TRINITY RESERVOIR CARRYOVER ANALYSIS

By

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Trinity County

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Introduction

The purpose of carry-over analyses was determine minimum October 1st carry-over storage volumes necessary to meet flow, diversions, and temperature objectives throughout the year (typically summer). Analyses were completed for Trinity Reservoir using the Trinity Reservoir Water Temperature Simulation Model (WTSM) for initial reservoir storage volumes of 750,000 acre-feet (AF), 1,250,000 AF, and 1,750,000 AF. Four EIS year-types were included: wet (1986), normal (1989), dry (1990), and critically dry (1977). The extremely wet year-type (1983) was not analyzed because under such hydrologic conditions reservoir levels would be sufficient to prevent elevated release water temperatures. Operations were defined using the restoration flow alternatives for the No Action, Flow Study, 40% Inflow, and Maximum Flow cases. In addition, a selective withdrawal analysis was completed for the four flow alternatives, for the dry year-type (1990). Output from WTSM runs was used as input for downstream modeling (BETTER, SNTEMP) and assessment of alternative carry-over storage and operations. Results of these downstream studies are included in the Appendix (G. Kamman memos).

Analysis Assumptions

Several assumptions were employed to maintain a consistent set of criteria for carry-over analysis. Carry-over storage volumes were selected to represent a range of initial reservoir storage levels, and were applied to each flow alternative. Hydrologic, climatic, inflow temperature data, and initial temperature profiles for the water year annual period (October 1 through September 30) were defined by year-type. For a description of the data sets and associated assumptions see the Trinity Reservoir Water Temperature Simulation Model Project report. Operations were derived from PROSIM temperature analyses of proposed flow alternatives for critically dry and dry year-types with carry-over storage of 650,000 AF. As such, operations did not necessarily reflect selected carry-over storage volumes. No attempt was made to adjust operations for the various carry-over storage volumes. The limitations associated with direct application of PROSIM runs to this analysis are significant. Given variable carry-over storage PROSIM would produce a different set of operations in response to variable operating rules and demands based on Trinity Reservoir storage. Thus, care should be used when interpreting these results. Certain runs were infeasible due to excessive or insufficient storage for selected carry-over storage values and were dropped from the analyses (Table 1).

For all carry-over analyses the power/main intake (centerline elevation 2114 feet mean sea level (msl)) was used (exception, selective withdrawal analysis). It was assumed that reservoir water temperatures at the centerline of the intake were representative of release temperatures. (There is some uncertainty concerning the location of withdrawal zones in Trinity Reservoir, additional details are included in the Trinity Reservoir Water Temperature Simulation Model Project report.)

An abbreviated selective withdrawal analysis was completed to determine the impact of using the auxiliary intake (elevation 1999 msl) in place of the power/main intake. Carry-over storage maintained at 750K for all runs and only the dry year-type (WY1990) was examined. As with the carry-over analyses, release water temperatures were assumed equal to the water temperatures at the centerline elevation of the intakes.

For all runs WTSM results formed the upstream boundary condition for the simulation of Lewiston Reservoir with the BETTER model, requiring an aggregate Trinity Reservoir outflow quantity and associated water temperature. To determine the aggregate water temperature from the power/main intake (centerline elevation 2114 ft msl) and the auxiliary intake (centerline elevation 1999 ft msl) a mass balance was applied. It was assumed that water was drawn from the reservoir was mixed completely and instantaneously immediately downstream of the dam. No heating of the water was assumed to occur in power generation or passing through the outlet works. The water was assumed to mix on a short time scale such that interaction with the atmosphere, outlet works, streambed, or receiving waters had negligible effects. Equation 1 defines the relationship relating quantity and temperature of each intake to final release temperature.

$$C_o = [Q_{p:m}C_{p:m} + Q_aC_a] / Q_o \qquad \text{Equation 1}$$

Where:

C_o = aggregate outflow temperature (°F)
$Q_o = Q_{p:m} + Q_a$; aggregate outflow (cfs)
$C_{p:m}$ = power/main centerline intake temperature (°F)
$Q_{p:m}$ = power/main flow (cfs)
C_a = auxiliary centerline intake temperature (°F)
Q_a = auxiliary flow (cfs)

Simulated biweekly temperatures at the centerline elevations were used calculate and interpolate daily outflow water temperatures for BETTER Model input.

Carry-over Results

Several mechanisms affect the thermal structure of Trinity Reservoir. Inflow temperatures, initial (carry-over) storage, rate and timing of draw down, final storage, and steadiness and duration of operations are some of the important factors. In addition, the intake structures used can draw water from different levels from the reservoir changing the outflow temperature and the thermal structure of the lake.

Carry-over storage, low storage and rate and timing of draw down appeared to be the most influential factors. In most cases, the 750,000 acre-foot carry-over storage simulations resulted in late summer elevated temperatures. Even for years where final storage exceeded initial storage some temperature impact was evident. Though inflow temperature was not explicitly examined, inflow quantity and quality affect the thermal structure of Trinity Reservoir. Comparing the mean winter and spring auxiliary outlet temperatures of WY 1977 with WY 1986 illustrates that bottom waters in Trinity Reservoir during WY 1977 are warmer by 3°F to 5°F. During WY 1986 large, cool winter inflows filled the reservoir creating a large cool water reserve (roughly 40°F). Small inflows of WY 1977 were insufficient to create such a cool water reserve. This can be observed even when there is appreciable storage in WY 1977. At high carryover storage, the winter is not sufficiently cold nor long enough, and the lake is too large to cool below about 42° to 45°F. (i.e., Trinity Reservoir is sensitive to inflow water temperature. Just having a cold winter isn't enough to cool the entire lake, the lake needs to be filled with cold water).

Table 1. Simulations for carry-over analyses

Flow Alternative	Year-Type	Carry-over Storage (1000's AF)		
		750	1250	1750
40% Inflow	Wet (1986)	X	X	O
	Normal (1989)	X	X	X
	Dry (1990)	X	X	X
	Critically Dry (1977)	X	X	X
Maximum Flow	Wet (1986)	X	X	O
	Normal (1989)	X	X	X
	Dry (1990)	X	X	X
	Critically Dry (1977)	X	X	X
Flow Study	Wet (1986)	X	O	O
	Normal (1989)	X	X	X
	Dry (1990)	X	X	X
	Critically Dry (1977)	X	X	X
No Action	Wet (1986)	X	O	O
	Normal (1989)	X	X	X
	Dry (1990)	X	X	X
	Critically Dry (1977)	O	X	X

For the purposes of this report, temperature impacts at the power/main intake centerline elevation were defined as none, moderate, significant, and severe for the summer months. No impact (none) was defined as power/main intake elevation temperatures less than 50°F; moderate, 50°F to 55°F; significant 55°F to 65°F, and severe as greater than 65°F. Table 2 outlines the results for all simulations. Results for each carry-over storage volume are described below. Time series plots of reservoir storage and water temperature at the power/main intake elevation, auxiliary intake elevation, and at elevation 2150 msl for all simulations are included in the Appendix. Table 3 outlines annual and maximum storage change for each alternative and may prove useful when examining the results of Table 2 for the various carry-over storage volumes.

750,000 AF Carry-over

Low carry-over storage typically led to excessive reservoir draw down with an accompanying entrainment of surface waters into the power/main intake. Rate and timing of reservoir draw down also impacted reservoir temperatures. Typically water is stored during spring runoff and released through the summer period. The mid- to late-summer draw down rate affected water temperature. Greater withdrawal rates can result in a larger vertical intake envelope or zone of influence, thus allowing warmer near-surface waters to be entrained. (Similarly, extended periods of draw down can allow the zone of influence to continue to expand.)

All flow alternatives except No Action (Wet and Normal) exhibited some degree of elevated temperature at the power/main intake elevation by the end of the simulation period. Time series plots of temperature for the several simulations illustrate that typically excessive temperatures do not occur until mid- to late-summer months.

Table 2. Trinity Reservoir annual and maximum storage change

Flow Alternative	Year-Type	Temperature Impact for Carry-over Storage (1000's AF)		
		750	1250	1750
40% Inflow	Wet (1986)	moderate	none	n/a
	Normal (1989)	moderate	none	none
	Dry (1990)	moderate	none	none
	Critically Dry (1977)	significant	none	none
Maximum Flow	Wet (1986)	moderate	none	n/a
	Normal (1989)	moderate	none	none
	Dry (1990)	severe	moderate	none
	Critically Dry (1977)	severe	none	none
Flow Study	Wet (1986)	significant	n/a	n/a
	Normal (1989)	significant	none	none
	Dry (1990)	moderate	none	none
	Critically Dry (1977)	significant	none	none
No Action	Wet (1986)	none	n/a	n/a
	Normal (1989)	none	none	none
	Dry (1990)	moderate	none	none
	Critically Dry (1977)	n/a	significant	none

Minimal: Power/main intake temperature<50ºF
Moderate: Power/main intake temperatures 50ºF to 55ºF
Significant: Power/main intake temperatures 55ºF to 65ºF
Severe: Power/main intake temperatures >65ºF
n/a: not applicable

Table 3. Trinity Reservoir annual and maximum storage change

		Flow Alternative			
		40% Inflow	Flow Study	Maximum Flow	No Action
Dry (1990)	Annual	88,400	15,611	342,500	102,100
	Maximum	239,500	215,700	392,800	208,300
Normal (1989)	Annual	-208,400	22,100	-1400	-137,500
	Maximum	517,300	606,100	278,500	543,200
Wet (1986)	Annual	-289,600	-163,800	-256,400	-366,700
	Maximum	847,400	1,052,500	702,200	891,000
Crit. Dry (1997)	Annual	363,500	339,600	343,000	700,000
	Maximum	364,200	342,300	348,800	702,000

Annual storage change = final storage – initial storage
Maximum storage change = lmaximum storage – minimum storagel

1,250,000 AF Carry-over

Few temperature concerns were observable at 1,250,000 AF carry-over storage. When they did occur they were associated with large draw down rates and/or low reservoir storage. Maximum Flow (Dry) and No Action (Critically Dry) experienced moderate and significant temperature impacts, most likely due to the large annual draw down of the reservoir.

1,750,000 AF Carry-over

There were no discernible elevated temperatures for the 1,750,000 AF carry-over storage. However, high rates of draw down still resulted in rising temperature (albeit only slightly and always less than 50ºF) in the late summer.

The carry-over studies illustrate that reservoir levels below approximately 1,000,000 AF may compromise water temperatures at the intake elevations. However, rate and duration of draw down (release rate) can impact release temperatures. Long periods of large release rates can result in increased entrainment of warmer near-surface waters. Storage volumes less than 1,000,000 AF may not result in warmer release temperatures under modest or low release rates. Elevated water temperatures (>50°F) at the power/main intake elevation problems typically manifest themselves in summer periods as reservoir levels are reduced. Through the summer period (heating period) the depth to the thermocline increases as heat diffuses and is mixed (e.g., wind) into the reservoir. At the same time, reservoir storage is being reduced as releases exceed inflow. As reservoir storage drops, the cross section of the reservoir decreases, further increasing the depth to the thermocline. These processes increase the potential for warmer waters to be entrained at the power/main intake elevation.

Selective Withdrawal Results

Selective withdrawal operations were examined for each flow alternative using the Dry year-type and carry-over storage of 750,000 AF. After reviewing carry-over storage simulations without selective withdrawal it was determined that releases would be assigned to the power/main intake from October 1 through June 30, and to the auxiliary intake from July 1 through September 30. There were no intake capacity issues from July 1 through September 30 for the four flow alternatives. Average flows for the three month period were approximately

Flow Alternative	1200 cfs
40 % Inflow	1400 cfs
Maximum Flow	700 cfs
No Action	1225 cfs

Maximum flow was approximately 2075 cfs.

Results indicate that for all cases temperature control was attained (temperatures at the power/main intake <50°F) for the provided flow rates at the selected carry-over storage – a marked improvement over the results tabulated in Table 2, above. Further, utilizing the auxiliary intake reduced temperatures at the power/main intake for all flow alternatives. These results may be due to the auxiliary outlet not entraining near-surface waters (centerline elevation of the auxiliary intake is over 100 feet lower than the power/main intake – 1999 ft msl versus 2114 ft msl). Comparing non-selective with selective withdrawal illustrated that water temperatures at the auxiliary intake elevation are cooler under selective withdrawal operations then during power/main intake operation. It is possible that the power/main intake with its large diameter has a withdrawal envelop or zone of influence that affects water temperature at significantly greater depths. Initial analysis illustrates that selective withdrawal has considerable promise for temperature control (albeit at a sacrifice to hydropower). Additional analysis of would further define potential cause and effect relationships between temperature and operations at various levels in the reservoir.

[Note: For the Maximum Flow alternative, temperatures begin to increase considerably in about Mid-May. No actions were taken to examine the impact of switching to the auxiliary outlet earlier than July 1. Nor were any attempts made to utilize both outlets to control water temperature. Under current conditions selective withdrawal would require foregoing power production in the absence of something similar to the Shasta Dam TCD. There are many permutations for carry-over storage. These preliminary results show there is potential for temperature control at Trinity Reservoir by using the auxiliary outlet.]

Conclusion and Recommendations

Temperature control both within Trinity Reservoir and in downstream reaches appears feasible under certain conditions. Specifically, if sufficient storage is maintained and release rates are not excessive in magnitude and duration. Each set of operations and carry-over storage provides unique thermal conditions of Trinity Reservoir throughout the simulation period (water year).

In general, elevated water temperature at the power/main intake elevation was an issue for carry-over storage of 750,000 AF. Only under certain circumstances was temperature a concern at 1,250,000 AF, and there were no temperature concerns for carry-over storage of 1,750,000 AF. Operations under varying carry-over storage volumes would ideally be modified to account for available storage. However, even these preliminary results illustrate that there are carry-over issues for reduced storage conditions at Trinity Reservoir

Selective withdrawal provided sufficient operational flexibility to accommodate each flow recommendation at 750,000 AF of carry-over storage without any temperature concerns. Additionally, the thermal structure of Trinity Reservoir at both the auxiliary and power/main intake elevations was notably affected under selective withdrawal.

These analyses provide preliminary results that show there is potential for temperature control at Trinity Reservoir through selection of appropriate carry-over storage, operations, and selective withdrawal. This project has illustrated a need for additional analysis to further define carry-over storage issues at Trinity Reservoir. Outlined below are specific recommendations

RECOMMENDATION: Complete a formal carry-over analysis

Applying operations for a designated carry-over storage volume to a different carry-over volume is a limitation of this analysis. For any particular carry-over storage month to month operations would differ. It is recommended that PROSIM be applied for selected carry-over storage (e.g., 750K, 1250K, 1750K) to define potential operations under the flow alternatives (or additional/other operational scenarios). These operations would then be used to define minimum storage and minimum carry-over for selected year-types. Comparisons between alternatives would be more appropriate under these conditions.

RECOMMENDATION: Optimization of selective withdrawal

Selective withdrawal was examined only briefly in this analysis. It is recommended that an expanded examination be completed to determine the extent and efficacy of selective withdrawal for temperature control at Trinity Reservoir. The Trinity Reservoir Water Temperature Simulation Model has an option to optimize release temperature given a release temperature target for multiple intakes. This feature could be used to determine operating criteria to preserve cool water while maintaining release requirements.

RECOMMENDATION: Multiple Year Carry-over Analysis

This analysis examined a single year given carry-over storage from a previous year. As such, it could be argued that two years could be examined using this approach. However, there is often the need to examine extended periods (e.g., drought). It is recommended that multiple year carry-over analysis be completed to determine the combined impact of long term hydrologic, climatic and operating conditions on temperature control at Trinity Reservoir. Such an approach would also allow a more thorough examination of fall months such as October.

Appendix

Contents:

1. Analyses Summary/assumptions
2. Carry-over Analysis Results - Figures
3. Selective Withdrawal Results - Figures
4. Memo: 5/19/98, Greg Kamman: Draft Carry-over Storage Analysis Results – 40% Inflow, Maximum Flow, Flow Study, and No Action Alternative.
5. Memo: 5/21/98, Greg Kamman: Draft Carry-over Storage Analysis Results – Maximized Auxiliary Bypass Releases

1. Analyses Summary/Assumptions

- All runs were completed using the calibrated and verified Trinity Reservoir Water Temperature Simulation Model.
- Three carry-over volumes were selected for Trinity Reservoir: 750,000 AF, 1,250,000 AF, and 1,750,000 AF.
- Four EIS year-types were included: wet (1986), normal (1989), dry (1990), and critically dry (1977).
- All hydrologic, climatic, inflow temperature data and initial temperature profiles are outlined in the Trinity Reservoir Water Temperature Simulation Model project report.
- Four operational scenarios were analyzed: No Action, Flow Study, 40% Inflow, and Maximum Flow
- One Selective-withdrawal scenarios was completed for the dry year-type (1990) for each of the four operational scenarios. For this case, all releases were transferred from the power/main to the auxiliary intake for July 1 through September 30.
- Reservoir elevations less than 2150 were not explored.
- System geometry and capacity
- auxiliary intake centerline elevation is 1999 ft msl, capacity: 2500 cfs
- power/main intake centerline elevation is 2114 ft msl, capacity: power, 4000; main, 4000 cfs

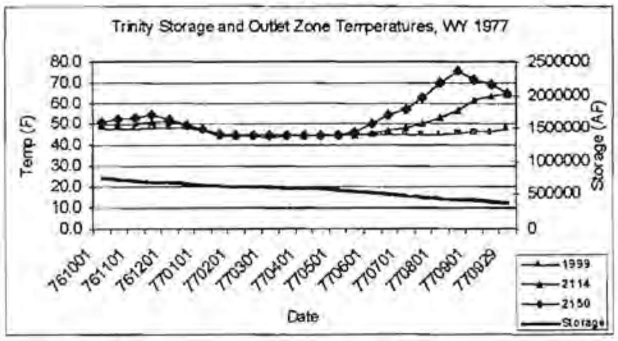
  (water temperatures associated with intake centerline elevations were assumed equivalent to reservoir release temperatures)

2. Carry-over Analysis Results

WY1977 – Flow Alternative and No Action, Carry-over: 750K, 1250K, 1750K
WY1986 – Flow Alternative and No Action, Carry-over: 750K, 1250K, 1750K
WY1989 – Flow Alternative and No Action, Carry-over: 750K, 1250K, 1750K
WY1990 – Flow Alternative and No Action, Carry-over: 750K, 1250K, 1750K
WY1977 – 40% Inflow and Maximum Flow, Carry-over: 750K, 1250K, 1750K
WY1986 – 40% Inflow and Maximum Flow, Carry-over: 750K, 1250K, 1750K
WY1989 – 40% Inflow and Maximum Flow, Carry-over: 750K, 1250K, 1750K
WY1990 – 40% Inflow and Maximum Flow, Carry-over: 750K, 1250K, 1750K

Trinity Reservoir EIS Carryover Results

Flow Alternative | **No Action**



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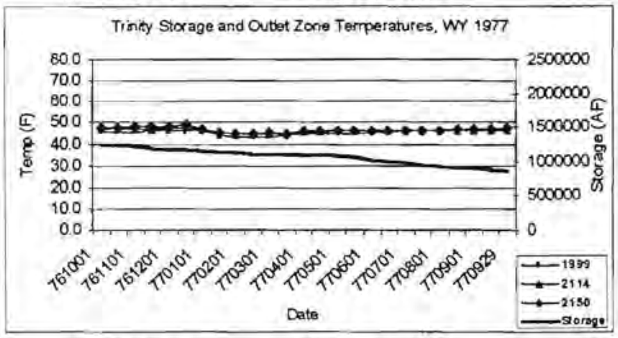
No Alternative at 750K



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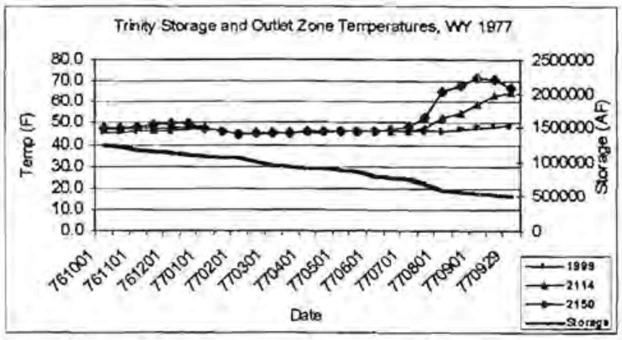

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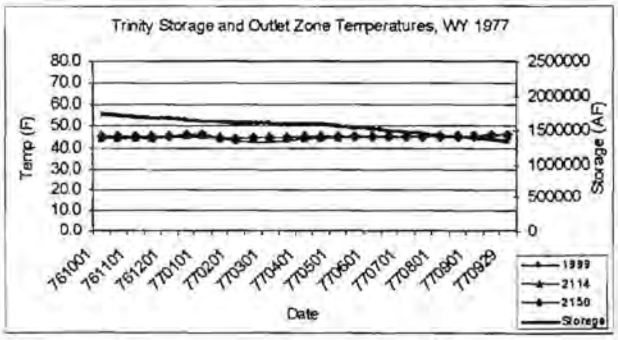

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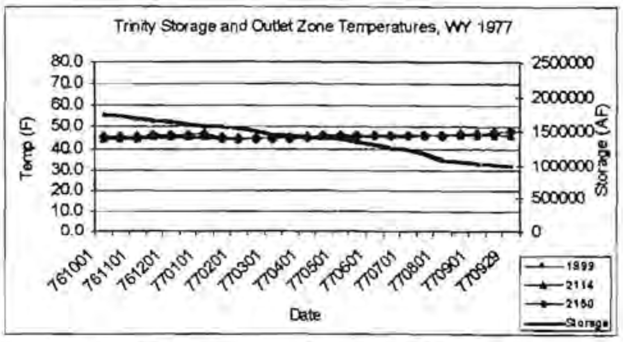

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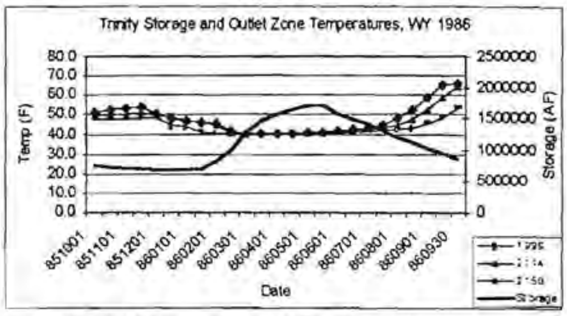
Trinity Reservoir EIS Carryover Results

Flow Alternative



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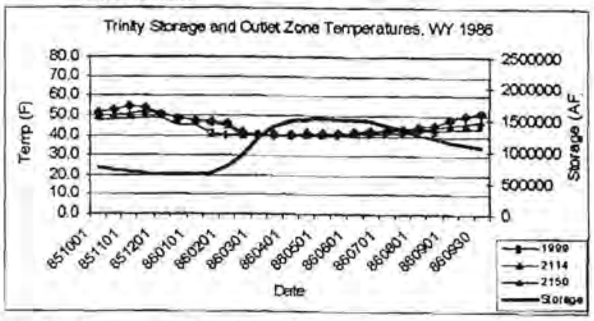
No Action



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No Alternative at 1250K

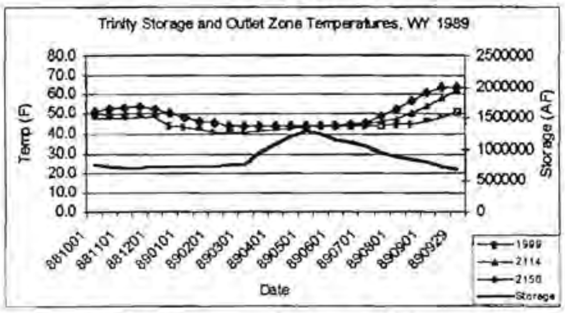
No Alternative at 1250K

No Alternative at 1750K

No Alternative at 1750K

Trinity Reservoir EIS Carryover Results

Flow Alternative



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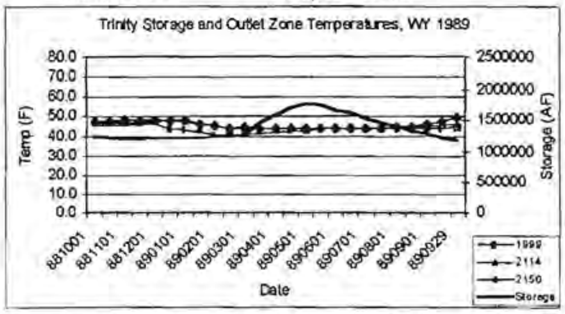

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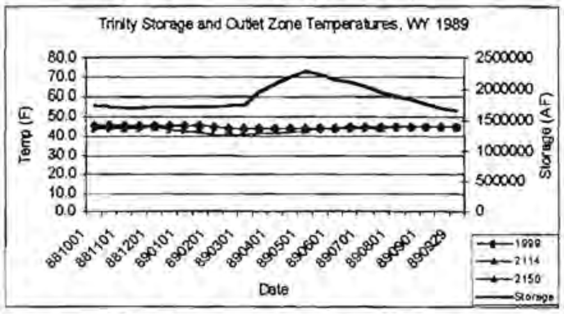

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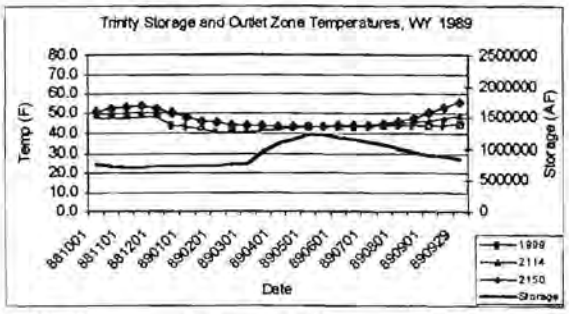

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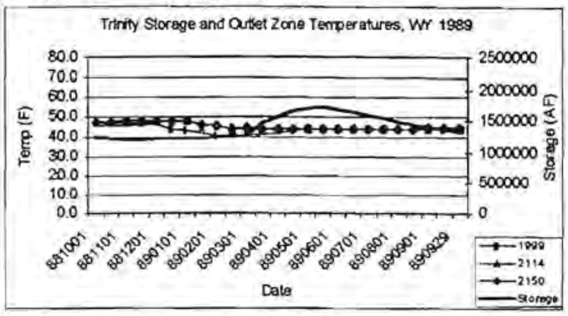

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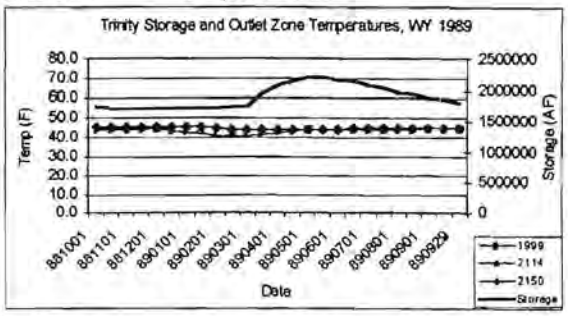

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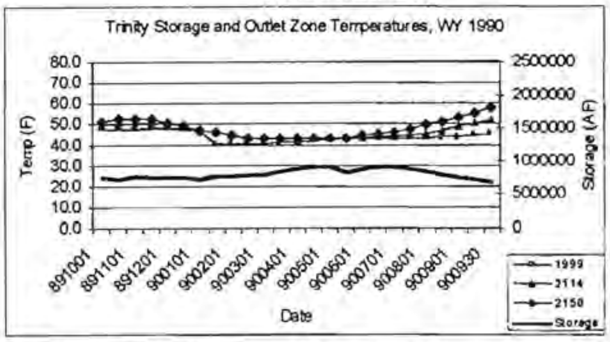
Trinity Reservoir EIS Carryover Results

Flow Alternative	No Action



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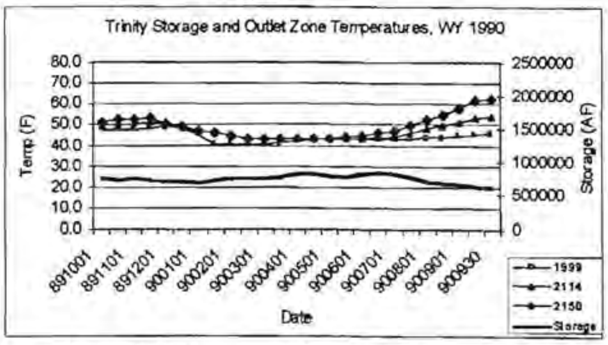

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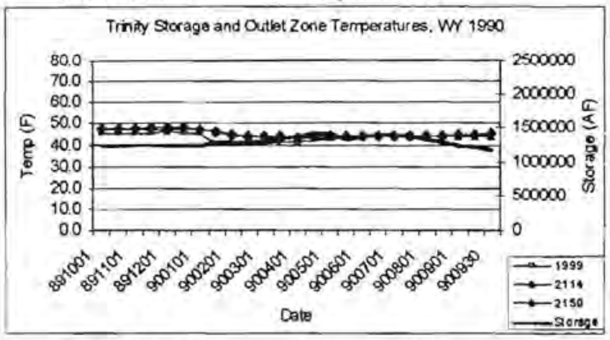

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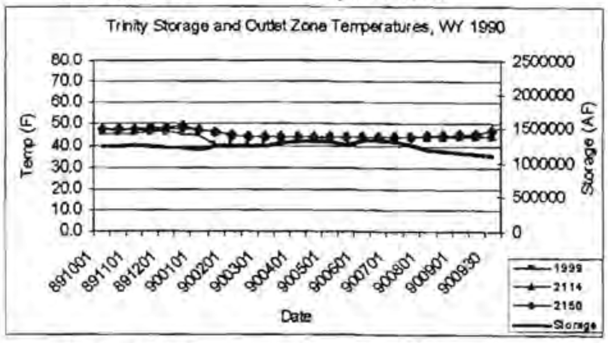

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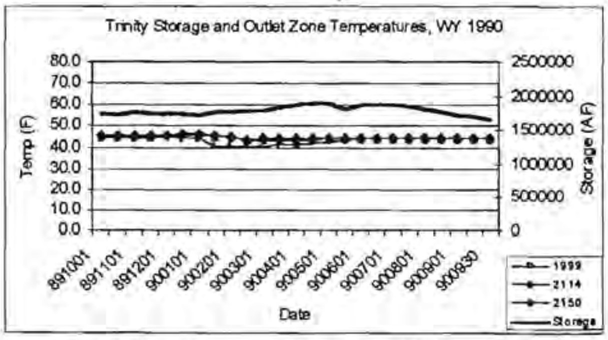

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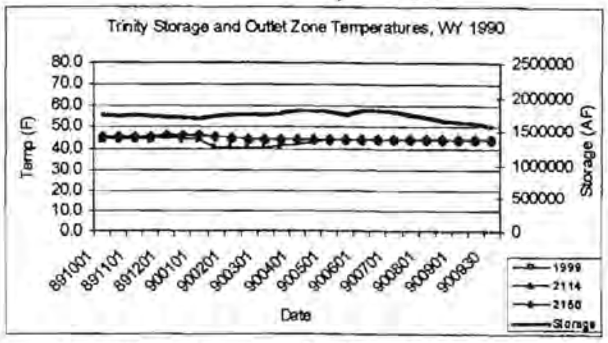

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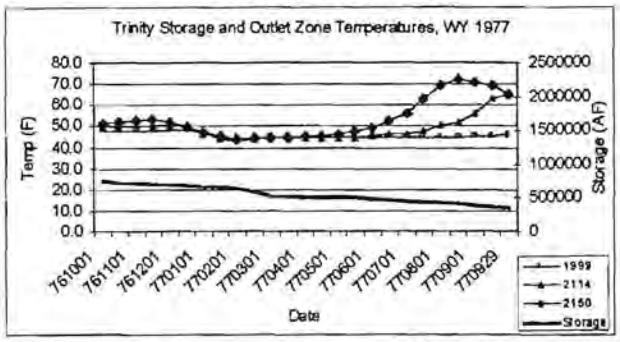
Trinity Reservoir EIS Carryover Results

40% Flow Alternative	Max Flow Alternative



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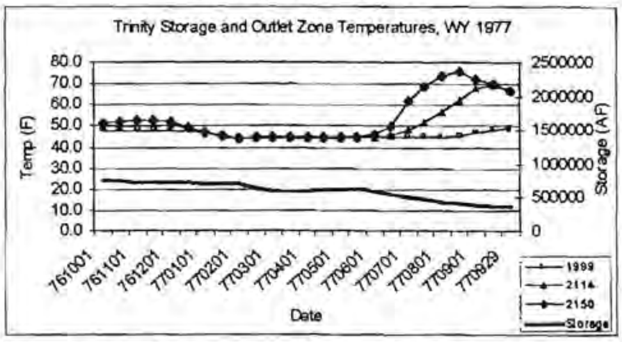

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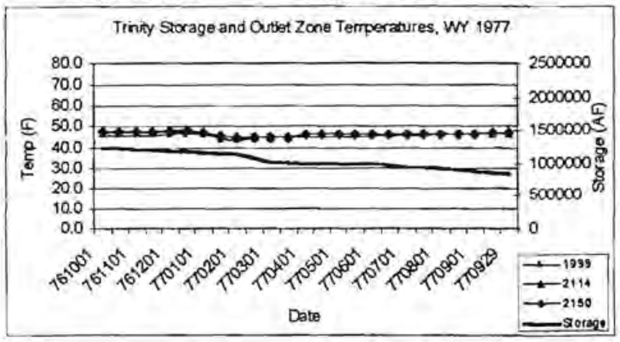

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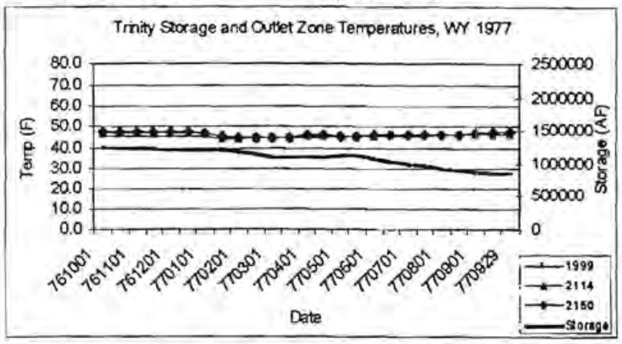

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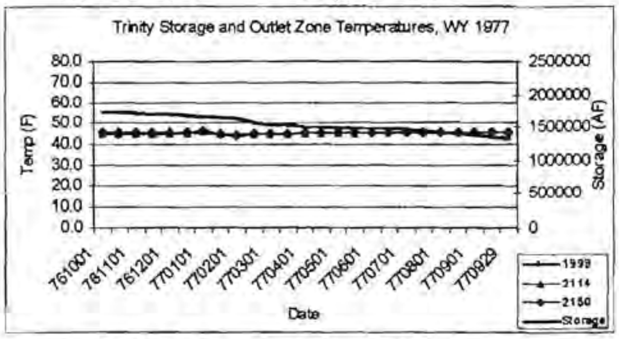

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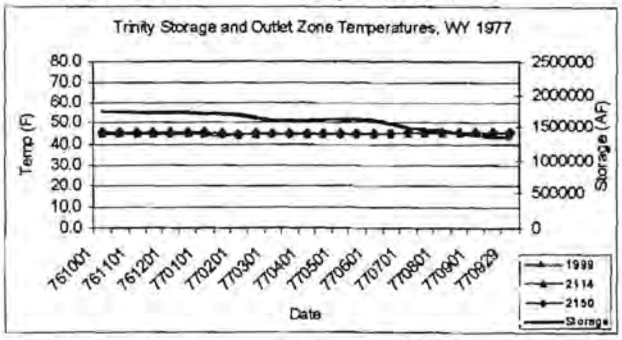
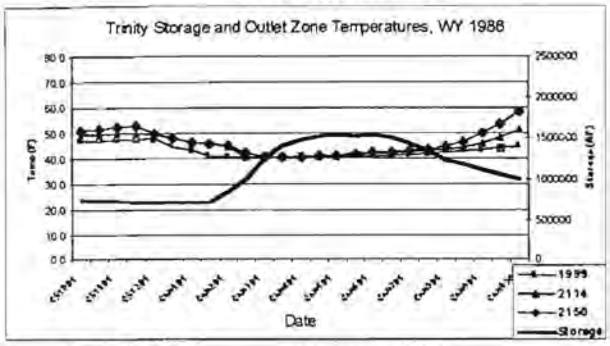


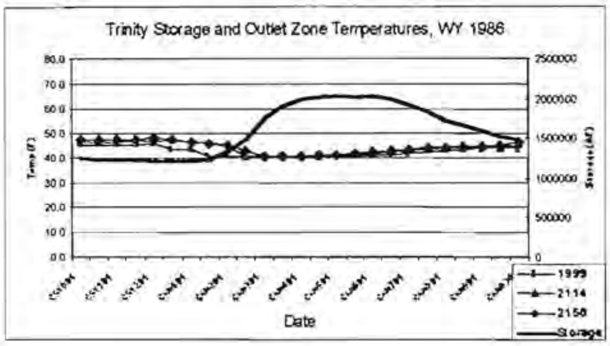
file: trmf77c.out Carryover: 1750K

Trinity Reservoir EIS Carryover Results

40% Flow Alternative



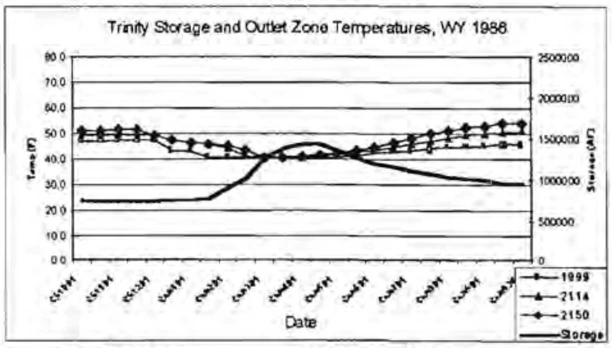
file: tr4086a.out Carryover: 750K



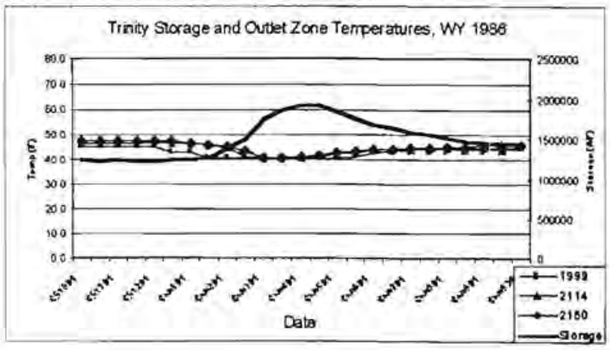
file: tr4086a.out Carryover: 1250K

No Alternative at 1750K

Max Flow Alternative



file: trmf86a.out Carryover: 750K

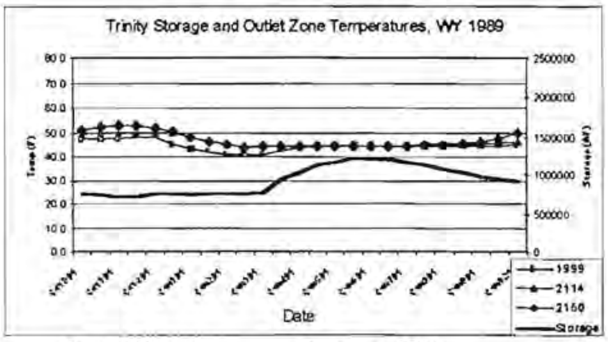


file: trmf86a.out Carryover: 1250K

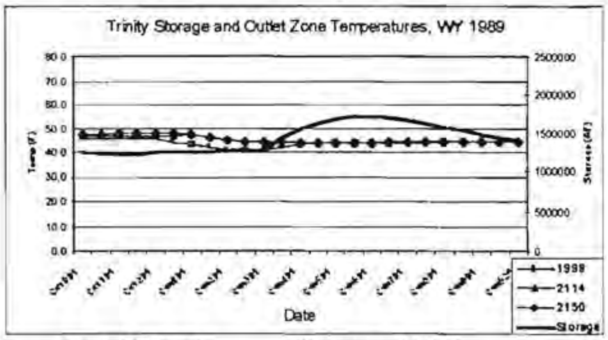
No Alternative at 1750K

Trinity Reservoir EIS Carryover Results

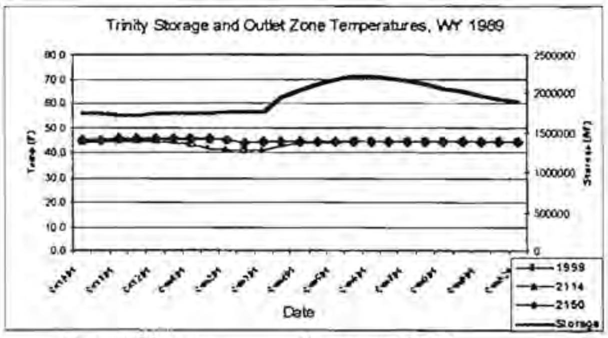
40% Flow Alternative



file: tr4089a.out Carryover: 750K

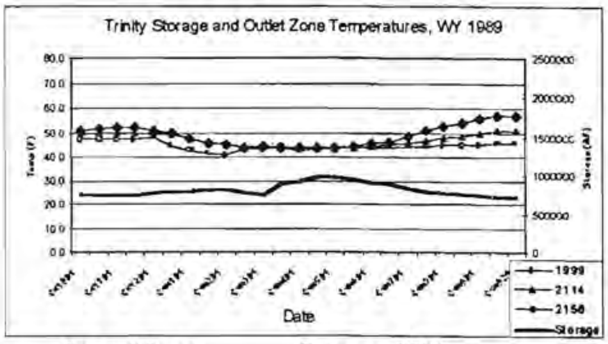


file: tr4089b.out Carryover: 1250K

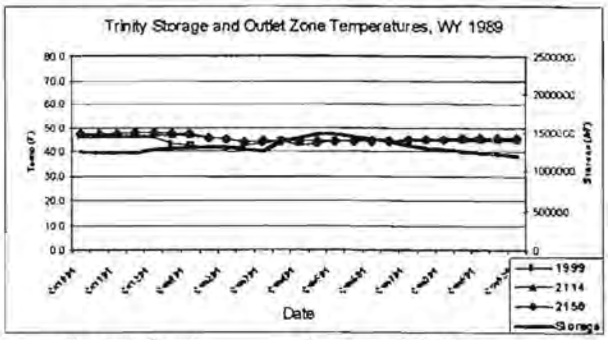


file: tr4089c.out Carryover: 1750K

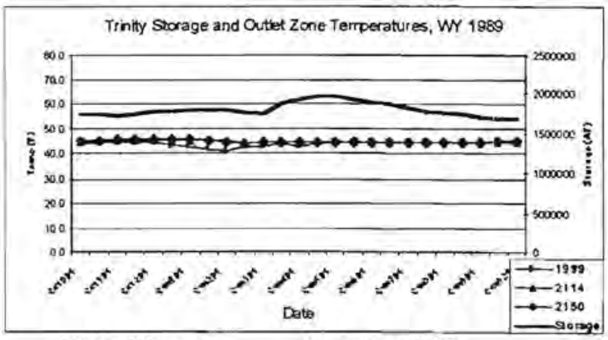
Max Flow Alternative



file: trmf89a.out Carryover: 750K



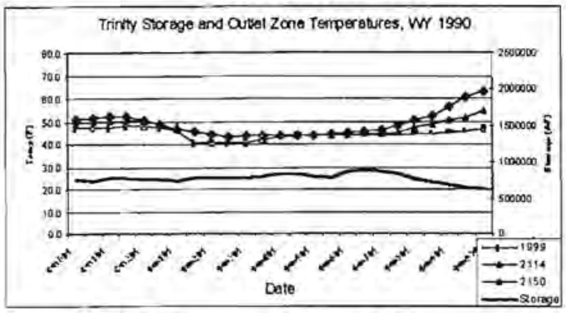
file: trmf89b.out Carryover: 1250K



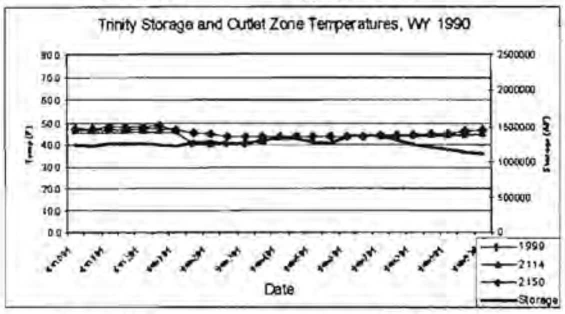
file: trmf89c.out Carryover: 1750K

Trinity Reservoir EIS Carryover Results

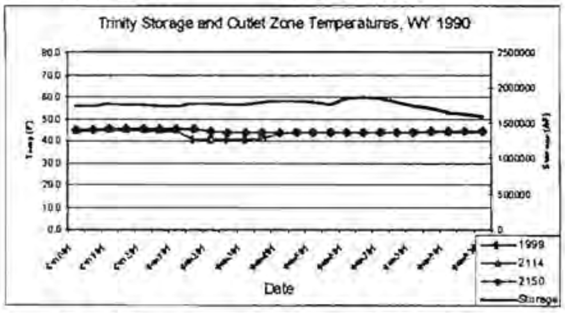
40% Flow Alternative



file: tr4090a.out Carryover: 750K

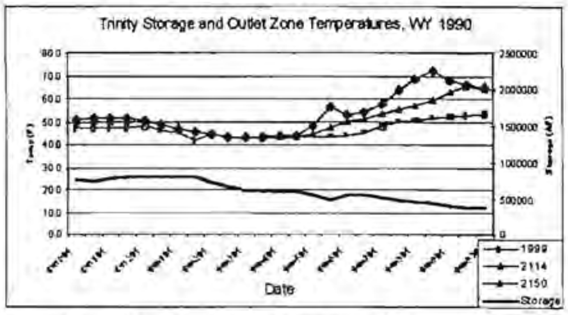


file: tr4090b.out Carryover: 1250K

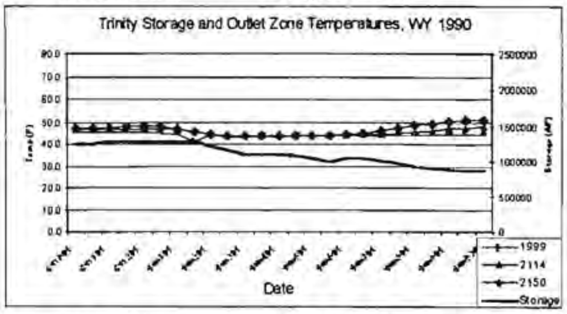


file: tr4090c.out Carryover: 1750K

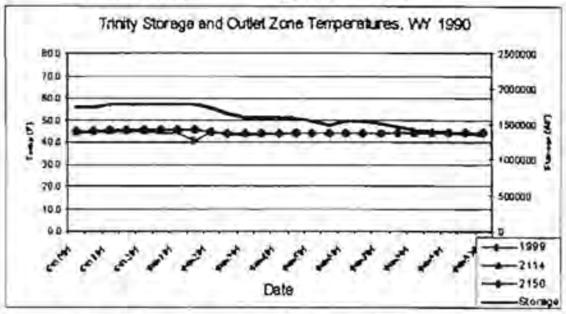
Max Flow Alternative



file: trmf90a.out Carryover: 750K



file: trmf90b.out Carryover: 1250K



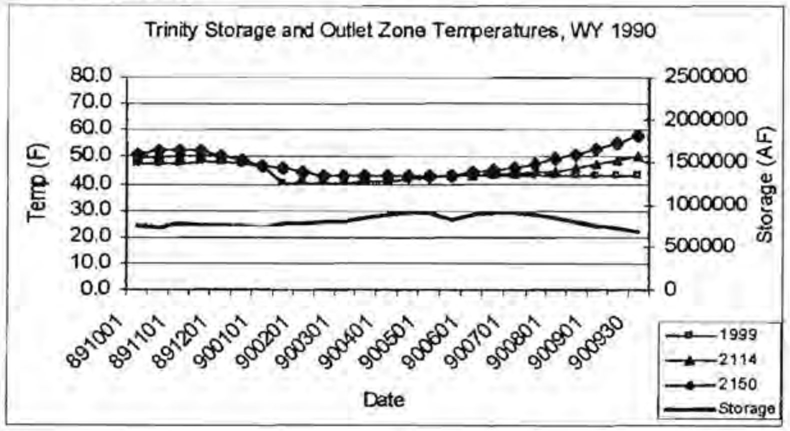
file: trmf90c.out Carryover: 1750K

3. Selective Withdrawal Results

Trinity Reservoir EIS Carryover Results

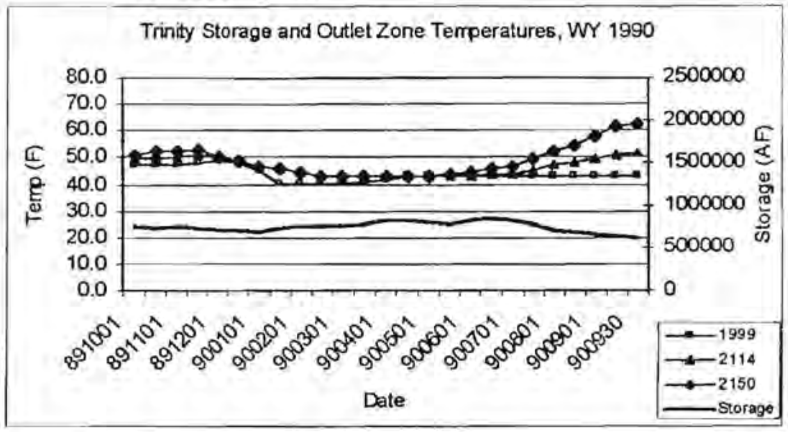
Flow Alternative

WY1990 750K



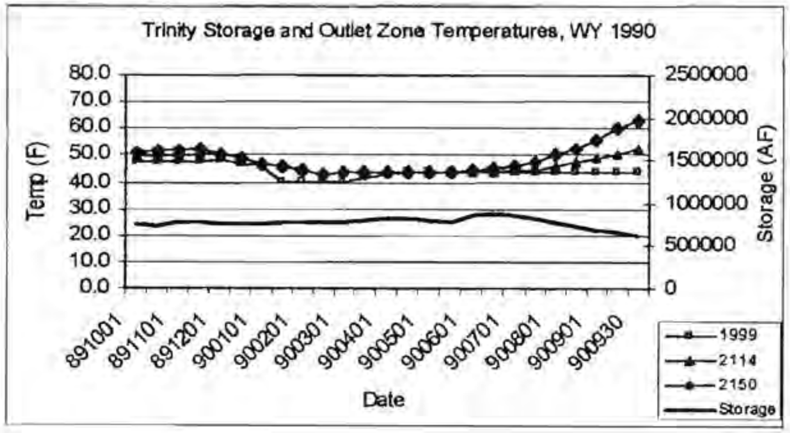
No Action Alternative

WY1990 750K



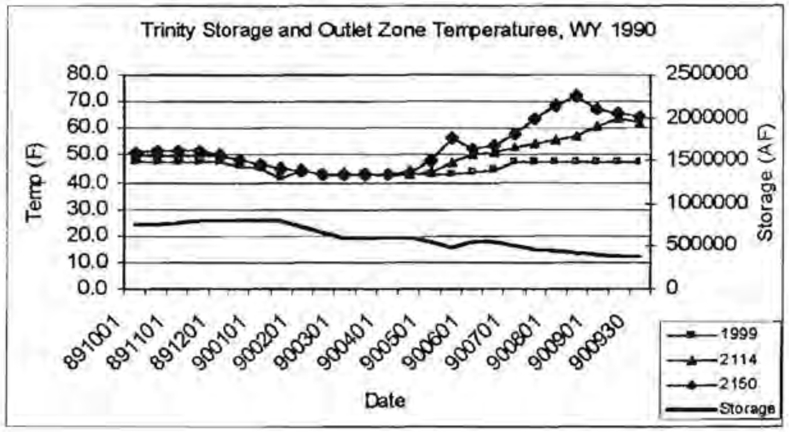
40% Flow Alternative

WY1990 750K



Max Flow Alternative

WY1990 750K



4. Memo: 5/19/98, Greg Kamman: Draft Carry-over Storage Analysis Results – 40% Inflow, Maximum Flow, Flow Study, and No Action Alternative.

MEMORANDUM

To: Tom Stokely and Mike Deas
From: Greg Kamman
Date: May 19, 1998
Subject: Draft Carryover Storage Analysis Results
40% Inflow, Maximum Flow, Flow Study, and No Action Alternatives

I have finished running the 40% Inflow and Maximum Flow Alternative scenarios through the BETTER model using the most recent WQRRS output. All of these runs simulated "normal" operations (i.e. the majority of releasese through the power outlet). Tables summarizing how these alternatives faired at complying with downstream temperature objectives according to various carryover storage volumes are presented in Tables 1 and 2; compliance results are based on the "median" hydrometeorological evaluation criteria developed by Paul Zedonis (USFWS) using the Trinity River SNTEMP model. For completeness, I am also providing the results of the Flow Study and No Action alternatives, Tables 3 and 4 respectively. Please note one further correction has been made to the 1989-750K results of the No Action alternative; it should read 93% not 100%.

Based on these results, it appears that the 40% Inflow and Maximum Flow alternatives don't benefit from higher carryover storage volumes like the No Action and Flow Study alternatives. In fact, carryover storage does not appear to make much of a difference under the 40% Inflow alternative. As indicated in my EIS/EIR appendix report, it is likely that 40% Inflow river release volumes are just too low during the summer to satisfy downstream temperature objectives, even under the minimum release temperatures. This is probably also the case for certain periods under the Maximum Flow alternative.

I will now proceed with the simulations in which we optimize releases through the lower (auxiliary bypass) outlet of Trinity Dam. These analyses will be completed on the 'dry year-type (1990) - 750K ac-ft carryover storage' scenario for each proposed flow alternative. Mike has provided me with the WQRRS results for these simulations. I will have them completed by early Friday morning.

Water Year-Type	PROSIM/RTM Results		Using WQRRS Modeling Results (carryover storage in AF)		
	Carryover Storage (KAF)	% compliance	750K	1250K	1750K
wet year (1986)	1118	26	27	26	n/a
normal (1989)	880	14	13	13	13
dry (1990)	1052	13	11	13	13
crit. dry (1977)	1084	0	0	0	0

Table 1: Evaluation of <u>40% Inflow alternative</u> results using evaluation criteria based on "median" hydrometeorological conditions. Numbers represent percentage of time temperature objectives are met from July 1 through October 15.

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Water Year-Type	PROSIM/RTM Results		Using WQRRS Modeling Results (carryover storage in AF)		
	Carryover Storage (KAF)	% compliance	750K	1250K	1750K
wet year (1986)	1147	72	39	72	n/a
normal (1989)	1189	72	44	71	72
dry (1990)	1153	71	25	71	72
crit. dry (1977)	999	71	21	72	72

Table 2: **Evaluation of Maximum Flow Alternative results using evaluation criteria based on "median" hydrometeorological conditions. Numbers represent percentage of time temperature objectives are met from July 1 through October 15.**

Water Year-Type	PROSIM/RTM Results		Using WQRRS Modeling Results (carryover storage in AF)		
	Carryover Storage (KAF)	% compliance	750K	1250K	1750K
wet year (1986)	1046	100%	74%	n/a	n/a
normal (1989)	962	99%	68%	100%	100%
dry (1990)	895	99%	71%	100%	100%
crit. dry (1977)	1026	99%	31%	98%	99%

Table 3: **Evaluation of Flow Study Alternative results using evaluation criteria based on "median" hydrometeorological conditions. Numbers represent percentage of time temperature objectives are met from July 1 through October 15.**

Water Year-Type	PROSIM/RTM Results		Using WQRRS Modeling Results (carryover storage in AF)		
	Carryover Storage (KAF)	% compliance	750K	1250K	1750K
wet year (1986)	1174	100%	100%	n/a	n/a
normal (1989)	1043	100%	93%	100%	100%
dry (1990)	1134	100%	65%	100%	100%
crit. dry (1977)	1227	60%	n/a	46%	100%

Table 4: **Evaluation of No Action Alternative results using evaluation criteria based on "median" hydrometeorological conditions. Numbers represent percentage of time temperature objectives are met from July 1 through October 15.**

5. Memo: 5/21/98, Greg Kamman: Draft Carry-over Storage Analysis Results – Maximized Auxiliary Bypass Releases

MEMORANDUM

To:	Tom Stokely and Mike Deas
From:	Greg Kamman
Date:	May 21, 1998
Subject:	Draft Carryover Storage Analysis Results Maximized Auxiliary Bypass Releases

I have finished running some simulations in which we maximize releases through the Trinity dam auxiliary bypass (lower) outlet. These simulations were completed for the 'dry year (1990)-750K AF carryover storage' scenario. Previous temperature modeling results for this scenario indicated that, under normal operating conditions (i.e. maximized releases through the Trinity dam power outlet), summer Trinity dam releases are relatively warm, leading to poor compliance with downstream temperature objectives (see my memo dated May 19, 1998 memo and table presented below). Therefore, these most recent simulations alter Trinity dam release operations by preferentially drawing upon the deeper cool water pool (i.e. maximizing releases through the dam's lower auxiliary outlet). During the summer period, the total releases from Trinity dam are low enough that essentially all water passes through the lower outlet, prohibiting the generation of power.

A table comparing how these two operational scenarios faired at complying with downstream temperature objectives are presented below; compliance results are based on the "median" hydrometeorological evaluation criteria developed by Paul Zedonis (USFWS) using the Trinity River SNTEMP model. Notable reductions in release temperatures are realized when summer-time Trinity dam releases are directed through the lower auxiliary outlet. In turn, these lower temperatures are propagated through the system, leading to better compliance with mainstem temperature objectives. These increases in compliance with temperature objectives are limited (2%) for the 40% Inflow alternative but quite dramatic (almost 50%) for the Maximum Flow alternative. The No Action and Flow Study alternatives also showed notable increases in compliance (34% and 28%, respectively).

Comparison of Simulations: 1990 (dry year) with 750K AF Carryover Storage		
Proposed Flow Alternative	**Normal Trinity Lake Releases 750K AF Carryover Storage**	**Maximized Auxiliary Bypass Releases 750K AF Carryover Storage**
No Action	65%	99%
Flow Study	71%	99%
40% Inflow	11%	13%
Maximum Flow	25%	74%

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