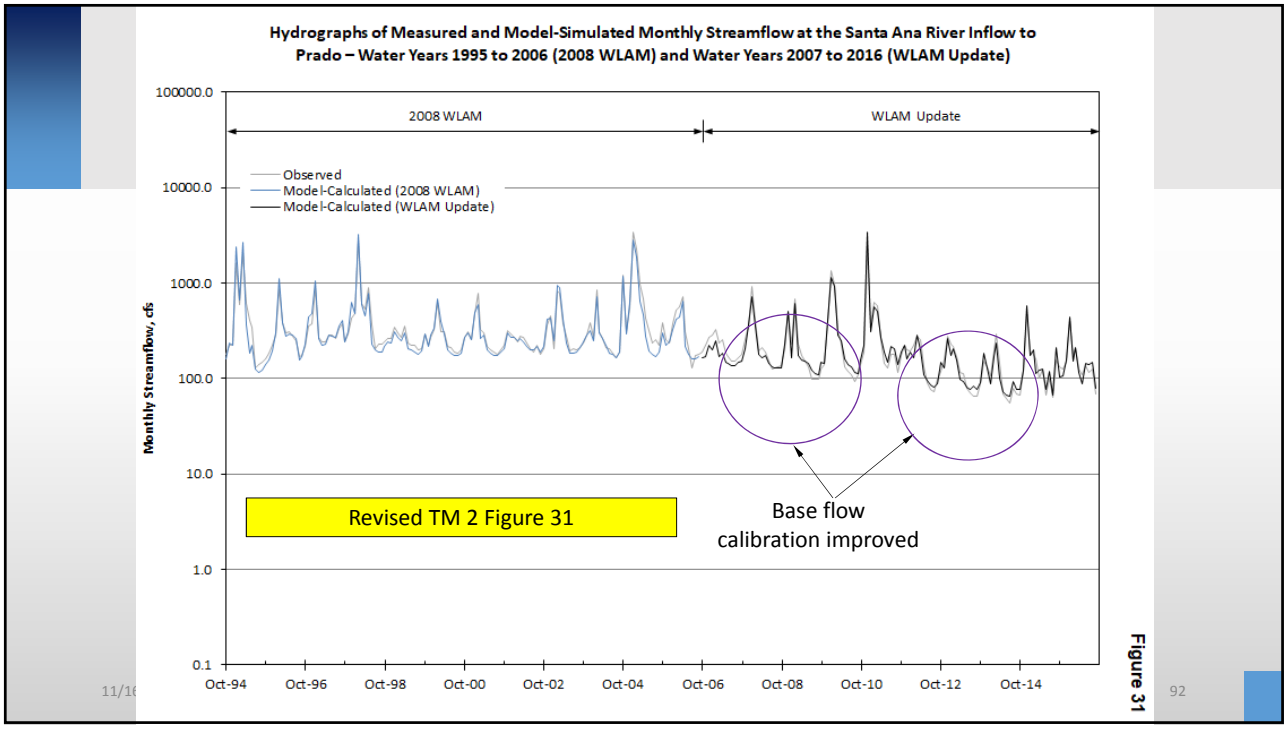
Comments on Draft TM No. 2 from OCWD – Comment No. 8

No.	Section	Pg.	Comment	GEOSCIENCE Response
8	3.3	15	Section 3.3, Streamflow Calibration Results – the R2 values should be included in the table on page 15.	R^2 values will be added

Comments on Draft TM No. 2 from OCWD – Comment No. 9

No.	Section	Pg.	Comment	GEOSCIENCE Response
9	3.3	15	Section 3.3, Streamflow Calibration Results – in the table on page 15, the monthly streamflow calibration is listed as 'very good' for both the 2008 WLAM and the WLAM Update for the Prado Inflow – in looking at Figure 31, the 2008 WLAM calibration result is noticeably better than the WLAM Update – since (1) Prado Dam is where runoff in the upper Santa Ana Watershed collects before flowing to the lower Santa Ana Watershed, (2) Water Quality Objectives are identified for Reach 2 and 3 in the Regional Board's Basin Plan, and (3) Reaches 2 and 3 are demarcated at Prado Dam, additional attention should be given to the WLAM Update calibration results at Prado Dam. OCWD is not yet ready to use the WLAM Update for assessing future conditions until more evaluation is given to the calibration shown in Figure 31.	Model calibration at Prado Dam was revisited.


Hydrographs of Measured and Model-Simulated Monthly Streamflow at the Santa Ana River Inflow to Prado – Water Years 1995 to 2006 (2008 WLAM) and Water Years 2007 to 2016 (WLAM Update)
2008 WLAM
WLAM Update
Observed
Model-Calculated (2008 WLAM)
Model-Calculated (WLAM Update)
Monthly Streamflow, cfs
100000.0
10000.0
1000.0
100.0
10.0
1.0
0.1
Oct-94
Oct-96
Oct-98
Oct-00
Oct-02
Oct-04
Oct-06
Oct-08
Oct-10
Oct-12
Oct-14
Draft TM 2 Figure 31
Model underestimation of base flow
Figure 31
91


Hydrographs of Measured and Model-Simulated Monthly Streamflow at the Santa Ana River Inflow to Prado – Water Years 1995 to 2006 (2008 WLAM) and Water Years 2007 to 2016 (WLAM Update)
2008 WLAM
WLAM Update
Observed
Model-Calculated (2008 WLAM)
Model-Calculated (WLAM Update)
Monthly Streamflow, cfs
100000.0
10000.0
1000.0
100.0
10.0
1.0
0.1
Oct-94
Oct-96
Oct-98
Oct-00
Oct-02
Oct-04
Oct-06
Oct-08
Oct-10
Oct-12
Oct-14
Revised TM 2 Figure 31
Base flow calibration improved
Figure 31
92

Comments on Draft TM No. 2 from OCWD – Comment No. 10

No.	Section	Pg.	Comment	GEOSCIENCE Response
10	3.3	13	Section 3.3, Streamflow Calibration Results – it would be helpful to have more discussion of the parameters that were changed for calibration – for example, discussion could be added to explain the degree to which each parameter was changed, and whether it was changed throughout the model or in certain areas; this should be added to Section 3.3, or an earlier section.	Additional discussion will be added.

Comments on Draft TM No. 2 from OCWD – Comment No. 11

No.	Section	Pg.	Comment	GEOSCIENCE Response
11	3.3	15	Section 3.3, Streamflow Calibration Results – the daily streamflow calibration for the WLAM Update is listed as 'poor' for the SAR at Santa Ana – the reason for the poor calibration should be described in greater detail.	The poor calibration for daily streamflow at Santa Ana River at Santa Ana is a product of the modeling process. Flow at this location is largely from the OCWD recharge facilities model, which simulated Prado Dam operations. Actual releases from Prado may be different, which causes a discrepancy between the modeled and observed streamflow at this location. Explanation will be added.

Comments on Draft TM No. 2 from OCWD – Comment No. 12

No.	Section	Pg.	Comment	GEOSCIENCE Response
12	3.4	16	Section 3.4, TDS and TIN Calibration – the table showing the residuals on page 16 should also include the residuals calculated on a percentage basis.	The percentage will be added.

TDS Calibration Statistics - Mean Residuals

Gaging Station	2008 WLAM WY 1995-2006			2017 WLAM HSPF WY 2007-2016		
	Mean Residuals	Average of Observed TDS	Mean Residual as % of Average of Observed TDS	Mean Residuals	Average of Observed TDS	Mean Residual as % of Average of Observed TDS
	mg/L	mg/L	%	mg/L	mg/L	%
Santa Ana River at MWD Crossing	16.4	591	2.8%	5.5	587	0.9%
Santa Ana River below Prado Dam	20.7	535	3.9%	6.0	615	1.0%
Santa Ana River at Imperial Highway near Anaheim	NA	NA	NA	0.1	640	0.0%

TIN Calibration Statistics - Mean Residuals

Gaging Station	2008 WLAM WY 1995-2006			2017 WLAM HSPF WY 2007-2016		
	Mean Residuals	Average of Observed TIN	Mean Residual as % of Average of Observed TIN	Mean Residuals	Average of Observed TIN	Mean Residual as % of Average of Observed TIN
	mg/L	mg/L	%	mg/L	mg/L	%
Santa Ana River at MWD Crossing	-0.45	6.14	-7.4%	-0.31	8.45	-3.6%
Santa Ana River below Prado Dam	-0.07	5.13	-1.4%	-0.54	3.92	-13.8%
Santa Ana River at Imperial Highway near Anaheim	NA	NA	NA	-0.21	3.09	-6.9%

Comments on Draft TM No. 2 from OCWD – Comment No. 13

No.	Section	Pg.	Comment	GEOSCIENCE Response
13	3.4	16	Section 3.4, TDS and TIN Calibration – the evaluation of the flow calibration uses the methodology of Donigian (2002) to categorize the calibration performance; is there a similar methodology for the calibration of TDS and TIN that can be used to categorize the residuals?	There is no similar way to categorize calibration performance for TDS/TIN. However, per other comments, additional statistics (e.g., RMSE) will be added to the tables.

TDS Calibration Statistics - RMSE Normalized to Range of Observed TDS

Gaging Station	2008 WLAM WY 1995-2006			2017 WLAM HSPF WY 2007-2016		
	RMSE	Range of Observed TDS	RMSE as % of Range of Observed TDS	RMSE	Range of Observed TDS	RMSE as % of Range of Observed TDS
	mg/L	mg/L	%	mg/L	mg/L	%
Santa Ana River at MWD Crossing	77	563	13.7%	82	537	15.4%
Santa Ana River below Prado Dam	77	620	12.5%	104	690	15.0%
Santa Ana River at Imperial Highway near Anaheim	NA	NA	NA	86	570	15.2%

TIN Calibration Statistics - RMSE Normalized to Range of Observed TIN

Gaging Station	2008 WLAM WY 1995-2006			2017 WLAM HSPF WY 2007-2016		
	RMSE	Range of Observed TIN	RMSE as % of Range of Observed TIN	RMSE	Range of Observed TIN	RMSE as % of Range of Observed TIN
	mg/L	mg/L	%	mg/L	mg/L	%
Santa Ana River at MWD Crossing	2.42	11.60	20.8%	1.20	6.20	19.4%
Santa Ana River below Prado Dam	1.61	8.48	19.0%	1.38	7.03	19.7%
Santa Ana River at Imperial Highway near Anaheim	NA	NA	NA	1.04	5.94	17.5%

Streamflow Calibration Statistics – Mean Residuals (Monthly)

Gaging Station	2008 WLAM WY 1995-2006			2017 WLAM HSPF WY 2007-2016		
	Mean Residuals	Average of Observed Flow	Mean Residual as % of Average of Observed Flow	Mean Residuals	Average of Observed Flow	Mean Residual as % of Average of Observed Flow
	cfs	cfs	%	cfs	cfs	%
San Timoteo Creek near Loma Linda	-2.2	5.5	-41%	-0.4	8.2	-5%
Warm Creek near San Bernardino	4.9	6.4	77%	-0.6	3.5	-16%
Santa Ana River at E Street	12.8	69.8	18%	-4.3	26.3	-16%
Santa Ana River at MWD Crossing	32.9	183.3	18%	-5.5	97.2	-6%
Temescal Creek at Main Street	-1.3	34.1	-4%	0.5	17.3	3%
Chino Creek at Schaefer Avenue	1.8	24.5	7%	-2.5	9.0	-28%
Cucamonga Creek near Mira Loma	9.6	64.9	15%	1.6	37.4	4%
Santa Ana River Inflow to Prado	11.5	399.0	3%	2.9	223.6	1%
Santa Ana River at Santa Ana	NA	NA	NA	-5.0	49.7	-10%

Streamflow Calibration Statistics - RMSE Normalized by Range of Observed Flow (Monthly)

Gaging Station	2008 WLAM WY 1995-2006			2017 WLAM HSPF WY 2007-2016		
	RMSE	Range of Observed Flow	RMSE as % of Range of Observed Flow	RMSE	Range of Observed Flow	RMSE as % of Range of Observed Flow
	cfs	cfs	%	cfs	cfs	%
San Timoteo Creek near Loma Linda	9.2	124	7%	11.7	77	15%
Warm Creek near San Bernardino	8.0	55	15%	2.8	48	6%
Santa Ana River at E Street	45.0	1,185	4%	39.0	764	5%
Santa Ana River at MWD Crossing	110.1	2,305	5%	33.7	1,704	2%
Temescal Creek at Main Street	32.4	397	8%	12.0	221	5%
Chino Creek at Schaefer Avenue	14.9	220	7%	11.8	95	12%
Cucamonga Creek near Mira Loma	28.6	421	7%	12.5	325	4%
Santa Ana River Inflow to Prado	123.5	3,268	4%	98.7	2,407	4%
Santa Ana River at Santa Ana	NA	NA	NA	142.8	1,484	10%

Comments on Draft TM No. 2 from OCWD – Comment No. 14

No.	Section	Pg.	Comment	GEOSCIENCE Response
14	3.4	16	Section 3.4, TDS and TIN Calibration – it would be helpful to have more discussion of the parameters that were changed for calibration – for example, discussion could be added to explain the degree to which each parameter was changed, and whether it was changed throughout the model or in certain areas; a brief amount of text is already included for the nitrogen reaction rate coefficients, but discussion should be added for the other parameters that were changed.	Additional discussion will be added.

Comments on Draft TM No. 2 from OCWD – Comment No. 15

No.	Section	Pg.	Comment	GEOSCIENCE Response
15	General	-	General document formatting comment – the tables that are imbedded in the text are not numbered (for example, there is no table number for the table on page 16); these tables are some of the most important tables in the document and will be referred to frequently; these tables should be numbered for ease of reference.	Tables will be numbered and listed in the Table of Contents.

Response to Comments on TM No. 2 from IEUA and Chino Basin Watermaster

Comments on Draft TM No. 2 from IEUA and Chino Basin Watermaster – General Comment No. 2

No.	Section	Pg.	Comment	Response
G-2	General	-	Model appears to rely on a national database for several of its parameters. It is recommended that local data use be maximized and supplemented with national database parameters. More details are provided in TM-2 comments below.	Comment noted and is addressed through responses to comments below.

Comments on Draft TM No. 2 from IEUA and Chino Basin Watermaster – Comment No. 1

No.	Section	Pg.	Comment	Response
1	General	-	The work described in the RFP as Tasks 2e (stream flow volume from major stream segments), 2f (concentration and mass of TDS recharging from major streams), and 2g (concentration and mass of TIN recharging from major streams) was not reported in TM-2.	Stream flow volume and concentration and mass of TDS and TIN recharging from major streams will be reported in TM-2.

Comments on Draft TM No. 2 from IEUA and Chino Basin Watermaster – Comment No. 2

No.	Section	Pg.	Comment	Response
2	2.3.4	7	Precipitation: The TM should compare the spatial/temporal estimates of precipitation to the gridded NEXRAD estimates on an annual basis to demonstrate that the recommended method of assigning precipitation estimate to the sub watershed is reliable and the best alternative. There is significant variability across the watershed year to year, and using a thirty-year average isohyetal map may not be the appropriate representation. There are gridded radar-based precipitation estimates that can be used to estimate precipitation on the watershed on daily and sub-daily time steps. These datasets may be more accurate than estimating based on a 30-year average annual isohyetal map. The comparison and recommendation of estimating precipitation should be provided in the TM for the task force's review and concurrence.	A comparison of NEXRAD precipitation and the recorded precipitation used for model calibration will be performed as part of Task 11. The PRISM 30-year average data were only used to develop precipitation adjustment factors for each subwatershed, following an industry standard approach. Since actual precipitation is used as model input, variations in local precipitation are represented. This methodology will be clarified.

Comments on Draft TM No. 2 from IEUA and Chino Basin Watermaster – Comment No. 3

No.	Section	Pg.	Comment	Response
3	2.3.5	8	Evapotranspiration (ET): A regression is developed based on the statement that ET is a function of elevation. Solar radiation, wind, temperature, and humidity may vary with elevation at any point in time but elevation cannot be used to predict their individual values. The TM developed regression equations without discussing alternative approaches. The text uses "ET" and "evaporation" interchangeably– this should be corrected. There are two CIMIS stations in the upper watershed and one in the lower watershed with potential ET estimates based on solar radiation, temperature, humidity and wind – and not elevation. The TM does not provide a clear relationship between ET and elevation. The TM does not address why the CIMIS stations were not used and the scientific basis for the regression equations. It would be instructive for the TM to present elevation vs ET estimates from the various CIMIS stations in the southern California area and see how closely it matches the ET estimates used in the work documented in the TM. The TM reports the use of evaporation pans for four stations that were used to develop the regression equations. It is our understanding that only two of those stations have pan evaporation data during the entire calibration period. One station has no data during the calibration period, please clarify.	CIMIS stations will be revisited to address this comment.

Comments on Draft TM No. 2 from IEUA and Chino Basin Watermaster – Comment No. 4

No.	Section	Pg.	Comment	Response
4	2.3.9	9	Rising Groundwater: There was no demonstrated attempt to develop rising groundwater estimates upstream of the Riverside Narrows or at Prado Dam. Attempting to mimic rising water by reducing streambed infiltration may not be the best or most accurate alternative. The impact of rising water on TDS concentration is very significant at the Riverside Narrows and at Prado Dam. The rising water contributions and their associated TDS and nitrogen concentrations can be estimated from available data. Please describe the alternatives of how to accurately address rising groundwater.	Rising groundwater was based on groundwater model results, rather than an assumed (constant) value. This will reflect the local hydrology. Clarification of the rising water approach will be provided in the revised TM No. 2. Rising water will also be added between Upper Temescal Valley and Temescal Basin, based on the September 2017 report from Eastern Municipal Water District (WEI, 2107).

Comments on Draft TM No. 2 from IEUA and Chino Basin Watermaster – Comment No. 5

No.	Section	Pg.	Comment	Response
5	General	-	General Comment. Both the Wildermuth Environmental, Inc. (WEI) and Geoscience modeling work are referenced throughout the report – in text and exhibits. Both are referred to as the WLAM. A timeframe is generally used to distinguish between the two models, but not consistently. The WEI model is interchangeably referred to as WLAM, 2008 WLAM, existing 2008 WLAM, R4 model, and R4 computer code. The Geoscience work is referred to as WLAM, "this WLAM", "updated WLAM", "WLAM update". For clarity, we recommend using a single unique name for each and using those consistently throughout to improve clarity for the reader.	The WEI model will be called the "2008 WLAM" (or "2004 WLAM", where appropriate) and the GEOSCIENCE model will be referred to as "2017 WLAM HSPF".

Comments on Draft TM No. 2 from IEUA and Chino Basin Watermaster – Comment No. 6

No.	Section	Pg.	Comment	Response
6	1.1	1	Page 1, Paragraph 1. The text states that Geoscience was retained to "update, calibrate and apply the Wasteload Allocation Model (WLAM)...". It is our understanding that Geoscience was going to be developing and implementing a whole new model platform (HSPF) for the Waste Load Allocation analysis, not updating the old model. Please clarify.	The "update" refers to the update of modeled data (e.g., streamflow, precipitation, etc.) for the longer calibration period. Text will be clarified

Comments on Draft TM No. 2 from IEUA and Chino Basin Watermaster – Comment No. 7

No.	Section	Pg.	Comment	Response
7	1.2	2	Page 2, Paragraph 3. The R4 model was never applied by WEI for the wasteload allocation work; and R4 was developed prior to 2008.	Text will be corrected. However, mention of the R4 in connection to the WLAM is made in the 2008 model report on page 2-1.

Section 2 – Model Description and Calibration

2.1 Model Origin and Uses

The origin of the WLAM traces to the CBWCD and the Chino Basin Watermaster. These agencies wanted to estimate the storm water recharge in the Chino Basin that occurred in recharge basins, flood retention basins, and in unlined streams. WEI developed daily simulation models (RUNOFF and ROUTER) to estimate runoff, route the runoff through the Chino Basin drainage system, calculate recharge on a daily basis, and produce reports that summarized recharge performance. These models were initially developed for the western Chino Basin in 1994 (Mark J. Wildermuth, 1995) and were expanded to the entire Chino Basin in 1996 (WEI, 1998). Subsequently, the model was used in the Chino Basin to estimate the recharge performance of new basins and the recharge benefits of improved basin maintenance. The *Phase 2 Chino Basin Recharge Master Plan* (Black & Veatch, 2001) used the RUNOFF and ROUTER model results as a basis of recharge facility design and cost estimates.

In 2001, WEI updated the model to include water quality simulations and expanded the modeling area to the Santa Ana River Basin for the wasteload allocation investigation (WEI, 2002).

The WLAM was applied, along with the Storm Water Management Model (SWMM), to evaluate various water resources management alternatives and facilities for the Beaumont area (WEI, 2006).

WEI added a root zone (or top soil zone) soil moisture accounting module, ROOTZONE module, to the WLAM, and the WLAM became known as the R4 model (RAINFALL, RUNOFF, ROUTER, and ROOTZONE). The R4 model can be used to simulate rainfall infiltration to the soil zone, irrigation demand, evapotranspiration consumption, and deep percolation below root zone. WEI has successfully applied the R4 model to estimate 40 years of historical surface recharge in the Beaumont (report in preparation) and Arlington (WEI, 2008) Basins and 70 years of historical surface recharge in the Chino Basin (WEI, 2007).

Computer Code Used for 2008 WLAM

Comment No. 8 stated that the R4 model was never applied by WEI for the wasteload allocation work. However, mention of the R4 in connection to the WLAM is made in the 2008 model report on page 2-1

Source: WEI 2009

Comments on Draft TM No. 2 from IEUA and Chino Basin Watermaster – Comment No. 8

No.	Section	Pg.	Comment	Response
8	1.2	2	Page 2, Paragraph 4. Please clarify if the WEI version of the WLAM was updated and recalibrated, or if a new model was constructed and calibrated for this study.	The 2008 WLAM was originally updated with 2012 land use for comparison/validation, but it was not recalibrated. Text will be clarified.

Comments on Draft TM No. 2 from IEUA and Chino Basin Watermaster – Comment No. 9

No.	Section	Pg.	Comment	Response
9	2.1.1	3	Page 3, Section 2.1.1, Paragraph 1. The comparison to R4 is incorrect. It should be compared to the 2008 WLAM.	Text will be corrected.

Comments on Draft TM No. 2 from IEUA and Chino Basin Watermaster – Comment No. 10

No.	Section	Pg.	Comment	Response
10	2.2	4	Page 4, Section 2.2, Paragraph 3. Beyond this brief paragraph, there is no other discussion of the RFM or presentation of modeling showing interaction or its result of OCWD recharge basins.	Additional explanation will be added.

Comments on Draft TM No. 2 from IEUA and Chino Basin Watermaster – Comment No. 11

No.	Section	Pg.	Comment	Response
11	2.3	4	Page 4, Section 2.3, Last sentence. This may be misleading. TM-1 very generally describes the data collection process, but does not provide or present the data for anything other than land use and soil types.	Addressing comments on TM-1 will satisfy this comment as well.

Comments on Draft TM No. 2 from IEUA and Chino Basin Watermaster – Comment No. 12

No.	Section	Pg.	Comment	Response
12	2.3.2	5	Page 5 and Table 1. Soil group and infiltration rate. Infiltration rate values are significantly lower compared to the values recommended in the HSPF user guide. The procedure to estimate initial infiltration rate should be discussed in detail. Table 1 should include an infiltration index, as well as initial and final calibrated infiltration rates for each sub-watershed.	Additional detail will be added regarding the procedure to estimate initial infiltration rates. All values are within the possible range listed in EPA Basins Technical Note 6 (Estimating Hydrology and Hydraulic Parameters for HSPF, July 2000) of 0.001-0.50 in/hr.

Infiltration Rates

United States Environmental Protection Agency | Office of Water 4305 | EPA-823-R00-012 July 2000

EPA **BASINS Technical Note 6**

Estimating Hydrology and Hydraulic Parameters for HSPF

SCS Hydrologic Soil Group	INFILT Estimate (in/hr)	(mm/hr)	Runoff Potential
A	0.4 - 1.0	10.0 - 25.0	Low
B	0.1 - 0.4	2.5 - 10.0	Moderate
C	0.05 - 0.1	1.25 - 2.5	Moderate to High
D	0.01 - 0.05	0.25 - 1.25	High

HSPF HYDROLOGY PARAMETERS AND VALUE RANGES

			RANGE OF VALUES					
NAME	DEFINITION	UNITS	TYPICAL		POSSIBLE		FUNCTION OF ...	COMMENT
			MIN	MAX	MIN	MAX		
INFILT	Index to Infiltration Capacity	in/hr	0.01	0.25	0.001	0.50	Soils, land use	**Calibration**, divides surface and subsurface flow

Comments on Draft TM No. 2 from IEUA and Chino Basin Watermaster – Comment No. 13

No.	Section	Pg.	Comment	Response
13	2.3.3	7	Page 7 – Inset Table on Land Use % Pervious. The pervious area percentages presented in this table may not be representative of the development in the Santa Ana River watershed. Most of the development that has occurred between the 1980s and 2010 were at higher densities than prior 1980. This means a simple national average reported by Aqua Terra may not be representative in the Santa Ana River watershed. Please provide additional clarification to demonstrate the applicability of information in the table.	The Aqua Terra report is from modeling done in Ventura County, southern California. In addition, the pervious percentages compare similarly to those listed in the Riverside County Flood Control and Water Conservation District and San Bernardino County Hydrology Manuals, as well as those used in the 2004 WLAM and 2008 WLAM.

Impervious Land Percentages

Land Use Type	GSSI 2017	WEI 2004	WEI 2008	RCFC&WCD	SBC
Ag/Golf/Parks	0	2-5	0-2, 80[1]	0-10	0-25
Open/Dry Ag/Water	0	0-2	2	0-10	0
Commercial/Industrial	80	0-100	90	80-100	80-100
Residential Low	10	40	30	10-25	5-25
Residential Med	50	60	50	30-45	20-50
Residential High	60	80	75	45-90	35-90

Notes:
[1] WEI used 80% for parks

Comments on Draft TM No. 2 from IEUA and Chino Basin Watermaster – Comment No. 14

No.	Section	Pg.	Comment	Response
14	2.3.4	7	Page 7, Section 2.3.4. The method used to estimate daily precipitation may not be appropriate. Given that there is significant variability across the watershed from year to year, it may be more appropriate to use an annual isohyetal map for each year in the calibration period instead of using a 30-year average isohyetal map. There are gridded radar-based precipitation estimates that can be used to estimate precipitation on the watershed on daily and sub-daily time steps. Please provide a comparison of a subset of your sub-watershed estimates to the gridded NEXRAD estimates to demonstrate this method is reliable and the best alternative.	The PRISM 30-year average data were only used to develop precipitation correction factors for each subwatershed. The precipitation adjustment factors were then used to assign daily precipitation data from precipitation stations across the watershed area to the individual subwatersheds delineated in the HSPF model. This is an industry standard approach. Since actual precipitation is used as model input, variations in local precipitation are represented. This methodology will be clarified.

Comments on Draft TM No. 2 from IEUA and Chino Basin Watermaster – Comment No. 15

No.	Section	Pg.	Comment	Response
15	2.3.6	9	Page 9. Section 2.3.6. Seven Oaks Dam outflow was used as boundary inflow. Please explain how will the future Seven Oaks Dam operation will be handled.	Based on conversations with Valley District, the existing control manual is the underlying assumption for now. The assumptions for future scenarios will be provided in the predictive scenarios TM.

Comments on Draft TM No. 2 from IEUA and Chino Basin Watermaster – Comment No. 16

No.	Section	Pg.	Comment	Response
16	2.3.7	9	Page 9, Section 2.3.7. There is no mention of the stormwater diversions to spreading basins or how they were used. Please explain if/how these diversions were included in the model. If they were not included, please explain. Also, there is no information in TM-1 or TM-2 describing the stream system characteristics, just that they were considered and their associated properties were developed from a national database. Please describe how urban storm drainage system data were used.	Spreading basins were handled outside of the HSPF model because actual percolation data was obtained. This will be clarified in the text.

Comments on Draft TM No. 2 from IEUA and Chino Basin Watermaster – Comment No. 17

No.	Section	Pg.	Comment	Response
17	2.3.8	9	Page 9, Section 2.3.8. This section describes the non-tributary discharge from POTWs. Please explain if this is comprehensive in including other non-tributary discharges, and how they are accounted for in the model.	Non-tributary discharge from Eastern Municipal Water District and OC-59 will be added to the text.

Comments on Draft TM No. 2 from IEUA and Chino Basin Watermaster – Comment No. 18

No.	Section	Pg.	Comment	Response
18	2.3.9	9-10	Page 9/10, Section 2.3.9. Please clarify the approach to modeling rising groundwater. Our understanding is that the model parameters are adjusted to mimic rising water by reducing streambed infiltration. If this is the case, what will be the resulting impact to the estimation of TDS and TIN in streambed infiltration and surface flow downstream of the rising water areas? The impact of rising water on TDS concentration is significant at Prado Dam and for this reason, this method may not be appropriate.	Modeling approach to rising groundwater will be clarified. Mass was added at locations of rising groundwater according to the rising water concentrations.

Comments on Draft TM No. 2 from IEUA and Chino Basin Watermaster – Comment No. 19

No.	Section	Pg.	Comment	Response
19	3.1	12	Page 12, Section 3.1, Paragraph 2. Please explain why the calibration period of WY 2007 through WY 2016 was selected. Why not a longer calibration period?	This calibration period represents an appropriate time period for calibration to 2012 land use. Explanation will be added.

Comments on Draft TM No. 2 from IEUA and Chino Basin Watermaster – Comment No. 20

No.	Section	Pg.	Comment	Response
20	3.3, 3.4	13	Page 13, Section 3.3/3.4 (Figures 15 through 32). Please provide clarity on the purpose of comparing the old (2008 WLAM) and new model (2017 WLAM-HSPF) calibration results in these figures if each calibration effort is based on completely different calibration time periods/data sets?	The purpose of comparing the 2008 WLAM results with the HSPF model results is to ensure model calibration performance is consistent with previous work.

Comments on Draft TM No. 2 from IEUA and Chino Basin Watermaster – Comment No. 21

No.	Section	Pg.	Comment	Response
21	3.4	16	Page 16, Inset Table. The residual values for TDS seem misleading given the large range in positive and negative residuals seen in Figures 51 through 53. Please provide a table that compares the measured versus modeled data and the residual calculations more explicitly.	New columns will be added showing residuals as a percentage of observed TDS and TIN concentrations, in response to comments during the meeting, along with standard deviation.

Comments on Draft TM No. 2 from IEUA and Chino Basin Watermaster – Comment No. 22

No.	Section	Pg.	Comment	Response
22	3.4		The mean residual error approach used to evaluate the calibration for TIN and TDS is unclear. Please provide further explanation of how the quality of the calibration was assessed. Review of TM-2 Figures 51 and 52 show that there are large positive and negative values and the resulting near zero residuals is caused by compensatory errors that cancel each other out. The residual error does explain systematic error.	Clarification will be added and standard deviations will be included.

Comments on Draft TM No. 2 from IEUA and Chino Basin Watermaster – Comment No. 23

No.	Section	Pg.	Comment	Response
23	General	-	We recommend that a peer review be conducted prior to using the model for planning or wasteload allocation scenarios evaluation. Due to the comments above, and the fact that the WLAM is 1) Being updated with substantially different information and methods, and 2) Being moved to a new model platform, it is recommended that the model undergo a peer review. A peer review at this critical juncture will provide the modeler and the BMP TF with a defensible foundation, and build confidence in this significant modeling effort. It is critical that the new WLAM replicate the functionality and accuracy of the most recent WLAM.	Comment noted. A peer review meeting will be held to review the detailed technical work, and GEOSCIENCE will continue to work with the technical group.