SCENARIO 1 – ELIMINATE PUMPBACK POWER OPERATIONS

OBJECTIVE:

Investigate the effects of eliminating pumpback operations on water temperatures in the Oroville - Thermalito Complex and the Feather River.

DESCRIPTION:

Concerns have been expressed that the power operations have a dramatic impact on temperature in the Oroville – Thermalito complex and the Feather River. This scenario will provide information on the relationship between the pumpback portion of the power operations and temperatures throughout the system. The information will be useful in selecting specific actions to be included in the final alternatives for the license application.

MODELING ASSUMPTIONS:

CALSIM II - Use Existing Conditions benchmark simulation

HYDROPS – New HYDROPS simulation with following assumptions:

- Model entire CALSIM period of record
- Pump-back operations are not permitted
- Peaking operations will be permitted within the existing physical and operational limits of the Oroville – Thermalito Complex.
- Maintain the same storage targets in Oroville Reservoir
- Maintain the same flow targets in the Feather River, both low and high flow channels

WQRRS – New WQRRS simulation with following assumptions

- Maintain the same Oroville reservoir withdrawal levels at intake.
- Run simulation to get temperatures. No iterations of WQRRS or HYDROPS-WQRRS to meet specific temperature goals.

RESOURCE ACTION:

EWG-35 Lower existing water temperatures at the Thermalito Afterbay Outlet for the purpose of reducing feeding rates for predators in the Feather River.

EWG-83 Operate the Thermalito Complex to provide colder water to Lower Feather River for the benefit of salmonids.

EWG-87 Operate or modify the Oroville Complex in a manner to provide suitable warm water for agricultural purposes, while providing adequate cold water releases at the Thermalito Afterbay Outlet.

SCENARIO 2 – ELIMINATE PUMPBACK AND PEAKING POWER OPERATION

OBJECTIVE

Investigate the effects of eliminating pump back, and peaking power operations on water temperatures in the Oroville - Thermalito Afterbay and Feather River.

DESCRIPTION

Concerns have been expressed that the power operations have a dramatic impact on temperature in the Oroville – Thermalito complex and the Feather River. This scenario will provide information on the relationship between the power operations, both peaking and pumpback, and temperatures throughout the system. Power operations will be limited to running Hyatt and the Thermalito Powerhouses at a constant flow rate to match the net releases from the benchmark.

The information will be useful in selecting specific actions to be included in the final alternatives for the license application.

MODELING ASSUMPTIONS

CALSIM II - - Use Existing Conditions benchmark simulation.

Option 1. HYDROPS – New HYDROPS simulation with following assumptions:

- Model entire CALSIM period of record
  - Pump-back operations are not permitted
  - Peaking operations are not permitted
  - Maintain the same storage targets in Oroville Reservoir
- Maintain the same flow targets in the Feather River, both low and high flow channels.

WQRRS – New WQRRS simulation with following assumptions

- Maintain the same Oroville reservoir withdrawal levels at intake.
- Run simulation to get temperatures. No iterations of WQRRS or HYDROPS-WQRRS to meet specific temperature goals.

RESOURCE ACTION

EWG-35 Lower existing water temperatures at the Thermalito Afterbay Outlet for the purpose of reducing feeding rates for predators in the Feather River.

EWG-83 Operate the Thermalito Complex to provide colder water to Lower Feather River for the benefit of salmonids.

EWG-87 Operate or modify the Oroville Complex in a manner to provide suitable warm water for agricultural purposes, while providing adequate cold water releases at the Thermalito Afterbay Outlet.

MODELING SCENARIO 3 – ELIMINATE THERMALITO AFTERBAY FLUCTUATION DURING BASS AND WATERFOWL NESTING

OBJECTIVE

Investigate the effects of minimizing Thermalito Afterbay water surface elevation fluctuations to protect waterfowl and bass nests in the Thermalito Afterbay.

DESCRIPTION

Thermalito Afterbay is used to smooth out pump back and peaking power pulse releases before the water is released into the Feather River. During high power releases the storage in Thermalito Afterbay increases as the inflow above the desired release to the Feather River is captured. During periods of low power releases or pump back operations the storage decrease as the water is pumped back into Oroville Reservoir or released to the Feather River. This results in changes in Thermalito Afterbay surface elevation on a daily basis.

The fluctuations have the potential to impact waterfowl nests, by flooding them as the elevation rises and bass nests, by dewatering them as the surface elevation lowers. Minimization of the Thermalito Afterbay water surface fluctuations during the water fowl nesting period (mid-March through May) and the bass nesting period (March through June) would protect the bass nests from de-watering and the duck nests from flooding. Since water fowl nests are usually slightly above the actual water surface level and bass required a minimum depth to nest there is probably some acceptable level of fluctuation that could be allowed while still maintaining the goal of protecting the nest. An allowable fluctuation of about ½ a foot would mean a +/- 3 inch change from the mean elevation, which is assumed to be within the tolerance of both species.

Note: If the fluctuation is completely eliminated this will have the effect of eliminating all peaking and pump back power operations. In this case the scenario is the same as Scenario 2.

MODELING ASSUMPTIONS

CALSIM II - Use Existing Conditions benchmark simulation

HYDROPS – New HYDROPS simulation with following assumptions:

- Option 1 - Thermalito surface level will not be allowed to fluctuate during the March through June period. The surface elevation will be maintained at 136 ft (54,800 AF storage)
- Option 2 - Thermalito surface level will be allowed to fluctuate between 135.4 and 136.0 ft elevation (52,300 AF to 54,800 AF storage)
- Model entire CALSIM period of record

- Pump-back operations are permitted within the physical and operational limits of the Oroville – Thermalito Complex.
- Peaking operations will be permitted within the existing physical and operational limits of the Oroville – Thermalito Complex.
- Maintain the same storage targets in Oroville Reservoir
- Maintain the same flow targets in the Feather River, both low and high flow channels

Note: the assumption of no surface elevation fluctuation will result in no peaking or pumpback power operations.

WQRRS – New WQRRS simulation with following assumptions

- Maintain the same Oroville reservoir withdrawal levels at intake.
- Run simulation to get temperatures. No iterations of WQRRS or HYDROPS-WQRRS to meet specific temperature goals.

RESOURCE ACTION

EWG-28 Manage water levels in the Thermalito Afterbay to provide increased nesting and initial rearing habitat for nesting warmwater species.

SCENARIO 4 – MAXIMIZE THERMALITO AFTERBAY LEVEL FLUCTUATION DURING BASS AND WATERFOWL NESTING PERIOD

OBJECTIVE

Investigate the effects of maintaining a consistent level of Thermalito Afterbay water surface elevation fluctuations in order to protect bass and waterfowl nests.

DESCRIPTION

Thermalito Afterbay is used to smooth out pump back and peaking power pulse releases before the water is released into the Feather River. During high power releases the storage in Thermalito Afterbay increases as the inflow above the desired release to the Feather River is captured. During periods of low power releases or pump back operations the storage decrease as the water is pumped back into Oroville Reservoir or released to the Feather River. This results in changes in Thermalito Afterbay surface elevation on a daily basis.

These Thermalito Afterbay water surface fluctuations have the potential to cause problems during the waterfowl-nesting period (mid-March through May) and bass nesting period (March through June). Maintaining a consistent level of Thermalito Afterbay water level fluctuation during this time period would encourage bass to build nests below the low point of the fluctuations, thus protecting them from dewatering, and encourage the waterfowl to nest above the high point, thus protecting them from flooding.

Since the goal of the scenario is to maintain a consistent high and low point for surface elevation over the entire period we also have to maintain the same high and low points each day. This means that in some days there would be less fluctuation than is desirable for power production and some days when there would be more fluctuation. This also implies that the new requirement could be imposed as a single upper and lower elevation for the entire period that must be meet each day. For the purposes of this scenario it does not matter what the elevations are, only that they are the same each day. This means that the elevation fluctuation requirement has different storages depending on how far apart they are.

The reason that the Thermalito Afterbay storage fluctuates is to smooth out the peaking and pumpback power operations of the complex before the water is returned to the Feather River by capturing and releasing a specific volume of water. Since this volume will be the same every day it also will be higher than desired in some days and lower in others. In order to balance these highs and lows out historical Thermalito storage and elevation data was examined.

Figure 1 shows the historical exceedance of daily storage fluctuations in Thermalito Afterbay computed from operational data for the period 1981 – 2001. Table 1. is a summary of the exceedance values.

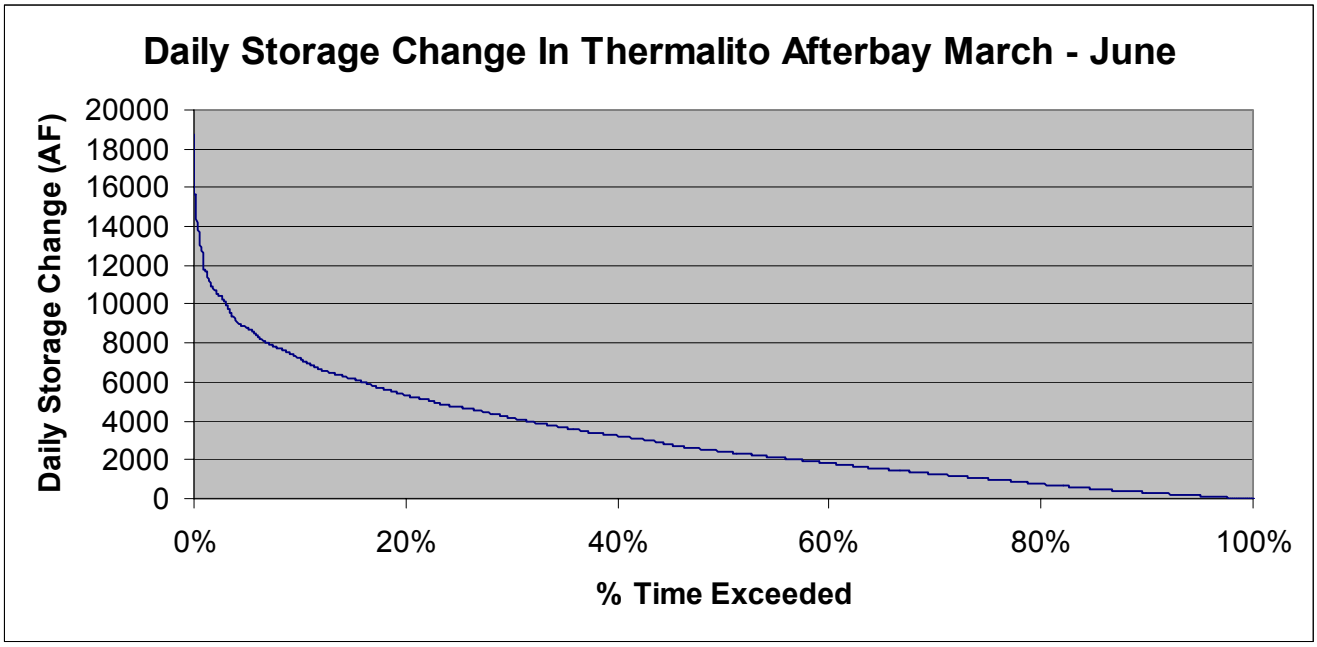

Figure 1. – Historical daily Thermalito Storage Change Exceedance

Table 1. – Summary of Historical daily Thermalito Storage Change Exceedance

Daily Storage Change In Thermalito Afterbay, March - June									
Exceedance	10%	20%	30%	40%	50%	60%	70%	80%	90%
Storage Change (AF)	324	746	1262	1813	2422	3236	4158	5300	7201
Operations data from 1981 - 2001									

The 50% exceedance value means that the value is exceeded half the time and not meet half the time which would balance the over and under storages in the individual days over the longer time horizon. From Table 1. the 50% exceedance storage change is about 2500 AF. Table 2 is the surface elevation - storage curve computed from the operational data.

Table 2. Surface elevation

Thermalito Afterbay Elevation Storage			
Elevation	**Storage**	**Elevation**	**Storage**
(ft)	(af)	(ft)	(af)
122.9	12611	130.0	32152
123.0	12850	131.0	35556
124.0	15156	132.0	39120
125.0	17581	133.0	42842
126.0	20172	134.0	46721
127.0	22918	135.0	50739
128.0	25831	136.0	54906
129.0	28909	136.4	56698

If we assume that would like to maintain Thermalito as nearly full as practical can select 136 ft (about 54,800 af storage) as the upper limit of the surface fluctuation. From the curve can then compute that a 2500 AF storage change would give a lower elevation requirement of 135.4 ft (about 52,300 af storage)

Significant operational flexibility, while meeting the goals of protecting the waterfowl and bass nests, might be obtained if the maximum fluctuation was not required each day. If the fluctuation was not required each day a higher maximum could be used to allow better utilization of the limited water available for power generation resources since the requirement to

It does take waterfowl and bass some period of time to build and occupy a nest. If the maximum fluctuation occurred during that time period then partially construction nests would be flooded or dewatered encouraging the nest to be built outside the fluctuation zone. Modeling of this assumption would require development of the time interval requirements to prevent nesting in the fluctuation zone.

MODELING ASSUMPTIONS

CALSIM II - Use Existing Conditions benchmark simulation

HYDROPS – New HYDROPS simulation with following assumptions:

- Option 1 - Thermalito surface level will be <u>required</u> to fluctuate <u>each day</u> from135.4 ft to 136.0 ft, (storages 52,300 to 54,800 AF) during the March through June period.
- Option 2 – Require that the maximum fluctuation occur over a 2 day period.
- Model entire CALSIM period of record
- Pumpback operations are permitted within the physical and operational limits of the Oroville – Thermalito Complex
- Peaking operations will be permitted within the physical and operational limits of the Oroville – Thermalito Complex.
- Maintain the same storage targets in Oroville Reservoir

- Maintain the same flow targets in the Feather River, both low and high flow channels

WQRRS – New WQRRS simulation with following assumptions

- Use results of new HYDROPS simulation.
- Maintain the same Oroville reservoir withdrawal levels at intake.
- No iterations of WQRRS or HYDROPS-WQRRS to meet specific temperature goals.

RESOURCE ACTION

EWG-28 Manage water levels in the Thermalito Afterbay to provide increased nesting and initial rearing habitat for nesting warmwater species.

SCENARIO 5 - ELIMINATE THE FEATHER RIVER HATCHERY WATER TEMPERATURE CONSTRAINTS AS THE DRIVER FOR RELEASES FROM OROVILLE DAM

OBJECTIVE

Remove the Feather River Hatchery water temperature requirements as a factor governing Oroville temperature operations.

DESCRIPTION

Under current conditions Oroville temperature operations are sometimes controlled by Feather River Hatchery water temperature requirements, resulting in temperatures in the low flow portion of the Feather River that are colder than the temperature targets at Robinson's Riffle. If the Feather River Hatchery temperature requirements were removed then Oroville could operate to meet the Robinson's Riffle temperature requirement and possibly maintain the cold-water pool for use later in the year.

This scenario would be performed like a new benchmark simulation with the elimination of the temperature requirements at the Feather River Hatchery. Iterations will be performed as required with WQRRS, HYDROPS, and possibly CALSIM II.

MODELING ASSUMPTIONS

CALSIM II - No initial CALSIM II simulation required, use existing conditions benchmark simulation. CALSIM II re-simulation may be required as discussed under WQRRS assumptions.

HYDROPS – No initial HYDROPS simulation required, use existing conditions benchmark simulation. HYDROPS – WQRRS iterations may be required as discussed under WQRRS assumptions.

WQRRS – New WQRRS simulation with following assumptions

- No temperature targets at Feather River Hatchery
- Adjust Oroville intake operations to meet Feather River temperature goals while maintaining maximize agricultural diversion temperatures. This may require several iterations of the WQRRS model
- May require iteration with HYDROPS if Oroville intake operations are not sufficient to meet temperature goals.
- May require iteration with CALSIM II if HYDROPS re-operations are not sufficient to meet temperature goals.

RESOURCE ACTION

EWG-35 Lower existing water temperatures at the Thermalito Afterbay Outlet for the purpose of reducing feeding rates for predators in the Feather River.

EWG-36 Operate the Oroville Facilities in a manner which would provide additional cold water in the low flow channel of the Feather River for benefit of Chinook salmon and steelhead.

EWG-37 Operate the Oroville Facilities in a manner which would provide additional cold water in the high flow channel of the Feather River for benefit of Chinook salmon and steelhead.

EWG-38 Manage withdrawals from Lake Oroville to minimize reduction of coldwater pool.

EWG-83 Operate the Thermalito Complex to provide colder water to Lower Feather River for the benefit of salmonids.

EWG-87 Operate or modify the Oroville Complex in a manner to provide suitable warm water for agricultural purposes, while providing adequate cold water releases at the Thermalito Afterbay Outlet.

SCENARIO 6 – INCREASE MINIMUM LOW FLOW FEATHER RIVER CHANNEL REQUIREMENT TO 725 CFS

OBJECTIVE

Investigate the effect of increasing the base flow to 725 CFS in the Low Flow Channel of the Feather River during the Chinook salmon spawning season to optimize available spawning habitat.

DESCRIPTION

The low flow section of the Feather River (The reach from the Thermalito Diversion Dam to the Thermalito Afterbay Return) is the prime spawning reach of the Feather River below Oroville. PHABSIM modeling conducted for SP-F16 found that the maximum spawning potential, measured in WUA, in the low flow section of the Feather River occurs at a flow of 725 CFS. This scenario is to investigate the impacts of increasing the base flow in the Low Flow Channel of the Feather River from the current minimum flow requirement of 600 CFS to 725 CFS at the onset of Chinook salmon spawning (September) and maintain the 725 CFS flow through the spawning and incubation periods (September through April).

Table 1. Feather River flow below Thermalito Afterbay return from Existing Benchmark simulation.

Feather River below Thermalito Afterbay Return								
	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr
	(CFS)	(CFS)	(CFS)	(CFS)	(CFS)	(CFS)	(CFS)	(CFS)
Min	756.3	1130.5	907.5	894.5	894.5	869.3	748.1	756.2
Max	5814.1	5292.7	14569.0	24345.5	35878.1	23682.2	31844.7	18936.7
Average	2106.0	2537.7	2285.7	3984.4	5019.2	5917.1	6044.0	3431.3

As shown in this table there is always sufficient release from Oroville Reservoir to meet the 725 CFS minimum requirement in the Feather River low flow section.

MODELING ASSUMPTIONS:

CALSIM II - Since the release from Oroville reservoir in the Existing Conditions benchmark is always sufficient to meet this new minimum flow requirement the is no need for a new CALSIM II simulation. Use the Existing Conditions Benchmark.

HYDROPS – New HYDROPS simulation with following assumptions:

- Model entire CALSIM period of record
- Set Feather River low flow section minimum flow requirement from Sep 1 to Apr 30 to 725 CFS

WQRRS – New WQRRS simulation with following assumptions

- Use results of new HYDROPS simulation.

- Maintain all temperature goals from the benchmark scenario.
- Run temperature simulation. (It is anticipated that the results of the new temperature simulation will show colder temperatures throughout the low flow section of the Feather River. If true this means that it might be possible to modify Oroville intake operations to meet the temperature targets along the Feather River and increase temperatures of the agricultural diversions from the Thermalito Complex. This evaluation would require iterative runs of WQRRS and possibly HYDROPS. The evaluation will not be performed under this scenario.)

RESOURCE ACTION:

EWG-88 Increase flows in the low flow reach of the Feather River to increase available spawning habitat. This resource action would increase flows above the current levels (600 CFS) during peak Chinook spawning to increase the quantity of habitat available for salmonids.

SCENARIO 7 – GRADUAL FLOW INCREASE IN THE LOW FLOW CHANNEL OF THE FEATHER RIVER GRADUALLY DURING THE CHINOOK SALMON SPAWNING PERIOD

OBJECTIVE:

Investigate the effect of increasing the flow in the Low Flow Channel of the Feather River gradually during the Chinook salmon spawning season (September through December) to provide additional potential spawning habitat.

DESCRIPTION:

This proposal would increase the flow in the low flow section of the Feather River from the current minimum flow requirement of 600 CFS to 1000 CFS over the course of the Chinook salmon spawning season (September through December). The idea is that this increase in flow rate would flood additional potential spawning areas week over the spawning period. As the flow increases new suitable spawning habitat would become available to salmon in the low flow channel that had not already been used by other fish.

Two options to implement this would be explored:

- Option 1 - Increase the flow in the low flow section of the Feather River from the current minimum flow requirement of 600 CFS to 1000 CFS gradually over the course of the Chinook salmon spawning season (September through December).

- Option 2 – Increase the flow in the low flow section of the Feather River from the current minimum flow requirement of 600 CFS to 725 CFS at the beginning of the Chinook salmon spawning season (September 1) and again from 725 CFS to 1000 CFS in the middle of the Chinook salmon spawning season (October 15)

Under either option the flow would then remain at 1000 CFS through April in order to prevent dewatering of Chinook salmon reds.

Table 1 is a summary of the Father River flow below the Thermalito Afterbay return from the Existing Conditions Benchmark simulation. The flow at this point represent the portion of the total Oroville release that goes down the Feather river after all diversions from the Thermalito Forebay-Afterbay complex are made. This is the maximum flow that could be put down the low flow channel without additional releases from Oroville reservoir. As can be seen from table one additional releases will need to be made from Oroville reservoir in order to maintain the 1000 CFS flow in the low flow channel through the end of May.

Table 1. - Feather River Below Thermalito Afterbay Return												
	Oct	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**
Avg.	2622	2530	4322	5863	6460	6422	3864	3868	4829	5285	4916	2217
Min.	1130	907	894	894	869	748	756	748	786	889	947	756
Max.	5293	14569	24345	35878	23682	31845	18937	20229	11590	12160	8191	5814

MODELING ASSUMPTIONS:

CALSIM II - Will require new CALSIM II simulations with new minimum flows in the low flow Feather River as follows:

Option 1:

Mon	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
Min (CFS)	667	775	883	983	1000	1000	1000	1000	1000	620	600	600

Option 2:

Mon	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
Min (CFS)	725	876	1000	1000	1000	1000	1000	1000	1000	620	600	600

HYDROPS – New HYDROPS simulation with following assumptions:

- New minimum flow targets in the low flow section of the Feather River as follows:

Minimum Required Flow Low Flow Section Feather River					
Start Date	End Date	Min Flow (CFS)	Start Date	End Date	Min Flow (CFS)
1-Sep	7-Sep	625	17-Nov	23-Nov	900
8-Sep	14-Sep	650	24-Nov	30-Nov	925
15-Sep	21-Sep	675	1-Dec	7-Dec	950
22-Sep	28-Sep	700	8-Dec	14-Dec	975
29-Sep	5-Oct	725	15-Dec	21-Dec	1000
6-Oct	12-Oct	750	22-Dec	31-May	1000
13-Oct	19-Oct	775	1-Jun	1-Jun	900
20-Oct	26-Oct	800	2-Jun	2-Jun	800
27-Oct	2-Nov	825	3-Jun	3-Jun	700
3-Nov	9-Nov	850	4-Jun	31-Aug	600
10-Nov	16-Nov	875			

Option 2:

Minimum Required Flow Low Flow Section Feather River		
Start Date	End Date	Min Flow (CFS)
1-Sep	15-Oct	725
16-Oct	31-May	1000
1-Jun	31-Aug	600

- Model entire CALSIM period of record
- Maintain the same storage targets in Oroville Reservoir

WQRRS – New WQRRS simulation with following assumptions

- Maintain the same Oroville reservoir withdrawal levels at intake.
- Maintain all temperature goals from the benchmark scenario.
- Run initial temperature simulation. (It is anticipated that the results of the new temperature simulation will show colder temperatures throughout the low flow section of the Feather River. If true this means that it might be possible to modify Oroville intake operations to meet the temperature targets along the Feather River and increase temperatures of the agricultural diversions from the Thermalito Complex. This evaluation would require iterative runs of WQRRS and possibly HYDROPS and will not be performed under this scenario.)

RESOURCE ACTION:

EWG-15A Incrementally increase flows in the low flow channel from relatively low flows (for example, 400-600 CFS or 600-800CFS) to relatively high flows (for example 800-1000 CFS or 1000- 1200 CFS) through out the Chinook salmon spawning season (for example Sep 1 – Dec 1 or Sep 1 – Dec 15) in order to change the lateral spawning habitat distribution from center of river channel in the early portion of the spawning season to the margins of the river channel in the later portion of the spawning season. Flows would be increased by some relatively consistent interval each week (for example 25, 50, or 75 CFS/week) in order to increase useable spawning habitat and reduce superimposition of Chinook salmon redds. Once flows reach the high target, the high flow target would be maintained through May 30 in order to avoid de-watering steelhead redds through the incubation period.

EWG-15B Provide relatively low flows (for example, 400-800 CFS in the low flow channel from the beginning of the Chinook salmon spawning season (for example Sep 1 – Oct 7 or Sep 1 – Oct 15) until spring run salmon are believed to have spawned and then change flows to a relatively high flow (for example, 800 to 1200 CFS from October 8 to Dec 1 or October 15 to December 15) in order to change the lateral spawning habitat distribution from center of river channel in the early portion of the spawning season to

the margins of the river channel in the later portion of the spawning season. Flows would be increased once during the spawning season in order to increase useable spawning habitat and reduce superimposition of Chinook salmon redds. Once flows reach the high target, the high flow target would be maintained through May 30 in order to avoid de-watering steelhead redds through the incubation period.

SCENARIO 8 – ELIMINATE RELEASES FROM THE THERMALITO AFTERBAY OUTLET DURING THE CHINOOK SALMON SPAWNING PERIOD

OBJECTIVE

Investigate the effect of eliminating releases to the Feather River from the Thermalito Afterbay Outlet during the Chinook salmon spawning season (September through December).

DESCRIPTION

This scenario would route all water not diverted for agricultural use from the Forebay – Afterbay Complex during the Chinook salmon spawning season (September through December) through the Feather River low flow channel to try and reduce temperatures in the river for the fish and increase temperatures in the Forebay – Afterbay complex for the agricultural diversions. Based on the results of the Existing Conditions Benchmark Simulation the expected flow in the low flow channel during this period would be:

Anticipated flow in low flow section of Feather River from Existing Benchmark Simulation				
	Sep (CFS)	Oct (CFS)	Nov (CFS)	Dec (CFS)
Min.	756	1130	907	894
Max.	5814	5293	14569	24345
Avg.	2106	2538	2286	3984

PHABSIM modeling conducted for SP-F16 found that the maximum spawning potential, measured in WUA, in the low flow section of the Feather River occurs at a flow of 725 CFS. The anticipated flow rates are much higher than this rates and indicate a substantial decrease in potential spawning habitat.

Under this operational scenario there would also be large reductions in the flows during this spawning period as well as in the incubation period of Jan – March in virtually all years. Since spawning tends to occur in the shallow parts of the stream these reductions have the potential to subject a large portion of any redds that do occur to dewatering impacts with disastrous results to the fishery.

Even if this scenario produced the optimum temperatures for both the agricultural diversions and the fishery the impacts of the reduced habitat and annual dewatering of redds could mean there would be no fish present to enjoy the perfect temperatures. The rational for this scenario needs to be re-thought and a decision made if the scenario should actually be modeled.

MODELING ASSUMPTIONS

CALSIM II - Use Existing Conditions benchmark simulation

HYDROPS – New HYDROPS simulation with following assumptions:

- Model entire CALSIM period of record
- Maintain the same storage targets in Oroville Reservoir
- Set Thermalito Afterbay Return capacity equal to zero (0) CFS for the period Sep 1 to Dec 31
- Pump-back operations are permitted within the physical and operational limits of the Oroville – Thermalito Complex
- Peaking operations will be permitted within the existing physical and operational limits of the Oroville – Thermalito Complex.

WQRRS – New WQRRS simulation with following assumptions

- Maintain the same Oroville reservoir withdrawal levels at intake.
- Maintain all temperature goals from the benchmark scenario.
- Run initial temperature simulation. (It is anticipated that the results of the new temperature simulation will show colder temperatures throughout the low flow section of the Feather River. If true this means that it might be possible to modify Oroville intake operations to meet the temperature targets along the Feather River and increase temperatures of the agricultural diversions from the Thermalito Complex. This evaluation would require iterative runs of WQRRS and possibly HYDROPS and will not be performed under this scenario.)

RESOURCE ACTION:

EWG-35 Lower existing water temperatures at the Thermalito Afterbay Outlet for the purpose of reducing feeding rates for predators in the Feather River.

EWG-36 Operate the Oroville Facilities in a manner which would provide additional cold water in the low flow channel of the Feather River for benefit of Chinook salmon and steelhead.

EWG-37 Operate the Oroville Facilities in a manner which would provide additional cold water in the high flow channel of the Feather River for benefit of Chinook salmon and steelhead.

EWG-38 Manage withdrawals from Lake Oroville to minimize reduction of coldwater pool.

EWG-83 Operate the Thermalito Complex to provide colder water to Lower Feather River for the benefit of salmonids.

EWG-87 Operate or modify the Oroville Complex in a manner to provide suitable warm water for agricultural purposes, while providing adequate cold water releases at the Thermalito Afterbay Outlet.

SCENARIO 9 – IMPOSE A 60°F WATER TEMPERATURE REQUIREMENT AT ROBINSON RIFFLE

OBJECTIVE

Investigate the effect of imposing a 60°F water temperature requirement from June through September at Robinson Riffle to protect over-summering steelhead and holding adult spring-run Chinook salmon.

DESCRIPTION:

This simulation would implement a 60°F water temperature requirement from June through September at Robinson Riffle. All other temperature targets would stay the same.

MODELING ASSUMPTIONS:

CALSIM II - No initial CALSIM II simulation required, use existing conditions benchmark simulation. CALSIM II re-simulation may be required as discussed under WQRRS assumptions.

HYDROPS – No initial HYDROPS simulation required, use existing conditions benchmark simulation. HYDROPS – WQRRS iterations may be required as discussed under WQRRS assumptions.

WQRRS – New WQRRS simulation with following assumptions

- Adjust Oroville intake operations to meet Feather River temperature goals while maintaining maximize agricultural diversion temperatures. This may require several iterations of the WQRRS model
- May require iteration with HYDROPS if Oroville intake operations are not sufficient to meet temperature goals.
- May require iteration with CALSIM II if HYDROPS re-operations are not sufficient to meet temperature goals.

RESOURCE ACTION:

EWG-36 Operate the Oroville Facilities in a manner which would provide additional cold water in the low flow channel of the Feather River for benefit of Chinook salmon and steelhead.

EWG-37 Operate the Oroville Facilities in a manner which would provide additional cold water in the high flow channel of the Feather River for benefit of Chinook salmon and steelhead.

EWG-38 Manage withdrawals from Lake Oroville to minimize reduction of coldwater pool.

SCENARIO 10 – IMPOSE A 60°F WATER TEMPERATURE REQUIREMENT FROM JUNE THROUGH SEPTEMBER IN THE LOW FLOW FEATHER RIVER CHANNEL TO THE THERMALITO AFTERBAY OUTLET

OBJECTIVE

Investigate the effect of imposing a 60°F water temperature requirement from June through September in the low flow Feather River channel downstream to the Thermalito Afterbay return to protect over-summering steelhead and holding adult spring-run Chinook salmon.

DESCRIPTION

This simulation would implement a 60°F water temperature requirement from June through September in the low flow Feather River channel downstream to the Thermalito Afterbay return.

MODELING ASSUMPTIONS

CALSIM II - No initial CALSIM II simulation required, use existing conditions benchmark simulation. CALSIM II re-simulation may be required as discussed under WQRRS assumptions.

HYDROPS – No initial HYDROPS simulation required, use existing conditions benchmark simulation. HYDROPS – WQRRS iterations may be required as discussed under WQRRS assumptions.

WQRRS – New WQRRS simulation with following assumptions

- Adjust Oroville intake operations to meet Feather River temperature goals while maintaining maximize agricultural diversion temperatures. This may require several iterations of the WQRRS model
- May require iteration with HYDROPS if Oroville intake operations are not sufficient to meet temperature goals.
- May require iteration with CALSIM II if HYDROPS re-operations are not sufficient to meet temperature goals.

RESOURCE ACTION

EWG-36 Operate the Oroville Facilities in a manner which would provide additional cold water in the low flow channel of the Feather River for benefit of Chinook salmon and steelhead.

EWG-37 Operate the Oroville Facilities in a manner which would provide additional cold water in the high flow channel of the Feather River for benefit of Chinook salmon and steelhead.

EWG-38 Manage withdrawals from Lake Oroville to minimize reduction of coldwater pool.

SCENARIO 11 – IMPOSE A 65°F WATER TEMPERATURE REQUIREMENT FROM JUNE THROUGH SEPTEMBER IN THE LOW FLOW FEATHER RIVER CHANNEL TO THE THERMALITO AFTERBAY OUTLET

OBJECTIVE

Investigate the effect of imposing a 65°F water temperature requirement from June through September in the low flow Feather River channel downstream to the Thermalito Afterbay return to protect over-summering steelhead and holding adult spring-run Chinook salmon.

DESCRIPTION:

This scenario would implement a 65°F water temperature requirement from June through September in the low flow Feather River channel downstream to the Thermalito Afterbay return.

MODELING ASSUMPTIONS:

CALSIM II - No initial CALSIM II simulation required, use existing conditions benchmark simulation. CALSIM II re-simulation may be required as discussed under WQRRS assumptions.

HYDROPS – No initial HYDROPS simulation required, use existing conditions benchmark simulation. HYDROPS – WQRRS iterations may be required as discussed under WQRRS assumptions.

WQRRS – New WQRRS simulation with following assumptions

- Adjust Oroville intake operations to meet Feather River temperature goals while maintaining maximize agricultural diversion temperatures. This may require several iterations of the WQRRS model
- May require iteration with HYDROPS if Oroville intake operations are not sufficient to meet temperature goals.
- May require iteration with CALSIM II if HYDROPS re-operations are not sufficient to meet temperature goals.

RESOURCE ACTION:

EWG-36 Operate the Oroville Facilities in a manner which would provide additional cold water in the low flow channel of the Feather River for benefit of Chinook salmon and steelhead.

EWG-37 Operate the Oroville Facilities in a manner which would provide additional cold water in the high flow channel of the Feather River for benefit of Chinook salmon and steelhead.

EWG-38 Manage withdrawals from Lake Oroville to minimize reduction of coldwater pool.

SCENARIO 12 – IMPOSE A 9 FEET PER MONTH WATER SURFACE ELEVATION REDUCTION LIMIT ON LAKE OROVILLE FROM MARCH THROUGH JUNE

OBJECTIVE:

Investigate the effect of imposing a 9 feet per month water surface elevation reduction limit on Lake Oroville from March through June to protect bass nests.

DESCRIPTION:

Lake Oroville is subject to surface elevation reduction, or drawdown, as releases are made from the reservoir. If this drawdown rate exceeds 9 ft in any month there is the potential to dewater bass nests. This scenario is to investigate the potential impacts of imposing a 9 feet per month from March through June drawdown limit on Oroville Reservoir unless the drawdown is dictated by flood control requirements.

Table 1. contains a summary of the Oroville Reservoir drawdown during the months of March through June from the CALSM II Existing Condition Benchmark simulation.

Table 1 - Oroville Drawdown Summary Existing Conditions Benchmark

	Mar	Apr	May	Jun
Max Drawdown	21.2	20.0	16.1	74.4
# > 9 feet	2	5	8	45

As can be seen in this table the potential drawdown limit of 9 feet is rarely exceeded except in June. This is because the reservoir is typically filling during the earlier months and the surface elevation is increasing instead of decreasing.

Reducing Oroville drawdown below the 9 foot limit is expected to cause major water supply and system wide impacts. The CALSIM II simulation should be evaluated when completed and a decision made at that time if the HYDROPS and WQRRS simulations are required.

MODELING ASSUMPTIONS:

CALSIM II – CALSIM II will need to be re-run to try and maintain a drawdown of less than 9 feet during these months at Oroville Reservoir. All other assumptions will be the same as in the Existing Conditions Benchmark.

HYDROPS – If desired, perform a HYDROPS simulation using the results of the CALSIM II simulation with all assumptions the same as the Existing Conditions Benchmark simulation.

WQRRS – If desired, perform a WQRRS simulation of the HYDROPS results with all assumptions the same as the Existing Conditions Benchmark simulation.

RESOURCE ACTION

EWG-30 Regulate reservoir drawdowns to less than 9 ft/month to reduce bass nest de-watering and subsequent mortality.

SCENARIO 13 – INVESTIGATE IMPACTS OF REDUCTIONS IN SWP DEMAND

OBJECTIVE:

Investigate the impacts of reductions in SWP demand on Oroville Reservoir storages and surface elevation.

DESCRIPTION:

This scenario was developed to investigate the effect of altering SWP demands on Lake Oroville's water surface elevation and storage. There are two major SWP demands on Lake Oroville, the Feather River Service Area (FRSA) and the south of Delta SWP contractor demands. While Oroville reservoir storage and levels are impacted by the SWP south of Delta demands the impacts are limited as much of the releases from Oroville reservoir are made for other reasons. This investigation will quantify the potential for changes in Oroville storage and elevation from reduction of these demands. This scenario will only consider the impacts of reducing the SWP south of Delta demands.

The south of Delta SWP demand for water will be fixed at 0 MAF, 1.0 MAF, 2.0 MAF, 3.0 MAF, and full Table A amounts (approximately 4.2 MAF) requiring 5 simulations.

MODELING ASSUMPTIONS:

CALSIM II – Five (5) new CALSIM II simulations will be performed with the following changes in assumptions:

- The SWP south of Delta demand for water will be fixed at 0 MAF, 1.0 MAF, 2.0 MAF, 3.0 MAF, and full Table A amounts (4.7 MAF).
- The demands will be reduced proportionally at all SWP south of Delta delivery points.

HYDROPS – No HYDROPS modeling will be performed.

WQRRS – No WQRRS modeling will be performed

RESOURCE ACTION:

This scenario does not reflect any specific resource actions.

SCENARIO 14 - EFFECTS ON LAKE OROVILLE'S WATER SURFACE ELEVATION AND STORAGE OF ALTERING FLOOD RESERVATION SPACE

OBJECTIVE

DESCRIPTION:

Investigate the effect of additional flood reservation space on Lake Oroville's water surface elevation and storage and on water supply. 50, 100, and 150 TAF of additional flood reservation space would be evaluated and the water surface elevation, storage, and water supply occurring under those conditions will be compared to the water surface elevation and storage occurring under the Existing Conditions (No Action/Project).

MODELING ASSUMPTIONS:

CALSIM II - Several new CALSIM II simulations will be performed with the following changes in assumptions:

- 50, 100, and 150 TAF of additional flood reservation space would be evaluated under this scenario.
- Flood control space is different in different years already. Probably move the minimum allowable storage down by the amount being used. Assume that the month with maximum allowable storage (0 flood reservation) remains the same, reduce allowable storage in months between these by linear interpolation. Setup and compute the new flood control reservations. Do we need to look at how DWR came up with the different limits each year and compute new limits with the same procedure but increased amounts of maximum flood control limits. Final flood control limits in attached tables.

HYDROPS – No HYDROPS modeling will be performed.

WQRRS – No WQRRS modeling will be performed

RESOURCE ACTIONS:

No applicable resource actions.

Oroville Flood Control Pattern Existing Conditions Benchmark												
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1922	3163	3163	2931	3105	2813	2922	3446	3538	3538	3538	3538	3350
1923	3163	3163	2922	2976	3137	3163	3459	3538	3538	3538	3538	3350
1924	3163	3163	3163	3150	3096	3163	3459	3538	3538	3538	3538	3350
1925	3158	3163	3094	3163	2896	3002	3363	3538	3538	3538	3538	3350
1926	3163	3163	3163	3012	2872	3145	3348	3538	3538	3538	3538	3350
1927	3163	2788	3046	2985	2788	2999	3396	3538	3538	3538	3538	3350
1928	3163	2966	3045	3072	3108	2797	3350	3538	3538	3538	3538	3350
1929	3163	3163	3133	3163	3163	3163	3459	3538	3538	3538	3538	3350
1930	3163	3163	2822	2927	2972	3105	3433	3538	3538	3538	3538	3350
1931	3163	3163	3163	3163	3163	3159	3459	3538	3538	3538	3538	3350
1932	3163	3163	2788	2931	3120	3163	3433	3538	3538	3538	3538	3350
1933	3163	3163	3163	2956	3135	3081	3459	3538	3538	3538	3538	3350
1934	3115	3163	2941	3108	3009	3095	3459	3538	3538	3538	3538	3350
1935	3163	3045	3055	2965	3002	3027	3234	3538	3538	3538	3538	3350
1936	3163	3163	3143	2950	2788	2954	3408	3538	3538	3538	3538	3350
1937	3163	3163	3143	3013	2900	2904	3385	3538	3538	3538	3538	3350
1938	3163	2865	2867	2924	2788	2788	3277	3538	3538	3538	3538	3350
1939	3163	3163	3163	3134	3163	3133	3459	3538	3538	3538	3538	3350
1940	3163	3163	3154	2870	2788	2788	3238	3538	3538	3538	3538	3350
1941	3163	3163	2788	2788	2788	2918	3334	3538	3538	3538	3538	3350
1942	3163	3163	2788	2788	2806	3058	3281	3538	3538	3538	3538	3350
1943	3163	3085	2966	2788	2890	2937	3350	3538	3538	3538	3538	3350
1944	3163	3163	3163	3100	2916	3069	3425	3538	3538	3538	3538	3350
1945	3163	3032	2982	3116	2981	3022	3459	3538	3538	3538	3538	3350
1946	3018	2947	2788	3007	3064	3063	3459	3538	3538	3538	3538	3350
1947	3163	3007	3076	3163	3099	2982	3447	3538	3538	3538	3538	3350
1948	3081	3163	3163	3140	3163	2963	3084	3538	3538	3538	3538	3350
1949	3163	3163	3111	3163	3104	3004	3459	3538	3538	3538	3538	3350
1950	3163	3163	3163	2882	2935	2940	3373	3538	3538	3538	3538	3350
1951	2984	2788	2866	2846	2925	3105	3435	3538	3538	3538	3538	3350
1952	3163	2998	2788	2788	2832	2988	3452	3538	3538	3538	3538	3350
1953	3163	3163	2918	2809	3101	3059	3284	3538	3538	3538	3538	3350
1954	3163	3115	3163	2918	2903	2943	3292	3538	3538	3538	3538	3350
1955	3163	3163	3074	3095	3105	3163	3366	3538	3538	3538	3538	3350
1956	3163	3157	2788	2788	2788	3018	3427	3538	3538	3538	3538	3350
1957	3080	3163	3163	3116	2847	2990	3388	3538	3538	3538	3538	3350
1958	3156	3163	2996	2860	2788	2788	3235	3538	3538	3538	3538	3350
1959	3163	3163	3163	2978	2839	3054	3459	3538	3538	3538	3538	3350
1960	3163	3163	3163	2965	2936	2909	3365	3538	3538	3538	3538	3350
1961	3163	3001	3117	3055	3077	3021	3416	3538	3538	3538	3538	3350
1962	3163	3081	3106	3116	2788	2936	3426	3538	3538	3538	3538	3350
1963	2839	3010	3051	2940	3057	2927	3180	3538	3538	3538	3538	3350
1964	3163	3024	3163	3034	3163	3163	3459	3538	3538	3538	3538	3350
1965	3163	3068	2788	2788	2997	3096	3354	3538	3538	3538	3538	3350
1966	3163	2943	2946	3015	3100	3163	3459	3538	3538	3538	3538	3350
1967	3162	2913	2973	2787	2951	2847	3236	3538	3538	3538	3538	3350
1968	3162	3162	3141	2922	2962	3036	3459	3538	3538	3538	3538	3162
1969	3162	3097	2908	2788	2788	3027	3470	3538	3538	3538	3538	3162
1970	3162	3162	2806	2787	2787	3163	3465	3538	3538	3538	3538	3350
1971	3163	2957	2788	3004	3162	3162	3433	3538	3538	3538	3538	3162
1972	3163	3163	3029	3088	3058	3163	3463	3538	3538	3538	3538	3338
1973	3163	3053	3053	2788	2788	2951	3463	3538	3538	3538	3538	3338
1974	3163	2788	2800	2870	3009	2788	3292	3538	3538	3538	3538	3338
1975	3163	3163	3163	3163	2884	2833	3320	3538	3538	3538	3538	3338
1976	3140	3163	3163	3163	3162	3163	3463	3538	3538	3538	3538	3338
1977	3163	3163	3163	3163	3163	3163	3463	3538	3538	3538	3538	3338
1978	3163	3163	2908	2788	2853	2944	3218	3538	3538	3538	3538	3338
1979	3163	3163	3163	3111	2843	3001	3380	3538	3538	3538	3538	3351
1980	3115	3107	2917	2813	2788	3028	3445	3538	3538	3538	3538	3351

Oroville Flood Control Pattern Existing Conditions Benchmark												
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1981	3163	3163	3163	2947	3075	3024	3459	3538	3538	3538	3538	3351
1982	3163	2788	2788	2943	2987	2936	3303	3538	3538	3538	3538	3351
1983	3149	2981	2930	2854	2788	2788	3208	3538	3538	3538	3538	3351
1984	3163	2950	2788	3091	3078	3120	3459	3538	3538	3538	3538	3351
1985	3163	2977	3133	3163	3163	3117	3459	3538	3538	3538	3538	3351
1986	3163	3029	3125	2939	2788	2788	3381	3538	3538	3538	3538	3351
1987	3163	3163	3163	3150	3098	3053	3459	3538	3538	3538	3538	3351
1988	3163	3163	3009	3010	3160	3163	3447	3538	3538	3538	3538	3351
1989	3163	2973	3021	3144	3163	2788	3335	3538	3538	3538	3538	3351
1990	3102	3123	3163	3078	3108	3163	3451	3538	3538	3538	3538	3351
1991	3163	3163	3163	3163	3163	2858	3393	3538	3538	3538	3538	3351
1992	3163	3163	3163	3163	3163	2858	3393	3538	3538	3538	3538	3351
1993	3157	2788	2788	2794	2856	2964	3456	3538	3538	3538	3538	3351
1994	3163	3163	3156	3121	2985	3163	3459	3538	3538	3538	3538	3351

Modified Oroville Flood Control Pattern Additional 50 TAF Reservation												
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1922	3137	3137	2889	3075	2763	2880	3440	3538	3538	3538	3538	3337
1923	3133	3133	2872	2930	3104	3133	3453	3538	3538	3538	3538	3335
1924	3121	3121	3121	3106	3046	3121	3450	3538	3538	3538	3538	3329
1925	3128	3134	3059	3134	2846	2960	3349	3538	3538	3538	3538	3335
1926	3135	3135	3135	2973	2822	3115	3334	3538	3538	3538	3538	3336
1927	3138	2738	3013	2948	2738	2963	3387	3538	3538	3538	3538	3337
1928	3138	2927	3012	3041	3079	2747	3337	3538	3538	3538	3538	3337
1929	3117	3117	3083	3117	3117	3117	3449	3538	3538	3538	3538	3327
1930	3137	3137	2772	2884	2932	3075	3426	3538	3538	3538	3538	3337
1931	3114	3114	3114	3114	3114	3109	3449	3538	3538	3538	3538	3325
1932	3138	3138	2738	2891	3092	3138	3426	3538	3538	3538	3538	3337
1933	3131	3131	3131	2906	3100	3042	3452	3538	3538	3538	3538	3334
1934	3080	3132	2891	3072	2965	3058	3452	3538	3538	3538	3538	3334
1935	3130	3002	3013	2915	2955	2982	3207	3538	3538	3538	3538	3334
1936	3138	3138	3117	2911	2738	2915	3399	3538	3538	3538	3538	3337
1937	3134	3134	3112	2972	2850	2854	3373	3538	3538	3538	3538	3335
1938	3138	2820	2822	2883	2738	2738	3260	3538	3538	3538	3538	3337
1939	3117	3117	3117	3084	3117	3083	3449	3538	3538	3538	3538	3327
1940	3138	3138	3128	2825	2738	2738	3218	3538	3538	3538	3538	3337
1941	3138	3138	2738	2738	2738	2877	3320	3538	3538	3538	3538	3337
1942	3138	3138	2738	2738	2757	3026	3264	3538	3538	3538	3538	3337
1943	3138	3055	2928	2738	2847	2897	3337	3538	3538	3538	3538	3337
1944	3133	3133	3133	3065	2866	3031	3416	3538	3538	3538	3538	3335
1945	3129	2987	2932	3078	2931	2976	3452	3538	3538	3538	3538	3333
1946	2983	2908	2738	2972	3032	3031	3454	3538	3538	3538	3538	3337
1947	3129	2959	3034	3129	3060	2932	3439	3538	3538	3538	3538	3333
1948	3041	3130	3130	3105	3130	2913	3045	3538	3538	3538	3538	3334
1949	3128	3128	3071	3128	3063	2954	3452	3538	3538	3538	3538	3332
1950	3134	3134	3134	2832	2889	2894	3360	3538	3538	3538	3538	3336
1951	2947	2738	2821	2800	2884	3076	3428	3538	3538	3538	3538	3337
1952	3138	2962	2738	2738	2785	2951	3446	3538	3538	3538	3538	3337
1953	3137	3137	2875	2759	3071	3026	3267	3538	3538	3538	3538	3337
1954	3133	3082	3133	2869	2853	2896	3273	3538	3538	3538	3538	3335
1955	3123	3123	3024	3047	3058	3123	3347	3538	3538	3538	3538	3330
1956	3138	3132	2738	2738	2738	2983	3420	3538	3538	3538	3538	3337
1957	3047	3136	3136	3085	2797	2950	3377	3538	3538	3538	3538	3336
1958	3131	3138	2960	2815	2738	2738	3215	3538	3538	3538	3538	3337
1959	3136	3136	3136	2938	2789	3019	3453	3538	3538	3538	3538	3337
1960	3133	3133	3133	2919	2888	2859	3351	3538	3538	3538	3538	3335
1961	3128	2951	3078	3010	3034	2973	3405	3538	3538	3538	3538	3332
1962	3138	3051	3077	3088	2738	2896	3419	3538	3538	3538	3538	3337
1963	2789	2972	3016	2897	3023	2883	3154	3538	3538	3538	3538	3337
1964	3127	2974	3127	2985	3127	3127	3451	3538	3538	3538	3538	3332
1965	3138	3037	2738	2738	2961	3067	3342	3538	3538	3538	3538	3337
1966	3131	2893	2896	2971	3063	3131	3452	3538	3538	3538	3538	3334
1967	3137	2871	2935	2737	2912	2801	3216	3538	3538	3538	3538	3337
1968	3131	3131	3109	2872	2915	2995	3453	3538	3538	3538	3538	3131
1969	3137	3068	2866	2738	2738	2993	3465	3538	3538	3538	3538	3137
1970	3137	3137	2757	2737	2737	3138	3460	3538	3538	3538	3538	3337
1971	3138	2918	2738	2968	3137	3137	3426	3538	3538	3538	3538	3137
1972	3126	3126	2979	3044	3011	3126	3456	3538	3538	3538	3538	3318
1973	3138	3021	3021	2738	2738	2912	3458	3538	3538	3538	3538	3325
1974	3138	2738	2751	2825	2974	2738	3276	3538	3538	3538	3538	3325
1975	3136	3136	3136	3136	2838	2783	3305	3538	3538	3538	3538	3324
1976	3090	3116	3116	3116	3115	3116	3454	3538	3538	3538	3538	3313
1977	3113	3113	3113	3113	3113	3113	3453	3538	3538	3538	3538	3311
1978	3138	3138	2866	2738	2807	2904	3197	3538	3538	3538	3538	3325
1979	3136	3136	3136	3080	2793	2962	3369	3538	3538	3538	3538	3338
1980	3087	3078	2876	2765	2738	2994	3439	3538	3538	3538	3538	3339

Modified Oroville Flood Control Pattern Additional 50 TAF Reservation												
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1981	3131	3131	3131	2897	3036	2981	3452	3538	3538	3538	3538	3335
1982	3138	2738	2738	2903	2950	2896	3287	3538	3538	3538	3538	3339
1983	3123	2944	2889	2808	2738	2738	3186	3538	3538	3538	3538	3339
1984	3138	2911	2738	3061	3047	3092	3454	3538	3538	3538	3538	3339
1985	3130	2927	3097	3130	3130	3079	3452	3538	3538	3538	3538	3334
1986	3138	2995	3097	2899	2738	2738	3371	3538	3538	3538	3538	3339
1987	3124	3124	3124	3110	3053	3003	3451	3538	3538	3538	3538	3332
1988	3128	3128	2959	2960	3124	3128	3438	3538	3538	3538	3538	3333
1989	3138	2935	2987	3118	3138	2738	3321	3538	3538	3538	3538	3339
1990	3055	3078	3122	3028	3061	3122	3442	3538	3538	3538	3538	3331
1991	3135	3135	3135	3135	3135	2808	3382	3538	3538	3538	3538	3337
1992	3135	3135	3135	3135	3135	2808	3382	3538	3538	3538	3538	3337
1993	3132	2738	2738	2744	2811	2926	3451	3538	3538	3538	3538	3339
1994	3129	3129	3121	3083	2935	3129	3452	3538	3538	3538	3538	3334

Modified Oroville Flood Control Pattern Additional 100 TAF Reservation												
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1922	3111	3111	2847	3045	2713	2837	3433	3538	3538	3538	3538	3324
1923	3102	3102	2822	2885	3072	3102	3446	3538	3538	3538	3538	3319
1924	3078	3078	3078	3062	2996	3078	3441	3538	3538	3538	3538	3307
1925	3099	3105	3025	3105	2796	2919	3336	3538	3538	3538	3538	3321
1926	3107	3107	3107	2933	2772	3086	3319	3538	3538	3538	3538	3322
1927	3113	2688	2980	2911	2688	2927	3377	3538	3538	3538	3538	3325
1928	3112	2889	2978	3009	3050	2697	3325	3538	3538	3538	3538	3325
1929	3070	3070	3033	3070	3070	3070	3439	3538	3538	3538	3538	3304
1930	3111	3111	2722	2842	2893	3045	3418	3538	3538	3538	3538	3324
1931	3064	3064	3064	3064	3064	3059	3438	3538	3538	3538	3538	3300
1932	3113	3113	2688	2850	3064	3113	3419	3538	3538	3538	3538	3325
1933	3099	3099	3099	2856	3066	3002	3445	3538	3538	3538	3538	3318
1934	3044	3100	2841	3036	2920	3021	3446	3538	3538	3538	3538	3319
1935	3098	2959	2971	2865	2908	2938	3181	3538	3538	3538	3538	3317
1936	3113	3113	3090	2872	2688	2876	3391	3538	3538	3538	3538	3325
1937	3104	3104	3081	2931	2800	2805	3361	3538	3538	3538	3538	3321
1938	3113	2775	2778	2842	2688	2688	3242	3538	3538	3538	3538	3325
1939	3070	3070	3070	3034	3070	3033	3439	3538	3538	3538	3538	3304
1940	3113	3113	3103	2781	2688	2688	3198	3538	3538	3538	3538	3325
1941	3113	3113	2688	2688	2688	2835	3307	3538	3538	3538	3538	3325
1942	3113	3113	2688	2688	2708	2994	3247	3538	3538	3538	3538	3325
1943	3113	3025	2890	2688	2804	2857	3325	3538	3538	3538	3538	3325
1944	3103	3103	3103	3030	2816	2994	3407	3538	3538	3538	3538	3320
1945	3096	2941	2882	3040	2881	2929	3445	3538	3538	3538	3538	3316
1946	2949	2868	2688	2936	3001	3000	3448	3538	3538	3538	3538	3325
1947	3096	2911	2993	3096	3020	2882	3431	3538	3538	3538	3538	3316
1948	3002	3098	3098	3071	3098	2863	3005	3538	3538	3538	3538	3317
1949	3093	3093	3031	3093	3023	2904	3444	3538	3538	3538	3538	3315
1950	3106	3106	3106	2782	2843	2849	3348	3538	3538	3538	3538	3321
1951	2910	2688	2776	2754	2843	3047	3421	3538	3538	3538	3538	3325
1952	3113	2926	2688	2688	2738	2915	3441	3538	3538	3538	3538	3325
1953	3112	3112	2833	2709	3041	2993	3249	3538	3538	3538	3538	3324
1954	3104	3048	3104	2820	2803	2849	3253	3538	3538	3538	3538	3320
1955	3082	3082	2974	3000	3012	3082	3329	3538	3538	3538	3538	3309
1956	3113	3106	2688	2688	2688	2949	3412	3538	3538	3538	3538	3325
1957	3014	3109	3109	3055	2747	2911	3366	3538	3538	3538	3538	3323
1958	3105	3113	2924	2770	2688	2688	3195	3538	3538	3538	3538	3325
1959	3109	3109	3109	2898	2739	2985	3448	3538	3538	3538	3538	3323
1960	3103	3103	3103	2874	2840	2809	3337	3538	3538	3538	3538	3320
1961	3093	2901	3039	2965	2991	2925	3393	3538	3538	3538	3538	3315
1962	3113	3020	3048	3060	2688	2856	3411	3538	3538	3538	3538	3325
1963	2739	2934	2981	2854	2988	2840	3129	3538	3538	3538	3538	3323
1964	3090	2924	3090	2936	3090	3090	3444	3538	3538	3538	3538	3313
1965	3113	3005	2688	2688	2925	3037	3329	3538	3538	3538	3538	3325
1966	3100	2843	2847	2927	3026	3100	3446	3538	3538	3538	3538	3318
1967	3112	2830	2898	2687	2873	2755	3196	3538	3538	3538	3538	3325
1968	3101	3101	3077	2822	2868	2955	3446	3538	3538	3538	3538	3101
1969	3112	3038	2824	2688	2688	2959	3461	3538	3538	3538	3538	3112
1970	3112	3112	2709	2687	2687	3113	3455	3538	3538	3538	3538	3325
1971	3113	2880	2688	2933	3112	3112	3419	3538	3538	3538	3538	3112
1972	3089	3089	2929	3000	2964	3089	3448	3538	3538	3538	3538	3299
1973	3113	2988	2988	2688	2688	2873	3453	3538	3538	3538	3538	3311
1974	3113	2688	2702	2781	2938	2688	3259	3538	3538	3538	3538	3311
1975	3110	3110	3110	3110	2791	2733	3289	3538	3538	3538	3538	3310
1976	3040	3069	3069	3069	3068	3069	3444	3538	3538	3538	3538	3288
1977	3063	3063	3063	3063	3063	3063	3443	3538	3538	3538	3538	3285
1978	3113	3113	2824	2688	2762	2865	3175	3538	3538	3538	3538	3311
1979	3109	3109	3109	3050	2743	2924	3357	3538	3538	3538	3538	3324
1980	3059	3050	2834	2716	2688	2960	3433	3538	3538	3538	3538	3326

Modified Oroville Flood Control Pattern Additional 100 TAF Reservation												
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1981	3100	3100	3100	2847	2997	2937	3446	3538	3538	3538	3538	3319
1982	3113	2688	2688	2864	2914	2856	3272	3538	3538	3538	3538	3326
1983	3097	2907	2849	2763	2688	2688	3164	3538	3538	3538	3538	3326
1984	3113	2872	2688	3031	3017	3064	3448	3538	3538	3538	3538	3326
1985	3096	2877	3061	3096	3096	3042	3445	3538	3538	3538	3538	3318
1986	3113	2961	3070	2859	2688	2688	3360	3538	3538	3538	3538	3326
1987	3086	3086	3086	3070	3007	2953	3443	3538	3538	3538	3538	3312
1988	3092	3092	2909	2910	3089	3092	3430	3538	3538	3538	3538	3316
1989	3113	2898	2952	3091	3113	2688	3308	3538	3538	3538	3538	3326
1990	3007	3033	3081	2978	3015	3081	3432	3538	3538	3538	3538	3310
1991	3108	3108	3108	3108	3108	2758	3372	3538	3538	3538	3538	3324
1992	3108	3108	3108	3108	3108	2758	3372	3538	3538	3538	3538	3324
1993	3106	2688	2688	2695	2765	2887	3445	3538	3538	3538	3538	3326
1994	3095	3095	3087	3046	2885	3095	3445	3538	3538	3538	3538	3317

Modified Oroville Flood Control Pattern Additional 150 TAF Reservation												
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1922	3085	3085	2805	3015	2663	2795	3427	3538	3538	3538	3538	3311
1923	3072	3072	2772	2839	3039	3072	3440	3538	3538	3538	3538	3304
1924	3036	3036	3036	3018	2946	3036	3432	3538	3538	3538	3538	3286
1925	3069	3075	2990	3075	2746	2877	3322	3538	3538	3538	3538	3306
1926	3079	3079	3079	2894	2722	3056	3305	3538	3538	3538	3538	3308
1927	3088	2638	2948	2874	2638	2891	3368	3538	3538	3538	3538	3312
1928	3087	2850	2945	2978	3021	2647	3312	3538	3538	3538	3538	3312
1929	3024	3024	2983	3024	3024	3024	3430	3538	3538	3538	3538	3280
1930	3084	3084	2672	2799	2853	3014	3411	3538	3538	3538	3538	3311
1931	3015	3015	3015	3015	3015	3009	3428	3538	3538	3538	3538	3276
1932	3088	3088	2638	2810	3036	3088	3412	3538	3538	3538	3538	3312
1933	3066	3066	3066	2806	3031	2963	3439	3538	3538	3538	3538	3302
1934	3009	3069	2791	3000	2876	2984	3439	3538	3538	3538	3538	3303
1935	3065	2916	2929	2815	2862	2893	3154	3538	3538	3538	3538	3301
1936	3088	3088	3064	2832	2638	2837	3382	3538	3538	3538	3538	3312
1937	3075	3075	3050	2890	2750	2755	3349	3538	3538	3538	3538	3306
1938	3088	2730	2733	2801	2638	2638	3225	3538	3538	3538	3538	3312
1939	3024	3024	3024	2984	3024	2983	3430	3538	3538	3538	3538	3280
1940	3088	3088	3077	2736	2638	2638	3178	3538	3538	3538	3538	3312
1941	3088	3088	2638	2638	2638	2794	3293	3538	3538	3538	3538	3312
1942	3088	3088	2638	2638	2660	2962	3230	3538	3538	3538	3538	3312
1943	3088	2994	2852	2638	2760	2817	3312	3538	3538	3538	3538	3312
1944	3073	3073	3073	2994	2766	2956	3398	3538	3538	3538	3538	3305
1945	3062	2896	2832	3002	2831	2883	3438	3538	3538	3538	3538	3299
1946	2914	2829	2638	2901	2969	2968	3443	3538	3538	3538	3538	3312
1947	3062	2864	2951	3062	2981	2832	3422	3538	3538	3538	3538	3299
1948	2962	3065	3065	3036	3065	2813	2966	3538	3538	3538	3538	3301
1949	3058	3058	2991	3058	2982	2854	3437	3538	3538	3538	3538	3297
1950	3077	3077	3077	2732	2797	2803	3335	3538	3538	3538	3538	3307
1951	2873	2638	2732	2708	2802	3018	3414	3538	3538	3538	3538	3312
1952	3088	2890	2638	2638	2691	2878	3435	3538	3538	3538	3538	3312
1953	3086	3086	2790	2659	3011	2960	3232	3538	3538	3538	3538	3311
1954	3074	3015	3074	2772	2753	2802	3234	3538	3538	3538	3538	3306
1955	3042	3042	2924	2952	2965	3042	3310	3538	3538	3538	3538	3289
1956	3088	3081	2638	2638	2638	2914	3405	3538	3538	3538	3538	3312
1957	2981	3082	3082	3024	2697	2871	3355	3538	3538	3538	3538	3309
1958	3080	3088	2888	2724	2638	2638	3174	3538	3538	3538	3538	3312
1959	3083	3083	3083	2858	2689	2950	3442	3538	3538	3538	3538	3310
1960	3074	3074	3074	2828	2792	2759	3324	3538	3538	3538	3538	3305
1961	3058	2851	2999	2920	2948	2877	3382	3538	3538	3538	3538	3297
1962	3088	2990	3020	3032	2638	2816	3404	3538	3538	3538	3538	3312
1963	2689	2897	2946	2812	2954	2796	3103	3538	3538	3538	3538	3310
1964	3054	2874	3054	2887	3054	3054	3436	3538	3538	3538	3538	3295
1965	3088	2974	2638	2638	2889	3008	3317	3538	3538	3538	3538	3312
1966	3068	2793	2797	2883	2990	3068	3439	3538	3538	3538	3538	3303
1967	3087	2788	2860	2637	2834	2709	3176	3538	3538	3538	3538	3312
1968	3070	3070	3044	2772	2822	2914	3440	3538	3538	3538	3538	3070
1969	3087	3009	2782	2638	2638	2925	3456	3538	3538	3538	3538	3087
1970	3087	3087	2660	2637	2637	3088	3450	3538	3538	3538	3538	3312
1971	3088	2841	2638	2897	3087	3087	3412	3538	3538	3538	3538	3087
1972	3052	3052	2879	2955	2917	3052	3441	3538	3538	3538	3538	3279
1973	3088	2956	2956	2638	2638	2834	3448	3538	3538	3538	3538	3298
1974	3088	2638	2652	2736	2903	2638	3243	3538	3538	3538	3538	3298
1975	3083	3083	3083	3083	2745	2683	3274	3538	3538	3538	3538	3295
1976	2990	3022	3022	3022	3020	3022	3435	3538	3538	3538	3538	3263
1977	3013	3013	3013	3013	3013	3013	3433	3538	3538	3538	3538	3258
1978	3088	3088	2782	2638	2716	2825	3154	3538	3538	3538	3538	3298
1979	3082	3082	3082	3019	2693	2885	3346	3538	3538	3538	3538	3311
1980	3030	3021	2793	2668	2638	2926	3426	3538	3538	3538	3538	3314

Modified Oroville Flood Control Pattern Additional 150 TAF Reservation												
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1981	3068	3068	3068	2797	2957	2894	3439	3538	3538	3538	3538	3304
1982	3088	2638	2638	2824	2877	2816	3256	3538	3538	3538	3538	3314
1983	3071	2870	2808	2717	2638	2638	3142	3538	3538	3538	3538	3314
1984	3088	2832	2638	3002	2986	3036	3443	3538	3538	3538	3538	3314
1985	3063	2827	3025	3063	3063	3004	3438	3538	3538	3538	3538	3301
1986	3088	2927	3042	2819	2638	2638	3350	3538	3538	3538	3538	3314
1987	3047	3047	3047	3030	2962	2903	3435	3538	3538	3538	3538	3293
1988	3057	3057	2859	2860	3053	3057	3421	3538	3538	3538	3538	3298
1989	3088	2860	2918	3065	3088	2638	3294	3538	3538	3538	3538	3314
1990	2960	2988	3041	2928	2968	3041	3423	3538	3538	3538	3538	3290
1991	3080	3080	3080	3080	3080	2708	3361	3538	3538	3538	3538	3310
1992	3080	3080	3080	3080	3080	2708	3361	3538	3538	3538	3538	3310
1993	3081	2638	2638	2645	2720	2849	3440	3538	3538	3538	3538	3314
1994	3061	3061	3052	3008	2835	3061	3438	3538	3538	3538	3538	3300