APPENDIX B.
Hydrologic Analysis of the Yuba County Water Agency Lower Yuba River Accord Pilot 2006 EWA/DWR Transfer
Prepared by Stephen Grinnell, P.E. MWH

Introduction

The Yuba County Water Agency (YCWA) plans to transfer up to a total of 125,000 acre-ft of water in 2006. YCWA plans to transfer at least 62,000 acre-ft of this water to the California Department of Water Resources (DWR) for the CALFED Environmental Water Account (EWA), and the balance to DWR for the EWA or DWR's 2006 dry year program. The transfer is planned to occur between April 1, 2006 and February 28, 2007. A portion of the water transfer will be from storage in New Bullards Bar Reservoir and a portion may be from substitution of groundwater for surface water deliveries by several member units of YCWA.

The planned transfer will change flows in the Yuba River below Englebright Dam. Because of the widely varying hydrology of the Yuba River from year to year, and because the 2006 water year is unknown at this time, the water year could result in a wide range of hydrologic conditions. This analysis has been conducted to examine the potential range of hydrologic conditions that could occur in the absence of the transfer, and then transfer operations have been included in the set of operational conditions and analyzed to determine the effects of the transfer when compared to the without-transfer conditions.

The YCWA 2006 transfer will be accomplished by operating the Yuba River Development Project (YRDP) facilities to comply with one of 6 flow schedules that have been developed by YCWA and other entities in a collaborative process called the Lower Yuba River Accord (LYR Accord). The specific flow schedule to be followed will be determined using an index that is a combination of the volume of active storage that remained in New Bullards Bar Reservoir on September 30, 2005, plus the total inflow volume to New Bullards Bar Reservoir in 2006. The combined volume of water is indexed to the 6 flows schedules and is called the North Yuba Index. The amount of active storage in New Bullards Bar Reservoir on September 30, 2005 was 474,999 acre-ft (total storage of 708,999 - 234,000 minimum FERC license storage). New Bullards Bar total inflow for 2006 is calculated by adding the measured inflow to date plus the forecasted inflow volume for the remainder of the 2006 water year. Complete descriptions of the North Yuba Index, and the LYR Accord flow schedules were provided as exhibits to the transfer petition filed with the SWRCB. An additional part of the LYR

Accord is an end of September target storage in New Bullards Bar reservoir of 650,000 acre-ft, which is 55,000 acre-ft lower than the operationally target previously used by YCWA, which is part of the operational conditions agreed to with PG&E in the 1966 YCWA-PG&E Power Purchase Agreement. This lower storage target for the end of September results in increased releases from storage during the summer months of wetter years when storage is relatively high and storage operations govern the release schedule from New Bullards Bar Reservoir.

The transfer water will be provided to the Delta for export by DWR by YCWA releasing water that would have otherwise been stored without the operations to meet the LYR Accord flow schedules or to meet the end of September storage target. Supplemental transfer water may also be released if YCWA decides to released water from storage by further reducing storage beyond that required to meet the flow schedules and target storage of the LYR Accord and the flows that would occur in the absence of the transfer. Additional transfer flows could also be released to the Delta if YCWA and Member Units decide to implement a groundwater substitution program in 2006.

This hydrologic analysis addresses the following parameters and assumptions;

- Determination of the range and probability of occurrence of flows and temperatures in the Lower Yuba River that would occur without a transfer and with YCWA operations to comply with the SWRCB RD-1644 Long Term flow requirements. This is the without-transfer condition assuming the SWRCB RD-1644 Long Term flows requirements would be implemented.

- Determination of the range and probability of occurrence of flows and temperatures in the Lower Yuba River that would occur without a transfer, with YCWA operations to comply with the SWRCB RD-1644 Interim flow requirements. This is the without-transfer condition assuming the SWRCB RD-1644 Interim flows requirements would be continued.

- Determination of the range and probability of occurrence of flows and temperatures in the Lower Yuba River that would occur with the proposed transfer, with YCWA operations to comply with the SWRCB RD-1644 Interim flow requirements and the flow schedules of the LYR Accord, whichever is the higher requirement.

- Determination of the amount and timing of transfer water storage and releases that would occur with YCWA operations to comply with the SWRCB RD-1644 Long Term flow requirements and the flow schedules of the LYR Accord, when these resulting flows are compared to the storage and release of water that would result from YCWA operations to comply with the SWRCB RD-1644 Long Term flow requirements.

- Determination of the additional amount and timing of transfer water storage and releases that would result from using as the without-transfer condition the storage and releases resulting from YCWA operations to comply with SWRCB RD-1644 Interim flow requirements versus using the storage and releases resulting from YCWA operations to comply with the flow schedules of the LYR Accord and the SWRCB RD-1644 Interim flow requirements.

- Assessment of the potential increased diversion delivery shortages that would occur in 2007 if YCWA were to operate to the flow schedules of the LYR Accord, and an extension of the RD-1644 Interim flow requirements until March 1, 2007 were not granted by the SWRCB, thereby requiring operation to the RD-1644 Long Term requirements in addition to the LYR Accord flow schedules.

Surface Water Modeling Description

The YCWA YRDP facilities were simulated using the Lower Yuba River Basin Model (LYRBM) developed by MWH for modeling the lower Yuba River. The model operates on a monthly time-step, and uses inflows that are a result of modeling historical hydrology routed through the Yuba River upper basin facilities which have been simulated to operate under current operational constraints. This upper basin simulation was completed using an HEC-5 model developed by Bookman Edmonston Engineering for the 2001 SWRCB Lower Yuba River hearings.

The HEC-5 model results are used as inputs to the LYRBM which define the monthly inflows to New Bullards Bar Reservoir, Englebright Reservoir, and flows from Deer Creek for 1922 through 2004. The primary operational objectives for reservoir operations in the LYRBM are flood control, agricultural water supply, power generation and instream flows. The features modeled by the LYRBM include New Bullards Bar Reservoir, Englebright Reservoir, the Lower Yuba River between Englebright Dam and Daguerre Point Dam, diversions at Daguerre Point Dam and the Lower Yuba River from Daguerre Point Dam to Marysville. The LYRBM has been verified by comparing results from this model against the results of the HEC-5 Yuba Basin model, which was reviewed by DWR for the 2001 SWRCB hearings.

The LYRBM simulation includes operations for several sets of requirements for the lower Yuba River and New Bullards Bar Reservoir. These sets of requirements include the following:

- Federal Energy Regulatory Commission (FERC) License for Yuba River Development Project
- 1966 Pacific Gas & Electric (PG&E) Power Purchase Contract (when implemented in the model)
- Flood Control Agreement Between YCWA and the U.S. Army Corps of Engineers
- 1993 Narrows I FERC License
- Yuba County Water Agency Water Right Permits and Member Unit Contracts
- Lower Yuba River Accord (when implemented in the model)
- RD-1644 flow requirements (Interim or Long Term flow schedules as selected)
- Minimum monthly power generation (set at 18,500 Megawatt-hours for all scenarios)
- Target storage operating line (varies by scenario)

New Bullards Bar Reservoir is the major storage facility of the YRDP and the primary operational feature of the LYRBM. The reservoir has a total storage capacity of 966,000 acre-feet with a minimum pool of 234,000 acre-feet, leaving 732,000 acre-feet of operable storage. A portion of the storage, 170,000 acre-feet, is reserved from September through April for flood control. Releases from New Bullards Bar Reservoir are made through either the Colgate Powerhouse, with a release capacity of 3,700 cubic feet per second (cfs), the dam's bottom outlet, or a gated spillway.

Englebright Reservoir has a total storage capacity of 70,000 acre-feet, but this capacity normally is used only for day-to-day regulation of flows. Englebright Reservoir receives flows from New Bullards Bar Reservoir and flows from the Middle and South Yuba Rivers. Releases are made through the Narrows I and II powerhouses, with a combined capacity of 4,170 cfs and over an uncontrolled spillway. Since the LYRBM operates on a monthly time-step, Englebright Reservoir storage is not simulated and all inflows to the reservoir are released within the same time step. New Bullards Bar Reservoir operations take into consideration Englebright Reservoir inflows from the Middle and South Yuba Rivers and the Narrows I and II powerhouses capacities to obtain release amounts to meet downstream demands for each time-step.

The lower Yuba River refers to the 24-mile section of the river between Englebright Dam and the confluence with the Feather River south of Marysville. Instream flow requirements are specified on the lower Yuba River at the Smartville Gage immediately below Englebright Dam, and at the Marysville Gage near the confluence of the Yuba and Feather Rivers.

Daguerre Point Dam controls water elevations for irrigation diversions into the Hallwood-Cordua Canal (North Canal) and South Yuba Canal (South Canal). Browns Valley Irrigation District diverts water at its Pumpline Diversion Facility, approximately 1 mile upstream from Daguerre Point Dam. Cordua Irrigation District, Hallwood Irrigation Company, and Ramirez Water District receive water via North Canal from the north side of the Yuba River just upstream from the north abutment of Daguerre Point Dam. Brophy Water District, South Yuba Water District, and Dry Creek Mutual Water Company receive water via the South Canal from the south side of the Yuba River just upstream from the south abutment of Daguerre Point Dam. For the LYRBM, all diversions are assumed to occur at Daguerre Point Dam.

Modeling the Lower Yuba River for 2006

For the 2006 transfer, the LYRBM simulates water year 2006 (October 2005 through September 2006) and the 2007 water year (October 2006 through September 2007) using a Monte Carlo simulation. Because the sequence of hydrologic conditions in 2006 or 2007 cannot be predicted at this time, the Monte Carlo simulation uses historical conditions of each 2 water year pair from 1922 to 2004 to represent a range of historical hydrology with the starting reservoir conditions for water year 2006 and current operational constraints as listed above. Therefore, 83 two-year series of monthly hydrologic conditions are modeled and results are calculated. In other words, 1922 and 1923 hydrology are used for 2006 and 2007, then 1923 and 1924 hydrology are used for 2006 and 2007, then 1924 and 1925 and so on. For the 2006 water year, the starting storage condition (end-of-September New Bullards Bar storage) modeled was 708,000 acre-feet. Using this starting condition for each simulation period, the Monte Carlo LYRBM simulates lower Yuba River flows for 24 months, using the 24 months of historical inflows for each of the 83 time periods of 1922 through 2004 as described above, generating a range of hydrologic conditions for the 2006 and 2007 water years varying from very wet to very dry. This range of possible outcomes can be used to statistically identify the potential occurrence of reservoir and river conditions for 2006. For the analysis to determine flows, temperatures and transfer storage and releases, only the months of April 2006 to February 2007 transfer period are used from the modeling.

Modeling results from the Monte Carlo simulation provide information about lower Yuba River operations, including reservoir storage, power generation, flows at Smartville, diversions from Daguerre Point Dam, and flows at Marysville. The flow results for the lower Yuba River are, in turn, used with a temperature model to predict the ranges of temperatures expected on the Lower Yuba River, as discussed below.

Surface water modeling for the Lower Yuba River 2006 transfer involved four alternative flow and operational scenarios:

- RD-1644 Interim flow requirements
- RD-1644 Long Term flow requirements
- Lower Yuba River Accord Flow and related requirements, where the RD-1644 Interim flow requirements are also complied with
- Lower Yuba River Accord Flow and related requirements, where the RD-1644 Long Term flow requirements are also complied with (this scenario is used for determination of transfer amounts under the LYR Accord combined with RD-1644 Long Term versus transfer amounts under the LYR Accord combined with RD-1644 Interim)

All four alternatives include the present level of demands for diversions from Daguerre Point Dam. One of the operational constraints of the YRDP and modeled is to attempt to protect against drought conditions and the potential for diversion delivery shortage. This is accomplished by maintaining a storage amount (carryover storage) on September 30 in New Bullards Bar Reservoir that would ensure providing at least 50 percent of local diversion demands in the following year, if the following year were to have 1-in-100-year drought conditions. This carryover storage amount is used to determine when and how much shortage in diversion deliveries would be imposed in the current year to maintain storage at the required carryover storage amount.

For the LYR Accord in 2006, the starting storage amount, used for the North Yuba Index, is already known, and therefore the probability of occurrence of the various flow schedules is based on the probability of inflow volume to New Bullards Bar Reservoir for the 2006 water year. The 2005 water year was very wet, and the 2005 YCWA-DWR transfer operations did not take place before September 30, 2005 because of Delta conditions. Therefore YCWA operated to meet the end of September target of 705,000 acre-ft, and actual storage was at 708,999 acre-ft on September 30, 2005. Because of the wet conditions, the amount of active storage in New Bullards Bar Reservoir was 474,999 acre-ft. This amount of storage is well above the maximum amount of September 30th storage that would typically be reached under long term LYR Accord implementation, and is well above the storages used to determining the North Yuba River Index values for the six flow schedules. Because of the high storage amount for calculating the North Yuba Index, the probability of occurrence of the various schedules for 2006 is skewed heavily to the wetter schedules. As example, the LYR Accord flow schedules and North

Yuba Index were designed so that either a schedule 4, 5, 6 or a Conference Year would occur with a 15 percent probability. For the 2006 water year the probability of one of these schedule years occurring is 8.9 percent. Additionally, although it is statistically possible to have a conference year in 2006, the inflow into New Bullards Bar Reservoir would have to be less than 25,001 acre-ft for this to occur and over 20,000 acre-ft of inflow already has occurred during the first month and one half of the water year, so a Conference Year in 2006 is very unlikely. Table 1 shows the probability of occurrence for the LYR Accord schedules for 2006.

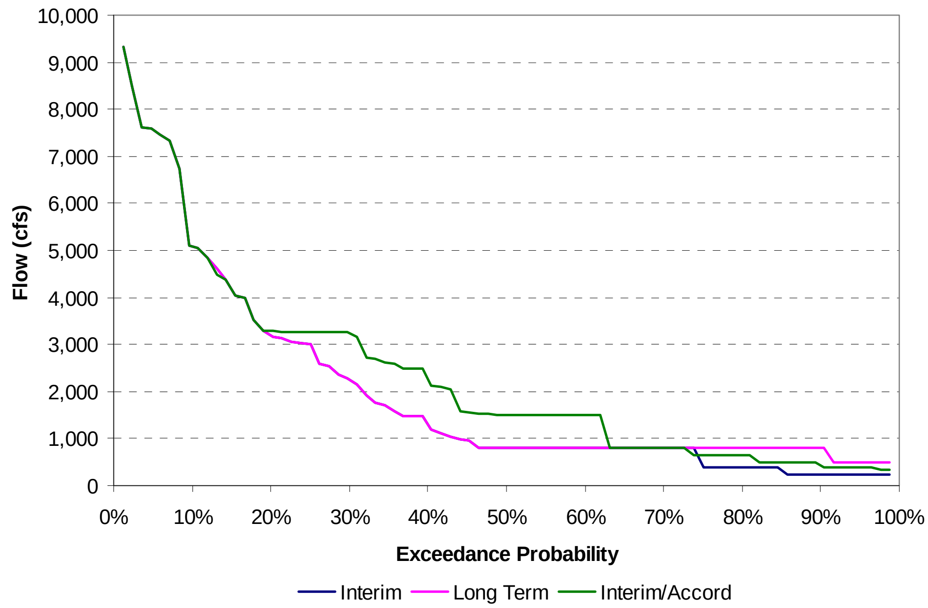
Table 1. Probability of Occurrence of LYR Accord Schedules for 2006

North Yuba Index	Percent	Schedule	% Exceedance
500	0.4%	Conf.	
693	2.0%	6	99.6%
820	3.0%	5	97.7%
920	3.5%	4	94.7%
1,040	5.5%	3	91.1%
1,400	21.8%	2	85.7%
> 1,400	63.9%	1	63.9%
Total	100%		

Simulation Results

The results of the Monte Carlo simulation are 83 separate series of monthly New Bullards Bar Reservoir storage values, and flows in the Lower Yuba River. For each month (April 2006 through February 2007) the 83 values from the Monte Carlo simulation are ranked in order from highest to lowest and plotted against exceedance probability. Plotting position (rank/(1+ n), where n = 83) is used to determine exceedance probability. Figure 1 is an example of the results of flows for a single month simulated for the 83 years of hydrologic conditions, for the three flow requirement scenarios. Results for the months April 2006 through February 2007 are attached to this report as Attachment A. The three scenarios are labeled in the plots as "Interim", representing the results of the flow analysis for simulated operations to RD-1644 Interim flow requirements; "Long Term", representing the results of the flow analysis for simulated operations to RD-1644 Long Term flow requirements; and "Interim/Accord", representing the results of the flow analysis for simulated operations for the combination of the LYR Accord and the RD-1644 Interim flow requirements, with each day's requirement being the greater of the LYR Accord requirement and the RD-1644 Interim requirement for that day.

Figure 1. Exceedance Probability of Yuba River Flow at Marysville for June 2006



Supplemental Releases and Groundwater Substitution

In addition to operation to the LYR Accord, YCWA may release additional water from storage during July and August of 2006 to augment the transfer flows of the LYR Accord. Member Units of the YCWA may also pump groundwater as a substitution for surface water deliveries and the forgone surface water diversions will be made available by YCWA releasing this water to the Delta during July and August of 2006.

Supplemental storage releases would be made only if the water year is relatively wet and storage in New Bullards Bar would be at or near 650,000 acre-ft at the end of September without these releases. Storage must be at or near this level to ensure that the supplemental releases do not impact YCWA's ability to provide full diversion demand deliveries in 2007 if 2007 were to be a dry year. The hydrologic conditions that are needed for a supplemental transfer release in 2006 are relatively wet conditions on the Yuba River for the reason described above, but moderate to dry for the rest of the Sacramento River Valley, because capacity must exist at the export pumps to export the supplemental releases. It is very unlikely that this combination of hydrological conditions will occur.

The maximum amount of supplemental storage release for the 2006 transfer would be about 50,000 acre-ft. This would result in a minimum end of September storage in New Bullards Bar Reservoir of about 600,000 acre-ft. The water would be released in the months of July and August at flow rate of about 450 cfs and would be in addition to the flows released for the LYR Accord flow schedules and releases to meet the target storage of 650,000 acre-ft. These releases, if they were to occur, would be implemented in a gradual manner, and in compliance with the ramping rates of the LYR Accord. The possibility of these potential releases would raise by about 450 cfs very small portions of the green curves in the attached Figures A-7 through A-10 at some point near the 20 to 25% exceedance probabilities.

Groundwater substitution would be implemented only if conditions were dry enough so that excess capacity existed at the SWP and CVP export pumps to export the water in the summer of 2006, and there was a need for the water in the SWP and CVP service areas. On the Yuba River, groundwater substitution would be initiated only if conditions were dry and stored water in New Bullards Bar Reservoir were not available for supplemental transfer releases.

The maximum groundwater substitution amount would be 85,000 acre-ft. This water would be delivered during the months of July and August, at flow rate of about 750 cfs and would be in addition to the flows released for the LYR Accord flow schedules. These releases, if they were to occur, would be implemented in a gradual manner, and complying with the ramping rates of the LYR Accord. The possibility of these potential releases would raise by about 750 cfs some portions of the green curves in the attached Figures A-7 through A-10 at some points in the 60 to 99% exceedance probability range.

Because either a supplemental surface water transfer or a groundwater substitution transfer would occur only during July and August, such a transfer would not affect the curves for any of the other months in Attachment A.

Lower Yuba River Temperature Modeling

Temperature modeling of the lower Yuba River focuses on predicting temperatures at two locations on the Lower Yuba River: at Daguerre Point Dam and at the Marysville Gage. The purpose of the analysis is to determine the relative effect of flow on water temperature for the two locations of interest. This analysis provides a relative comparison of the changes in water temperature that would occur with the 2006 YCWA transfer and operation to the LYR Accord flow schedules versus without-transfer conditions. For the temperature model, water temperatures at Daguerre Point Dam and the Marysville gage are simulated on a monthly basis.

Temperature modeling analysis for the SWRCB 2001 hearings showed that the main variables for prediction of water temperature in the Lower Yuba River are the release temperature at Narrows II powerhouse, located below Englebright Reservoir, the Marysville air temperature, and the flow of the Lower Yuba River.

Temperatures for the analysis are calculated using flow output results from the LYRBM. These flows are used in a multivariate linear statistical model to calculate temperatures. The multivariate linear statistical model was determined through regression analysis on available historical flow and temperature data. A significant amount of temperature data has been collected since 1999 on the Lower Yuba River. Prior to 1999 very little temperature data was available for the Daguerre Dam location. The new Daguerre Dam temperature data has allowed for regression analysis of this information to develop a statistical model for predicting temperatures at Daguerre Dam, which previously was done in an indirect manner and less accurate approach. The new data also has provided greater insight into the relative influence of flow, air temperature and other influences, such as Yuba Goldfield flow returns to the Yuba River, on water temperature at the Marysville Gage.

Development of the statistical temperature model is done using daily data. Because of the strong influence of release temperature on water temperature at Daguerre Dam and Marysville Gage, the regressions use the Narrows II release temperature as an upstream condition. Both regressions were determined using historical daily data for 1999 through 2005. Flow results from the LYRBM are for the period of 1922 to 2004. Available temperature data for the two variables besides flow that are used in the statistical model are the Narrows II temperature release and the Marysville air temperature. Because of a lack of available historical daily data (or monthly data for Narrows II releases) for the full period of record, the Narrows II release temperature and Marysville air temperatures used in the temperature prediction are defined as a single series of 12 monthly values. These values are the historical average monthly Narrows II release temperature and Marysville daily mean air temperatures. These 12 month series of values are used for all scenarios modeled. As a result, all variation in water temperature from one scenario to another is a result of the flow amount variation.

Daguerre Point Dam Water Temperature

As previously described, Daguerre Point Dam is approximately 12 miles downstream of Englebright Dam. The terrain for this reach of the river varies significantly, changing from a steep, narrow gorge near Englebright Dam, to a wide, flat, open area near Daguerre Point. Also, multiple accretions and depletions exist between Englebright and Daguerre Point, including Deer Creek, Dry Creek, and the Yuba River Goldfields. While a flow gage is present at the mouth of Deer Creek, there are very limited temperature data below Smartville and no flow gages below Deer Creek except for the Marysville gage.

Historical data used for developing a statistical model of water temperatures at Daguerre Point Dam include the Yuba River flow at the Smartville gage, Narrows II release temperature, Daguerre Point Dam water temperature, and Marysville air temperature. Daily data for these variables are available from 1999 through 2005. Regression equations are used to relate Daguerre Point Dam water temperature to flow at the Smartville gage, Narrows II release temperature, and air temperature at Marysville.

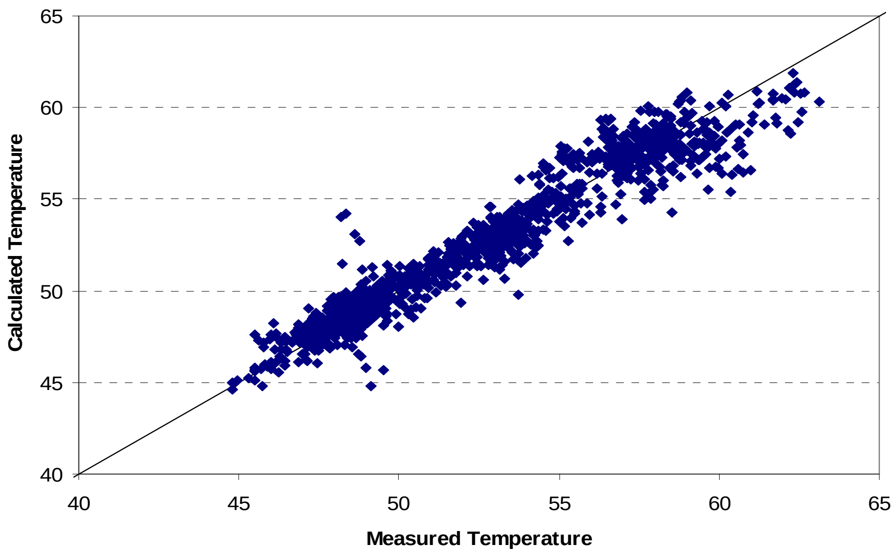
The statistical temperature model resulting from regression analysis use a single set of coefficients for all months. The independent variables for the model are: Narrows II release temperature, flow at Smartville, and average monthly air temperature at Marysville. The representative equation has the form:

DGP = 0.83 * (N2) + 0.16*(Air) -7.79E-5*(YRS)

Where:
DGP = Water temperature at Daguerre Point Dam (degrees Fahrenheit)
N2 = Release temperature of Narrows II powerhouse (degrees Fahrenheit)
Air = Air temperature at Marysville (degrees Fahrenheit)
YRS = Flow at Smartville (cfs)

As shown in the equation, the Narrows II release temperature has the strongest influence on water temperatures at Daguerre Dam, with a .83 coefficient. This relationship has an R-squared value of .95. Figure 2 is a scatter plot of the calculated daily water temperature at Daguerre Point Dam versus the measured daily water temperature.

Figure 2. Measure Daguerre Point Dam Daily Water temperature Versus Calculated Daily Water Temperature



Marysville Gage Water Temperature

The Marysville gage is approximately 6 miles downstream from Daguerre Point Dam. The river in this reach is relatively wide and flat, with very little cover or shade. Few accretions or depletions are present in this reach. While the Yuba Goldfields have an influence on temperatures, they are relatively high in the reach, and the flow attains equilibrium with the Yuba Goldfields return flow temperature when it reaches the Marysville gage. Due to diversions at Daguerre Point Dam, the flow below Daguerre Point Dam to the confluence with the Feather River is lower than the flow above the dam. For predicting the temperature at Marysville gage, a two step process would needs to be used. First the temperature at Daguerre is calculated for a time step as described above. Then this temperature is used as the upstream release temperature for calculating the Marysville Gage flow temperature. For simplification, and to reduce error in the analysis, rather than predicting a temperature at Daguerre and then using this as an input to the prediction for temperature at Marysville, the variables for predicting the Daguerre temperature are used directly in the regression analysis for determining the statistical model for the Marysville temperature and a single equation is used to calculate the Marysville Gage flow temperature.

Available historical data for developing a statistical model of water temperature at the Marysville gage included Daguerre Point Dam water temperature, Marysville air temperature, Yuba River flow at the Marysville gage, and Marysville water temperature. Daily historical data are available from 1999 to 2005. Analysis is similar to that described for Daguerre Point Dam water temperature. The general representative equation has the form:

MRY = A * (N2) + B*(Air) + C*(YRS)+D*(MRYF)

Where:

MRY = Water temperature at Marysville gage (degrees Fahrenheit)

N2 = Release temperature of Narrows II powerhouse (degrees Fahrenheit)

Air = Air temperature at Marysville (degrees Fahrenheit)

YRS = Yuba River flow at Smartville gage (cfs)

MRYF = Yuba River flow at Marysville gage (cfs)

As seen in the equation the variables for the Daguerre Point Dam water temperature prediction (Narrows II release temperature, flow at Smartville and Marysville air temperature) are included in the variables for the Marysville Gage water temperature prediction.

Observation of the relationship between flows and temperatures shows a reduction in influence on water temperature as flows increase. Therefore, a linear regression providing a singular linear relationship between flow and temperature will tend to overestimate predicted water temperature at high flows and underestimate water temperatures at low flows. To capture this nonlinear effect in a simplified quasi-linear relationship, different sets of coefficients are used for Marysville Gage flows above and below a transition flow, where the flow-temperature relationship weakens. Analysis showed that the most accurate use of a transition point for Marysville Gage flow varied by month in order to maintain continuity as different Narrows II temperatures and Marysville air temperatures are used for each month. Transition flow points were determined through iteration of 50 cfs intervals to ensure no sudden changes in temperature prediction occur for a small increase or decrease in flow at the transition point. Figure 3 is an example of the relationship between Marysville Gage flow and Marysville Gage temperature for a given release temperature and a given Marysville air temperature. Table 2 shows the two sets of coefficients for prediction of the Marysville Gage water temperature and Table 3 shows the monthly Marysville Gage transition flow rate used to determine which equation to is applied to each time step.

Figure 3. Relationship of Flow versus Temperature at the Marysville Gage for August

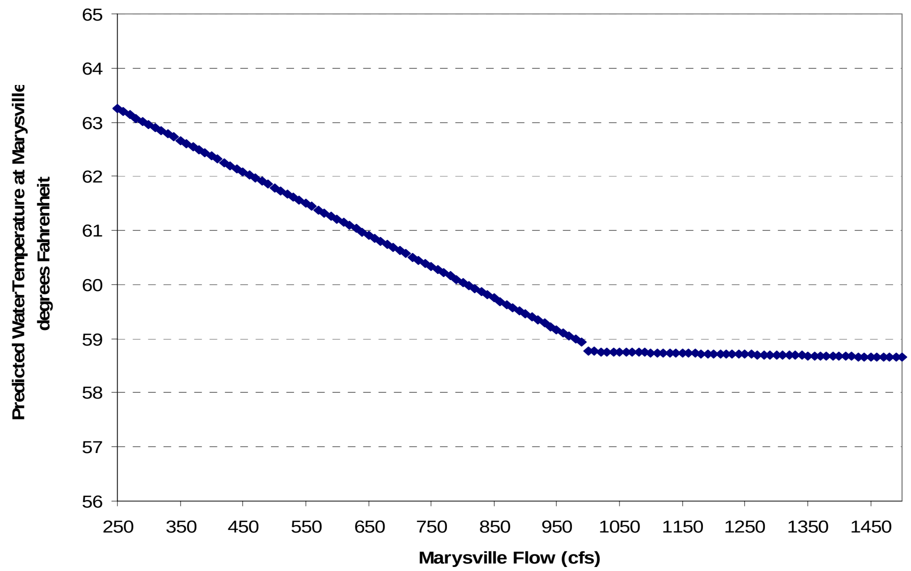


Table 2. Coefficients for Water Temperatures at Marysville Gage

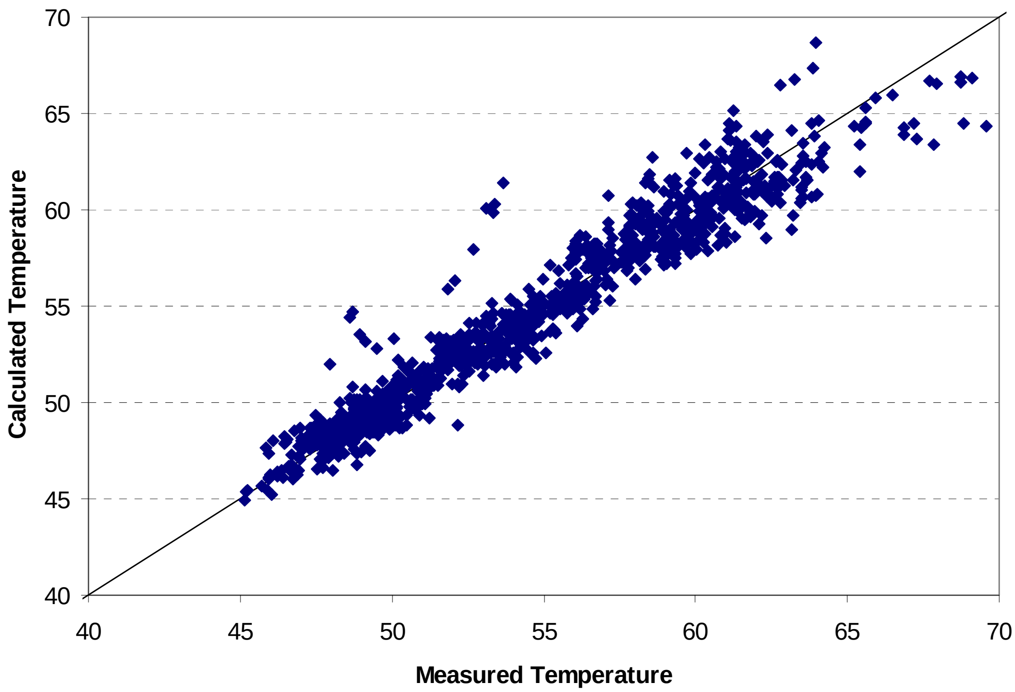
	A	B	C	D
Flow < Q	0.76	0.30	2.73E-4	-6.11E-3
Flow > Q	0.81	0.20	-3.23E-4	9.30E-5

Table 3. Transition Flow Rates for Calculating Water Temperatures at Marysville Gage

Month	Flow (Q) (cfs)
January	450
February	550
March	550
April	650
May	900
June	950
July	1,050
August	1,000
September	950
October	750
November	550
December	450

The resulting temperature predictions, when compared to measured temperatures for the Marysville Gage flow have an R-squared value of .95. Figure 4 is a scatter plot of the calculated daily water temperature at Marysville Gage versus the measured daily water temperature using the equation and two sets of coefficients and transition flows listed above.

Figure 4. Measure Marysville Gage Daily Water temperature Versus Calculated Daily Water Temperature



The results of the temperature modeling are shown in Attachment B as exceedance probability plots each month of April 2006 through February 2007 for the three flow scenarios. The three scenarios are labeled in the plots as "Interim", representing the results of the temperature analysis for simulated operations to RD-1644 Interim flow requirements; "Long Term", representing the results of the temperature analysis for simulated operations to RD-1644 Long Term flow requirements; and "Interim/Accord", representing the results of the temperature analysis for simulated operations for the combination of the LYR Accord and the RD-1644 Interim flow requirements, with each day's requirement being the greater of the LYR Accord requirement and the RD-1644 Interim requirement for that day.

Transfer Water Storage and Release

The analysis of transfer flow for the 2006 transfer differs from past YCWA transfers because the operations by YCWA for the 2006 transfer will differ from past transfers. In recent transfers, YCWA has made operational decisions regarding the timing and amount of transfer releases only after the hydrology for the water year is known or can be accurately predicted. The transfer releases are planned as releases of water from storage above the releases that must be made for other purposes such as instream flows, power generation and diversion deliveries. In contrast, for the 2006 transfer, the YCWA operations for the water year are predetermined based on the LYR Accord flow schedules, the North Yuba River Index and a new maximum target storage for September 30, 2006. The LYR Accord flow schedules are generally higher than the required flow schedules of RD-1644, and the target storage is lower than the normal target storage for New Bullards Bar Reservoir for the end of the water year on September 30th. Therefore, although the baseline, without transfer condition is the same under both types of transfers, the amount of transfer under operation to the LYR Accord is determined by the amount of additional water released from storage because of YCWA operating to the LYR Accord flow schedules and September 30 target storage. This operation is pre-determined by the LYR Accord requirements. Because of these differences, the amount and timing of transfer releases is calculated by subtracting the without-transfer flows from the with-transfer flows and accounting for transfer flows when the water is released during balanced conditions[1].

The amounts and timing of transfer water storage and releases were calculated using the flow scenarios described under the surface water modeling portion of this report. A calculation of the total amount of transfer water for each of the 73 Monte Carlo simulation flow series was made to determine the transfer amounts that would be generated under the range of historical hydrology for 1922 to 1994. The years 1995 to 2004 are not used in the calculation because Delta model simulations do not extend through these more recent years.

As described in the introduction of this report, the transfer amount calculation has been completed by comparing the release of water that would result from YCWA operations to comply with the SWRCB RD-1644 Interim flows requirements and the flow schedules of the LYR Accord, with the release of water that would result from YCWA operations to comply with the SWRCB RD-1644 Long Term flow requirements.

Although the transfer period is from April 1, 2006 to February 28, 2007, the majority of transfer water, that is the additional releases from storage above the without-transfer scenario, will be made during the summer of 2006. Some additional transfer water will likely be released in the fall of 2006 and early winter of 2007. However, comparison of storage amounts at the end of the transfer period will not reliably show the reduction in storage due to the transfer, because by the end of February 2007 in many of the 73-year series of simulated conditions New Bullard Bar Reservoir has refilled. Because the majority of transfer water is released prior to the end of September 2006 for all of the 73-year series, comparison of end-of-September storage for the with- and without-transfer

[1] This is a simplification of the complete terms and conditions of the accounting of the 2006 transfer as described in the agreement between YCWA and DWR

conditions provides a reasonable assessment of the storage impacts of the transfer operations and can be compared to the transfer amounts.

Another complex relationship of the transfer is that the increased flows from the Yuba River resulting from operation to the LYR Accord do not always occur when the water can be exported by DWR at the SWP facilities in the Delta. The facts that the Delta is sometimes in excess conditions and that the changes in flow on the Yuba River do not affect Delta operations or SWP or Central Valley Project (CVP) storage is a fundamental part of how transfers provide water supply benefits downstream, without impacting these projects at times when the storage evacuated from New Bullards Bar Reservoir for the transfer is refilled. Under past YCWA water transfers, YCWA would make transfer releases only when the Delta was in balanced conditions and the water could be exported. This timing of releases will not be as flexible during 2006 because the releases of water to meet the LYR Accord flow schedules are predetermined. Therefore, during some time periods, the increased flows will occur when they can not be exported and therefore will not be accounted for as transfer water. This is also true for time periods when flows under the LYR Accord operations are less than the baseline conditions. This can occur when the flow requirements of the without-transfer condition are higher than the with-transfer condition. This is the case for some time periods when comparing the flows under RD-1644 Long Term to the flows resulting from operation to the LYR Accord. Because the determination of when water can be exported at the Delta is quite complex and dependent upon many variables, a simplified approach has been used for this analysis to determine transfer periods. In this analysis, results from a DWR CALSIM II simulation that provides the monthly amount of surplus Delta outflow, if any, has been used to determine time periods when transfer flows occur. The assumption for this analysis is that if there is surplus Delta outflow, then no transfer may occur during that month.

Figure 5 is a chart of the total transfer water amounts (shown as red bars) for each of the 73 years of simulation of the 11 months of LYR Accord operations with the RD-1644 Long Term flow requirements in effect and using a baseline of YCWA operations to comply only with the RD-1644 Long Term requirements. (Although this scenario does not represent the proposed project, it is discussed here to show the portion of the proposed project transfer that would result solely from storage releases.) The average transfer amount for the 73 years of simulation is 58,000 acre-ft. Also shown on the figure (shown as red dots) are the differences in end-of-September storage between the two scenarios (RD-1644 Long Term storage - LYR Accord storage) for each year of simulation. Although the storage amounts are not directly related to the transfer amounts, as described above, the figure shows that storage would be reduced substantially due to the transfer. The average storage reduction for the end of September between these two scenarios is 67,000 acre-ft.

Figure 5. Sum of Monthly Flow Differences during Months with no Surplus Delta Outflow: Simulation of April 06 to Feb 07 using 73 years of Historical Hydrology For the Yuba River Accord under D-1644 Long Term Requirements Compared to a baseline flow of D-1644 Long Term (red bars). Storage difference (RD-1644 Long Term - LYR Accord) is also shown (red dots).

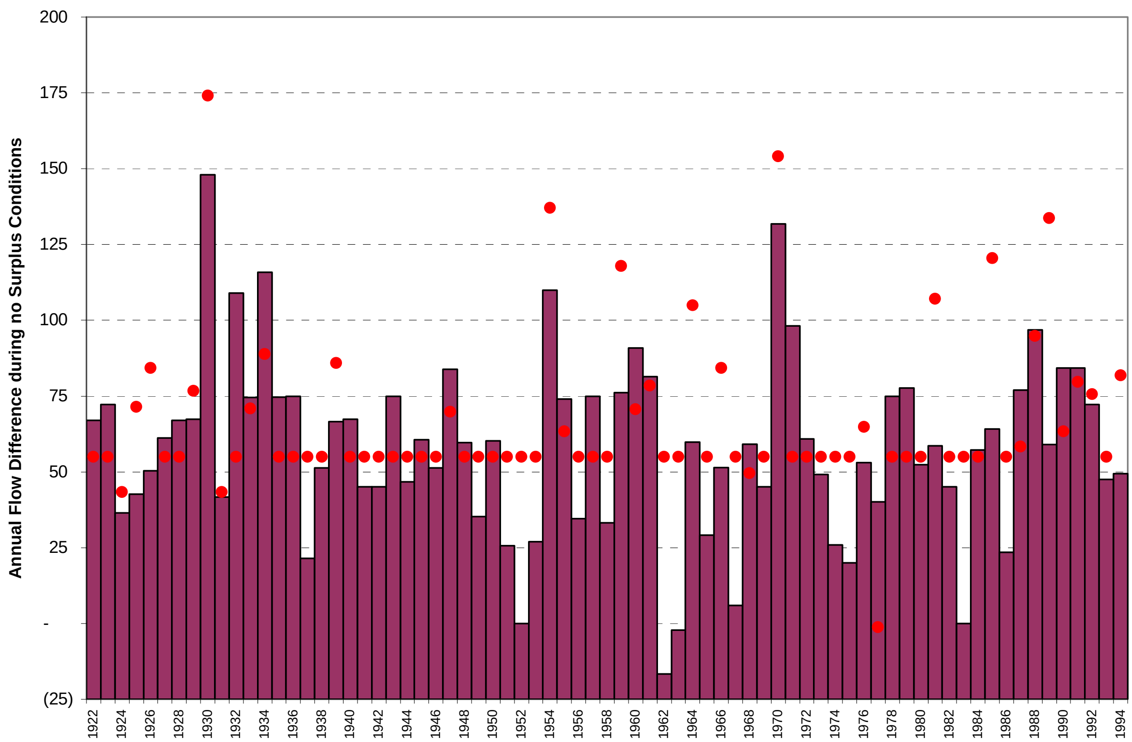
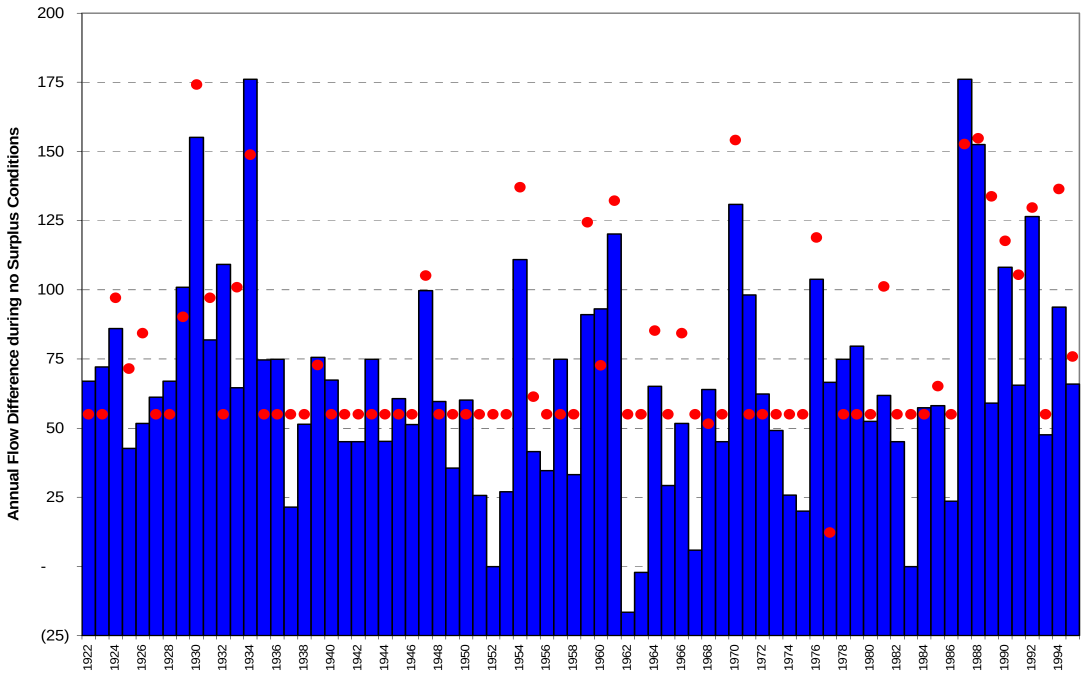


Figure 6 is a chart of the total transfer water amounts (shown as purple bars) for each of the 73 years of simulation for the 11 months of LYR Accord operations with the RD-1644 Interim flow requirements and using a baseline of operations to comply only with RD-1644 Interim. The average transfer amount for the 73 years of simulation for the operation is 66,000 acre-ft. Also shown on the figure (shown as red dots) are the differences in end-of-September storage between the two scenarios (RD-1644 Interim storage - LYR Accord storage). Although the storage amounts are not directly related to the transfer amounts, as described above, the figure shows that storage would be reduced substantially due to the transfer. The average storage reduction for the end of September between these two scenarios is 76,000 acre-ft. These figures show that the effect of the requested extension of the RD-1644 Interim requirements would be to increase the average transfer amount by 8,000 acre-ft. (66,000 – 58,000 = 8,000.) These figures also show that, regardless of which RD-1644 requirements are in effect, the average reduction in storage because of the transfer would exceed the average transfer amount.

Figure 6. Sum of Monthly Flow Differences during Months with no Surplus Delta Outflow: Simulation of April 06 to Feb 07 using 73 years of Historical Hydrology For the Yuba River Accord under D-1644 Interim Requirements Compared to a baseline flow of D-1644 Interim (blue bars). Storage difference (RD-1644 Interim - LYR Accord) is also shown (red dots).



Impacts of Operating to RD-1644 Long Term in 2006 with the LYR Accord

The LYR Accord flow schedules were developed to maximize the use of the hydrology of the Yuba River and the capacity of YRDP facilities to provide fishery benefits and to provide water for transfer while maintaining a reliable level of water supply for local irrigation needs. If the RD-1644 Long Term flow requirements, which are scheduled to go into effect on April 21, 2006, are not delayed, then YCWA will be required to meet the RD-1644 Long Term flow requirements starting on April 21, 2006, which would require more water in the drier year types than is required with the RD-1644 Interim flow requirements. The effect of these additional required releases would be to reduce storage in New Bullards Bar Reservoir in Dry, Critical and Extreme Critical years (as defined in RD-1644), if they were to occur, below the levels that would occur with the RD-1644 Interim flow requirements and the LYR Accord. The end-of-September storage reduction with the LYR Accord and RD-1644 Long Term flow requirements below the levels reached with the LYR Accord and RD-1644 Interim flow requirements averages 33,000 acre-ft in Dry, Critical and Extreme Critical years, which would be about 20% of all years. In about 10% of all years, the reduction would range from 40,000 acre-ft to 70,000 acre-ft. With the LYR Accord and operations to comply with the RD-1644 Long Term flow requirements, the average storage amount at the end of September 2006 in the 10% driest years would be 410,000 acre-ft.

Using a starting storage amount of 410,000 acre-ft, the LYRBM was used to simulate conditions in the 2007 water year, with operations to comply with RD-1644 Long Term flow requirements, and no LYR Accord operations. The results of simulation of the historical hydrology of 1922 through 2004 for these starting conditions indicate about a 30% chance of shortages greater than 40,000 acre-ft in deliveries to YCWA's Member Units during 2007 . The average shortage amount, when a shortage occurs, is estimated to be 173,000 acre-ft, or about 50% of the diversion demand for YCWA's deliveries to its Member Units.

YCWA, in cooperation with its Member Units has been developing a conjunctive use program that would be used to support the LYR Accord during drought conditions. Although this analysis has assumed that the LYR Accord would not be implemented in 2007 and that YCWA would operate only to the RD-1644 Long Term flow requirements, the pumping capacity of the conjunctive use program nevertheless would be available to attempt to meet water supply shortages by Member Units pumping groundwater. However, the total estimated pumping capacity for irrigation for the Member Units is about 100,000 to 120,000 acre-ft. Therefore, any shortage amount above 100,000 acre-ft would not be able to be replaced with groundwater. For the simulation described above, the diversion delivery shortage would be greater than 100,000 acre-ft in about 20% of all years when the 2007 starting storage was 410,000 acre-ft. Based on the simulation results, the additional storage reduction resulting from operations to comply with RD-1644 Long Term flow requirements in 2006 with LYR Accord operations, which range from 40,000 to 70,000 acre-ft in the 10% driest years, could not be made up through groundwater pumping in 2007 if shortages of more than 100,000 acre-ft were to occur.

Attachment A

Exceedance Probability Plots for flow at Marysville Gage and Smartville for April 2006 to February 2007

Figure A-1: Exceedance Probability of Yuba River Flow at Smartville for April, 2006

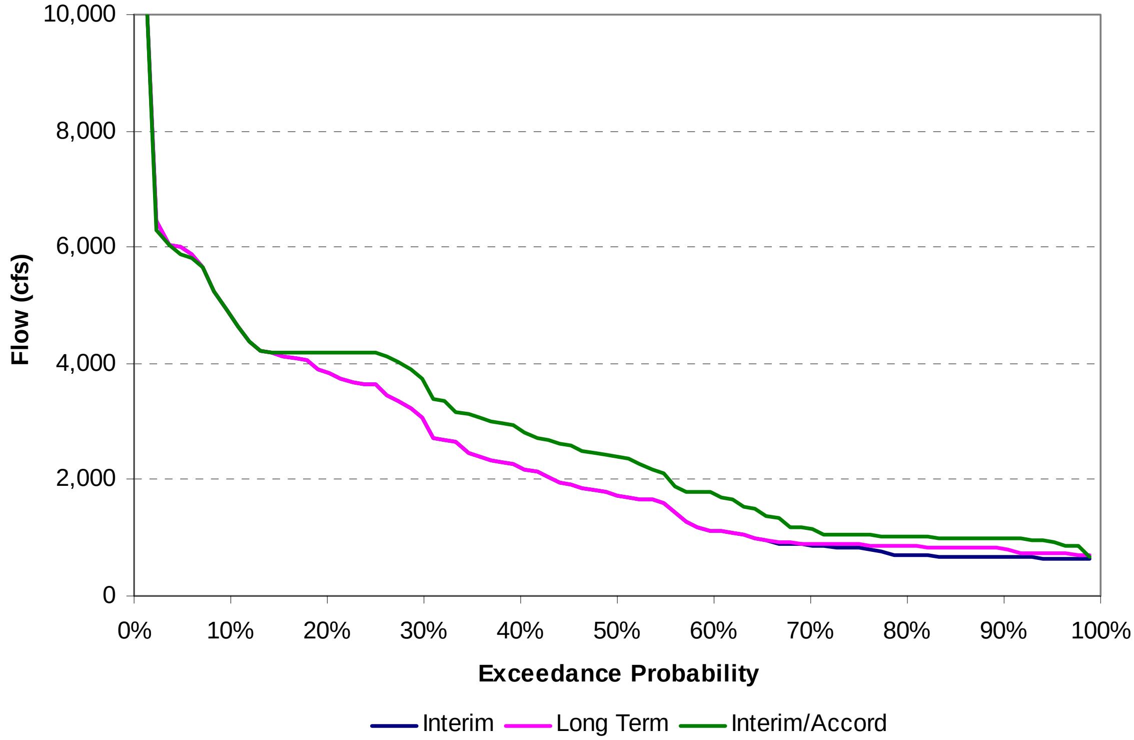


Figure A-2: Exceedance Probability of Yuba River Flow at Marysville for April, 2006

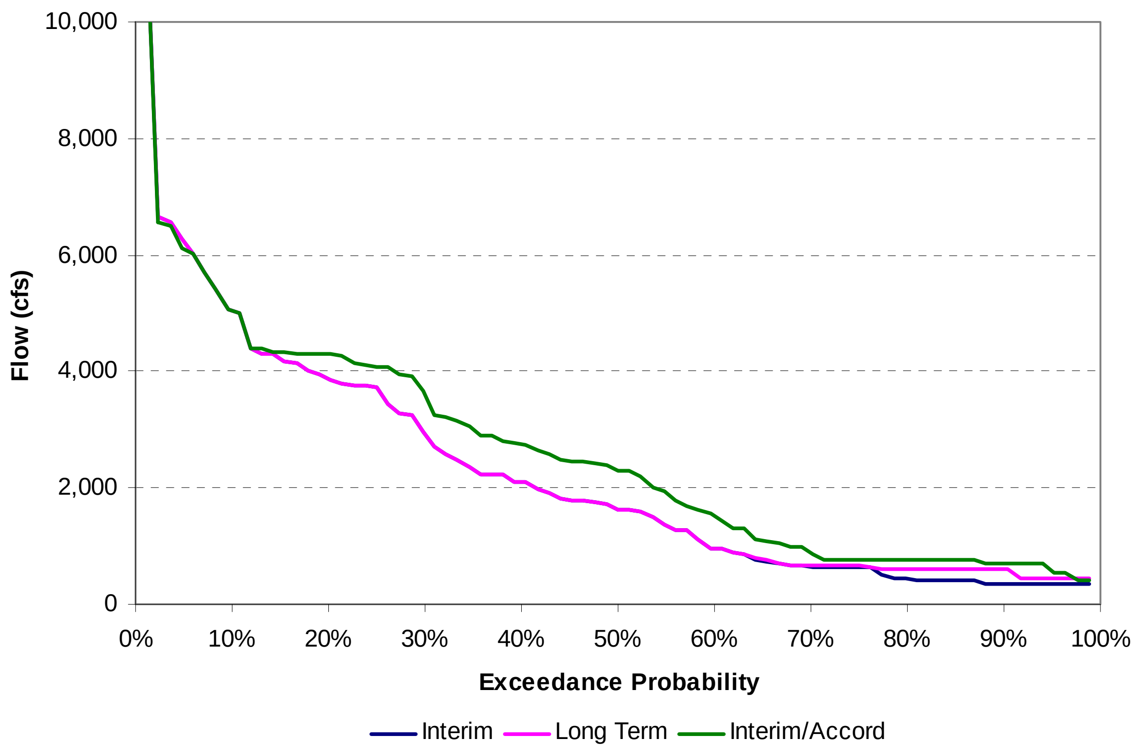


Figure A-3: Exceedance Probability of Yuba River Flow at Smartville for May, 2006

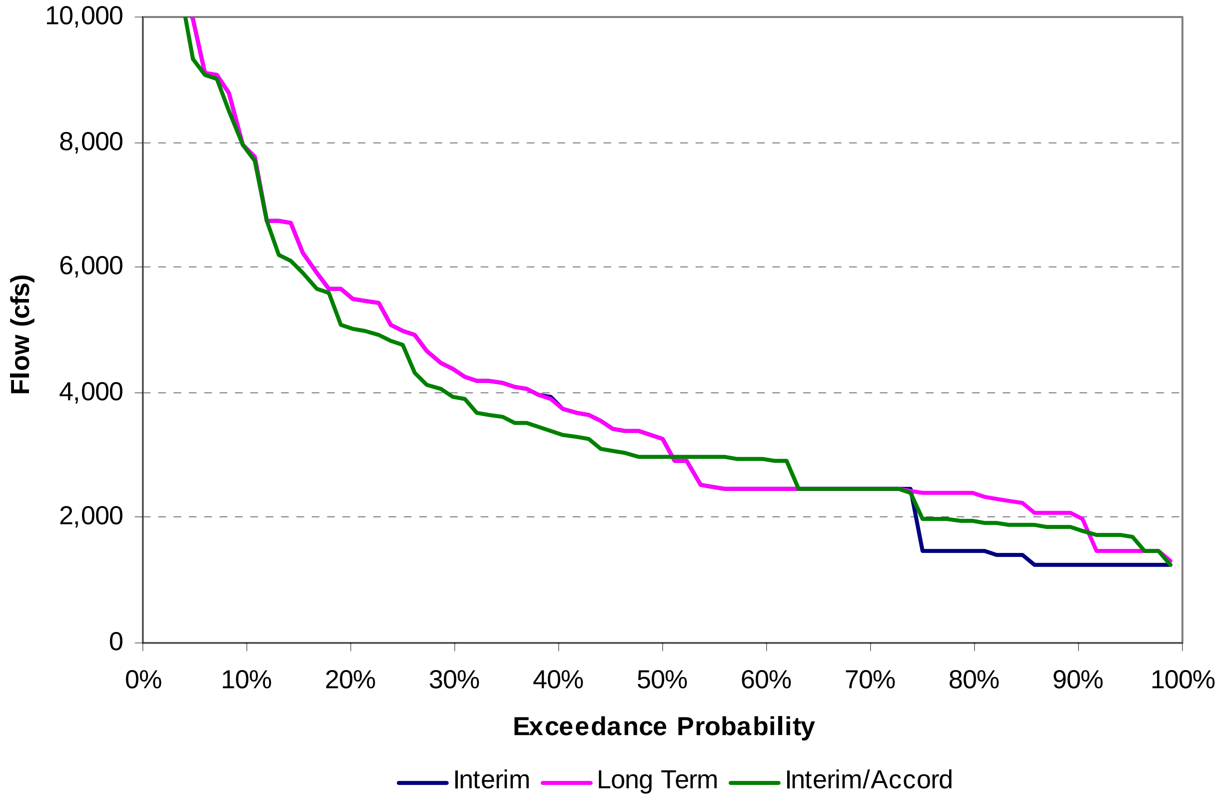


Figure A-4: Exceedance Probability of Yuba River Flow at Marysville for May, 2006

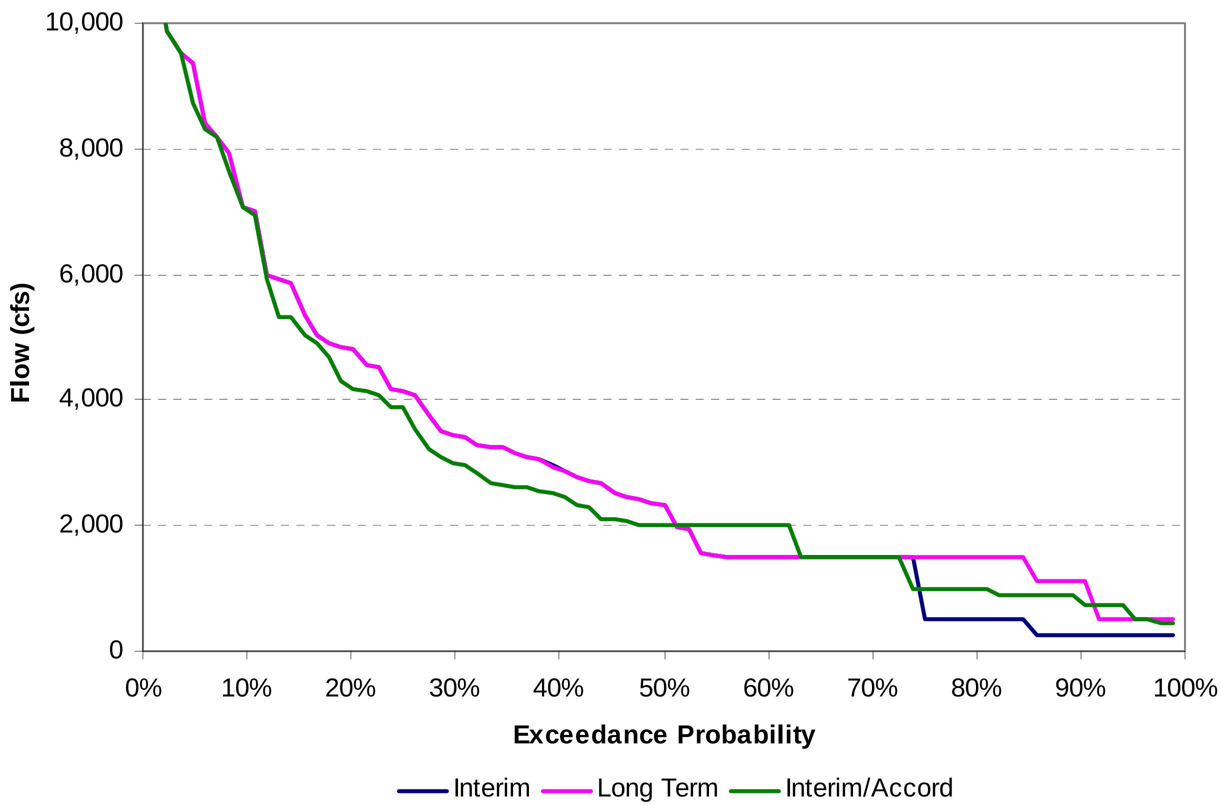


Figure A-5: Exceedance Probability of Yuba River Flow at Smartville for June, 2006

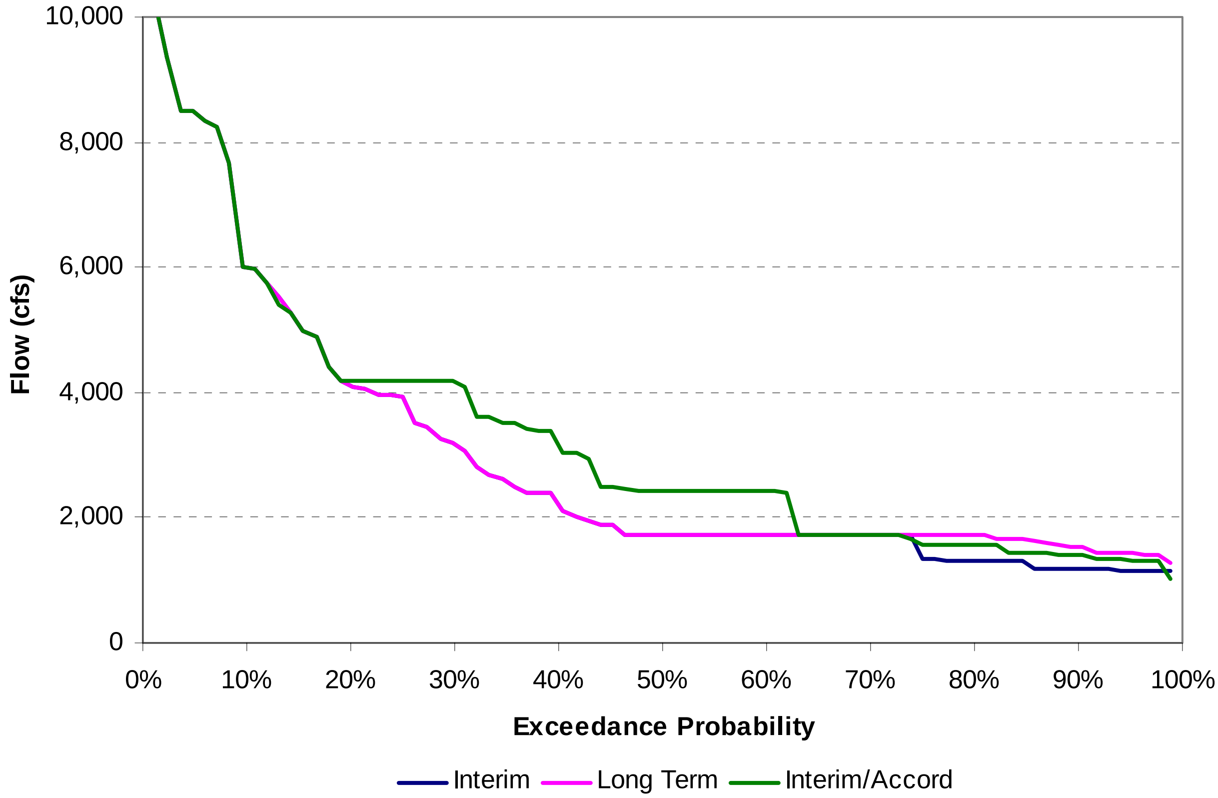


Figure A-6: Exceedance Probability of Yuba River Flow at Marysville for June, 2006

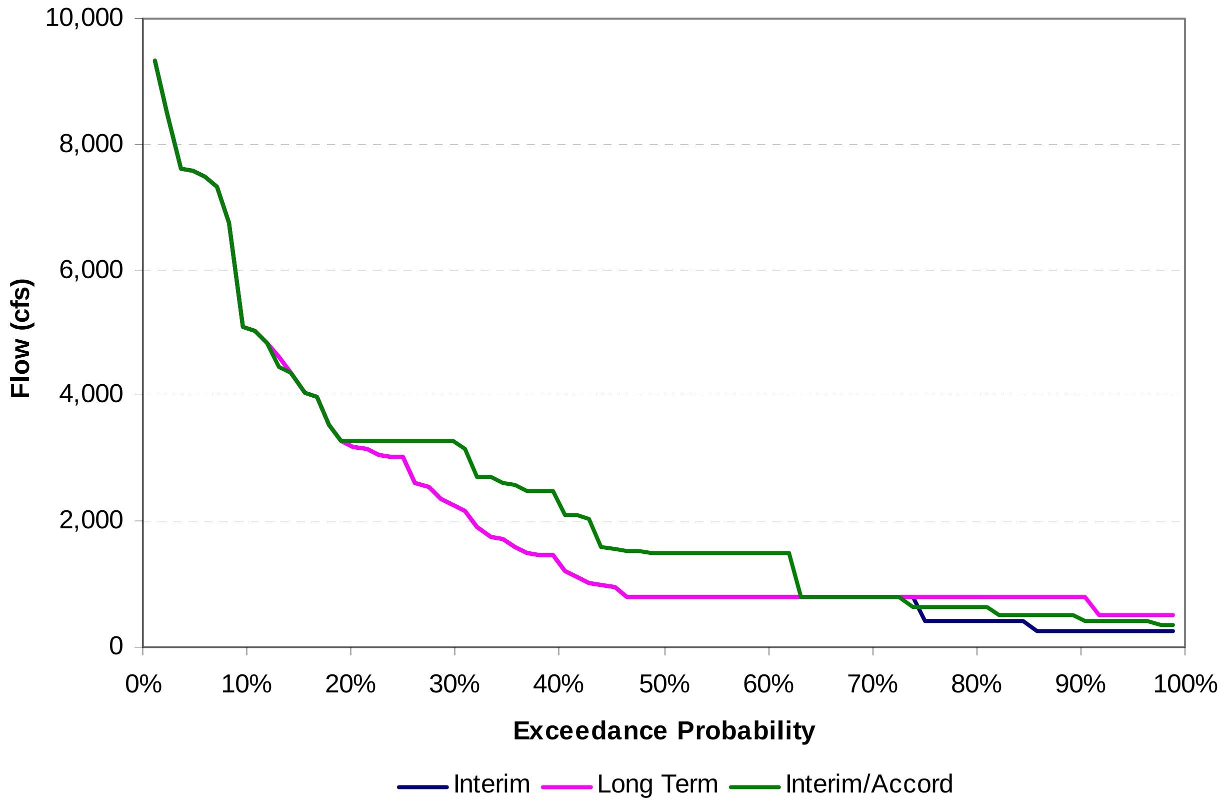


Figure A-7: Exceedance Probability of Yuba River Flow at Smartville for July, 2006

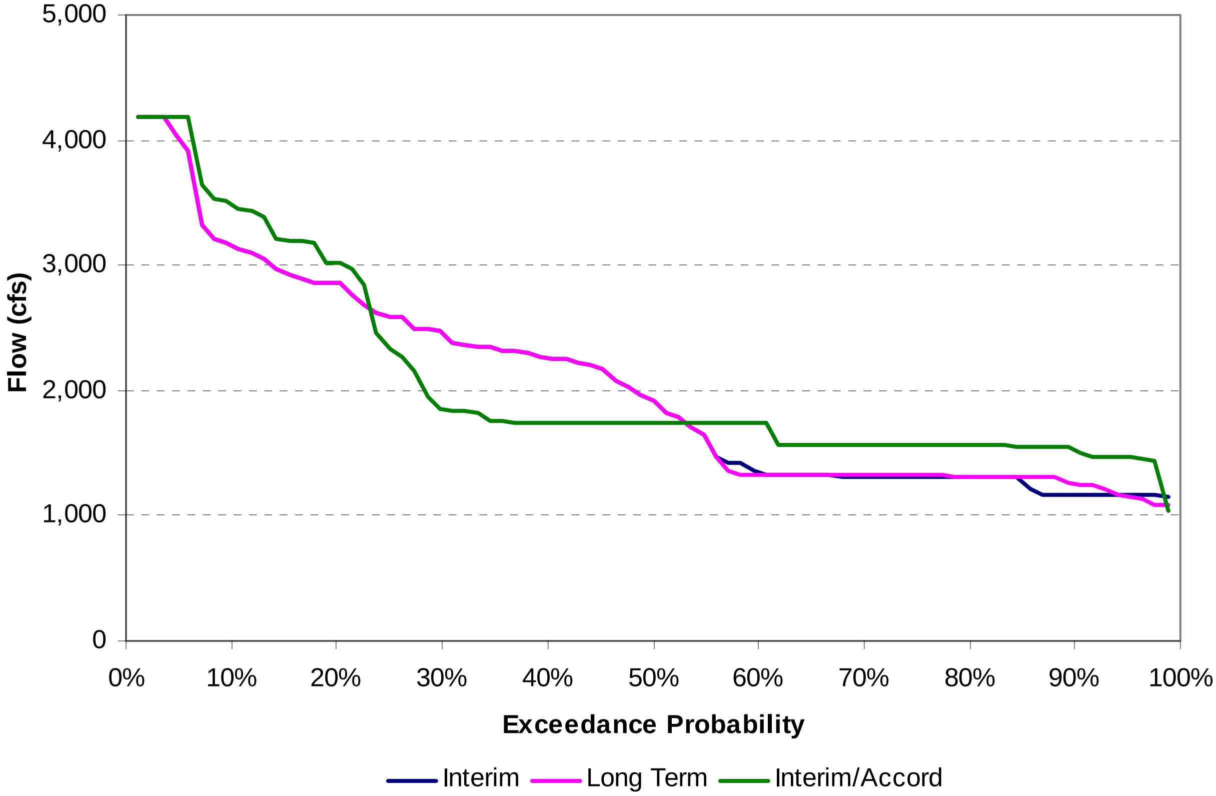


Figure A-8: Exceedance Probability of Yuba River Flow at Marysville for July, 2006

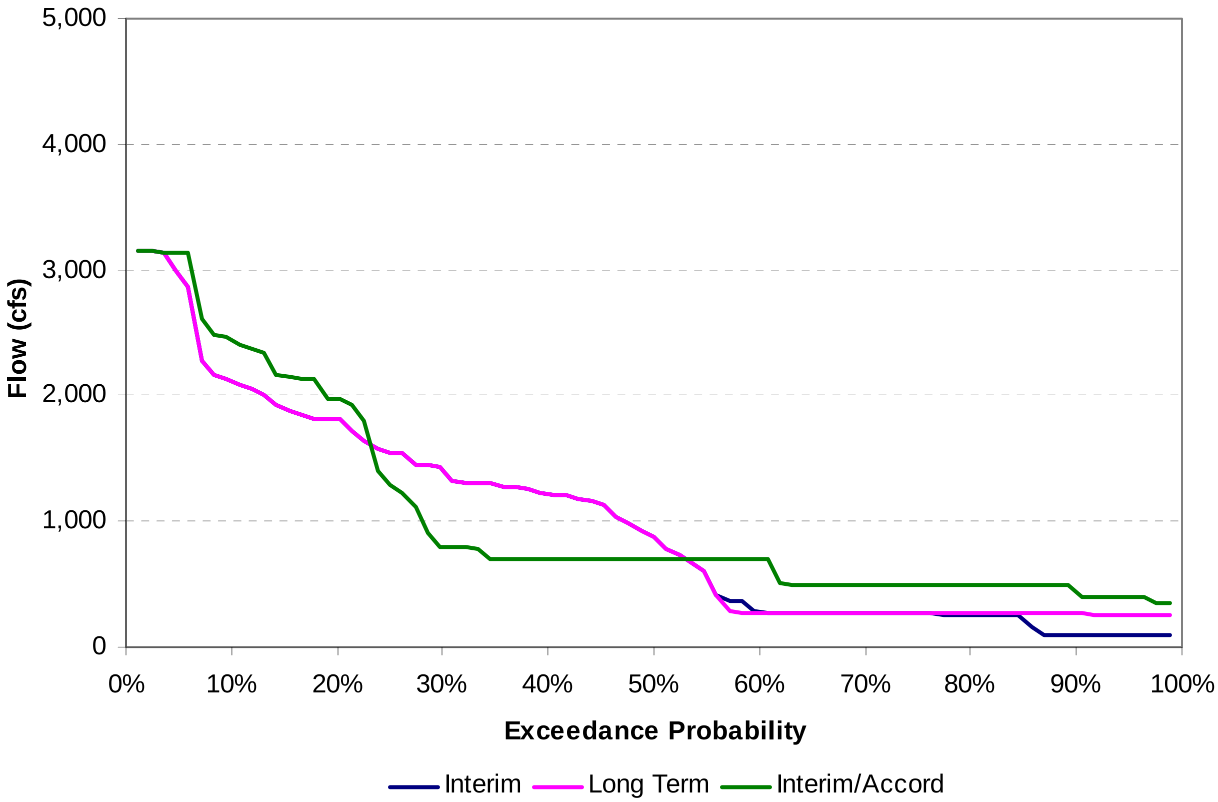


Figure A-9: Exceedance Probability of Yuba River Flow at Smartville for August, 2006

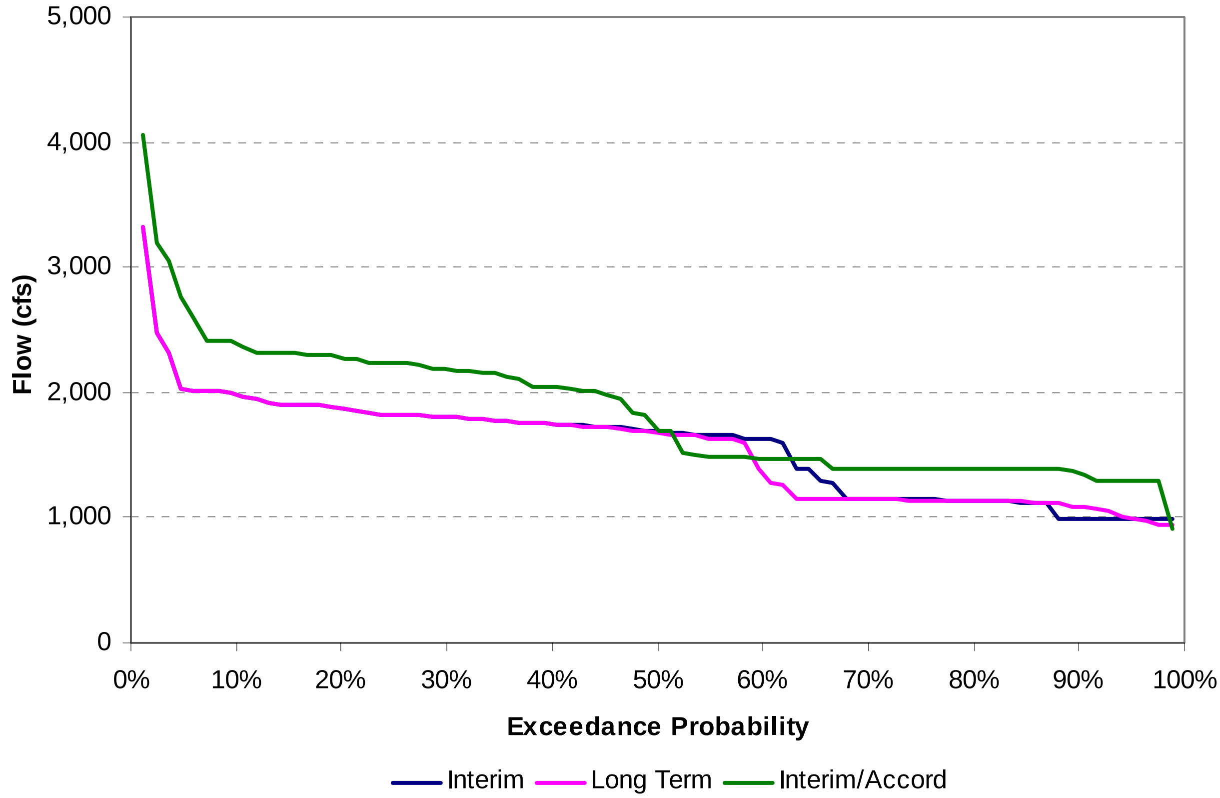


Figure A-10: Exceedance Probability of Yuba River Flow at Marysville for August, 2006

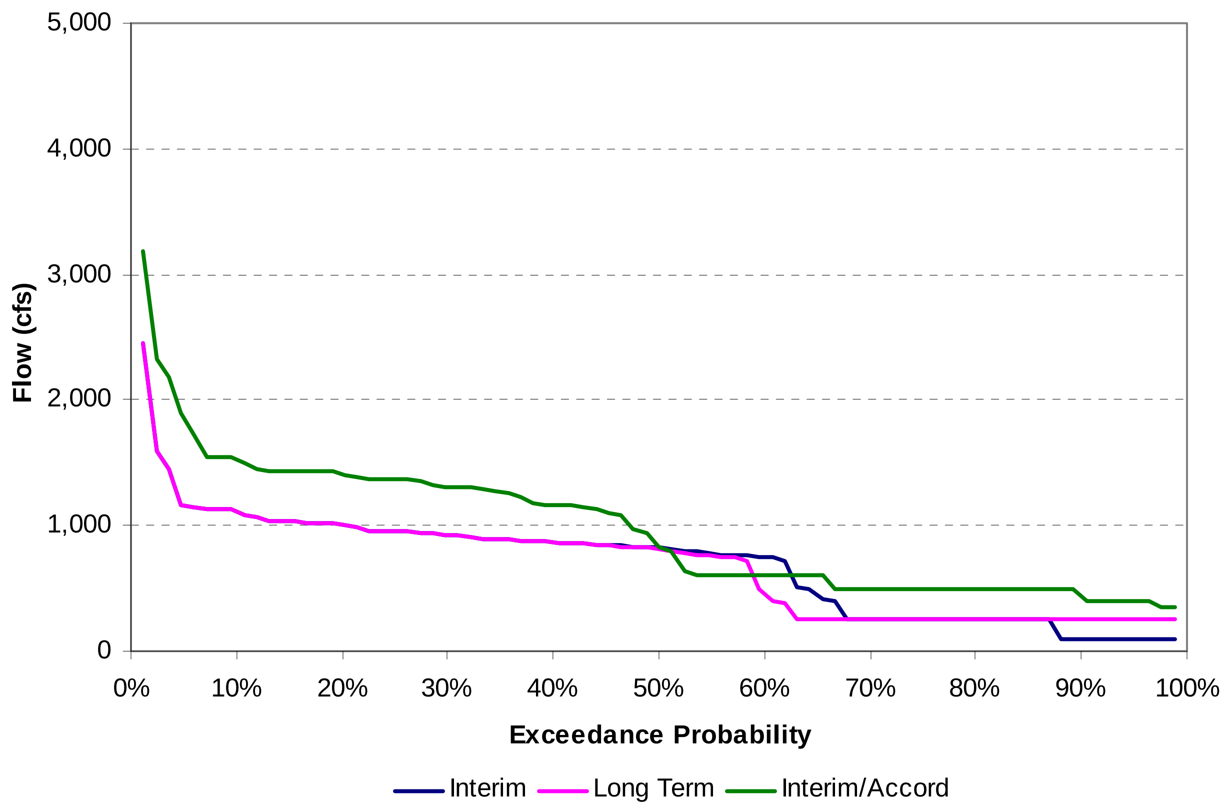


Figure A-11: Exceedance Probability of Yuba River Flow at Smartville for September, 2006

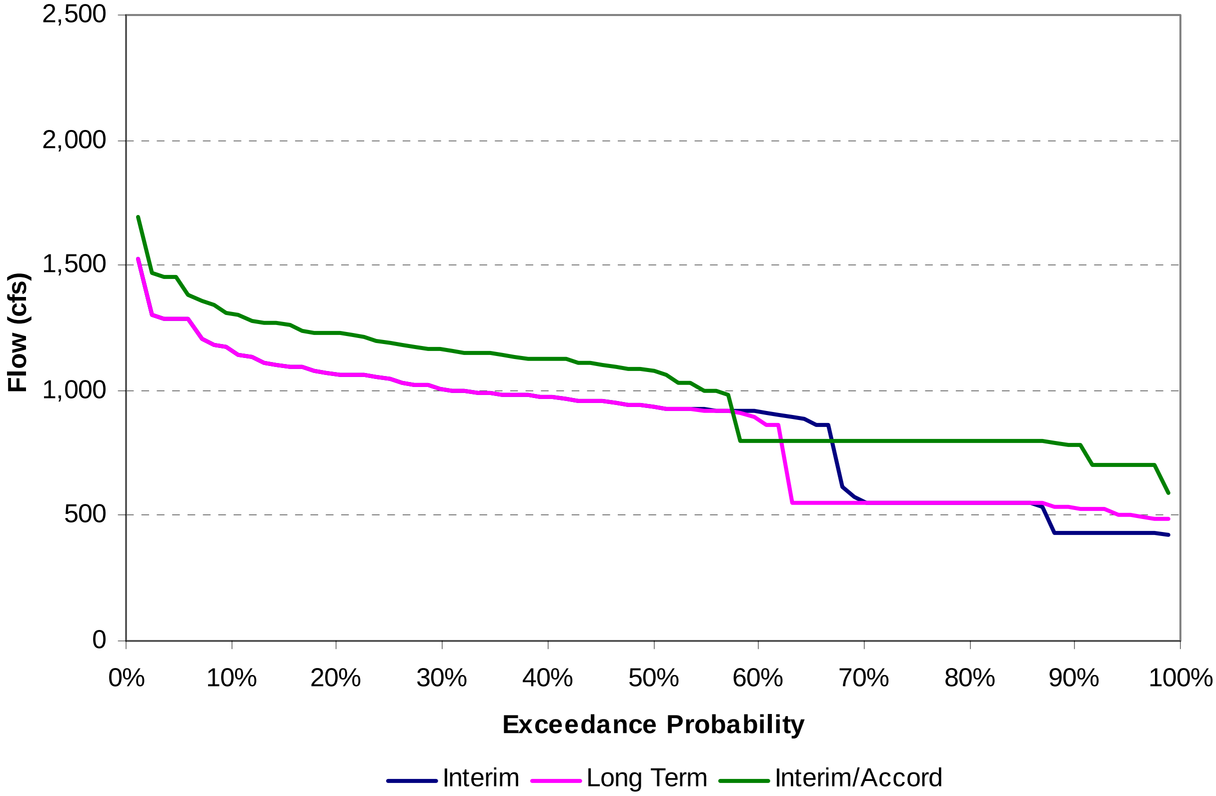


Figure A-12: Exceedance Probability of Yuba River Flow at Marysville for September, 2006

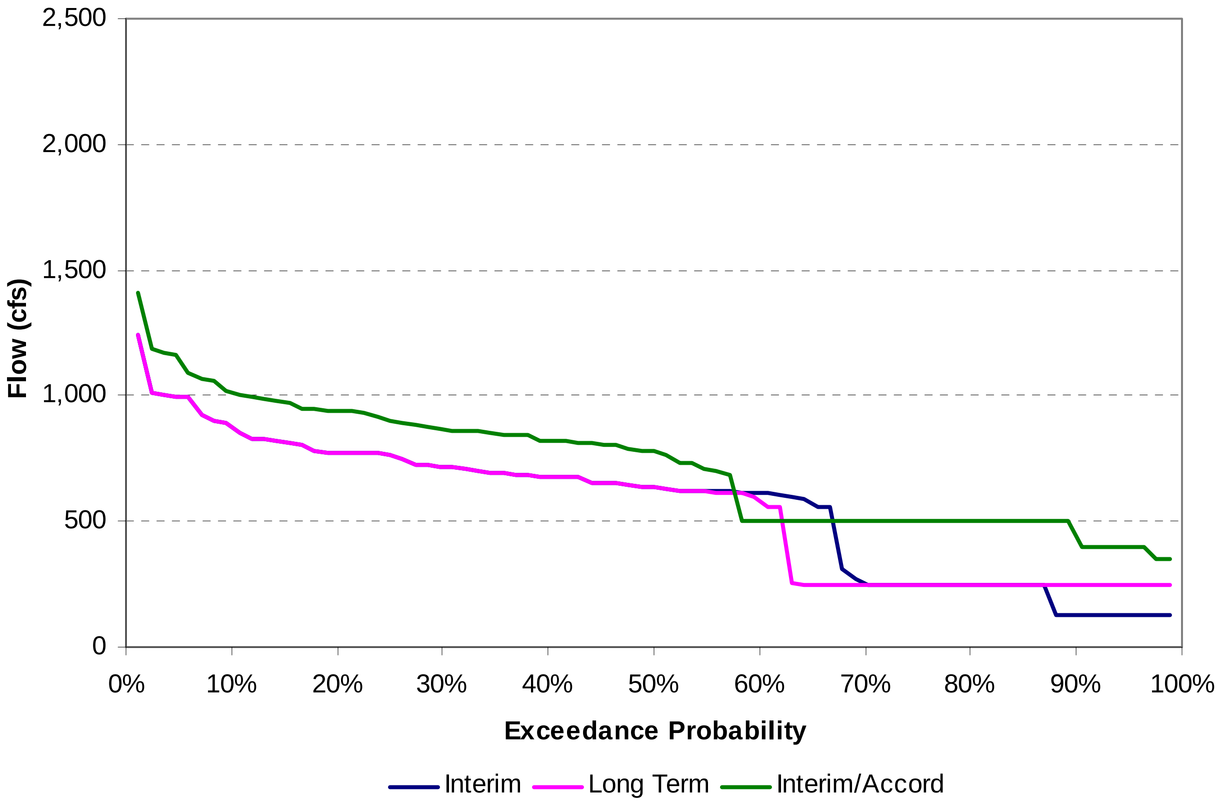


Figure A-13: Exceedance Probability of Yuba River Flow at Smartville for October, 2006

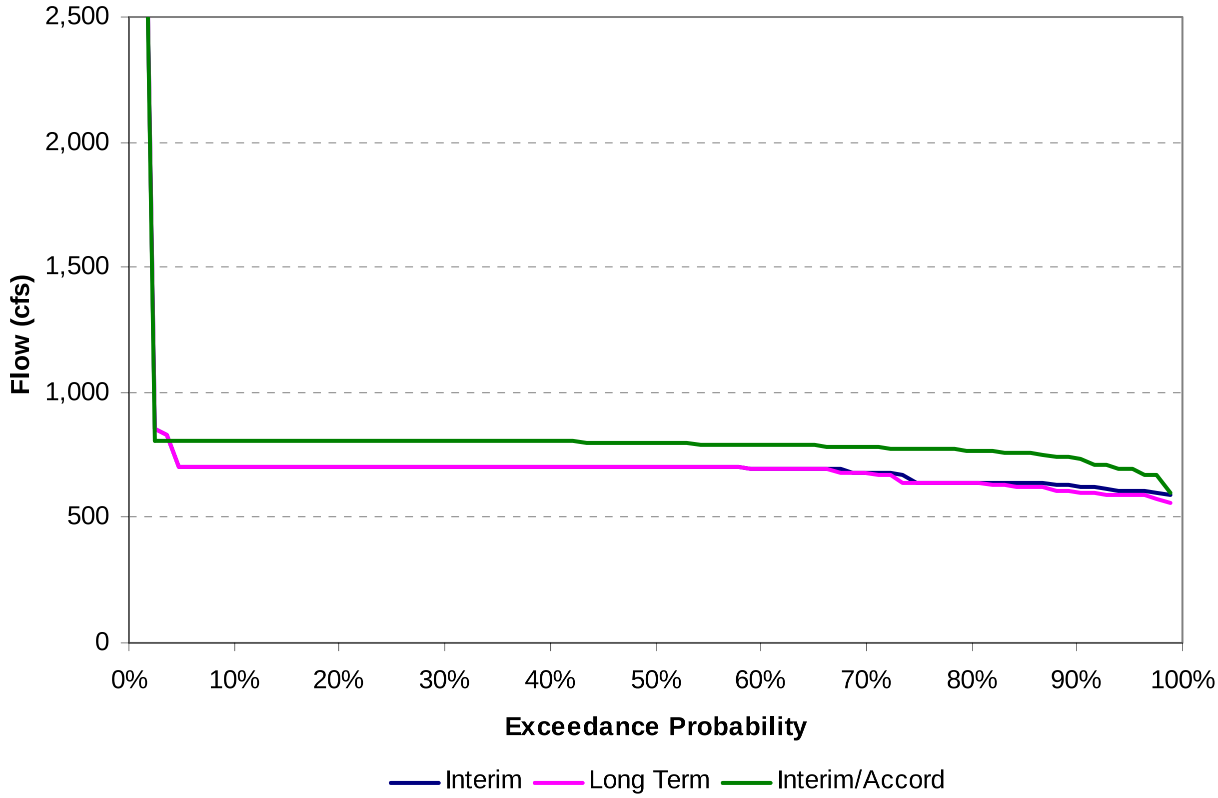


Figure A-14: Exceedance Probability of Yuba River Flow at Marysville for October, 2006

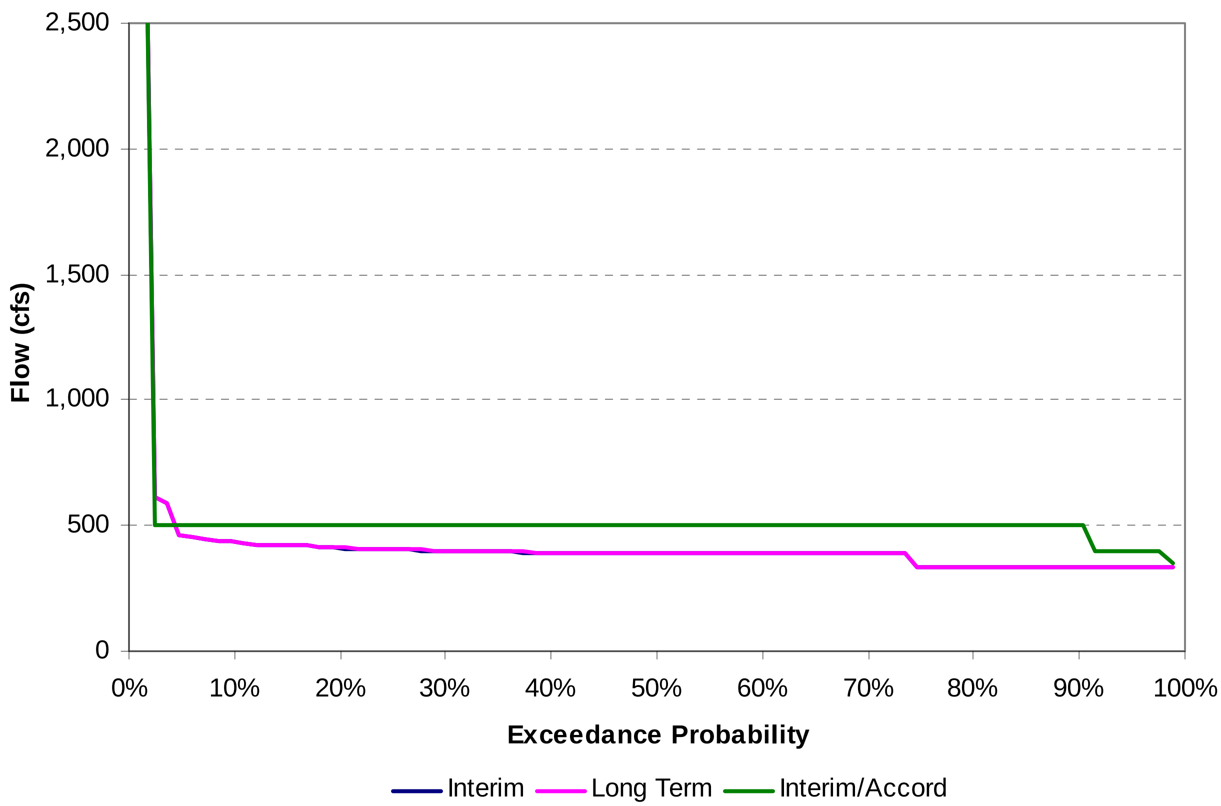


Figure A-15: Exceedance Probability of Yuba River Flow at Smartville for November, 2006

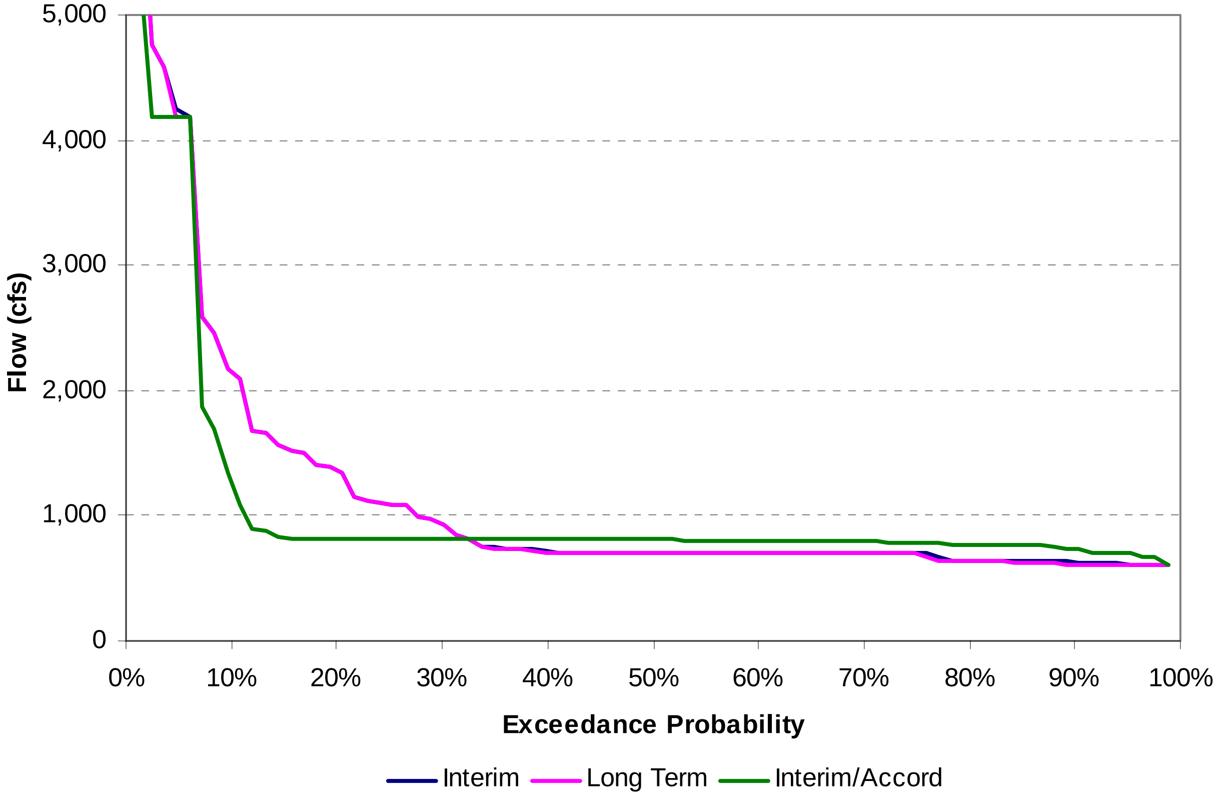


Figure A-16: Exceedance Probability of Yuba River Flow at Marysville for November, 2006

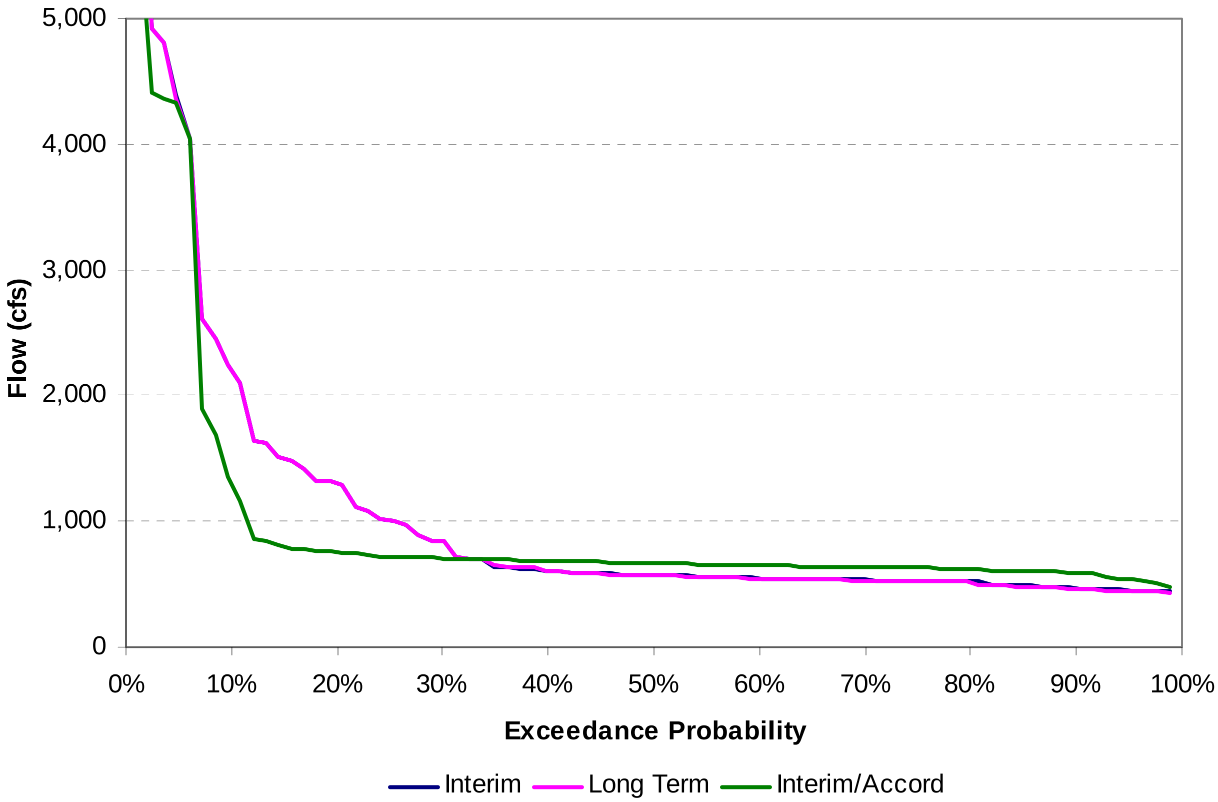


Figure A-17: Exceedance Probability of Yuba River Flow at Smartville for December, 2006

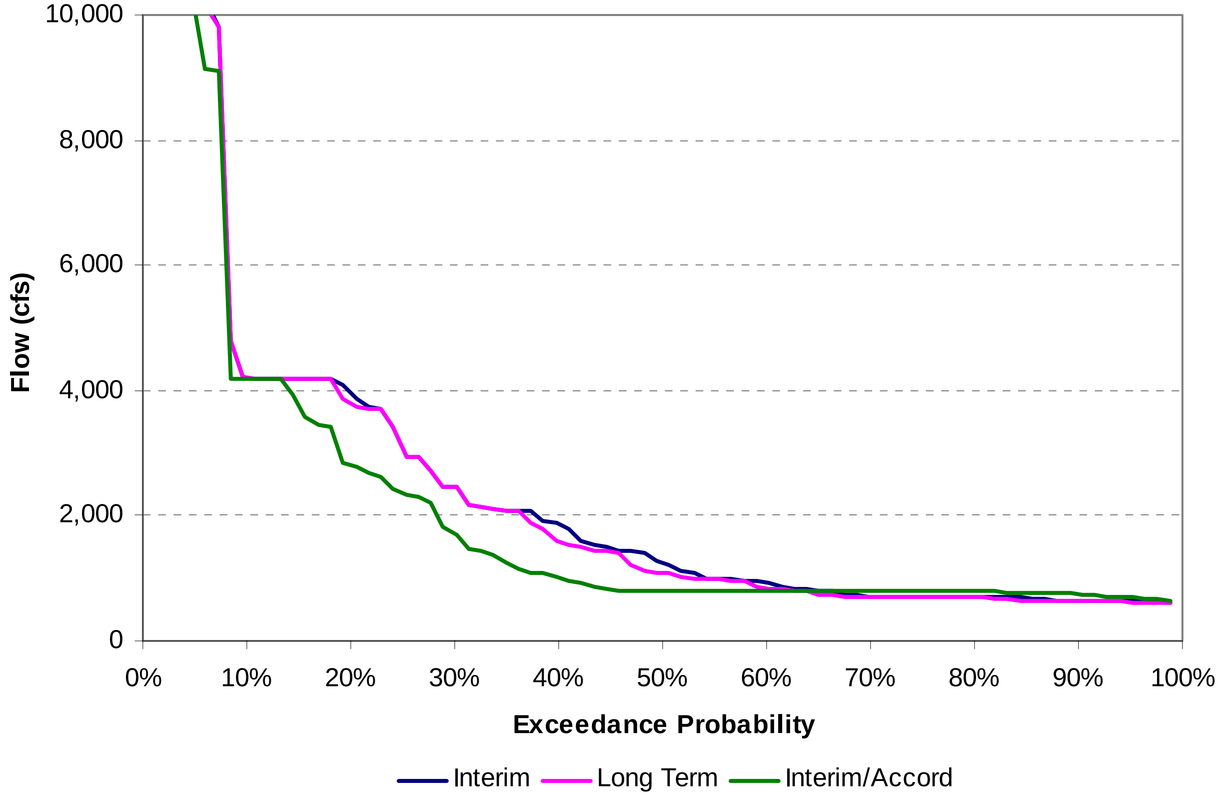


Figure A-18: Exceedance Probability of Yuba River Flow at Marysville for December, 2006

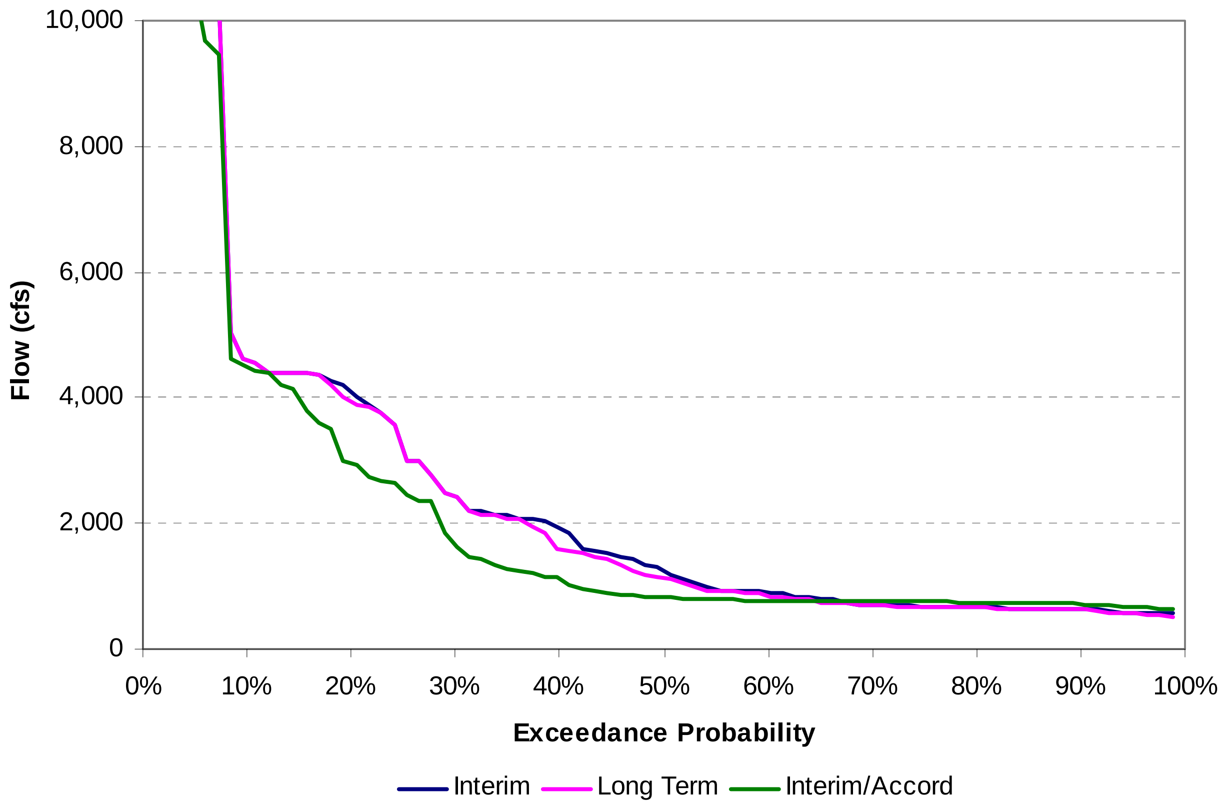


Figure A-19: Exceedance Probability of Yuba River Flow at Smartville for January, 2007

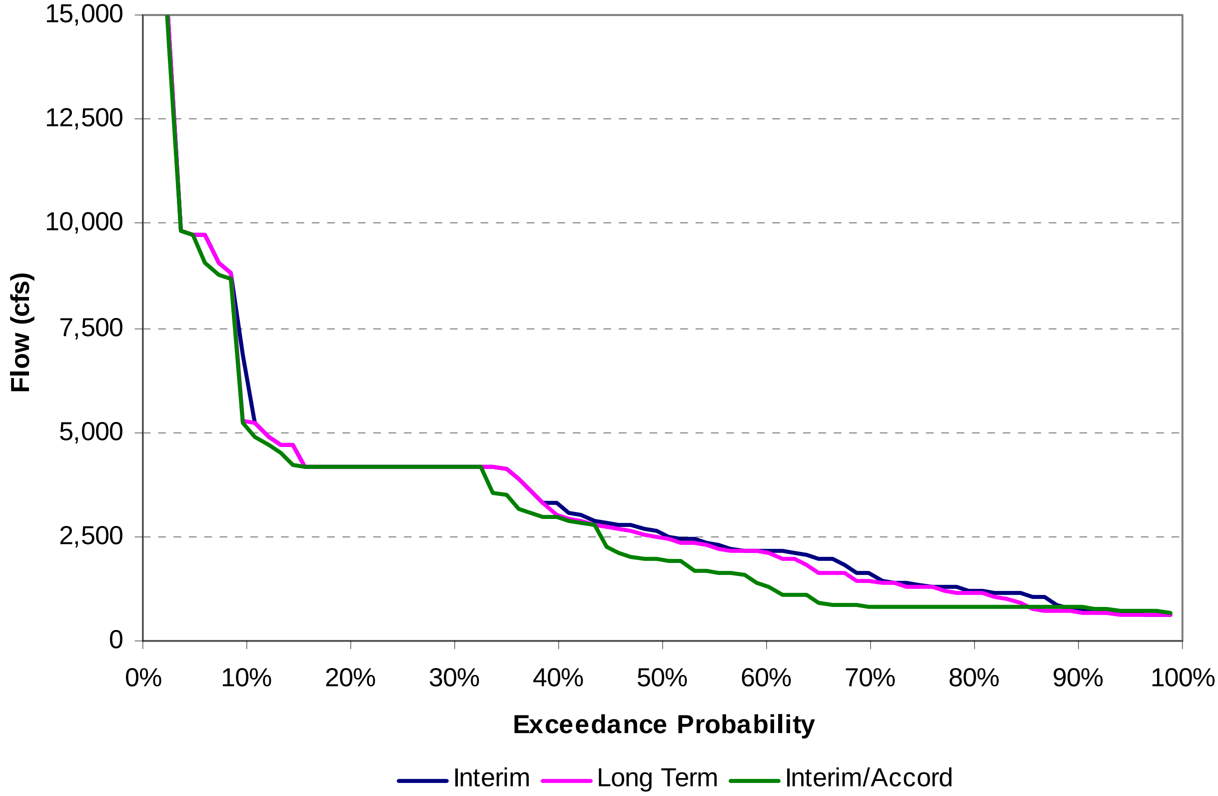


Figure A-20: Exceedance Probability of Yuba River Flow at Marysville for January, 2007

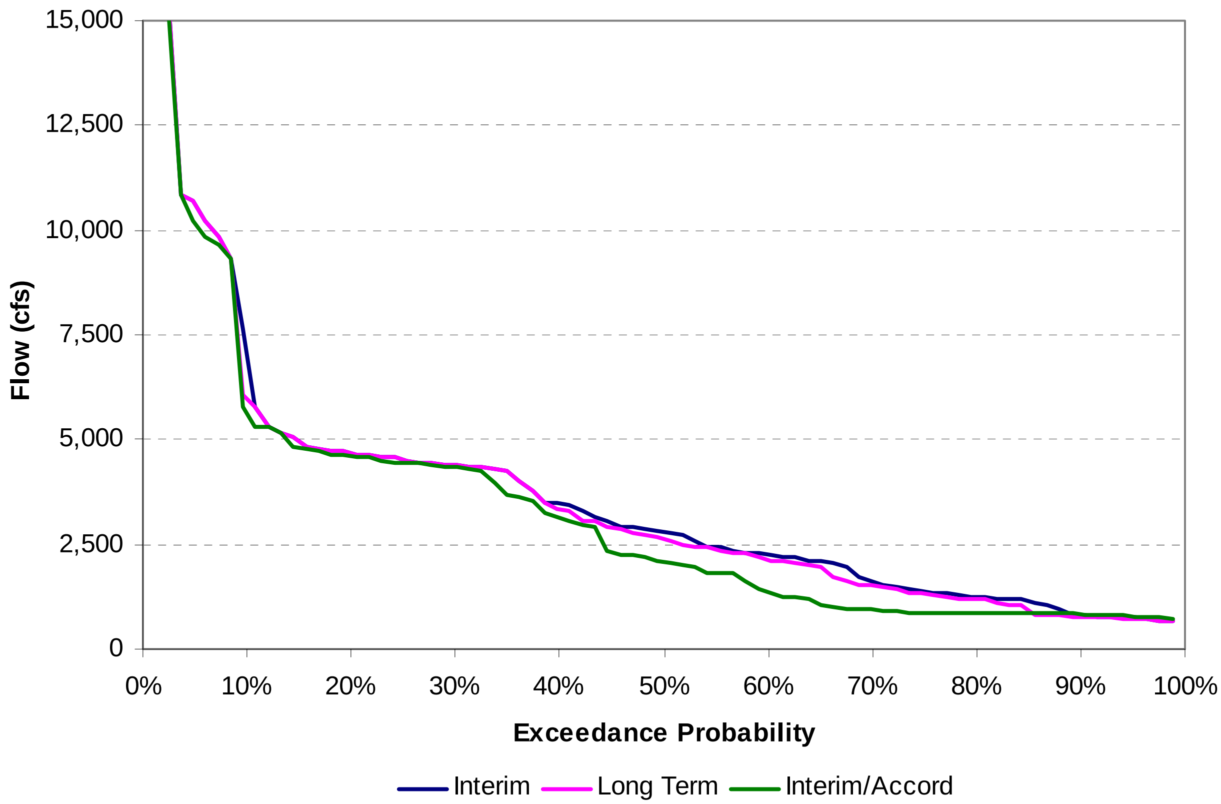


Figure A-21: Exceedance Probability of Yuba River Flow at Smartville for February, 2007

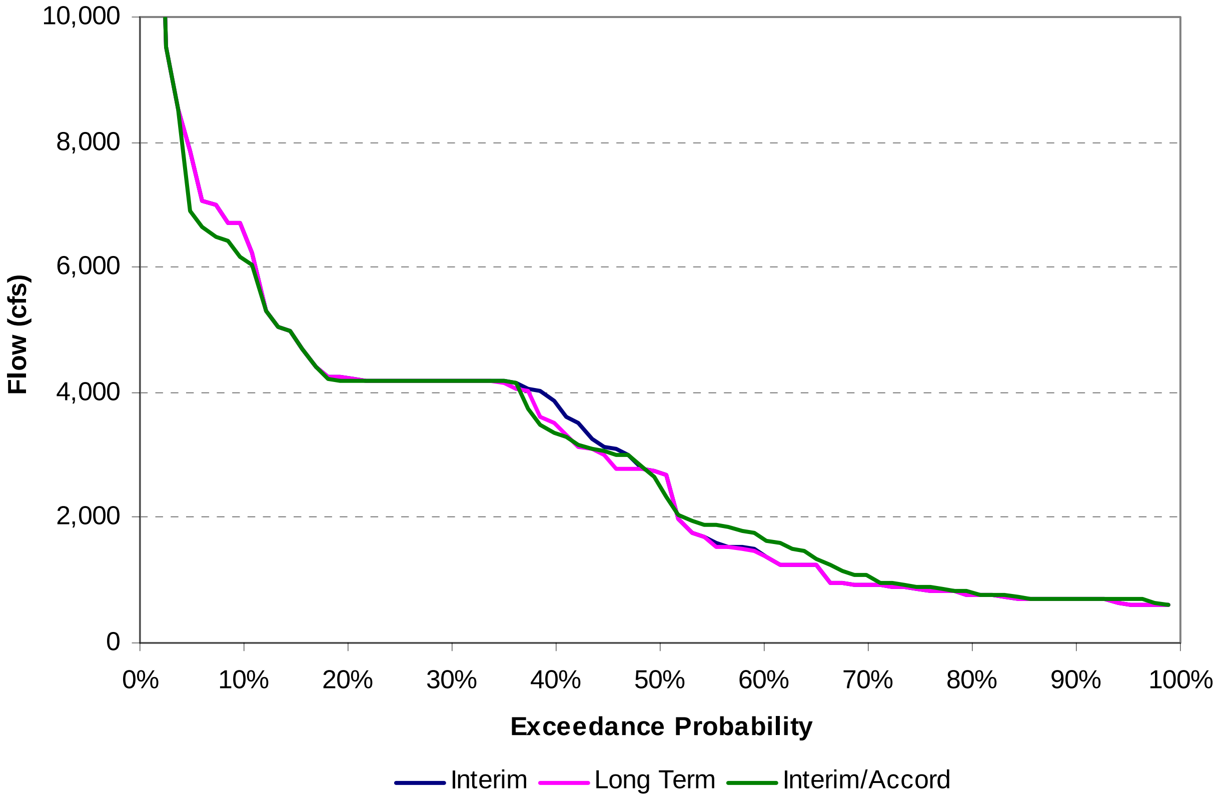
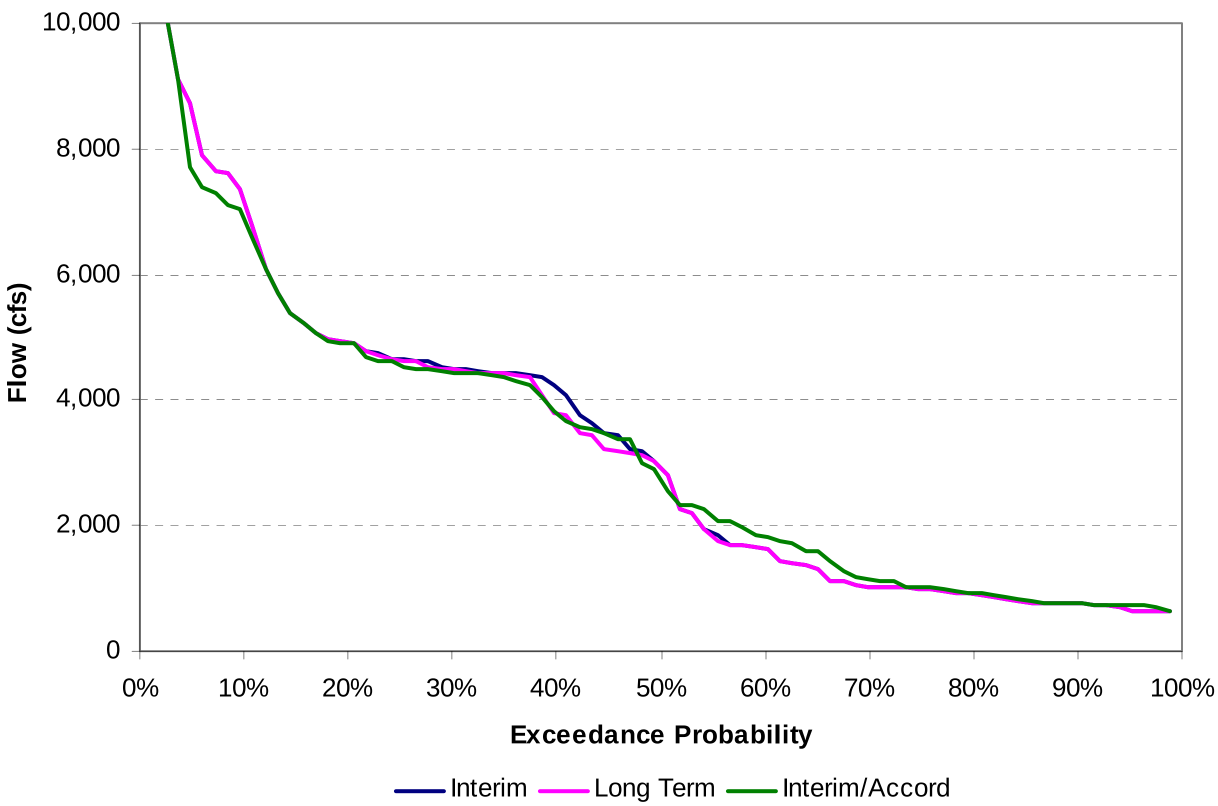


Figure A-22: Exceedance Probability of Yuba River Flow at Marysville for February, 2007



Attachment B

Exceedance Probability Plots for Water Temperature at Marysville Gage and Daguerre Dam for April 2006 to February 2007

Figure B-1: Exceedance Probability of Yuba River Water Temperature at Daguerre Point Dam for April, 2006

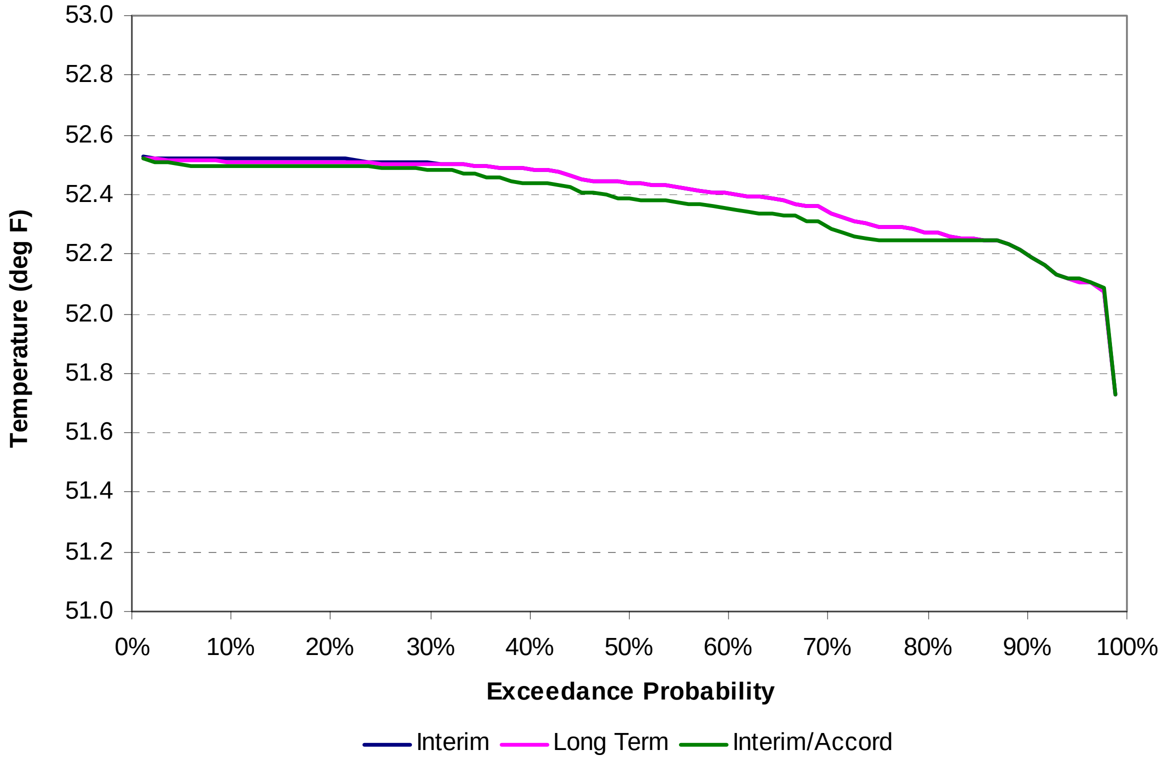


Figure B-2: Exceedance Probability of Yuba River Water Temperature at Marysville for April, 2006

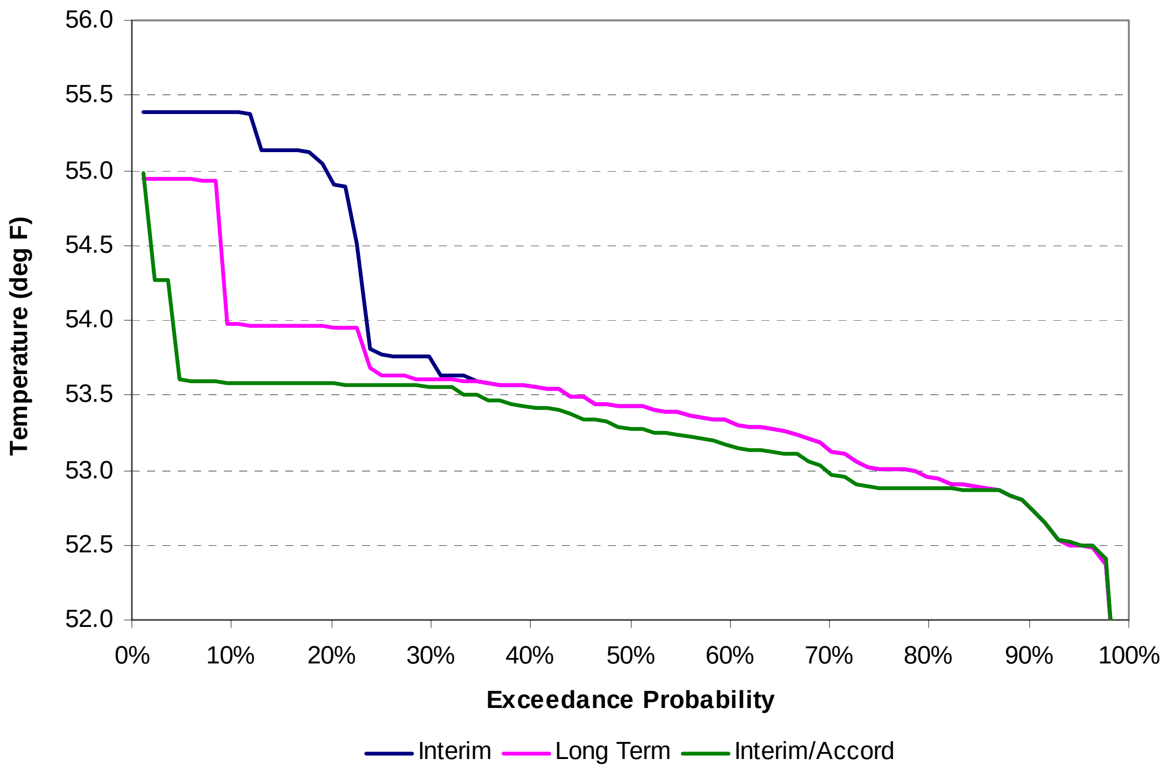


Figure B-3: Exceedance Probability of Yuba River Water Temperature at Daguerre Point Dam for May, 2006

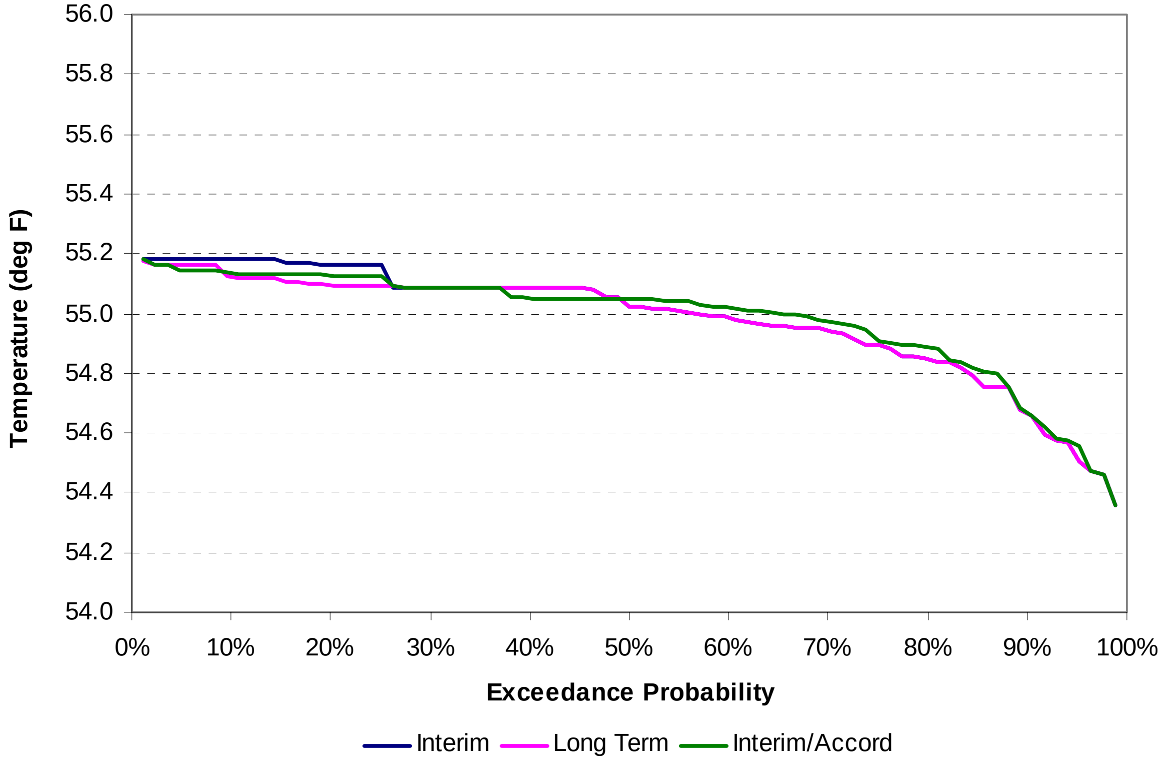


Figure B-4: Exceedance Probability of Yuba River Water Temperature at Marysville for May, 2006

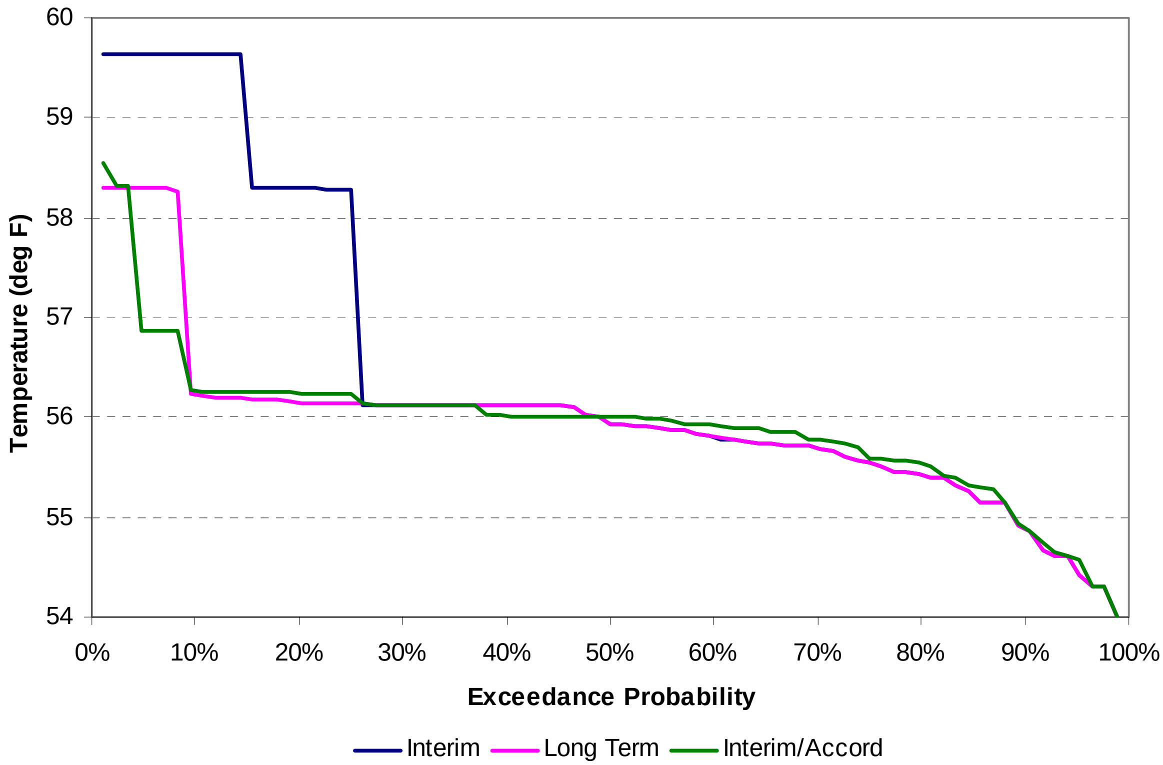


Figure B-5: Exceedance Probability of Yuba River Water Temperature at Daguerre Point Dam for June, 2006

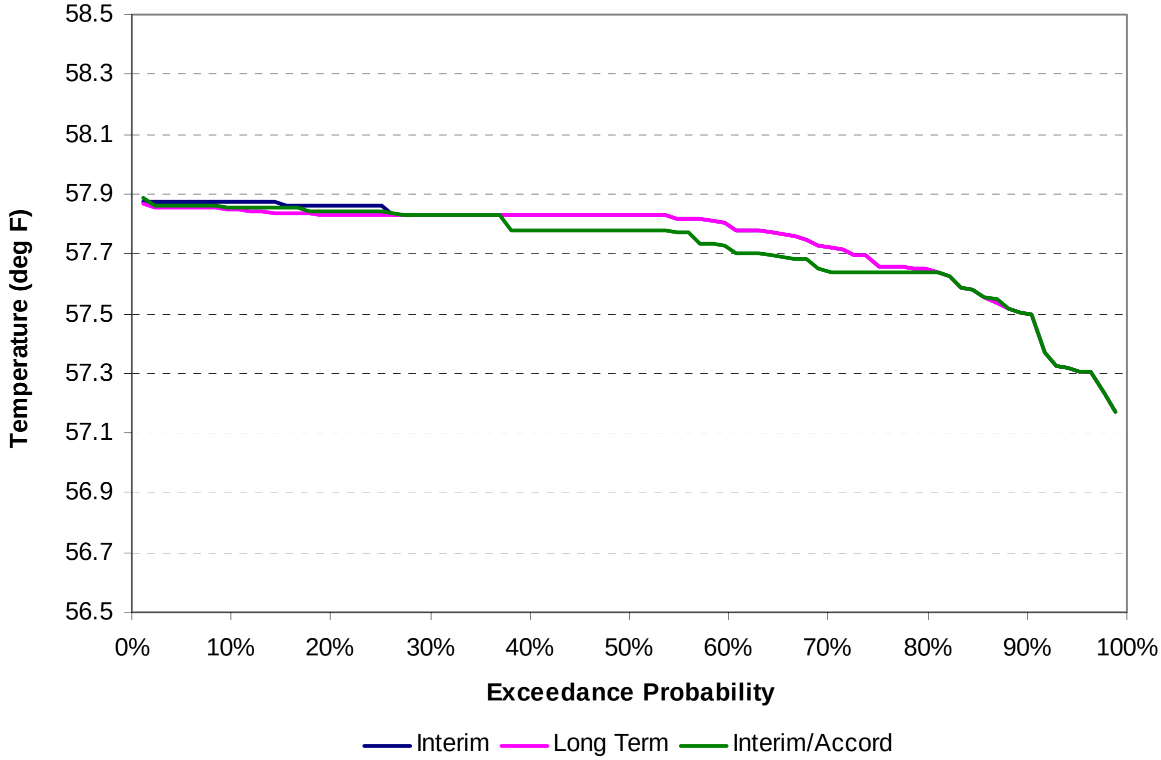


Figure B-6: Exceedance Probability of Yuba River Water Temperature at Marysville for June, 2006

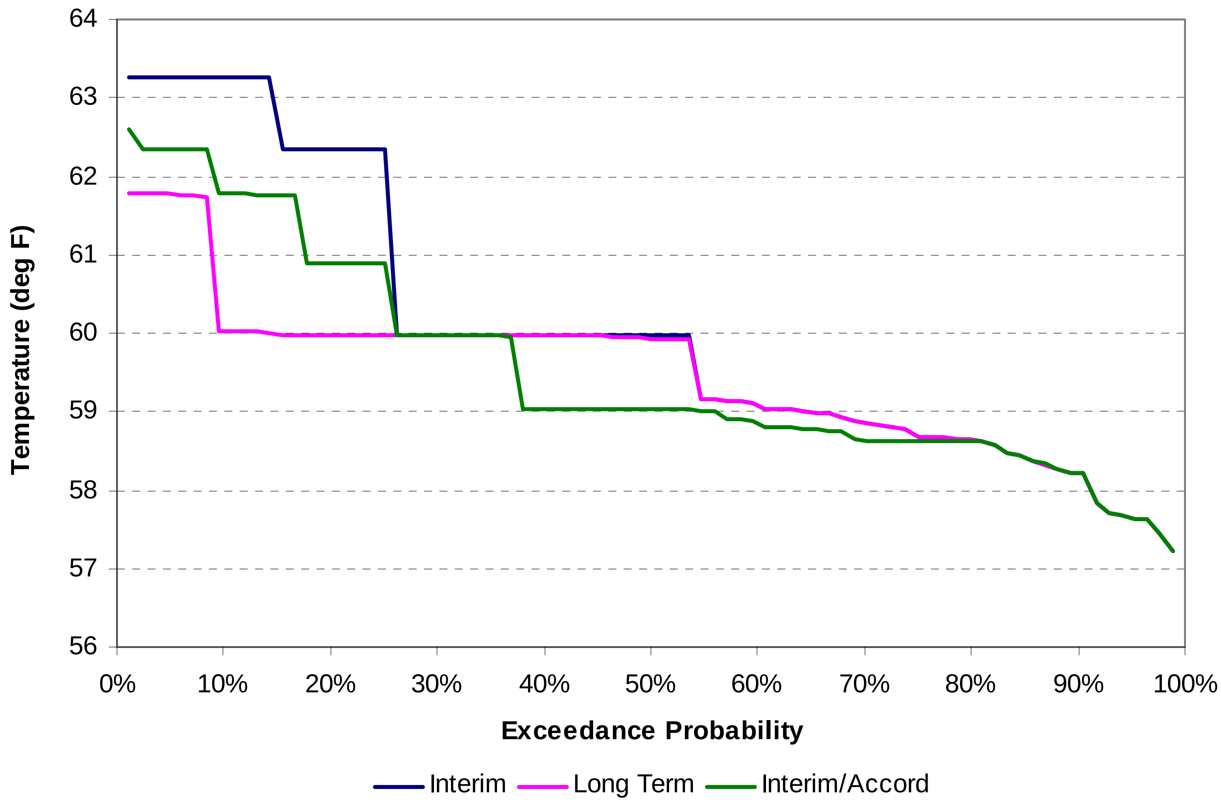


Figure B-7: Exceedance Probability of Yuba River Water Temperature at Daguerre Point Dam for July, 2006

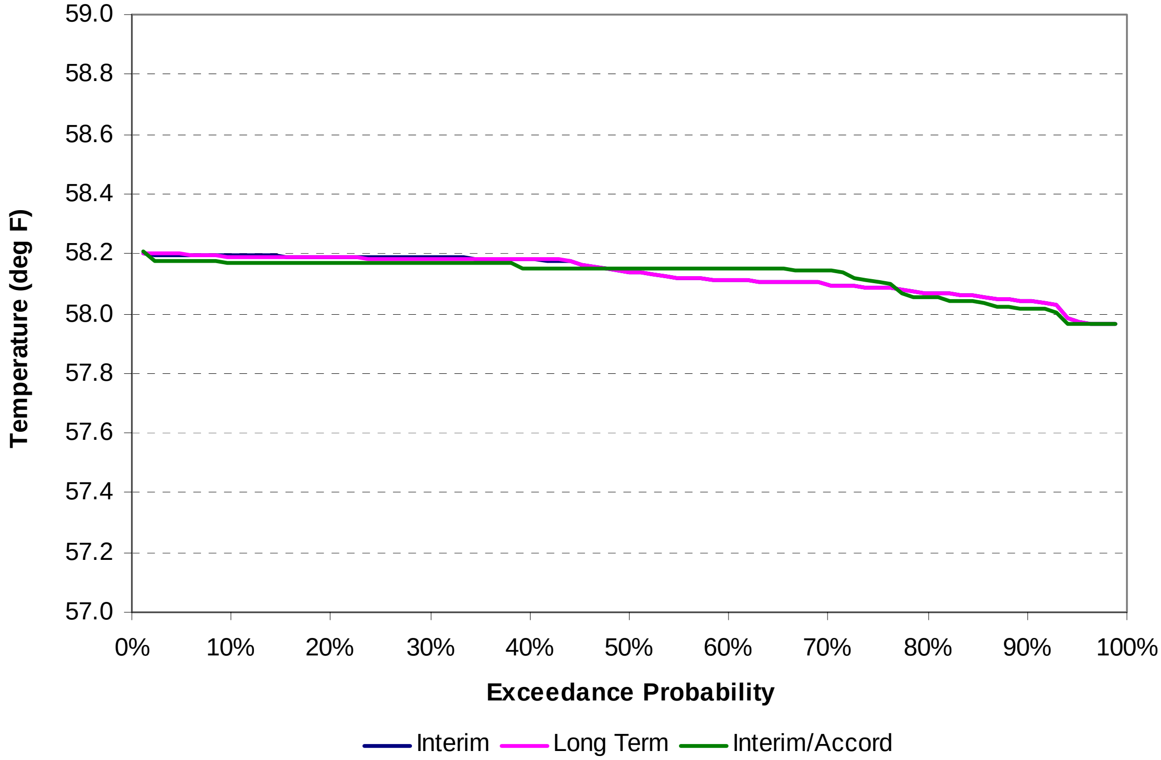


Figure B-8: Exceedance Probability of Yuba River Water Temperature at Marysville for July, 200

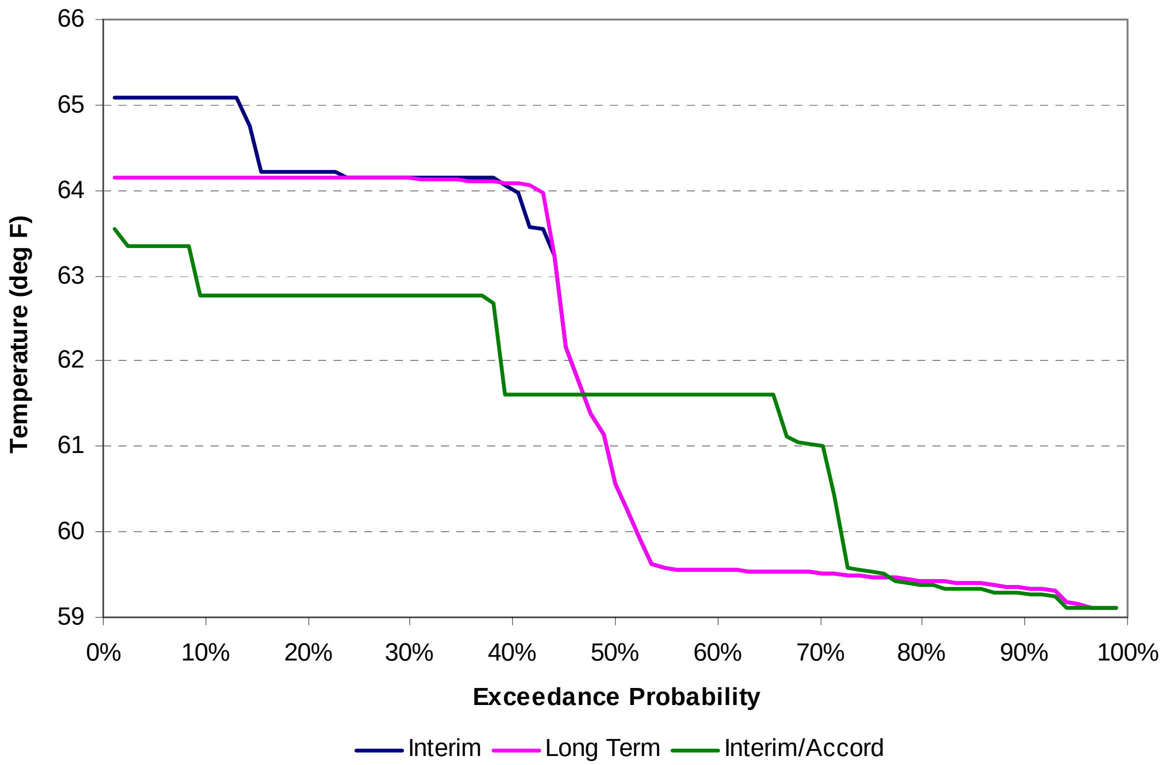


Figure B-9: Exceedance Probability of Yuba River Water Temperature at Daguerre Point Dam for August, 2006

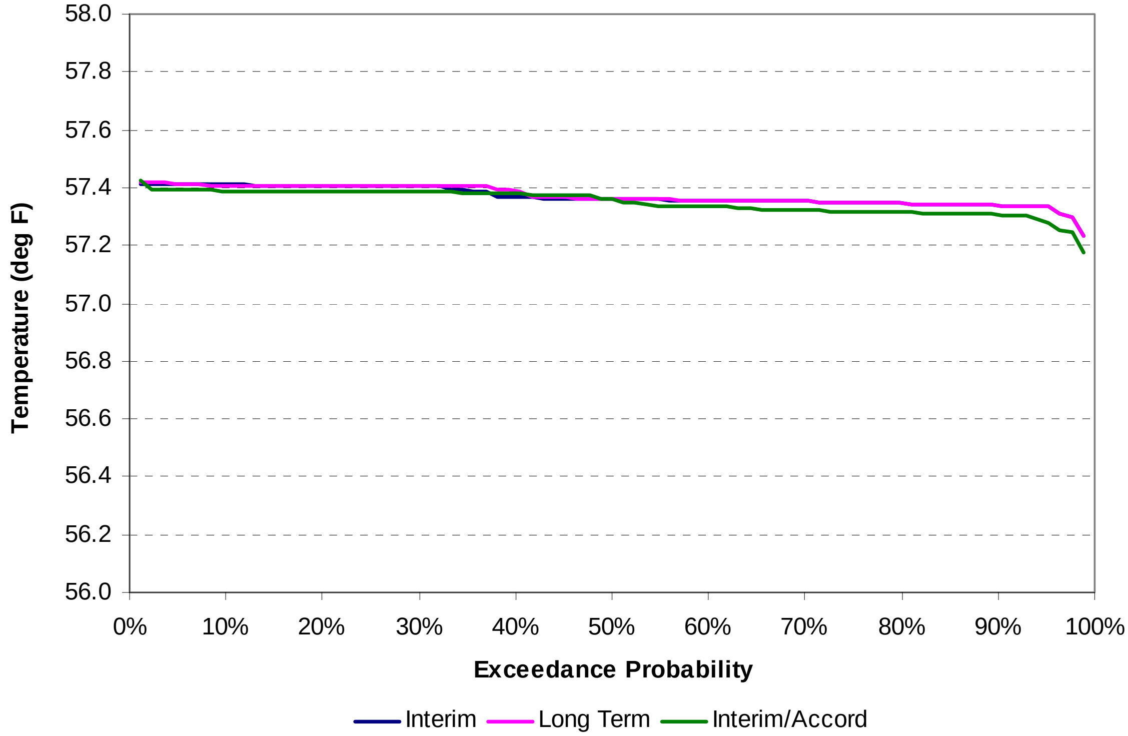


Figure B-10: Exceedance Probability of Yuba River Water Temperature at Marysville for August, 2006

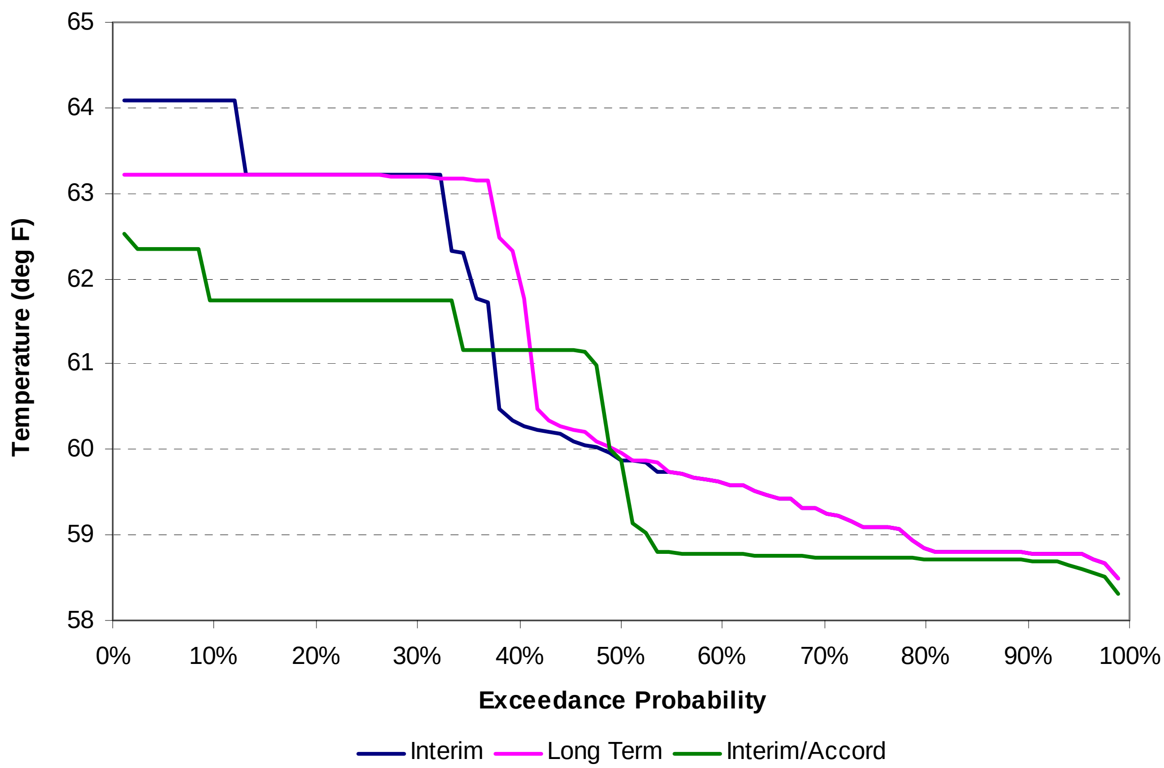


Figure B-11: Exceedance Probability of Yuba River Water Temperature at Daguerre Point Dam for September, 2006

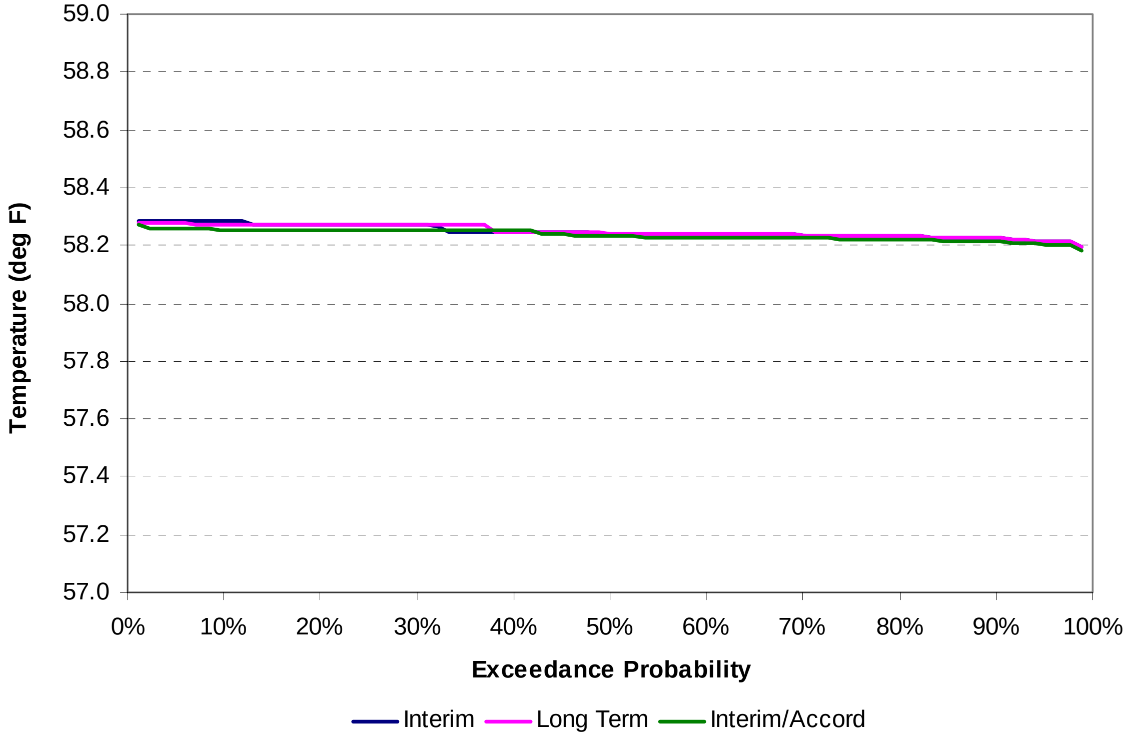


Figure B-12: Exceedance Probability of Yuba River Water Temperature at Marysville for September, 2006

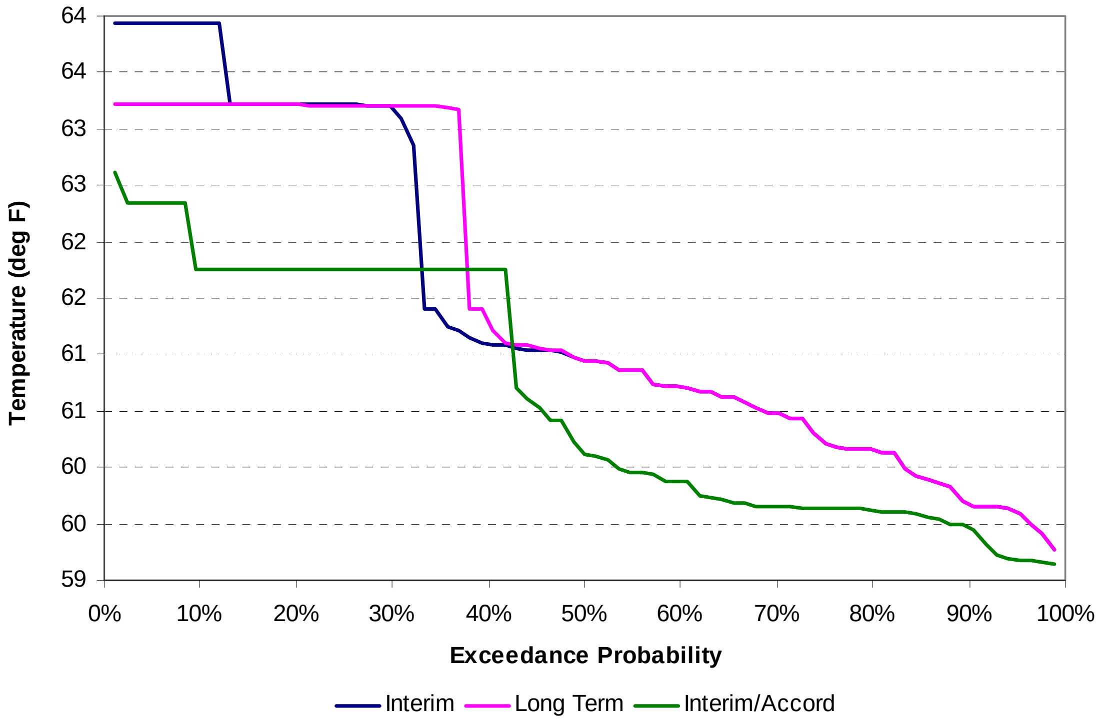


Figure B-13: Exceedance Probability of Yuba River Water Temperature at Daguerre Point Dam for October, 2006

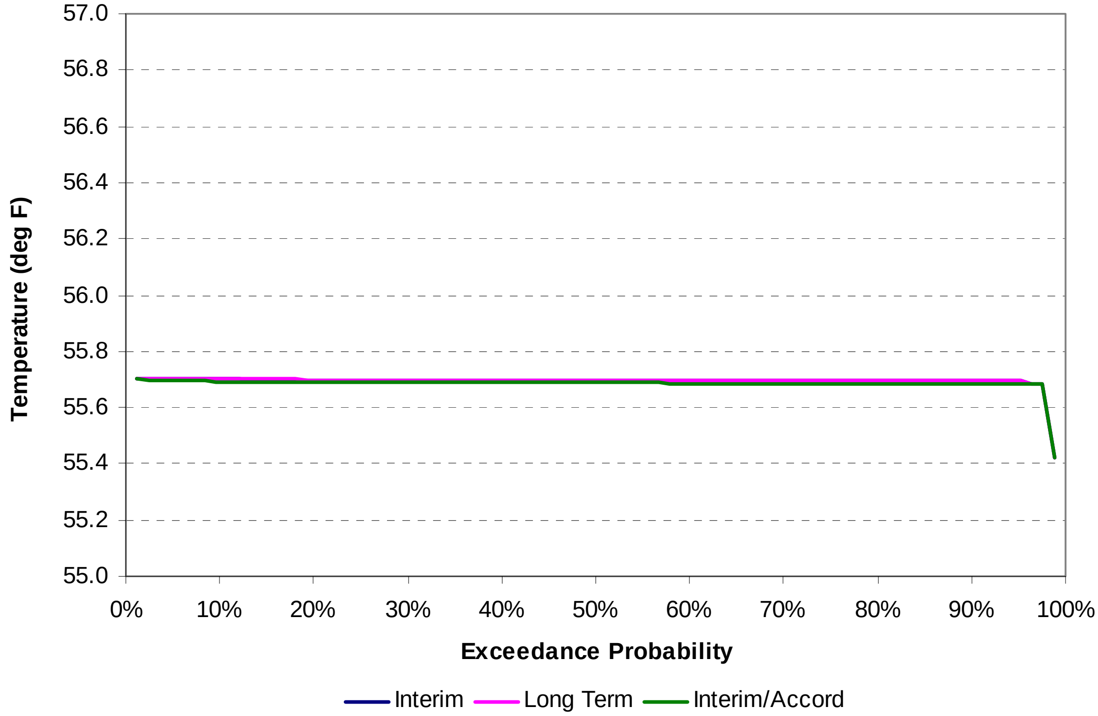


Figure B-14: Exceedance Probability of Yuba River Water Temperature at Marysville for October, 2006

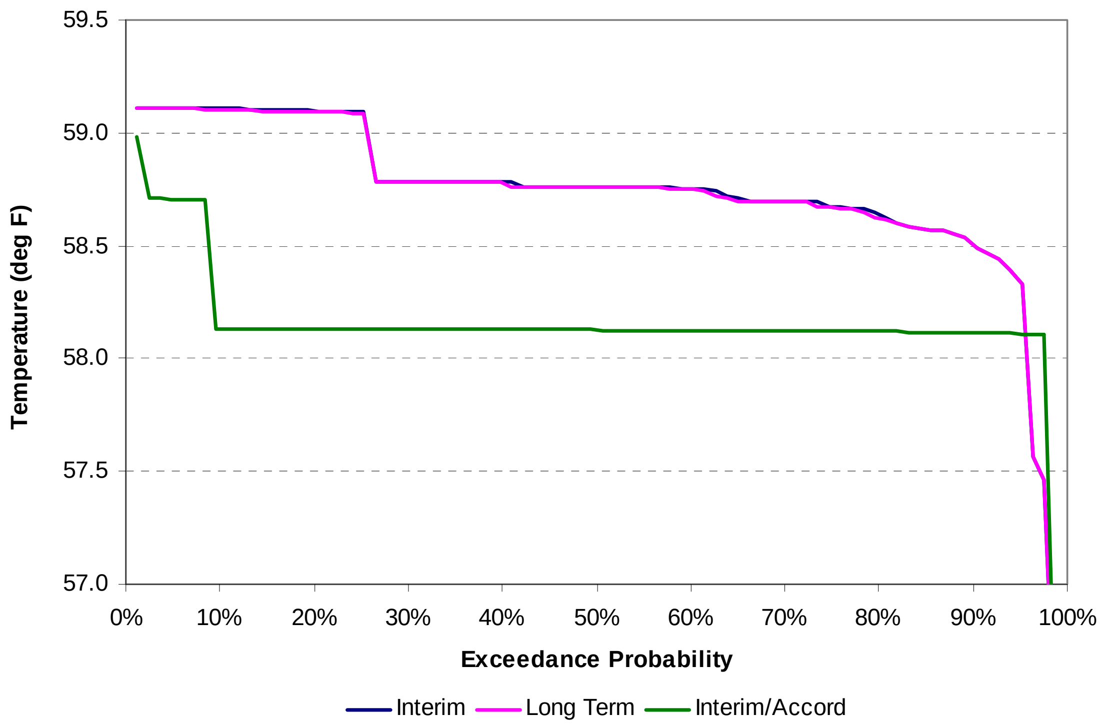


Figure B-15: Exceedance Probability of Yuba River Water Temperature at Daguerre Point Dam for November, 2006

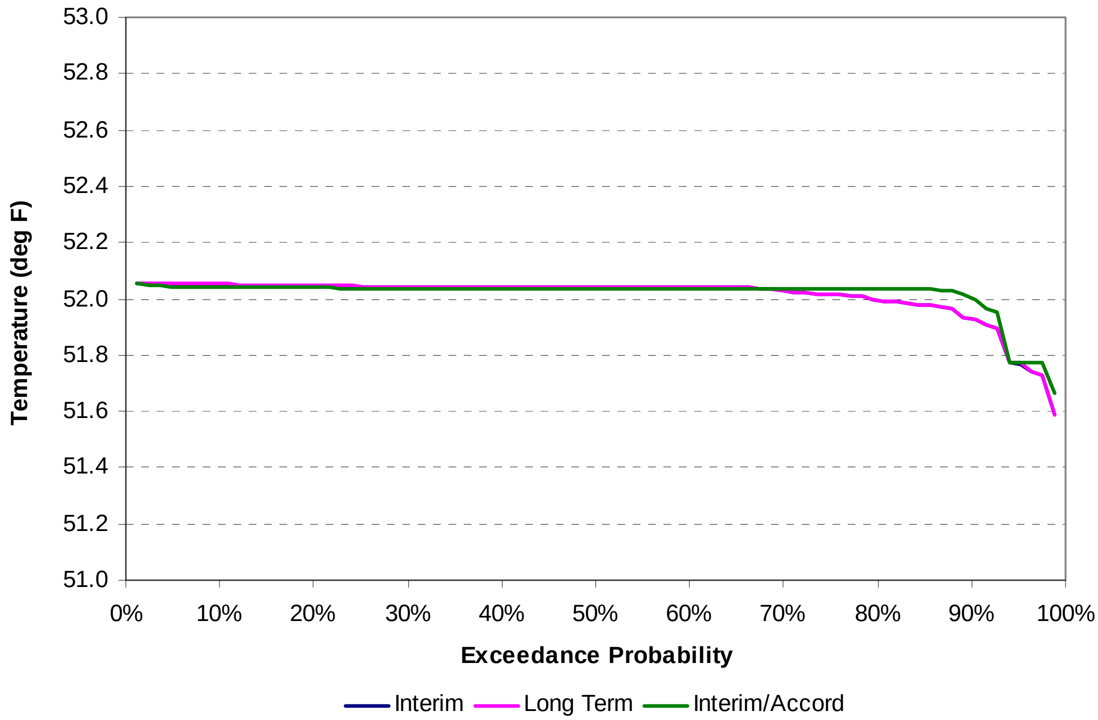


Figure B-16: Exceedance Probability of Yuba River Water Temperature at Marysville for November, 2006

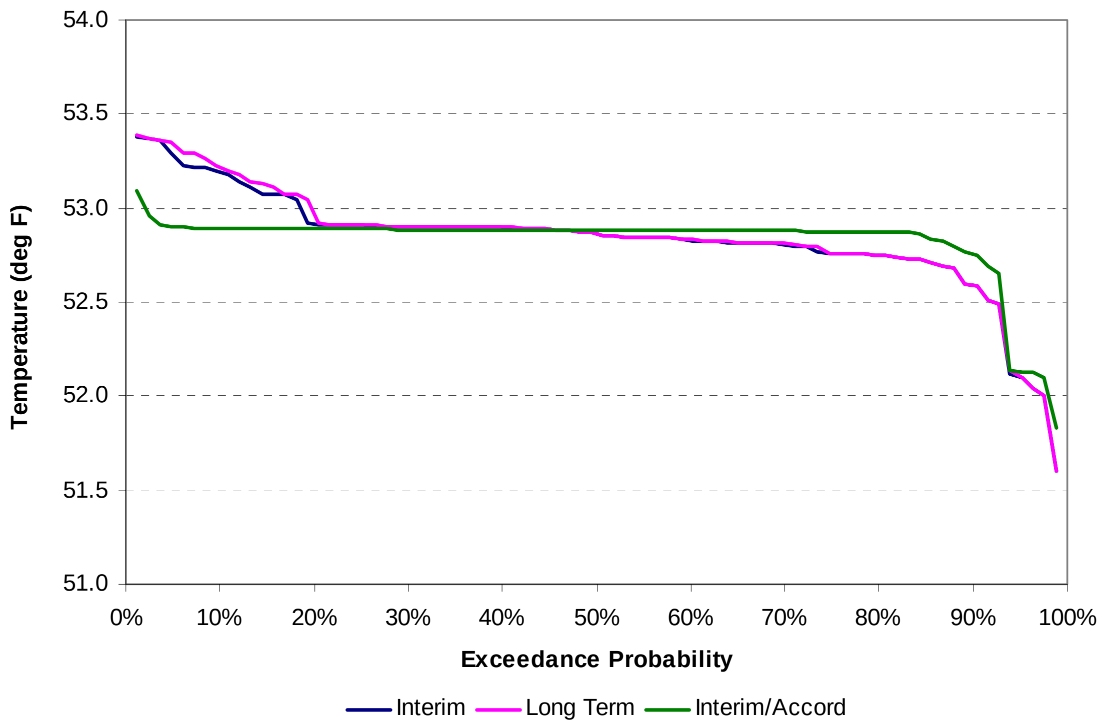


Figure B-17: Exceedance Probability of Yuba River Water Temperature at Daguerre Point Dam for December, 2006

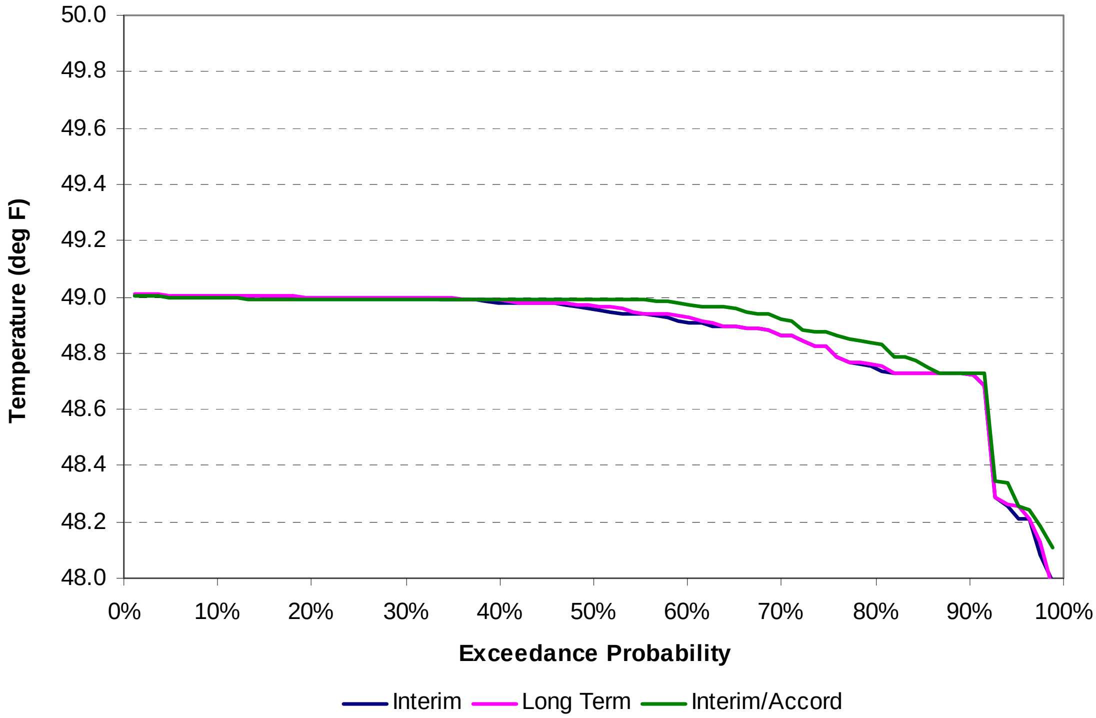


Figure B-18: Exceedance Probability of Yuba River Water Temperature at Marysville for December, 2006

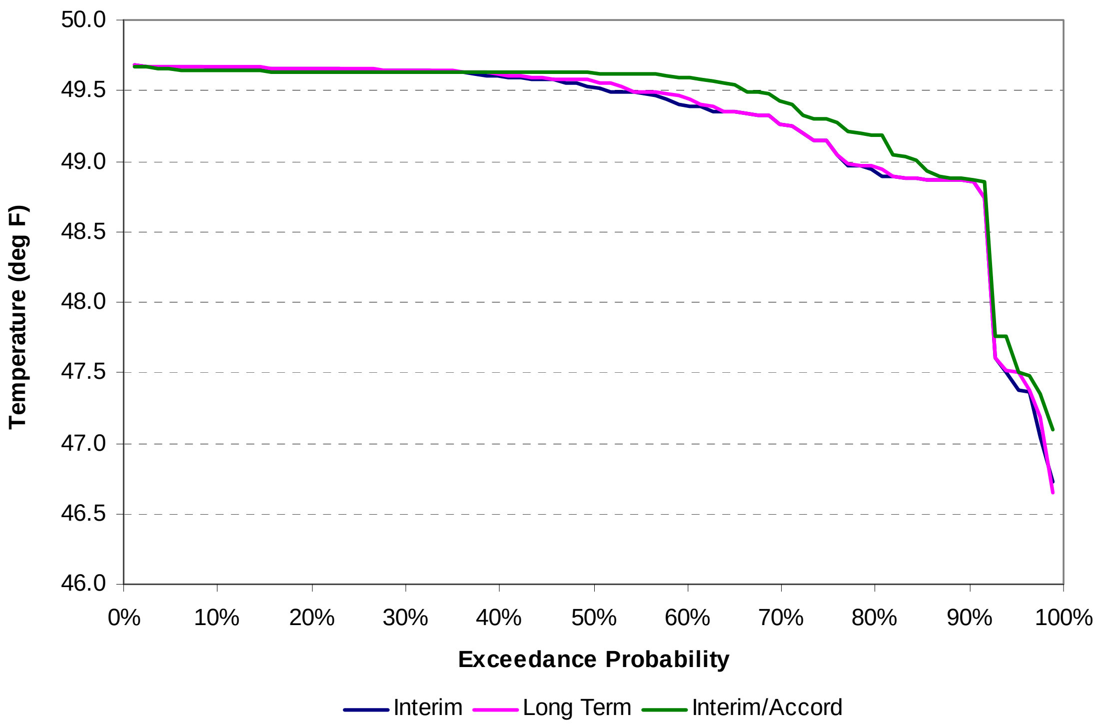


Figure B-19: Exceedance Probability of Yuba River Water Temperature at Daguerre Point Dam for January, 2007

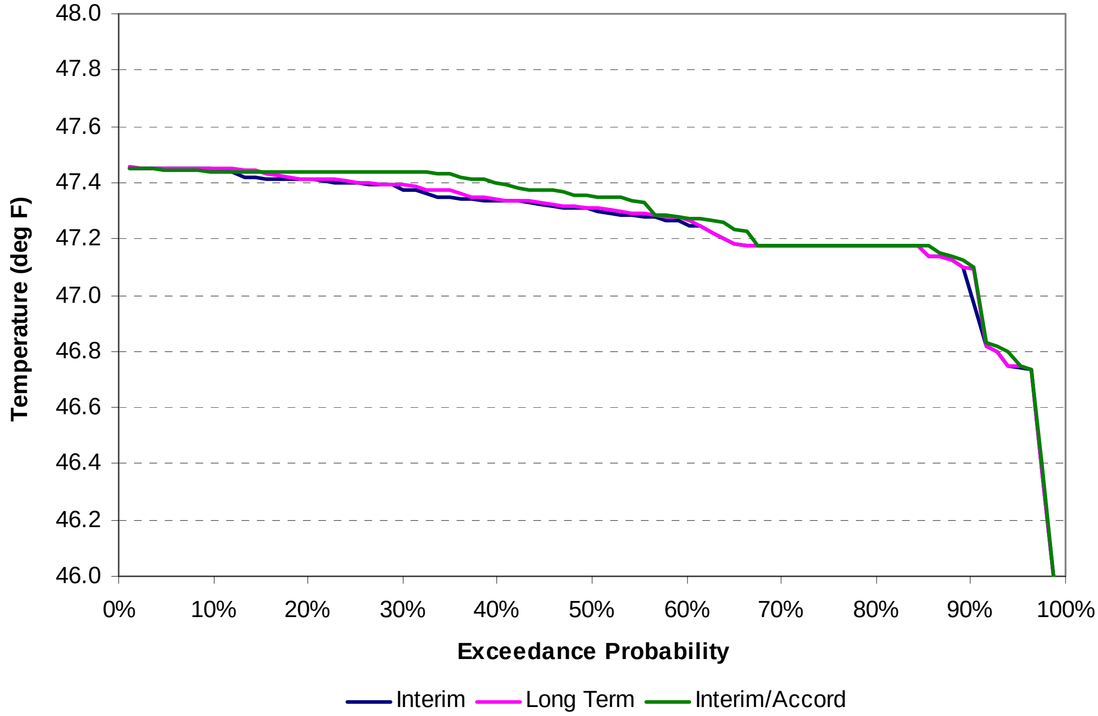


Figure B-20: Exceedance Probability of Yuba River Water Temperature at Marysville for January, 2007

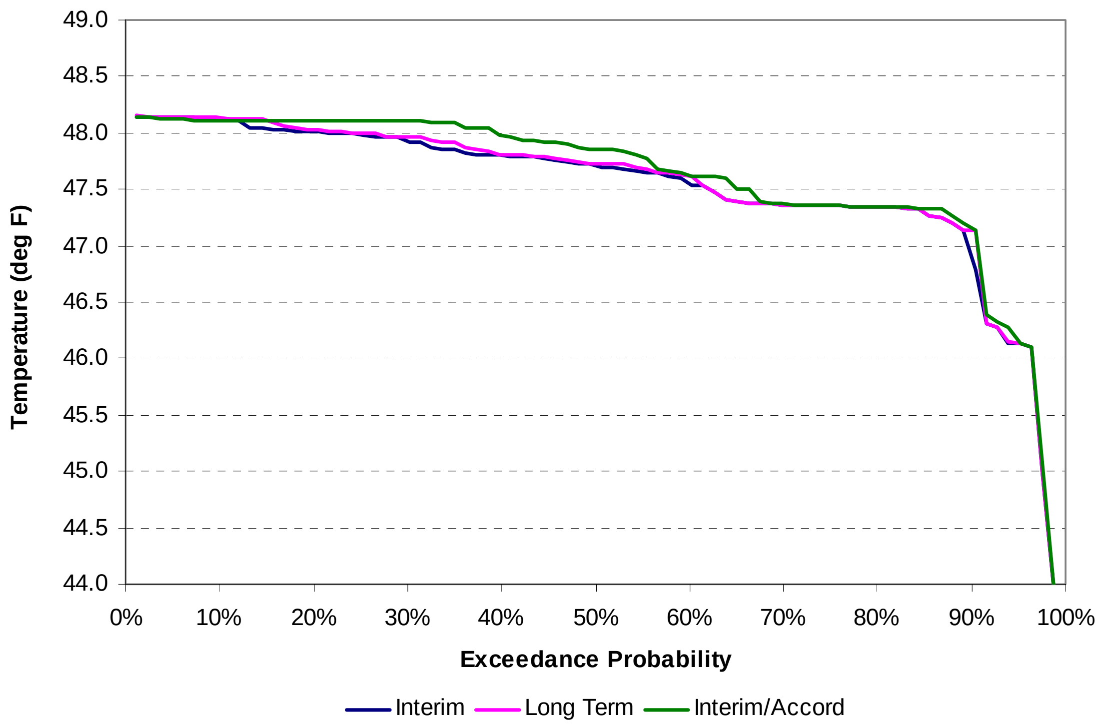


Figure B-21: Exceedance Probability of Yuba River Water Temperature at Daguerre Point Dam for February, 2007

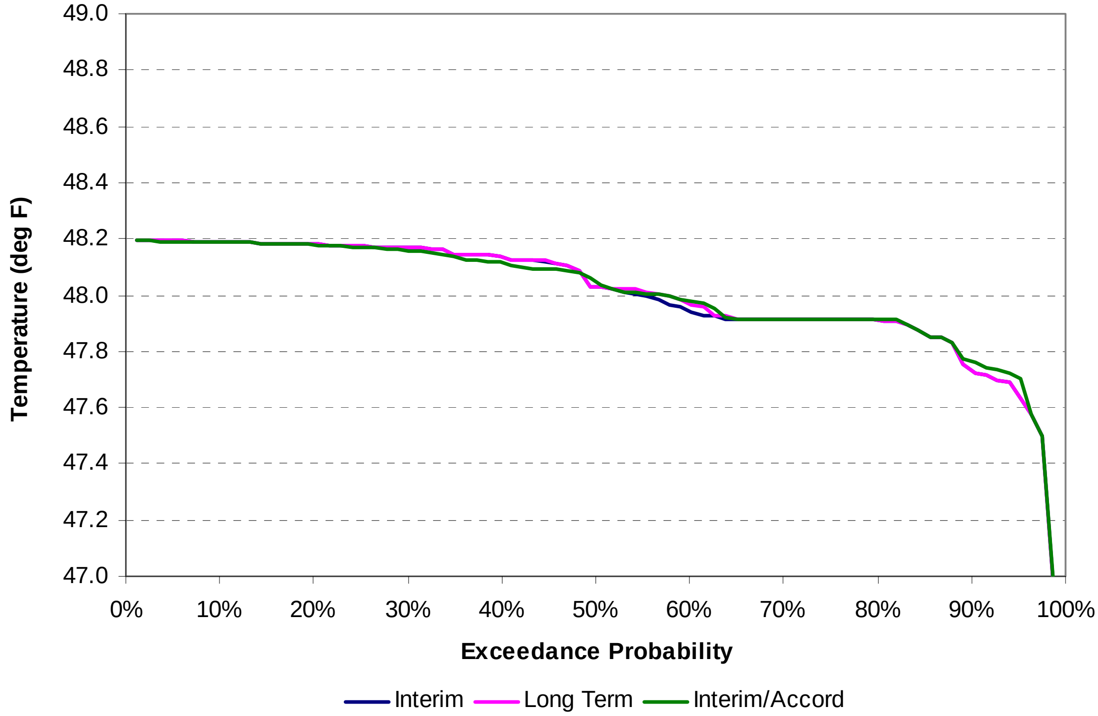


Figure B-22: Exceedance Probability of Yuba River Water Temperature at Marysville for February, 2007