N. Technical Memorandum – Estimation of Flow Changes in Lower Alameda Creek with Implementation of the WSIP

APPENDIX N

Technical Memorandum – Estimation of Flow Changes in Lower Alameda Creek with Implementation of the WSIP

Introduction

To determine the effects of the WSIP, flow changes in lower Alameda Creek at the Niles Gage were estimated using the following methodology:

1. Available U.S. Geological Survey (USGS) gage records were reviewed on a monthly basis for upper Alameda Creek (Alameda C BL Welch C), Arroyo de la Laguna (Arroyo de la Laguna A Verona), and lower Alameda Creek (Alameda C Near Niles) for overlapping periods of gage record (Water Years [WY] 2000 to 2007).

2. Monthly relationships were developed between the three gages to determine flow proportions at the Niles Gage from each of the two major upstream watersheds, named Arroyo de la Laguna (ADLL) and upper Alameda Creek for this analysis to reflect the major tributaries draining each watershed.

3. Gage records from Arroyo Hondo (unimpaired inflow to Calaveras) were used to classify the years of available gage record into year types based on the index developed for the PEIR analysis. The PEIR analysis used aggregated annual inflow to local reservoirs to rank years for the 82-year period (from 1921 to 2002) into 20th percentiles. The five percentile groups were labeled: Wet, Above Normal, Normal, Below Normal, and Dry.

4. Analysis of the eight years of gage record was performed using the flow changes developed for the PEIR as input to the Hetch Hetchy/Local Simulation Model (HH/LSM). The analysis was performed based on hydrologic year types. Charts and tables tabulating the expected changes in flow for each of the eight actual years were developed to illustrate the potential effects of the WSIP on flow in lower Alameda Creek for the period of available gage record.

Analysis

Gage Record Analysis

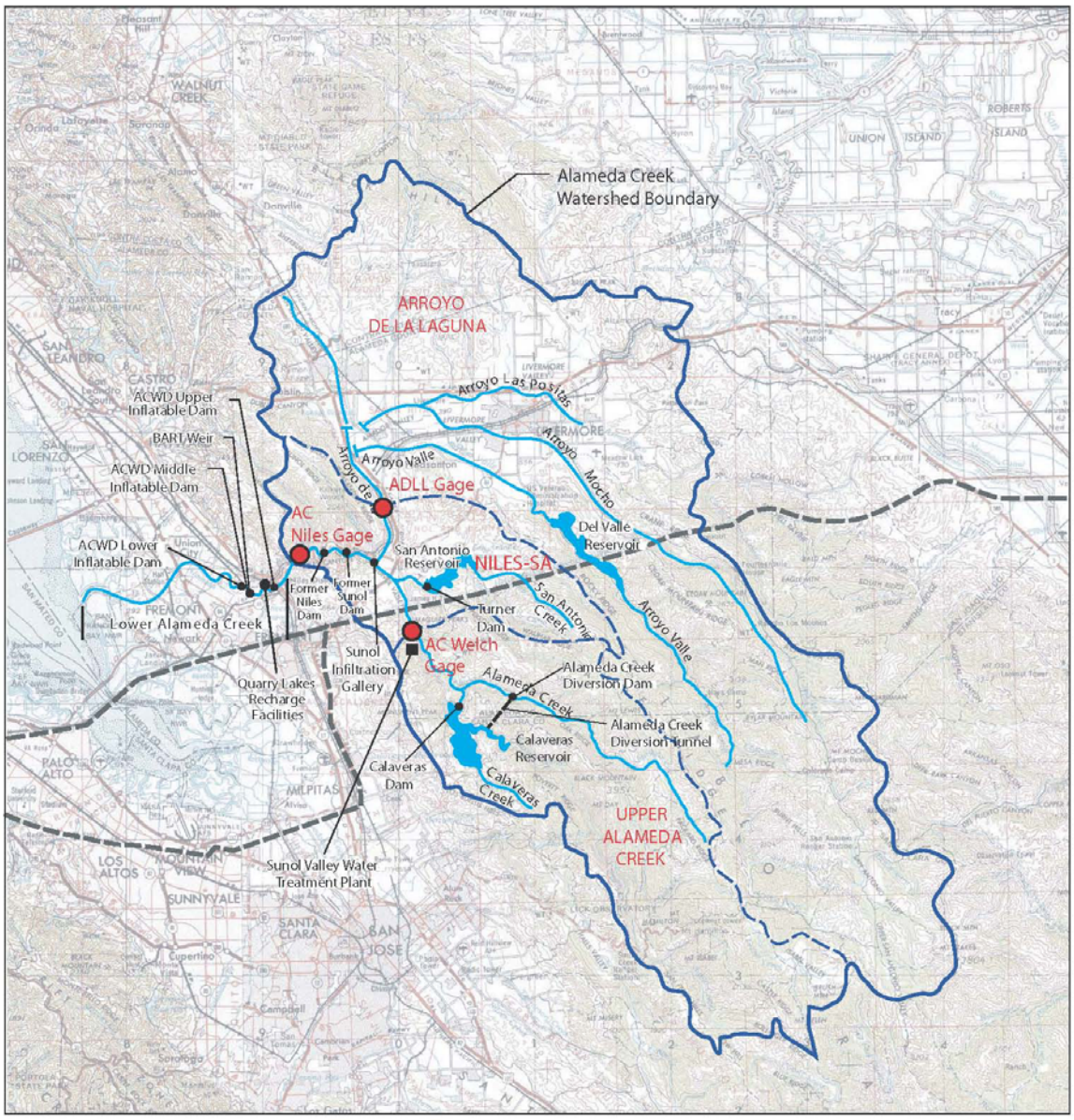
Flow records were reviewed on an average monthly flow basis at three USGS gages in the Alameda Creek watershed for periods of overlapping record (WY 2000-2007). The three gages

were chosen to represent flow in the two major upstream basins of the Alameda Creek watershed (upper Alameda Creek and Arroyo de la Laguna) and flow in the lower reach of Alameda Creek. Upper Alameda Creek flow is recorded by the USGS "Alameda C BL Welch C" gage (AC Welch Gage), located in the Sunol Valley reach of Alameda Creek below the confluence at Welch Creek, near the Sunol Valley Water Treatment Plant. Arroyo de la Laguna flow is monitored by the USGS "Arroyo de la Laguna A Verona" gage (ADLL Gage) on ADLL approximately three miles upstream of the ADLL and Alameda Creek confluence. The USGS "Alameda C Near Niles" gage (AC Niles Gage) records a combination of these two flows as well as the contribution or loss of flow from the watershed between these gages and the Niles Gage, including flow from San Antonio Creek and State Water Project releases.

Figure N.1 shows the location of the three gages and the watersheds associated with each gage.

Figure N.2 presents the mean monthly flow over the eight-year period for the three gages. Review of the data reveals that flow measured at the ADLL Gage (shown as a blue shaded area) generally contributes a higher percentage of the flow measured at the Niles Gage (shown as a black line) compared to that measured at the Welch Gage (shown as a green shaded area). The discrepancy between the summation of the ADLL and AC Welch flows and the flow at the Niles Gage (the white space below the black line) is assumed to be other inflow from the watershed between the two upper gages and the Niles Gage (labeled Niles-SA watershed on Figure N.1). The Niles-SA watershed includes releases made from San Antonio Reservoir and the State Water Project, which occur downstream of the two upper gages.

Releases or spills from San Antonio Reservoir rarely occur. The flow in San Antonio Creek is usually the result of groundwater seepage or runoff from the watershed downstream of Turner Dam. The Niles-SA watershed contribution noted during the summer months is assumed to be primarily releases from the State Water Project and contribution from groundwater in Niles Canyon. Also notable in the chart are the spikes in flow from upper Alameda Creek in the winter and spring of WY 2005 and 2006. These spikes are the result of above-normal runoff in the watershed as well as restricted storage at Calaveras Reservoir.



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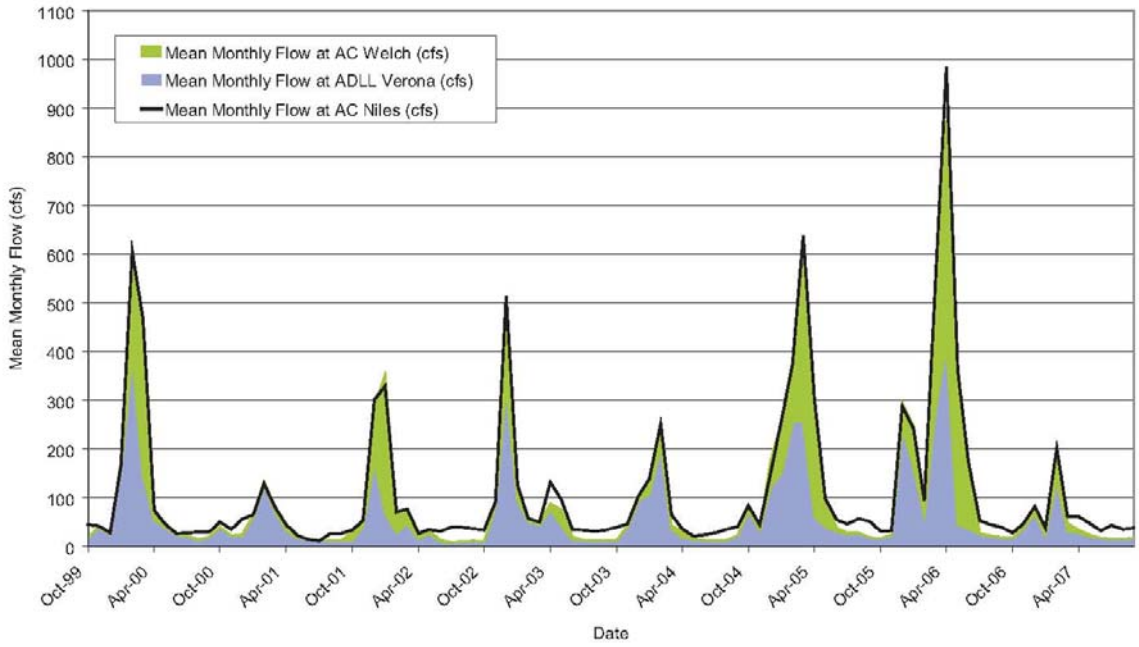
SOURCE: ESA+Orion; USGS, 1969.

Figure N.1
Location of USGS Gages and
Contributing Watersheds for Lower Alameda Creek



SOURCE: ESA+Orion.

Figure N.2
Flow Contribution from ADLL and AC Welch Gages
at the AC Niles Gage, WY 2000-2007

Monthly Relationships

Table N.1 provides a month-by-month review of the percent contribution from each of the watersheds contributing to flow in Alameda Creek, as measured at the Niles Gage.

TABLE N.1
PERCENT FLOW CONTRIBUTION AT THE AC NILES GAGE

ADLL

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	WY Total
2000	40%	96%	91%	95%	65%	32%	74%	83%	87%	75%	45%	67%	60%
2001	76%	62%	40%	92%	98%	88%	76%	74%	104%	119%	42%	41%	78%
2002	38%	79%	58%	21%	39%	61%	59%	82%	34%	21%	25%	30%	43%
2003	29%	89%	64%	75%	89%	90%	58%	43%	41%	37%	42%	32%	63%
2004	33%	86%	91%	78%	81%	55%	48%	68%	56%	43%	35%	54%	71%
2005	88%	73%	81%	58%	68%	40%	20%	41%	56%	55%	48%	35%	51%
2006	54%	72%	85%	68%	65%	52%	42%	12%	21%	46%	49%	44%	47%
2007	62%	79%	82%	61%	68%	50%	46%	44%	50%	36%	43%	46%	60%

AC Welch

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	WY Total
2000	1%	2%	6%	10%	30%	61%	18%	17%	13%	6%	2%	2%	33%
2001	2%	3%	2%	5%	6%	10%	8%	8%	7%	4%	1%	1%	5%
2002	52%	2%	37%	86%	52%	36%	29%	13%	6%	2%	0%	0%	46%
2003	0%	6%	23%	21%	9%	5%	8%	35%	14%	3%	1%	0%	17%
2004	1%	1%	2%	17%	10%	8%	39%	6%	1%	1%	0%	0%	9%
2005	0%	1%	36%	40%	25%	55%	76%	54%	12%	6%	1%	1%	42%
2006	1%	2%	18%	35%	29%	32%	47%	90%	77%	4%	2%	1%	44%
2007	2%	4%	12%	14%	28%	27%	7%	4%	3%	1%	0%	0%	14%

Niles-SA Wshed

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	WY Total
2000	59%	2%	4%	-5%	5%	7%	8%	0%	0%	19%	53%	30%	8%
2001	22%	35%	57%	3%	-3%	1%	16%	18%	-11%	-23%	57%	59%	17%
2002	10%	20%	5%	-7%	8%	3%	12%	6%	60%	77%	75%	70%	11%
2003	71%	5%	13%	5%	2%	4%	33%	22%	45%	60%	58%	68%	20%
2004	67%	13%	8%	5%	9%	37%	12%	26%	43%	57%	65%	46%	20%
2005	12%	25%	-17%	2%	6%	4%	4%	5%	32%	39%	51%	65%	8%
2006	45%	26%	-2%	-2%	6%	16%	11%	-2%	2%	49%	49%	55%	10%
2007	36%	17%	6%	25%	4%	23%	47%	51%	47%	64%	57%	54%	27%

Niles-SA watershed values, as mentioned previously, were calculated by subtracting ADLL and AC Welch flow rates from the flow gaged at Niles. Negative values for the Niles-SA watershed are assumed to be the result of loss to groundwater (particularly in the Sunol reach downstream of the Welch Gage), discrepancy introduced when converting daily flows to monthly average flows, or gage error.

Table N.2 provides a summary of the month-by-month analysis for WY 2000-2007.

TABLE N.2
MEAN MONTHLY PERCENTAGES OF WATERSHED CONTRIBUTIONS AT THE AC NILES GAGE, WY 2000-2007

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	WY Total
ADLL	58%	81%	71%	61%	70%	46%	42%	34%	40%	47%	41%	43%	55%
AC Welch	6%	3%	23%	40%	24%	44%	45%	59%	39%	3%	1%	1%	33%
Niles-SA	36%	16%	6%	-1%	5%	10%	13%	7%	20%	50%	58%	57%	13%

Table N.3 shows the relative contribution of the upstream watersheds to flow at the Niles Gage over the past eight hydrologic years from WY 2000 to 2007. SFPUC operations would alter flow in the upper Alameda Creek watershed. Therefore, implementation of the WSIP would only affect approximately one-third of the flow that contributes to flow at the Niles Gage.

TABLE N.3
SUMMARY OF FLOW CONTRIBUTIONS AT THE AC NILES GAGE, WY 2000-2007

Watershed	Eight-Year Average Contribution	Eight-Year Range of Contribution
Arroyo de la Laguna	55%	43% – 71%
Upper Alameda Creek	33%	5% – 46%
Niles–San Antonio Creek	13%	8% – 27%

Classification of Year Types

The ranking system for the local watershed systems used for the PEIR (5 Reservoir Index) was developed for WY 1921 to 2002. Years were ranked into 20th percentiles and labeled Wet, Above Normal, Normal, Below Normal, and Dry based on inflow to local (non-Tuolumne) reservoirs. The ranking system developed for the PEIR covers WY 2000 to 2002. WY 2003 to 2007 were ranked according to the same index using unimpaired runoff at Arroyo Hondo. **Table N.4** summarizes the year types over the period analyzed.

TABLE N.4
YEAR TYPES FOR WY 2000-2007

2000	Above Normal
2001	Below Normal
2002	Below Normal
2003	Normal
2004	Normal
2005	Above Normal
2006	Above Normal
2007	Dry

Table N.4 shows that the past eight years provide a reasonable cross-section of water year types, with only wet years being absent.

Table N.5 presents a series of tables summarizing the monthly flow reductions predicted by the HH/LSM for Alameda Creek below the San Antonio Creek confluence. The first of the Table N.5 tables shows the existing condition (Calaveras Down) compared with the WSIP. The second table compares the Calaveras Up scenario (i.e., the pre-DSOD restricted condition at Calaveras Reservoir) with conditions under the WSIP. Note that the biggest impacts on flow in Alameda Creek with the WSIP would occur in Normal and Above Normal months, which are both represented in this analysis.

TABLE N.5
CALCULATED FLOW REDUCTIONS IN ALAMEDA CREEK
BELOW THE SAN ANTONIO CREEK CONFLUENCE

Percent Change, Revised Base (Calaveras Down) vs Revised WSIP (Proposed Program)

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep
All	0%	0%	-28%	-32%	-21%	-15%	-4%	9%	0%	0%	0%	0%
Wet	0%	0%	-23%	-26%	-9%	-9%	-7%	16%	0%	0%	0%	0%
Above Normal	0%	0%	-38%	-43%	-35%	-21%	17%	1%	0%	0%	0%	0%
Normal	0%	0%	-34%	-47%	-56%	-45%	-12%	0%	0%	0%	0%	0%
Below Normal	0%	0%	0%	0%	-6%	0%	3%	0%	0%	0%	0%	0%
Dry	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

Percent Change, Base (Calaveras Up) vs WSIP Proposed Program (Not Revised)

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep
All	0%	0%	32%	19%	22%	2%	-3%	12%	0%	0%	0%	0%
Wet	0%	0%	49%	14%	13%	-3%	-7%	8%	0%	0%	0%	0%
Above Normal	0%	0%	26%	38%	67%	15%	18%	38%	0%	0%	0%	0%
Normal	0%	0%	5%	14%	17%	18%	16%	0%	0%	0%	0%	0%
Below Normal	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Dry	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

Increase of greater than 1%
Decrease of greater than 1%
Decrease of greater than 5%

The Base condition with Calaveras Up was included in the analysis because the DSOD restriction on Calaveras Reservoir was implemented in 2001. Review of Calaveras Reservoir water surface elevations reveals that the restricted operations were fully implemented in WY 2002. Therefore, this analysis uses the Base, Calaveras Up condition for WY 2000-2001 and the Base, Calaveras Down condition for the remainder of the years.

Revised model runs (April 2008) for the Base (Calaveras Down) and the WSIP were used for WY 2002-2007. Model runs performed in July 2006 for the Draft PEIR were used for Base (Calaveras Up) and the WSIP for WY 2000-2001. Model runs for the Base (Calaveras Up) scenario were not revised in 2008; therefore, the earlier model runs were used for the Calaveras Up condition in the first two years of the analysis.

The implementation of the WSIP assumes that there would be releases from either Calaveras Dam or the Alameda Creek Diversion Dam in accordance with the 1997 California Department of Fish and Game Memorandum of Understanding (MOU) as well as recapture of those flows upstream of the confluence with San Antonio Creek. Therefore, the flow in Alameda Creek below San Antonio Creek calculated for the WSIP does not include these MOU flows; the model assumes they have been recaptured and conveyed to the regional water system. The model does not account for groundwater loss in the Sunol Valley. Therefore, both the base case and the future scenario with implementation of the WSIP assume no change in groundwater losses.

This assumption is conservative for two reasons. First, the future condition will likely include the cumulative project to install slurry walls adjacent to the quarries in the Sunol Valley, reducing the loss to groundwater and increasing the amount of flow that reaches lower Alameda Creek from the Sunol Valley. Secondly, this analysis likely overestimates the contribution of upper Alameda Creek to flow at the AC Niles Gage, because no loss to groundwater is assumed in the Sunol reach of Alameda Creek below the AC Welch Gage. If groundwater losses were included in the

model, the upper Alameda Creek watershed contribution would be reduced and the Niles-SA watershed contribution would be increased.

Analysis of the Eight Water Years of Record

The percent reductions in monthly flow estimated using the HH/LSM and presented above were applied to monthly gage flow at AC Welch. The resulting changes in flow at AC Welch and AC Niles are presented in the following charts and tables. Appendix N1 presents a year-by-year summary of monthly flow changes at AC Welch and AC Niles that would occur with the WSIP.

The AC Welch Gage and the HH/LSM analysis location of Alameda Creek below the San Antonio confluence are not the same. The San Antonio Creek confluence is approximately 2.7 miles downstream of the AC Welch Gage. This analysis applied the percent change in flow from the HH/LSM analysis, not actual flow numbers, to the Welch Gage. This difference in location was not considered significant for this level of analysis, and the percent reduction in flow was considered applicable for flow in Alameda Creek in the vicinity of the Welch Gage.

Table N.6 presents the results of applying the HH/LSM flow reductions to the gage record for AC Welch for WY 2000-2007. The second table represents the future condition with implementation of the WSIP.

TABLE N.6
COMPARISON OF RECORDED AND CALCULATED FLOW IN ALAMEDA CREEK AT THE AC WELCH GAGE

Recorded Flow in Alameda Creek at Welch Gage (cfs, avg. monthly)

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	Year Type
2000	0	1	2	17	183	287	13	8	3	2	1	1	AN
2001	1	1	1	3	7	8	3	2	1	0	0	0	BN
2002	17	1	112	282	37	28	8	4	2	1	0	0	BN
2003	0	5	117	26	5	3	11	34	5	1	0	0	N
2004	0	0	2	24	26	5	14	1	0	0	0	0	N
2005	0	1	53	106	95	351	227	53	7	3	1	0	AN
2006	0	1	51	84	27	177	466	325	133	2	1	0	AN
2007	1	2	10	5	56	16	4	2	1	0	0	0	D

Calculated Flow at Welch for Revised WSIP Proposed Program (cfs, avg. monthly)

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	Year Type
2000	0	1	2	23	305	331	16	10	3	2	1	1	AN
2001	1	1	1	3	7	8	3	2	1	0	0	0	BN
2002	17	1	112	282	35	28	8	4	2	1	0	0	BN
2003	0	5	78	14	2	1	10	34	5	1	0	0	N
2004	0	0	1	12	11	3	12	1	0	0	0	0	N
2005	0	1	33	60	62	276	267	53	7	3	1	0	AN
2006	0	1	31	47	18	139	547	328	133	2	1	0	AN
2007	1	2	10	5	56	16	4	2	1	0	0	0	D

Difference Between Recorded and Calculated Flow for Revised WSIP Proposed Program at Welch (cfs, avg. monthly)

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	Year Type
2000	0 [0%]	0 [0%]	0 [26%]	6 [38%]	122 [67%]	44 [15%]	2 [18%]	3 [38%]	0 [0%]	0 [0%]	0 [0%]	0 [0%]	AN
2001	0 [0%]	0 [0%]	0 [0%]	0 [0%]	0 [0%]	0 [0%]	0 [0%]	0 [0%]	0 [0%]	0 [0%]	0 [0%]	0 [0%]	BN
2002	0 [0%]	0 [0%]	0 [0%]	0 [0%]	-2 [-6%]	0 [0%]	0 [3%]	0 [0%]	0 [0%]	0 [0%]	0 [0%]	0 [0%]	BN
2003	0 [0%]	0 [0%]	-40 [-34%]	-12 [-47%]	-3 [-56%]	-1 [-45%]	-1 [-12%]	0 [0%]	0 [0%]	0 [0%]	0 [0%]	0 [0%]	N
2004	0 [0%]	0 [0%]	-1 [-34%]	-11 [-47%]	-14 [-56%]	-2 [-45%]	-2 [-12%]	0 [0%]	0 [0%]	0 [0%]	0 [0%]	0 [0%]	N
2005	0 [0%]	0 [0%]	-20 [-38%]	-46 [-43%]	-33 [-35%]	-76 [-21%]	39 [17%]	1 [1%]	0 [0%]	0 [0%]	0 [0%]	0 [0%]	AN
2006	0 [0%]	0 [0%]	-19 [-38%]	-36 [-43%]	-9 [-35%]	-38 [-21%]	81 [17%]	4 [1%]	0 [0%]	0 [0%]	0 [0%]	0 [0%]	AN
2007	0 [0%]	0 [0%]	0 [0%]	0 [0%]	0 [0%]	0 [0%]	0 [0%]	0 [0%]	0 [0%]	0 [0%]	0 [0%]	0 [0%]	D

Increase of greater than 1%
Decrease of greater than 1%
Decrease of greater than 5%

Figure N.3 and **Table N.7** detail the predicted changes in flow that would occur in Alameda Creek at AC Niles over the eight-year period (WY 2000-2007) with implementation of the WSIP. On the chart, the solid blue area represents average monthly gage flow at AC Niles, and the black line is calculated flow under the WSIP. The discrepancy between the two lines represents the change between gage records and calculated flow under the proposed program.

The analysis shows that reductions in flow at the Niles Gage would occur with the WSIP when compared to the current DSOD-restricted operating condition, based on the historical hydrology from 2001 to 2007. Reductions of up to 18% in average monthly flow could occur in years similar to the past eight years of record. The maximum flow reduction would occur during January of 2005, an Above Normal year. However, there would be a flow increase of 13% in April of that same year type. No changes in flow would occur in Dry and Below Normal years, with the exception of a slight decrease in February of Below Normal years. It should be noted that in 2000, an Above Normal year, there would be up to a 20% increase in flow with implementation of the WSIP; this year represents historical operating conditions prior to the DSOD operating restrictions.

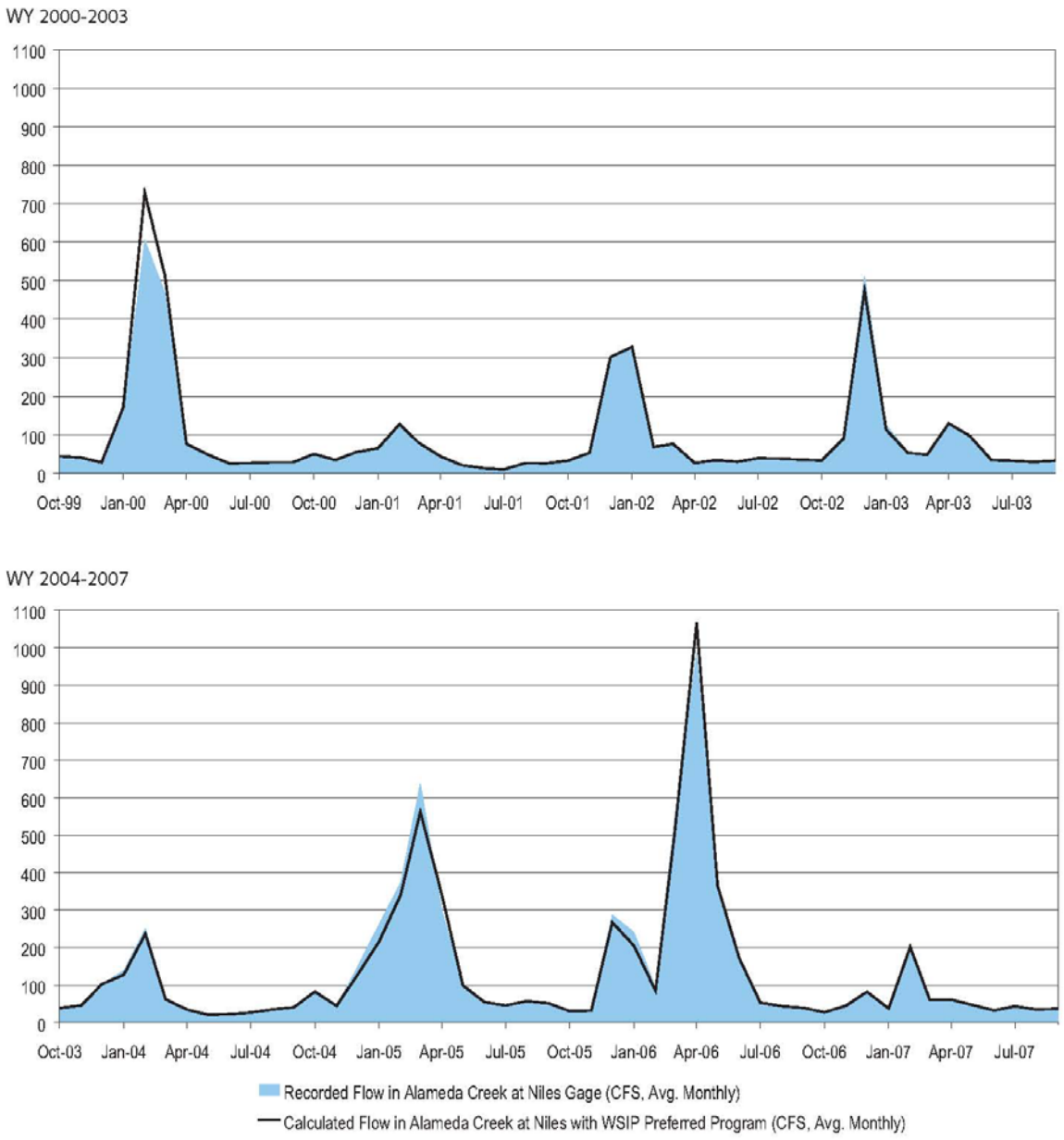
The past eight years include four of the five year types; note that a Wet year is absent. However, as shown in Table N.5, the largest reductions in flow with the WSIP would occur during Normal and Above Normal years, which are included in this analysis. Therefore, this analysis covers the flow reduction scenario with the greatest impacts expected under the WSIP.

The largest decrease in flow in lower Alameda Creek in the analysis would occur in a month similar to January of 2005, with a reduction in average monthly flow of 46 cubic feet per second, or 18%, of the average monthly flow recorded in January 2005. This corresponds to a reduction in upper Alameda Creek of 43%. Further review of the data reveals that flow reductions are calculated to occur in December through March of Normal to Wet years and in April of Wet years. In all other months, including winter months of Below Normal (with the exception of a slight decrease in February) and Dry years, flow in upper Alameda Creek and at Niles would either remain the same or increase under the WSIP.

Limitations of the Analytical Results

- The data are based on monthly flows and do not reflect the range of fluctuations that occur during shorter time intervals. However, the monthly data provide a sufficient level of detail to determine the general magnitude of the effects on flow in lower Alameda Creek, as well as the season and water year type in which the effects would occur. The monthly data also provide a definitive indication of when no changes would occur.

- The discrepancy between the model prediction for flow in Alameda Creek below the San Antonio Creek confluence and the application of these flow reductions to the AC Welch Gage may introduce some error. The model flow predictions include the flow contribution from the watershed between Welch Creek and the San Antonio Creek confluence, and the flow contribution from San Antonio Reservoir releases. However, releases from the reservoir are very infrequent, and the contribution from the watershed between Welch and San Antonio Creeks is minor.



Notes:
- WSIP conditions includes recapture of MOU flows released from Calaveras Dam.
- Years 2000 and 2001 analysis includes a comparison of Base with Calaveras Up vs WSIP Proposed Program. DSOD restriction was implemented in 2001, with Calaveras Reservoir level reduction beginning in WY 2002.
- Analysis for WSIP only, no other cumulative projects analyzed.

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SOURCE: ESA+Orion.

Figure N.3
Comparison of Average Monthly Flow at the AC Niles Gage, Recorded Flow versus Calculated Flow under the WSIP

TABLE N.7
COMPARISON OF AVERAGE MONTHLY FLOW AT THE AC NILES GAGE, RECORDED FLOW VERSUS CALCULATED FLOW UNDER THE WSIP

Recorded Flow in Alameda Creek at Niles (cfs, avg. monthly)

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	Year Type
2000	44	41	28	165	606	469	74	46	26	27	29	29	AN
2001	50	35	55	65	128	79	44	22	14	10	27	27	BN
2002	33	53	302	329	71	76	27	34	30	39	38	36	BN
2003	34	91	513	126	56	50	131	97	35	33	30	33	N
2004	39	45	104	138	251	65	36	21	23	27	35	41	N
2005	83	45	148	262	374	638	300	98	55	46	57	51	AN
2006	30	32	287	242	94	551	986	361	172	53	44	39	AN
2007	28	45	82	38	202	61	61	47	32	43	35	37	D

Calculated Flow at Niles for Revised WSIP Proposed Program (cfs, avg. monthly)

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	Year Type
2000	44	41	28	171	728	513	76	49	26	27	29	29	AN
2001	50	35	55	65	128	79	44	22	14	10	27	27	BN
2002	33	53	302	329	68	76	27	34	30	39	38	36	BN
2003	34	91	474	114	53	48	130	97	35	33	30	33	N
2004	39	45	103	127	237	62	34	21	23	27	35	41	N
2005	83	45	127	216	341	562	340	99	55	46	57	51	AN
2006	30	32	267	205	85	513	1067	365	172	53	44	39	AN
2007	28	45	82	38	202	61	61	47	32	43	35	37	D

Difference Between Recorded and Calculated Flow for Revised WSIP Proposed Program at Niles (cfs, avg. monthly)

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	Year Type
2000	0 [0%]	0 [0%]	0 [1%]	6 [4%]	122 [20%]	44 [9%]	2 [3%]	3 [6%]	0 [0%]	0 [0%]	0 [0%]	0 [0%]	AN
2001	0 [0%]	0 [0%]	0 [0%]	0 [0%]	0 [0%]	0 [0%]	0 [0%]	0 [0%]	0 [0%]	0 [0%]	0 [0%]	0 [0%]	BN
2002	0 [0%]	0 [0%]	0 [0%]	0 [0%]	-2 -[3%]	0 [0%]	0 [1%]	0 [0%]	0 [0%]	0 [0%]	0 [0%]	0 [0%]	BN
2003	0 [0%]	0 [0%]	-40 -[8%]	-12 -[10%]	-3 -[5%]	-1 -[2%]	-1 -[1%]	0 [0%]	0 [0%]	0 [0%]	0 [0%]	0 [0%]	N
2004	0 [0%]	0 [0%]	-1 -[1%]	-11 -[8%]	-14 -[6%]	-2 -[4%]	-2 -[5%]	0 [0%]	0 [0%]	0 [0%]	0 [0%]	0 [0%]	N
2005	0 [0%]	0 [0%]	-20 -[14%]	-46 -[18%]	-33 -[9%]	-76 -[12%]	39 [13%]	1 [1%]	0 [0%]	0 [0%]	0 [0%]	0 [0%]	AN
2006	0 [0%]	0 [0%]	-19 -[7%]	-36 -[15%]	-9 -[10%]	-38 -[7%]	81 [8%]	4 [1%]	0 [0%]	0 [0%]	0 [0%]	0 [0%]	AN
2007	0 [0%]	0 [0%]	0 [0%]	0 [0%]	0 [0%]	0 [0%]	0 [0%]	0 [0%]	0 [0%]	0 [0%]	0 [0%]	0 [0%]	D

Increase of greater than 1%
Decrease of greater than 1%
Decrease of greater than 5%

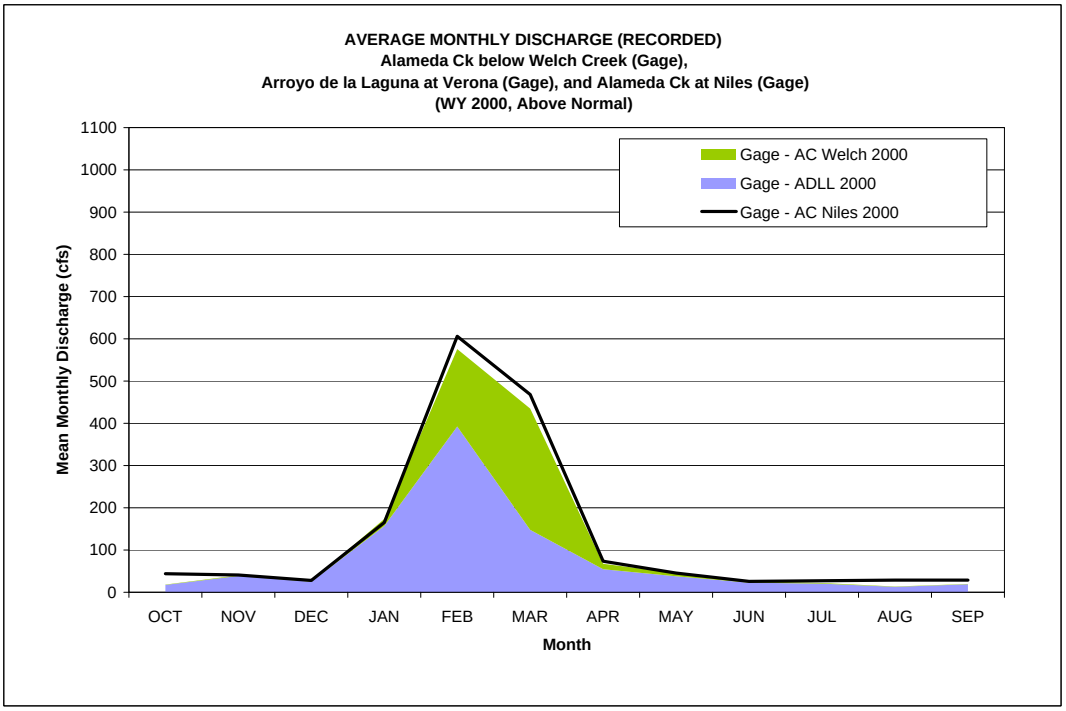
- As discussed previously, this analysis did not account for losses to groundwater in the Sunol Valley. Losses to groundwater can be significant, and inclusion of this assumption in the analysis would decrease the upper Alameda Creek contribution to flow at the AC Niles Gage and would mute the impacts of the WSIP, particularly if the future condition assumes less loss to groundwater with implementation of the slurry wall project adjacent to the Sunol Quarries. The current analysis is therefore conservative; however, including a quantified loss to groundwater in the Sunol reach was considered too speculative.

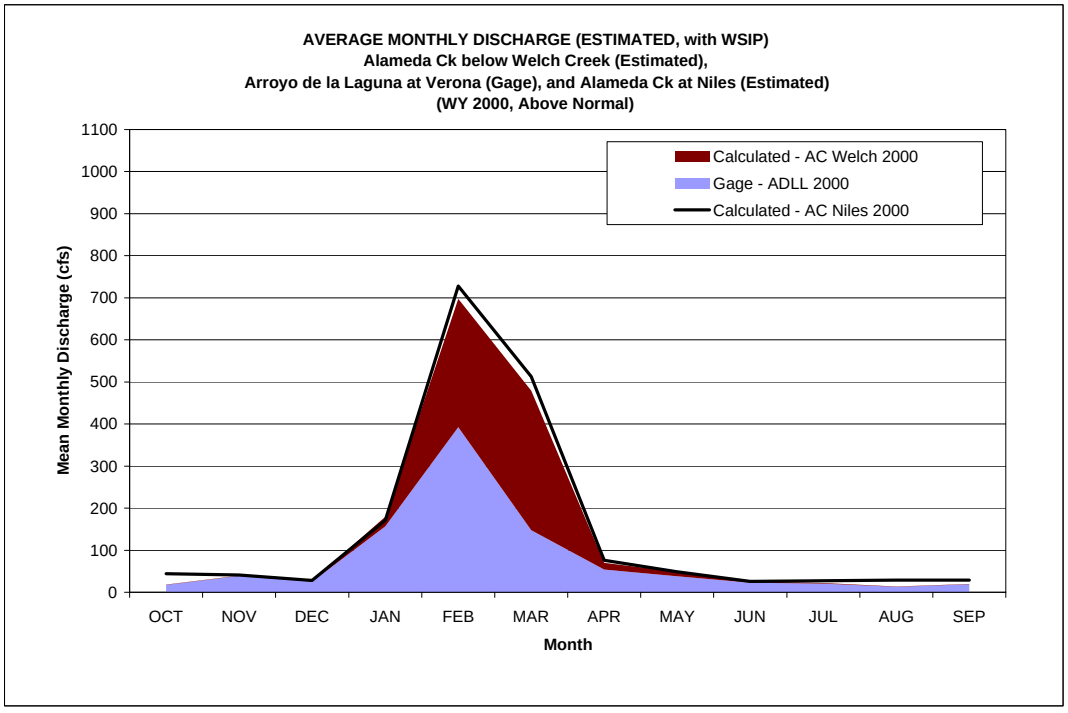
- A Wet year is not included in the analysis because one was not present in the available gage record. A Wet year could be synthesized; however, since the greatest effects of the WSIP are shown to occur in Above Normal and Normal years, the current analysis includes the year types with the greatest impact on flows.

- Actual upstream operations in the upper Alameda Creek and ADLL watersheds were not accounted for in the analysis. For instance, large spikes in flow in 2005 and 2006 are likely a result of DSOD-restricted operations as well as releases made from Calaveras Reservoir for the flow/infiltration studies in the Sunol Valley. The additional releases for these studies had the affect of increasing upper Alameda Creek's flow contribution at the Niles Gage. Similar operational anomalies could be reviewed for the ADLL watershed and used to refine the flow percentages from the upper watersheds, but such an effort exceeded the scope of this analysis.

APPENDIX N1

Annual Flow in Alameda Creek at the Niles Gage, Water Years 2000-2007 – Existing Condition and with Implementation of the WSIP





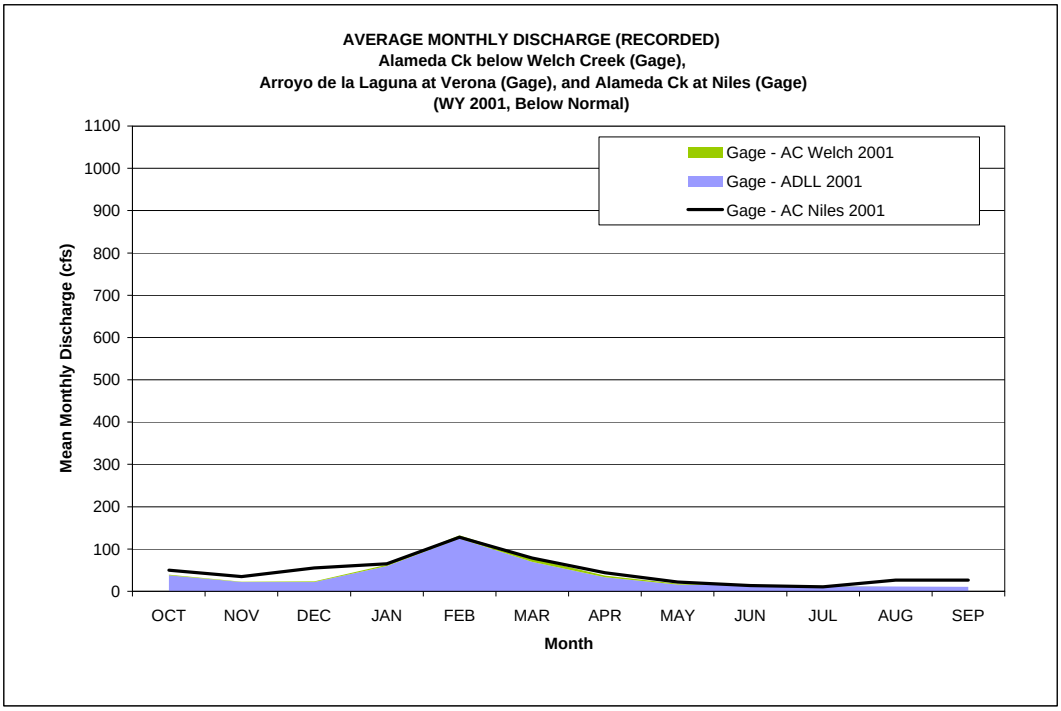
AC below Welch Ck, Gage versus Calculated w WSIP 2030

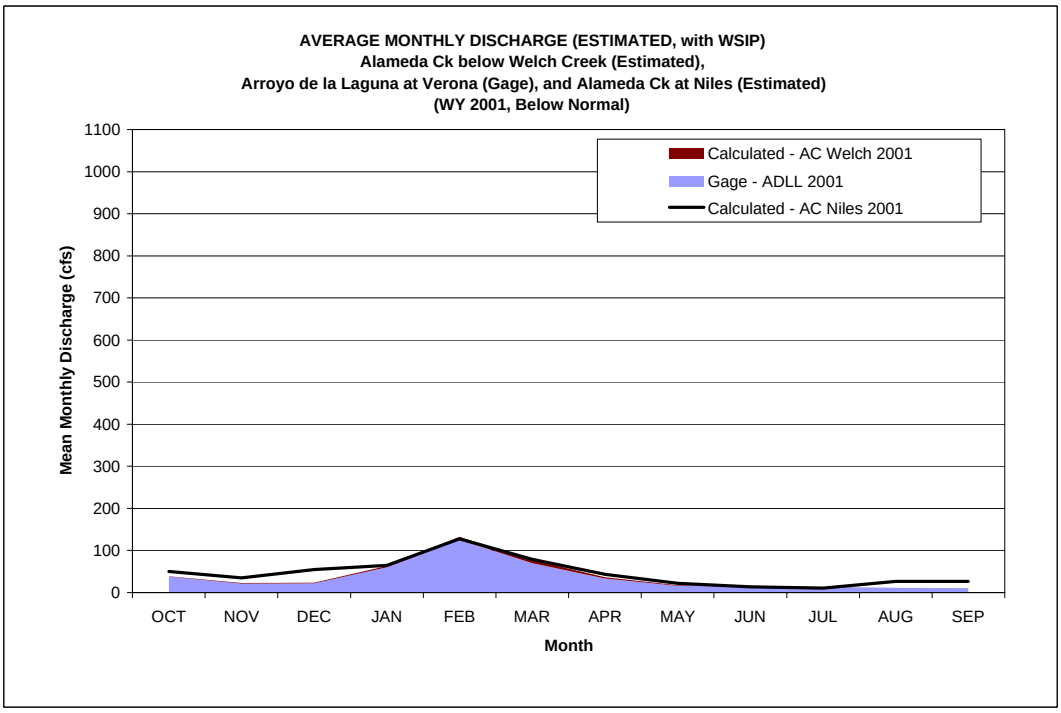
	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
2000	0	1	2	17	183	287	13	8	3	2	1	1
2000	0	1	2	23	305	331	16	10	3	2	1	1
Delta	0	0	0	6	122	44	2	3	0	0	0	0
Delta %	0%	0%	26%	38%	67%	15%	18%	38%	0%	0%	0%	0%

AC at Niles, Gage versus Calculated w WSIP 2030

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
2000	44.3	40.8	27.9	164.9	606.3	468.5	73.5	45.8	26.1	27.1	28.8	28.6
2000	44.3	40.8	28.3	171.2	728.1	512.8	75.9	48.7	26.1	27.1	28.8	28.6
Delta	0	0	0	6	122	44	2	3	0	0	0	0
Delta %	0%	0%	1%	4%	20%	9%	3%	6%	0%	0%	0%	0%

Increase of greater than 1% | Decrease of greater than 1% | Decrease of greater than 5%





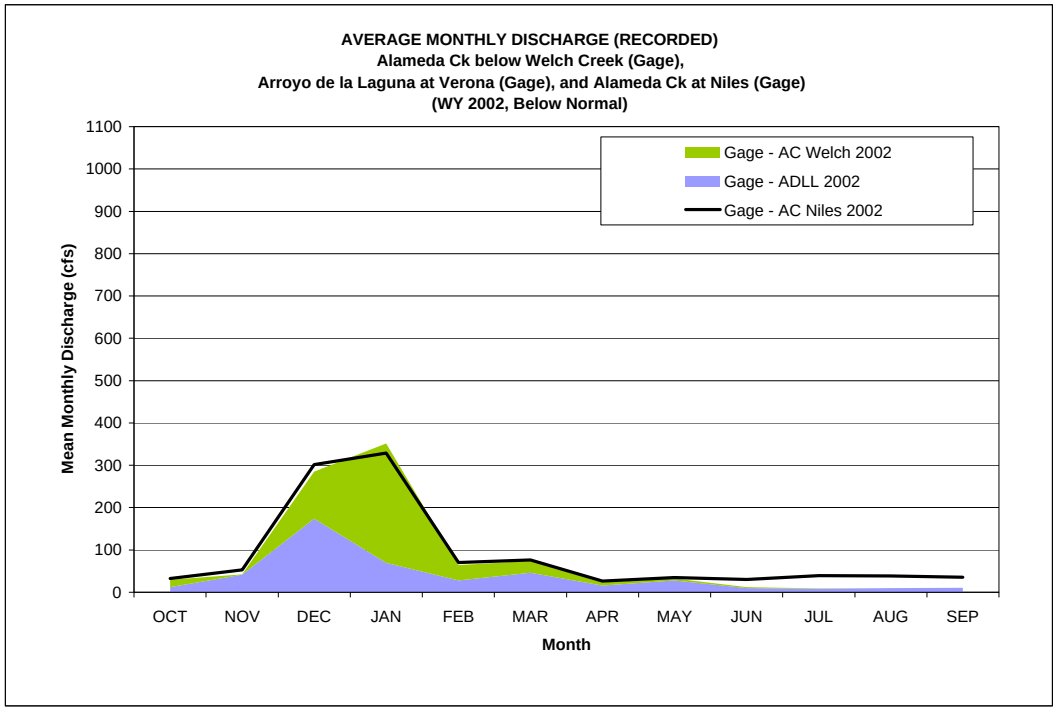
AC below Welch Ck, Gage versus Calculated w WSIP 2030

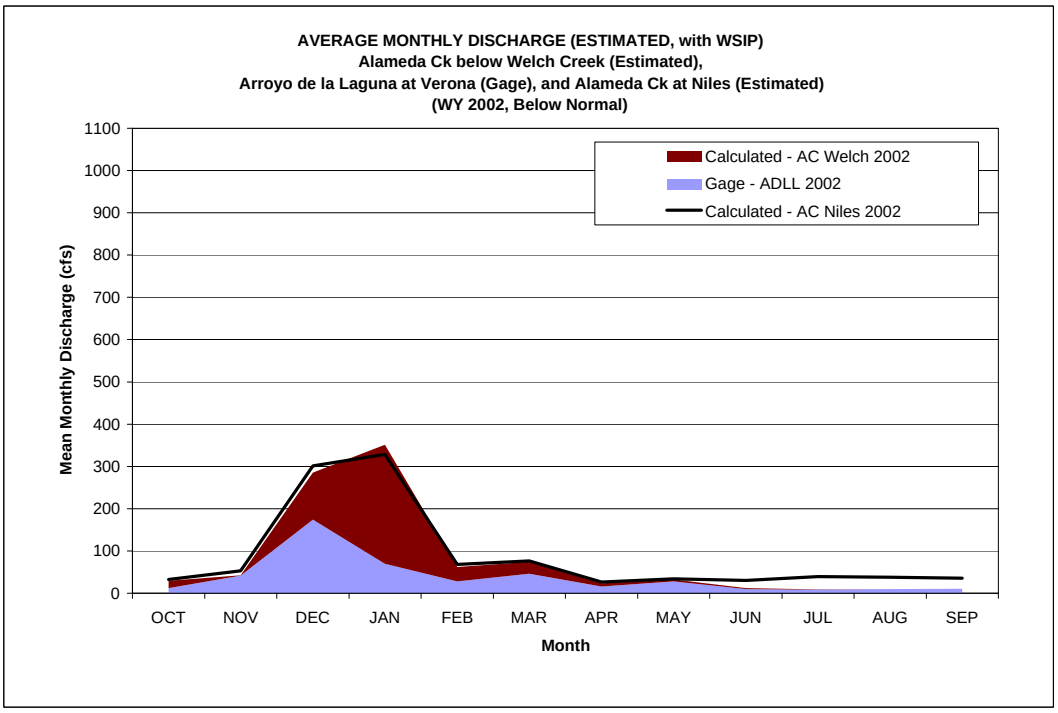
	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
2001	0.9	1.0	1.1	2.9	7.1	8.0	3.5	1.7	0.9	0.4	0.3	0.1
2001	0.9	1.0	1.1	2.9	7.1	8.0	3.5	1.7	0.9	0.4	0.3	0.1
Delta	0	0	0	0	0	0	0	0	0	0	0	0
Delta %	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

AC at Niles, Gage versus Calculated w WSIP 2030

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
2001	50.2	34.8	55.1	64.8	127.8	78.9	43.7	21.8	13.6	10.4	26.7	26.6
2001	50.2	34.8	55.1	64.8	127.8	78.9	43.7	21.8	13.6	10.4	26.7	26.6
Delta	0	0	0	0	0	0	0	0	0	0	0	0
Delta %	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

Increase of greater than 1% | Decrease of greater than 1% | Decrease of greater than 5%





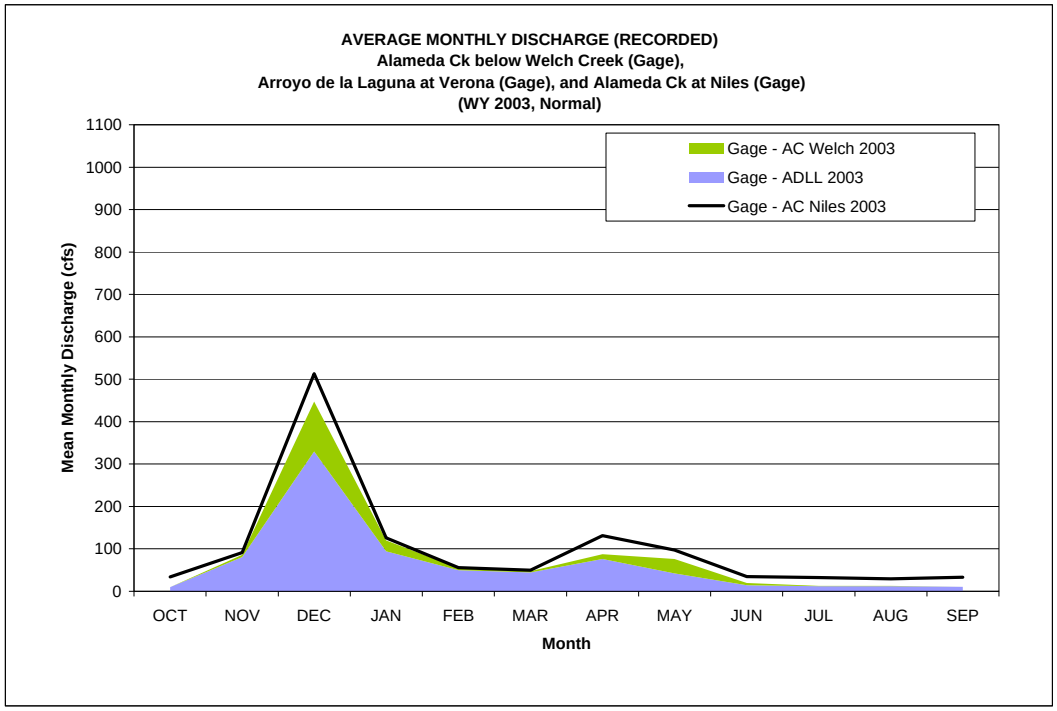
AC below Welch Ck, Gage versus Calculated w WSIP 2030

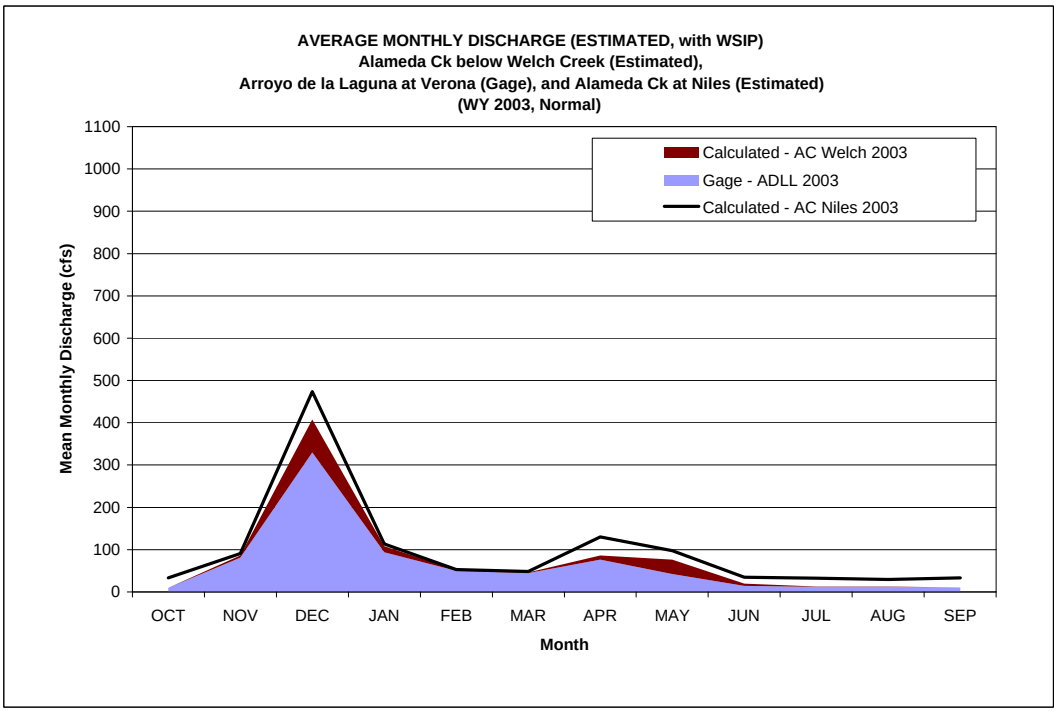
	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
2002	17.2	0.9	111.5	281.9	36.9	27.8	7.7	4.3	1.9	0.7	0.1	0.0
2002	17.2	0.9	111.5	281.9	34.7	27.8	7.9	4.3	1.9	0.7	0.1	0.0
Delta	0	0	0	0	-2	0	0	0	0	0	0	0
Delta %	0%	0%	0%	0%	-6%	0%	3%	0%	0%	0%	0%	0%

AC at Niles, Gage versus Calculated w WSIP 2030

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
2002	32.8	53.1	301.5	328.5	70.6	76.2	26.6	34.4	30.1	39.1	38.2	35.7
2002	32.8	53.1	301.5	328.5	68.4	76.2	26.8	34.4	30.1	39.1	38.2	35.7
Delta	0	0	0	0	-2	0	0	0	0	0	0	0
Delta %	0%	0%	0%	0%	-3%	0%	1%	0%	0%	0%	0%	0%

Increase of greater than 1% | Decrease of greater than 1% | Decrease of greater than 5%





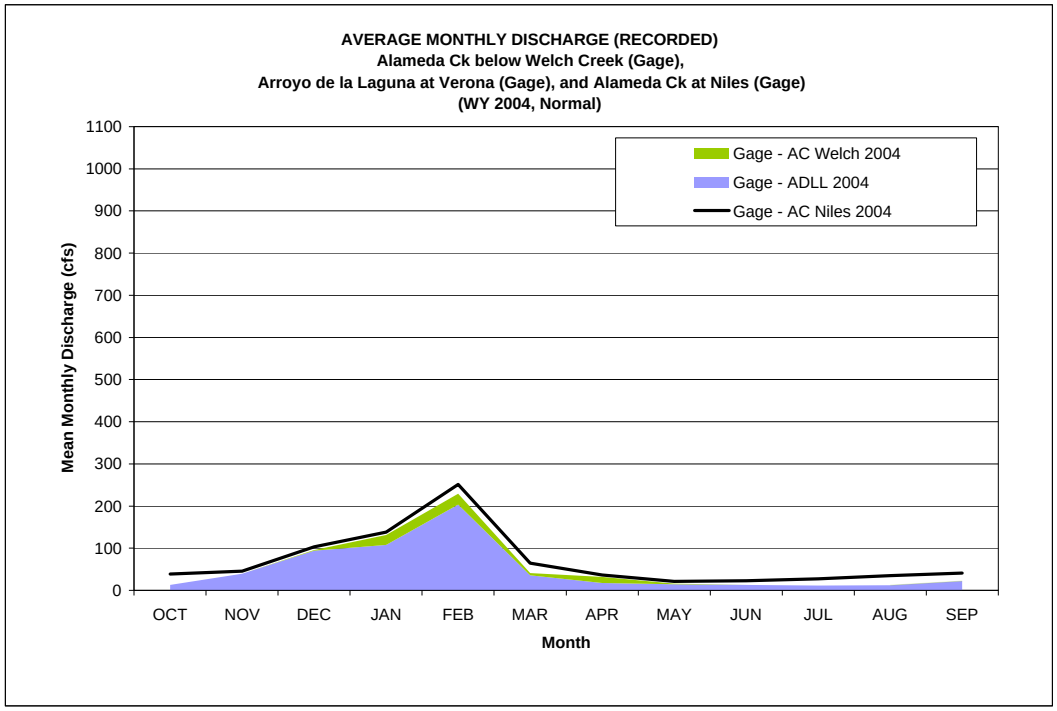
AC below Welch Ck, Gage versus Calculated w WSIP 2030

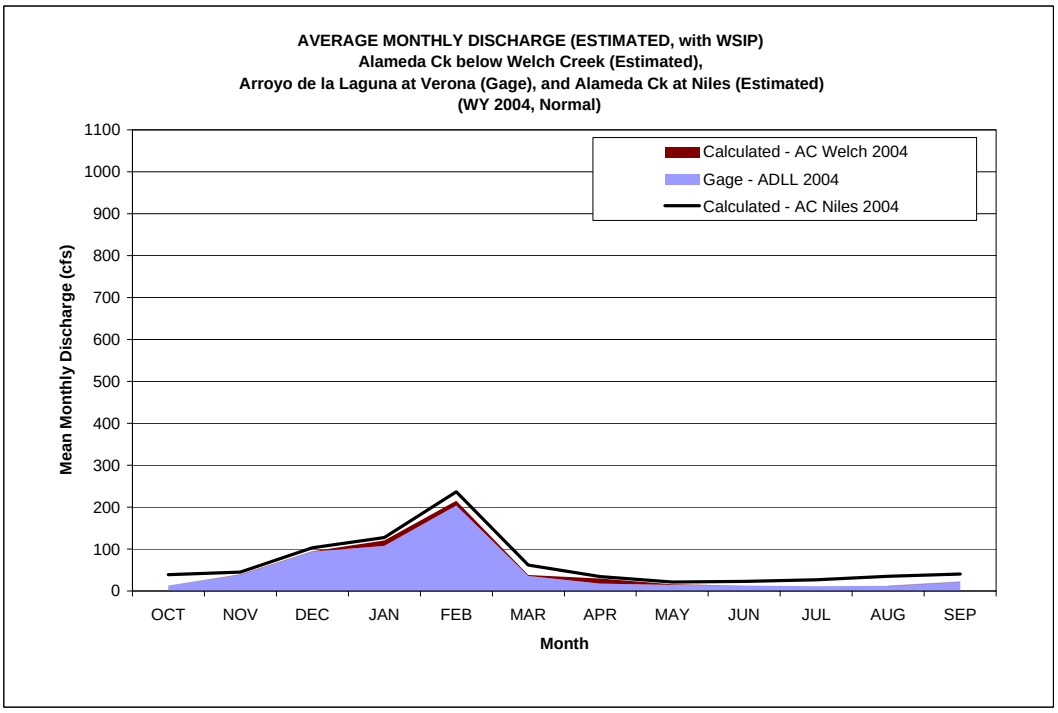
	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
2003	0.1	5.4	117.4	26.0	5.0	2.7	11.1	33.8	4.9	0.8	0.2	0.1
2003	0.1	5.4	77.8	13.8	2.2	1.5	9.8	33.8	4.9	0.8	0.2	0.1
Delta	0	0	-40	-12	-3	-1	-1	0	0	0	0	0
Delta %	0%	0%	-34%	-47%	-56%	-45%	-12%	0%	0%	0%	0%	0%

AC at Niles, Gage versus Calculated w WSIP 2030

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
2003	33.6	91	513.3	126	56.1	49.7	131.1	97.3	34.9	32.7	29.7	33
2003	33.6	91.0	473.7	113.8	53.3	48.5	129.8	97.3	34.9	32.7	29.7	33.0
Delta	0	0	-40	-12	-3	-1	-1	0	0	0	0	0
Delta %	0%	0%	-8%	-10%	-5%	-2%	-1%	0%	0%	0%	0%	0%

Increase of greater than 1% | Decrease of greater than 1% | Decrease of greater than 5%





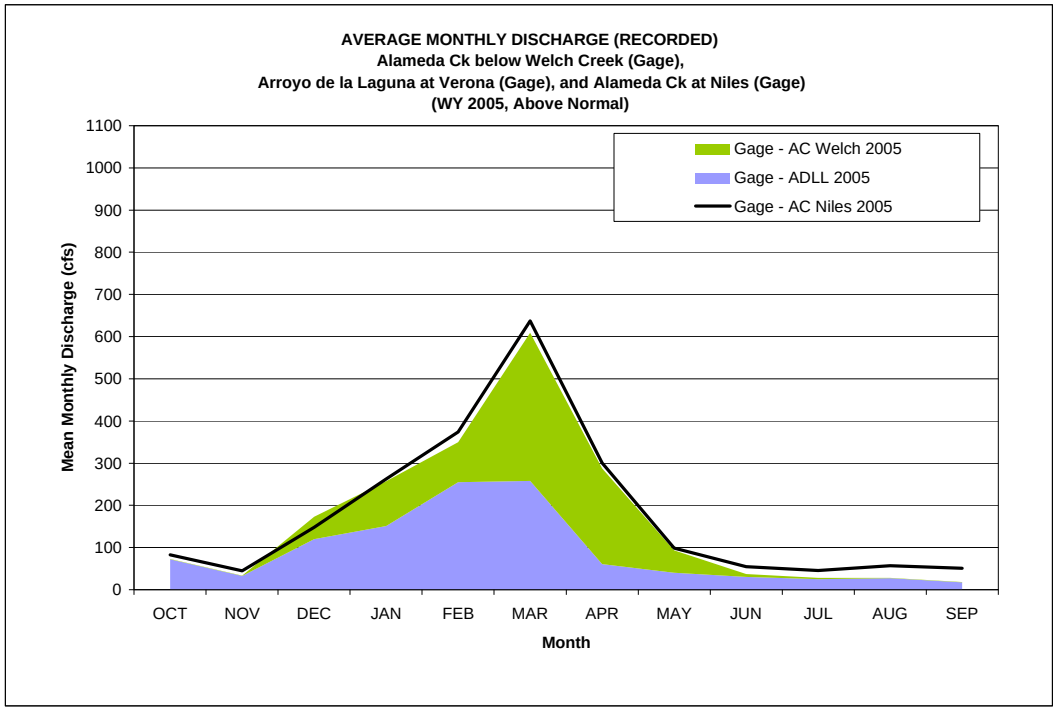
AC below Welch Ck, Gage versus Calculated w WSIP 2030

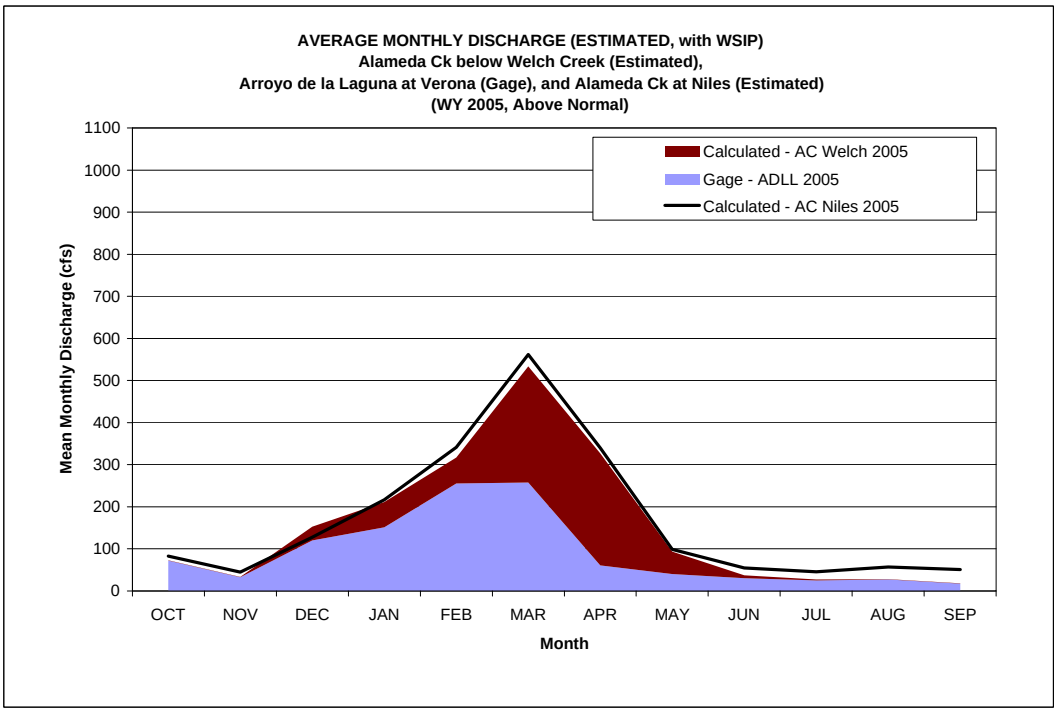
	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
2004	0.2	0.4	1.8	23.5	25.6	5.2	14.2	1.3	0.3	0.2	0.0	0.0
2004	0.2	0.4	1.2	12.5	11.2	2.8	12.5	1.3	0.3	0.2	0.0	0.0
Delta	0	0	-1	-11	-14	-2	-2	0	0	0	0	0
Delta %	0%	0%	-34%	-47%	-56%	-45%	-12%	0%	0%	0%	0%	0%

AC at Niles, Gage versus Calculated w WSIP 2030

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
2004	39	45.4	103.5	138.4	251.1	64.5	36.1	21.1	22.8	27	34.9	40.7
2004	39.0	45.4	102.9	127.4	236.7	62.1	34.4	21.1	22.8	27.0	34.9	40.7
Delta	0	0	-1	-11	-14	-2	-2	0	0	0	0	0
Delta %	0%	0%	-1%	-8%	-6%	-4%	-5%	0%	0%	0%	0%	0%

Increase of greater than 1% | Decrease of greater than 1% | Decrease of greater than 5%





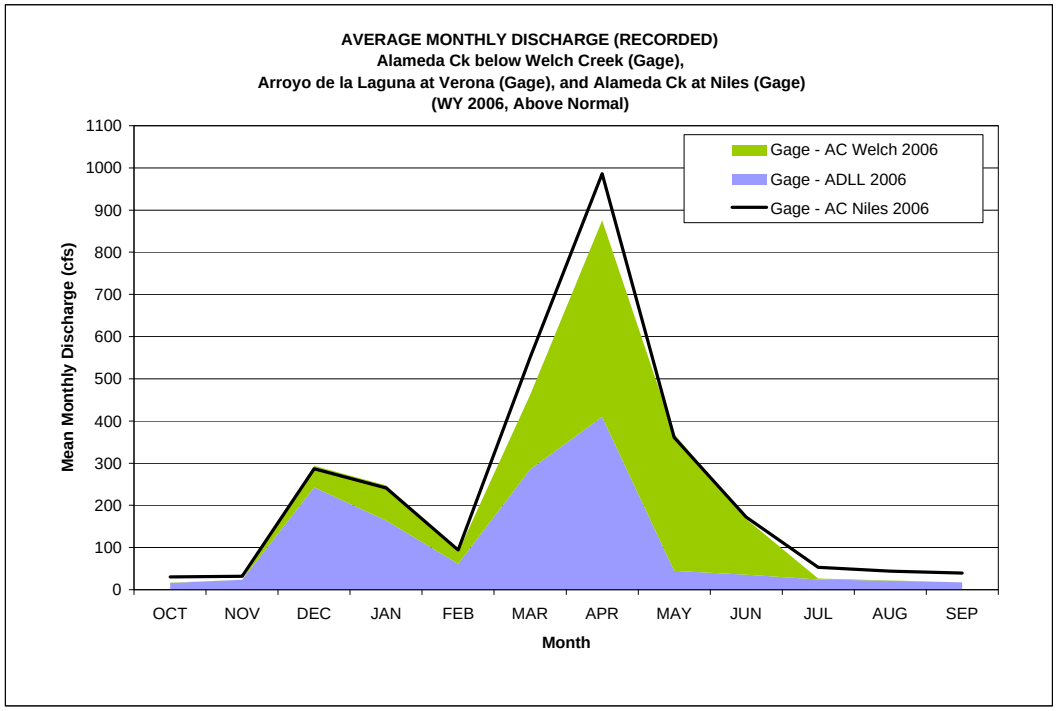
AC below Welch Ck, Gage versus Calculated w WSIP 2030

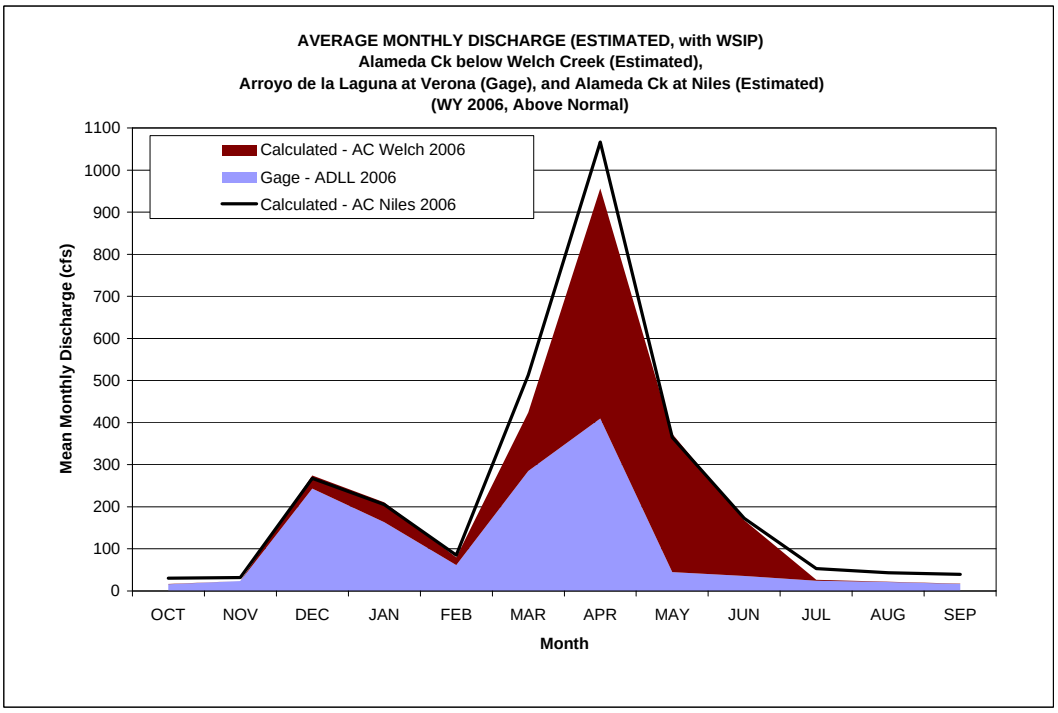
	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
2005	0.3	0.6	53.4	106.1	94.9	351.4	227.1	52.8	6.7	2.5	0.6	0.4
2005	0.3	0.6	33.0	60.1	62.1	275.9	266.5	53.4	6.7	2.5	0.6	0.4
Delta	0	0	-20	-46	-33	-76	39	1	0	0	0	0
Delta %	0%	0%	-38%	-43%	-35%	-21%	17%	1%	0%	0%	0%	0%

AC at Niles, Gage versus Calculated w WSIP 2030

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
2005	82.5	44.5	147.8	262.4	373.8	637.6	300.1	98.3	54.5	45.5	57.2	51.1
2005	82.5	44.5	127.4	216.4	341.0	562.1	339.5	98.9	54.5	45.5	57.2	51.1
Delta	0	0	-20	-46	-33	-76	39	1	0	0	0	0
Delta %	0%	0%	-14%	-18%	-9%	-12%	13%	1%	0%	0%	0%	0%

Increase of greater than 1% | Decrease of greater than 1% | Decrease of greater than 5%





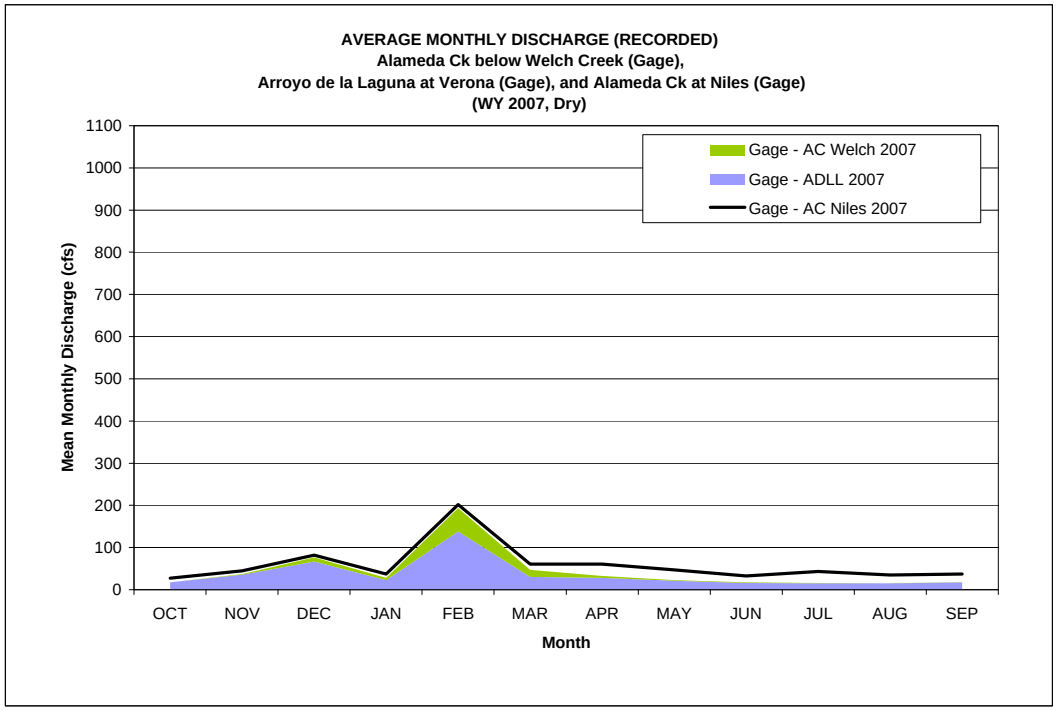
AC below Welch Ck, Gage versus Calculated w WSIP 2030

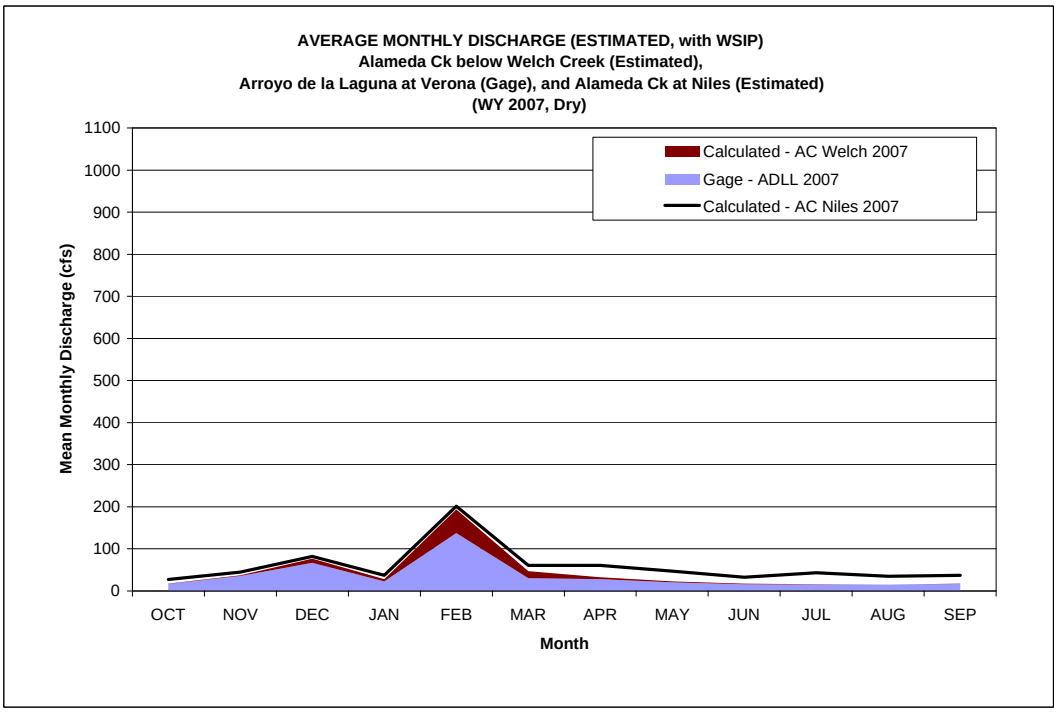
	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
2006	0.3	0.6	50.7	83.5	27.4	177.0	465.9	324.9	132.5	2.2	1.0	0.4
2006	0.3	0.6	31.3	47.3	17.9	138.9	546.7	328.4	132.5	2.2	1.0	0.4
Delta	0	0	-19	-36	-9	-38	81	4	0	0	0	0
Delta %	0%	0%	-38%	-43%	-35%	-21%	17%	1%	0%	0%	0%	0%

AC at Niles, Gage versus Calculated w WSIP 2030

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
2006	30.3	32.2	286.8	241.5	94.4	551	985.9	361.1	172.3	53.1	43.7	39.3
2006	30.3	32.2	267.4	205.3	84.9	512.9	1066.7	364.6	172.3	53.1	43.7	39.3
Delta	0	0	-19	-36	-9	-38	81	4	0	0	0	0
Delta %	0%	0%	-7%	-15%	-10%	-7%	8%	1%	0%	0%	0%	0%

Increase of greater than 1% | Decrease of greater than 1% | Decrease of greater than 5%





AC below Welch Ck, Gage versus Calculated w WSIP 2030

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
2007	0.6	1.8	9.9	5.1	55.8	16.4	4.4	2.0	0.8	0.3	0.1	0.0
2007	0.6	1.8	9.9	5.1	55.8	16.4	4.4	2.0	0.8	0.3	0.1	0.0
Delta	0	0	0	0	0	0	0	0	0	0	0	0
Delta %	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

AC at Niles, Gage versus Calculated w WSIP 2030

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
2007	27.6	45.1	81.8	37.5	201.6	61	60.9	47	32.4	43.4	35.1	36.9
2007	27.6	45.1	81.8	37.5	201.6	61.0	60.9	47.0	32.4	43.4	35.1	36.9
Delta	0	0	0	0	0	0	0	0	0	0	0	0
Delta %	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

Increase of greater than 1% | Decrease of greater than 1% | Decrease of greater than 5%