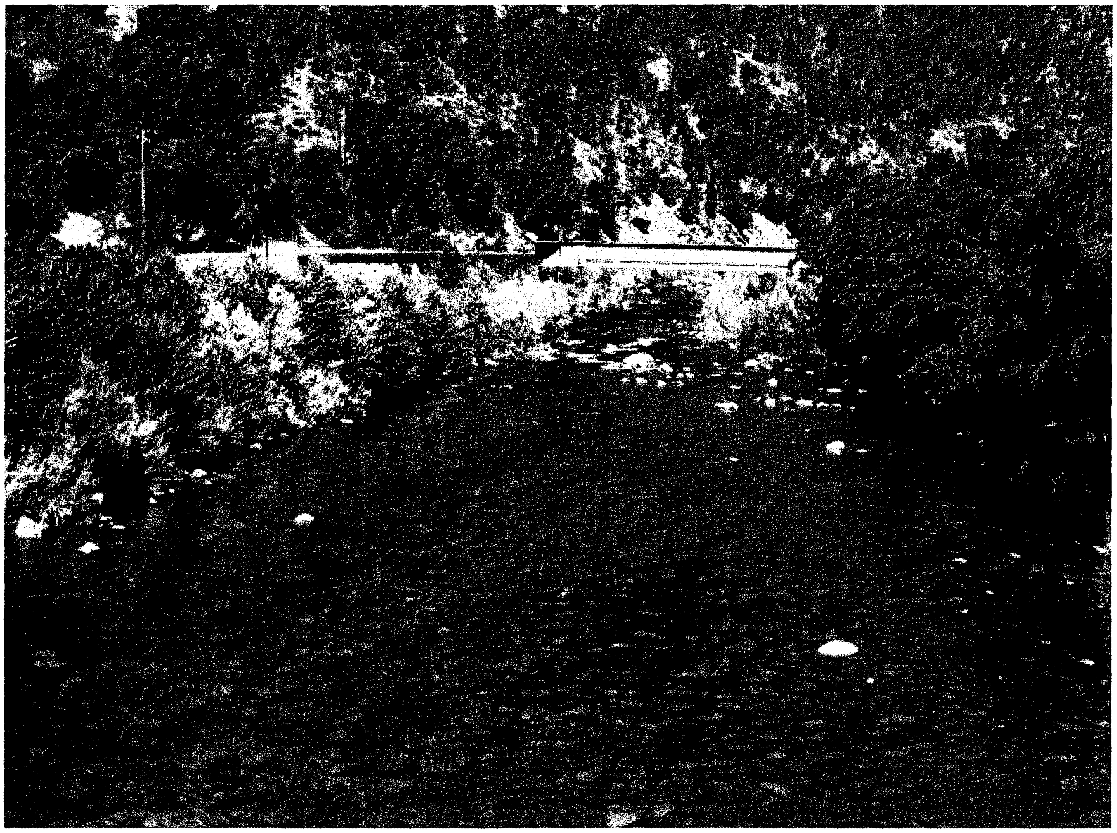
APPENDIX B

North Fork Feather River
Study Data and Informational Report on Water Temperature Monitoring and Additional Reasonable Water Temperature Control Measures



Amended September 2005

This report represents the results of PG&E's evaluation of water temperature monitoring, modeling and control options, reflects only PG&E's views and is being submitted to the Rock Creek – Cresta Ecological Resources Committee (ERC) so that the ERC may review the report and begin working towards recommendations concerning flow and Project operations and, if feasible, making any affirmative determinations concerning water temperature control actions.

Pacific Gas and Electric Company™

PART 1

EXECUTIVE SUMMARY

This report has been prepared by Pacific Gas and Electric Company (Licensee) pursuant to License Condition 4D of the Rock Creek-Cresta Project, FERC Project No. 1962, license issued by the Federal Energy Regulatory Commission (FERC) on October 24, 2001. License Condition 4D requires Licensee to prepare a report that evaluates whether a mean daily water temperature of 20°C or less has been and will be achieved in the Rock Creek and Cresta reaches of the North Fork Feather River (NFFR), and if not, whether additional reasonable water temperature control measures are available. The purpose of achieving a mean daily water temperature of 20°C or less is to enhance cold water fish habitat, primarily for trout. This report may also be of use in the current ongoing relicensings of Licensee's Upper NFFR Project (FERC Project No. 2105) and Poe Project (FERC Project No. 2107) located on the NFFR, upstream and downstream of the Rock Creek-Cresta Project. A map of the NFFR from Lake Almanor to Lake Oroville is provided on Page iii for reference.

In summary, water temperature monitoring indicates that a mean daily water temperature of 20°C or less is not consistently achieved in the months of July and August on the Rock Creek and Cresta reaches, and evaluation of twenty-four potential water temperature control alternatives indicates that no reasonable water temperature control measures are available to achieve such water temperatures year-round.

In order to evaluate existing water temperatures, Licensee conducted water temperature monitoring in the Rock Creek and Cresta reaches, as well as several other reaches of the NFFR during 2002, 2003 and 2004. The monitoring was conducted consistent with a monitoring plan prepared by Licensee in consultation with state and federal resource agencies and approved by FERC pursuant to Rock Creek-Cresta Project License Condition 4C. The three monitoring years are classified as Dry, Normal and Normal water year types, respectively, using the definitions in the Rock Creek-Cresta Project license. The water year type and meteorological conditions are the primary influencing factors that affect water temperature in the subject reaches.

The water temperature monitoring showed that water temperatures of 20°C or less were generally achieved in all months except July and August. The monitoring showed that during the months of July and August in the years 2002, 2003 and 2004 mean daily water temperatures in the warmest part of the Rock Creek Reach exceeded 20°C 95, 66, and 97 percent of the time, respectively and water temperatures in the warmest part of the Cresta Reach exceeded 20°C 95, 50, and 95 percent of the time, respectively. Maximum water temperatures in the reaches were 24.0°C and 23.9°C, respectively (Appendix A). Licensee has also collected water temperature monitoring data for numerous other locations on the NFFR going back to 1985. Licensee used this more extensive data set along with the 2002, 2003 and 2004 data in various water temperature predictive models to evaluate potential alternatives for achieving colder water temperatures.

Ultimately, Licensee identified and evaluated twenty-four potential water temperature control alternatives for achieving colder water in the NFFR. Twenty of the twenty-four alternatives have potential application to the Rock Creek and Cresta reaches. Two others are targeted at reducing water temperatures in the downstream Poe Reach, and the other two target the upstream Belden Reach. The twenty-four potential alternatives are generally grouped into three categories which are as follows.

1) Obtain cold water from Lake Almanor through the use of thermal curtains or other means at the existing Prattville Intake structure located in the lake;

2) Obtain cold water from Lake Almanor by increasing the magnitude of seasonal water releases using the low-level gates in the existing Canyon Dam Outlet structure located in the lake, and/or re-operate Licensee's Upper NFFR, Rock Creek-Cresta, Poe and Bucks Creek projects; and

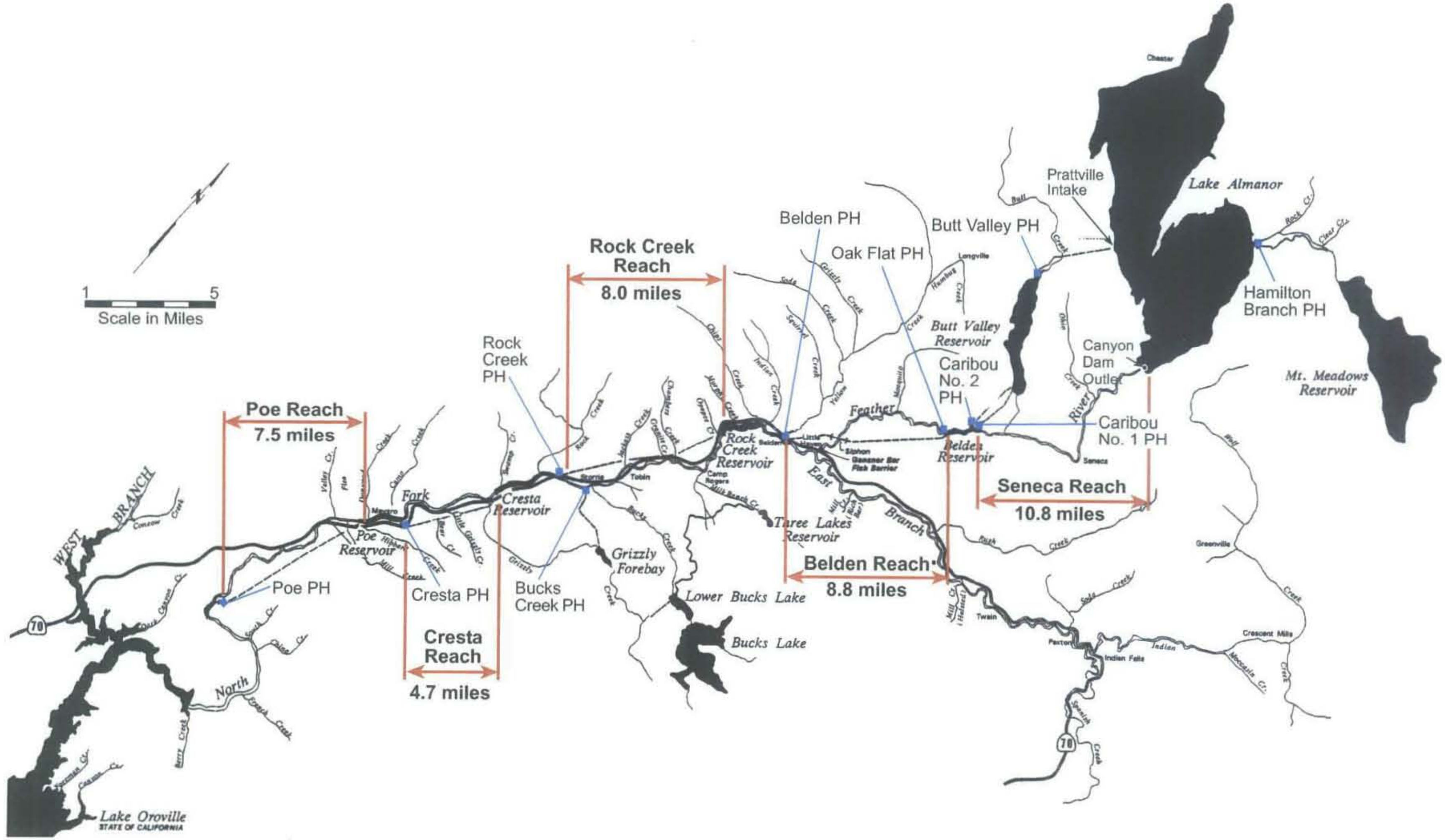
3) Obtain cold water from sources other than Lake Almanor.

The process of identifying potential water temperature control alternatives was innovative and thorough, so that no potentially reasonable water temperature control measure would be left unconsidered. The evaluation process was comprehensive and scientific, with an aggregate cost to the Licensee of data acquisition and analysis in excess of $3 million to date.

Licensee's analysis of each of the twenty-four potential water temperature control alternatives indicates that some of the first and second category alternatives (thermal curtain and increased magnitude water releases) have the best potential to reduce water temperatures in the Rock Creek and Cresta reaches. Sophisticated computer modeling indicates that some of these alternatives have the potential to reduce water temperatures from 1 to 3°C in July and August. However, such reductions in water temperature would only increase the cold water trout habitat in the Rock Creek Reach by about 3 to 8 percent and in the Cresta Reach by about 0.5 to 2 percent in July and August of Normal water years. The overall benefits of such modest gains in cold water trout habitat are very limited and likely not measurable given natural fish population variability. Also, these alternatives would likely have a corresponding potential effect of *reducing* cold water fish habitat in Lake Almanor and *reducing* fish production in Butt Valley Reservoir, resulting in a decrease of the aquatic resources and recreational value at each of these reservoirs.

All of the potential water temperature control alternatives identified and evaluated have substantial costs in the range of tens of millions of dollars which, if implemented, would likely be borne by Licensee's electric customers. Other factors considered in the evaluations include the effects of each potential alternative on other beneficial uses such as irrigation, power production, recreation, aesthetic enjoyment, and warm and cold water habitat, as well local economic considerations and public opinion expressed during the course of the evaluation.

In summary, Licensee's evaluation of twenty-four potential water temperature control alternatives for achieving year-round mean daily water temperature of 20°C or less in the Rock Creek and Cresta reaches of the NFFR has not identified an alternative for which the level of water temperature benefits is commensurate with the corresponding adverse effects and costs. Therefore, Licensee concludes that there are no additional reasonable water temperature control measures for achieving a year-round water temperature of 20°C or less in the subject reaches.



North Fork Feather River from Lake Almanor to Lake Oroville, California

OVERVIEW OF POTENTIAL WATER TEMPERATURE CONTROL ALTERNATIVES

Licensee has identified and evaluated twenty-four potential water temperature control alternatives for achieving colder water for the NFFR. Twenty of the twenty-four alternatives have potential application to the Rock Creek and Cresta reaches. Two others (Alternatives 12 and 24) are targeted at reducing water temperatures in the downstream Poe Reach and the other two (Alternatives 9 and 18) are targeted at the upstream Belden Reach. A detailed description of each of the potential water temperature control alternatives and Licensee's evaluation of each alternative's potential to achieve a mean daily water temperature of 20°C or less year-round in the subject reaches is provided in Part 2 of this report. A brief summary of each potential alternative and its evaluation is provided in the following overview.

Category 1 – Obtain Cold Water from Lake Almanor Through the use of Thermal Curtains or Other Means at the Existing Prattville Intake Located in the Lake

Alternative 1 – Install a Thermal Curtain at Existing Prattville Intake Located in Lake Almanor. This alternative consists of installing a thermal curtain in Lake Almanor at the existing Prattville Intake to cause colder water to enter the intake for release to the NFFR. Six thermal curtains of different sizes and layouts were evaluated. Hydraulic model tests were conducted to compare and select the most effective and viable thermal curtain. The most effective thermal curtain configuration (U-shaped; 900-feet x 770-feet x 900-feet) provides about 1°C water temperature reduction at the Belden, Rock Creek, Cresta and Poe reaches during July and August, but also results in reduced cold water fish habitat in Lake Almanor and reduced fish production in Butt Valley Reservoir. A thermal curtain would be very costly to install. The level of water temperature benefits for this alternative is not commensurate with the corresponding adverse effects and costs, leading to the conclusion that it is not a reasonable water temperature control measure.

Alternative 2 – Install a Submerged Hooded Pipeline at Existing Prattville Intake in Lake Almanor. This alternative consists of installing a submerged hooded pipeline at the existing Prattville Intake to cause colder water to enter the intake for release to the NFFR. Two configurations (long and short) of a submerged hooded pipeline (three 12-foot diameter pipes) were evaluated. Hydraulic model tests were conducted to compare and select the most effective and viable alternative between the submerged hooded pipeline and thermal curtain. The thermal curtain alternative was determined to be more effective and viable, and therefore, the submerged hooded pipeline was eliminated from consideration as a potential reasonable water temperature control measure.

Alternative 3 – Dredge Existing Prattville Intake Area and nearby Underwater Channel at Lake Almanor Exclusively or in Combination with Installation of a Thermal Curtain or Submerged Pipeline. This alternative consists of dredging of the Prattville Intake area and nearby underwater channel at Lake Almanor exclusively or in combination with installing a thermal curtain or submerged pipeline to cause colder water to enter the intake for release to the NFFR. Hydraulic model tests were conducted to compare and select the most effective and viable combination of dredging, submerged pipeline and thermal curtain. Dredging alone provides about 0.5°C water temperature reduction at the Belden, Rock Creek, Cresta, and Poe reaches during July and August, but also reduced cold water fish habitat in Lake Almanor and reduced fish production in Butt Valley Reservoir. This alternative would be costly to install. The level of water temperature benefits for this alternative is not commensurate with the corresponding adverse effects and costs, leading to the conclusion that it is not a reasonable water temperature control measure.

Alternative 4 – Install Two Thermal Curtains in Butt Valley Reservoir (One at the Lower End of Butt Valley Reservoir at the Existing Caribou Powerhouse Intake and One at the Upper End of Butt Valley Reservoir) and One Thermal Curtain at the Existing Prattville Intake in Lake Almanor, with Dredging of the Prattville Intake Area. This alternative consists of installing a combination of two thermal curtains in Butt Valley Reservoir and one thermal curtain at Prattville Intake in Lake Almanor, with dredging of the Prattville Intake area to cause colder water to enter the intakes at both lakes for release to the NFFR. This combination of configurations provides about 3°C water temperature reduction at the Belden, Rock Creek, Cresta, and Poe reaches during July and August, but also results in reduced cold water fish habitat in Lake Almanor and reduced fish production in Butt Valley Reservoir. This alternative would be extremely costly to install. The level of water temperature benefits for this alternative is not commensurate with the corresponding adverse effects and costs, leading to the conclusion that it is not a reasonable water temperature control measure.

Category 2– Obtain Cold Water from Lake Almanor by Increasing the Magnitude of Seasonal Water Releases Using the Low-Level Gates in the Existing Canyon Dam Outlet Structure Located in the Lake and/or Re-operation of Licensee's Upper NFFR, Rock Creek-Cresta, Poe and Bucks Creek Projects.

Alternative 5 – Re-operate Butt Valley Powerhouse to Reduce Butt Valley Powerhouse Flows and Draw Cooler Water from Lake Almanor for Release to the NFFR at Butt Valley Powerhouse. This alternative consists of reducing Butt Valley Powerhouse flows so that cooler water is drawn from Lake Almanor and subsequently released to the NFFR from Butt Valley Powerhouse. Operational flow tests were conducted which resulted in a marginal reduction in water temperature (less than 1°C) at Butt Valley Powerhouse. However, the reduced flows through Butt Valley Powerhouse equates to slower flow pass-thru in Butt Valley Reservoir, which in turn equates to a potential increase in water temperatures in Butt Valley Reservoir and a corresponding reduction in fish production. This alternative is not expected to result in any measurable water temperature reduction to the Belden, Rock Creek, Cresta and Poe reaches. Also, the reduced flows through Butt Valley Powerhouse have a corresponding effect of reduced flows through the downstream Caribou, Belden, Rock Creek, Cresta, and Poe powerhouses resulting in very adverse impacts on power generation. The extremely limited water temperature benefits for this alternative are not commensurate with the corresponding adverse effects and costs, leading to the conclusion that it is not a reasonable water temperature control measure.

Alternative 6 – Re-operate Butt Valley Powerhouse to Reduce Butt Valley Powerhouse Flows and Draw Cooler Water from Lake Almanor for Release to the NFFR at Butt Valley Powerhouse, Combined with Increasing the Magnitude of Water Releases from Lake Almanor at Canyon Dam. This alternative consists of reducing Butt Valley Powerhouse flows so that cooler water is drawn from Lake Almanor and subsequently released to the NFFR from Butt Valley Powerhouse, combined with increasing the magnitude of water releases to the NFFR from the

Canyon Dam Outlet low level gate in Lake Almanor. This alternative provides a water temperature reduction of about 1°C in July and 2°C in August for the Belden, Rock Creek, Cresta and Poe reaches, but also results in reduced cold water fish habitat in Lake Almanor, reduced fish production in Butt Valley Reservoir and reduced quality of cold water fish habitat on the Seneca Reach. The reduced flows through Butt Valley Powerhouse have a corresponding effect of reduced flows through the downstream Caribou Powerhouse resulting in very adverse impacts on power generation. The level of water temperature benefits for this alternative is not commensurate with the corresponding adverse effects and costs, leading to the conclusion that it is not a reasonable water temperature control measure.

Alternative 7 – Re-operate Caribou No. 1 Powerhouse to Select Caribou No. 1 Powerhouse Operation over Caribou No. 2 Powerhouse Operation and Draw Cooler Water from Butt Valley Reservoir for Release to the NFFR. This alternative consists of re-operation of the Caribou No. 1 Powerhouse to select Caribou No. 1 Powerhouse operation over Caribou No. 2 Powerhouse operation and draw cooler water from Butt Valley Reservoir for release to the NFFR. Caribou No. 1 Powerhouse water intake is located in a deeper portion of Butt Valley Reservoir than the Caribou No. 2 Powerhouse water intake, thereby providing better access to the available cooler water. Operation tests flows conducted with the exclusive use of Caribou No. 1 Powerhouse resulted in downstream water temperature reductions of 3°C at Belden Dam, 1°C at Rock Creek Dam and 0.5°C at Cresta Dam. However, the reserve pool of cold water in Butt Valley Reservoir is limited and was exhausted after only several days of operation, causing water temperatures in Butt Valley Reservoir's lower levels to rapidly warm. Additionally, Caribou No. 1 Powerhouse is about 10 percent less efficient than Caribou No. 2 Powerhouse, resulting in adverse impacts on power generation. The level of water temperature benefits for this alternative is not commensurate with the corresponding adverse effects and costs, leading to the conclusion that it is not a reasonable water temperature control measure.

Alternative 8 – Re-operate the Existing Canyon Dam Outlet in Lake Almanor to Selectively Use the High/Low Outlet Gates to Preserve Cold Water in Lake Almanor. This alternative consists of re-operation of the existing Canyon Dam Outlet to selectively use the high/low outlet gates to preserve more cold water in Lake Almanor for release to the NFFR at the existing Prattville Intake. Evaluation of selective operation of the high/low outlet gates indicated only a slight difference of about 0.1°C in water temperatures in Lake Almanor at the Prattville Intake was achievable. Such minor water temperature reduction at Prattville Intake would not produce measurable water temperature benefits in the Belden, Rock Creek, Cresta and Poe reaches, leading to the conclusion that it is not a reasonable water temperature control measure.

Alternative 9 – Re-operate Belden Dam to Provide Increased Magnitude Water Releases to NFFR at Belden Dam to Cool the Belden Reach. This alternative consists of re-operating Belden Dam to provide increased magnitude water releases at Belden Dam to cool the Belden Reach of the NFFR. The Belden Reach is unique as it has significant riparian vegetation that provides shading and cooling effects to water temperatures. Water temperature modeling and tests concluded that increased magnitude water releases at Belden Dam will not produce a cooling of the water in the Belden Reach but would actually slightly warm the water in the Belden Reach. Additionally, increased magnitude water releases would result in adverse impacts on power generation. These considerations lead to the conclusion that it is not a reasonable water temperature control measure.

Alternative 10 – Re-operate Rock Creek Dam to Provide Increased Magnitude Water Releases to the NFFR at Rock Creek Dam to Cool the Rock Creek Reach. This alternative consists of re-operating Rock Creek Dam to provide increased magnitude water releases at Rock Creek Dam to cool the Rock Creek Reach of the NFFR. The Rock Creek Reach has several natural tributary streams and inflows from the Bucks Creek Project that cause a cooling effect to water in this reach. Increasing the magnitude of water releases at Rock Creek Dam would over-ride the cooling effect of these tributary sources and would actually have the effect of warming the water in this reach. Additionally, increased magnitude water releases would result in adverse impacts on power generation. These considerations lead to the conclusion that it is not a reasonable water temperature control measure.

Alternative 11 – Re-operate Cresta Dam to Provide Increased Magnitude Water Releases at Cresta Dam to Cool the Cresta Reach. This alternative consists of re-operating Cresta Dam to provide increased magnitude water releases at Cresta Dam to cool the Cresta Reach of the NFFR. Water temperature modeling concluded that even with a doubling of the already substantial 220 cubic feet per second (cfs) minimum streamflow, only a slight reduction of 0.2°C in water temperature would be achieved in the Cresta Reach. Additionally, increased magnitude water releases would have adverse impacts on power generation. The minor level of water temperature benefits for this alternative is not commensurate with the cost in the form of foregone power generation, leading to the conclusion that it is not a reasonable water temperature control measure.

Alternative 12 – Re-operate Poe Dam to Provide Increased Magnitude Water Releases at Poe Dam to Cool Poe Reach. This alternative consists of re-operating Poe Dam to provide increased magnitude water releases at Poe Dam to cool the Poe Reach of the NFFR. Increased magnitude water releases at Poe Dam would result in water temperature reductions of about 1.5°C in the lower flow range (increasing flows from the currently required minimum of 50 cfs to 200 cfs). Once flows are above 200 cfs, even a doubling of flows reduces water temperatures only about 0.5°C. Increased minimum streamflows on the order of 200 cfs are anticipated to be required through the ongoing relicensing of the Poe Project. Flows in excess of this range are anticipated to have serious adverse effects on amphibians. Additionally, increased magnitude water releases will have adverse impacts on power generation. The minor level of water temperature benefits for flow increases beyond about 200 cfs is not commensurate with the corresponding adverse effects to amphibians and costs in the form of foregone power generation, leading to the conclusion that this alternative is not a reasonable water temperature control measure.

Alternative 13 – Re-operate and/or Reconfigure Bucks Creek Project to Provide Cooler Inflows to the NFFR. This alternative consists of re-operating and/or reconfiguring the Bucks Creek Project to reduce water temperatures in a short portion of the Rock Creek Reach. An evaluation was conducted and it was concluded that current configuration and operation of the Bucks Creek Project provides very favorable water temperature benefits to the NFFR and that any reconfiguration or re-operation would have little effect on reducing NFFR water temperatures but would have adverse impacts on power generation by this high-head peaking facility and on recreation use of Bucks Lake. The anticipated minor level of water temperature benefits for this alternative is not commensurate with the corresponding adverse effects and costs, leading to the conclusion that it is not a reasonable water temperature control measure.

Category 3 –Obtain Cold Water from Sources Other than Lake Almanor

Alternative 14 – Construct Mechanical Water Cooling Towers at Belden, Rock Creek, Cresta and Poe Dams. This alternative consists of constructing and operating mechanical water cooling towers at each of the four dams to cool incoming river water approximately 1°C and deliver it back to the NFFR immediately downstream of each dam. Even to achieve a modest 1°C water temperature reduction would require approximately 14 very large (50 feet long x 50 feet wide x 75 feet high) cooling towers at each dam. Adequate space to site the cooling towers does not exist at or in the immediate vicinity of each dam, leading to extremely challenging and costly construction. This alternative would also require a substantial amount of electric power to operate the cooling towers. The modest level of water temperature benefits for this alternative is not commensurate with the corresponding adverse effects and costs, leading to the conclusion that it is not a reasonable water temperature control measure.

Alternative 15 – Construct Mechanical Water Chillers at Belden, Rock Creek, Cresta and Poe Dams. This alternative consists of constructing and operating mechanical water chillers at each of the four dams to cool incoming river water approximately 1°C and deliver it back to the NFFR below each dam. Even to achieve a modest 1°C water temperature reduction would require six very large water chillers and three large cooling towers at each dam. Adequate space to site the chillers and cooling towers does not exist at or in the immediate vicinity of each dam, leading to extremely challenging and costly construction. This alternative would also require a substantial amount of electric power to operate the water chillers and the cooling towers. The modest level of water temperature benefits for this alternative is not commensurate with the corresponding adverse effects and costs, leading to the conclusion that it is not a reasonable water temperature control measure.

Alternative 16 – Construct Water Wells at Belden, Rock Creek, Cresta and Poe Dams. This alternative consists of drilling, constructing and operating large water wells along the NFFR to deliver cooler well water to the river below each dam. The cooling requirement would require numerous very productive cold water wells at each dam. This alternative is not viable, as existing geologic information and well driller's data demonstrate that it is not likely that an adequate aquifer exists near the dams, leading to the conclusion that it is not a reasonable water temperature control measure.

Alternative 17 – Construct a Water Pipeline and Pumping Stations to Pump Cool Water from Lake Oroville for Release to the NFFR at Belden, Rock Creek, Cresta and Poe Dams. This alternative consists of constructing and operating about 40 miles of very large diameter water pipeline and pumping stations on the NFFR to deliver cooler water from the depths of Lake Oroville to the NFFR at each dam. This alternative would cool incoming river water approximately 3°C below each dam. The cooling requirement would require a very large diameter pipeline, numerous large pumping stations, and a substantial amount of electric power to operate the pumping stations. No feasible pipeline route exists. This alternative is not viable as the construction of a large water transport pipeline would be a major engineering and construction task with significant construction costs, environmental impacts, and risks. The level of water temperature benefits for this alternative is not commensurate with the corresponding adverse effects and costs, leading to the conclusion that it is not a reasonable water temperature control measure.

Alternative 18 – Construct a New Dam and Water Pipeline on Upper NFFR to Cool the Belden Reach. This alternative consists of constructing and operating a new diversion dam and about 1 mile of 4-foot diameter water pipeline on the Upper NFFR above Caribou Powerhouse to deliver cooler water to the NFFR immediately below Belden Dam. This alternative would cool incoming water approximately 2.5°C below Belden Dam. However, this alternative is not viable as there is no feasible pipeline route that does not have significant construction costs and major adverse impacts on Caribou Powerhouse and the Caribou road. The level of water temperature benefits for this alternative is not commensurate with the corresponding adverse effects and costs, leading to the conclusion that it is not a reasonable water temperature control measure.

Alternative 19 – Construct a New Dam and Water Pipeline on Yellow Creek to Cool the Rock Creek Reach. This alternative consists of constructing and operating a new diversion dam and about 3 miles of 3-foot diameter water pipeline on Yellow Creek above Belden Powerhouse to deliver cooler water to the NFFR immediately below Rock Creek Dam. This alternative would cool incoming river water approximately 1.2°C below Rock Creek Dam. However, this alternative is not viable as there is no feasible pipeline route that does not have significant construction costs and major adverse impacts on Highway 70. The level of water temperature benefits for this alternative is not commensurate with the corresponding adverse effects and costs, leading to the conclusion that it is not a reasonable water temperature control measure.

Alternative 20 – Construct a New Diversion Structure and Water Pipeline at Bucks Creek Powerhouse to Cool the Cresta Reach. This alternative consists of constructing and operating a new diversion structure in the NFFR at Bucks Powerhouse tailrace outlet and about 4 miles of 4-foot diameter water pipeline to deliver cooler water to the NFFR immediately below Cresta Dam. This alternative would cool incoming river water approximately 1.2°C below Cresta Dam. However, this alternative is not viable as there is no feasible pipeline route that does not have significant construction costs and major adverse impacts on Bucks Creek and Rock Creek Powerhouses and Highway 70. The level of water temperature benefits for this alternative is not commensurate with the corresponding adverse effects and costs, leading to the conclusion that it is not a reasonable water temperature control measure.

Alternative 21 – Construct a New Large Dam and Reservoir on Yellow Creek and/or the East Branch Feather River to Collect and Deliver Seasonally Cooler Water to NFFR. This alternative consists of constructing and operating a new large dam and reservoir on Yellow Creek and/or the East Branch Feather River or its tributaries to store cool water for later release to Yellow Creek and/or the East Branch. Both Yellow Creek and the East Branch flow into the NFFR upstream of the Rock Creek, Cresta, and Poe reaches. A new dam would need to be over 100 feet high to have sufficient water depth and volume to produce a large quantity of stratified cold water. Three potential sites were evaluated for a new dam and reservoir. However, given the very long travel distance (30 to 40 river miles) and significant warming effect of the East Branch Feather

River, cold water released from a new dam is not expected to result in any measurable water temperature changes at the Rock Creek, Cresta and Poe reaches. Also, it is anticipated that any new dam and reservoir would have significant adverse environmental impacts and very large costs. The level of water temperature benefits for this alternative is not commensurate with the corresponding adverse effects and costs, leading to the conclusion that it is not a reasonable water temperature control measure.

Alternative 22 – Enlarge an Existing Dam and Reservoir on the East Branch Feather River to Collect and Deliver Seasonally Cooler Water to NFFR. This alternative consists of enlarging and operating an existing dam and reservoir on the East Branch Feather River or its tributaries to provide a large amount of thermally stratified cold water for later release to the East Branch. The East Branch flows into the NFFR upstream of the Rock Creek, Cresta, and Poe reaches. An enlarged dam would need to be over 100 feet high to have sufficient depth and volume to produce a large quantity of stratified cold water. Potential enlargement of the existing Round Valley Dam and Reservoir was evaluated as the most promising dam for this alternative. However, the evaluation concluded the annual runoff for the Round Valley basin is not large enough to produce the water volume needed to fill an enlarged reservoir. This finding combined with the other adverse effects and costs identified in Alternative 21 lead to the conclusion that enlargement of an existing dam is not a reasonable water temperature control measure.

Alternative 23 – Plant and Manage Riparian Vegetation to Improve River Shading on East Branch Feather River. This alternative consists of performing streamside vegetation management and planting on the East Branch Feather River and its tributaries to promote shading and reduce water temperatures in the East Branch Feather River. The East Branch flows into the NFFR upstream of the Rock Creek, Cresta, and Poe reaches. Any water temperature benefits of streamside vegetation management on the East Branch Feather River and its tributaries would be subject to the long travel distance (30 to 40 river miles) and the significant warming effect of the East Branch Feather River. Because of this warming effect, analysis indicates that vegetation management would not be expected to result in measurable water temperature change in the Rock Creek, Cresta, and Poe reaches, leading to the conclusion that it is not a reasonable water temperature control measure.

Alternative 24 – Construct a Water Pipeline from the Existing Poe Tunnel Adit to Transport Cool Water to a Portion of the Poe Reach. This alternative consists of constructing and operating a pressurized, 2-foot diameter water pipeline to transport cool Poe Tunnel water from Poe Tunnel Adit #1 to the NFFR near Bardees Bar, located approximately 4.5 river miles below Poe Dam. This alternative would provide minor water temperature benefits to less than half the length of the Poe Reach and would have substantial construction costs and adverse impacts on power generation. For this alternative, the level of water temperature benefits is not commensurate with the cost, leading to the conclusion that it is not a reasonable water temperature control measure.

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PART 2

1 INTRODUCTION

1.1 Purpose of Report

This report has been prepared to satisfy two objectives. The first objective pertains to License Condition 4D of the Rock Creek-Cresta Project (FERC Project No. 1962), which specifies that within five years of the date when the Commission approves the water temperature monitoring plan required by Condition 4C, Licensee shall prepare a report that evaluates whether mean daily water temperatures of 20°C or less have been or will be achieved in the Rock Creek and Cresta reaches, and if not, whether additional reasonable water temperature control measures are available. Condition 4D also specifies that the report shall include recommendations for the implementation of any such measures, specifically factoring in economic considerations in the assessment of whether additional water temperature control measures are reasonable (PG&E 2001). The second objective is to provide a document that summarizes and consolidates all of the available information and studies pertaining to water temperatures that have been produced in the course of relicensing the Rock Creek-Cresta Project and in Licensee's other two ongoing relicensing proceedings on the North Fork Feather River (NFFR), the Upper NFFR Project (FERC Project No. 2105) and the Poe Project (FERC Project No. 2107). This information can then be used by participants in the Upper NFFR and Poe relicensing proceedings as well the Rock Creek Cresta Ecological Resources Committee (ERC) and resource agencies of jurisdiction for implementing the Rock Creek Cresta Project license to evaluate project impacts and make informed resource management decisions.

1.2 Report Organization

This report is organized into three parts, targeted at the needs of different readers. The first part consists of an Executive Summary and Overview of Potential Water Temperature Control Alternatives. This part is intended to meet the needs of a policy level reader or a reader who wants a general overview of the report and its findings. The second part consists of the detailed report, with a more comprehensive presentation of the background for the report, the studies performed, potential alternatives considered, and conclusions. This second part is intended to meet the needs of active participants in the Rock Creek-Cresta ERC and the Upper NFFR and Poe relicensing proceedings. The third part of the report consists of a listing of references, including detailed study results, used in preparation of the report. This part is intended to meet the needs of technical experts who need to review original study data. Many of the referenced documents have already been provided to the participating technical experts through other filings. Licensee will provide additional copies of the referenced documents upon reasonable request.

1.3 Summary of Water Use on the NFFR

Licensee's NFFR Projects (Upper NFFR Project [FERC Project No. 2105], Rock Creek-Cresta Project [FERC Project No. 1962], Poe Project [FERC Project No. 2107], and Bucks Creek Project [FERC Project No. 619], and non-licensed Hamilton Branch Project) are located on the NFFR watershed in northeastern California. They encompass approximately 48 river miles of the NFFR with approximately 20.5 river miles in the Upper NFFR, 18.1 river miles in the Rock Creek and Cresta reaches of the NFFR, and approximately 9.3 river miles in the Poe Reach in the lower NFFR (including forebays) (PG&E 2002, 2003a, 2004a).

The NFFR is part of the greater Sacramento River watershed and drains a large portion of the eastern Sierra-Cascade geomorphic area in California. The NFFR watershed extends from its headwater area originating on the southeastern slope of Mount Lassen to Lake Oroville, traversing lands in Lassen, Plumas, and Butte counties. The main stem of the Feather River is formed downstream of Lake Oroville; the North, Middle, and South forks of the Feather River are impounded behind Oroville Dam, which was completed in 1967.

The Department of Water Resources' (DWR) Lake Oroville receives inflow from the NFFR. As part of the Central Valley Project, Lake Oroville is the major storage facility on the Feather River, providing power generation, flood control, irrigation diversions, recreation, and fish and wildlife habitat. As a major tributary to the Sacramento River, the Feather River contributes to supporting the water supply needs of much of northern and southern California (PG&E 2002).

Upstream of the Upper NFFR Project (FERC Project No. 2105), Licensee operates the non-licensed Hamilton Branch Project. This project includes a small powerhouse on the eastern shore of Lake Almanor and uses water taken from Mountain Meadows Reservoir (PG&E 2002). Licensee's Upper NFFR Project (FERC Project No. 2105) is located in Plumas County and consists of a series of major hydroelectric facilities including Butt Valley, Caribou No. 1, Caribou No. 2, Oak Flat, and Belden powerhouses (PG&E 2002).

The primary storage reservoir on the NFFR is Lake Almanor, about 20 miles upstream of the Rock Creek-Cresta Project and 90 miles upstream of the city of Oroville. Lake Almanor was created in 1913 by the construction of a hydraulic fill dam, Canyon Dam, and has a normal maximum water surface elevation of 4,504 feet (United States Geological Survey [USGS] datum) and a storage capacity of 1,142,000 acre-feet. Major tributaries feeding the lake are the NFFR (which accounts for approximately half the annual inflow), the Hamilton Branch of the NFFR (which provides 20 to 25% of the annual inflow), and a number of minor tributaries including Benner, Last Chance, and Bailey creeks. In addition, there are numerous submerged springs that feed into Lake Almanor. Major lake outlets include the Canyon Dam Outlet, which releases water to the NFFR downstream of Lake Almanor, and the Prattville Intake, which is the source of water for the Butt Valley Powerhouse and the principal source of inflow for the Butt Valley Reservoir. The average water residence time in Lake Almanor is approximately 291 days.

The Canyon Dam Outlet releases a minimum of 35 cfs, in accordance with License Article 26 of FERC Project No. 2105 (Upper NFFR Project), to provide for the sustenance of aquatic life in the upper NFFR. Canyon Dam Outlet consists of two gate configurations, mid-level gates, and low-level gates. The invert of the two upper gates at the Canyon Dam Outlet is located at elevation 4,477 feet (USGS datum). The other three outlet gates are located at elevation 4,432 feet (USGS datum).

Releases from the Prattville Intake to Butt Valley Reservoir make up the greatest portion of water released from Lake Almanor, generally up to 1,792 cfs, but as great as 2,200 cfs

(Woodward Clyde Consultants [WCC] 1986, PG&E 2002). The invert of Prattville Intake is located at elevation 4,420 feet (USGS datum) on the bottom of a narrow 40-foot deep steep-sided trough that connects the relatively shallow cove location of the intake with deeper areas of the reservoir (WCC 1986). Access to the deeper areas of Lake Almanor is restricted by the shallow approach channel that has a base elevation of 4,432 feet (USGS datum). Thus, the water withdrawn by Prattville Intake is primarily from the warmer layers in the lake due to the restriction of the approach channel (PG&E 2002, 2003c, 2004a, 2005b). Studies conducted by CDFG (1982–1985), DWR (1974), and Licensee (1984) indicate that the water temperature withdrawn by Prattville Intake is related to lake water surface elevation and meteorological conditions (WCC 1986).

Butt Valley Reservoir was created in 1924 and has a usable storage of 49,897 acre-feet. Water surface elevations fluctuate by about 10 to 15 feet from the maximum water surface elevation of 4,142 feet (USGS datum) on an annual basis (PG&E 2003c, 2004a, 2005b). The reservoir serves as the afterbay to Butt Valley Powerhouse and the forebay for the Caribou No.1 and No. 2 powerhouses. Some additional flow enters Butt Valley Reservoir through Butt Creek below Lake Almanor and possibly through seepage. Water is released to the two Caribou powerhouses through two separate intake structures. The Caribou No. 1 Intake is located at an invert elevation of 4,077 feet (USGS datum) in Butt Valley Reservoir and releases up to 1,100 cfs (PG&E 2002). The actual Caribou No. 1 Intake structure is located in a small depression zone. Recent bathymetric surveys (from April 1996) indicated that the main approach channel has an elevation of 4,095 feet (USGS datum) (PG&E 2003c, 2004a, 2005b). The Caribou No. 2 intake is located in a shallow cove area with an entrance elevation of 4,110 feet (USGS datum) and normally releases up to 1,460 cfs to the Caribou No. 2 Powerhouse. Both Caribou No. 1 and No. 2 powerhouses discharge to the Belden Reservoir located in the NFFR approximately 10 river miles downstream of Canyon Dam Outlet.

Belden Reservoir was created by a rock-filled dam in 1958, and has a maximum water surface elevation of 2,985 feet (USGS datum) and a theoretical usable storage capacity of 2,477 acre-feet. Under normal operation, the water surface elevation fluctuates between 2,960 and 2,973 feet, depending on power operations. The average water residence time in Belden Reservoir is estimated at approximately 0.5 to 1.0 days. The principal sources of inflow to this small reservoir are the Caribou No. 1 and No. 2 powerhouses which have average annual flow rates of 615 and 674 cfs, respectively. Additional inflow is received from the Seneca Reach of the NFFR; the average annual inflow from this source is approximately 120 cfs. An intake structure located near the downstream end of the reservoir can release up to 2,610 cfs to the Belden Powerhouse located on Yellow Creek, located immediately upstream of the confluence of Yellow Creek with the NFFR. Under the terms of the license for FERC Project No. 2105 (Upper NFFR Project) and the CDFG agreement, Licensee has a minimum streamflow requirement of 140 cfs to the NFFR downstream of Belden Dam during the fishing season (generally the May through September period) for the purpose of maintaining fish and wildlife in the NFFR; and 60 cfs during the rest of the year. Prior to July 1985, releases from the Belden Reservoir to the NFFR immediately downstream of the Belden Dam were made from the dam's low level outlet or its spillway. During summer 1985, construction of the Oak Flat Powerhouse immediately downstream of Belden Dam had proceeded sufficiently to allow releases through the powerhouse to the NFFR. The penstock for Oak Flat Powerhouse is connected to the former low level outlet.

Downstream of the Upper NFFR Project (FERC Project No. 2105), Licensee operates the Rock Creek-Cresta Project (FERC Project No. 1962) and Poe Project (FERC Project No. 2107) on the lower NFFR. Water released from Belden Powerhouse and other sources of inflow enter Rock Creek Reservoir downstream of Yellow Creek. The additional inflows include the NFFR downstream of Belden Dam, Mosquito Creek, the East Branch NFFR (EBNFFR), Chips Creek, and other smaller tributaries. Rock Creek Reservoir was formed with the construction of Rock Creek Dam in 1950. The reservoir has a maximum water surface elevation of 2,216 feet. Rock Creek Reservoir's original operating capacity of 4,400 acre-feet has been reduced by greater than 50% by sediment accumulation in the 1980s. Under the terms of the FERC Project No. 1962 license (Rock Creek-Cresta Project), there are three five-year minimum streamflow periods specified for the various environmental conditions (normal/wet, dry, and critically dry). Currently, 250 cfs in the spring and 180 cfs in the summer and fall is the minimum streamflow requirement to the NFFR downstream of Rock Creek Dam for "normal/wet" years (as part of the first five-year flow period). Rock Creek Reservoir water is generally well mixed throughout its length, with little water temperature variation occurring through the length of the reservoir. Rock Creek Reservoir water is characterized as having a residence time of several hours.

The Rock Creek Reach is an 8.4-mile section of the NFFR extending from Rock Creek Dam to the tailrace of Rock Creek Powerhouse. Tributaries to the Rock Creek Reach of the NFFR include Milk Ranch Creek, Chambers Creek, and Bucks Creek. Rock Creek Powerhouse discharges water into the Cresta Reservoir; other upstream sources of inflow into the Cresta Reservoir include the NFFR downstream of Rock Creek Dam, tributary inflows to the NFFR from Chambers, Jackass, and Bucks creeks and other smaller tributaries, and Rock Creek. Bucks Creek Powerhouse normally contributes up to 350 cfs to Cresta Reservoir, but can be operated to a maximum capacity of 375 cfs.

Cresta Reservoir was formed in 1949 with the construction of Cresta Dam and had an original storage capacity of 4,045 acre-feet at a normal maximum water surface elevation of 1,681 feet (USGS datum). The capacity of the Cresta Reservoir has also been decreased by sedimentation. A maximum of 3,560 cfs can be released from Cresta Reservoir through the tunnel and two parallel penstocks to the Cresta Powerhouse. Cresta Reservoir is generally well mixed vertically, with small vertical water temperature differences found primarily near the surface, which are indicative of localized heating in the upper part of the water column. Cresta Reservoir water is characterized as having a residence time of several hours. The Cresta Reach is a 4.9-mile section of the NFFR extending from Cresta Dam to the tailrace of Cresta Powerhouse. Under the terms of the FERC Project No. 1962 License (Rock Creek-Cresta Project), Licensee must release sufficient water to meet a minimum flow level now in the NFFR downstream of Grizzly Creek (and Cresta Dam). The monthly flow level varies from a high of 250 cfs in the spring of normal and wet years to a low of 220 cfs in the winter and spring. Minimum flow levels in both Rock Creek and Cresta reaches will increase in 2007 according to the second five-year requirements.

The Poe Project (FERC Project No. 2107) is located on the NFFR near Pulga in Butte County. The Poe Project uses water that is diverted from the NFFR at Poe Reservoir and transported through a tunnel and underground penstock to Poe Powerhouse (PG&E 2003a). The Poe Reach of the NFFR, which extends between Poe Dam and Poe Powerhouse, has a lower gradient than the upper portions of the NFFR. The Poe Reach is 7.6 miles in length, with a change in elevation of approximately 500 feet (PG&E 2003a). Poe Reservoir (formed in 1958 by the construction of Poe Dam) functions primarily as a regulating forebay for hydroelectric operations (PG&E 2003a).

Inflows into Poe Reservoir include flow originating upstream in the NFFR from Cresta Dam, Grizzly Creek, minor tributaries (Camp, Dogwood, and Heinz creeks), which are representative of a small fraction of the total flow into the Poe Project, and from Cresta Powerhouse. Poe Reservoir is long and narrow and has a maximum surface area of approximately 53 acres and a gross holding capacity of 1,203 acre-feet and the hydrologic characteristics of the reservoir are essentially run of the river. The average residence time of water in the reservoir is short (estimated at 0.3 days [7 hours]) (PG&E 2003a). Up to 4,200 cfs can be diverted through 6.22 miles of tunnel to the Poe Powerhouse. Under the terms of FERC Project No. 2107 license, a minimum of 25 cfs must be released to the NFFR downstream of Poe Dam, and the release must be sufficient to maintain 50 cfs as measured at gage NF23 near Pulga. Water released from the Poe Powerhouse along with flow released from Poe Dam and minor tributaries travels approximately eight river miles from the Poe Powerhouse to the confluence of Berry Creek in Oroville Reservoir.

The Bucks Creek Project (FERC Project No. 619) is operated by Licensee on Bucks Creek, a major tributary of the lower NFFR. Bucks Lake is the largest of the Bucks Creek Project reservoirs and has a maximum capacity of 105,300 acre-feet. Water is collected into the man-made reservoir through Bucks Creek, Mill Creek, Middle Fork Mill Creek, Right Hand Branch Mill Creek, and Haskins Creek, and is discharged through the dam into Lower Bucks Lake. Lower Bucks Lake has a maximum capacity of 5,800 acre-feet and receives water from Bucks Lake and the Milk Ranch Conduit. The Milk Ranch Conduit diverts water from Three Lakes (the smallest of the reservoirs with a maximum capacity of 606 acre-feet) and nine smaller tributaries between Three Lakes and Lower Bucks Lake into Lower Bucks Lake. Additionally, Grizzly Powerhouse, which is owned by the City of Santa Clara, is dispatched by Licensee in coordination with the Bucks Creek Project. Water is diverted from Lower Bucks Lake through the Grizzly Powerhouse Intake Tunnel to Grizzly Powerhouse and a minimum release of 3 cfs in the summer and 1 cfs in the winter is maintained through the dam at Lower Bucks Lake into Bucks Creek to sustain aquatic life below the Project reservoirs. Water that is diverted through the Grizzly Powerhouse is collected in Grizzly Forebay, which has a maximum capacity of 1,100 acre-feet. Water is diverted from Grizzly Forebay through twin penstocks approximately 4,780 feet to Bucks Creek Powerhouse. A minimum release of 4 cfs in the summer and 2 cfs in the winter is maintained through the dam at Grizzly Forebay into Grizzly Creek to sustain aquatic life from the forebay to the confluence with the NFFR (PG&E 1997).

1.4 Summary of Water Temperature Studies on the NFFR

1.4.1 Water Temperature Studies Prior to Year 2000

In July 1980 as part of the Rock Creek-Cresta Project relicensing, Licensee funded CDFG to conduct a six-year study (1981–1986) (CDFG 1988) of the fishery in the NFFR Project's stream sections and reservoirs, under different flow releases, to determine means to protect the fishery resources and suggest mitigation if necessary (CDFG 1988). The primary water temperature-related objectives of the study determined if cold water was available for downstream distribution from selected reservoirs; documented the current water temperature conditions in various sections of the NFFR; and determined the feasibility of obtaining colder water released from upstream reservoirs and the impact of the colder water upon the sections of the NFFR (CDFG 1988).

In conjunction with Licensee's amended application for new license for the Rock Creek-Cresta Project (FERC Project No. 1962) in May 1985, Licensee contracted with WCC as part of the ongoing CDFG study effort to perform a cold water feasibility study (WCC 1986, 1987).

As part of the feasibility study, reservoir and stream water temperature models were developed to predict the effects of Project improvements and altered operations on water temperatures within the Project. A one-dimensional numerical model (*MITEMP*) was used in conjunction with the collection of field data to make the assessment. The field studies consisted of collecting synoptic water temperature data, meteorological data, hydrological data, data on hydraulic characteristics of intakes and water bodies, operations data, and an analysis of historical data. The objectives of the study were to 1) characterize the reservoir elevations drawn upon by the Prattville Intake and Caribou No. 1 and No. 2 intakes; 2) characterize the volume of cold water present in Lake Almanor and Butt Valley Reservoir in the vicinity of the intake structures; and 3) determine what downstream water temperatures could be expected in the NFFR from the Belden Reservoir to the confluence of the Poe Powerhouse tailrace with the NFFR if cooler water were released throughout the system.

During the 1985 feasibility study, an initial analysis of a skimmer wall (thermal curtain) intake concept in Lake Almanor was performed to evaluate the possibility of providing colder outflow water temperatures than the existing intake. The evaluation was conducted using the 1985 (hot, dry year, and very low water surface in Lake Almanor) field data. The results suggested that the skimmer wall (thermal curtain) may provide approximately 3°C colder water from Lake Almanor at Prattville Intake and that greater water temperature reductions may be obtained from alternative intake scenarios during more extreme years (WCC 1986).

In 1994, the U.S. Bureau of Reclamation (BOR) performed a physical model study as part of the design to verify the skimmer (thermal curtain) concept (BOR 1995). Four alternatives were tested at an undistorted hydraulic model (scale 1:40), including two skimmer walls (thermal curtain), a hooded-pipe inlet, and an excavated channel. However, due to a number of limitations in the model set-up and procedures, no definite conclusion was achieved in the study results.

1.4.2 Water Temperature Studies Year 2000 to 2005

During 1999, 2000, and 2003 Licensee performed various water quality and water temperature monitoring studies as part of the Poe Project (FERC Project No. 2107) relicensing. Data were collected from the Poe Reach of the NFFR and were used to further test and fine-tune the *WCC-SNTEMP* model (Stream Network Water Temperature Model [Theruer, et al. 1984]) (PG&E 2003a). The *PG&E-WCC-SNTEMP* model was used to simulate water temperatures in the Poe Reach under various flow management scenarios to determine the benefit of increased magnitude water releases at Poe Dam to cool Poe Reach (PG&E 2003a). Additional information regarding this study can be found in Alternative 12 of this document.

During 2000 and 2001 Licensee performed various water quality and water temperature monitoring studies in Lake Almanor and Butt Valley and in the Seneca and Belden reaches of the NFFR as part of the Upper NFFR Project (FERC Project No. 2105) relicensing (PG&E 2002). The data were used to further test and fine-tune the one-dimensional water temperature model (*MITEMP*) developed by WCC (Bechtel 2002). In addition, to better understand the dissolved oxygen (DO) concentration patterns in Lake Almanor and the potential effects of a thermal curtain, a water quality model was developed for Lake Almanor. The *CE-QUAL-W2* reservoir water quality model was used to simulate water quality conditions in Lake Almanor. A summary of the results of this model study are presented in Section 4.2.

During 2002–2004, Licensee performed various water quality and water temperature monitoring studies in Lake Almanor, Butt Valley, Seneca Reach, Belden Reach, Rock Creek Reach, and Cresta Reach of the NFFR as part of the Rock Creek-Cresta Project (FERC Project No. 1962) (License Condition 4C, FERC Project No. 1962 License). The data that were collected were used to further test and fine-tune the *WCC-SNTEMP* model. As part of the most recent Rock Creek-Cresta Project effort (FERC Project No. 1962), the 1986 *WCC-SNTEMP* water temperature models were revised and updated. As part of the updating process, data collected in 2002 were incorporated into the existing models to extend the model to include Rock Creek Reservoir (PG&E 2003c). The results of this modeling analysis were presented in *Revised Water Temperature Modeling for the Rock Creek-Cresta Hydroelectric Project – FERC Project No. 1962* (PG&E 2003c, TRPA 2003). Additional information regarding this study can be found in Alternatives 10 and 11 of this document.

In 2003–2004, Licensee contracted with Iowa Institute of Hydraulic Research (IIHR) to study means of modifying the Prattville Intake to enable selective withdrawal of colder water from beneath the epilimnion layer (IIHR 2004). Additional information is provided in Section 3.1 of this document.

Recent study efforts have also included the Prattville modifications physical and numerical modeling efforts (IIHR 2004), 33 years of synthesized reservoir operations, and the Butt Valley re-operation and increased magnitude of Seneca Reach release flow option study (Bechtel and TRPA 2005).

Thirty-three years of synthesized reservoir operations have been summarized in the report prepared by Bechtel and TRPA (2005). The principal objective of the analyses presented in the report is to estimate the instream flow water temperatures for the NFFR for conditions with and without a water temperature control thermal curtain(s) in Lake Almanor, and Butt Valley Reservoir. Effects of blending the outflows from Canyon Dam Outlet are also considered. Inflows for the analyses were based on 33-years of re-regulated flows developed in accordance with recent settlement agreements and provided by PG&E (2004d). Additional information is presented in Section 2.3 and in Alternatives 3, 4, and 6 of this document.

In February–April 2005, Licensee initiated a series of modeling study investigation options of re-operating Butt Valley and Caribou powerhouses combined with increased magnitude water releases at Canyon Dam Outlet. Six model series were simulated for Lake Almanor and Butt Valley Reservoir, respectively (Bechtel and TRPA 2005). Additional information is presented in Alternative 6 of this document.

2 WATER TEMPERATURE MONITORING PROGRAM

This section includes a discussion of current Rock Creek-Cresta Project (FERC Project No. 1962) license water temperature monitoring requirements, a discussion of the water temperature conditions in the NFFR under existing upstream conditions for both pre- and post new license studies in the NFFR as related to the 20°C goal; and a discussion of the use of the water temperature monitoring data for modeling purposes.

2.1 Current Project 1962 License Monitoring Requirements

Pursuant to Condition 4C of the FERC Project No. 1962 License (issued October 24, 2001), water temperature monitoring is required on the Rock Creek and Cresta reaches of the NFFR during the summer months (mid-June to mid-September) to determine if and to what extent the 20°C daily average water temperature goal can be met with reasonable control measures (PG&E 2004b).

The Rock Creek-Cresta Project License (FERC Project No. 1962) required Licensee to file a water temperature monitoring plan with FERC, which described the implementation (including a schedule for implementation) of the water temperature monitoring program described in Condition 4C of the new Project License. The Rock Creek-Cresta water temperature monitoring plan was prepared in consultation with the Rock Creek-Cresta ERC and the Forest Service (FS) and filed with FERC on October 24, 2002. FERC's February 28, 2003 order approved the Plan; however, monitoring commenced in June 2002.

Results of 2002 monitoring data were provided in a report submitted to FERC in May 2003 (PG&E 2003c). Results of 2003 monitoring data were provided in the annual report submitted to FERC in May 2004 (PG&E 2004b). Results of 2004 monitoring data were provided in the annual report submitted to FERC in May 2005 (PG&E 2005c).

Additionally, by FERC order (FERC Project No. 1962-058, September 11, 2003), FERC approved a list of operation and compliance plans to address procedures and criteria for the adjustment of flow releases in critically dry years to maintain cold water temperatures. Although 2003 was not a critically dry year, Licensee completed one of the specific water temperature control actions that involved switching operation to Caribou No. 1 Powerhouse instead of Caribou No. 2 Powerhouse. The results of an evaluation of the special Caribou Powerhouse selective use test were included in the annual report submitted in May 2004.

The objectives of the approved water temperature monitoring program are to:

1. Document summer water temperatures and flows in the Rock Creek and Cresta reaches as well as in upstream areas tributary to the Project.

2. Install and monitor continuous water temperatures at two telemetry stations installed at two flow gaging stations in the Rock Creek and Cresta reaches.

3. Determine if mean daily water temperatures of 20°C or less can be met in the Rock Creek and Cresta reaches to the extent that Licensee can reasonably control such water temperatures, particularly if a modified Prattville Intake is implemented.

4. Develop and verify a water temperature model that predicts, with reasonable accuracy, the water temperature profile of the river based on data from two telemetered water temperature stations.

2.2 Water Temperature Conditions in the NFFR

NFFR water temperatures in the Rock Creek and Cresta reaches reflect a combination of temperatures of the water delivered from the Upper NFFR Project (FERC Project No. 2105) upstream, flows from the unregulated EBNFFR and other tributaries, the minimum flows of the Rock Creek-Cresta Project (FERC Project No. 1962), and flow delivered from Bucks Creek Project (FERC Project No. 619). The water temperatures from the Upper NFFR Project (FERC Project No. 2105) are primarily determined by water temperature conditions at the non-selective Prattville Intake in Lake Almanor.

2.2.1 Pre-New Rock Creek-Cresta License

Previous to the requirements of the new Rock Creek-Cresta Project License (FERC Project No. 1962), water temperature conditions in the NFFR can be assessed by examining the data provided by WCC in 1986 (WCC 1986). Visual estimations were conducted by drawing a line across the 20°C level shown in the corresponding figures of the WCC 1986 report and making a visual estimation of the number of data points that fell above the line during July and August.

Visual estimation of the data for 1985 (considered a hot year with low water surface in Lake Almanor) provided by WCC indicates that approximately 40–50% of the time during July and August, the mean daily water temperatures were above the 20°C goal in the Butt Valley Powerhouse Tailrace (WCC 1986, Figure 3.1-23). This percentage increases below Belden Dam to approximately 70% (WCC 1986, Figure 3.1-54). The EBNFFR provided water that was above the 20°C goal nearly 100% of the time during 1985 (WCC 1986, Figure 3.1-59).

Water temperatures were above the 20°C goal approximately 75% of the time during July and August 1985 in the NFFR below Rock Creek Dam (WCC 1986, Figure 3.1-73). The percentage drops to approximately 30% in the NFFR above Rock Creek Powerhouse, primarily due to colder Bucks Creek Powerhouse inflows in this part of the Rock Creek Reach (WCC 1986, Figure 3.1-79). Approximately 50% of the time during July and August 1985 the mean water temperatures were above 20°C upstream of Cresta Powerhouse, the lowest station on the NFFR on the Cresta Reach (WCC 1986, Figure 3.1-88).

2.2.2 Post-New Rock Creek-Cresta License

Pursuant to the requirements of the Rock Creek-Cresta Project License (FERC Project No. 1962), Condition 4C, Licensee has collected three years of water temperature data (2002–2004) that show water temperatures in the NFFR during July and August (PG&E 2003b, 2004a, 2005b).

To facilitate evaluation of current results with previous year's data, a comparative summary of the data was presented in Table 3.8 of the FERC Project No. 1962 Water Temperature Monitoring of 2004 Data Report, FERC License Condition 4C (PG&E 2005c). The table summarizes average conditions measured during the July–August period from the three compliance monitoring years (2002–2004) and is reproduced in the Appendix A to this report.

Based on the definition outlined in the Rock Creek-Cresta Relicensing Settlement Agreement, the study years 2002, 2003, and 2004 can be classified as Dry, Normal, and Wet water year types (PG&E 2005c, Table 3-8).

Initial conditions in the Butt Valley Powerhouse Tailrace (BV1) indicate that the percent of daily average exceedance of the 20°C goal is not met approximately 85%, 15%, and 69% of the time during July and August of 2002, 2003, and 2004, respectively. Once the water has passed through Butt Valley Reservoir and below Belden Forebay in the NFFR below Belden Dam (NF-5), the daily average percent of exceedance of the 20°C goal decreases slightly for July and August in each of the three years respectively (61%, 23%, and 79%). As the water continues to travel down the NFFR below the confluence of the EBNFFR, the trend is for increasing daily average percent exceedances as shown at Station NF-8, NFFR at Belden Town Bridge. This may be primarily due to large number of days that exceed the 20°C goal in the EBNFFR (greater than 96% for all three years).

Continued warming of the water as it travels through the Rock Creek Reservoir contributes to increased daily average exceedance data from the beginning of Rock Creek Reach at Station NF-10 (NFFR below Rock Creek Dam near gage NF-57). However, daily average exceedance data from the end of Rock Creek Reach at Station NF-12 (NFFR above Bucks Creek Powerhouse) during July and August show that the goal of 20°C was not met 95%, 66%, and 97% of the time during 2002, 2003, and 2004, respectively. The Rock Creek Reach of the NFFR receives more cold water inflow from cold water tributaries (Bucks Creek Powerhouse) near the end of the reach. Thus, the percent of daily average exceedances of the 20°C goal were lower at the end of the Rock Creek Reach. However, after the water has traveled through Cresta Reservoir and the Cresta Reach, the data show that the temperature of the water has returned to the water temperatures measured above Bucks Creek Powerhouse (as shown by the percent of daily average exceedance data from Station NF-16 [NFFR upstream of Cresta Powerhouse] during July and August, the goal of 20°C was not met 95%, 50%, and 95% of the time during 2002, 2003, and 2004, respectively).

2.3 Use of the Data for Modeling Purposes

Licensee has developed and tested five instream water temperature models and two reservoir models using data from 1983–2003 from FERC licensed projects (Upper NFFR, Rock Creek-Cresta, and Poe).

Water temperature data collected were used to provide a fundamental understanding of water temperature characteristics in the NFFR; and establish a series of prediction tools. These prediction tools are capable of providing a comparative analysis to investigate the cumulative water temperature effect under a variety of alternatives relative to the existing condition(s). The study effort, including data coverage and modeling development and application, is designed on the watershed basis that covers an area from the headwater storage at Lake Almanor down to the very lowest NFFR location above Poe Powerhouse. The coverage encompasses three PG&E projects (FERC Project No. 2105, FERC Project No. 1962, and FERC Project No. 2107), two major reservoirs (Lake Almanor and Butt Valley Reservoir), and five NFFR stream reaches (Seneca, Belden, Rock Creek, Cresta, and Poe reaches).

Two types of mathematical models have been developed as prediction tools. The reservoir model, *MITEMP*, predicts the vertical water temperature stratification in the lake/reservoir (Bechtel 2002). *MITEMP* predicted water temperatures from outflows of the lake/reservoir (e.g., Canyon Dam Outlet, Prattville Intake or Butt Valley Powerhouse, and Caribou No. 1 and No. 2 powerhouses) are used in the instream water temperature model, *SNTEMP,* to predict downstream water temperatures in the NFFR (Theurer et al. 1984).

Calibration and validation of the models against multiple years of data indicate the accuracy of the model is within 0.5°C (on the 50% confidence level) for *SNTEMP* ([PG&E 2002], [Appendix B, FERC Project No. 1962 Annual Report, May 2003], [PG&E 2003a]) and about 1°C for *MITEMP* (Bechtel 2002, Bechtel and TRPA 2005). While the models have been calibrated under the existing Prattville Intake condition, calibration of the *MITEMP* model for conditions with the Prattville alternatives relied on results from the physical model studies of the Prattville Intake (Bechtel and TRPA 2005).

These models were used to determine the long-term water temperature effect for a variety of potential alternatives as compared to the existing upstream condition.

Inflow to the *MITEMP* model for Lake Almanor and Butt Valley Reservoir consisted of 33 years (1970–2002) of stream inflow and re-regulated outflow through Prattville Intake and the Canyon Dam Outlet (PG&E 2004a). Submerged spring flows in Lake Almanor were assumed as 430 cfs in normal years and 375 cfs in dry years. Meteorological data were synthesized based on long-term data at three weather stations, Chester, Canyon Dam, and McArthur. Instream water flow releases follow all pertinent or the most recent relicensing settlement agreements or draft 4(e) condition for all project licenses (PG&E 2000, 2003a, 2004d). *MITEMP* predicts daily mean water temperatures beginning March 1 and ending September 30 for each of the 33 years. For each month, all of the 33 years of generated outflow water temperatures were analyzed statistically. Five statistical rankings (10%, 25%, 50%, 75%, and 90%) are used to bracket the water temperature variations. Each of the five statistical ranking defines one unique set of environmental condition. The 50% ranking (median value) coupled with normal hydrological and meteorological environment defines the most frequent condition; the 10% (and 25%) ranking combined with warm weather and dry hydrology environment defines "extreme" condition(s); while the 75% (and 90%) ranking together with cold/wet defines the other extreme(s).

3 ALTERNATIVE COLD WATER SOURCES

Pursuant to the Rock Creek-Cresta Relicensing Settlement Agreement (PG&E 2000), the ERC and FS have agreed to a post-license monitoring and modeling study to determine if structural modification of the existing Prattville Intake is feasible, and if these modifications can sustain water deliveries such that daily average water temperatures in the Rock Creek and Cresta reaches would be maintained at or below 20°C.

Licensee has identified and evaluated twenty-four potential water temperature control alternatives for achieving colder water for the NFFR. Twenty of the twenty-four alternatives have potential application to the Rock Creek and Cresta reaches. Two others (Alternatives 12 and 24) are targeted at reducing water temperatures in the downstream Poe Reach and the other two (Alternatives 9 and 18) are targeted at the upstream Belden Reach. The twenty-four potential alternatives are generally grouped into three main categories.

- Category 1. Obtain cold water from Lake Almanor through the use of thermal curtains or other means at the existing Prattville Intake structure located in Lake Almanor.
- Category 2. Obtain cold water from Lake Almanor by increasing the magnitude of seasonal water releases using the low-level gates in the existing Canyon Dam Outlet structure located in the lake and/or re-operation of Licensee's Upper NFFR, Rock Creek-Cresta, Poe, and Bucks Creek Projects.
- Category 3. Obtain cold water from sources other than Lake Almanor.

Much of the information provided in this section was previously submitted to FERC in Licensee's *Reply to FERC's December 17, 2004, Additional Information Request* for Project 2105 (PG&E 2005a).

3.1 Category 1. Obtain Cold Water from Lake Almanor Through the Use of Thermal Curtains or Other Means at the Existing Prattville Intake structure Located in Lake Almanor

Prattville Intake draws water from Lake Almanor, a storage reservoir that becomes thermally stratified during summer (mid-June to mid-September). For its normal operating outflow of 1,600 cfs, the intake presently draws water from the full depth of water in the lake, including the warm upper layer that develops in the lake during summer. Several intake modifications were identified as potentially enabling the intake to draw more cold water from deeper in the lake, thereby reducing the water temperature of the outflow releases: 1) a large thermal curtain placed around the intake; 2) a short submerged pipe (with hooded inlet) extending out from the intake; and 3) a long submerged pipe (with hooded inlet) extending from the intake out to the lakebed (BOR 1995, IIHR 2004).

An extensive hydraulic model study (IIHR 2004) was conducted to evaluate the anticipated effectiveness of the identified Prattville Intake modification control measures to draw more cold water from Lake Almanor. The hydraulic model encompassed a 3.1-mile x 1.9-mile area of Lake Almanor surrounding Prattville Intake. The model was calibrated, validated, and verified with both field data and two smaller scale "test boxes," and evaluated several modification alternatives, including; several thermal curtain arragements with different lengths and locations around the Prattville Intake, a long submerged pipe fitted with a hooded inlet, and a short submerged pipe fitted with a hooded inlet. Also tested in conjunction with these alternatives were dredged adjustments to the lake bathymetry in the vicinity of Prattville Intake. Test conditions included various flow releases, stratification levels and water surface elevations (PG&E 2004c).

The hydraulic model study provided detailed insight into the flow and water-mixing processes associated with operation of Prattville Intake in its present form. Additionally, the results led to recommended potential design modifications for Prattville Intake. The most effective set of modifications in producing a water temperature reduction benefit was a large thermal curtain placed around Prattville Intake, with minor bathymetric adjustments made in the vicinity of the intake. These modifications would enable Prattville Intake to release colder water from Lake Almanor during summer months than the intake in its present configuration can release (IIHR 2004).

3.1.1 Alternative 1. Install a Thermal Curtain at Existing Prattville Intake Located in Lake Almanor

This alternative consists of installing a thermal curtain in Lake Almanor at Prattville Intake to cause colder water to enter the intake for release to the NFFR. Six thermal curtains of different sizes and layouts were evaluated. Several preliminary hydraulic model tests were conducted to determine the optimal deployment position of a thermal curtain (IIHR 2004). The preliminary tests examined the geometric aspects of the thermal curtain configuration in the context of the plan layout and the thermal curtain bottom elevation. A series of screening tests examined the performances of six thermal curtain layouts placed at different locations around the modeled Prattville Intake and subjected to the August-condition water temperature profile and water surface elevation. The test result revealed that the various degrees of water temperature reductions at Butt Valley Powerhouse Tailrace (Prattville Intake), varying from 1 to 4.5°C from the existing condition (no thermal curtain case), can be achieved with different thermal curtain configurations. Thermal Curtain No. 4 and Thermal Curtain No. 5 produced the most pronounced water temperature reduction benefit. Thermal Curtain No. 5 produced the largest reduction (4.5°C) in water temperature of the outflow (total length is 4,000 feet). However, it was determined that practically the same effect obtained with Thermal Curtain No. 5 could be obtained with Thermal Curtain No. 4 (total length 2,770 feet) if some relatively minor bathymetric adjustment were made, notably the removal of levees in front of the thermal curtain. That information, with the results of the thermal curtain screening tests, led to the selection of Thermal Curtain No. 4 for further testing (e.g., Thermal Curtain No. 4 combined with some dredging, which is discussed in Alternative 3). Thermal Curtain No. 4 is a U-shaped 770-feet-wide curtain placed 900 feet offshore from the intake with its bottom elevation at 4,455 feet (USGS datum) and a total opening area of 5,280 square feet. Table 1 lists the summary of the outflow water temperatures at Butt Valley Powerhouse Tailrace from the various Prattville modifications. Thermal Curtain No. 4 alone will produce a water temperature reduction at Butt Valley Powerhouse Tailrace (Prattville Intake) from 3.4 to 4.4°C compared to the existing configuration. This alternative (Thermal Curtain No. 4) has been combined with other potential measures to improve its effectiveness and is described in Alternatives 3 and 4 below.

Table 1. Summary of Hydraulic-Model Data on Outflow Water temperatures, T_{out}, and Water temperature Reductions, ΔT_{out}, for 1,600 cfs Water Released from Prattville Intake

Prattville Intake Configuration	June		July		August	
	T_{out} (°C)	ΔT_{out} (°C)	T_{out} (°C)	ΔT_{out} (°C)	T_{out} (°C)	ΔT_{out} (°C)
Existing configuration	16.5	-	19.1	-	21.0	-
Thermal curtain added	12.2	4.3	14.7	4.4	17.6	3.4
Thermal curtain added with levees removed	12.0	4.5	13.1	6.0	15.8	5.2
Long pipe with hooded inlet	-	-	-	-	17.5	3.5
Short pipe with hooded inlet	-	-	-	-	18.0	3.0

3.1.2 Alternative 2. Install a Submerged Hooded Pipeline at Existing Prattville Intake Located in Lake Almanor

This alternative consists of installing a submerged hooded pipeline at Prattville Intake to cause colder water to enter the intake for release to the NFFR. In addition to the thermal curtain modification option, the hydraulic model also examined the performance of the intake modification by way of a submerged hooded pipe that extends out to the approach channel to tap additional cold water in Lake Almanor. This intake modification is called the hooded submerged pipe inlet alternative. Two configurations were considered: three short submerged hooded pipes about 250 feet out from the intake; and three long submerged hooded pipes about 800 feet from the intake (IIHR 2004). The submerged hooded pipes were 12 feet in diameter.

The long-hooded submerged pipe was placed along the incised channel with the location of its hooded inlet slightly beyond the location suggested for the thermal curtain. The performance of the long submerged pipe with hooded inlet (LSPHI) was tested for the following local bathymetry conditions: levees as they presently exist, levees removed, and incised channel blocked. The LSPHI performed best with the levees removed, but was not as effective in reducing the water temperature of the outflow as was the thermal curtain. For example, the LSPHI with the levees removed operated at the normal outflow rate for the August condition and reduced outflow water temperature at Butt Valley Powerhouse Tailrace (Prattville Intake) by about 3.5°C, whereas the Thermal Curtain No. 4 with levees removed reduced outflow water temperature by 5.2°C (IIHR 2004).

The short submerged pipe with hooded inlet did not cause the intake to release outflow at water temperatures as low as those obtained using the thermal curtain or the LSPHI alternatives.

Moreover, the depth of underwater excavation needed to locate the inlet posed construction concerns that would make the short submerged pipe with hooded inlet modification impractical. The concerns included the geotechnical stability of the side slopes of the lakebed ridges flanking the inlet. Also, use of the intake would be significantly interrupted during the excavation and construction of a barrier wall around the intake (IIHR 2004). The thermal curtain alternative was considered to be more effective and viable, and therefore, the submerged hooded pipeline was eliminated from consideration as a potential reasonable water temperature control measure.

3.1.3 Alternative 3. Dredge Existing Prattville Intake Area and Nearby Underwater Channel at Lake Almanor Exclusively or in Combination with Installation of a Thermal Curtain or Submerged Pipeline

This alternative consists of dredging of the Prattville Intake area and nearby underwater channel at Lake Almanor exclusively or in combination with installing a thermal curtain or submerged pipeline to cause colder water to enter the intake for release to the NFFR. Hydraulic model tests were conducted to compare and select the most effective and viable combination of dredging, submerged pipeline and thermal curtain.

Water Temperature at Butt Valley Powerhouse

Bathymetric field studies that Licensee conducted revealed that underwater levees exist in the Prattville Intake area. Physical modeling results indicated that removal of the levees substantially modified the flow field immediately outside the thermal curtain. Levee removal caused water near the lakebed to flow directly toward and through the thermal curtain opening. Consequently, the thermal curtain caused the intake to draw water more directly from lower elevations of the water column covering the region of the lakebed out in front of the thermal curtain (IIHR 2004).

According to the modeling data, Thermal Curtain No. 4 (a U-shaped 770-feet-wide thermal curtain placed 900 feet offshore from the intake) and the removal of portions of the levees bordering the submerged incised channel comprise the modification best enabling Prattville Intake to release colder water during June, July, and August. Alternative 3, the 770-feet-wide thermal curtain with levees removed reduced outflow water temperature at Butt Valley Powerhouse Tailrace (Prattville Intake) by 4.5, 6.0, and 5.2°C for the June, July, and August conditions, respectively (IIHR 2004).

Another prospective modification that was tested was the excavation of a region behind the thermal curtain and the region in approaching the thermal curtain. It was thought that further excavation might increase the amount of colder water drawn under the thermal curtain, and thereby enhance thermal curtain performance and further reduce outflow water temperature. In part, this thought was prompted by an interest in evaluating additional excavation work, besides levee removal, that might enhance thermal curtain performance (IIHR 2004).

Further hydraulic model testing showed that the additional excavation work did not significantly alter the performance of the thermal curtain. Moreover, further excavation adjustments of bathymetry behind the thermal curtain proved to have negligible effect on outflow water temperature. Included in the adjustments were exploratory tests to see how outflow water temperature would be influenced if the original approach channel adjacent to the current approach channel to the intake were blocked or in-filled using the soil excavated from the levees. Those exploratory tests revealed Prattville Intake withdrawal water temperature to be insensitive to bathymetry changes behind the thermal curtain. Once flow passed under the thermal curtain, it rose and mixed over much of the water column behind the thermal curtain before being drawn to the intake (IIHR 2004).

In summary, the alternative modifications tested—1) a long submerged pipe with hooded inlet; 2) a short submerged pipe with hooded inlet; and 3) sundry excavation and reshaping of the lakebed in the vicinity of Prattville Intake—enabled the modeled Prattville Intake to release colder water. However, none of these alternatives proved to be as effective as the modification comprising the thermal curtain and levee removal.

Water Temperature at Butt Valley Reservoir

As discussed in Section 2.3, prediction computer model tools were developed to determine the long-term water temperature effect for the best alternative associated with the thermal curtain (i.e., Thermal Curtain No. 4 combined with dredging of levees). The *MITEMP* model for Lake Almanor was applied for 33 years (1970–2002) of stream inflow and re-regulated outflow through Prattville Intake and the Canyon Dam Outlet (PG&E 2004a). *MITEMP* predicts daily mean water temperatures beginning March 1 and ending September 30 for each of the 33 years. For each month, all of the 33 years of generated outflow water temperatures were analyzed statistically. The exceedance distributions of the 33-year daily mean water temperatures at Butt Valley Powerhouse, with and without Alternative 3, are shown in Figures 1 and 2 for July and August, respectively. The horizontal scale of the figures shows the water temperature change given a fixed exceedance level, and the vertical scale delineates the change in occurrence for a given water temperature level. Compared to the existing Prattville Intake condition, the water temperatures at Butt Valley Powerhouse, based on the 50% exceedance level, are reduced by 3.8°C in July and 3.5°C in August using Alternative 3. From the vertical scale, Alternative 3 will also result in more frequent lower water temperature levels at Butt Valley Powerhouse. For instance, water temperatures from Butt Valley Powerhouse at a level equal to or less than 18°C would occur about 46% of the time for July under the existing Prattville condition, whereas the same water temperature level would occur more than 97% of the time under Alternative 3.

Warming occurs in the Butt Valley Reservoir with and without the Prattville thermal curtain. The *MITEMP* model for Butt Valley has been developed to determine such warming (Bechtel and TRPA 2005). Warming in Butt Valley Reservoir occurs naturally under the existing condition, varying from 0.9 to 3.3°C depending on the month and the exceedance levels (Curve A to Curve C in Figures 1 and 2). With Prattville thermal curtain installed, warming in Butt Valley Reservoir is more pronounced (Curve B to Curve D in Figures 1 and 2). Alternative 4 discusses additional measures to minimize Butt Valley Reservoir warming under the Prattville thermal curtain condition.

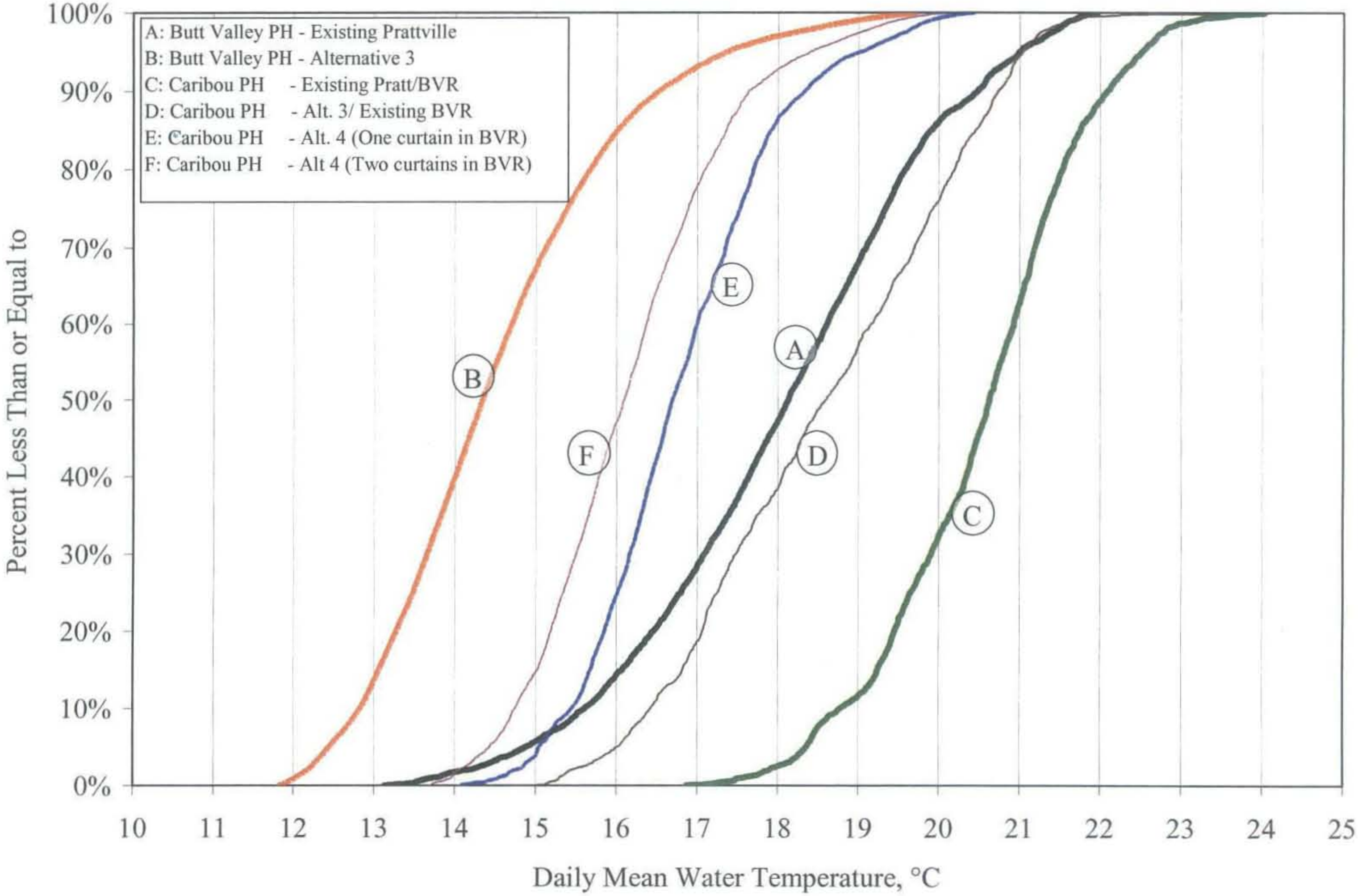

Figure 1. July water temperature distribution curves for Butt Valley Powerhouse and Caribou powerhouses with and without various thermal curtain alternatives.

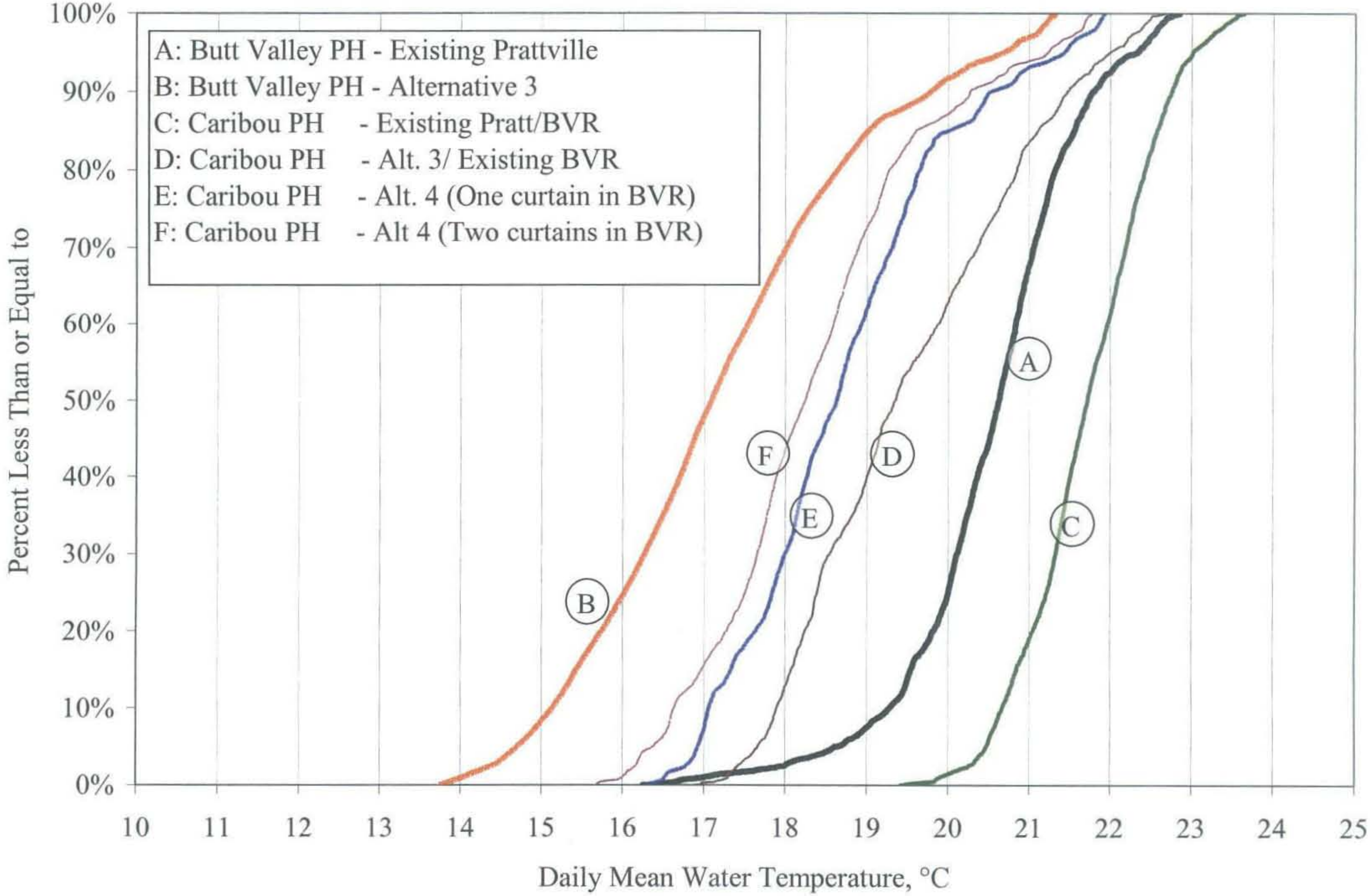

Figure 2. August water temperature distribution curves for Butt Valley Powerhouse and Caribou powerhouses with and without various thermal curtain alternatives.

NFFR Water Temperatures

Butt Valley Reservoir water flows through the Caribou Powerhouse and enters the NFFR and affects water temperature downstream. Water temperatures predicted by *MITEMP*, shown in Figures 1 and 2, are statistically ranked and subsequently used as input for downstream water temperature modeling by *SNTEMP*. Five statistical rankings (10%, 25%, 50%, 75%, and 90%) are used to bracket the water temperature variations. Each of the five statistical rankings defines one unique set of environmental conditions. The 50% ranking (median value) coupled with normal hydrological and meteorological environments defines the most frequent "normal" condition; the 10% (and 25%) ranking combined with warm weather and dry hydrology environments defines "extreme" condition(s); while the 75% (and 90%) ranking together with cold/wet defined the other extreme(s).

Figures 3 and 4 delineate one set (a normal July and a normal August) of the predicted daily mean water temperatures for the NFFR, from immediately below Canyon Dam Outlet to above Poe Powerhouse. Water temperature profiles representing the various thermal curtain alternatives are compared to a base case assuming the existing Prattville Intake configuration. Instream flow release schedules for different stream reaches are assumed in accordance with pertinent requirements, Settlement Agreement(s) and/or License conditions. Seneca Reach and Belden Reach instream flows follow the FERC Project No. 2105 (Upper NFFR Project) Relicensing Settlement Agreement (PG&E 2004a), with the exception that the blending of flow at Canyon Dam Outlet is not considered for this base case. Rock Creek and Cresta instream flow schedules are based on the first five-year instream flow plan in the FERC Project No. 1962 license (Rock Creek-Cresta Project). At the time of this report preparation, Poe instream flow release is still in negotiation and therefore the FS Draft 4(e) instream flow schedule is considered for the model simulation.

A 20°C water temperature line is drawn on Figures 3, 4, 5, and 6 as a reference for comparison to the water temperature goal set forth in the Rock Creek-Cresta Project (FERC Project No. 1962) Relicensing Settlement Agreement (PG&E 2000). Sudden "dips," "rises," or "discontinuity" in water temperature profiles at the various locations represents water temperature effects from either tributaries or powerhouses.

Base Case Condition

Under the existing Prattville configuration, normal July water temperatures (Figure 3) in the Seneca Reach are always lower than 14.5°C. The flows from the Caribou No. 1 and No. 2 powerhouses entering the NFFR are shown as a water temperature discontinuity in the water temperature profile at the end of Seneca Reach. The mixed flow from above Seneca Reach and the Caribou powerhouses defines the starting water temperature at Belden Dam. It is assumed that powerhouse flow will fully mix in the NFFR and that any warming in the small forebay is neglected. Water temperatures in the normal July remain relatively stable and slightly above 20°C for the entire Belden Reach, until the location where the warm unregulated EBNFFR joins the NFFR, which brings water temperature to above 21°C. Water temperatures cool slightly (around 20°C) at Rock Creek Dam as a result of the colder water from Belden Powerhouse. The NFFR water warms by about 0.8°C in Rock Creek Reach, from 20°C to 20.8°C, before the confluence with Bucks Creek Powerhouse Tailrace. Bucks Powerhouse brings colder water and cools the NFFR water temperature down to 18.2°C. Water temperatures in the Cresta Reach generally are colder than water temperatures in the Rock Creek Reach (due to the colder upstream tributaries), and vary from below 20°C to above 20.7°C. The lower NFFR generally experiences more than 1.5°C warming than the upstream reaches because of the lower elevation and wider river width.

In a normal August (Figure 4), NFFR water temperatures show different characteristics compared to July. For example, the starting water temperatures at each of the dam release points are warmer and the warming in the stream reach is milder. In certain portions of the NFFR the water temperature warming is reversed, such as in Belden Reach. Generally speaking, water temperatures in the entire NFFR, except Seneca Reach, are above 20°C. Under a more extreme (drier and warmer) condition, such as the 25% exceedance case shown in Figures 5 and 6 for extreme July and extreme August scenarios, respectively, NFFR water temperatures (excluding Seneca Reach) are above 20°C. Additional water temperature profiles with other environmental conditions, such as more extreme warm weather and drier water conditions (the 10% exceedance level), as well as the other extremes (colder and wetter conditions for the 90 and 75% exceedance levels) are provided in the Appendix B.

Daily mean water temperatures at several key locations in the NFFR are extracted and summarized in Table 2. The selected locations are at the very bottom of each reach or before a major unregulated tributary. It is noted that the water temperature levels in the table represent only one point in the reach, typically the highest water temperature, and should not be used to portray the entire reach. These numbers should be referenced with a clear understanding that they are conservative.

Alternative 3 Conclusion

Water temperatures in Seneca Reach under Alternative 3 are higher and are closer to the desirable range for trout, 15 to 17°C; as compared to the base case (Figures 3–6). The higher water temperature in Seneca Reach is designed by blending the cold water from the low-elevation Canyon Dam Outlet with warmer water from the mid-elevation gate. Under Alternative 3, NFFR water temperatures in normal July and August generally are maintained below 20°C, except in the NFFR in the low segment of Poe Reach. However, the 20°C water temperature goal cannot be met *all the time*. For instance, for extreme cases such as the 25 and 10% exceedance levels, there are parts of the NFFR that will exceed the 20°C. Water temperature profiles for all environmental conditions are provided in Appendix B, and water temperatures at selected key locations are tabulated in Table 2. In comparison to the existing Prattville condition, Alternative 3 would deliver colder water temperatures to all downstream dams below Butt Valley Reservoir (i.e., Belden, Rock Creek, Cresta, and Poe dams) varying from 0.8 to 2.5°C, averaging 1.4°C.

This alternative is feasible in maintaining NFFR water temperatures below 20°C, except in the lower Poe Reach under normal July–August period. The magnitude of the colder water temperatures (relative to the existing Prattville condition) delivered to all the dams below Butt Valley Reservoir averaged about 1.4°C. However, the 20°C goal is *not achievable all the time*. In addition, the results show that dredging alone provided about 0.5°C water temperature reduction at the Belden, Rock Creek, Cresta and Poe reaches during July and August, but also reduced cold water fish habitat in Lake Almanor and reduced fish production in Butt Valley Reservoir.

Thermal curtain construction, installation method, dredging requirements, and the associated costs have been prepared (Black and Veatch 2004) and are presented in Section 4.1. The cost to implement Thermal Curtain No. 4 is about $12.4 million; the cost for the recommended dredging (approximately at 23,000 cubic yards) is estimated at $5.4 million. The thermal curtain and dredging costs combined for Alternative 3 is $17.8 million. The costs listed above are for construction costs only, and do not include costs for operation and maintenance or the cost of resolving the low DO at Butt Valley Powerhouse. The corresponding ecological effects of this alternative are described in Section 4 of this report. The level of water temperature benefits for this alternative is not commensurate with the corresponding adverse effects and costs. These considerations lead to the conclusion that it is not a reasonable water temperature control measure.

Table 2. Monthly Daily Mean Water Temperature Distribution in NFFR under Base Case and Prattville Alternatives

	July					**August**				
Location	*Exceedance Level*									
In NFFR	*90%*	*75%*	*50%*	*25%*	*10%*	*90%*	*75%*	*50%*	*25%*	*10%*
	Existing Prattville Intake Configuration (Base case) - 2004 Settlement Agreement except blending in CD									
above Caribou	15.1	14.8	14.4	13.0	12.8	15.4	15.3	13.9	13.6	13.4
above East Branch	**20.5**	**20.1**	**20.3**	18.9	18.3	**21.2**	**21.0**	**20.4**	19.9	19.6
below East Branch	**21.9**	**21.6**	**21.0**	**20.1**	**20.0**	**21.8**	**21.7**	**20.8**	19.7	19.5
above Belden PH	**21.9**	**21.7**	**21.2**	**20.2**	**20.1**	**22.0**	**21.9**	**20.9**	19.8	19.6
above Bucks Creek	**21.7**	**21.3**	**20.8**	19.1	18.8	**22.0**	**21.9**	**20.7**	**20.0**	19.7
above Cresta PH	**21.9**	**21.5**	**20.7**	18.9	18.6	**22.1**	**22.0**	**20.2**	19.5	19.3
above Poe PH	**22.7**	**22.4**	**21.3**	19.8	19.5	**23.1**	**23.0**	**21.1**	**20.3**	**20.1**
	Alternative 3 (with dredging)									
above Caribou	16.1	15.8	16.3	15.1	14.8	15.4	15.3	15.1	14.8	14.6
above East Branch	19.7	19.3	19.0	17.4	16.7	**20.5**	**20.0**	18.9	18.0	17.7
below East Branch	**21.4**	**21.2**	**20.3**	19.7	19.5	**21.4**	**21.1**	19.8	18.9	18.7
above Belden PH	**21.5**	**21.3**	**20.5**	19.8	19.6	**21.6**	**21.4**	**20.0**	19.0	18.8
above Bucks Creek	**20.9**	**20.6**	19.9	18.2	17.7	**21.3**	**20.8**	19.4	18.5	18.2
above Cresta PH	**21.3**	**21.0**	19.8	18.1	17.7	**21.5**	**21.0**	19.1	18.2	18.0
above Poe PH	**22.2**	**21.9**	**20.5**	18.9	18.5	**22.5**	**22.1**	**20.0**	19.0	18.7
	Alternative 4 (one thermal curtain in BVR)									
above Caribou	16.1	15.8	16.3	15.1	14.8	15.4	15.3	15.1	14.8	14.6
above East Branch	18.6	18.2	17.6	16.4	16.0	**20.0**	19.4	18.3	17.6	17.0
below East Branch	**20.8**	**20.6**	19.5	19.4	19.3	**21.1**	**20.8**	19.5	18.7	18.4
above Belden PH	**21.0**	**20.8**	19.8	19.5	19.4	**21.4**	**21.1**	19.7	18.8	18.6
above Bucks Creek	19.8	19.3	18.8	17.8	17.4	**20.7**	**20.2**	18.9	18.2	17.7
above Cresta PH	**20.3**	19.9	18.9	17.7	17.4	**21.0**	**20.5**	18.7	17.9	17.5
above Poe PH	**21.3**	**20.8**	19.6	18.5	18.2	**22.1**	**21.6**	19.6	18.7	18.2

Table 2. Monthly Daily Mean Water Temperature Distribution in NFFR under Base Case and Prattville Alternatives (continued)

Location In NFFR	July					August				
	Exceedance Level									
	90%	*75%*	*50%*	*25%*	*10%*	*90%*	*75%*	*50%*	*25%*	*10%*
	Alternative 4 (two thermal curtains in BVR)									
above Caribou	16.1	15.8	16.3	15.1	14.8	15.4	15.3	15.1	14.8	14.6
above East Branch	18.3	17.9	17.1	15.9	15.5	19.9	19.2	18.0	17.4	16.7
below East Branch	**20.6**	**20.4**	19.2	19.3	19.1	**21.0**	**20.7**	19.3	18.6	18.3
above Belden PH	**20.8**	**20.6**	19.5	19.4	19.2	**21.3**	**21.0**	19.5	18.7	18.4
above Bucks Creek	19.4	19.0	18.6	17.5	17.1	**20.6**	**20.0**	18.6	18.0	17.4
above Cresta PH	19.9	19.5	18.7	17.4	17.1	**20.9**	**20.3**	18.4	17.8	17.3
above Poe PH	**20.9**	**20.5**	19.4	18.2	17.8	**22.0**	**21.4**	19.4	18.5	18.0

It is noted that the water temperature levels in the table represent only one point in the reach, typically the highest water temperature, and should not be used to portray the entire reach. These numbers should be referenced with a clear understanding that they are conservative.

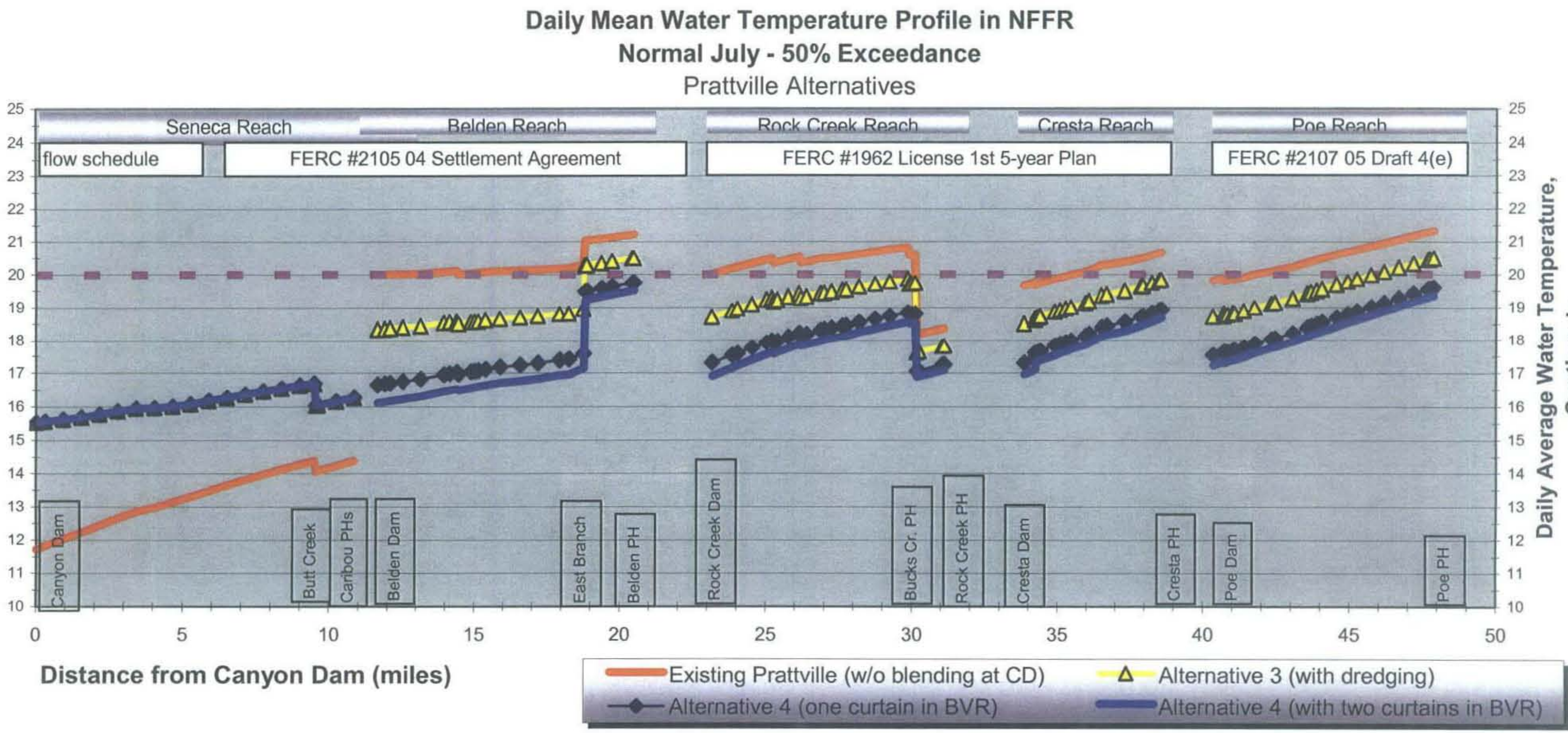

Figure 3. Daily mean water temperature profile in NFFR, normal July.

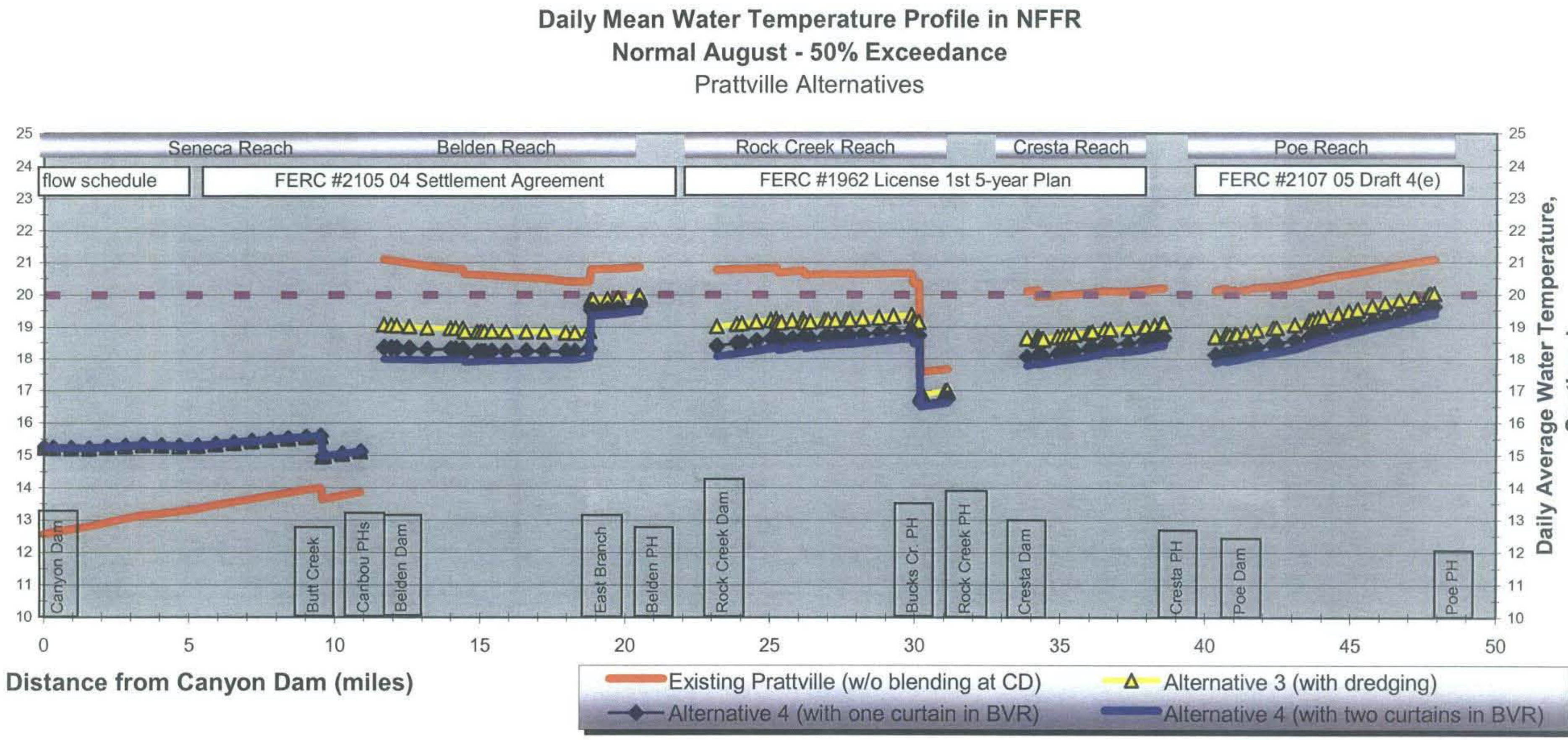

Figure 4. Daily mean water temperature profile in NFFR, normal August.

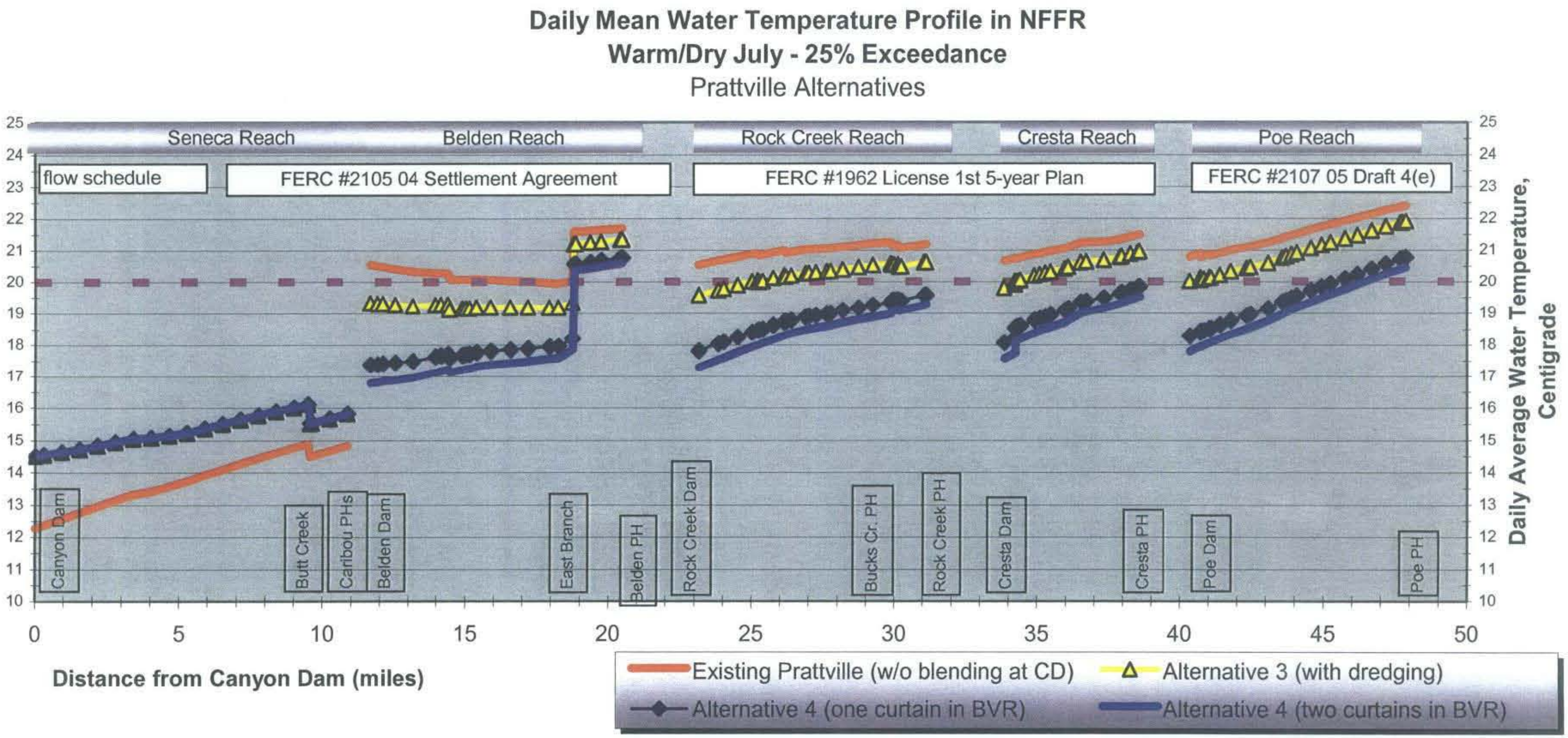

Figure 5. Daily mean water temperature profile in NFFR, warm/dry July.

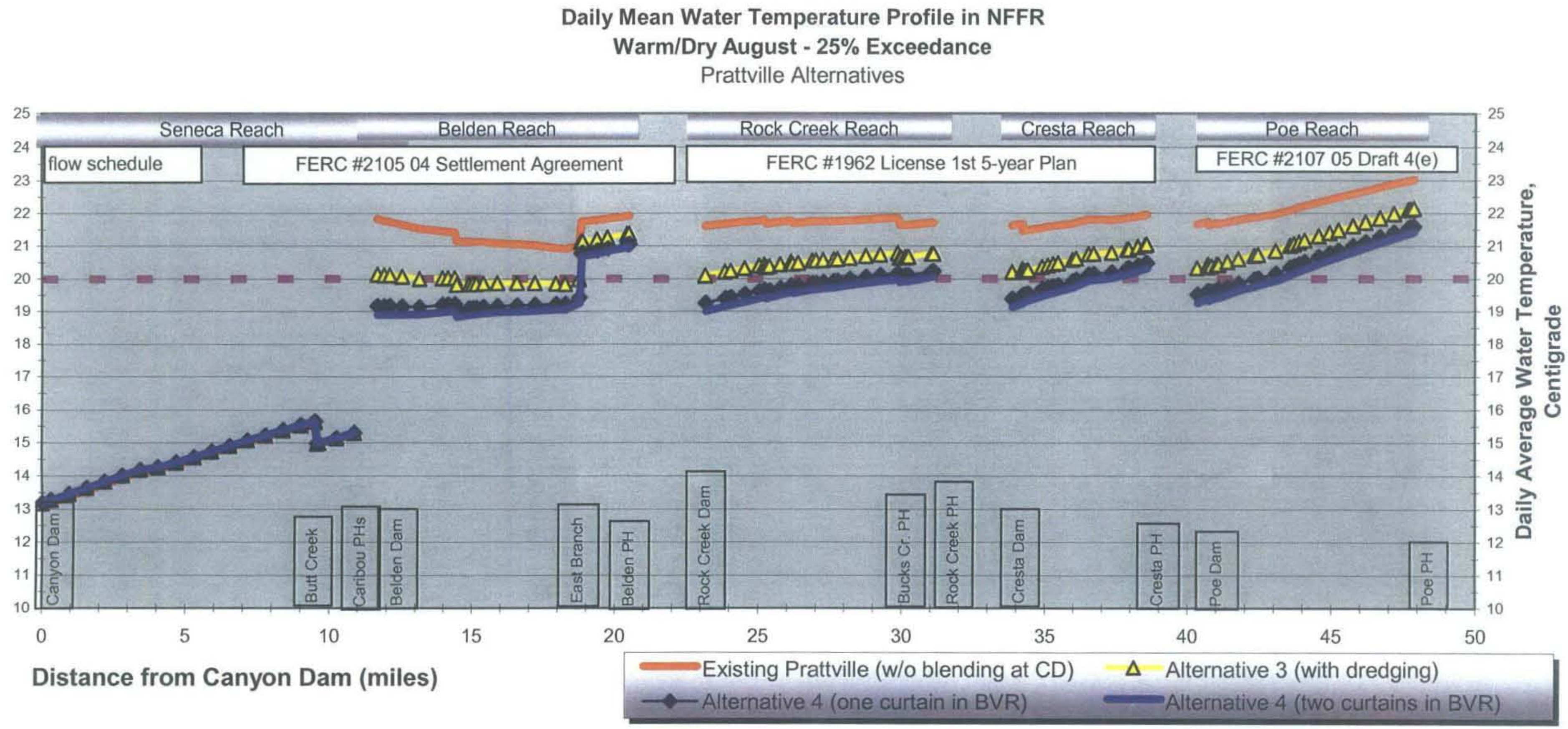

Figure 6. Daily mean water temperature profile in NFFR, warm/dry August.

3.1.4 Alternative 4. Install Two Thermal Curtains in Butt Valley Reservoir (One at the Lower End of Butt Valley Reservoir at the Existing Caribou Powerhouse Intake and the Other at the Upper End of Butt Valley Reservoir) and One Thermal Curtain at the Existing Prattville Intake in Lake Almanor with Dredging of the Prattville Intake Area

This alternative consists of installing a combination of two thermal curtains in Butt Valley Reservoir and one thermal curtain at Prattville Intake in Lake Almanor, with dredging of the Prattville Intake area to cause colder water to enter the intakes at both lakes for release to the NFFR.

Water Temperatures at Butt Valley Reservoir

Warming in Butt Valley Reservoir is more pronounced if the Prattville thermal curtain is installed (Figures 1 and 2). Measures to minimize Butt Valley Reservoir warming under the Prattville thermal curtain condition were investigated. Two potential thermal curtain options in Butt Valley Reservoir were considered (1) one thermal curtain and, (2) two thermal curtains. A down-reservoir thermal curtain, installed near the Caribou No. 1 and No. 2 intakes represents the one thermal curtain case. The down-reservoir thermal curtain combined with an additional upper thermal curtain near the reservoir entrance represents the two thermal curtains case. On average, both thermal curtain scenarios (with the Prattville thermal curtain installed) result in minimized warming in Butt Valley Reservoir of about 0.9 to 2.5°C for July and August, respectively (Curve D to Curve F in Figures 1 and 2).

NFFR Water Temperatures

Effects of additional water temperature thermal curtain measures in Butt Valley Reservoir are simulated, and the incremental water temperature benefits compared to Alternative 3 (Thermal Curtain No. 4 and levees removed) versus the existing condition are examined in this discussion. As shown in Figures 3–6, the additional thermal curtain(s) in Butt Valley Reservoir would yield additional cooling. In the normal July–August period, one thermal curtain in Butt Valley combined with Alternative 3 would maintain the entire NFFR below 20°C (Figures 3 and 4). However, the water temperature goal of 20°C cannot always be maintained for the entire NFFR. For instance, the lower Poe Reach under the 25 and 10% exceedance levels still exceed the 20°C. It is quite noticeable that the two thermal curtains scenario in Butt Valley Reservoir does not produce any substantial incremental water temperature reduction effect compared to the one thermal curtain scenario in Butt Valley Reservoir. Water temperature profiles under the various environmental conditions for both one and two thermal curtains are provided in Appendix B, and water temperatures at selected key locations are tabulated in Table 2.

One thermal curtain in Butt Valley Reservoir combined with Alternative 3 produces a total water temperature reduction from the existing configuration of 1.6 to 3.4°C in the July–August period, averaging 2.4°C, for all the dams below Butt Valley Reservoir. The two-thermal curtain case combined with Alternative 3 produces a total reduction of 1.7 to 3.9°C in the July–August period, averaging 2.8°C.

Alternative 4 Conclusion

When supplemented with one to two thermal curtains in Butt Valley Reservoir, Alternative 3 (Prattville thermal curtain and levees removed) would maintain the entire NFFR below 20°C for most—but *not all of the time*. The overall water temperature reduction for all downstream dams below Butt Valley Reservoir averages 2.4°C when Alternative 3 is supplemented with one thermal curtain in Butt Valley Reservoir. This combination of configurations provides about 3°C water temperature reduction at the Belden, Rock Creek, Cresta, and Poe reaches during July and August, but also results in reduced cold water fish habitat in Lake Almanor and reduced fish production in Butt Valley Reservoir.

Assuming the cost for the thermal curtain in Butt Valley is the same as in Prattville Intake (estimated at $12.4 million [Black and Veach 2004]), the total cost for the one thermal curtain combined with Alternative 3 is estimated at $30.2 million. The two thermal curtain alternatives in the Butt Valley Reservoir produce very marginal gain of water temperature reduction in the NFFR as compared to one thermal curtain case. With two thermal curtains in Butt Valley Reservoir, the averaged downstream temperature reduction is 2.8°C. Total cost for the two thermal curtains in Butt Valley combined with Alternative 3 is about $42.6 million. These costs reflect construction costs only and do not include costs for operation, maintenance, or the cost for resolving the low DO at Butt Valley Powerhouse. The corresponding ecological effects of this alternative are described in Section 4 of this report. The level of water temperature benefits for this alternative is not commensurate with the corresponding adverse effects and costs, leading to the conclusion that it is not a reasonable water temperature control measure.

3.2 Category 2. Obtain Cold Water from Lake Almanor by Increasing the Magnitude of Seasonal Water Releases Using the Low-Level Gates in the Existing Canyon Dam Outlet Structure Located in the Lake and/or Re-operation of Licensee's Upper NFFR, Rock Creek-Cresta, Poe, and Bucks Creek Projects)

3.2.1 Alternative 5. Re-operate Butt Valley Powerhouse to Reduce Butt Valley Powerhouse Flows and Draw Cooler Water from Lake Almanor for Release to the NFFR at Butt Valley Powerhouse

This alternative consists of reducing Butt Valley Powerhouse flows so that cooler water is drawn from Lake Almanor and subsequently released to the NFFR. A five-day special test was conducted from August 1–5, 1994 to determine the effects of reduced Butt Valley Powerhouse flows on the withdrawal of colder water from Lake Almanor. The data obtained from the test were modeled as part of the Lake Almanor Cold Water Feasibility Study, Hydraulic Model by IIHR in July 2004 (IIHR 2004). The test consisted of maintaining Butt Valley Powerhouse flows at 800 cfs initially and then increasing flows by 200 cfs increments up to 1,600 cfs. Each flow level was maintained for one day so that flow, velocity, and water temperature measurements could be collected.

Figure 7 is a performance curve that relates the bulk water temperature, T_{out}, of outflow water drawn through the intake versus intake outflow rate. As shown in Figure 7, at the initial flow rate of 800 cfs, the bulk water temperature of the outflow was equal to 20.1°C (T_{out}). When the intake outflow rate is equal to Prattville Intake release flow of 1,600 cfs, the T_{out} is equal to 21.0°C. So while this alternative results in a marginal reduction in water temperature (less than

1°C) of outflow water drawn through the intake, it still entrains warm water from the Lake Almanor epilimnion. In addition, reduced outflow from Butt Valley Powerhouse equates to potentially slower pass-through in Butt Valley Reservoir, which in turn equates to a potential increase in warming in Butt Valley Reservoir and a corresponding reduction in fish population. This alternative is not expected to result in any measurable temperature reduction to the Belden, Rock Creek, Cresta, and Poe reaches. The reduced flows through Butt Valley Powerhouse have a corresponding effect of reduced flows through the downstream Caribou, Belden, Rock Creek, Cresta, and Poe powerhouses resulting in very adverse impacts on power generation. The extremely limited water temperature benefits for this alternative are not commensurate with the corresponding adverse effects and costs, leading to the conclusion that it is not a reasonable water temperature control measure.

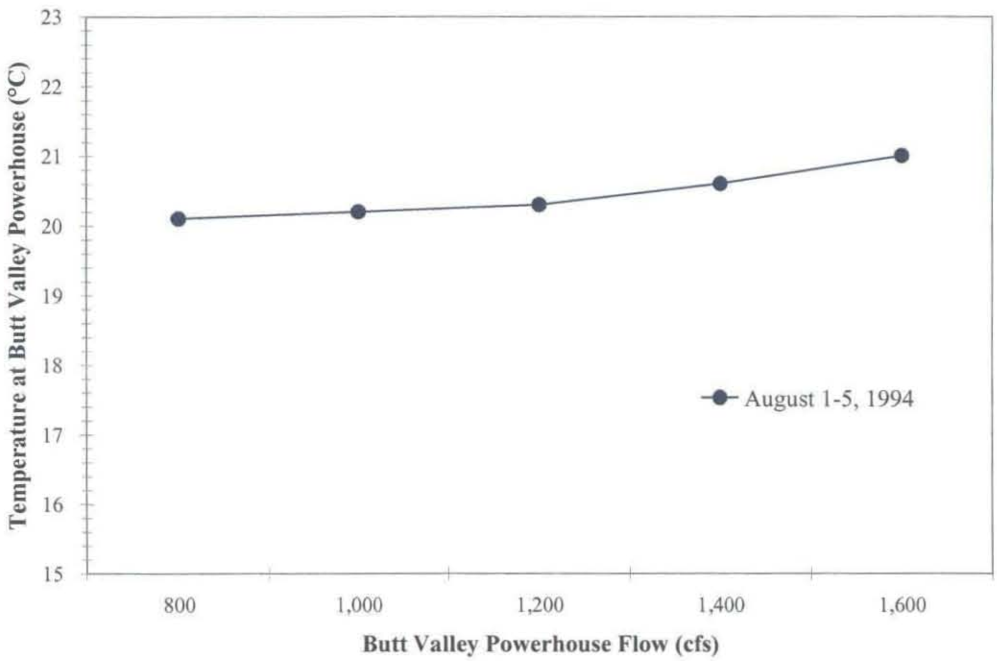

Figure 7. Variation of outflow water temperature with flow from Prattville Intake (as measured at Butt Valley Powerhouse) for August 1–5, 1994 (IIHR 2004).

3.2.2 Alternative 6. Re-operate Butt Valley Powerhouse to Reduce Butt Valley Powerhouse Flows and Draw Cooler Water from Lake Almanor for Release to the NFFR at Butt Valley Powerhouse, Combined with Increasing Magnitude of Water Releases from Lake Almanor at Canyon Dam

This alternative consists of reducing Butt Valley Powerhouse flows so that cooler water is drawn from Lake Almanor and subsequently released to the NFFR from Butt Valley Powerhouse, combined with increased magnitude water releases to the NFFR from the Canyon Dam Outlet low-level gate in Lake Almanor. In February–April, 2005, Licensee initiated a series of modeling study investigation options of re-operating Butt Valley and the Caribou powerhouses combined with increased magnitude water releases at Canyon Dam Outlet. This option takes into consideration that the Canyon Dam Outlet is comprised of two gate configurations, of which the low-level gate configuration (elevation 4,432 feet, USGS datum) can access the coldest water in Lake Almanor. The investigation included increased magnitude water releases from the low-level Canyon Dam Outlets, ranging from 200 to 575 cfs in the July–August period, while an equal or greater amount of water be curtailed from the Prattville Intake (which delivers the warmer water) to meet the targeted water temperature level at Belden Dam (set at approximately19°C). Six model series were simulated for Lake Almanor and Butt Valley Reservoir, respectively (Bechtel and TRPA 2005). The results were evaluated in the context of the achievability of the targeted water temperature under the various exceedance levels, the maintenance of Lake Almanor Reservoir levels, and the concern of not meeting the downstream irrigation water delivery (Western Canal Contract). At the recommendation of the 2105 Relicensing Collaboration Group, two model series were further evaluated to determine the corresponding water temperatures downstream in the NFFR. These two series are identified as "Swap Flow" series as they represent a case where the increased flow release into the Seneca Reach is matched by a corresponding reduction of water withdrawn at Prattville Intake.

The first swap flow series assumes that the low-level Canyon Dam Outlet releases a constant 200 cfs in July and a constant 500 cfs in August; an equal amount of water (in excess of what is specified in the Relicensing Settlement Agreement [PG&E 2004a]) is correspondingly reduced from Butt Valley and Caribou powerhouses. The series is targeted at achieving a 19°C daily mean water temperature at Belden Dam approximately 50% of the time in July–August period. The second swap flow series assumes increased Seneca Reach releases (275 cfs for July and 575 cfs for August) to achieve the 19°C water temperature goal more frequently, approximately 70% of the time. Both re-operation series assure that Lake Almanor and Butt Valley Reservoir will maintain the same specified storage volume as specified in the Relicensing Settlement Agreement, and that the total amount of water delivered to the downstream Western Canal Contract will remain intact. Figures 8 and 9 depict the predicted water temperature profiles with distance in the NFFR for normal July and August, respectively. A base case assumes the flow release schedule in accordance with each respective Relicensing Settlement Agreement(s) and/or license conditions; specifically, Seneca Reach and Belden Reach releases follow the Upper NFFR Project, FERC Project No. 2105, Relicensing Settlement Agreement (PG&E 2004a), Rock Creek and Cresta releases follow the FERC Project No. 1962 (Rock Creek-Cresta Project) first five-year plan (PG&E 2000), and Poe follows the FERC Project No. 2107 (Poe Project) FS Draft 4(e) condition (U.S. Department of Agriculture [USDA] 2005). Generally, both re-operation series produce cooler water temperatures than the base case, about 1°C in July and 2°C in August. In a normal July, water temperature levels under the "swapped flow" series can be maintained below the 20°C goal for the entire Belden Reach and can be maintained for one half to two thirds for each of the individual downstream reaches. In a normal August, water temperatures under the "swapped flow" series are below the 20°C goal for the entire NFFR.

Note that these alternatives do not necessarily bring water temperatures in the NFFR below the desired level (20°C) *all the time*. In some extreme conditions, for instance, warm weather combined with a dry water year, water temperatures in certain parts of the NFFR will exceed 20°C. Figures 10 and 11 illustrate water temperature profiles under such conditions for 25% extreme July and 25% extreme August, respectively. The 25% statistical rankings are determined based on a selection of upstream release water temperature and weather conditions ranked at the top 25% of the 33 years simulation record (i.e., a condition to be exceeded 25% of the time [25% exceedance level]). Additional profiles for other environmental conditions such as more extreme warm weather combined with a drier water year (10% exceedance levels) and cold weather combined with wet water years (90 and 75% exceedance levels) are also provided in the Appendix B.

Predicted daily mean water temperatures are extracted at several key locations in the NFFR (normally at the very bottom of each reach or before a major unregulated tributary) and are summarized in Table 3. It is noted that the water temperature levels in the table represent only one point in the reach, typically the highest water temperature in the reach, and are not representative of the entire reach. Thus, these numbers should be referenced with clear understanding that they are conservative.

Since the FERC Project No. 1962 (Rock Creek-Cresta Project) license flow schedule is designed with an adaptive management approach, the instream flow schedule has three phases (three five-year plans) so that an informed decision can be made following the evaluation of the monitoring study results from the preceding phase. Water temperature information presented above pertains to the first five-year plan in Rock Creek and Cresta reaches. Similar information predicted under the second and third five-year plans are included in Appendix B.

Alternative 6 Conclusion

This alternative can maintain NFFR water temperatures at or below 20°C for about one half to two thirds of the NFFR during July. In August, water temperatures can be maintained below the 20ºC for the entire NFFR. However, both alternatives cannot maintain water temperatures below 20ºC all the time. The average delivered water temperature reductions (relative to the existing Prattville condition) to all downstream dams below Butt Valley Reservoir averaged 1.4°C (ranging from 0.3 to 3.3ºC) for the first Swap flow series and averaged 1.8ºC (ranging 0.5 to 3.9ºC) for the second Swap flow series. The cost of generation losses are estimated at $2 million/year for the first Swap series and $2.6 million/year for the second Swap flow series.

This alternative provides a water temperature reduction of about 1°C in July and 2°C in August for the Belden, Rock Creek, Cresta, and Poe reaches, but also results in reduced cold water fish habitat in Lake Almanor, reduced fish production in Butt Valley Reservoir and reduced quality of cold water fish habitat on the Seneca Reach. The corresponding ecological effects of this alternative are described in Sections 4.3 and 4.4 of this report. The level of water temperature benefits for this alternative is not commensurate with the corresponding adverse effects and costs, leading to the conclusion that it is not a reasonable water temperature control measure.

Table 3. Monthly Daily Mean Water Temperature Distribution in NFFR Under Project Re-operation Alternatives

Location In NFFR	July					August				
	Exceedance level									
	10%	*25%*	*50%*	*75%*	*90%*	*10%*	*25%*	*50%*	*75%*	*90%*
	Existing Prattville Intake Configuration (Base Case)—2004 Settlement Agreement									
above Caribou	16.6	16.3	16.0	14.5	14.3	16.4	16.2	14.9	14.1	13.7
above East Branch	**20.5**	**20.2**	**20.4**	19.1	18.4	**21.2**	**21.0**	**20.4**	19.9	19.4
below East Branch	**21.9**	**21.7**	**21.1**	**20.2**	**20.0**	**21.9**	**21.7**	**20.8**	19.7	19.5
above Belden PH	**22.0**	**21.8**	**21.3**	**20.3**	**20.1**	**22.0**	**21.9**	**20.8**	19.8	19.6
above Bucks Creek	**21.7**	**21.4**	**20.9**	19.2	18.8	**22.0**	**21.8**	**20.6**	**20.0**	19.6
above Cresta PH	**21.9**	**21.6**	**20.7**	19.0	18.6	**22.1**	**21.9**	**20.0**	19.6	19.2
above Poe PH	**22.8**	**22.5**	**21.4**	19.9	19.5	**23.1**	**23.0**	**21.0**	**20.4**	**20.0**
	Alternative 6—First Swap Flow Series (July/August Release = 200/500 cfs)									
above Caribou	14.6	14.2	13.8	12.7	12.4	15.3	14.7	14.0	13.5	13.2
above East Branch	19.7	19.4	19.7	18.6	18.0	19.4	19.0	18.8	18.6	18.0
below East Branch	**21.4**	**21.2**	**20.7**	**20.0**	19.9	**20.8**	**20.5**	19.8	19.1	18.8
above Belden PH	**21.5**	**21.4**	**20.9**	**20.1**	**20.0**	**21.0**	**20.8**	19.9	19.2	19.0
above Bucks Creek	**20.9**	**20.6**	**20.4**	18.9	18.6	**20.1**	19.8	19.3	19.0	18.4
above Cresta PH	**21.2**	**21.0**	**20.3**	18.8	18.4	**20.5**	**20.2**	19.0	18.7	18.1
above Poe PH	**22.1**	**21.9**	**20.9**	19.6	19.3	**21.6**	**21.3**	**20.0**	19.4	18.9
	Alternative 6—Second Swap Flow Series (July/August Release = 275/575 cfs)									
above Caribou	14.5	14.0	13.6	12.6	12.3	15.3	14.7	14.0	13.5	13.2
above East Branch	19.2	18.9	19.3	18.4	17.8	19.0	18.7	18.5	18.4	17.7
below East Branch	**21.1**	**21.0**	**20.5**	**20.0**	19.8	**20.5**	**20.3**	19.6	19.0	18.7
above Belden PH	**21.3**	**21.1**	**20.7**	**20.1**	19.9	**20.8**	**20.7**	19.7	19.1	18.8
above Bucks Creek	**20.4**	**20.1**	**20.1**	18.8	18.4	19.8	19.4	19.0	18.8	18.2
above Cresta PH	**20.8**	**20.6**	**20.0**	18.6	18.3	**20.2**	19.9	18.8	18.5	17.9
above Poe PH	**21.8**	**21.5**	**20.7**	19.5	19.1	**21.3**	**21.0**	19.7	19.2	18.7

It is noted that the water temperature levels in the table represent only one point in the reach, typically the highest water temperature in the reach, and are not representative of the entire reach. Thus, these numbers should be referenced with clear understanding that they are conservative.

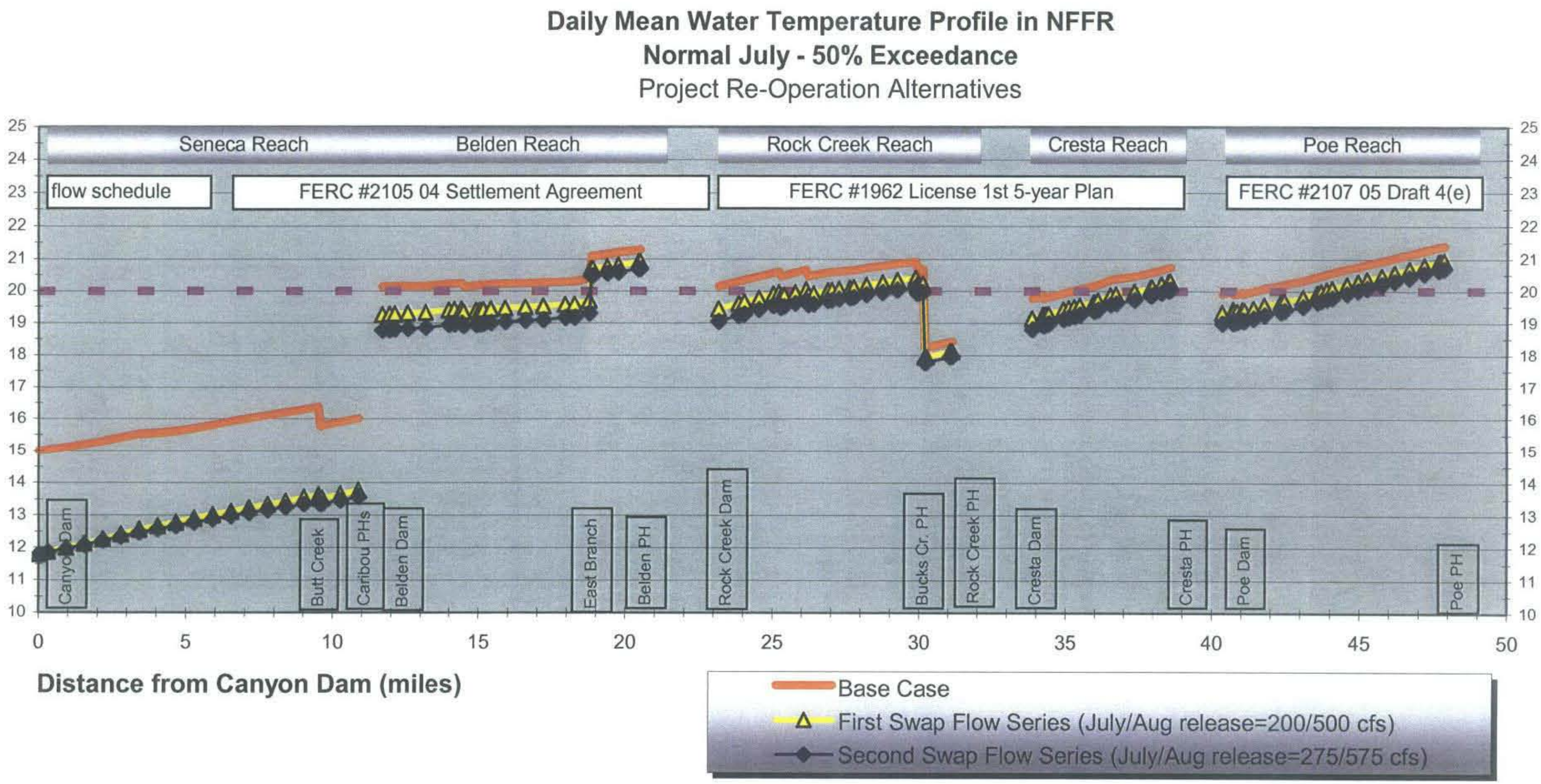

Figure 8. Predicted normal July daily average water temperature profiles in NFFR under Project Re-operation Alternatives.

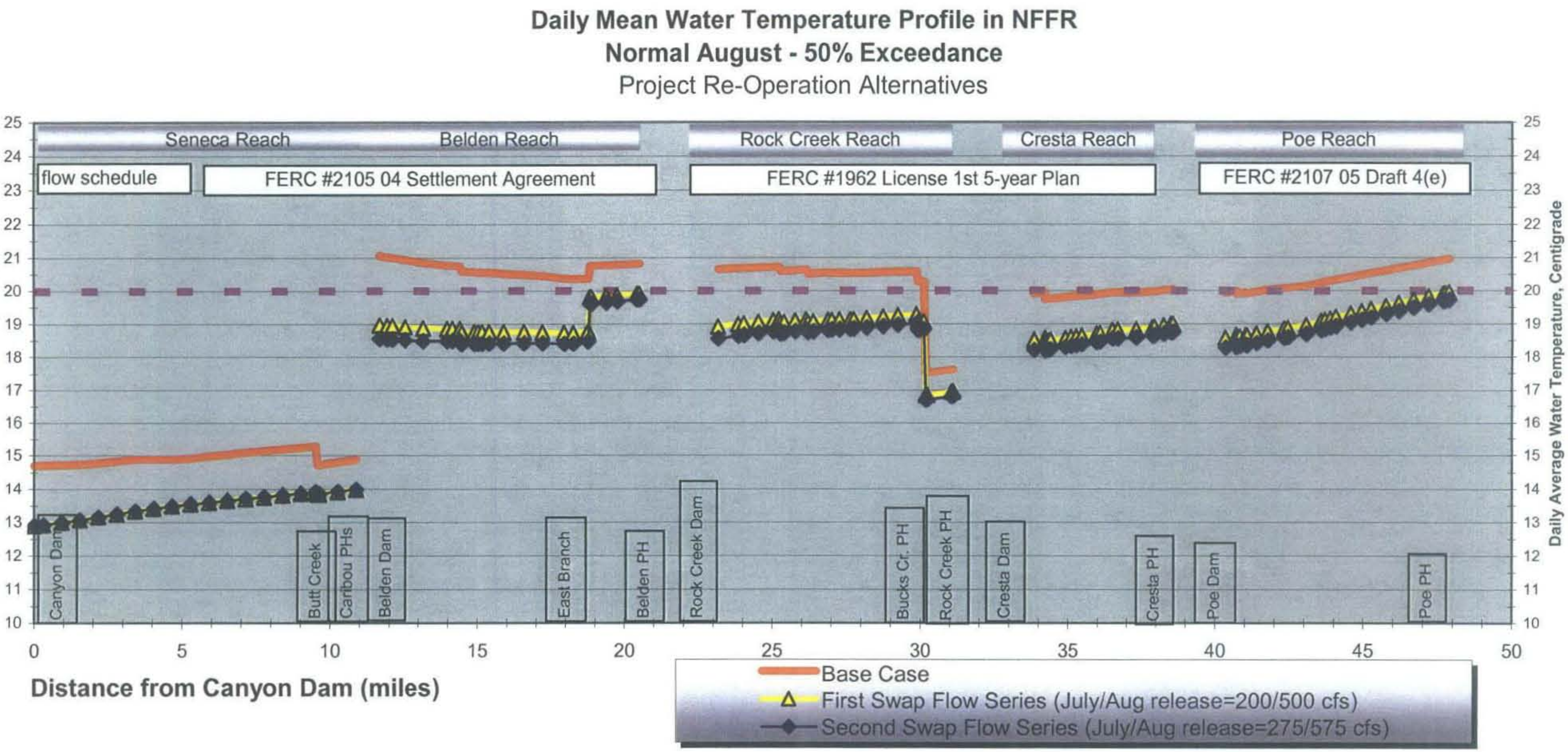

Figure 9. Predicted normal August daily average water temperature profiles in NFFR under Project Re-operation Alternatives.

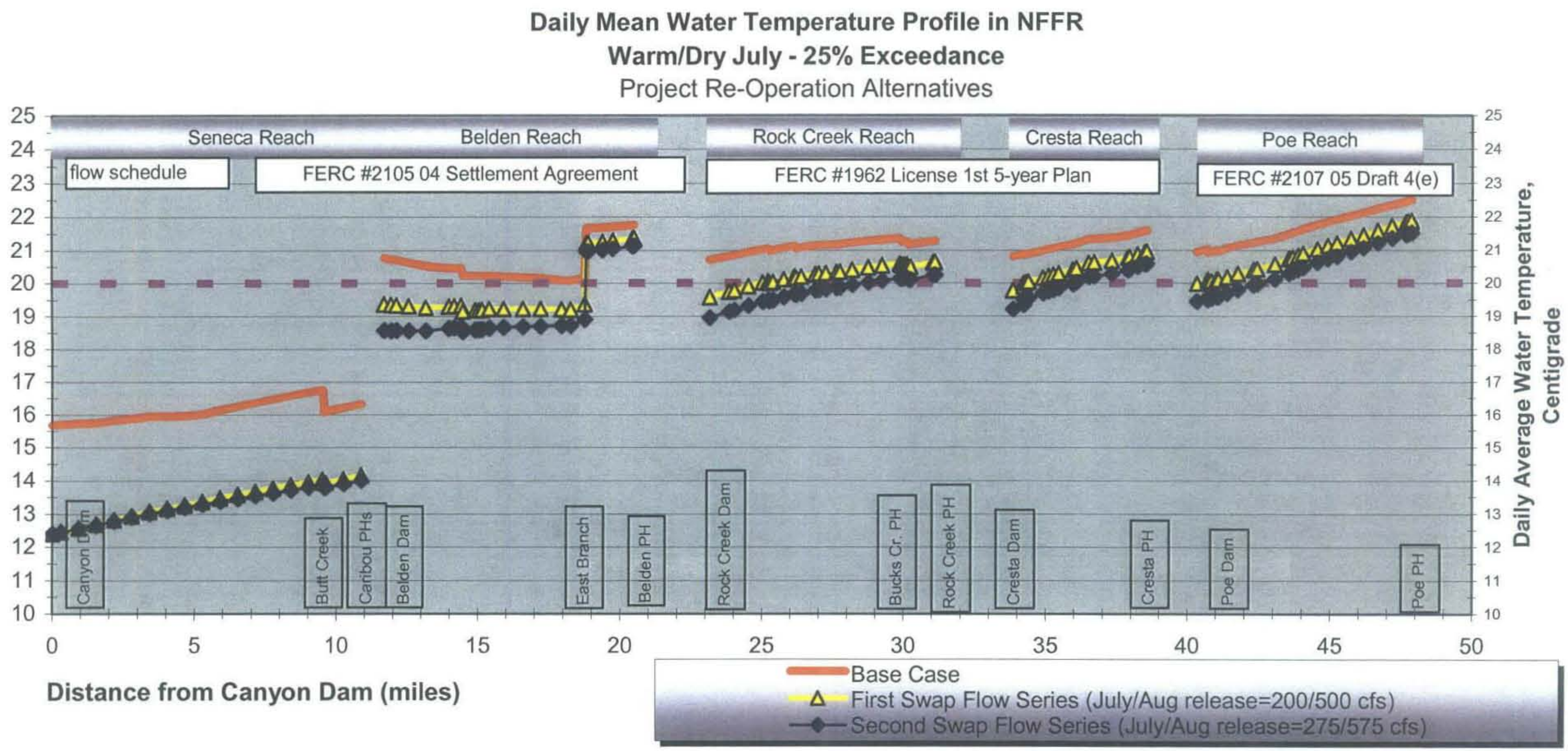

Figure 10. Predicted 25% extreme July daily average water temperature profiles in NFFR under Project Re-operation Alternatives.

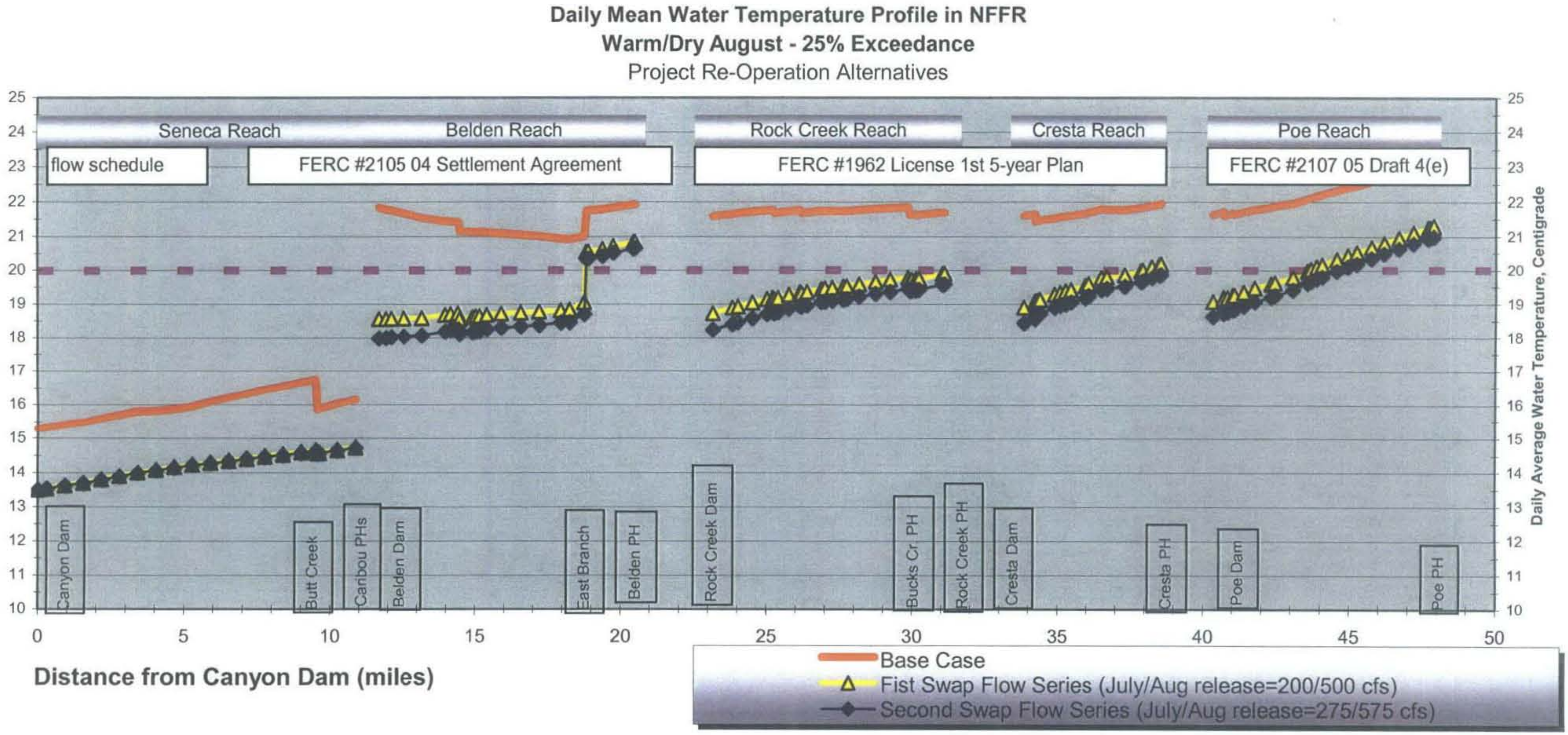

Figure 11. Predicted 25% extreme August daily average water temperature profiles in NFFR under Project Re-operation Alternatives.

3.2.3 Alternative 7. Re-operate Caribou No. 1 Powerhouse to Selectively Operate Caribou No. 1 Powerhouse over the Caribou No. 2 Powerhouse and Draw Cooler Water from Butt Valley Reservoir

This alternative consists of re-operation of the Caribou No. 1 Powerhouse to select Caribou No. 1 Powerhouse operation over Caribou No. 2 Powerhouse operation and draw cooler water from Butt Valley Reservoir for release to the NFFR. As a part of the Rock Creek-Cresta Project's license required annual water temperature monitoring, a test was performed to determine the water temperature effects of selectively operating Caribou No. 1 and Caribou No. 2 powerhouses. Caribou No. 1 Powerhouse Intake is located in a deeper portion of Butt Valley Reservoir thereby providing better access to the available pool of cooler water. Caribou No. 2 Powerhouse Intake is located in a shallow cove. Butt Valley Reservoir thermally stratifies in the summer, however only a limited supply of lower level cool water is available (PG&E 2003c, 2004d). Normally Licensee prefers to operate Caribou No. 2 Powerhouse as it is about 10 percent more efficient than Caribou No. 1 Powerhouse.

To define and quantify the effect that preferential use of Caribou No. 1 Powerhouse has on water temperatures in the lower NFFR, Licensee conducted a special short duration operational test in July 2003. This test was conducted from July 18 through July 25, 2003. During this period, Caribou No. 1 Powerhouse was operated preferentially over Caribou No. 2 Powerhouse. On eight days during this period, Caribou No. 2 Powerhouse was essentially not operated at all. Because the pool of cool water in Butt Valley Reservoir had not been utilized up to this point, this test represented a best-case scenario with regard to the mitigating effect of using Caribou No. 1 Powerhouse preferentially over Caribou No. 2 Powerhouse (PG&E 2003c).

The results of the test indicated that under current conditions, the preferential use of Caribou No. 1 Powerhouse over Caribou No. 2 Powerhouse produced the following results:

1. Under the best-case scenario, a 3°C decrease in water temperature was observed at Belden Dam.

2. The same test yielded a 1.1 and 0.5°C decrease in water temperature in the Rock Creek and Cresta reaches at the dams, respectively.

3. The reserve of cool water is limited in Butt Valley Reservoir, and the operation of Caribou No. 1 Powerhouse over Caribou No. 2 Powerhouse can at best provide only temporary periods (several days) of cool water. Depletion of the reserve of cool water in Butt Valley Reservoir results in rapid warming of water temperatures in the lower levels of Butt Valley Reservoir.

After several days of Caribou No. 1 Powerhouse operation the reserve of cool water in Butt Valley Reservoir is exhausted causing water temperatures in Butt Valley Reservoir's hypolimnion to rapidly warm to water temperatures that are similar to those observed entering the reservoir through Butt Valley Powerhouse. The level of water temperature benefits for this alternative is not commensurate with the corresponding adverse effects and costs, leading to the conclusion that it is not a reasonable water temperature control measure.

3.2.4 Alternative 8. Re-operate the Existing Canyon Dam Outlet in Lake Almanor to Selectively Use the High/Low Outlet Gates to Preserve Cold Water in Lake Almanor

This alternative consists of the re-operation of the Canyon Dam Outlet to selectively use the high/low outlet gates to preserve more cold water in Lake Almanor for release to the NFFR at Prattville Intake. The water temperature effect of blending of the outlet flows at Canyon Dam was evaluated.

Initially, this alternative was considered as one of the several cold water conservation measures that could preserve some cold water that might be saved for release later in the summer when it is needed. Several conservation measures were identified, including selective operation of Canyon Dam Outlet gates, timing of thermal curtain deployment and building a "fence" that would block the entry of the cold water (to Prattville Intake) during the spring and early summer period when water temperature is not an issue. The effects of these measures were evaluated by *MITEMP* model simulating the past 33 years of re-operated lake condition (Bechtel and TRPA 2005). The study revealed that even though these conservation measures do produce some colder water later in the summer in wet years, ultimately they would not yield a significant difference in water temperature released either at Prattville Intake or at Canyon Dam Outlet.

Canyon Dam Outlet has two gate configurations, the mid-level (elevation at 4,477 feet, USGS datum) and the low-level (elevation 4,422 feet) outlets. The mid-level outlet is within the epilimnion (warm water layer) all of the time, so it withdraws water primarily from the epilimnion. Since the 1980s, Licensee has made releases from low-level gates (except during emergency situations). However, during 2004 the low level gates were closed and not operated due to deterioration of gate components. One of the low level gates will be upgraded in 2005 to ensure future water releases can be made at this level. In the early part of the summer, releases from the low-level outlet may result in water that is too cold in the Seneca Reach downstream from Canyon Dam Outlet. Consequently, Licensee and the 2105 Relicensing Collaboration Group have considered an option in which the flows from the low and mid-level Canyon Dam Outlets are to be blended. The blending consists of releasing 60 cfs year-round through the low-level outlet. Flows greater than 60 cfs are released through the mid-level outlet. The 60 cfs flow is the minimum flow requirement for all months based on the Relicensing Settlement Agreement (PG&E 2004a). Blending would raise the water temperature release at Canyon Dam Outlet from approximately the 10–12°C range to the 14-15°C range in June–August period. The effect of blending the outflows from Canyon Dam Outlet is to slightly preserve the quantity of cold water withdrawn from the hypolimnion. Consequently, there is a slight difference in the outflow water temperature of about 0.1°C decrease from Prattville Intake in comparison with no blending option. Such minor water temperature reduction at Prattville Intake is not expected to produce any measurable water temperature benefits in the Belden, Rock Creek, Cresta and Poe reaches, leading to the conclusion that it is not a reasonable water temperature control measure.

3.2.5 Alternative 9. Re-operate Belden Dam to Provide Increased Magnitude Water Releases to NFFR at Belden Dam to Cool the Belden Reach

This alternative consists of re-operation of the Belden Dam to provide increased magnitude water releases at Belden Dam to cool the Belden Reach of the NFFR. The Belden Reach is unique as it has significant riparian vegetation that provides shading and cooling effects to water temperatures.

Increased magnitude water releases decrease flow travel time in the reach and thus minimize solar exposure duration to the atmospheric condition and consequently reduce the water temperature level at the end of the reach. The degree of reduced warming depends on the extent of the atmospheric heating, the elevation and the hydraulic geometry of the river, the riparian and topographic shadings in the canyon, the timing of the year and the starting water temperatures. This conventional understanding quite often leads to a measure to control river water temperature by increasing magnitude of water releases for a regulated system. However, when there are significant sources of cooling mechanisms that exist along the river segment, such as the cold water accretion and/or significant shading relative to the starting water temperature level, the effect of the increased magnitude water releases would be compensated and in a certain situation creates an opposite effect to the lowering of the downstream water temperatures by the increased magnitude water releases.

Belden Reach is the first river reach below Butt Valley Reservoir and is significantly controlled by the water temperature regime delivered by the powerhouses. Belden Reach is known to have significant riparian shading effect (in addition to the topographic shading). Such extensive shading results in a very mild water temperature warming through the river segment above the EBNFFR (see Figure 8 for typical July condition). The warming is less than 0.5ºC through the entire reach (approximately 9 miles). In August (Figure 9), when the starting water temperatures are warmer (due to the lowering of water surface in Lake Almanor), the water temperatures actually get colder as water travels downstream (the cooling from air temperature). As a result, the conventional increased magnitude water release measure does not produce significant benefit in lowering the water temperature downstream; in fact, this measure would create the opposite water temperature benefit in the river. Figure 12 was reproduced from Figure E2.6-33 in the *FERC Project No. 2105 (Upper NFFR Project) Final Application for License* (PG&E 2002) that shows the marginal to negative effects of increased magnitude water releases in Belden Reach. Water temperature modeling and tests concluded that increasing magnitude of water released at Belden Dam will not produce a cooling of the water in the Belden Reach but would actually slightly warm the water in the Belden Reach. Additionally, increased magnitude water releases would result in adverse impacts on power generation. These considerations lead to the conclusion that it is not a reasonable water temperature control measure.

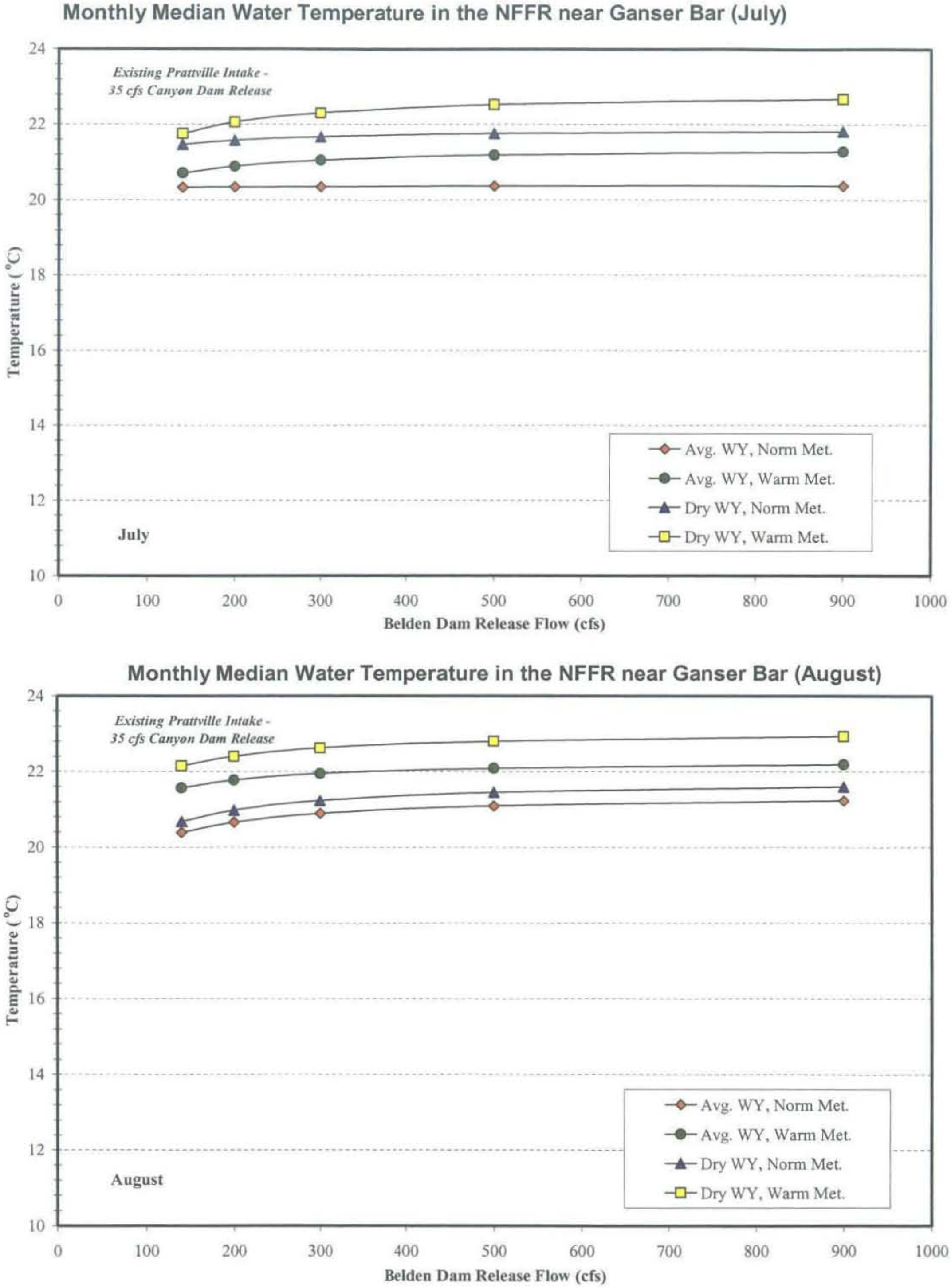

Figure 12. Effect of environmental condition on the relationship between monthly median water temperature in the NFFR near Gansner Bar and increasing water releases from Belden Dam (existing Prattville Intake configuration), July–August (PG&E 2002, Figure E2.6-33).

3.2.6 Alternative 10. Re-operate Rock Creek Dam to Provide Increased Magnitude Water Releases to the NFFR at Rock Creek Dam to Cool the Rock Creek Reach

This alternative consists of re-operating Rock Creek Dam to provide increased magnitude water releases at Rock Creek Dam to cool the Rock Creek Reach of the NFFR. The Rock Creek Reach has several tributaries and inflow from the Bucks Creek Powerhouse inflows that cause a cooling effect to water in this reach.

In 1986 WCC developed water temperature models of the Rock Creek Reach and Cresta Reach of the NFFR using the *SNTEMP* model (Theruer et al. 1984). As part of the most recent Rock Creek-Cresta Project effort (FERC Project No. 1962), the 1986 *SNTEMP* water temperature models were revised and updated. As part of the updating process, data collected in 2002 was incorporated into the existing models to strengthen model calibration (PG&E 2003). The results of this modeling analysis were presented in *Revised Water Temperature Modeling for the Rock Creek-Cresta Hydroelectric Project—FERC Project No. 1962* (PG&E 2003c, TRPA 2003).

License conditions issued in October 2001 specified that water release flows in each reach be increased to a new level for evaluation at intervals of every five qualified years (a total of three five-year periods are specified in the license) (PG&E 2001, 2003). Water release flows were tied to water year type (normal/wet, dry, and critical dry) and changed seasonally. Water temperature conditions resulting from the increased water release flows would then be monitored during each five-year time period. Actual measurements from 2002 data were used to simulate the effect of increased magnitude water releases on water temperature given the same meteorological conditions. The magnitude of the increased water release covered up to the "normal/wet" condition for the first, second, and third five-year periods (PG&E 2003c, TRPA 2003).

Under the "normal/wet" condition, model predictions for the Rock Creek Reach suggest that increased magnitude water releases produce incrementally higher average water temperature above Bucks Creek Powerhouse and Rock Creek Powerhouse (PG&E 2003c). During June, July, and August, a water temperature increase of 0.2°C, 0.1°C, and 0.4°C (above Bucks Creek Powerhouse) and 0.2°C, 0.6°C, and 1.0°C (above Rock Creek Powerhouse), respectively for each month were observed when flows were increased from 180 cfs to 390 cfs (PG&E 2003c, Table 3-11A). This is largely the result of increased magnitude water release flows over-riding the cooling benefit from colder tributaries and inflows from Bucks Powerhouse and other tributaries. Some reduction in water temperature is seen with increased magnitude water release flows closer to the dam.

Based upon model predictions, controllable factors (flow releases) are over-ridden by non-controllable physical factors (e.g., solar radiation, lack of shading, tributary inflow, starting water temperatures released from the dam). Increasing the magnitude of water releases at Rock Creek Dam would over-ride the cooling effect of these tributary sources and would actually have the effect of warming the water in this reach. Additionally, increased magnitude water releases would result in adverse impacts on power generation. These considerations lead to the conclusion that it is not a reasonable water temperature control measure.

3.2.7 Alternative 11. Re-operate Cresta Dam to Provide Increased Magnitude Water Releases at Cresta Dam to Cool the Cresta Reach

This alternative consists of re-operating Cresta Dam to provide increased magnitude water releases at Cresta Dam to cool the Cresta Reach of the NFFR. Similar to Rock Creek, the Cresta model simulated increased magnitude water release flows up to the "normal/wet" condition for the second and third five-year conditions, and model predictions for the Cresta Reach suggest that increased magnitude water releases produce incrementally lower water temperature with distance from the dam. During June, July, and August the water temperature change was 0.1°C, 0.2°C, and 0.0°C lower, respectively at the end of the reach (above Cresta Powerhouse) when water flows were increased from 220 cfs to 440 cfs (refer to Table 3-11B of the document PG&E 2003c). Increased magnitude water release flows show a marginal benefit to the Cresta Reach largely because of the lack of cooling tributary inflows. Overall, the net water temperature change (higher or lower) for the various water flow releases was small.

Based upon model predictions, controllable factors (magnitude of water releases) are over-ridden by non-controllable physical factors (e.g., solar radiation, lack of shading, tributary inflow, and starting water temperatures released from the dam). Water temperature modeling concluded that even with a doubling of the already substantial 220 cfs minimum streamflow, only a slight reduction of 0.2°C in water temperature would be achieved in the Cresta Reach. The minor level of water temperature benefits for this alternative is not commensurate with the cost in the form of foregone power generation, leading to the conclusion that it is not a reasonable water temperature control measure.

3.2.8 Alternative 12. Re-operate Poe Dam to Provide Increased Magnitude Water Releases at Poe Dam to Cool Poe Reach

This alternative consists of re-operation of the Poe Dam to provide increased magnitude water releases at Poe Dam to cool the Poe Reach of the NFFR. Similar to the study performed for the Rock Creek-Cresta Reach of the NFFR, a study was performed on the Poe Reach of the NFFR to determine the effect of increased magnitude water releases at Poe Dam on the water temperature measured at Poe Reach (PG&E 2003a). The results of this study show that the water temperature change related to increased magnitude water releases in the Poe Reach are more pronounced than they were in the Rock Creek-Cresta reaches. One influencing factor is that the Poe Reach is lower in elevation than the Rock Creek and Cresta reaches.

The *PG&E-WCC-SNTEMP* model was used to simulate water temperatures in the Poe Reach under various water flow management scenarios (PG&E 2003a). Eight water release flows at Poe Dam were modeled (existing [50], 100, 150, 200, 300, 500, 850, and 1,250 cfs). The Poe Project is still in relicensing collaboration and a settlement has not yet been reached.

Figure 13 shows the predicted relationship of water temperatures with flows in the NFFR just above Poe Powerhouse under normal conditions (PG&E 2003a). This figure shows that as the water flow release is increased beyond a certain flow there is a diminished return in the water temperature change (i.e., the decrease in water temperature levels off). Water temperature reduction is more pronounced (from 22.2°C to 20.6°C) in the lower water flow range (from 50 cfs to 200 cfs) and levels-off gradually above 200 cfs.

The water temperature change with increasing water flow was also predicted for the extreme conditions at the NFFR above Poe Powerhouse. Figure 14 shows the relationship between water temperature and water flow at NFFR above Poe Powerhouse under extreme conditions. Generally, the pattern of water temperature change with increasing water flow is similar for the extreme and normal conditions; however, the overall water temperatures are typically 1 to 2°C higher under extreme conditions than under normal conditions (PG&E 2003a).

In conclusion, increased magnitude water releases at Poe Dam would result in water temperature reductions of about 1.5°C in the lower flow range (increasing flows from the currently required minimum of 50 cfs to 200 cfs). Once flows are above 200 cfs, even a doubling of flows reduces water temperatures only about 0.5°C. Increased minimum streamflows on the order of 200 cfs are anticipated to be required through the ongoing relicensing of the Poe Project. Flows in excess of this range are anticipated to have serious adverse effects on amphibians. Additionally, increased magnitude water releases would result in adverse impacts on power generation. The minor level of water temperature benefits for flow increases beyond about 200 cfs is not commensurate with the corresponding adverse effects to amphibians and costs in the form of foregone power generation, leading to the conclusion that this alternative is not a reasonable water temperature control measure.

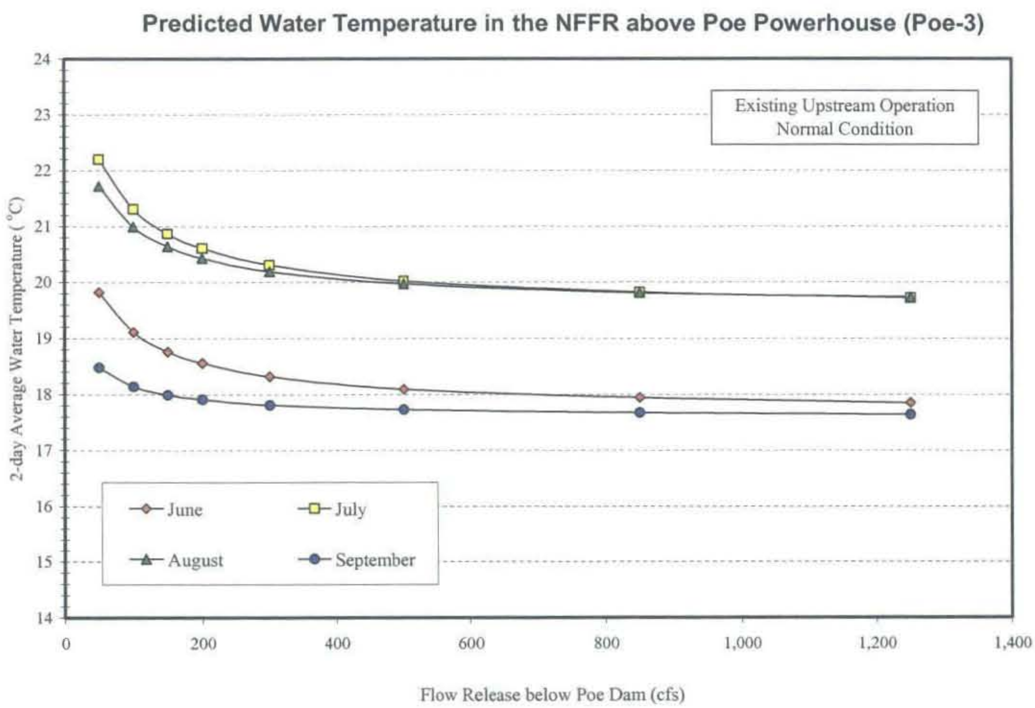

Figure 13. Relationship of water temperature with flow in the NFFR above Poe Powerhouse under normal conditions. (PG&E 2003a).

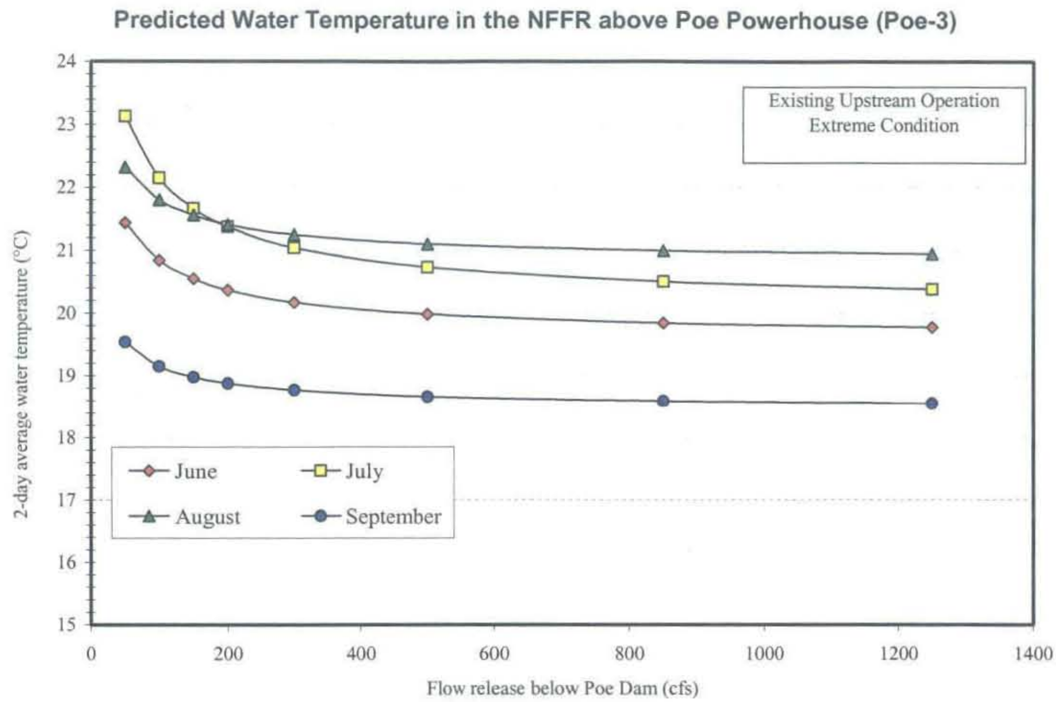

Figure 14. Relationship between water temperature and flow at NFFR above Poe Powerhouse under extreme conditions. (PG&E 2003a).

3.2.9 Alternative 13. Re-operate and/or Reconfigure Bucks Creek Project to Provide Cooler Inflows to the NFFR

This alternative consists of re-operation and/or reconfiguration of the Bucks Creek Project to reduce water temperatures in a short portion of the Rock Creek Reach. The Bucks Creek Project delivers relatively cool water to the lower portion of the Rock Creek Reach. The Bucks Creek Project is comprised of Bucks Lake, Lower Bucks Lake, Grizzly Powerhouse, Grizzly Forebay, and Bucks Creek Powerhouse. Bucks Lake is the main storage reservoir and delivers relatively cool water to Lower Bucks Lake through a low level outlet (PG&E 2005c). Water is then diverted from Lower Bucks Lake to Grizzly Forebay through Grizzly Powerhouse. A minimum water release of 3 cfs (in summer) is made to Bucks Creek downstream of Lower Bucks Dam; this flow subsequently discharges into the NFFR approximately 0.75 miles upstream of Rock Creek Powerhouse (PG&E 2005c). Flow from Grizzly Powerhouse immediately enters Grizzly Afterbay, which is then diverted through Bucks Creek Powerhouse. Bucks Creek Powerhouse discharges directly to the NFFR approximately 1.0 mile upstream of Rock Creek Powerhouse and 0.25 miles downstream of the mouth of Bucks Creek. The maximum operating flow for normal maximum head at Bucks Creek Powerhouse is 383 cfs.

A water temperature evaluation was performed on data from stations located upstream and downstream of inflows from the Bucks system and was presented in Licensee's 2004 *Water Temperature Monitoring Program Data Report* (PG&E 2005c). The evaluation focused on inflow from Bucks Creek and Bucks Creek Powerhouse. Water temperatures from Stations NF12 (NFFR above Bucks Creek), NF13 (NFFR below Bucks Creek Powerhouse), RC1 (Rock Creek Powerhouse), and NF14 (NFFR below Cresta Dam) were used to determine the effect of inflows from Bucks Creek (BUCK1) and Bucks Creek Powerhouse (BUCK2). Bucks Creek Powerhouse was operated on a peaking-type regime during the June through September period. This is done largely to conserve water for power generation and maintain lake levels in Bucks Lake through the summer period in support of recreational concerns and property owner issues (PG&E 2005c).

A sixteen-day evaluation period (July 2004) was selected which included five days of consistently higher Bucks Creek Powerhouse operation, six days of reduced powerhouse operation, and a five-day standard operation period (PG&E 2005c, Figure 3-26A). There was no period when Bucks Creek Powerhouse was not operated in 2004. During higher powerhouse operations, the average decrease in water temperatures measured in the NFFR downstream of the Bucks system inflows (NF13) were 2.7°C lower on average and were also below the 20°C level (PG&E 2005c, Figure 3-26A). The absolute effect of Bucks system inflows on the NFFR was measured at Station NF14. This station is below Cresta Dam and represents resulting water temperatures following the mixing of Rock Creek (RC2), Rock Creek Powerhouse (RC1), and the NFFR end of the Rock Creek Reach (NF13) in Cresta Reservoir. Water temperatures at Station NF14 during the five day period were 0.7°C cooler than the Rock Creek Powerhouse inflow and were 1.9°C warmer than Station NF13. During reduced powerhouse operations the water temperature measured in the NFFR downstream of the Bucks system inflows (NF13) was an average of 1.1°C lower and was also reduced below the 20°C level (PG&E 2005c). The absolute effect of Bucks Creek on the Cresta Reach measured at Station NF14 showed water temperatures that were 0.5°C cooler then the Rock Creek Powerhouse inflow and were 0.7°C warmer than Station NF13 (PG&E 2005c, Figure 3-26A).

Results of the evaluation indicate that operation of Bucks Creek Powerhouse can reduce water temperatures in the NFFR immediately upstream of Rock Creek Powerhouse. This effect was measurable even at reduced powerhouse flows. However, due to the large volume of inflow from Rock Creek Powerhouse at water temperatures similar to those measured in the NFFR upstream of inflows from the Bucks system, there appears to be no measurable effect downstream of Rock Creek Powerhouse.

Bucks Creek Project operates as a peaking facility when the water temperature is the hottest (current operation). As described above, the current configuration and operation of the Bucks Creek Project provides very favorable water temperature benefits to the NFFR. In conclusion, any reconfiguration or re-operation would have little effect on reducing NFFR water temperatures, but would have adverse impacts on power generation by this high-head peaking facility and recreation use of Bucks Lake. The anticipated minor level of water temperature benefits for this alternative is not commensurate with the corresponding adverse effects and costs, leading to the conclusion that it is not a reasonable water temperature control measure.

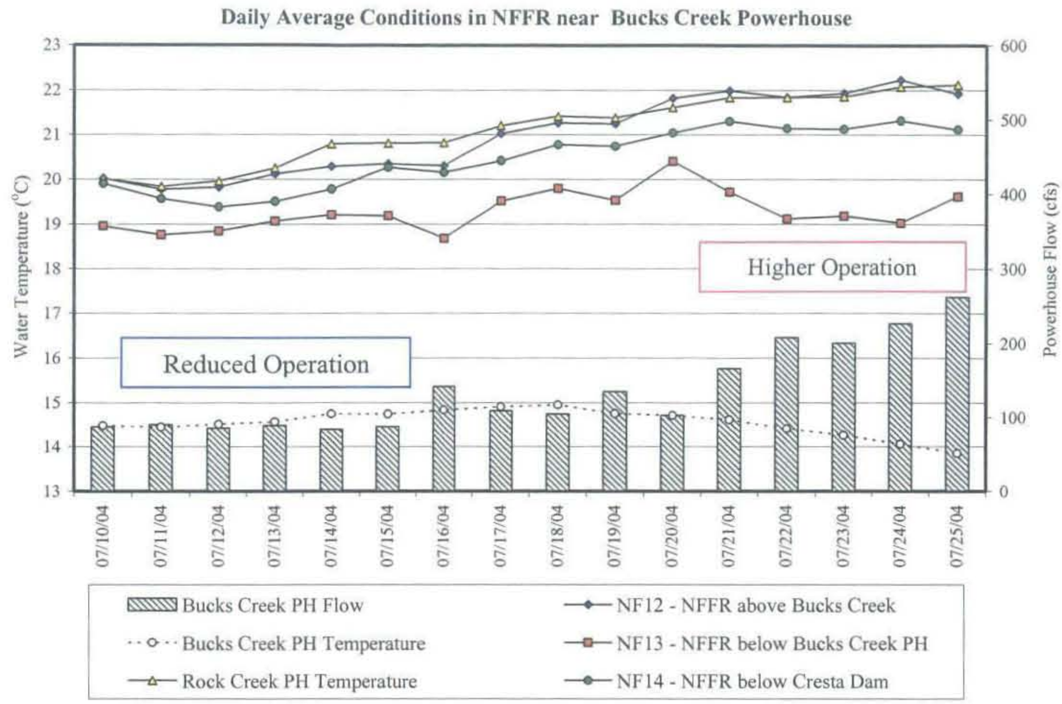

Figure 15. Result of Bucks Creek system mitigation evaluations on NFFR water temperatures—2004. Effect of Bucks Creek Powerhouse on NFFR water temperatures. (PG&E 2005c, Figure 3-26A).

3.3 Category 3. Obtain Cold Water from Sources Other than Lake Almanor

The following eleven potential alternatives (Alternatives 14 through 24) were originally presented in the, "*Evaluation of Additional Alternatives to Provide Cooler Water to the North Fork Feather River,*" which was prepared by Licensee in March 2005 (PG&E 2005b).

3.3.1 Alternative 14. Construct Mechanical Water Cooling Towers at Belden, Rock Creek, Cresta and Poe Dams

Alternative description: Construct and operate mechanical cooling towers on the NFFR to cool incoming river water and deliver it to the river below Belden, Rock Creek, Cresta and Poe Dams. The engineering firm of Black and Veatch provided the following conceptual feasibility assessment.

Assumptions: Divert, pipe, and pump the existing required instream flow release amount at each dam into mechanical draft wet-type cooling towers located in the vicinity of each dam. The wet-type cooling tower was chosen because it has the smallest footprint in relation to other types of cooling towers. For this analysis a flow of 250 cfs (112,200 gallons per minute [gpm]) and a cooling requirement of 1°C (1.8°F) is used. The cooling requirement would require numerous (fourteen – 50-feet long x 50-feet wide x 75-feet high) very large cooling towers at each dam. At or below each dam an area of approximately 200 feet x 900 feet would be needed to site the cooling towers, piping, pumps and electrical equipment.

Siting considerations: A review of the topography, river flood plain, and highway/railroad route locations below Rock Creek, Cresta, and Poe dams was conducted. The review concludes that adequate space does not exist to site the cooling towers near Belden, Rock Creek, Cresta, and Poe Dams. A flat area large enough for cooling towers exists at Rogers Flat located on the Rock Creek Reach. At this location, cooling towers installation would require a river diversion dam, pumps and piping to withdraw river water into the cooling towers. This area is currently occupied by Licensee's existing Feather River Hydro Operating Headquarters and Maintenance Area and therefore these existing facilities would need to be relocated. No suitable relocation area has been identified.

Two flat areas possibly large enough for cooling towers exist below Belden Dam (below Belden Dam and at the Belden Adit) however both sites have topography and geological uncertainties.

Other considerations: The operation of the cooling tower fans and water pumps would require considerable electric power supply. The power requirements of the cooling towers are about 5,500 kW. New transmission/distribution lines and substations would be required at each site to supply the required electrical power.

An estimated Construction Cost Budget range for cooling towers, pumps, piping, stream dam with sand filter, and bypass overflow stream is $9.8 to $13.5 million per river reach. Total estimated cost for the four reaches (Belden, Rock Creek, Cresta, and Poe) is $39.2 to $54 million. These estimated costs are for a typical installation. They do not address the confined site conditions along the Feather River, architectural appearance, or other potential mitigation measures required to allow construction at these sites. They also do not include costs for utilities including the transmission lines to bring power supply to each site.

Conclusion: Adequate space does not exist to site cooling towers near Belden, Rock Creek, Cresta and Poe dams without extremely challenging and costly construction. Due to inadequate space, major visual impacts, substantial construction, operation, and maintenance costs this alternative warrants no further evaluation. The modest level of water temperature benefits for this alternative is not commensurate with the corresponding adverse effects and costs. These considerations lead to the conclusion that it is not a reasonable water temperature control measure.

3.3.2 Alternative 15. Construct Mechanical Water Chillers at Belden, Rock Creek, Cresta and Poe Dams

Alternative description: Construct and operate mechanical water chillers on the NFFR to cool incoming river water and deliver it to the river below Belden, Rock Creek, Cresta, and Poe Dams. The engineering firm of Black and Veatch provided the following conceptual feasibility assessment (PG&E 2005b).

Assumptions: Divert, pipe, and pump the existing required instream flow release amount at each dam into mechanical chillers located in the vicinity of each dam. For this analysis a flow of 250 cfs (112,200 gpm) and a cooling requirement of 1°C (1.8°F) is used. A system employing high efficiency electrical centrifugal coolers with helper cooling towers is proposed. Based on the limited design criteria provided, the design cooling load for 250 cfs flow with a 1.8°F ΔT is

8,461 tons of cooling. The site area required for the cooling tower to allow proper air circulation would be about 130 feet by 200 feet with a chiller building occupying a space of 90 feet by 120 feet.

Siting considerations: A review of the topography, river flood plain and highway/railroad route locations below Rock Creek, Cresta and Poe dams was conducted. The review concludes that adequate space does not exist to site the water chiller system near Rock Creek, Cresta, and Poe Dams. A flat area large enough for water chillers exists at Rogers Flat located on the Rock Creek Reach. At this location, water chillers installation would require a river diversion dam, pumps and piping to withdraw river water into the water chillers. This area is currently occupied by Licensee's existing Feather River Hydro Operating Headquarters and Maintenance Area and therefore these existing facilities would need to be relocated. No suitable relocation area has been identified.

Two flat areas possibly large enough for water chillers exist below Belden Dam (below Belden Dam and at the Belden Adit) however both sites have topography and geological uncertainties.

Other considerations: The operation of the water chillers and water pumps would require considerable electric power supply. The power requirements of the water chiller system are about 3,600 kW. New transmission/distribution lines and substations would be required at each site to supply the required electrical power.

An estimated Construction Cost Budget range for the system described above is $1,400 to $1,800 per ton, or $11.8 to 15.2 million, per installation. Total estimated cost for four sites is $47.2 to 60.8 million. These estimated costs are for a typical installation. They do not address the confined site conditions along the Feather River, architectural appearance, or other potential mitigation measures required to allow construction at these sites. They also do not include costs for utilities including the transmission lines to bring power supply to each site.

Conclusion: Adequate space does not exist to site water chiller system near Rock Creek, Cresta, and Poe dams without extremely challenging and costly construction. Due to inadequate space, major visual impacts, substantial construction, operation, and maintenance costs this alternative warrants no further evaluation. The modest level of water temperature benefits for this alternative is not commensurate with the corresponding adverse effects and costs. These considerations lead to the conclusion that it is not a reasonable water temperature control measure.

3.3.3 Alternative 16. Construct Water Wells at Belden, Rock Creek, Cresta and Poe Dams

Alternative description: Drill, construct and operate water wells on the NFFR to deliver cooler well water to the river below Belden, Rock Creek, Cresta, and Poe Dams (PG&E 2005b).

Assumptions: For this analysis it is assumed an existing river flow of 200 cfs (89,766 gpm) is at 22°C (71.6°F) and will be cooled by 3°C (5.4°F) at the mixing point using well water. The 22°C river water temperature represents the existing August 25% exceedance water temperature. The input location of the cold well water (mass balance to provide 3°C cooling when initially mixed with the river water) is at or near each dam. The river water naturally heats up about 2°C as it travels down each river reach resulting in a net benefit of about 1°C cooling at the bottom of the river reach. The water temperature of the well water is assumed to be 10°C (50°F).

Calculations: It would require mixing 66 cfs or 29,623 gpm of well water at 10°C with 200 cfs at 22°C NFFR water below each dam to achieve the desired cooling of 3°C at the mixing point.

Siting considerations: A review was conducted of the topography, river flood plain, and highway/railroad route locations below Belden, Rock Creek, Cresta, and Poe dams. The review concludes that adequate space does not exist to site well pumps and the associated electrical equipment. A review of local well drillers and geologic information concludes that an adequate aquifer does not exist in the area.

Other considerations: No detailed construction cost estimate was performed for this alternative. The operation of the well pumps would require considerable electric power supply. New transmission/distribution lines and substations would be required at each site to supply the required electrical power. Well water may have chemical characteristics (minerals and DO) that are incompatible with the SWRCB Basin Plan water quality objectives for the NFFR.

Conclusion: It is not likely an adequate aquifer exists near Belden, Rock Creek, Cresta, and Poe dams. Therefore, this alternative warrants no further evaluation. These considerations lead to the conclusion that it is not a reasonable water temperature control measure.

3.3.4 Alternative 17. Construct a Water Pipeline and Pumping Stations to Pump Cool Water from Lake Oroville for Release to the NFFR at Belden, Rock Creek, Cresta and Poe Dams

Alternative description: Construct and operate a water pipeline and pumping stations on the NFFR to deliver cooler water from the lower depths of Lake Oroville to Belden, Rock Creek, Cresta, and Poe Dams (PG&E 2005b).

Assumptions: For this analysis it is assumed an existing river flow of 200 cfs (89,766 gpm) is at 22°C (71.6°F) and will be cooled by 3°C (5.4°F) at the mixing point using Lake Oroville water. The 22°C river water temperature represents the existing August 25% exceedance water temperature. The input location of the Lake Oroville pumped water (mass balance to provide 3°C cooling when initially mixed with the river water) is just below each dam. The river water naturally heats up about 2°C as it travels down the river reach resulting in a net benefit of about 1°C cooling at the bottom of the river reach. The water temperature of the Lake Oroville is assumed to be 10°C (50°F). Lake Oroville thermally stratifies each year and water temperature data indicates 10°C water is located about 60-75 feet in depth below the surface. There will be some heating effects to the pipeline water while in-route due to pumping and pipe surface heat transfer. This heating effect has not been calculated.

Calculations: It would require mixing 66 cfs or 29,623 gpm of Lake Oroville water at 10°C with 200 cfs at 22°C NFFR water below each dam to achieve the desired cooling of 3°C at the mixing point. Pumping cold water from Lake Oroville to Rock Creek, Cresta and Poe dams would require a minimum of 198 cfs or 88,869 gpm (not counting heat gain from pumping and conveyance).

Pipeline and pumping calculations: A 72-inch-diameter pipe is a good starting assumption for the 198 cfs (Lake Oroville to Poe dam pipeline section). Using this size of pipe and assuming standard friction head losses the flow velocities would be about 7 feet per second. The pipe could be reduced to a 60-inch-diameter for the Poe dam to Cresta dam pipeline section. Finally, the pipe could be reduced to a 48-inch-diameter for the Cresta dam to Rock Creek dam section. The total pipeline length would be more that 30 miles. The approximate total elevation difference of a pipeline would be about 1,600 feet. Numerous pumping stations would be required depending on the specific hydraulic grade and lift requirements. No pumping station estimate has been done at this time.

Siting considerations: A review of the topography, river flood plain and highway/railroad route locations below Rock Creek, Cresta and Poe dams was conducted. No feasible pipeline route was determined.

Other considerations: No detailed construction cost estimate was performed for this alternative. The operation of the pipeline and pumping stations would require considerable electric power supply. New transmission/distribution lines and substations would be required at each site to supply the required electrical power. Lake Oroville water may have chemical characteristics (minerals and DO) that are incompatible with the State Water Resources Control Board's Basin Plan water quality objectives for the NFFR.

Conclusion: Construction and operation of a large pipeline to transport Lake Oroville water to Belden, Rock Creek, Cresta, and Poe dams would be a major engineering and construction task with significant environmental impacts and risks. There exists no feasible pipeline route. Therefore, this alternative warrants no further evaluation. The level of water temperature benefits for this alternative is not commensurate with the corresponding adverse effects and costs. These considerations lead to the conclusion that it is not a reasonable water temperature control measure.

3.3.5 Alternative 18. Construct a New Dam and Water Pipeline on Upper NFFR to Cool the Belden Reach

Alternative description: Construct and operate a diversion dam and gravity water pipeline to deliver cooler water from the Upper NFFR just above Caribou Powerhouse to immediately below Belden Dam (PG&E 2005b).

Assumptions: During July and August the flows in the Upper NFFR just above Caribou Powerhouse are approximately 68 cfs. The measured Upper NFFR mean water temperature for July and August 2002 was 15 to 15.9°C. For this analysis it is assumed that 50 cfs at 15°C of Upper NFFR water is diverted and gravity piped about 1 mile to a point immediately below Belden Dam. Below Belden Dam it is mixed with existing river flow of 90 cfs at 22°C (71.6°F). The 22°C river water temperature represents the existing August 25% exceedance water temperature. The input location of the Upper NFFR piped water is immediately below Belden Dam. If an above-ground water pipeline was constructed, there will be heating effects to the pipeline water while in-route due to pipe surface heat transfer. This heating effect has not been calculated.

Calculations: The mixing of 50 cfs at 15°C Upper NFFR water with 90 cfs at 22°C Belden Reservoir released water will result in 140 cfs of 19.5°C water at the mixing point. This would be a 2.5°C water temperature reduction below Belden Dam.

Pipeline size calculations: An approximate minimum pipeline size of 48-inch-diameter is necessary to gravity pipe a flow of 50 cfs for 1 mile. The calculated minimum pipeline size requires a 13-foot head (ignoring entrance losses and bend losses) which locates the diversion dam above Caribou Powerhouse.

Siting considerations: Pipeline and diversion dam construction in the Upper NFFR canyon would have significant engineering, construction, and environmental challenges. Construction of a diversion dam and routing the pipeline through the existing Caribou Powerhouse area and along the Caribou road would be challenging.

Other considerations: No detailed construction cost estimate was performed for this alternative. Currently the Upper NFFR water provides a localized cooling effect at the confluence with Caribou Powerhouse outflows. This provides some cold water refuge for fish in the immediate area. The diversion dam would create fish passage issues. Operation and maintenance of a large water pipeline through the Caribou Powerhouse area and along the Caribou road would have failure risks from auto collisions, road maintenance equipment, and rock slides.

Conclusion: Construction and operation of a large pipeline to transport Upper NFFR water to Belden Dam would be a major engineering and construction task with significant environmental impacts and risks. There exists no feasible pipeline route that does not have major construction costs and impacts on Caribou Powerhouse and Caribou road. Therefore, this alternative warrants no further evaluation. The level of water temperature benefits for this alternative is not commensurate with the corresponding adverse effects and costs. These considerations lead to the conclusion that it is not a reasonable water temperature control measure.

3.3.6 Alternative 19. Construct a New Dam and Water Pipeline on Yellow Creek to Cool the Rock Creek Reach

Alternative description: Construct and operate a diversion dam and gravity water pipeline to deliver cooler water from Yellow Creek to immediately below Rock Creek Dam. The engineering firm of Black and Veatch provided the following conceptual feasibility assessment (PG&E 2005b).

Assumptions: During July and August the flows in Yellow Creek just above its confluence with the NFFR are approximately 50 cfs. The measured Yellow Creek mean water temperature for July and August 2003 was 15 to 16°C. For this analysis it is assumed that 50 cfs at 16°C of Yellow Creek water is diverted and gravity piped about 3 miles to a point immediately below Rock Creek Dam. Below Rock Creek Dam it is mixed with existing river flow of 200 cfs at 22°C (71.6°F). The 22°C river water temperature represents the existing August 25% exceedance water temperature. The input location of the Yellow Creek piped water is immediately below Rock Creek Dam. If an above-ground water pipeline was constructed, there will be heating effects to the pipeline water while in-route due to pipe surface heat transfer. This heating effect has not been calculated.

Calculations: The mixing of 50 cfs at 16°C Yellow Creek water with 200 cfs at 22°C Rock Creek Reservoir released water will result in 250 cfs of 20.8°C water at the mixing point. This would be a 1.2°C water temperature reduction below Rock Creek Dam.

Pipeline size calculations: Gravity piping of cold water from Yellow Creek is basically one of engineering economics in which one would have to weigh the cost variables for different-sized pipe heads necessary to overcome pipe friction and pipeline route/diversion dam location alternatives. Hydraulic calculations were performed and an approximate economic pipeline size of 3-foot diameter is necessary to gravity pipe a flow of 50 cfs for 3.1 miles.

Siting considerations: A review of the topography, river flood plain and highway route locations at Rock Creek reservoir was conducted. Field reconnaissance concluded the pipeline route would be a combination of surface and underground pipeline following Highway 70. Significant portions of the pipeline would need to be buried under Highway 70 due to limited space.

Other considerations: The estimated construction cost is $39,196,000. Currently Yellow Creek water provides a localized cooling effect at the confluence with the NFFR. This provides some cold water refuge for fish in the immediate area. The diversion of Yellow Creek would eliminate this local cool water refuge at the confluence. Operation and maintenance of a large water pipeline along Highway 70 would have failure risks from auto collisions, road maintenance equipment and rock slides.

Conclusion: Construction and operation of a large pipeline to transport Yellow Creek water to Rock Creek dam would be a major engineering and construction task with significant environmental impacts and risks. There exists no feasible pipeline route that does not have major construction costs and impacts on Highway 70. Therefore, this alternative warrants no further evaluation. The level of water temperature benefits for this alternative is not commensurate with the corresponding adverse effects and costs. These considerations lead to the conclusion that it is not a reasonable water temperature control measure.

3.3.7 Alternative 20. Construct a New Diversion Structure and Water Pipeline at Bucks Creek Powerhouse to Cool the Cresta Reach

Alternative description: Construct and operate gravity water pipeline to deliver cooler water from the Bucks Creek Powerhouse to immediately below Cresta Dam (PG&E 2005b).

Assumptions: During July and August the maximum flows through Bucks Creek Powerhouse are approximately 300 cfs. The measured Bucks Creek Powerhouse outflow mean water temperature for July and August 2003 was 14.3 to 16.7°C. For this analysis it is assumed that 50 cfs at 16°C of Bucks Creek Powerhouse water is diverted and gravity piped about 4 miles to a point immediately below Cresta Dam. Below Cresta Dam it is mixed with existing river flow of 200 cfs at 22°C (71.6°F). The 22°C river water temperature represents the existing August 25% exceedance water temperature. The input location of the Bucks Creek Powerhouse piped water is immediately below Cresta Dam. If an above-ground water pipeline was constructed, there will be heating effects to the pipeline water while in-route due to pipe surface heat transfer. This heating effect has not been calculated.

Calculations: The mixing of 50 cfs at 16°C Bucks Creek Powerhouse water with 200 cfs at 22°C Cresta Reservoir released water will result in 250 cfs of 20.8°C water at the mixing point. This would be a 1.2°C water temperature reduction below Cresta Dam.

Pipeline size calculations: An approximate minimum pipeline size of 4-feet diameter is necessary. The calculated minimum pipeline size requires a 13-foot head (ignoring entrance losses and bend losses). A pressurized water pipeline system along Highway 70 is not recommended.

Siting considerations: Pipeline construction in the NFFR canyon would have significant engineering, construction and environmental challenges. Major disruption of Highway 70 traffic would be expected during construction. Also, underground telephone lines traverse along Highway 70 which could be disrupted during construction.

Other considerations: No detailed construction cost estimate was performed for this alternative. Currently Bucks Creek Powerhouse water provides a localized cooling effect for the approximately 1 mile river reach to the Rock Creek Powerhouse. This provides cold water refuge for fish in the immediate area. The diversion of Bucks Creek Powerhouse water would eliminate some of the local cool water refuge in this reach. Operation and maintenance of a large water pipeline along Highway 70 would have failure risks from auto collisions, road maintenance equipment and rock slides.

Conclusion: Construction and operation of a large pipeline to transport Bucks Creek Powerhouse water to Cresta Dam would be a major engineering and construction task with significant environmental impacts and risks. There exists no feasible pipeline route that does not have significant construction costs and major adverse impacts on Bucks Creek and Rock Creek Powerhouses and Highway 70. Therefore, this alternative warrants no further evaluation. The level of water temperature benefits for this alternative is not commensurate with the corresponding adverse effects and costs. These considerations lead to the conclusion that it is not a reasonable water temperature control measure.

3.3.8 Alternative 21. Construct a New Large Dam and Reservoir on Yellow Creek and/or the East Branch Feather River to Collect and Deliver Seasonally Cooler Water to NFFR

Alternative description: Build and operate a large dam and reservoir on Yellow Creek and/or the EBNFFR and its tributaries to provide thermally stratified cold water from its lower depths to reduce water temperatures at the EBNFFR at its confluence with the NFFR and downstream on the Belden, Rock Creek, Cresta and Poe river reaches (PG&E 2005b).

Assumptions: A new dam and reservoir, if sized large enough, could store high winter/spring runoff and provide thermally stratified cold water from its lower depths during summer months. Based on Lake Almanor, Butt Valley Reservoir and Bucks Lake thermal stratification profiles, a new dam would need to be over 100 feet high to provide enough water depth and volume to supply sufficient quantities of cold water.

Three potential large reservoirs in the Upper Feather River basin were identified in the State of California Bulletin No. 3, titled Report on the California Water Plan, May, 1956 and the State of California, Department of Water Resources Bulletin No. 194, March 1974 titled Hydroelectric Energy Potential in California. The locations of the identified potential large reservoirs are as follows:

1. Humbug Valley Reservoir in Yellow Creek tributary to the NFFR
2. Genesee Reservoir on Indian Creek tributary to the EBNFFR
3. Squaw Queen Reservoir on Last Chance Creek tributary the Indian Creek then EBNFFR

Licensee and others have previously evaluated each of the above reservoir sites and have found them not feasible for various reasons.

Calculations: 1) At the confluence of the EBNFFR and the NFFR, the EBNFFR flows in July and August are approximately the same flow magnitude as those in the upstream NFFR. Therefore, using existing flows, any beneficial water temperature change made in the EBNFFR that reach the confluence will be reduced by 50% after mixing with the flows from the NFFR; 2) Below Belden Powerhouse the NFFR flows in July and August are approximately ten times greater than the EBNFFR flows. Therefore, using existing flows, any beneficial water temperature change made in the EBNFFR that reach the confluence will have a corresponding 10% water temperature change result in the NFFR immediately below Belden Powerhouse after mixing occurs.

This dilution effect using existing flows is illustrated by the following example: A 1.0°C water temperature reduction in the EBNFFR will result in 1) a 0.5°C water temperature reduction in the NFFR from the confluence to Belden Powerhouse (1.8 mile reach); and 2) a 0.1°C water temperature reduction in the NFFR below Belden Powerhouse.

It is expected that the Humbug Valley/Yellow Creek site would not provide any measurable water temperature changes to the NFFR.

Siting considerations: Both Genesee and Squaw Queen Reservoirs are approximately 30 to 40 miles upstream of Belden Powerhouse and significant warming of EBNFFR river water will continue to occur. Intervening Indian Valley irrigation withdrawals downstream of Genesee and Squaw Queen reservoirs could reduce any water temperature benefits. Significant environmental impacts of a new large reservoir will need to be considered.

Other considerations: No detailed construction cost estimate was performed for this alternative. Probability of obtaining additional storage water rights for new reservoirs is not likely unless adverse impacts on downstream prior water right holders are mitigated (i.e., DWR, Lake Oroville).

Water released from the lower portion of the reservoirs will have chemical characteristics (minerals and DO) that are incompatible with the State Water Resources Control Board's Basin Plan water quality objectives for the NFFR.

Conclusion: The identified potential large reservoirs at Genesee Valley and Squaw Valley could provide thermally stratified cooler water producing local water temperature benefits however those water temperature benefits are not expected to result in any measurable water temperature change to the NFFR below Belden Powerhouse. Also, it is anticipated that any new dam and reservoir would have adverse environmental impacts and very large costs. Therefore, this alternative warrants no further evaluation. The level of water temperature benefits for this alternative is not commensurate with the corresponding adverse effects and costs. These considerations lead to the conclusion that it is not a reasonable water temperature control measure.

3.3.9 Alternative 22. Enlarge an Existing Dam and Reservoir on the East Branch Feather River to Collect and Deliver Seasonally Cooler Water to NFFR

Alternative description: Enlarge and operate a existing reservoir on the EBNFFR and its tributaries to provide thermally stratified cold water from its lower depths to reduce water temperatures at the EBNFFR at its confluence with the NFFR and downstream on the Belden, Rock Creek, Cresta and Poe river reaches (PG&E 2005b).

Assumptions: An enlarged dam and reservoir, if sized large enough, could store high winter/spring runoff and provide thermally stratified cold water from its lower depths during summer months. Based on Lake Almanor, Butt Valley Reservoir and Bucks Lake thermal stratification profiles, a new dam would need to be over 100 feet high to provide enough water depth and volume to supply sufficient quantities of cold water.

One potential enlarged reservoir in the Upper Feather River basin was evaluated. Round Valley Reservoir is located about 3 miles south of the community of Greenville. The current impoundment was built in 1865. It has a water storage capacity of 5,200 AF with a surface area of 4878 acres. The dam is 35 feet high and 325 feet long.

Calculations: 1) At the confluence of the EBNFFR and the NFFR, the EBNFFR flows in July and August are approximately the same flow magnitude as those in the upstream NFFR. Therefore, using existing flows, any beneficial water temperature change made in the EBNFFR that reach the confluence will be reduced by 50% after mixing with the flows from the NFFR; 2) Below Belden Powerhouse the NFFR flows in July and August are approximately ten times greater than the EBNFFR flows. Therefore, using existing flows, any beneficial water temperature change made in the EBNFFR that reach the confluence will have a corresponding 10% water temperature change result in the NFFR immediately below Belden Powerhouse after mixing occurs.

This dilution effect using existing flows is illustrated by the following example: A 1.0°C water temperature reduction in the EBNFFR will result in 1) a 0.5°C water temperature reduction in the NFFR from the confluence to Belden Powerhouse (1.8 mile reach); and 2) a 0.1°C water temperature reduction in the NFFR below Belden Powerhouse.

An analysis of the Round Valley watershed was conducted to determine the annual runoff. The Round Valley watershed has a drainage area of 9.12 sq. miles. Using nearby watershed precipitation, snow and river flow gage information the annual runoff from the Round Valley

Basin was calculated to be 5,007 AF/year. It is concluded that the existing Round Valley Reservoir is sized appropriately for the annual runoff.

Siting considerations: Not determined.

Other considerations: No detailed construction cost estimate was performed for this alternative. Probability of obtaining additional storage water rights for new reservoirs is not likely unless adverse impacts on downstream prior water right holders are mitigated (i.e., DWR, Lake Oroville).

Conclusion: An evaluation of potential enlargement of Round Valley Reservoir was conducted. The annual runoff for the Round Valley basin is only 5,007 AF/year and would not produce enough water volume to fill an enlarged reservoir. Therefore, this alternative warrants no further evaluation. This finding combined with the other adverse effects and costs identified in Alternative 21 lead to the conclusion that enlargement of the existing dam is not a reasonable water temperature control measure.

3.3.10 Alternative 23. Plant and Manage Riparian Vegetation to Improve River Shading on East Branch Feather River

Alternative description: Perform streamside vegetation management on the EBNFFR and its tributaries to promote additional shading to reduce water temperatures at the EBNFFR at its confluence with the NFFR and downstream on the Belden, Rock Creek, Cresta, and Poe reaches (PG&E 2005b).

Assumptions: Water temperature monitoring on the 7.5 mile Belden Reach has demonstrated a water cooling effect of up to 1°C resulting from river shading. The river flow characteristics of the Belden Reach have been significantly altered by the presence of Lake Almanor, Butt Valley, and Belden dams. This results in limited high bank scouring flows allowing for dense vegetative growth. Conceptually, a similar density of vegetative growth at the margins of the EBNFFR and its tributaries (with similar geographic orientation and river area topography) could result in comparable cooling effects as those observed in the Belden Reach.

Calculations: 1) At the confluence of the EBNFFR and the NFFR, the EBNFFR flows in July and August are approximately the same flow magnitude as those in the upstream NFFR. Therefore, any beneficial water temperature change made in the EBNFFR that reach the confluence will be reduced by 50% after mixing with the flows from the NFFR. 2) Below Belden Powerhouse the NFFR flows in July and August are approximately ten times greater than the EBNFFR flows. Therefore, any beneficial water temperature change made in the EBNFFR that reach the confluence will have a corresponding 10% water temperature change result in the NFFR immediately below Belden Powerhouse after mixing occurs.

Siting considerations: Unlike the Upper NFFR, no significant large water storage facilities exist on the EBNFFR that have the ability to capture and control high flood flows. Therefore, when compared to the Belden Reach, it is not expected that any degree of vegetative management on the EBNFFR will be effective in improving the existing density of vegetative growth and majority canopy cover at the margins of the EBNFFR and its tributaries. Considerations of stream geographic orientation in relation to sun's daily path and area topography for any vegetative management on the EBNFFR will influence any expected water temperature benefits.

Other considerations: No detailed construction cost estimate was performed for this alternative. Existing land management practices on private lands in the EBNFFR may not allow vegetation management to any large degree. Also, intervening Indian Valley irrigation withdrawals and the long water travel time to the NFFR could reduce any water temperature benefits from vegetation management.

Conclusion: Uncontrolled periodic high flood flows control the primary geomorphic features and the resultant riverside vegetation/majority canopy cover of the EBNFFR and its tributaries. Vegetation management on the EBNFFR and its tributaries may provide some local water temperature benefits however those water temperature benefits are not expected to result in any measurable water temperature change to NFFR below Belden Powerhouse. Therefore, this alternative warrants no further evaluation. These considerations lead to the conclusion that it is not a reasonable water temperature control measure.

3.3.11 Alternative 24. Construct a Water Pipeline from the Existing Poe Tunnel Adit to Transport Cool Water to a Portion of the Poe Reach

Alternative description: Construct and operate a pressurized water pipeline to deliver cooler water from the Poe Tunnel Adit #1 to the NFFR near Bardees Bar. The engineering firm of Black and Veatch provided the following conceptual feasibility assessment (PG&E 2005b)

Assumptions: The Poe Tunnel Adit #1 (near Bardees Bar) is located approximately 4.5 miles downstream of the Poe Diversion Dam and there is an existing 940-foot length tunnel that intersects the main Poe Tunnel. Inside the Poe Audit #1 tunnel near the main Poe Tunnel there is a 20-foot long concrete plug with an 18-inch-diameter pipe and gate valve which is used during tunnel outages. A hydraulic analysis concluded that a new 24-inch-diameter by 2,389-foot-long water pipeline could deliver approximately 50 cfs of Poe Tunnel water from the Adit #1 to the river edge at Bardees Bar. For this analysis it is assumed that the water traveling in the Poe Tunnel reaching the Poe Adit #1 is at the same water temperature as when diverted at the Poe Diversion Dam. The 22°C river water temperature at Poe Dam represents the existing August 25% exceedance water temperature. It is assumed that a 150 cfs water release from Poe Dam into the river heats approximately 1°C while traveling approximately 4.5 miles to Bardees Bar.

Calculations: The mixing of 50 cfs at 22°C Poe Tunnel Adit #1 water with 150 cfs at 22°C water released from Poe Dam will result in 200 cfs of 22.75°C water at the mixing point at Bardees Bar. This would be a 0.75°C water temperature reduction below Bardees Bar.

Pipeline size calculations: The existing 18-inch-diameter gate valve is capable of releasing about 35 cfs therefore a new 24-inch-diameter gate valve and pipeline would be required to deliver approximately 50 cfs. This pipeline is pressurized and an energy dissipating valve will likely be required.

Siting considerations: The total horizontal length of the new pressurized pipeline alignment is estimated to be 2389-feet including 940-feet inside the adit tunnel. The pipeline would need to be buried and the 940-foot portion of the pipeline in the adit tunnel would either 1) need to be removable; or 2) need to be buried in the adit tunnel floor in the event of a need to access the main Poe Tunnel. The pressurized pipeline would also need to cross under the existing railroad tracks.

Other considerations: The estimated construction cost for this project is approximately $15,124,000 (Black and Veatch 2005). Any water delivered from the Poe Adit would bypass Poe Powerhouse and would result in lost power generation. The cost of replacement power would be in a range of $50,000 to $100,000 per month. Access to the adit area for construction and materials delivery would be challenging. It is expected that rail delivery of equipment and materials would be the best method.

Conclusion: Construction and operation of a pipeline to transport Poe Tunnel Adit #1 water to the North Fork Feather River would provide only small water temperature benefits. Therefore, this alternative warrants no further evaluation. This alternative has substantial construction costs and adverse impacts on power generation. For this alternative, the level of water temperature benefits is not commensurate with the cost, leading to the conclusion that it is not a reasonable water temperature control measure.

4 ENVIRONMENTAL EVALUATION AND OTHER FACTORS

4.1 Construction and Implementation Cost Associated with Prattville Modifications (Category 1)

The Prattville Intake Modifications, Phase 3, Feasibility Study Report prepared by Black & Veatch Corporation for Licensee provided a summary of construction and implementation costs, and estimated schedule for the various thermal curtains, dredging, and submerged hooded pipe alternatives (Black & Veatch 2004). Table 4 shows the comparison of alternatives and is reproduced from Table 7-1 of the Black & Veatch January 2004 report (Black and Veatch 2004).

In summary, the costs of the various thermal curtain options vary depending upon the specific thermal curtain configurations. The estimated cost for dredging alone was approximately $5.4 million. The estimated cost for the submerged hooded pipe with dredging was approximately $14.8 million (Black and Veatch 2004). Black & Veatch reported that the water temperature difference achievable at the Prattville Intake during a "typical" August day, with an outflow of 1,600 cfs at Prattville Intake, was found by the IIHR (IIHR 2004) to be best for the long thermal curtain (U-shaped with dimensions of 900x770x 900 feet) with dredging (Black and Veatch 2004, IIHR 2004). Black and Veatch reported that the hooded submerged pipe offers only slightly better performance than the long thermal curtain with no dredging (Black and Veatch 2004, IIHR 2004).

Table 4. Comparison of Prattville Modification Alternatives (Black & Veatch 2004).

Factor	Dredging Alone	Long Movable Thermal Curtain W/O Dredging	Long Fixed Thermal Curtain W/O Dredging	Long Movable Thermal Curtain W/ Dredging	Long Fixed Thermal Curtain W/ Dredging	Hooded Submerged Pipe W/ Dredging
Dredging	23,000 CY	0 CY	0 CY	23,000 CY	23,000 CY	43,000 CY
T change in Aug., 1,600 cfs @ Pratt Intake	N/A, no change expected	3.5°C	3.5°C	5.2°C	5.2°C	3.8°C
Head loss @ 1,600 cfs	0	0	0	0	0	2.3 feet
Operation	None	Thermal Curtains moved 2x each year	None	Thermal Curtains moved 2x each year	None	Gates moved 2x each year
Construction schedule	110 days	220 days	200 days	220 days	200 days	240 days
Cost opinion*	$5.4** million	$9.5 million	$12.4** million	$11.8 million	$17.8** million	$14.8 million

T = water temperature; CY = cubic yards; * Includes 25% contingency, taxes, engineering, construction management, PG&E management costs not included; ** Cost opinion updated (November 2004).

4.2 Potential In-Reservoir Thermal Curtain-Associated Water Quality Impacts

During the summer, DO concentrations at the bottom of Lake Almanor drop to zero. For much of the year, Lake Almanor is stratified. Warm water stays in the mixed surface layer (i.e., the epilimnion layer) and does not readily mix with the deeper water (i.e., the hypolimnion layer). The DO at the bottom of the lake is reduced by the breakdown of organic materials and is not replenished by re-aeration from the lake surface.

To better understand the DO concentration patterns in Lake Almanor and the potential effects of a thermal curtain, a water quality model was developed for Lake Almanor. The *CE-QUAL-W2* reservoir water quality model (developed by the U.S. Army Corps of Engineers) was used to simulate water quality conditions in Lake Almanor. The performance of the model was evaluated by assessing the match with 2000 and 2001 water quality measurements in Lake Almanor, particularly water temperature and DO (Jones and Stokes 2004).

The model was used to simulate the effect of placing a thermal curtain in front of the intake for the Butt Valley Powerhouse (Prattville Intake) to withdraw water from deeper, colder areas in the lake and thereby reduce the withdrawal water temperatures (Alternative 3 and 4). The results showed that the thermal curtain would reduce water temperature (up to 5°C) and lower the DO (to 1-2 mg/l) in water being released from the powerhouse and would have only a small effect on the water temperature and DO profiles in the lake. The primary effect of the thermal curtain was to increase the depth of the surface mixed layer and lower the thermocline by 0–10 feet (see Figure 16, [reproduced from Jones and Stokes 2004 Figure 12b]).

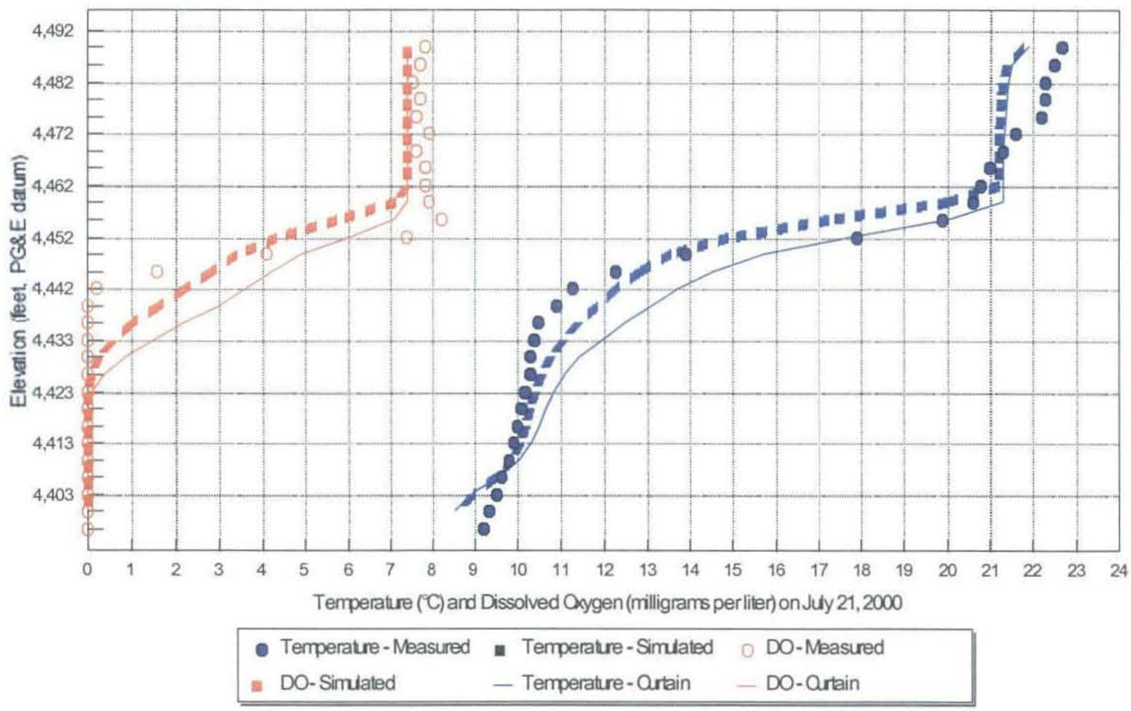

Figure 16. Simulated and measured profiles of water temperatures and dissolved oxygen (DO) in Lake Almanor near Canyon Dam on July 21, 2000.

The thermal curtain is also expected to pass the cold water but with low DO through the Butt Valley Powerhouse and consequently the Butt Valley Reservoir, although the water is not expected to be completely anoxic (Jones and Stokes 2004, Figure 24). The low DO water passing through Butt Valley Powerhouse would likely need to be re-aerated to meet Basin Plan standards. Mechanisms to aerate the water could be applied (i.e., turbine venting or oxygenation devices in the water body) (Jones and Stokes 2004).

Alternative 6 withdraws colder water from the lowest strata of Lake Almanor via low-level gates of the Canyon Dam Outlet. Similar to Alternative 3 and 4, this alternative would result in the lowering of the thermocline (see profile comparison in Figure 17 (provided by Bechtel) for one typical normal year operation). The maximum lowering of the thermocline for water temperatures between 17-20°C averaged about 2.6 feet for the entire 33 years simulated operation.

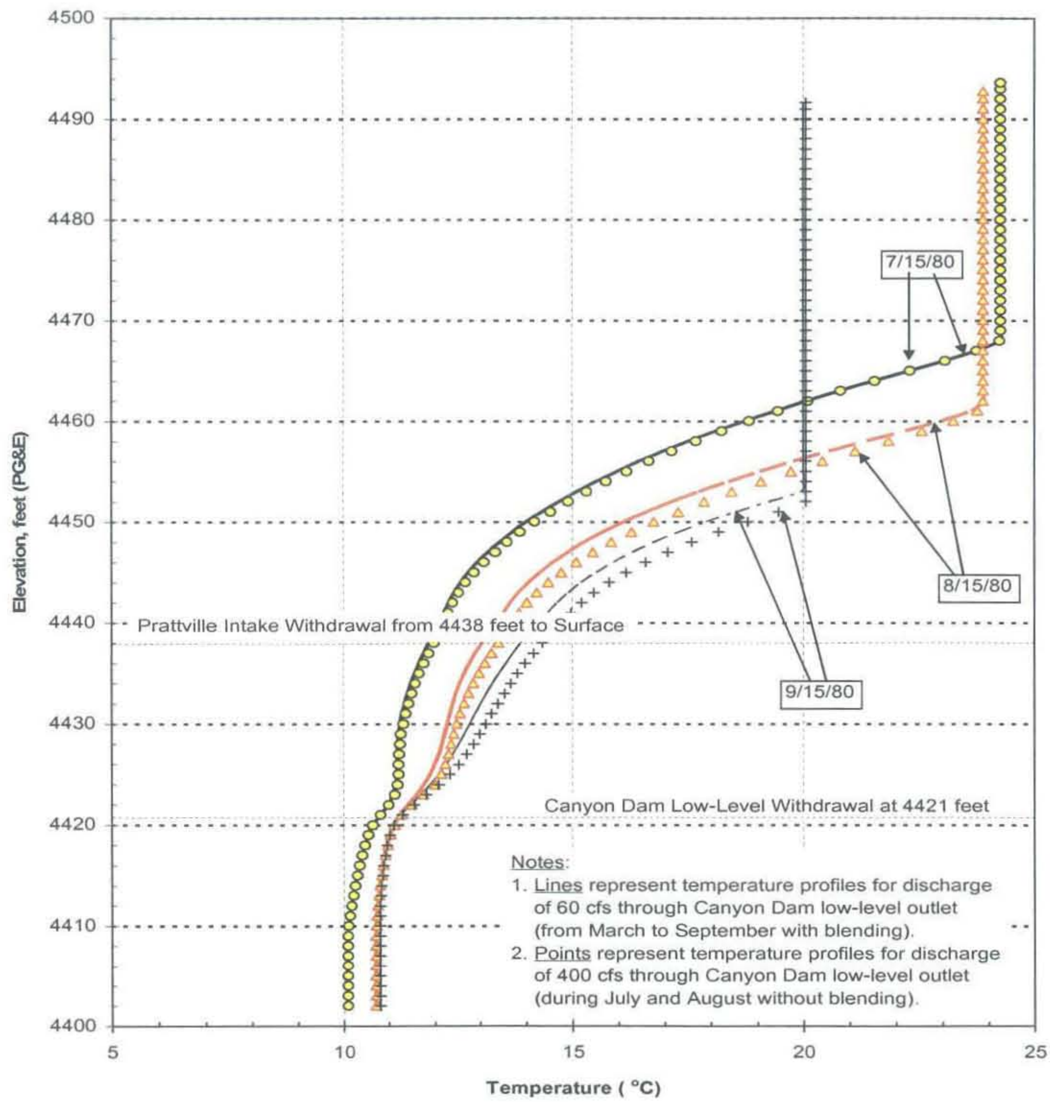

Figure 17. Lake Almanor water temperature profiles for average operation in a normal year (1980).

4.3 Potential Fishery Impact by Alternatives 1, 2, 3, 4, and 6

4.3.1 Impacts on Lake Almanor and Butt Valley Reservoir Fisheries

Lake Almanor and Butt Valley Reservoir are complex ecosystems with many parameters affecting their respective fisheries. Existing documentation was used to identify and evaluate the potential induced impacts from the preferential withdrawal of cold water from Lake Almanor (Alternatives 1, 2, 3, 4, and 6) to the lake's salmonid habitat resulting from changes to lake water temperatures and DO concentrations (Jones and Stokes 2004); and impacts to the burrowing mayfly (*Hexagenia limbata*) habitat and wakasagi (*Hypomesus nipponensis*) entrainment (Thomas R. Payne & Associates 2004).

The effects of the changes on water temperature and oxygen profiles (see Section 4.2, above) on suitable habitat for cold water fish (i.e., trout and salmon) in Lake Almanor were estimated using two methods: one that estimated suitable habitat volume using water temperature and DO thresholds (up to 22°C maximum and a minimum of 5.0 mg/l) and another that calculated habitat value using suitability indices (SI; range of 0.0 [lowest] to 1.0 [highest]) for water temperature and DO. For both of these methods, the results for the simulated values were similar to the results for the measured values. During the summer, as expected, the habitat values (both simulated and measured) decrease substantially. The SI method, which was found to produce smaller deviations between calculated and measured data, showed that minimal SI occurs in August under both simulated existing and simulated curtain conditions. For the two years modeled, 2000 and 2001, the SI value for the simulated existing condition were 0.06 and 0.03, respectively, and the SI value for the simulated curtain condition were 0.03 and 0.02, respectively (Jones and Stokes 2004, tables 20 and 21), compared to a maximum value of 1. This analysis indicates that under the selected parameters of water temperature and DO, both the simulated existing and simulated thermal curtain conditions would result in limited cold water habitat. It should also be noted that, although the simulated thermal curtain indices for both modeled years were less than that for simulated existing condition, these differences are within the range of accuracy of the model.

Lake salmonid habitat must have sufficient DO and cold enough water temperatures for fish survival and growth. Fish are unable to live in water with zero DO concentrations, and low DO concentrations can lead to the release of undesirable anaerobic chemicals. The existing summertime anoxic hypolimnion and warm epilimnion both limit the available habitat to the transition between the two layers, the thermocline. Cold water fish in Lake Almanor are confined to the portions of the lake that have the appropriate combination of sufficiently low water temperature and high DO concentrations. In some cases, this zone of suitable habitat may be confined to a relatively narrow band near the bottom of the mixed surface layer of the lake (Jones and Stokes 2004). The existing summertime conditions currently stress the salmonid populations. Although the reservoir model predictions with the thermal curtain compared to existing conditions predicts no major changes to lake DO concentrations and water temperature (Jones and Stokes 2004), those changes which are predicted reduce the available salmonid habitat. Any thermal curtain induced reductions in either quality or quantity of cold water habitat during times in which the existing conditions severely limit available habitat would constitute additional stress on the cold water fishery, and could result in lower lake productivity. During times in which the existing conditions are not limiting, the presence of the thermal curtain will have little impact on salmonid habitat in Lake Almanor. The thermal curtain will reduce the DO concentrations in the Butt Valley Powerhouse outflow (to 1 – 2 mg/l) (Jones and Stokes 2004, Figure 24) to the extent that mitigating measures will have to be implemented. DO mitigation measures at Butt Valley Powerhouse have not been thoroughly evaluated; however, such measures could include air/oxygen bubbling systems, tailrace weirs, etc.

The emergence of *Hexagenia limbata* (the "Hex Hatch") and consequent active salmonid feeding attract numerous fishermen to Lake Almanor. By increasing the depth at which the thermocline forms, the preferential withdrawal of cold water may actually increase the available habitat for the burrowing mayflies and, in the absence of other limiting factors, increase the population.

Large numbers of wakasagi (Japanese pond smelt) are currently entrained in the Prattville Intake and conveyed to the Butt Valley Reservoir via the Butt Valley Powerhouse. The entrained wakasagi supply food for the trophy trout existing in Butt Valley Reservoir and powerhouse tailrace. The potential effect on wakasagi entrainment was modeled in a similar fashion as described above (see Section 4.2) for the cold water habitat. Three methods were used; the first two both had a maximum water temperature of 22°C and minimum DO concentrations of either 5.0 or 6.0 mg/l, and the third method employed a suitability index. All three of these methods indicated that the preferential withdrawal of cold water at the Prattville Intake will likely reduce or eliminate the wakasagi entrainment for most summer months (June through September) by 3% to 100% (79% of the results showed a decrease of 50% or more in entrainment), as evaluated for Alternative 4. The reductions in entrainment will be greatest during times when the lake surface elevation is high. Minimum changes to entrainment are expected at low lake elevations (Thomas R. Payne & Associates 2004).

In summary, the preferential withdrawal of cold water and/or re-operation (Alternatives 1, 2, 3, 4, and 6) is expected to reduce cold water habitat in Lake Almanor and reduce fish production in Butt Valley Reservoir.

4.3.2 Impact Assessment in the NFFR

Recently, as part of Project relicensing, instream flow studies have been undertaken on the various project reaches of the NFFR utilizing the Instream Flow Incremental Methodology (IFIM), a structured aquatic habitat evaluation process. A sub-component model of the IFIM called PHABSIM (Physical HABitat SIMulation) was used in the NFFR studies to examine the reach-specific relationships of flow and instream habitat suitability for aquatic species (Hardin-Davis & WESCO 1986, TRPA 2001, 2002). Results of the habitat simulation analysis for a particular reach of stream are expressed in terms of a Relative Suitability Index (RSI) per unit length (Thomas R. Payne 2003). The RSI was originally described as weighted usable area, WUA (Bovee and Milhous 1978). The RSI associated with a given flow is the index of physical suitability for the microhabitat qualities of water depth, velocity, and substrate and cover types within a stream reach.

The existing calibrated and validated stream reach water temperature models were used to predict stream water temperatures under existing operations and with proposed water temperature-alteration operations, while subject to normal and extreme meteorological conditions. From the calibrated *PHABSIM* models, habitat values (RSI) at various levels of flow for each individual stream reach were paired with the predicted water temperatures at those same levels of flow to generate a water temperature-conditioned habitat versus flow relationship.

Modeling results indicated that the increases in cold water habitats were generally greater in the upper reaches and decreased moving downstream. From the uppermost to lowermost reaches of the NFFR, potentially affected by decreased water temperatures resulting from preferential withdrawal of cold water from the Prattville Intake in Lake Almanor, the maximum increase in modeled habitat for rainbow trout under normal conditions occurred only in July and August, and were about: 8.5% in the upper Belden Reach; 14% in the lower Belden Reach; 8.5% in the Rock Creek Reach; 2.5% in the Cresta Reach; and 5.5% in the Poe Reach (based on evaluation of Alternative 4, which provided the maximum water temperature benefits). Habitat for both juvenile and adult trout was predicted to decrease in the upper Belden Reach in June by -14.7% and -4.6%, respectively, because of below optimal temperatures. There was either no change or slight decreases (0.5%<) in predicted trout habitat for June and September in all the other reaches. Other fish species modeled, hardhead, Sacramento sucker, Sacramento pikeminnow, and smallmouth bass all showed various levels of decreased habitat under both normal and extreme conditions.

Alternative 6 has the potential to reduce water temperatures in the Rock Creek and Cresta reaches by 1 to 2°C. Temperature effects in the Rock Creek and Cresta reaches are expected to be similar as under Alternative 4; namely increased cold water habitat in July and August (up to 8% in the Rock Creek reach and up to 2% in the Cresta reach) and decreased habitat for fish species preferring slightly warmer water such as hardhead, Sacramento sucker, Sacramento pikeminnow, and smallmouth bass.

In summary, thermal enhancement in the NFFR system will result in lowered stream water temperatures during a limited portion of the summer (generally for July and August) under certain conditions. The potential consequences of this are: a general shift in species assemblage downstream, a reduction of the smallmouth bass population, and increased trout population. The resulting changes to the NFFR fish population dynamics will likely be small and perhaps only detectable over the long term, except for smallmouth bass whose density should decrease more quickly. Due to the very limited potential increase in cold water habitat for only a few months each summer and the dynamics of natural population fluctuations; any benefits may not actually be ever measurable. The meteorological and hydrological conditions after the installation of the selective water withdrawal device or re-operation will determine the degree to which any changes are detectable.

4.3.3 Impacts on Seneca Reach Fishery

The potential biological effects of either the Swap 1 or 2 flow series (Alternative 6) in July and August in the Seneca reach on juvenile and adult trout both result in reduced habitat (as measured as WUA- weighted usable area) for juvenile trout, increased habitat for adult trout, and a potential reduction in habitat quality for all aquatic and riparian resources. Under the Upper NFFR Relicensing Settlement Agreement (PG&E 2004a), juvenile rainbow trout habitat is estimated at 97 and 99% of maximum WUA for July and August, respectively. Under the Swap 1 series, the maximum WUA for July and August would decrease to 85% and 74%, and under Swap 2, they would further decrease to 81% and 73%, or up to a 25% reduction in juvenile habitat. Adult rainbow trout maximum WUA habitat increases under both swap series from the

Upper NFFR Relicensing Settlement Agreement flow releases of 67% in July and 64% in August to 88% and 98% under Swap 1 and 93% and 99% under Swap 2, or up to a maximum increase of 35% on a month to month basis (PG&E 2004a).

However, because the new water temperature releases from Canyon Dam in July (<12°C) and August (<13°C) are about 3 and 2°C colder for July and August, respectively, compared to the Upper NFFR Relicensing Settlement Agreement (PG&E 2004a) condition (see Figures 8 and 9), and are below the lower optimum level for both juvenile and adult trout (15 and 17°C, respectively) for most of the reach, juvenile trout will be doubly affected by both lower quality and reduced habitat, and the increased adult habitat will also be of lower quality. Also, the combination of short term increased flow levels (in contradiction to a normal hydrograph of decreasing flows from spring to fall) of substantially colder water at Canyon Dam will result in essentially sending out of season environmental cues that could negatively affect the productivity of the entire aquatic and riparian communities in this reach.

5 CONCLUSIONS

Licensee conducted water temperature monitoring in the Rock Creek, Cresta, and several other reaches of the NFFR during 2002, 2003 and 2004. Generally, water temperature monitoring showed that water temperatures of 20°C or less were achieved in all months except July and August. During July and August the water temperatures at the warmest location in both the Rock Creek and Cresta reaches exceeded 20°C most of the time.

Licensee has identified and evaluated twenty-four potential alternatives for achieving colder water for the NFFR. Twenty of the twenty-four alternatives have potential application to the Rock Creek and Cresta reaches. Evaluation of the twenty-four potential alternatives was conducted using the best information available to PG&E, sound scientific methods, consideration of the relative cost of the different alternatives and other relevant factors. The evaluation process was comprehensive and scientific, at an aggregate cost to the Licensee of data acquisition and analysis in excess of $3 million to date.

Licensee has found no potential water temperature control alternative for which the level of water temperature benefits is commensurate with the corresponding adverse effects and costs. Therefore, Licensee concludes that there are no additional reasonable control measures for achieving year-round mean daily water temperature of 20°C or less in the Rock Creek and Cresta reaches of the NFFR.

Licensee's analysis of each of the twenty-four potential water temperature control alternatives indicates the following.

> The twenty-four potential alternatives were grouped into three categories (Category 1, Category 2, and Category 3).
>
> Category 1 alternatives deal with obtaining cold water from Lake Almanor through the use of thermal curtains or other means at the existing Prattville Intake located in the lake. Among these alternatives, Alternative 4 (Install two thermal curtains in Butt Valley Reservoir and one thermal curtain at Prattville Intake in Lake Almanor with dredging of the Prattville Intake area) has the best potential to reduce water temperatures in the Rock Creek and Cresta reaches. Licensee's analysis indicates that water temperature reductions of 1 to 3°C may be possible. However, sophisticated computer modeling (over the three, 5-year test flow periods) shows that this alternative would only increase the cold water trout habitat in the Rock Creek Reach by about 3 to 8 percent and in the Cresta Reach by about 0.5 to 2 percent in July and August of normal water years. Additionally, the model shows that in June and September, this alternative would cause a *decrease* in cold water trout habitat in the upper Belden Reach of -14.7 percent for juveniles and -4.6 percent for adults, while the rest of the reaches would generally show no change (0 to -0.4%) under normal water year conditions. Other fish species modeled, (hardhead, Sacramento sucker, Sacramento pikeminnow, and smallmouth bass) all showed various levels of decreased habitat for all months modeled (June-September). The overall benefits of such modest gains in trout habitat are expected to be very limited and not measurable given natural fish population variability. Also, this alternative has the potential for having a corresponding effect of *reducing* cold water fish habitat in Lake Almanor and *reducing*

fish production in Butt Valley Reservoir, resulting in a decrease of the aquatic resources and recreational value in each reservoir.

Category 2 alternatives deal with obtaining cold water from Lake Almanor by increasing the magnitude of seasonal water releases using the low-level gates in the existing Canyon Dam Outlet structure located in the lake and/or re-operation of the Licensee's Upper NFFR, Rock Creek-Cresta, Poe, and Bucks Creek projects. Among these alternatives, Alternative 6 (Re-operate Butt Valley Powerhouse to reduce Butt Valley Powerhouse flows to draw colder water from Lake Almanor for release to the NFFR, combined with increased magnitude water releases from Lake Almanor at Canyon Dam) has the potential to reduce water temperatures in the Rock Creek and Cresta reaches. Licensee's analysis indicates that water temperature reductions of 1 to 2°C may be possible. Because the temperature benefits in the Rock Creek and Cresta reaches are similar as under the Category 1 alternative (i.e., Alternative 4), the expected effects (positive and negative) to both the cold water trout habitat and other fish species habitat for Alternative 6 are essentially the same as described above (i.e., increased trout habitat and decreased habitat for other listed fish species for July and August). The overall benefits of such modest gains in trout habitat are expected to be very limited and not measurable given natural fish population variability. Also, this alternative has a potential for having a corresponding effect of *reducing* cold water fish habitat in Lake Almanor, *reducing* fish production in Butt Valley Reservoir, and *reducing* the quality of cold water fish habitat in the Seneca Reach, resulting in a decrease of the aquatic resources and recreational value in each reservoir and the Seneca Reach.

Category 3 alternatives deal with obtaining cold water from sources other than Lake Almanor. All of these alternatives are less effective in reducing the water temperatures in the Rock Creek and Cresta reaches compared to the more favorable Category 1 and 2 alternatives, and have significant siting constraints and corresponding adverse environmental effects.

All of the alternatives identified and evaluated have substantial costs in the range of tens of millions of dollars which, if implemented, would likely be borne by Licensee's electric customers. Other factors considered in the evaluations include the effects of each alternative on other beneficial uses (irrigation, power, recreation, aesthetic enjoyment, warm and cold water habitat), local economic considerations and public opinion expressed during the course of the evaluation.

PART 3

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Appendix A

Comparison of 2004 Water Temperature Monitoring Data with 2002 and 2003 Water Temperature Monitoring Data during July and August for the NFFR

and

NFFR Water Temperature Sampling Locations

Comparison of 2004 water temperature monitoring data with 2002 and 2003 water temperature monitoring data

		July 1 through August 31			
Station	Year	Average Water Temperature (°C)	Daily Average Exceedance of 20°C (% of days)	Maximum Hourly Water Temperature (°C)	Average Flow (cfs)
River Stations					
NF1	2002	14.9	0%	20.1	148
	2003	13.9	0%	19.9	225
	2004	14.3	0%	19.1	160
HB1	2002	11.9	0%	17.1	75
	2003	11.5	0%	14.9	89
	2004	11.9	0%	15.5	29
BC1	2002	13.9	0%	18.9	44
	2003	13.7	0%	19.0	65
	2004	13.4	0%	18.1	50
NF2	2002	12.9	0%	14.0	36
	2003	11.9	0%	12.8	36
	2004	21.1	98%	23.0	36
NF3	2002	14.7	0%	17.4	----
	2003	13.9	0%	17.2	----
	2004	18.4	0%	21.4	----
NF4	2002	15.4	0%	18.4	75
	2003	14.8	0%	18.8	70
	2004	16.8	0%	20.1	64
BD1	2002	21.7	95%	23.0	----
	2003	20.0	65%	22.0	----
	2004	21.2	90%	22.4	----
NF5	2002	20.1	61%	21.5	143
	2003	19.1	23%	21.0	143
	2004	20.8	79%	22.1	145
NF6	2002	19.9	48%	22.9	----
	2003	18.9	8%	22.4	----
	2004	20.4	77%	23.2	----

Comparison of 2004 water temperature monitoring data with 2002 and 2003 water temperature monitoring data (Continued)

		July 1 through August 31			
Station	Year	Average Water Temperature (°C)	Daily Average Exceedance of 20°C (% of days)	Maximum Hourly Water Temperature (°C)	Average Flow (cfs)
River Stations					
NF7	2002	19.9	50%	24.0	----
	2003	19.1	10%	23.6	----
	2004	20.3	76%	23.9	----
NF8	2002	21.1	87%	25.2	----
	2003	20.7	73%	25.4	----
	2004	21.3	100%	25.5	----
EB1	2002	22.8	97%	26.5	66
	2003	22.3	100%	27.4	128
	2004	22.3	100%	26.6	76
NF9	2002	----	----	----	----
	2003	20.0	58%	22.2	----
	2004	21.1	92%	22.2	----
NF10	2002	21.3	97%	23.4	213
	2003	20.1	65%	22.8	214
	2004	21.1	92%	22.5	272
NF11	2002	21.3	93%	24.0	----
	2003	20.3	68%	24.3	----
	2004	21.1	95%	23.9	----
NF12	2002	21.3	95%	24.0	----
	2003	20.3	66%	23.9	----
	2004	21.2	97%	23.6	----
NF13	2002	20.0	58%	24.1	----
	2003	18.5	18%	24.2	----
	2004	18.8	10%	22.8	----
NF14	2002	20.9	94%	22.8	----
	2003	19.8	34%	22.9	----
	2004	20.7	87%	22.2	

Comparison of 2004 water temperature monitoring data with 2002 and 2003 water temperature monitoring data (Continued)

Station	Year	July 1 through August 31: Average Water Temperature (°C)	Daily Average Exceedance of 20°C (% of days)	Maximum Hourly Water Temperature (°C)	Average Flow (cfs)
River Stations					
NF15	2002	20.9	92%	23.5	263
	2003	19.9	42%	23.9	291
	2004	20.7	85%	23.3	273
NF16	2002	21.3	95%	23.9	----
	2003	20.1	50%	23.9	----
	2004	21.0	95%	23.4	----
Tributary Stations					
BC2	2002	10.7	0%	11.2	----
	2003	10.8	0%	11.9	----
	2004	10.7	0%	11.2	----
BC3	2002	12.4	0%	14.0	14.0
	2003	12.3	0%	14.3	15.1
	2004	12.6	0%	14.5	15.1
MC1	2002	14.3	0%	16.7	4.3
	2003	13.5	0%	NA	6.4
	2004	14.0	0%	16.2	5.6
YC1	2002	16.4	0%	20.1	55
	2003	15.7	0%	20.1	81
	2004	15.7	0%	18.1	64
CHIP	2002	16.3	0%	21.0	20.6
	2003	15.4	0%	20.7	30.1
	2004	15.6	0%	19.5	21.1
MR1	2002	15.7	0%	20.4	4.3
	2003	15.4	0%	21.1	11.7
	2004	15.5	0%	20.2	6.1

Comparison of 2004 water temperature monitoring data with 2002 and 2003 water temperature monitoring data (Continued)

		July 1 through August 31			
Station	Year	Average Water Temperature (°C)	Daily Average Exceedance of 20°C (% of days)	Maximum Hourly Water Temperature (°C)	Average Flow (cfs)
Tributary Stations					
CHAM	2002	16.3	0%	21.4	5.3
	2003	15.7	0%	22.2	10.1
	2004	16.0	0%	20.9	4.4
JC1	2002	16.5	0%	21.2	----
	2003	16.4	2%	22.8	----
	2004	16.5	0%	21.4	----
BUCK1	2002	17.7	3%	23.5	14.1
	2003	17.0	8%	23.5	25.1
	2004	17.3	0%	23.2	15.0
RC2	2002	17.6	0%	20.7	4.0
	2003	17.9	19%	22.7	5.5
	2004	17.4	0%	20.5	3.9
GR1	2002	18.7	19%	22.7	20.8
	2003	17.8	13%	22.7	27.4
	2004	18.4	3%	22.3	19.5
MB1	2002	21.1	76%	25.3	----
	2003	20.5	42%	24.6	----
	2004	20.7	76%	24.1	----

Comparison of 2004 water temperature monitoring data with 2002 and 2003 water temperature monitoring data (Continued)

		July 1 through August 31			
Station	Year	Average Water Temperature (°C)	Daily Average Exceedance of 20°C (% of days)	Maximum Hourly Water Temperature (°C)	Average Flow (cfs)
Powerhouse Stations					
HB2	2002	15.4	0%	21.6	51
	2003	15.6	0%	21.2	89
	2004	14.7	0%	19.4	23
BV1	2002	20.7	85%	22.6	865
	2003	18.6	15%	20.8	1,281
	2004	20.4	69%	22.1	1,445
CARB1	2002	20.4	68%	22.2	401
	2003	18.8	0%	20.3	406
	2004	20.6	74%	22.1	542
CARB2	2002	22.9	100%	24.7	408
	2003	20.9	80%	24.1	873
	2004	22.0	100%	23.4	841
BD2	2002	21.5	93%	22.8	759
	2003	20.0	65%	21.8	1,195
	2004	21.3	92%	22.3	1,283
BUCK2	2002	15.5	0%	20.0	98
	2003	13.4	0%	20.1	125
	2004	13.6	0%	15.9	164
RC1	2002	21.5	97%	22.8	925
	2003	20.5	77%	22.7	1,478
	2004	21.6	97%	22.7	1,455
CR1	2002	21.2	100%	22.8	977
	2003	19.9	47%	22.7	1,581
	2004	20.7	89%	21.9	1,627

Comparison of 2004 water temperature monitoring data with 2002 and 2003 water temperature monitoring data (Continued)

Classification	2002	2003	2004
Watershed Runoff			
Water Year classification	Dry	Above Normal	Below Normal
State Runoff Index	6.5	8.0	7.7
Watershed Precipitation[1]	72%	110%	82%
Total Annual Inflow to Lake Oroville[2]	3,072,482 acft	4,674,077 acft	3,803,803 acft
Water Year Type – Feather River[3]	Dry	Normal	Normal
Air Temperature Exceedance			
Canyon Dam Annual Ranking	18%	0%	2%
Canyon Dam June Ranking	15%	4%	17%
Canyon Dam July Ranking	2%	4%	25%
Canyon Dam August Ranking	23%	38%	25%
Canyon Dam Sept. Ranking	23%	5%	55%

1. Average based on four stations within the watershed.
2. CDEC – 2004.
3. Based on definition outlined in Rock Creek-Cresta Settlement Agreement.

Note: Table 3-8 from PG&E 2005c. *Rock Creek-Cresta Project FERC Project No. 1962, Water Temperature Monitoring of 2004, Data Report, FERC License Condition No. 4C*. Report No. 026.11.05.6. May.

NFFR Water Temperature Sampling Locations

Station ID	Alternate Station Identification	Station Location
River Stations		
NF1	----	NFFR above Chester, CA.
HB1	----	Hamilton Branch of NFFR at HWY bridge
BC1	----	Butt Creek upstream of Butt Valley Reservoir
NF2	----	NFFR below Canyon Dam
NF3	----	NFFR at Seneca
NF4	NF-47 (PG&E)	NFFR above Caribou No.1 Powerhouse
BD1	----	Belden Reservoir at powerhouse intake
NF5	---	NFFR below Belden Dam
NF6	----	NFFR near Queen Lily Campground
NF7	----	NFFR near Gansner Bar
NF8	----	NFFR at Belden Town Bridge
EB1	----	East Branch of NFFR above confluence
NF9	----	NFFR below Rock Creek Dam
NF10	----	NFFR below Rock Creek Dam at NF-57
NF11	----	NFFR below Granite Creek
NF12	----	NFFR above confluence with Bucks Creek
NF13	----	NFFR above Rock Creek Powerhouse
NF14	----	NFFR below Cresta Dam
NF15	----	NFFR downstream of Grizzly Creek
NF16	----	NFFR upstream of Cresta Powerhouse
Tributary Stations		
BC2	----	Butt Creek downstream of Butt Valley Reservoir
BC3	----	Butt Creek near confluence with NFFR
MC1	----	Mosquito Creek near mouth
YC1	----	Yellow Creek near mouth
CHIP	----	Chips Creek near mouth
MR1	----	Milk Ranch Creek near mouth
CHAM	----	Chambers Creek near mouth
JC1	----	Jackass Creek near mouth
BUCK1	11-403700	Bucks Creek near mouth
RC2	----	Rock Creek near mouth
GR1	----	Grizzly Creek near mouth
MB1	----	Middle Fork Feather River at Milsap Bar

NFFR Water Temperature Sampling Locations

Station ID	Alternate Station Identification	Station Location
Powerhouse Stations		
HB2	----	Hamilton Branch Powerhouse – canal head-works
BV1	----	Butt Valley Powerhouse Tailrace
CARB1	----	Caribou No. 1 Powerhouse (internal)
CARB2	----	Caribou No. 2 Powerhouse tailrace (internal)
BD2	----	Belden Powerhouse (internal)
BUCK2	----	Bucks Creek Powerhouse tailrace
RC1	11-403800	Rock Creek Powerhouse (internal)
CR1	----	Cresta Powerhouse (internal)

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Appendix B

FERC No. 1962 License
First, Second, and Third 5-Year Plan
Daily Mean Water Temperature Profiles in the NFFR
for
July and August (Normal, Warm/Dry, Cold/Wet Scenarios)
for
Prattville Alternatives
and
Project Re-operation Alternatives

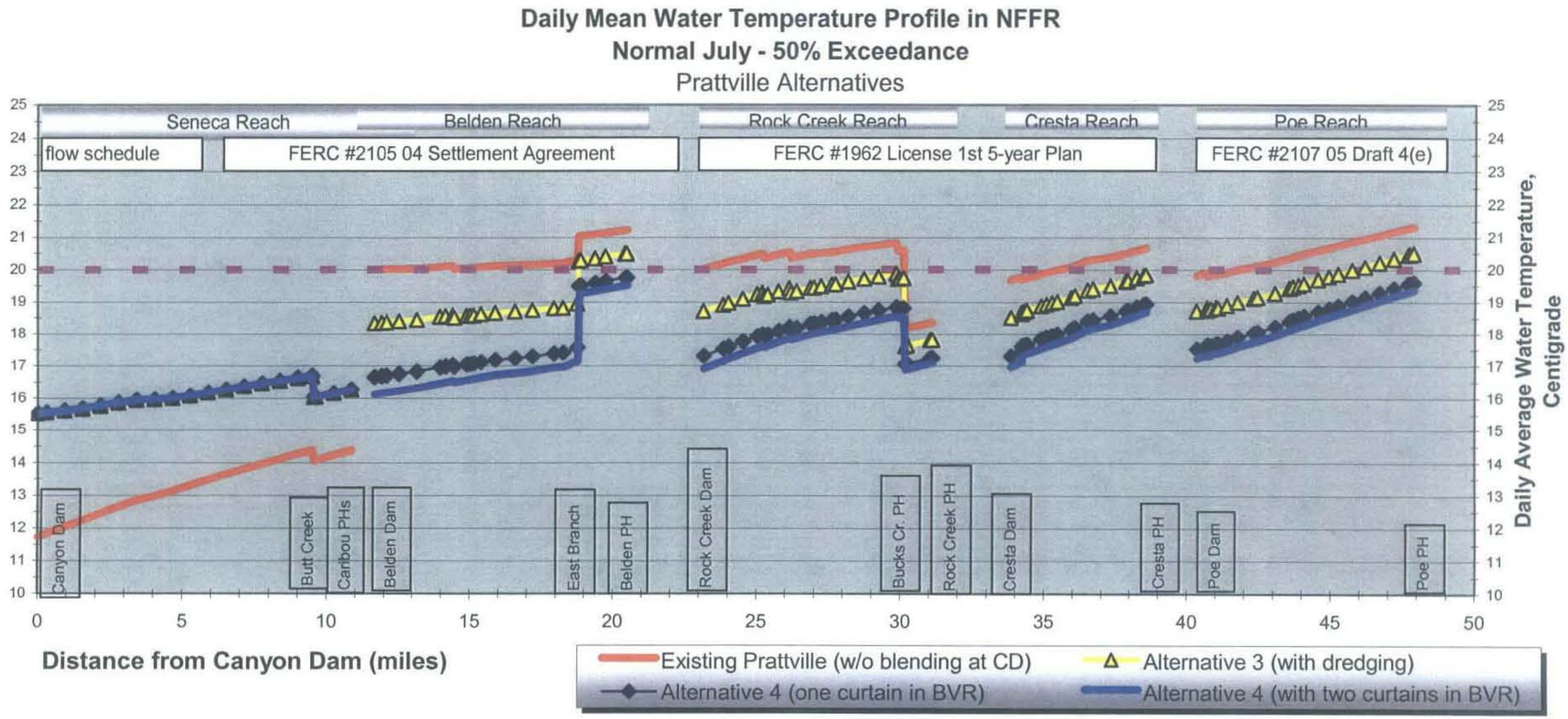
FERC No. 1962 License

First 5-Year Plan

Daily Mean Water Temperature Profiles in the NFFR

July and August (Normal, Warm/Dry, Cold/Wet Scenarios)

Prattville Alternatives


Daily Mean Water Temperature Profile in NFFR
Normal July - 50% Exceedance
Prattville Alternatives
Seneca Reach
Belden Reach
Rock Creek Reach
Cresta Reach
Poe Reach
flow schedule
FERC #2105 04 Settlement Agreement
FERC #1962 License 1st 5-year Plan
FERC #2107 05 Draft 4(e)
Canyon Dam
Butt Creek
Caribou PHs
Belden Dam
East Branch
Belden PH
Rock Creek Dam
Bucks Cr. PH
Rock Creek PH
Cresta Dam
Cresta PH
Poe Dam
Poe PH
Daily Average Water Temperature, Centigrade
Distance from Canyon Dam (miles)
Existing Prattville (w/o blending at CD)
Alternative 3 (with dredging)
Alternative 4 (one curtain in BVR)
Alternative 4 (with two curtains in BVR)
0
5
10
15
20
25
30
35
40
45
50
10
11
12
13
14
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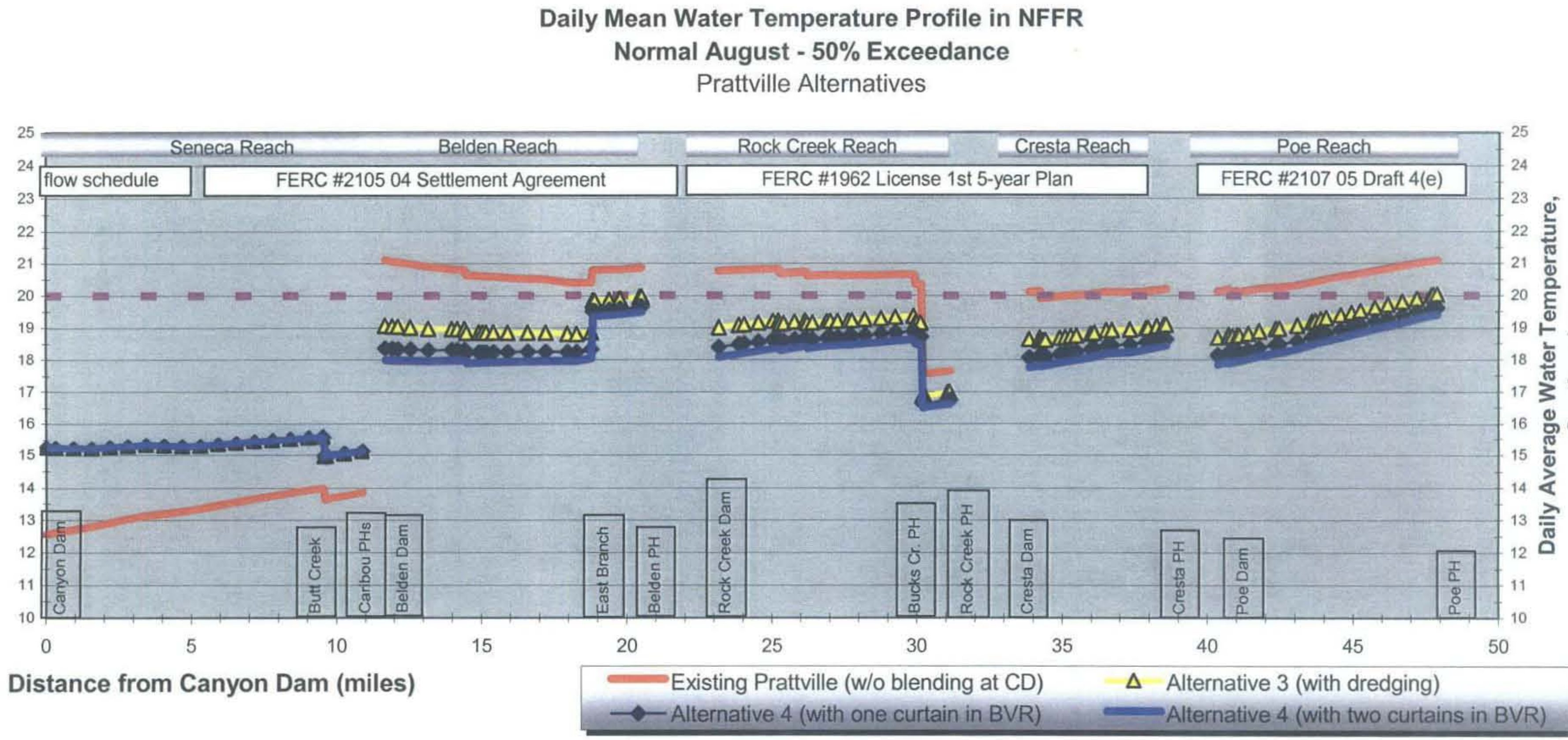
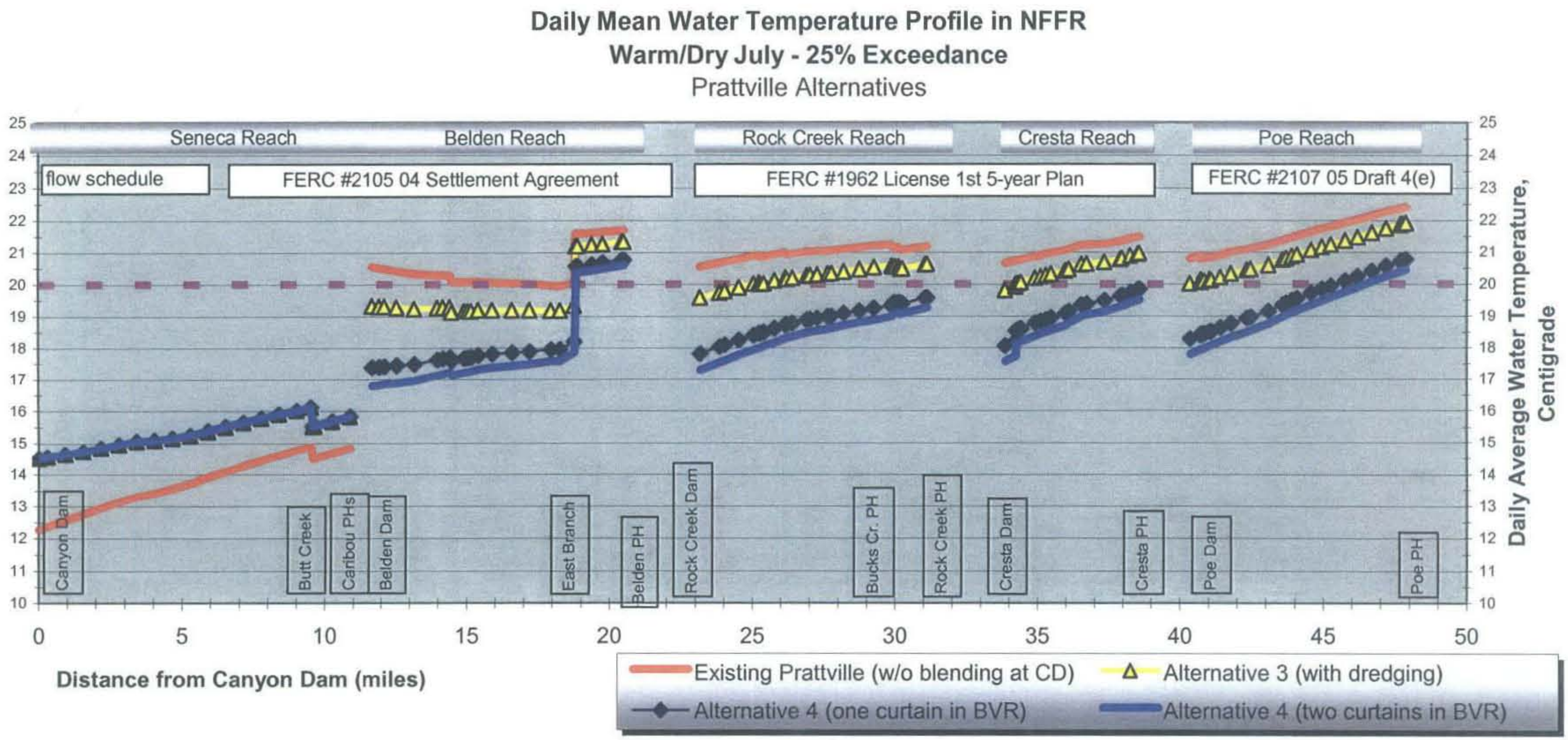
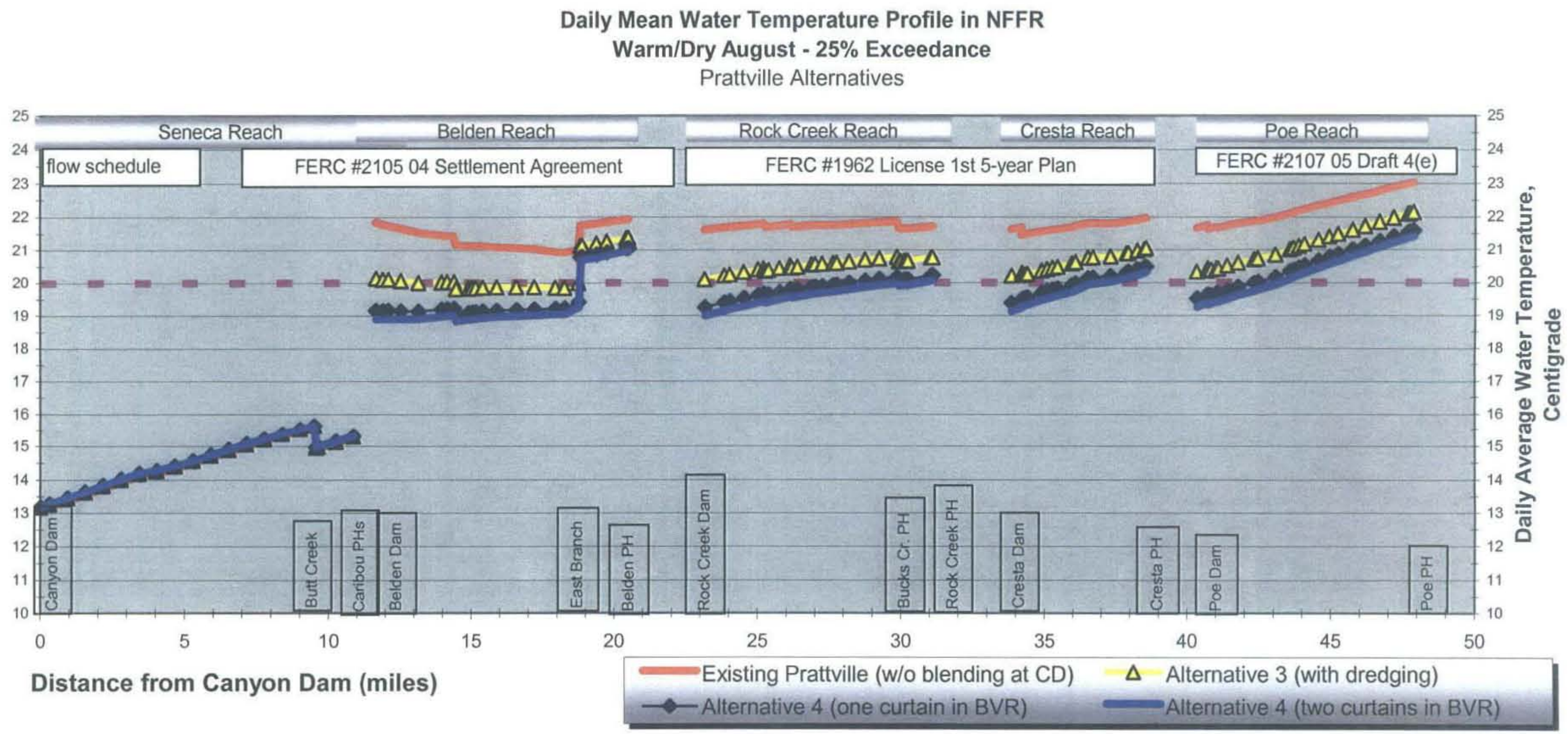
21
22
23
24
25



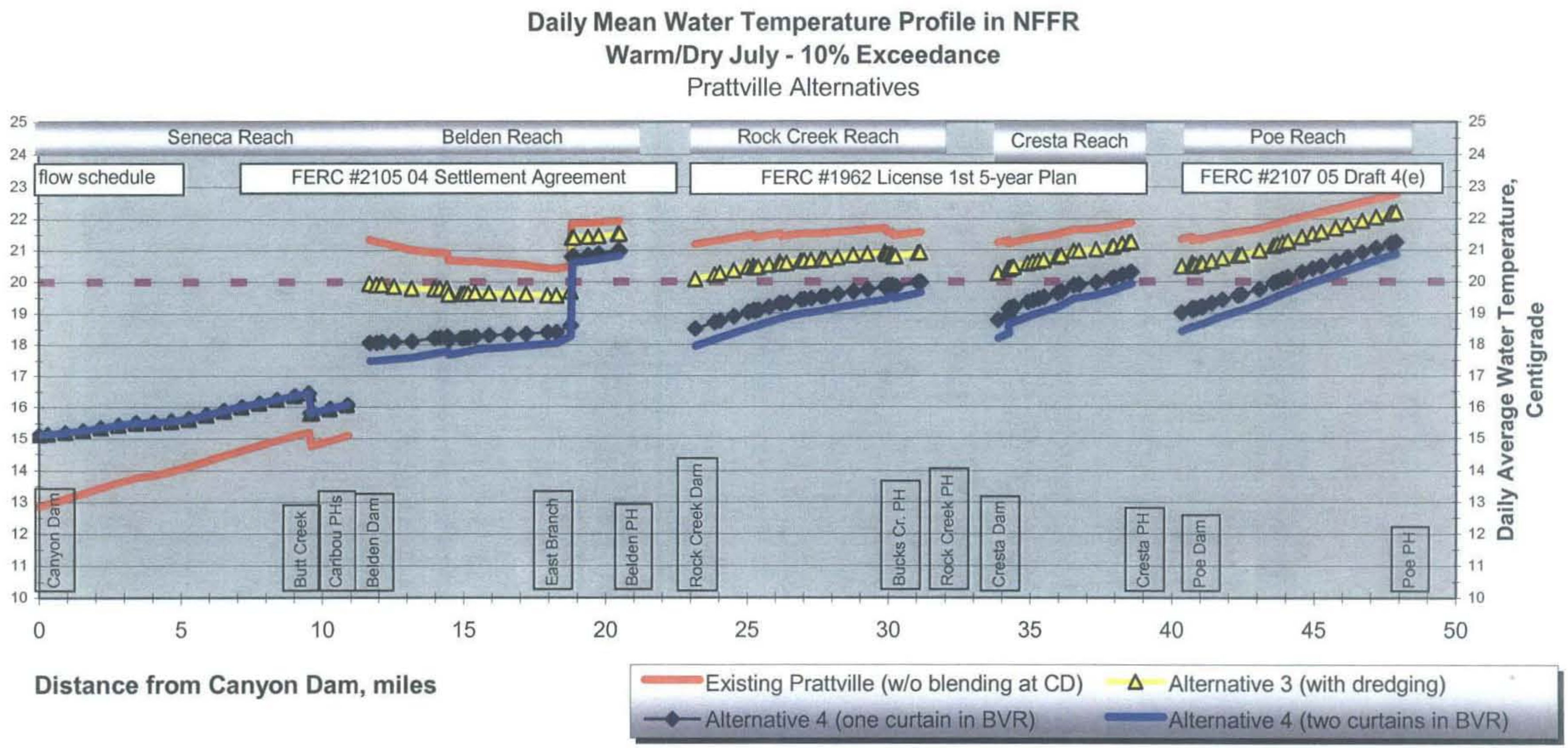
Daily Mean Water Temperature Profile in NFFR
Normal August - 50% Exceedance
Prattville Alternatives
Seneca Reach
Belden Reach
Rock Creek Reach
Cresta Reach
Poe Reach
flow schedule
FERC #2105 04 Settlement Agreement
FERC #1962 License 1st 5-year Plan
FERC #2107 05 Draft 4(e)
Canyon Dam
Butt Creek
Caribou PHs
Belden Dam
East Branch
Belden PH
Rock Creek Dam
Bucks Cr. PH
Rock Creek PH
Cresta Dam
Cresta PH
Poe Dam
Poe PH
Daily Average Water Temperature, Centigrade
Distance from Canyon Dam (miles)
Existing Prattville (w/o blending at CD)
Alternative 3 (with dredging)
Alternative 4 (with one curtain in BVR)
Alternative 4 (with two curtains in BVR)



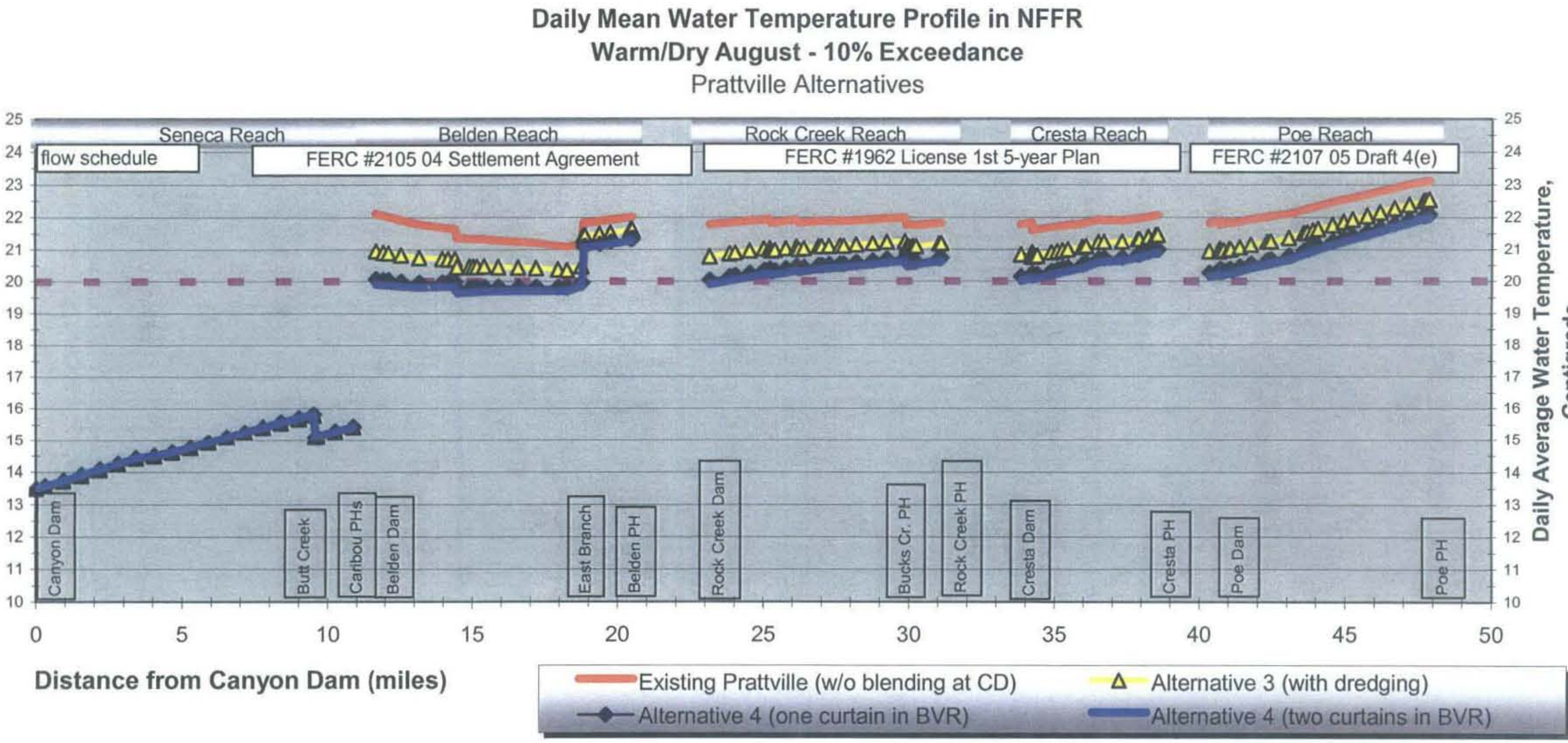
Daily Mean Water Temperature Profile in NFFR
Warm/Dry July - 25% Exceedance
Prattville Alternatives
Seneca Reach
Belden Reach
Rock Creek Reach
Cresta Reach
Poe Reach
flow schedule
FERC #2105 04 Settlement Agreement
FERC #1962 License 1st 5-year Plan
FERC #2107 05 Draft 4(e)
Canyon Dam
Butt Creek
Caribou PHs
Belden Dam
East Branch
Belden PH
Rock Creek Dam
Bucks Cr. PH
Rock Creek PH
Cresta Dam
Cresta PH
Poe Dam
Poe PH
Distance from Canyon Dam (miles)
Daily Average Water Temperature, Centigrade
Existing Prattville (w/o blending at CD)
Alternative 3 (with dredging)
Alternative 4 (one curtain in BVR)
Alternative 4 (two curtains in BVR)



Daily Mean Water Temperature Profile in NFFR
Warm/Dry August - 25% Exceedance
Prattville Alternatives
Seneca Reach
Belden Reach
Rock Creek Reach
Cresta Reach
Poe Reach
flow schedule
FERC #2105 04 Settlement Agreement
FERC #1962 License 1st 5-year Plan
FERC #2107 05 Draft 4(e)
Canyon Dam
Butt Creek
Caribou PHs
Belden Dam
East Branch
Belden PH
Rock Creek Dam
Bucks Cr. PH
Rock Creek PH
Cresta Dam
Cresta PH
Poe Dam
Poe PH
Distance from Canyon Dam (miles)
Daily Average Water Temperature, Centigrade
Existing Prattville (w/o blending at CD)
Alternative 3 (with dredging)
Alternative 4 (one curtain in BVR)
Alternative 4 (two curtains in BVR)

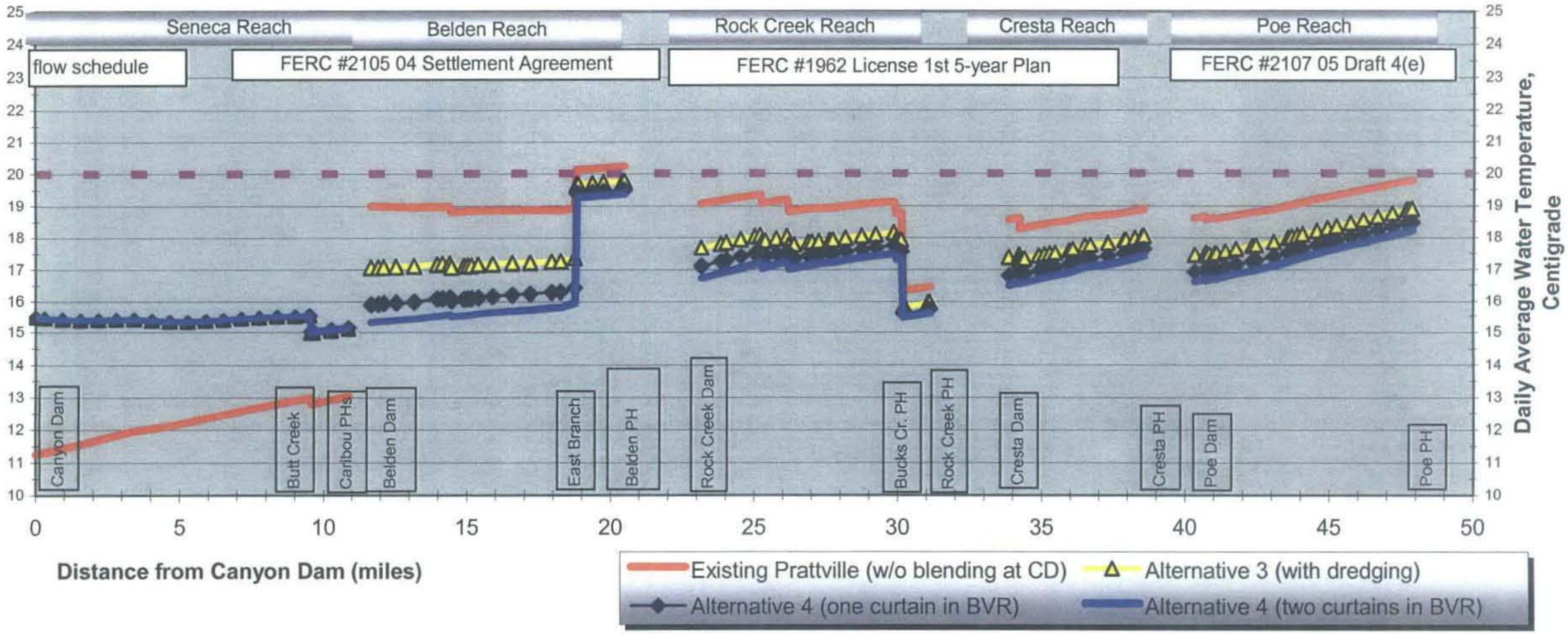


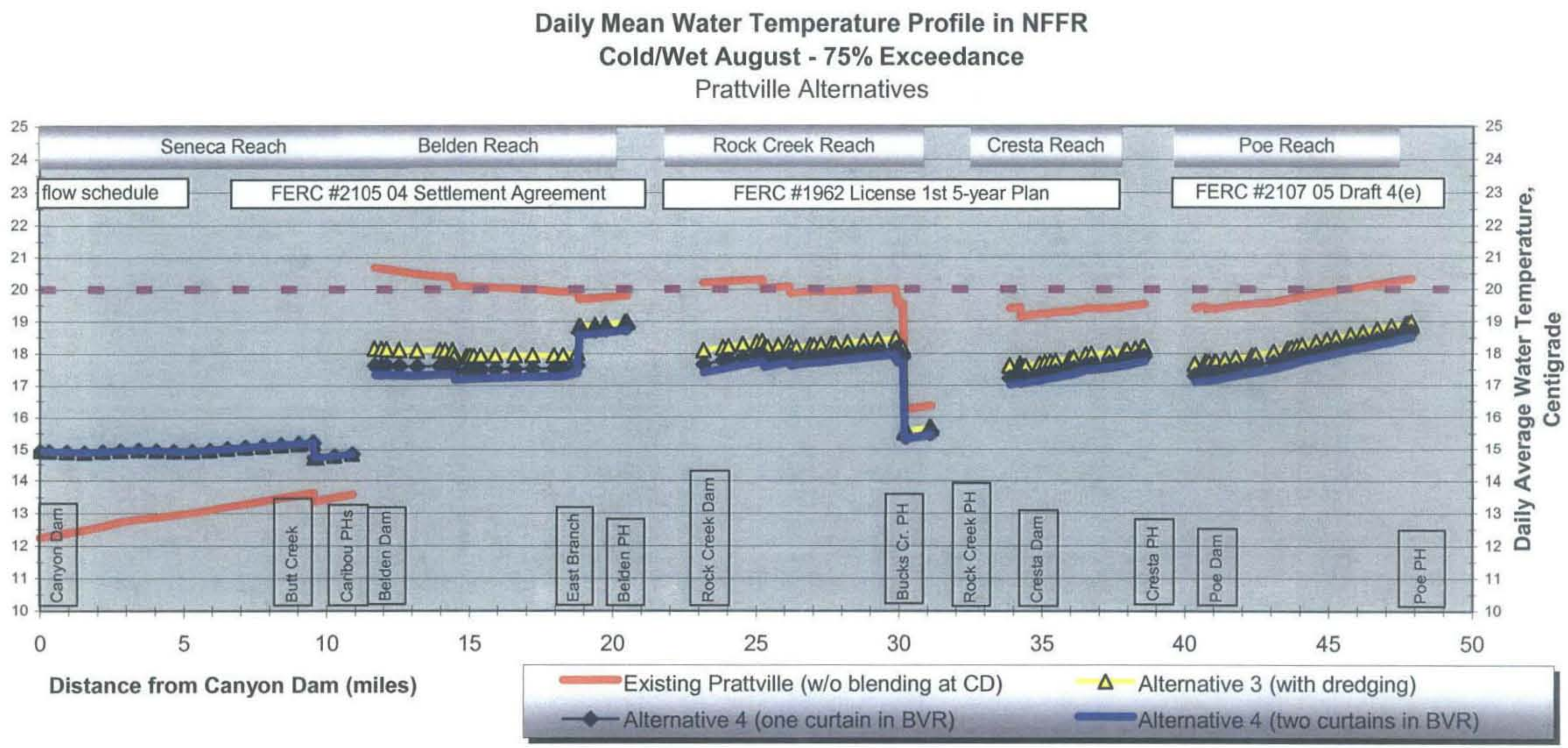
Daily Mean Water Temperature Profile in NFFR
Warm/Dry July - 10% Exceedance
Prattville Alternatives
Seneca Reach
Belden Reach
Rock Creek Reach
Cresta Reach
Poe Reach
flow schedule
FERC #2105 04 Settlement Agreement
FERC #1962 License 1st 5-year Plan
FERC #2107 05 Draft 4(e)
Canyon Dam
Butt Creek
Caribou PHs
Belden Dam
East Branch
Belden PH
Rock Creek Dam
Bucks Cr. PH
Rock Creek PH
Cresta Dam
Cresta PH
Poe Dam
Poe PH
Daily Average Water Temperature, Centigrade
Distance from Canyon Dam, miles
Existing Prattville (w/o blending at CD)
Alternative 3 (with dredging)
Alternative 4 (one curtain in BVR)
Alternative 4 (two curtains in BVR)



Daily Mean Water Temperature Profile in NFFR
Warm/Dry August - 10% Exceedance
Prattville Alternatives
Seneca Reach
Belden Reach
Rock Creek Reach
Cresta Reach
Poe Reach
flow schedule
FERC #2105 04 Settlement Agreement
FERC #1962 License 1st 5-year Plan
FERC #2107 05 Draft 4(e)
Canyon Dam
Butt Creek
Caribou PHs
Belden Dam
East Branch
Belden PH
Rock Creek Dam
Bucks Cr. PH
Rock Creek PH
Cresta Dam
Cresta PH
Poe Dam
Poe PH
Daily Average Water Temperature, Centigrade
Distance from Canyon Dam (miles)
Existing Prattville (w/o blending at CD)
Alternative 3 (with dredging)
Alternative 4 (one curtain in BVR)
Alternative 4 (two curtains in BVR)

Daily Mean Water Temperature Profile in NFFR
Cold/Wet July - 75% Exceedance
Prattville Alternatives





Daily Mean Water Temperature Profile in NFFR
Cold/Wet August - 75% Exceedance
Prattville Alternatives
Seneca Reach
Belden Reach
Rock Creek Reach
Cresta Reach
Poe Reach
flow schedule
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Belden Dam
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Belden PH
Rock Creek Dam
Bucks Cr. PH
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Daily Average Water Temperature, Centigrade
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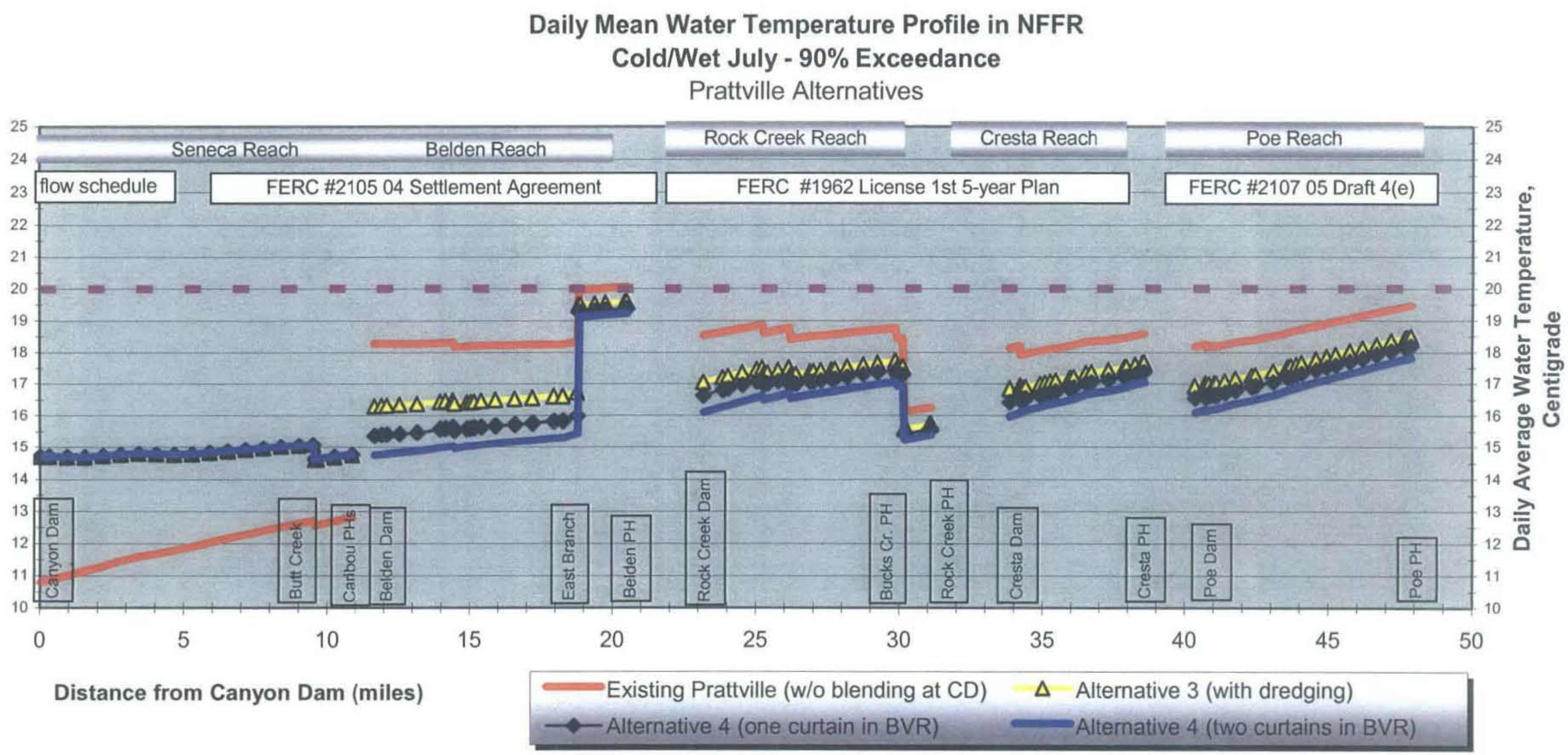

Daily Mean Water Temperature Profile in NFFR
Cold/Wet July - 90% Exceedance
Prattville Alternatives
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Belden Reach
Rock Creek Reach
Cresta Reach
Poe Reach
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Daily Average Water Temperature, Centigrade
Distance from Canyon Dam (miles)
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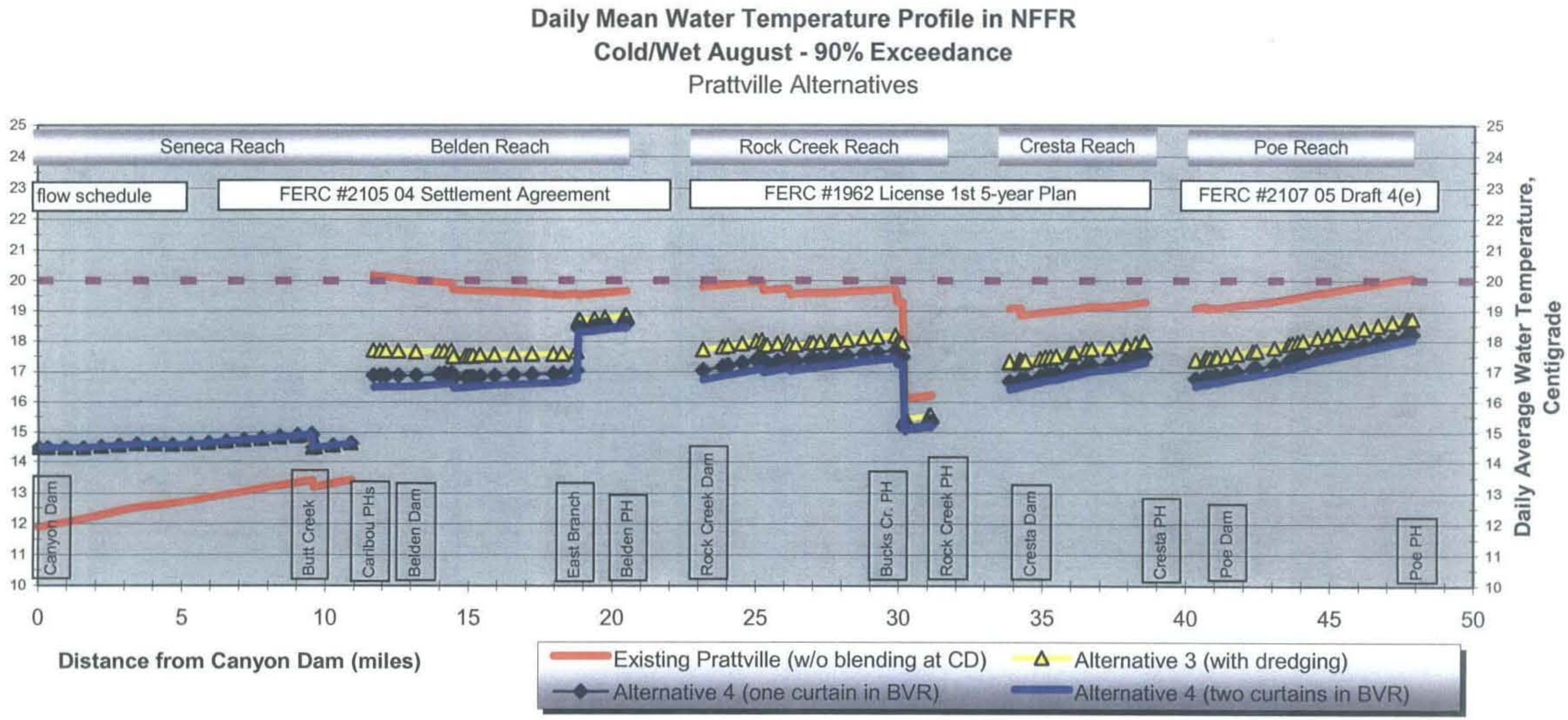
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Cresta PH
Poe Dam
Poe PH
Daily Average Water Temperature, Centigrade
Distance from Canyon Dam (miles)
Existing Prattville (w/o blending at CD)
Alternative 3 (with dredging)
Alternative 4 (one curtain in BVR)
Alternative 4 (two curtains in BVR)

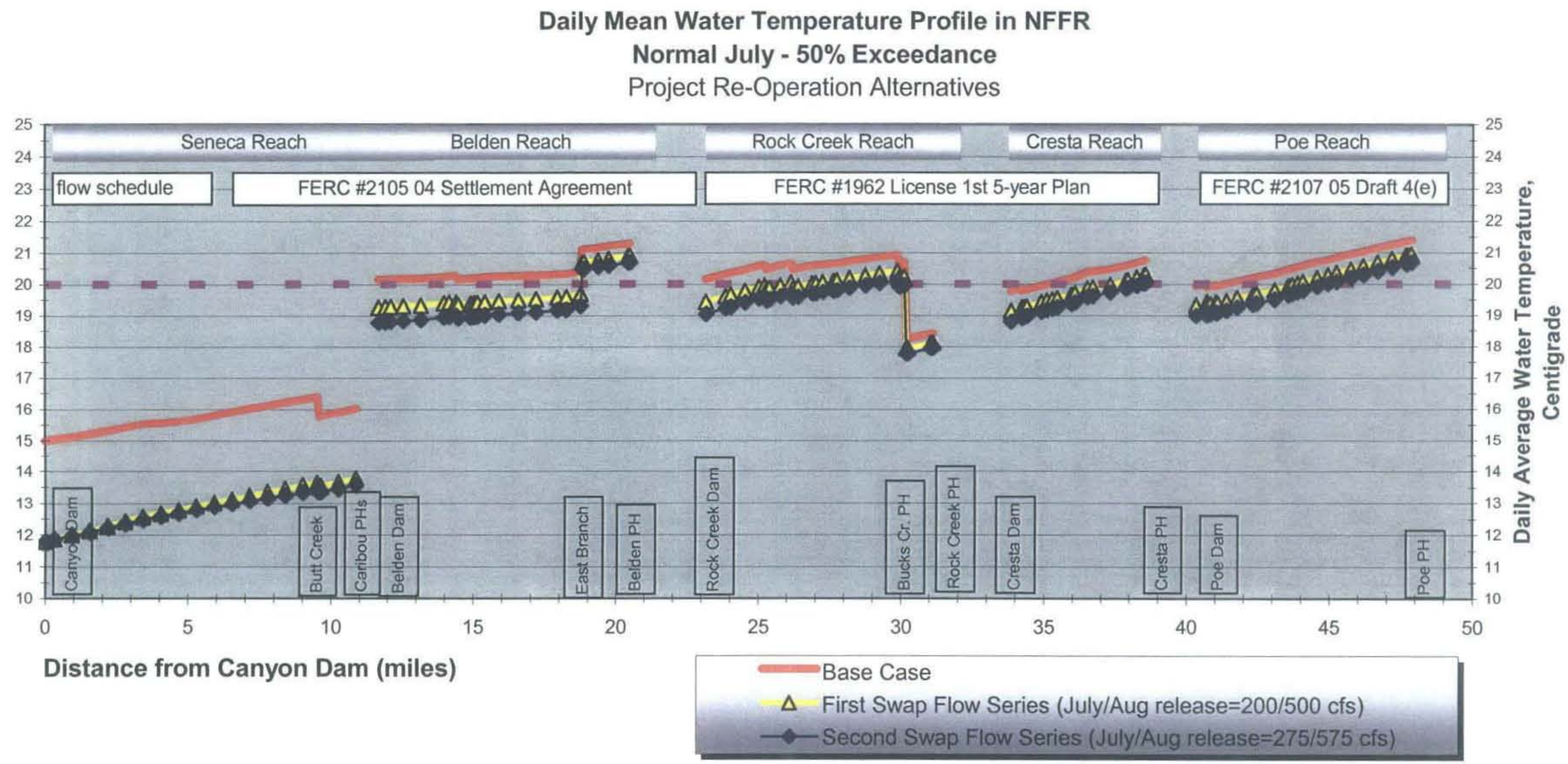
FERC No. 1962 License

First 5-Year Plan

Daily Mean Water Temperature Profiles in the NFFR

July and August (Normal, Warm/Dry, Cold/Wet Scenarios)

Project Re-operation Alternatives



Daily Mean Water Temperature Profile in NFFR
Normal July - 50% Exceedance
Project Re-Operation Alternatives
Seneca Reach
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Cresta Reach
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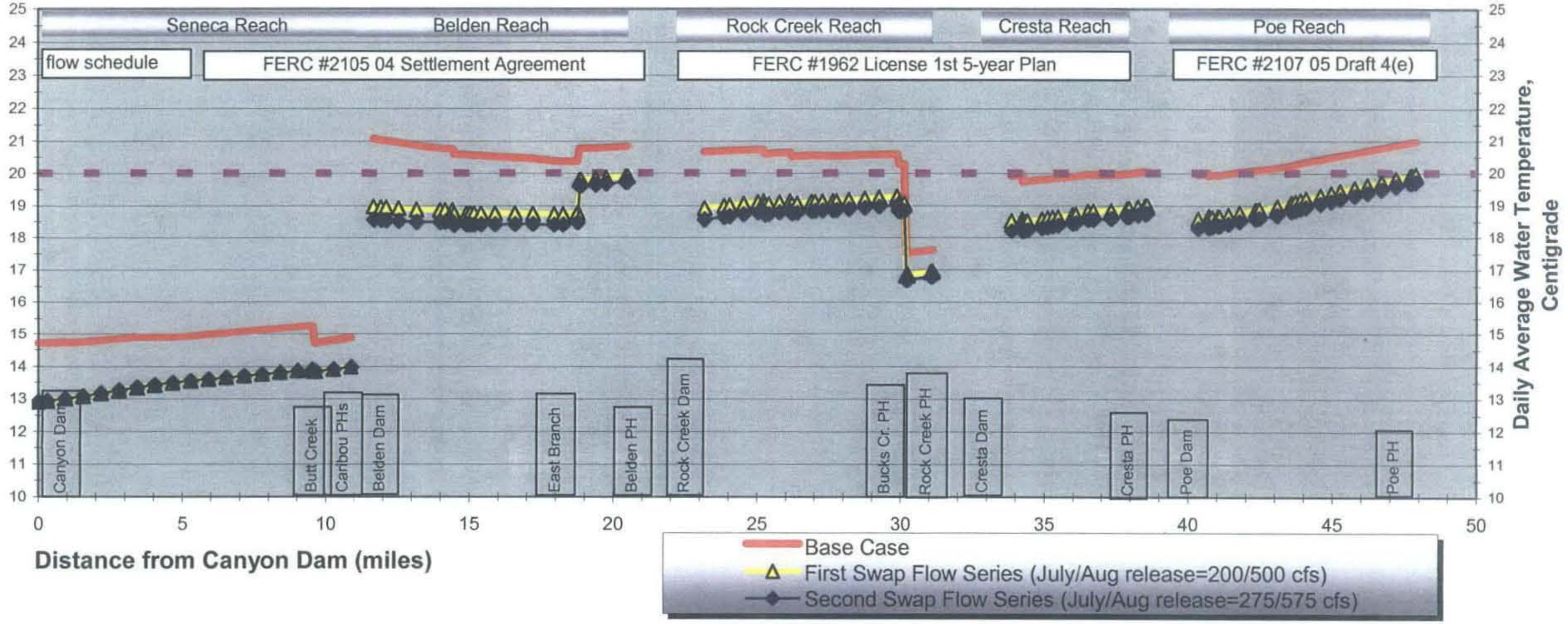
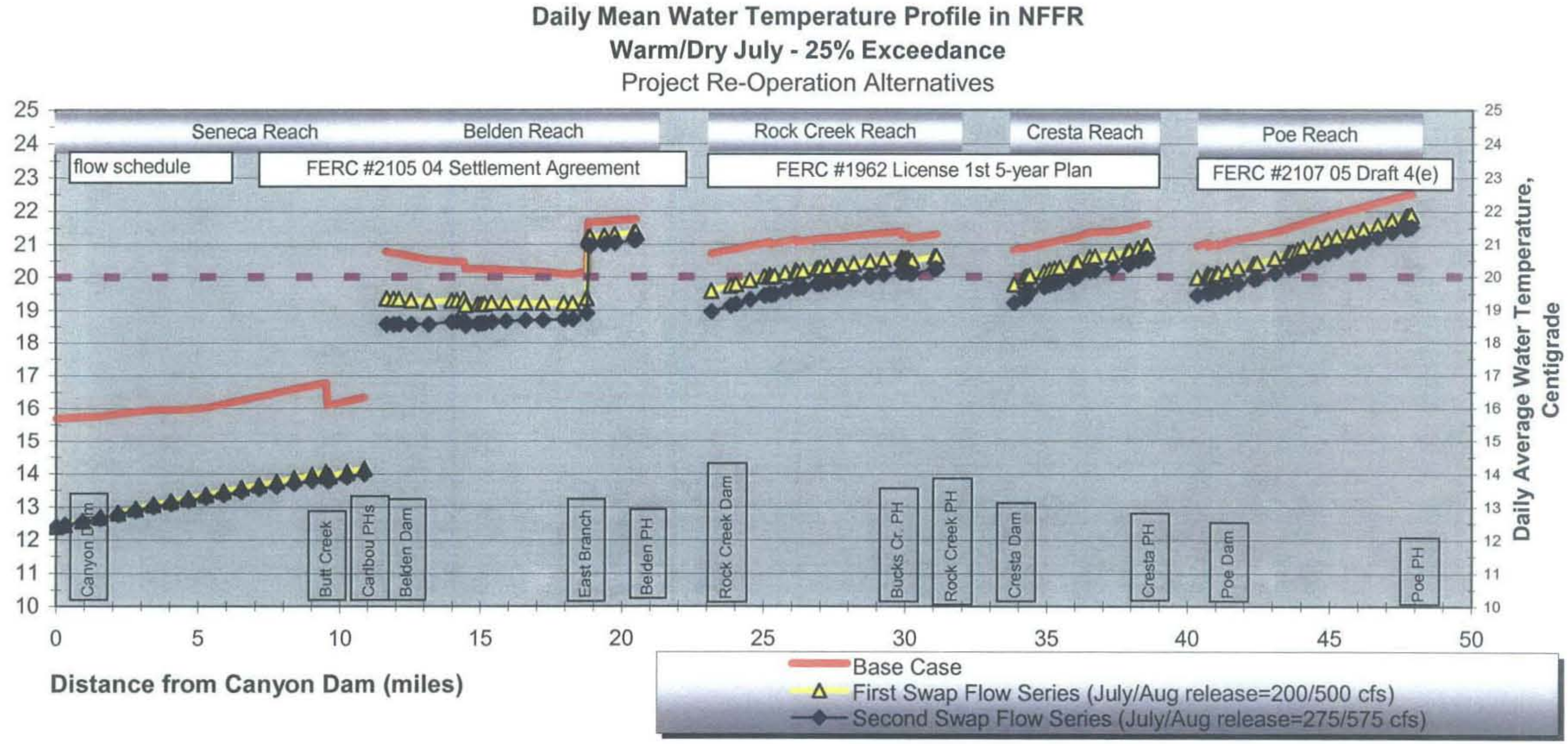
Rock Creek PH
Cresta Dam
Cresta PH
Poe Dam
Poe PH
Daily Average Water Temperature, Centigrade
Distance from Canyon Dam (miles)
Base Case
First Swap Flow Series (July/Aug release=200/500 cfs)
Second Swap Flow Series (July/Aug release=275/575 cfs)

Daily Mean Water Temperature Profile in NFFR
Normal August - 50% Exceedance
Project Re-Operation Alternatives





Daily Mean Water Temperature Profile in NFFR
Warm/Dry July - 25% Exceedance
Project Re-Operation Alternatives
Seneca Reach
Belden Reach
Rock Creek Reach
Cresta Reach
Poe Reach
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Poe Dam
Poe PH
Daily Average Water Temprature, Centigrade
Distance from Canyon Dam (miles)
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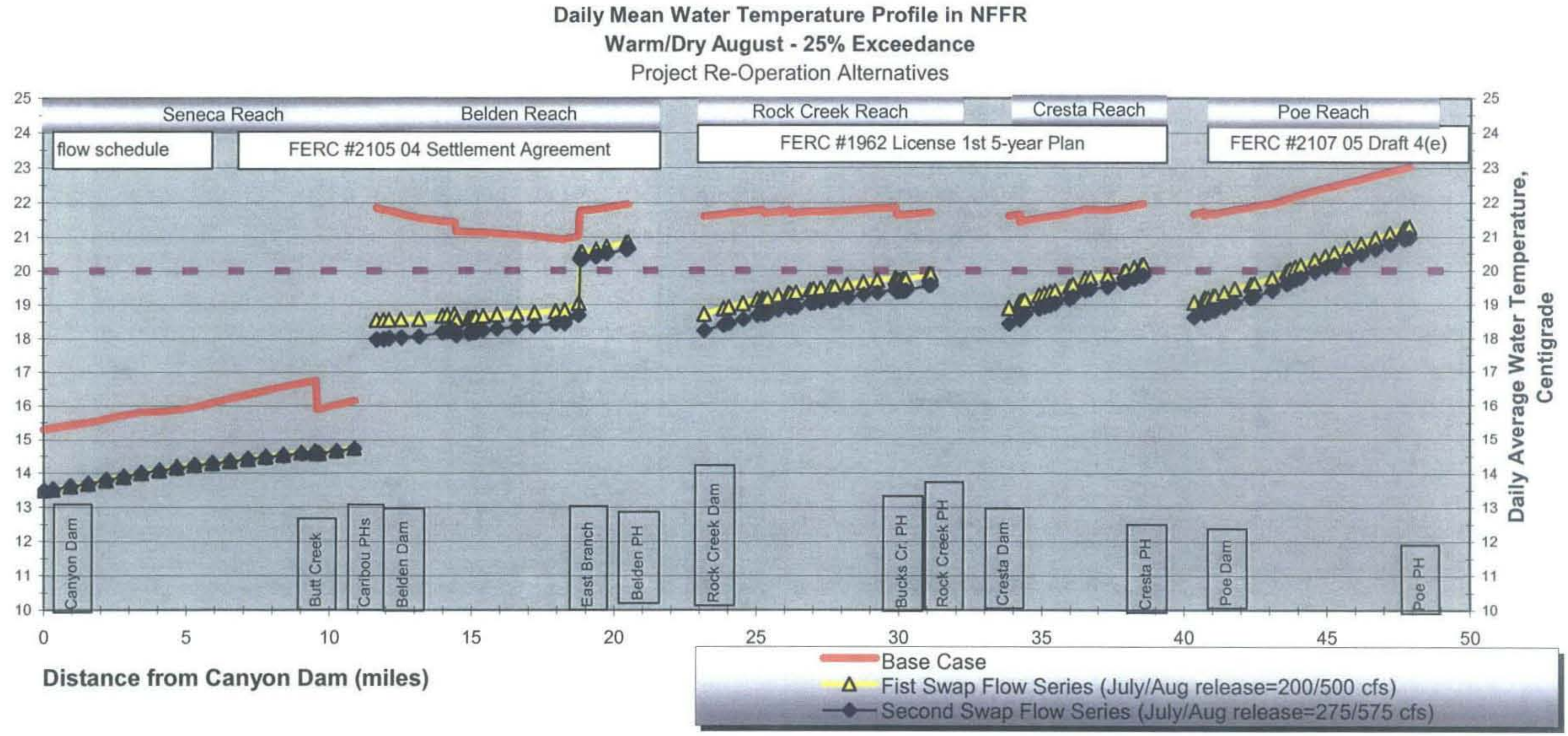
Daily Mean Water Temperature Profile in NFFR
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Poe Dam
Poe PH
Daily Average Water Temperature, Centigrade
Distance from Canyon Dam (miles)
Base Case
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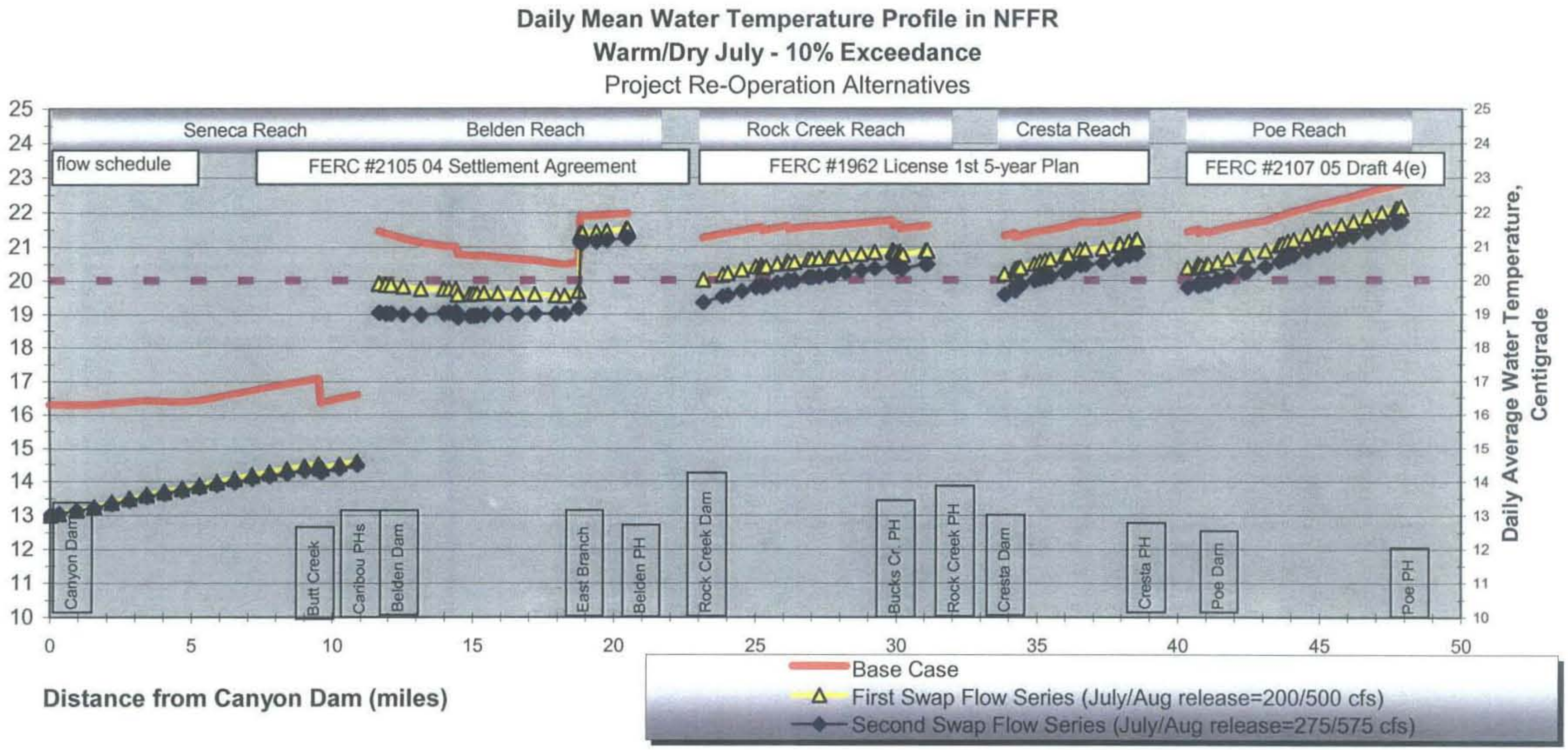

Daily Mean Water Temperature Profile in NFFR
Warm/Dry July - 10% Exceedance
Project Re-Operation Alternatives
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Poe Dam
Poe PH
Distance from Canyon Dam (miles)
Daily Average Water Temperature, Centigrade
Base Case
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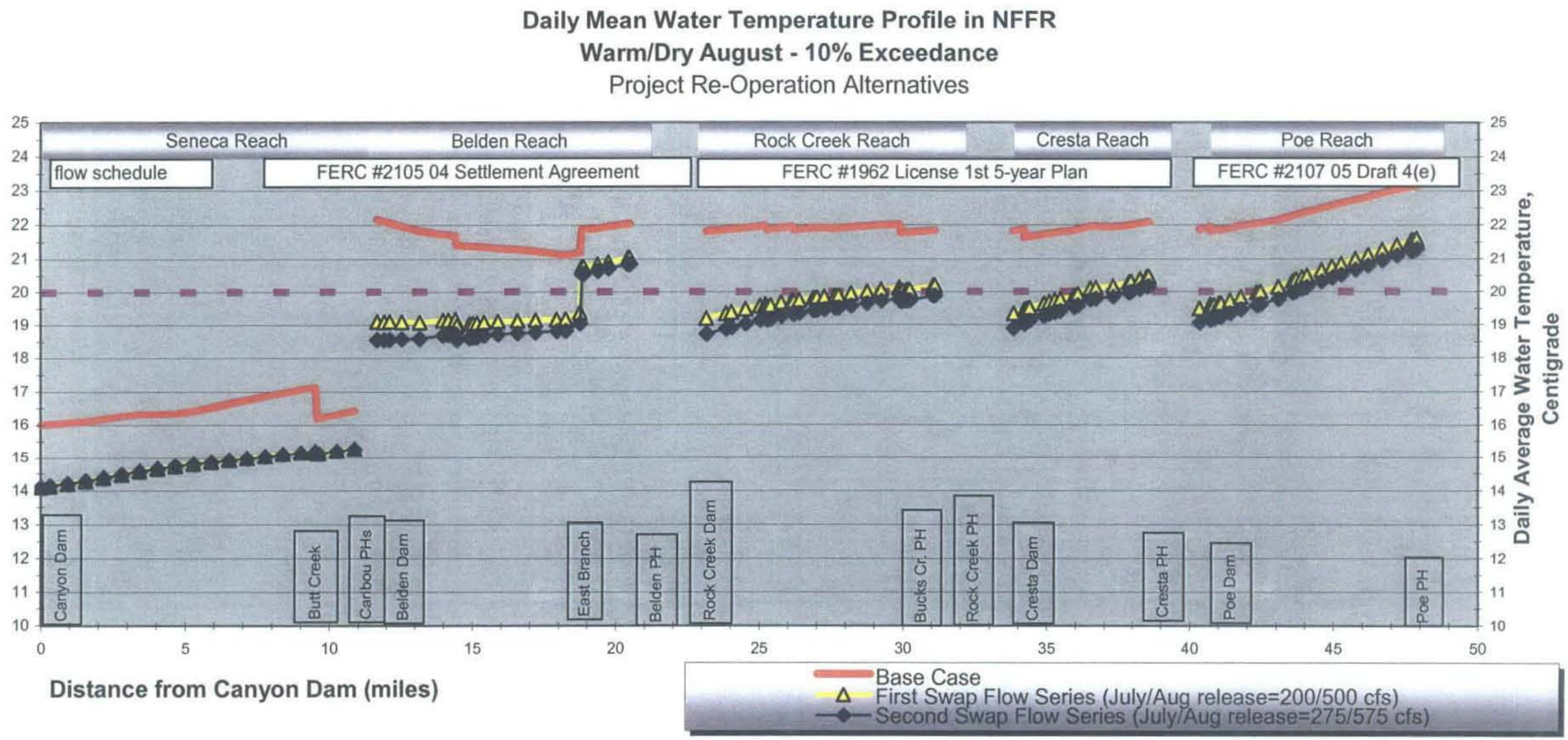

Daily Mean Water Temperature Profile in NFFR
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Project Re-Operation Alternatives
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Daily Average Water Temperature, Centigrade
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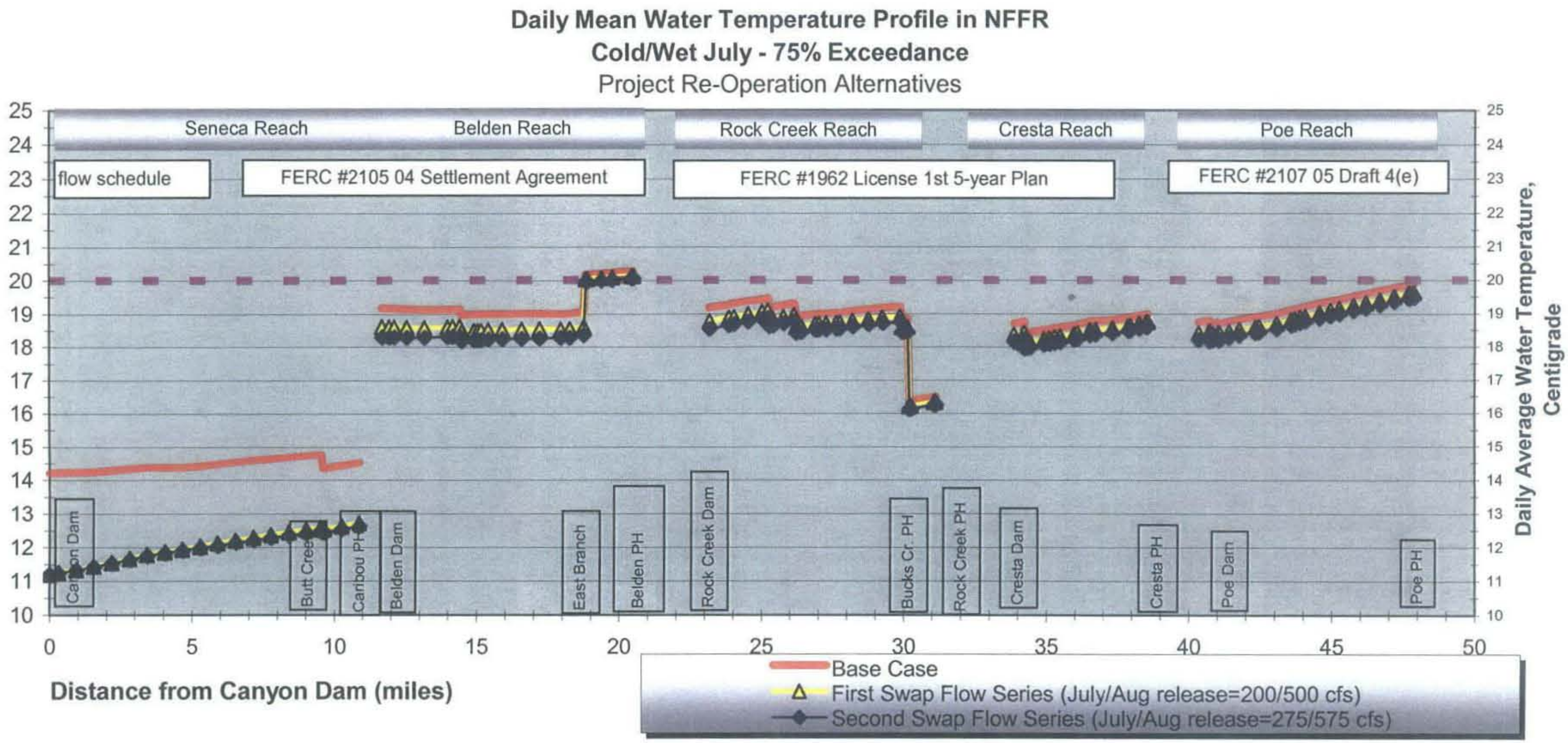

Daily Mean Water Temperature Profile in NFFR
Cold/Wet July - 75% Exceedance
Project Re-Operation Alternatives
Seneca Reach
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Poe Reach
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Bucks Cr. PH
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Cresta Dam
Cresta PH
Poe Dam
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Distance from Canyon Dam (miles)
Daily Average Water Temperature, Centigrade
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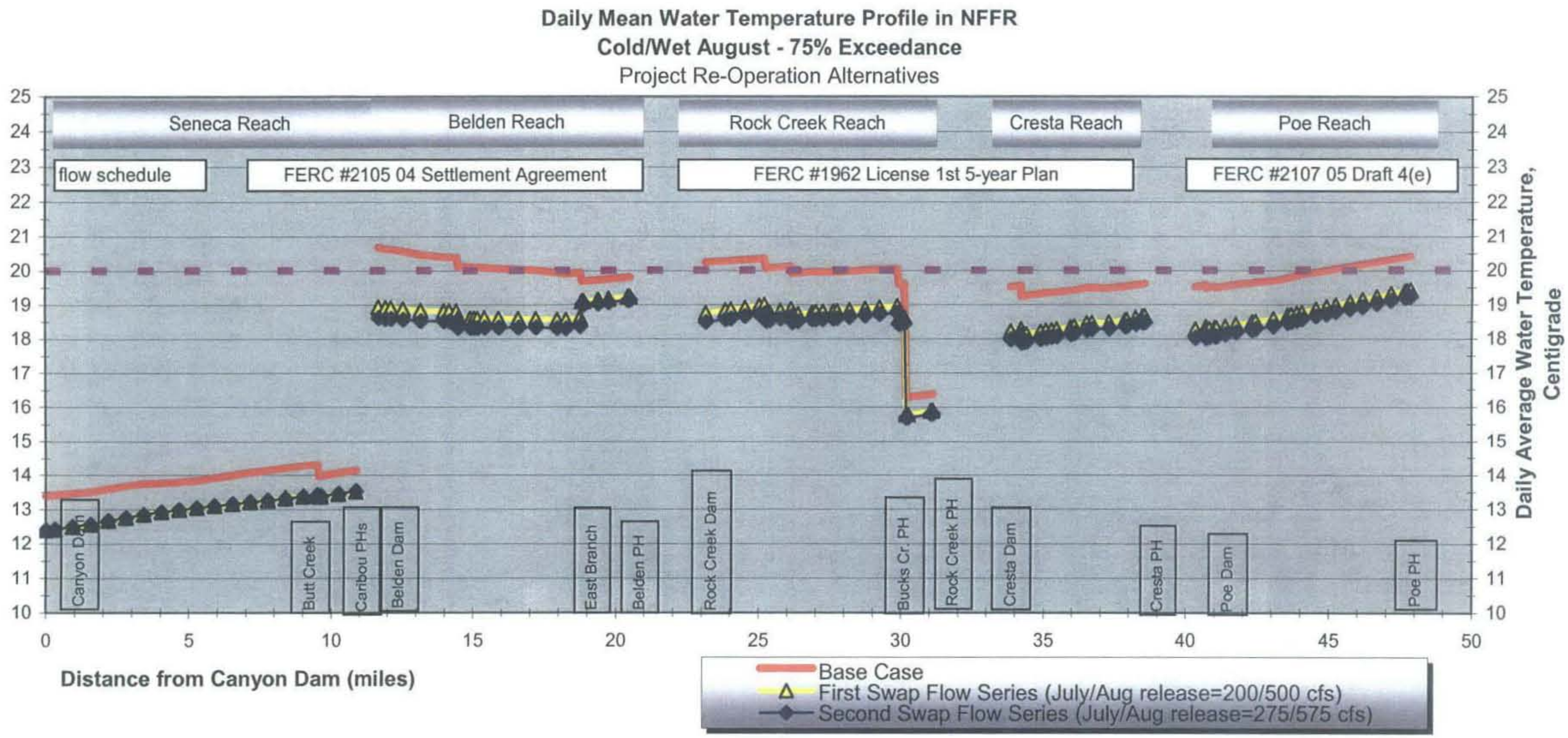

Daily Mean Water Temperature Profile in NFFR
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Daily Average Water Temperature, Centigrade
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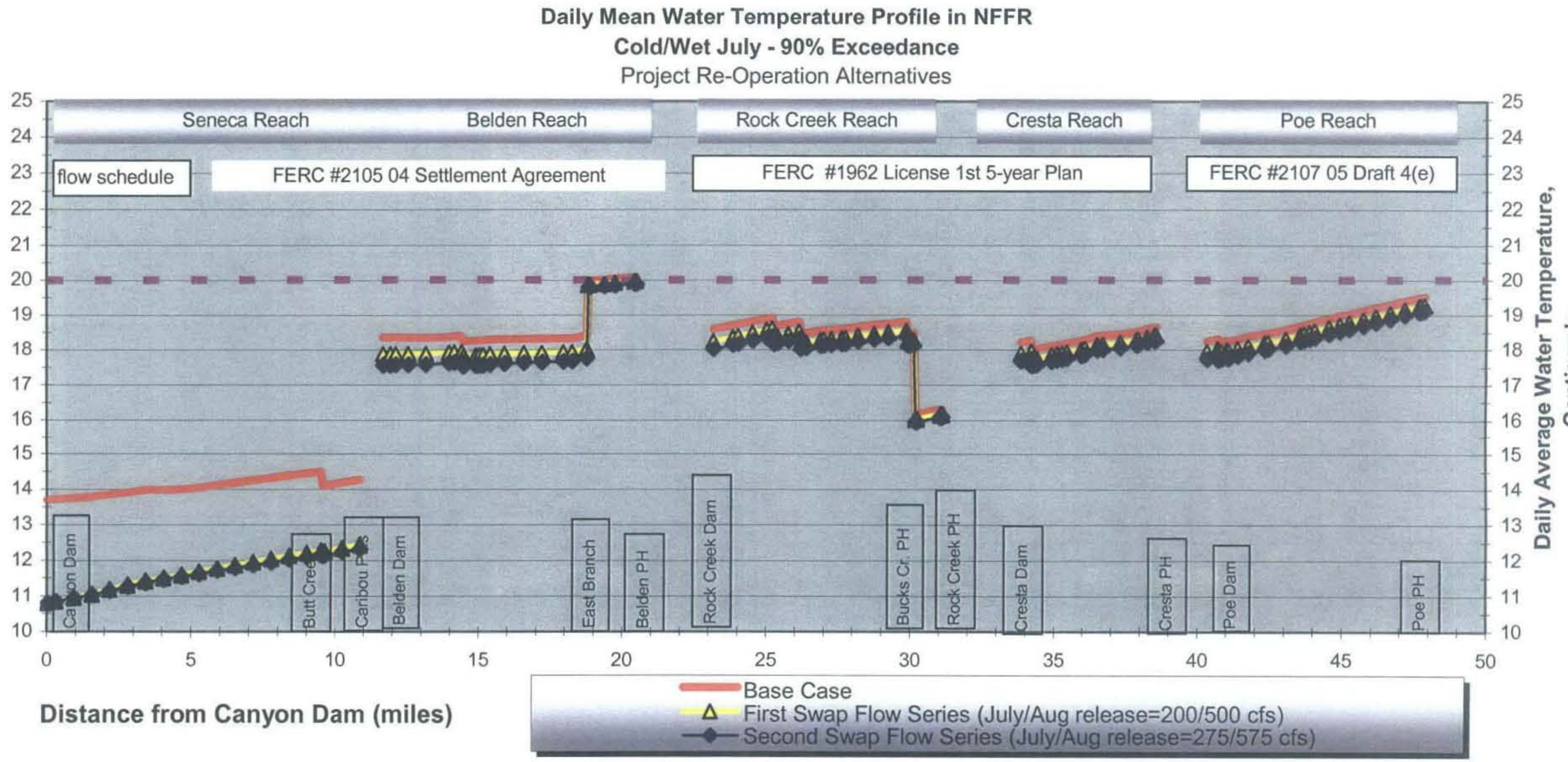
Daily Mean Water Temperature Profile in NFFR
Cold/Wet July - 90% Exceedance
Project Re-Operation Alternatives
Seneca Reach
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Bucks Cr. PH
Rock Creek PH
Cresta Dam
Cresta PH
Poe Dam
Poe PH
Distance from Canyon Dam (miles)
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Daily Mean Water Temperature Profile in NFFR
Cold/Wet August - 90% Exceedance
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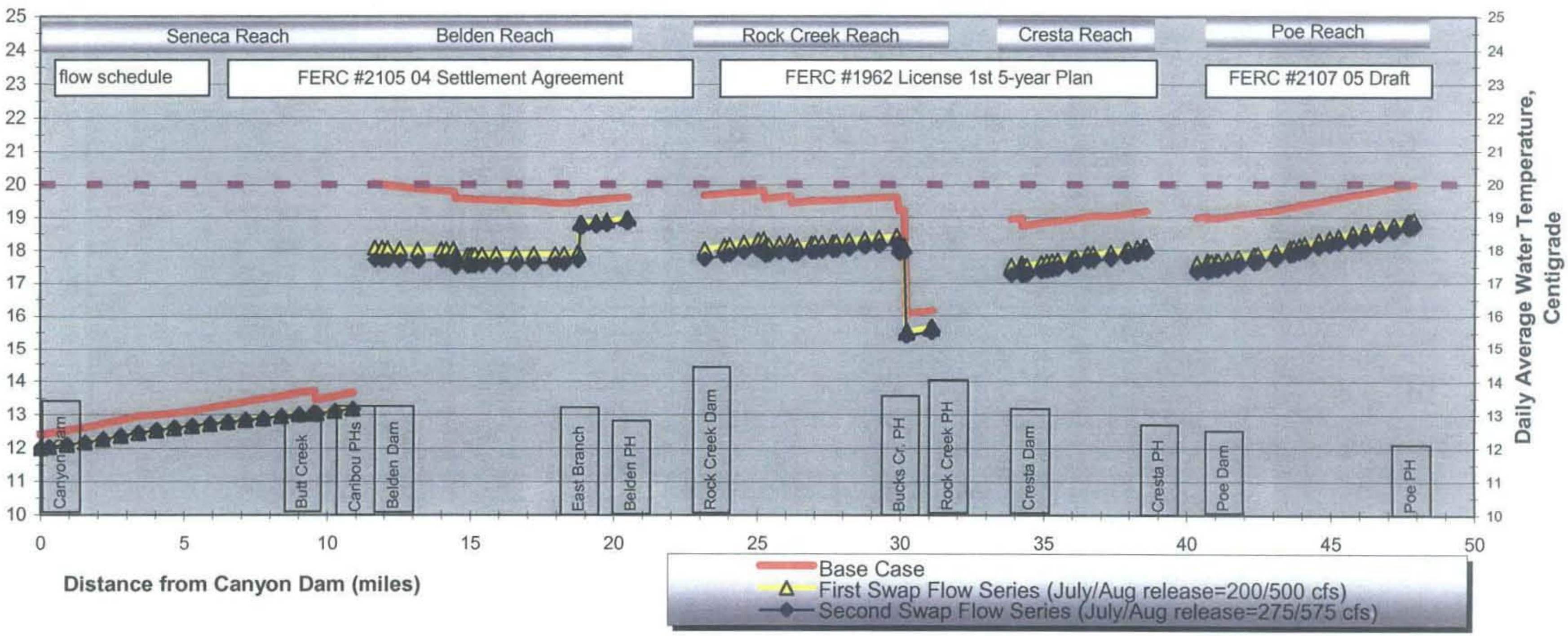


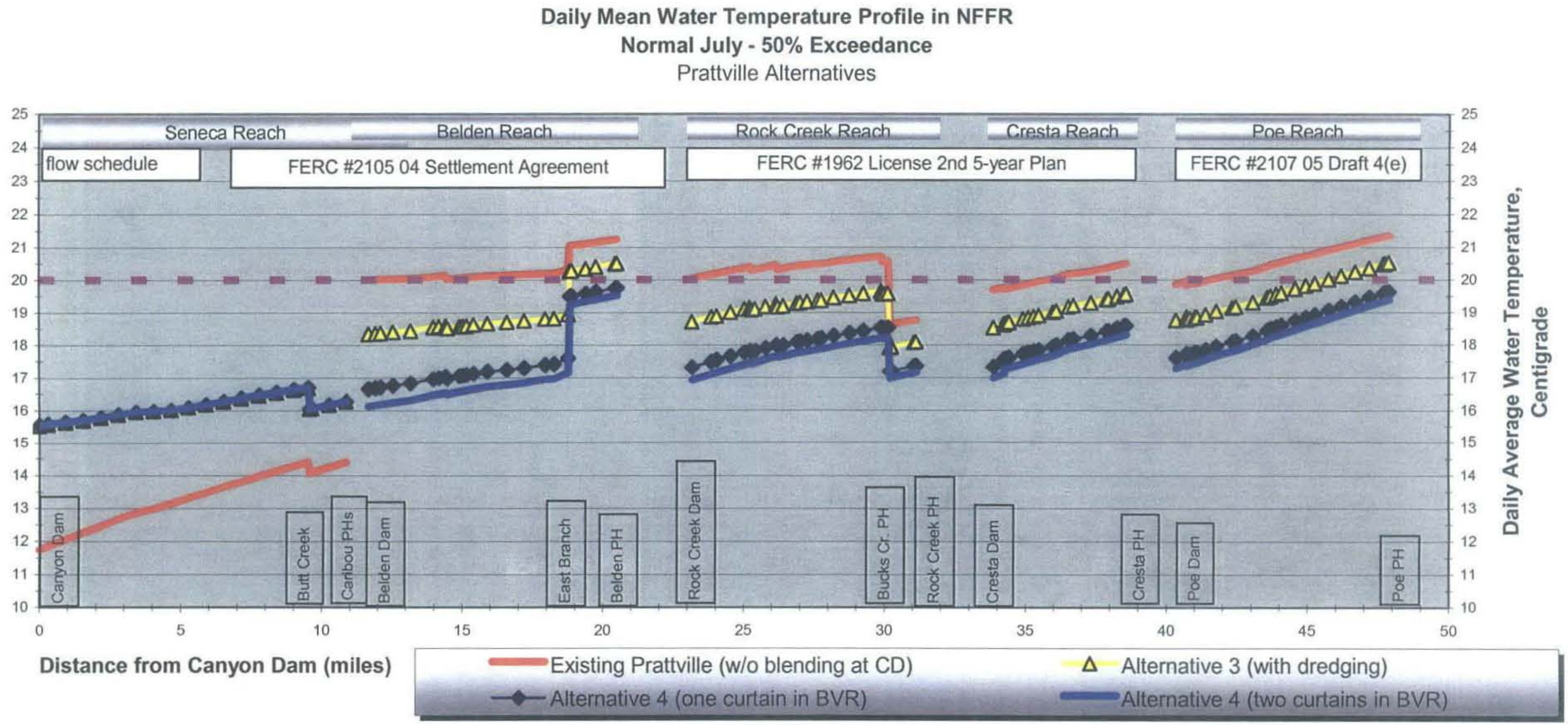
FERC No. 1962 License

Second 5-Year Plan

Daily Mean Water Temperature Profiles in the NFFR

July and August (Normal, Warm/Dry, Cold/Wet Scenarios)

Prattville Alternatives



Daily Mean Water Temperature Profile in NFFR
Normal July - 50% Exceedance
Prattville Alternatives
Seneca Reach
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Distance from Canyon Dam (miles)
Existing Prattville (w/o blending at CD)
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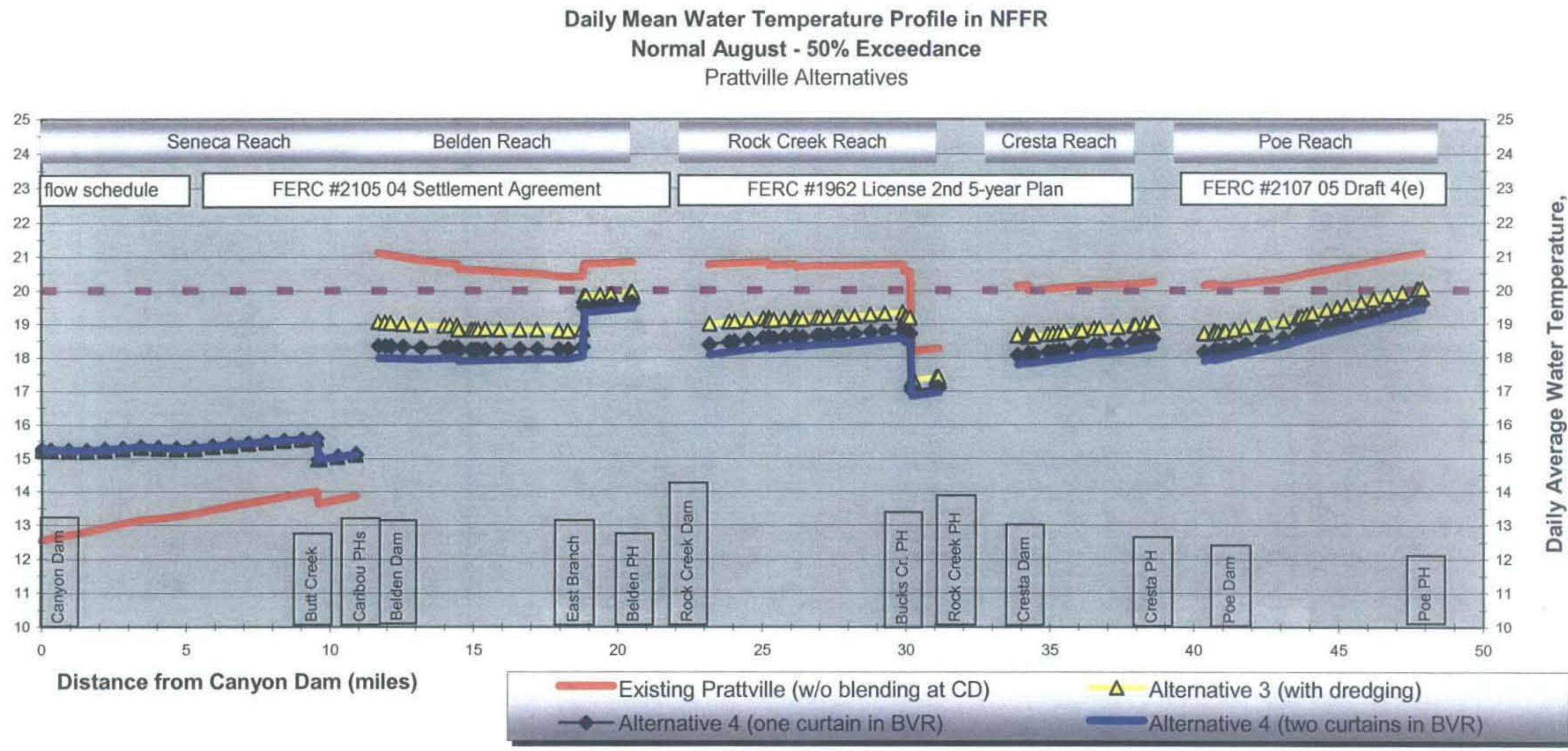
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Normal August - 50% Exceedance
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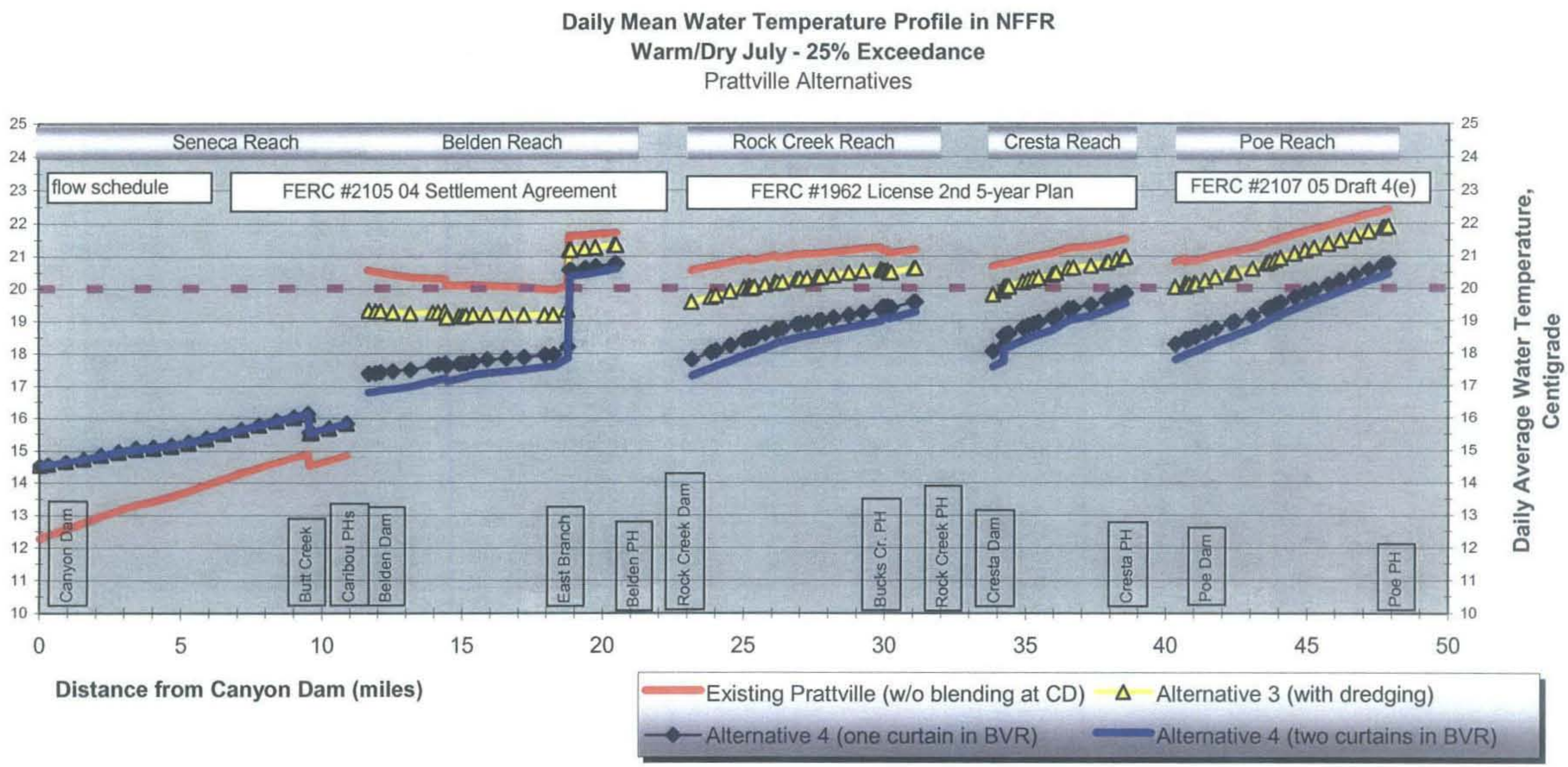
Daily Mean Water Temperature Profile in NFFR
Warm/Dry July - 25% Exceedance
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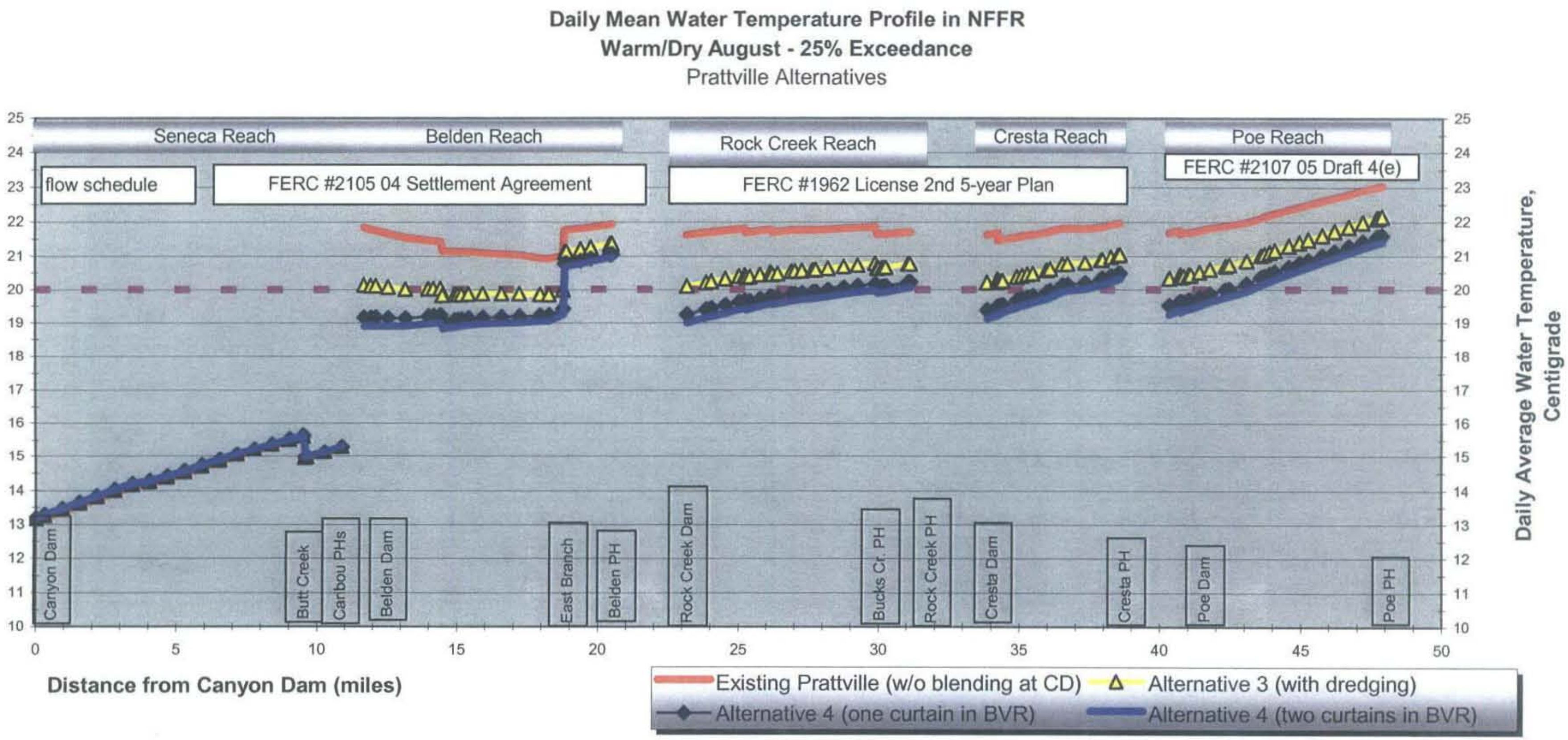

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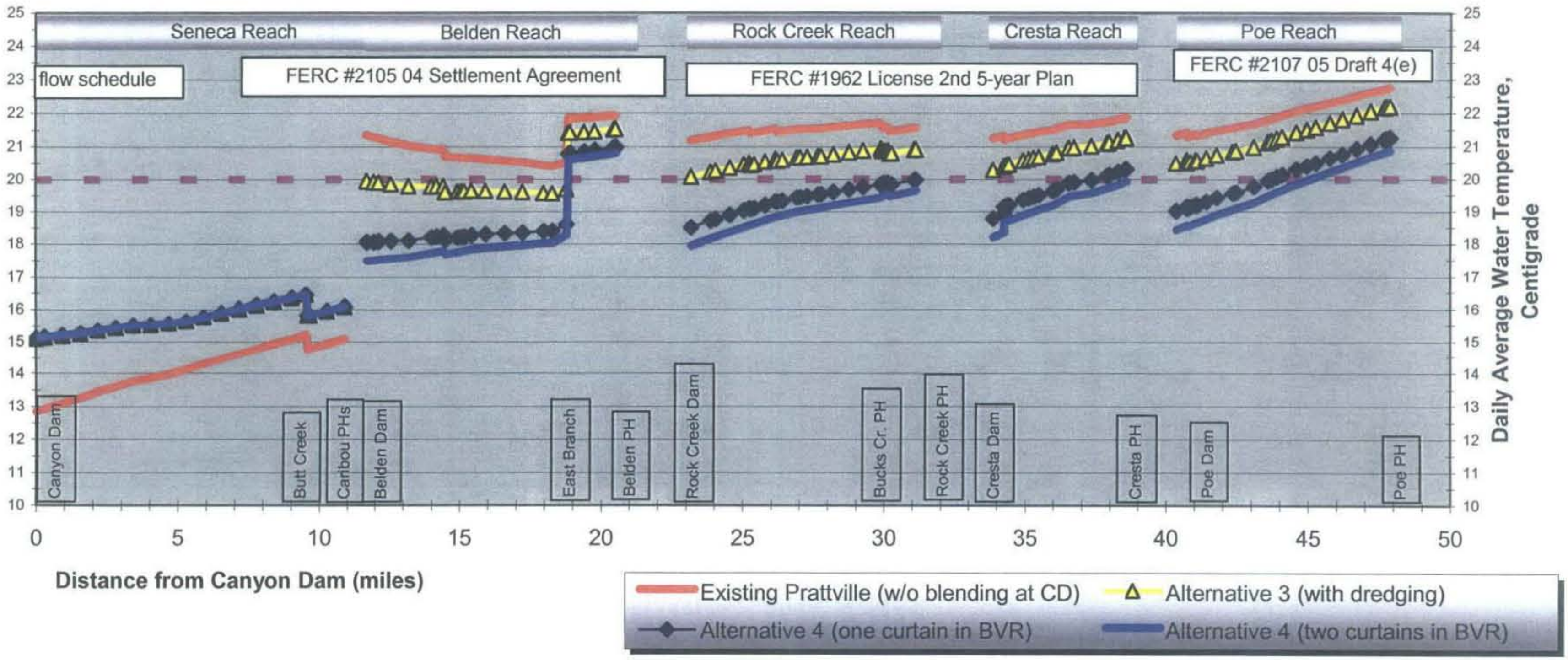
Daily Mean Water Temperature Profile in NFFR
Warm/Dry July - 10% Exceedance
Prattville Alternatives



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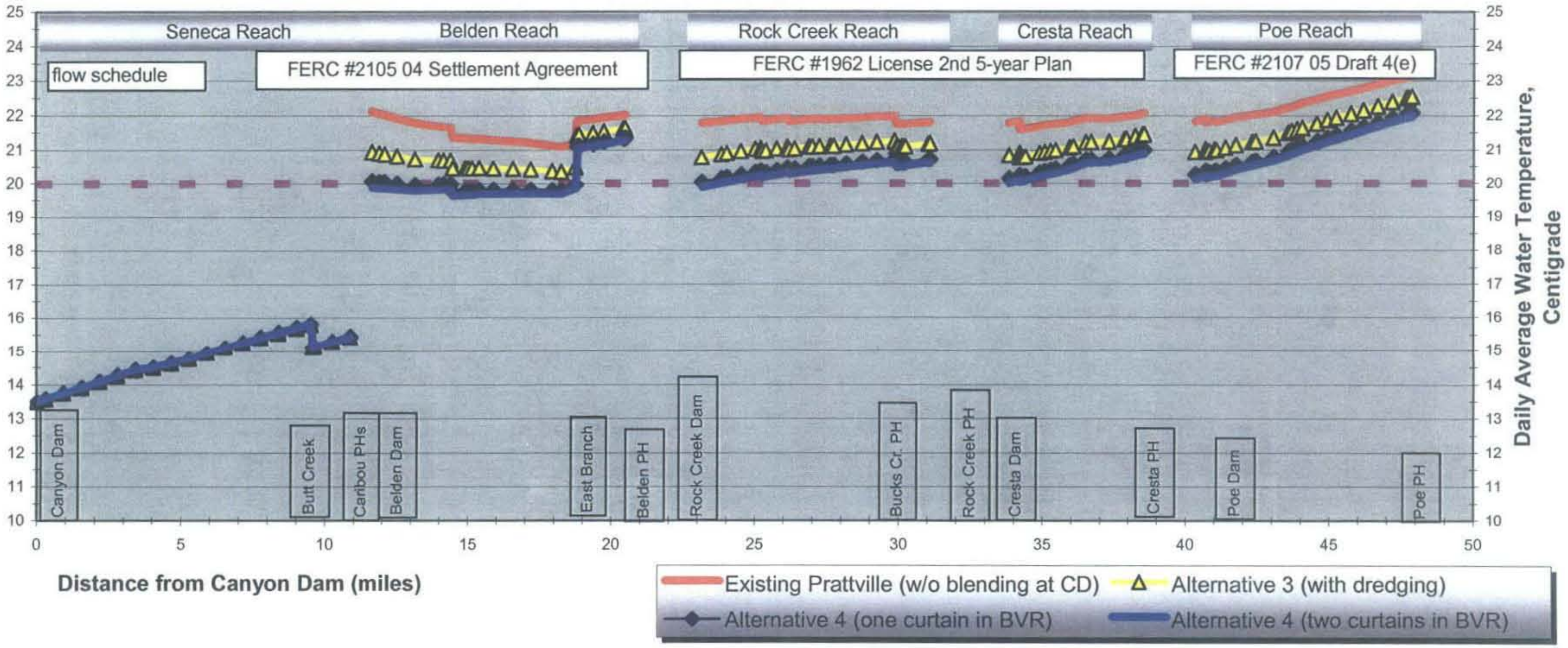
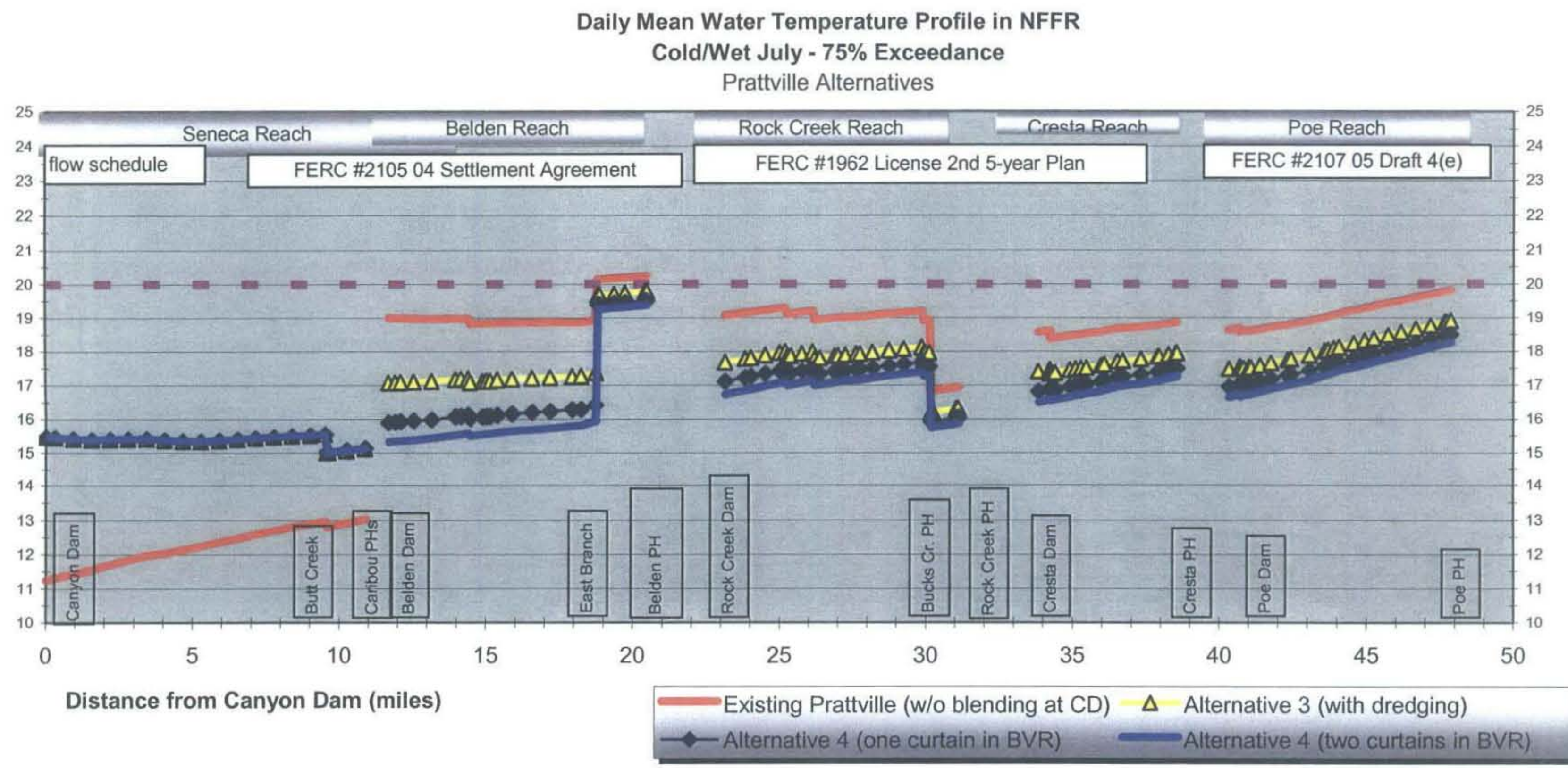
Warm/Dry August - 10% Exceedance
Prattville Alternatives





Daily Mean Water Temperature Profile in NFFR
Cold/Wet July - 75% Exceedance
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Poe PH
Distance from Canyon Dam (miles)
Daily Average Water Temperature, Centigrade
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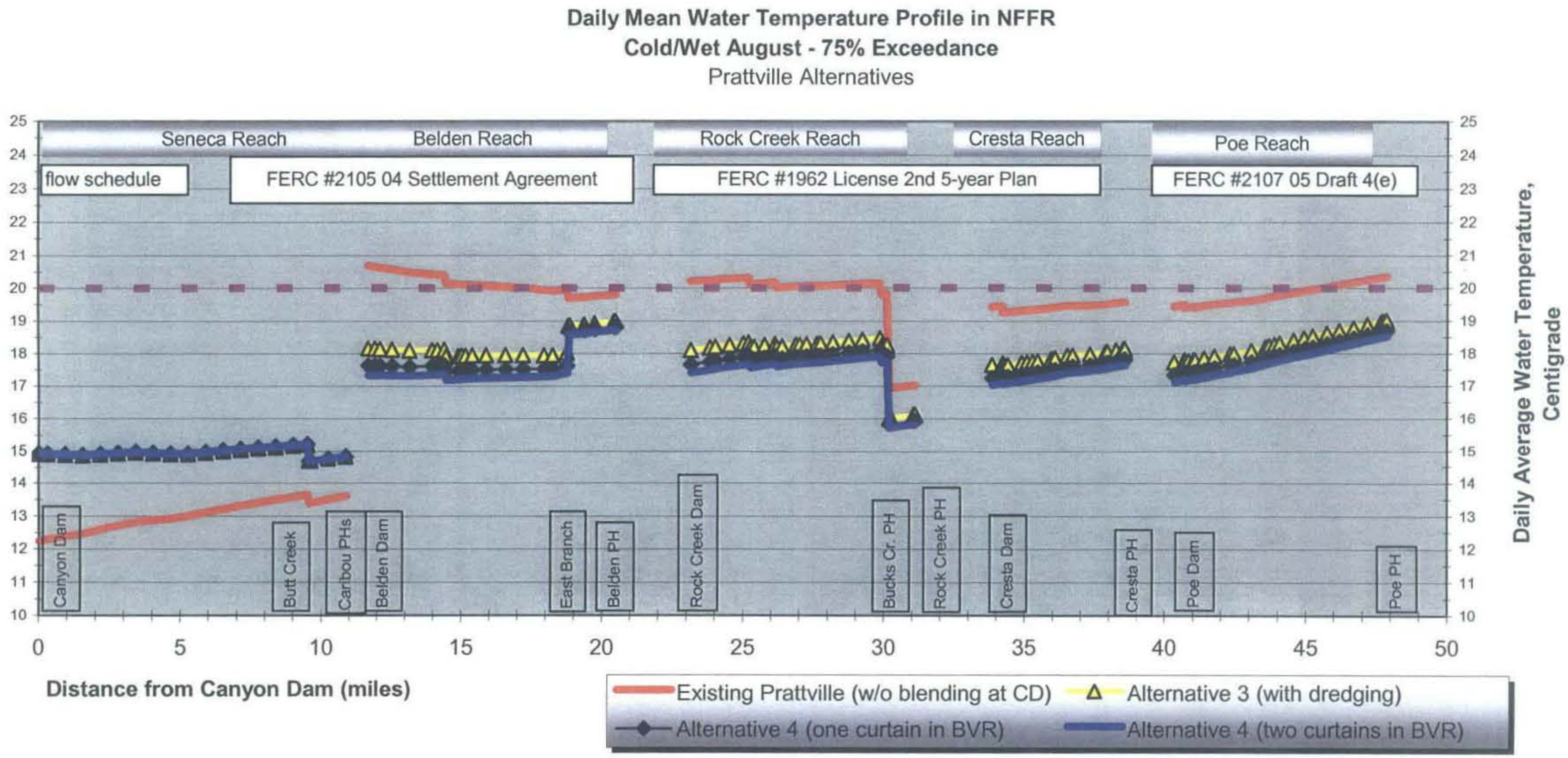
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Poe PH
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50
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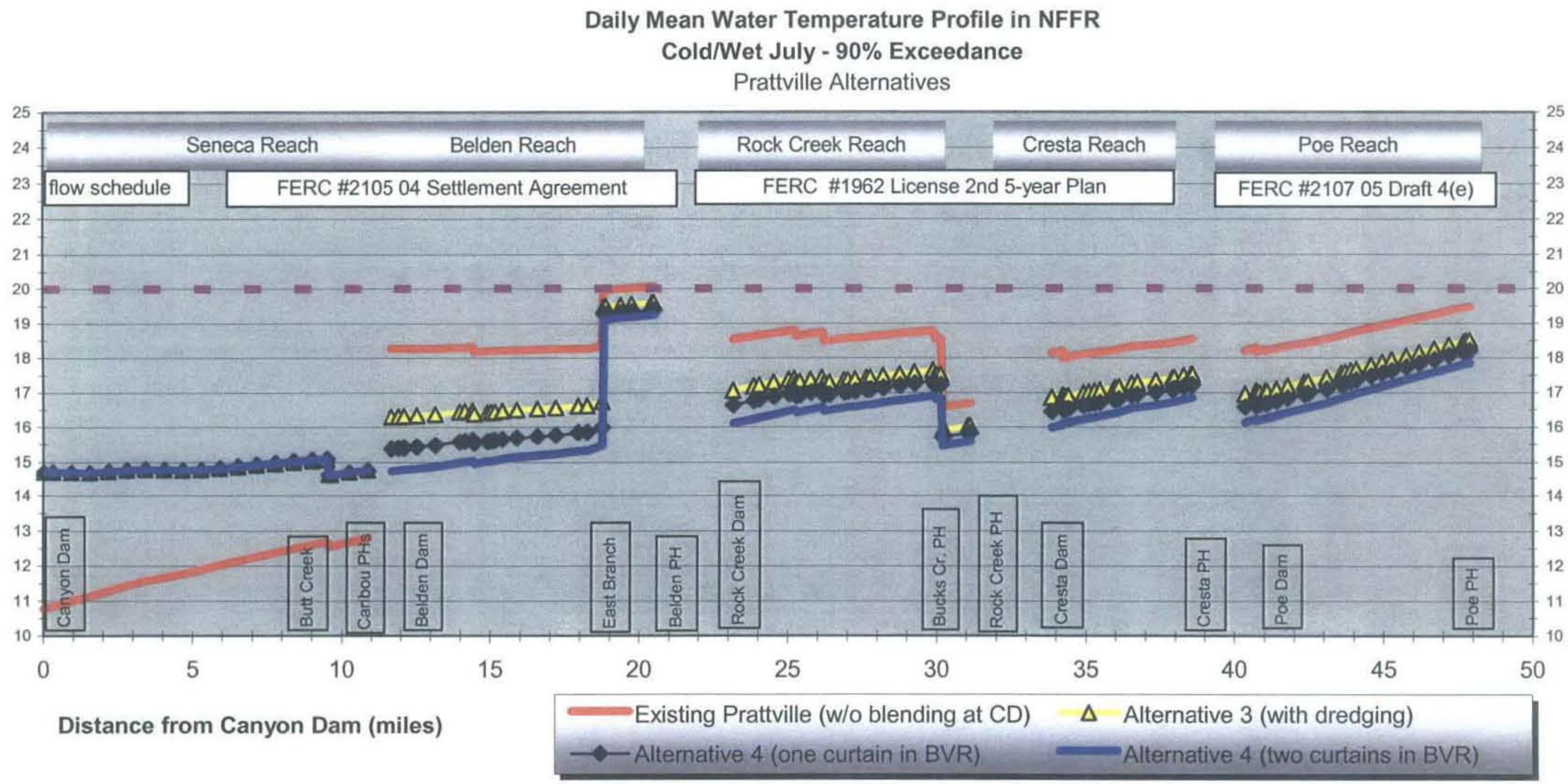
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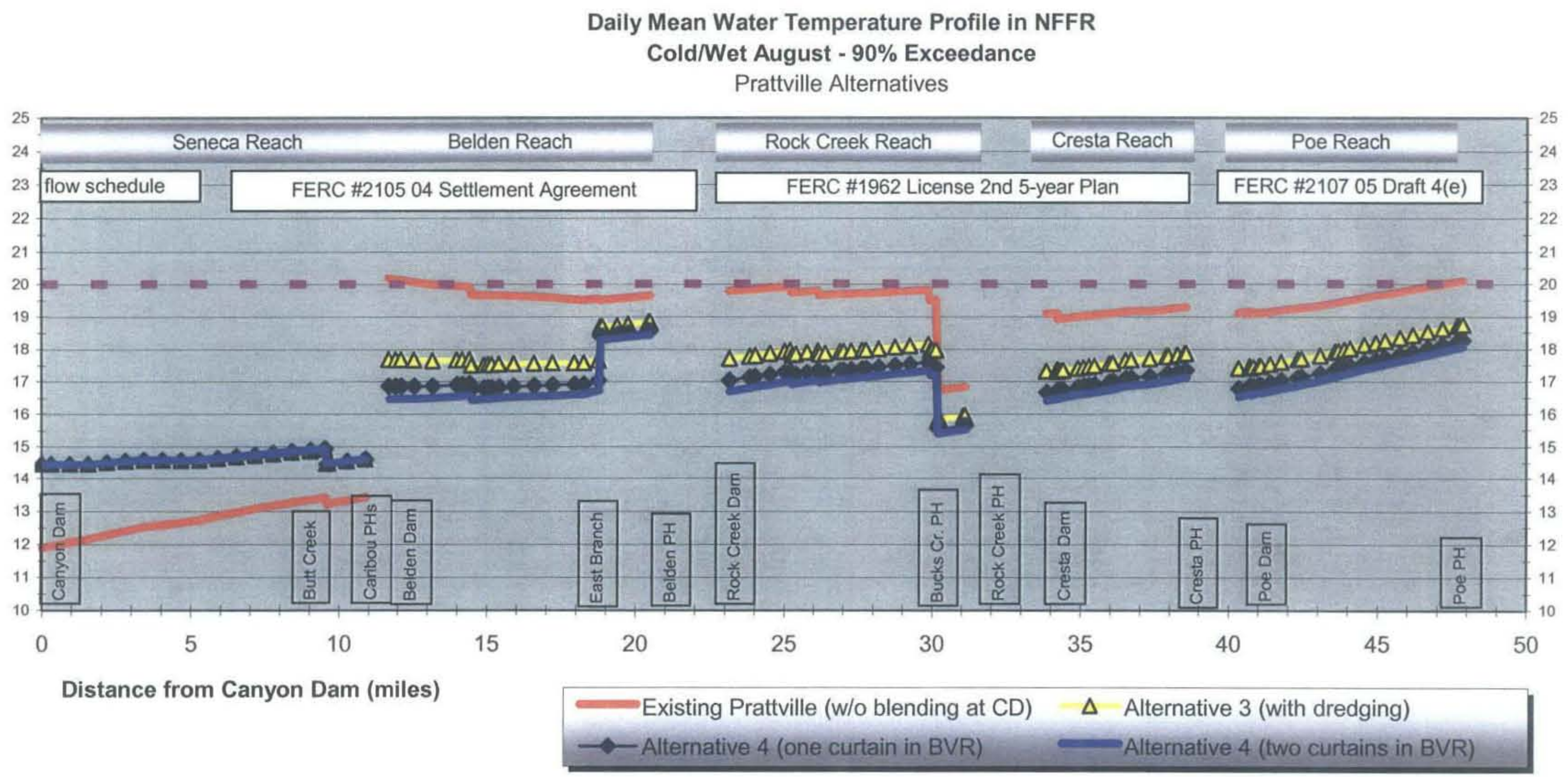

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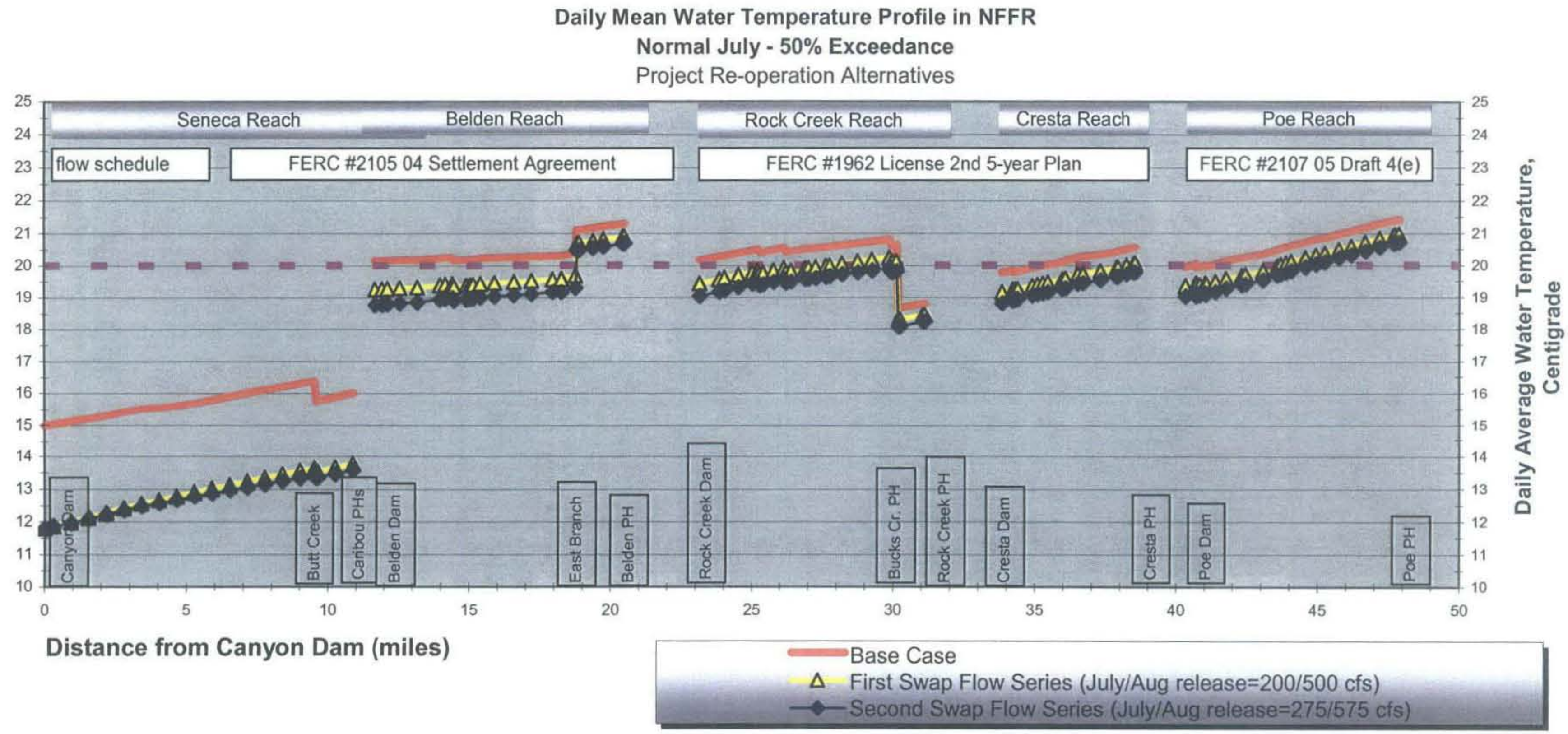
FERC No. 1962 License

Second 5-Year Plan

Daily Mean Water Temperature Profiles in the NFFR

July and August (Normal, Warm/Dry, Cold/Wet Scenarios)

Project Re-operation Alternatives



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Normal July - 50% Exceedance
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Rock Creek PH
Cresta Dam
Cresta PH
Poe Dam
Poe PH
Daily Average Water Temperature, Centigrade
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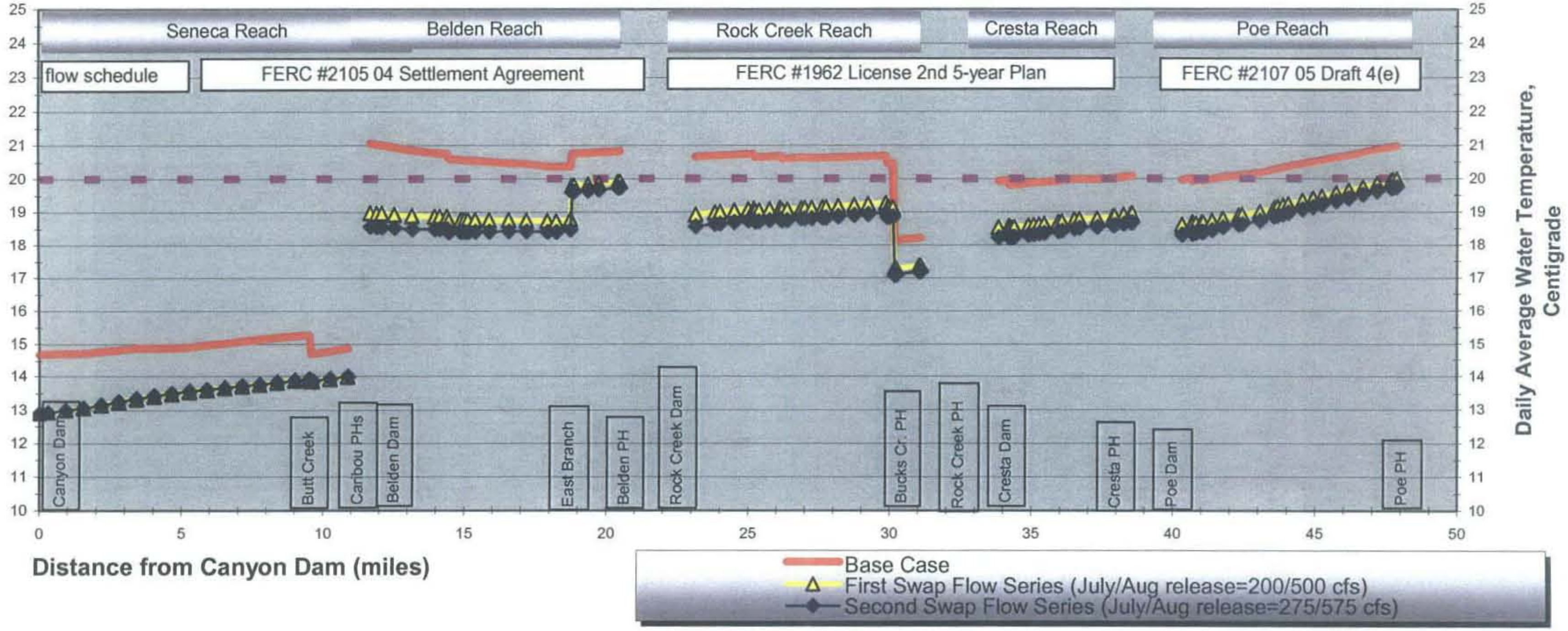
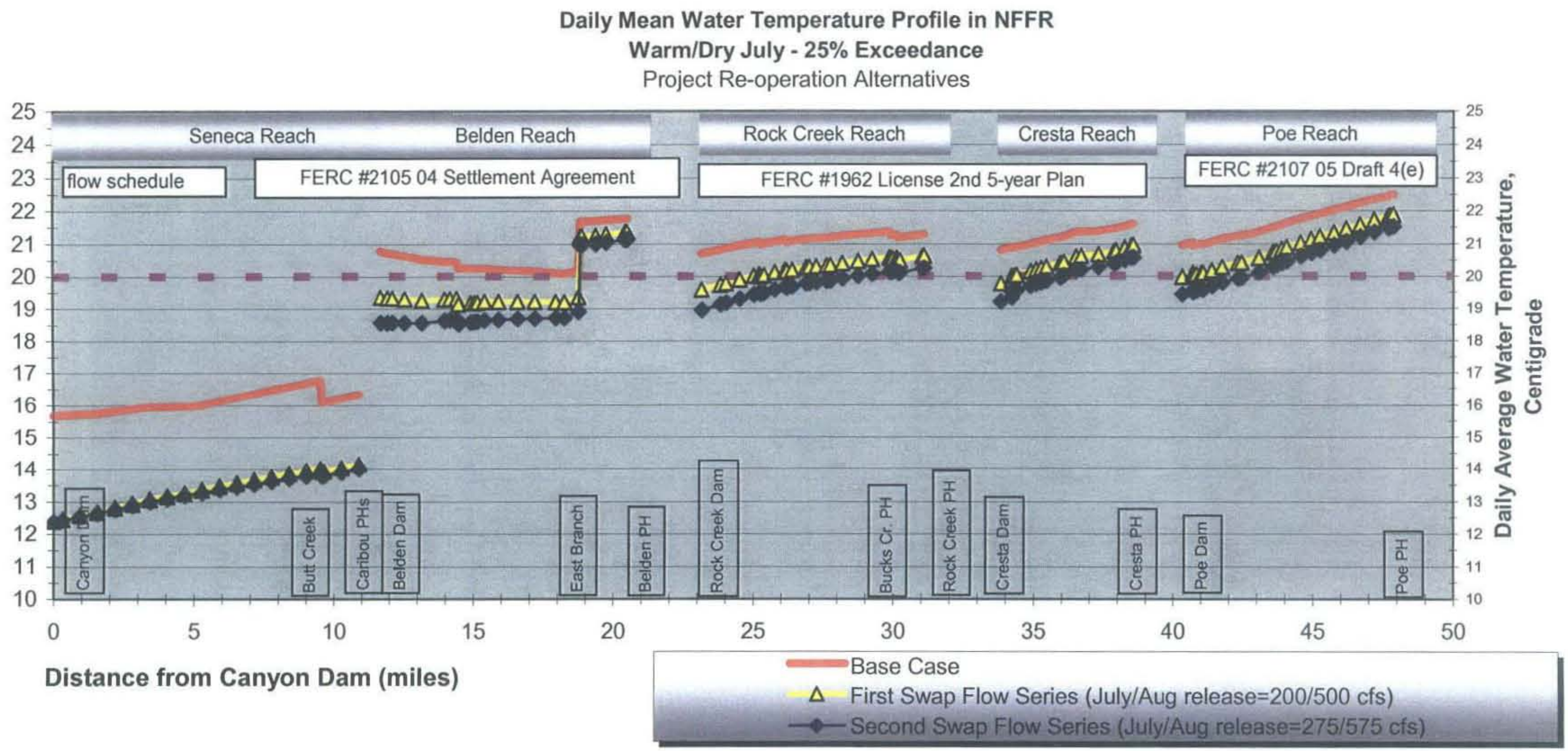
Daily Mean Water Temperature Profile in NFFR
Normal August - 50% Exceedance
Project Re-operation Alternatives




Daily Mean Water Temperature Profile in NFFR
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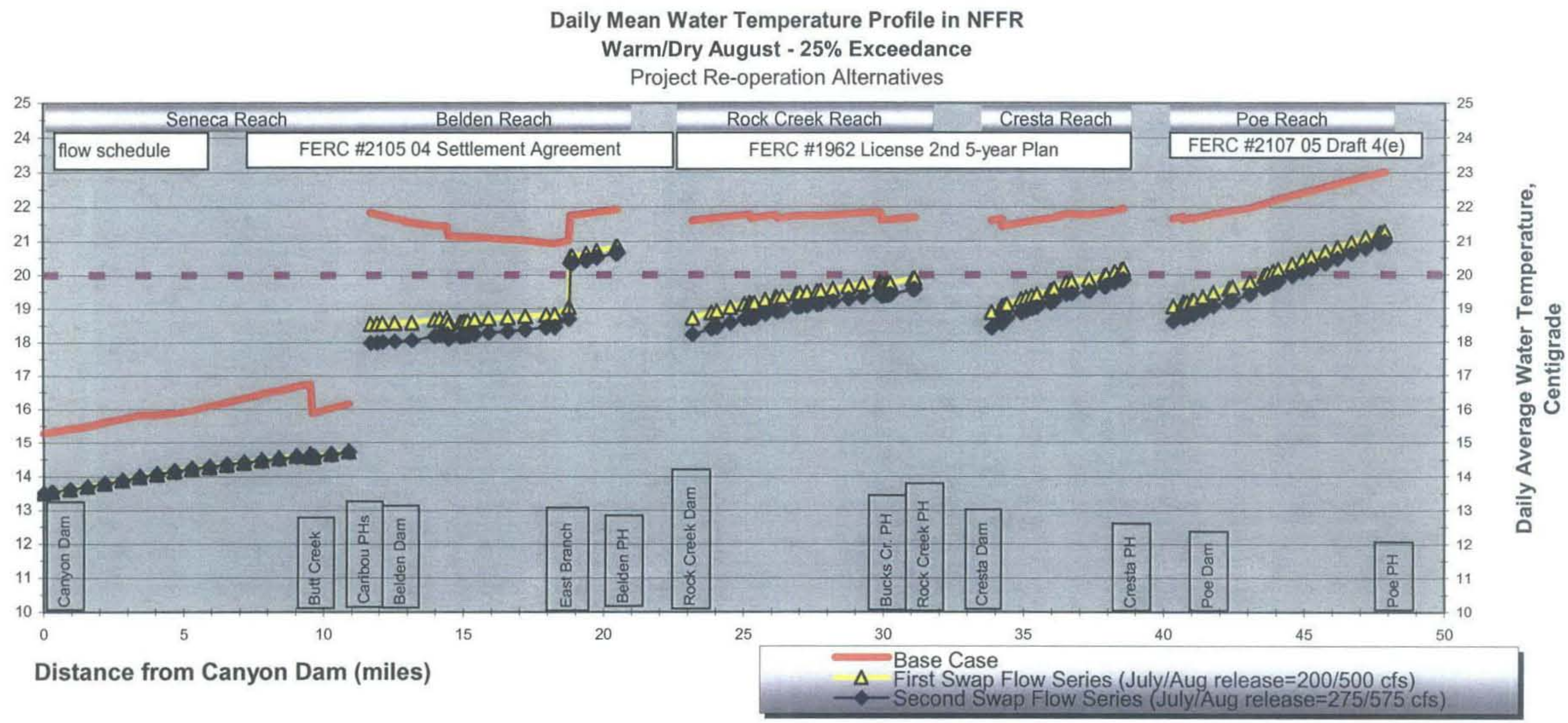
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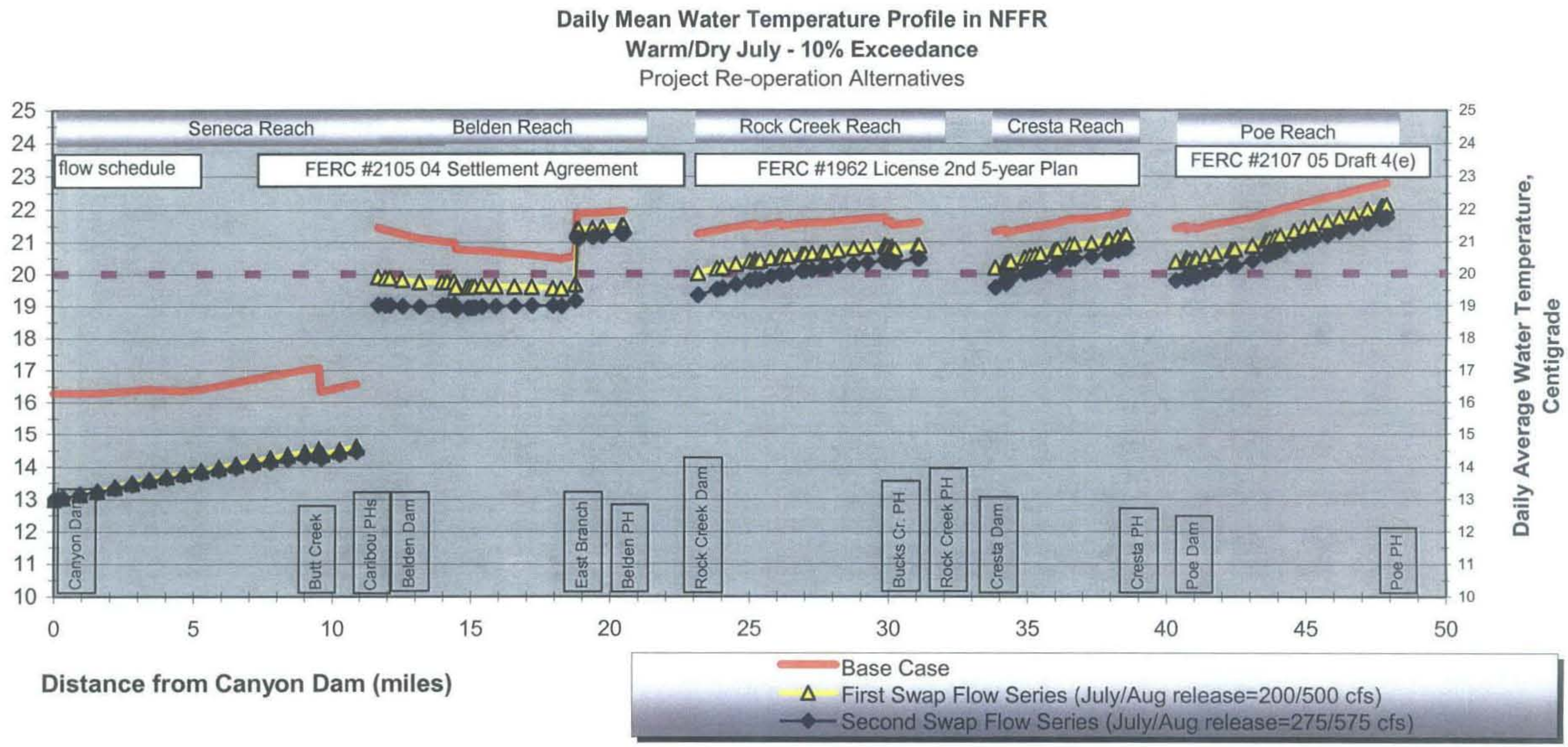
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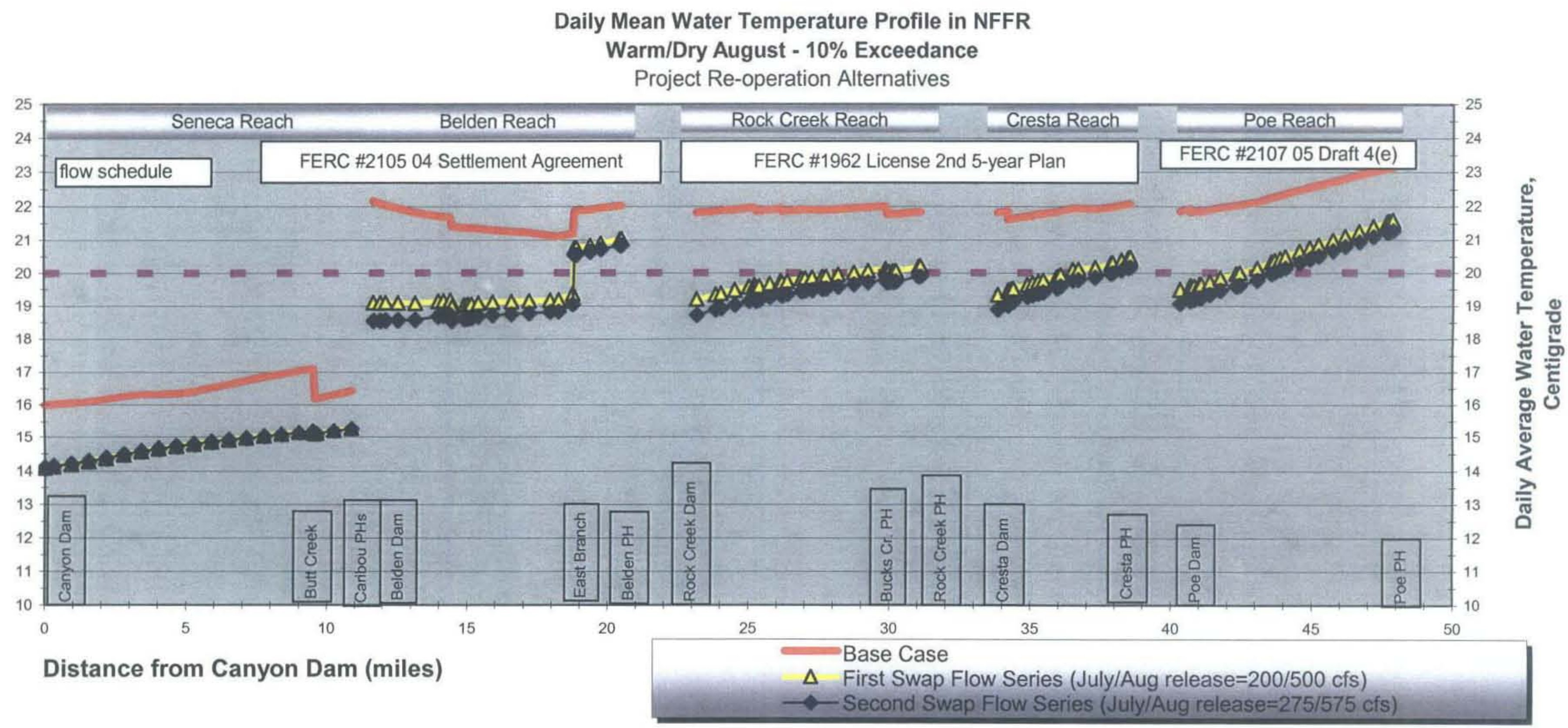
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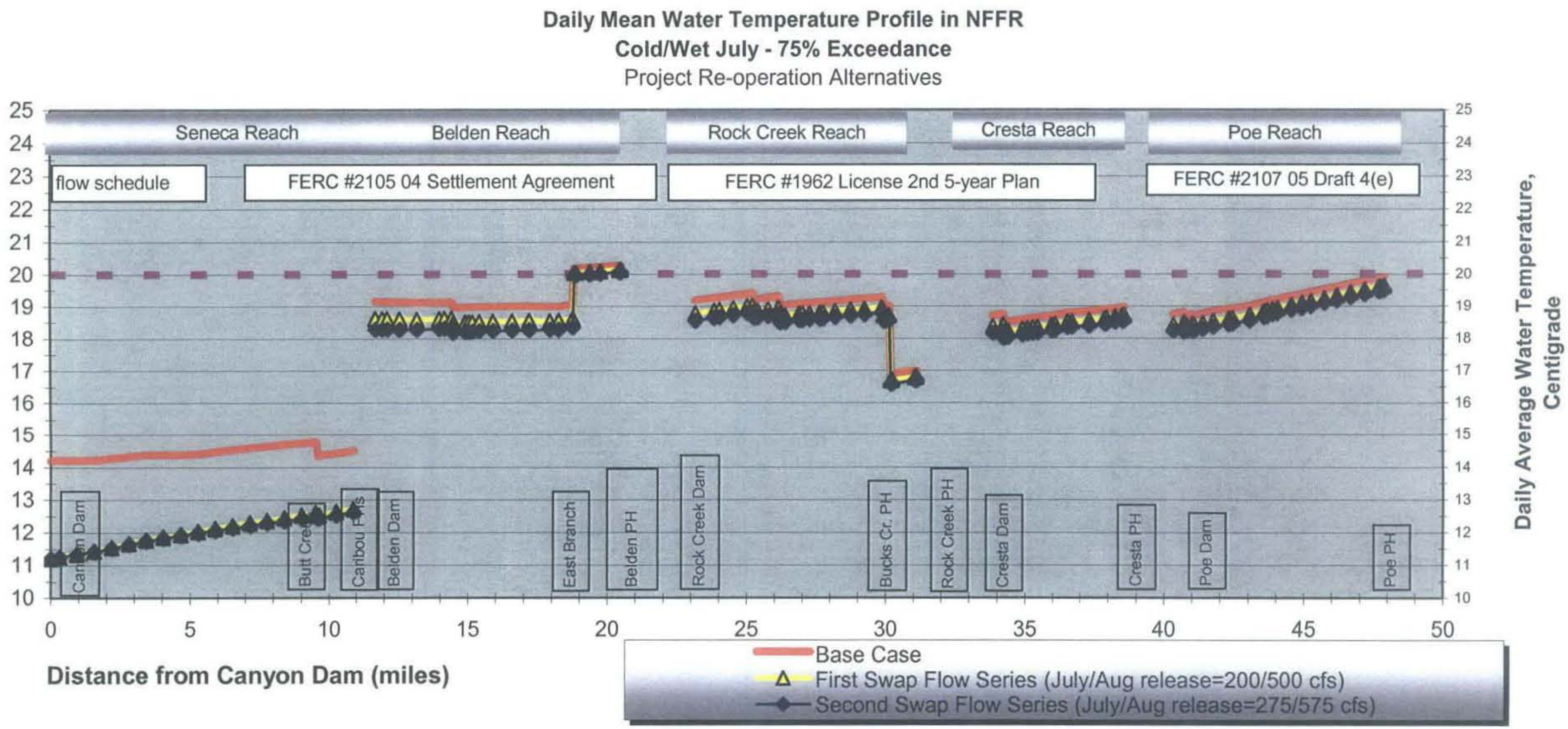

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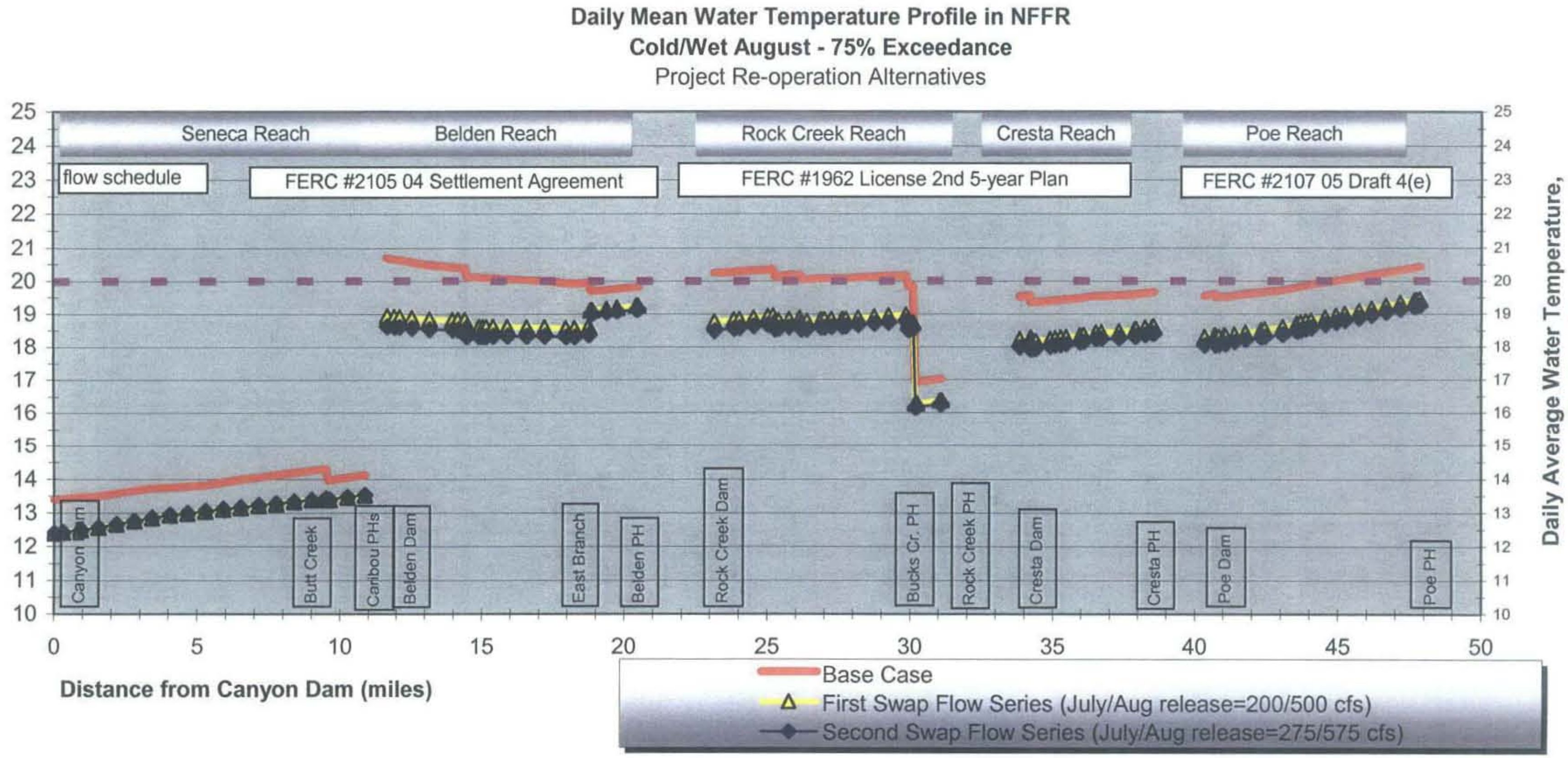

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Cold/Wet July - 90% Exceedance
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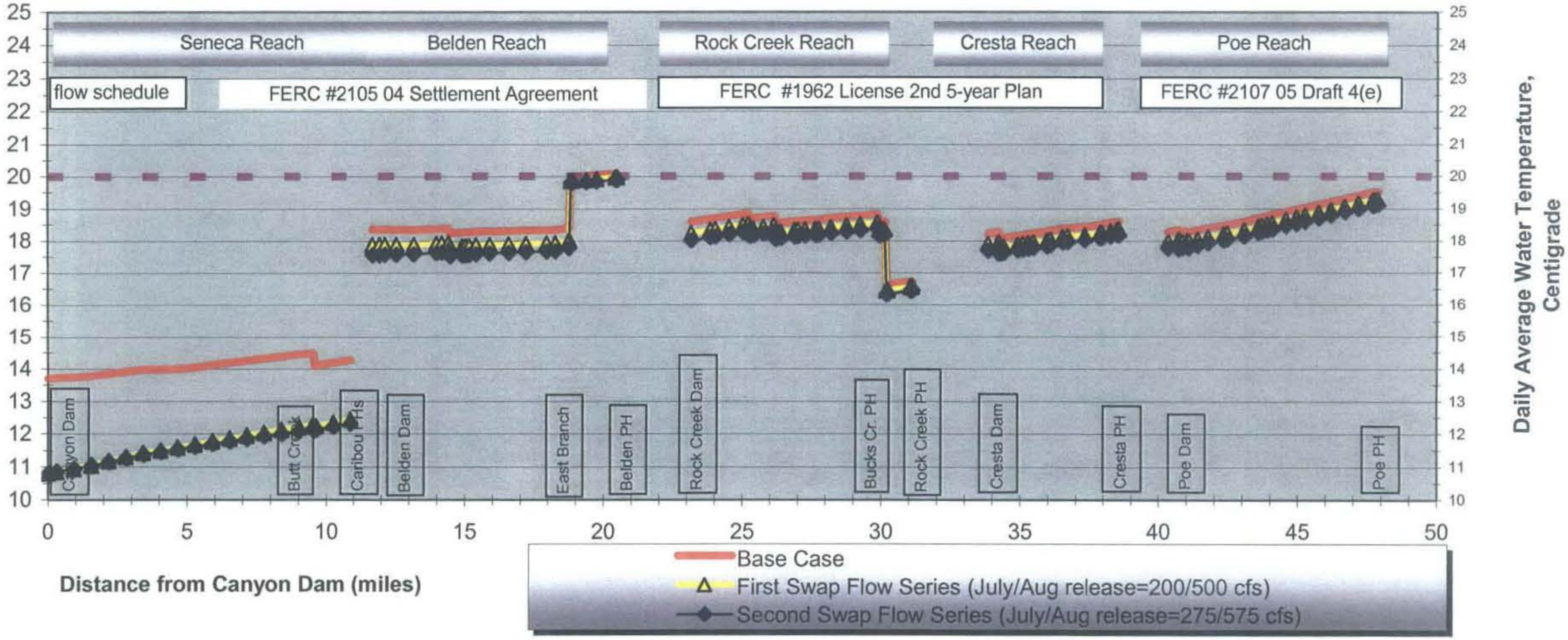

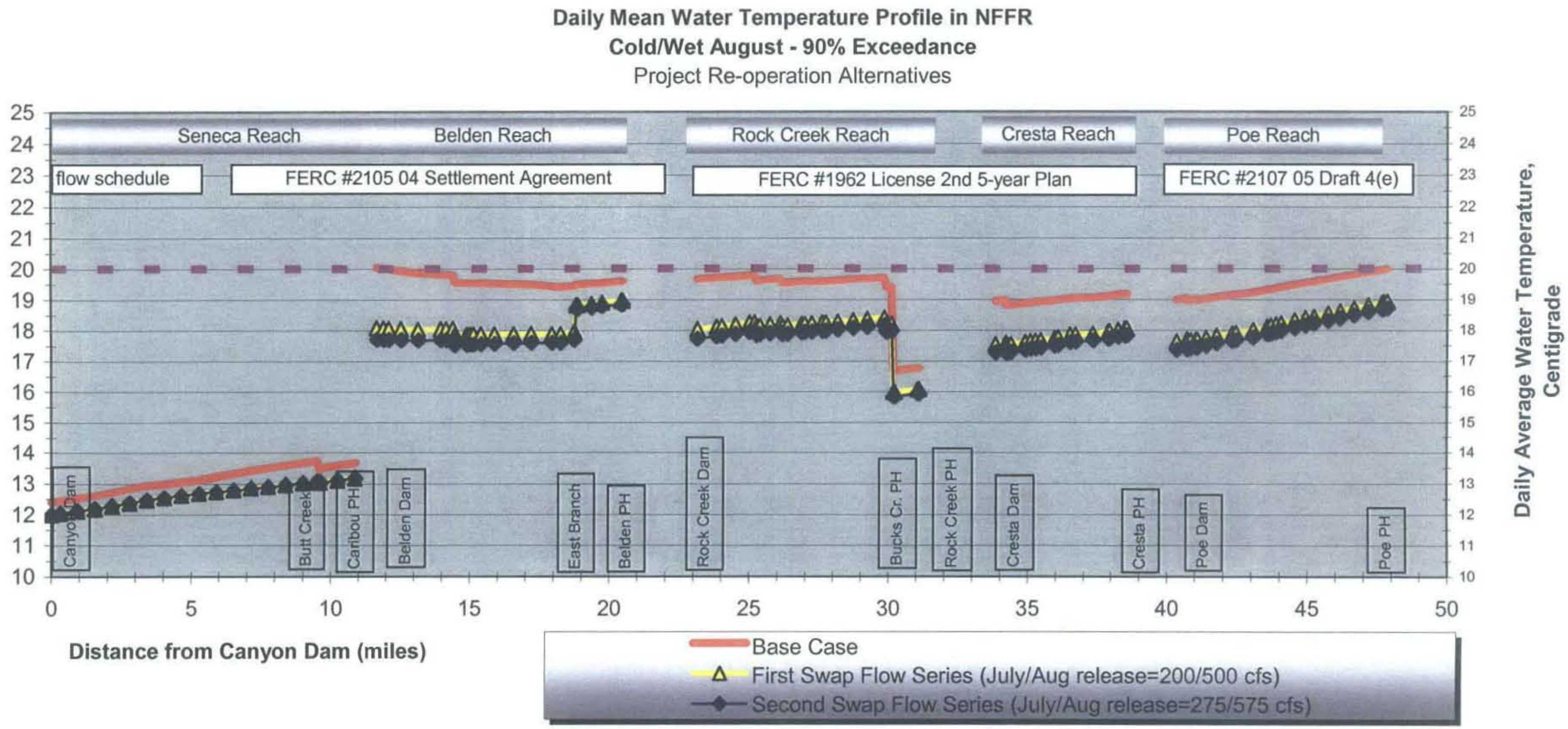

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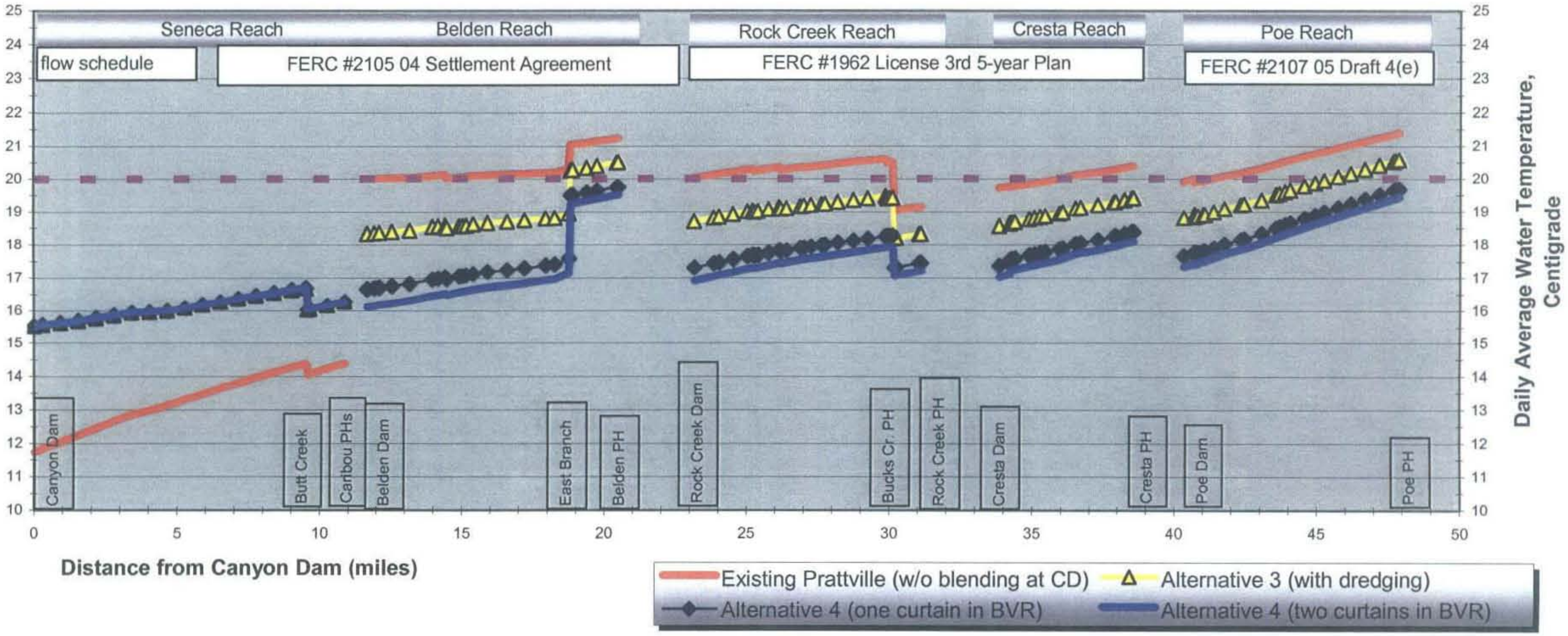
Third 5-Year Plan

Daily Mean Water Temperature Profiles in the NFFR

July and August (Normal, Warm/Dry, Cold/Wet Scenarios)

Prattville Alternatives

Daily Mean Water Temperature Profile in NFFR
Normal July - 50% Exceedance
Prattville Alternatives



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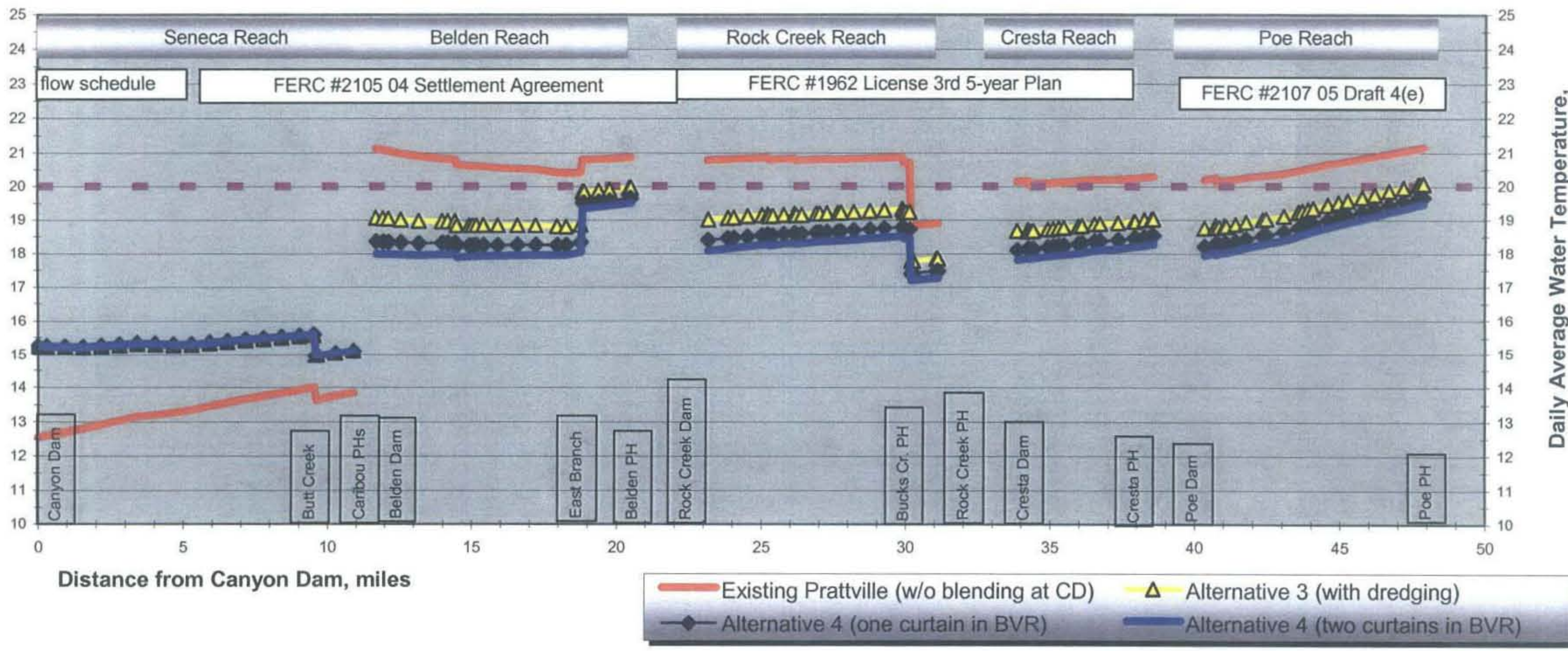

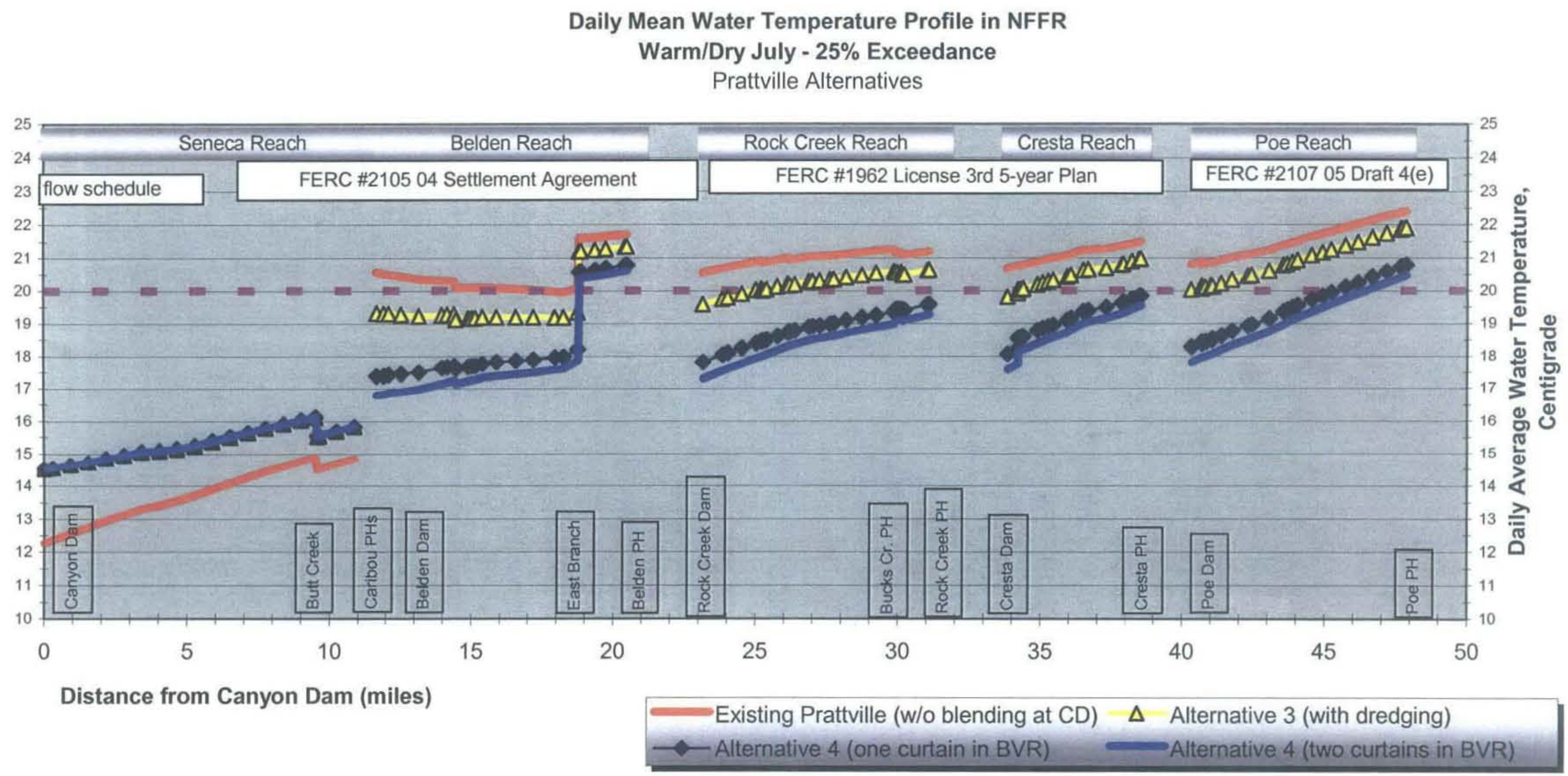

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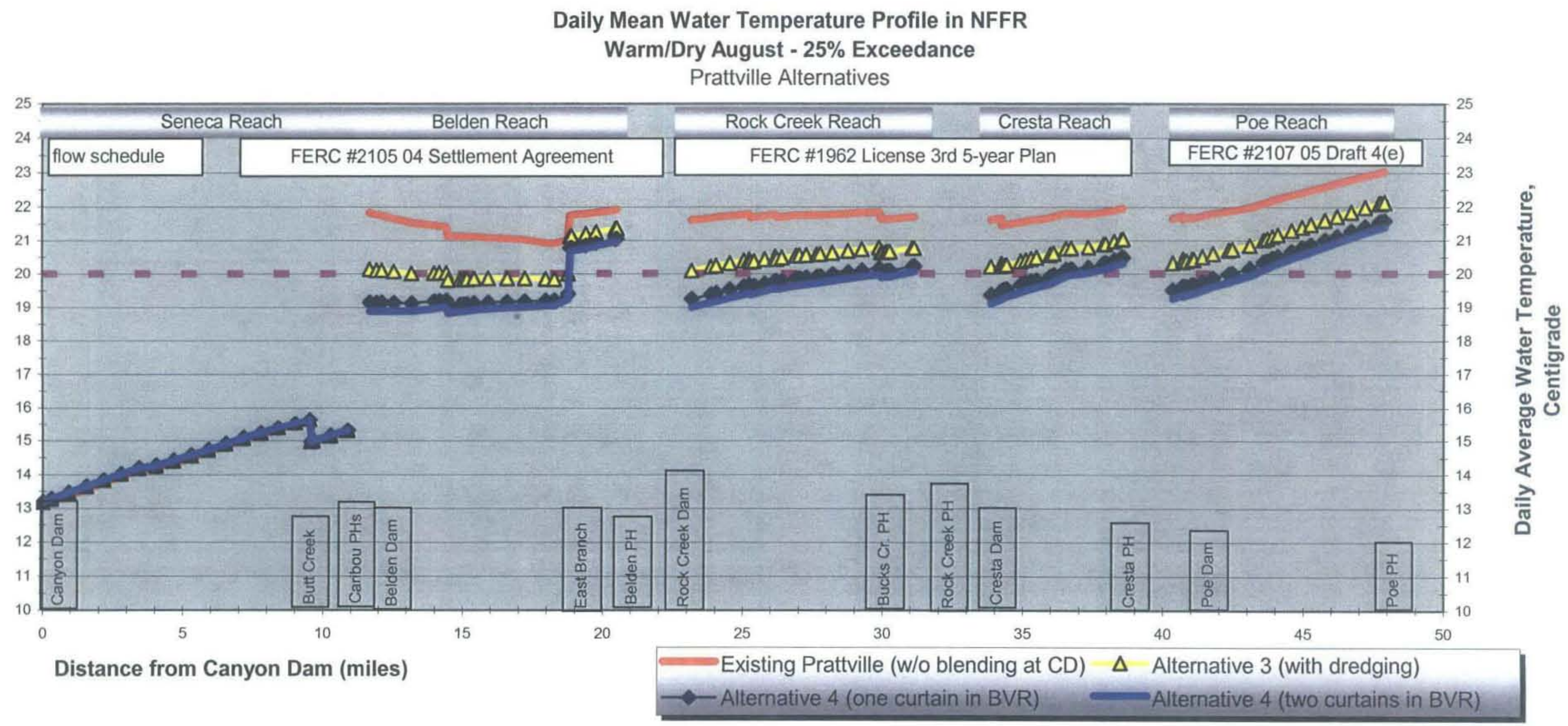
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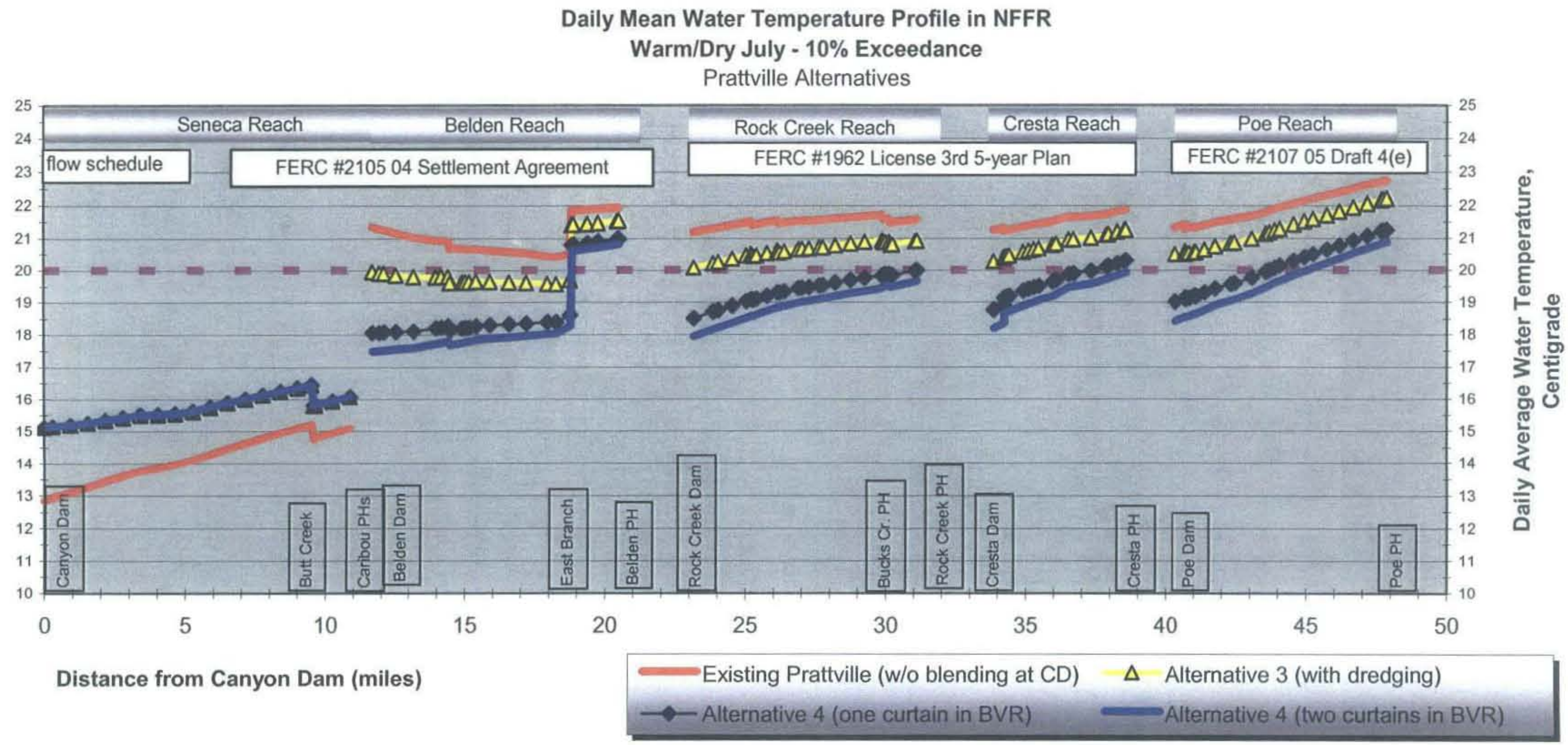
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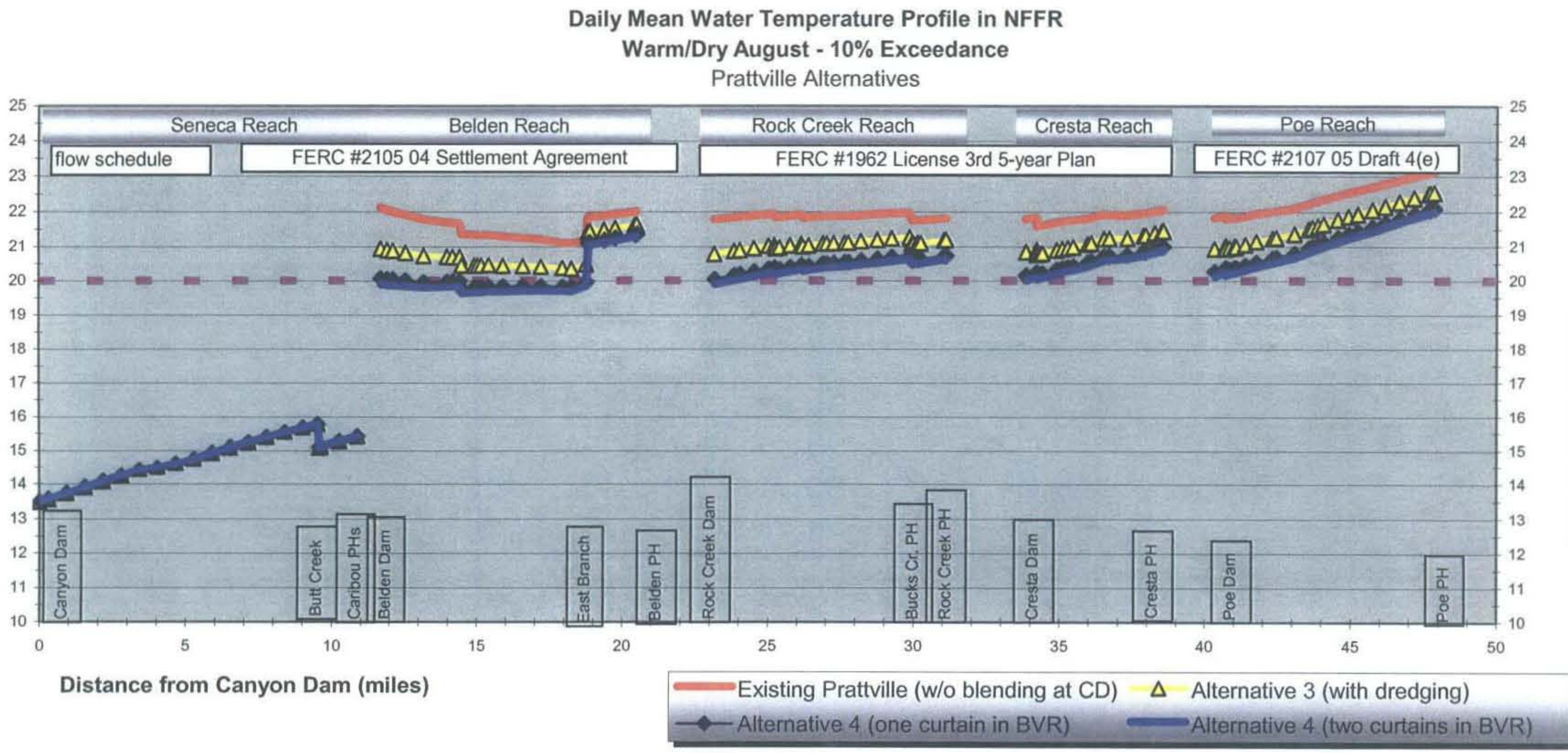

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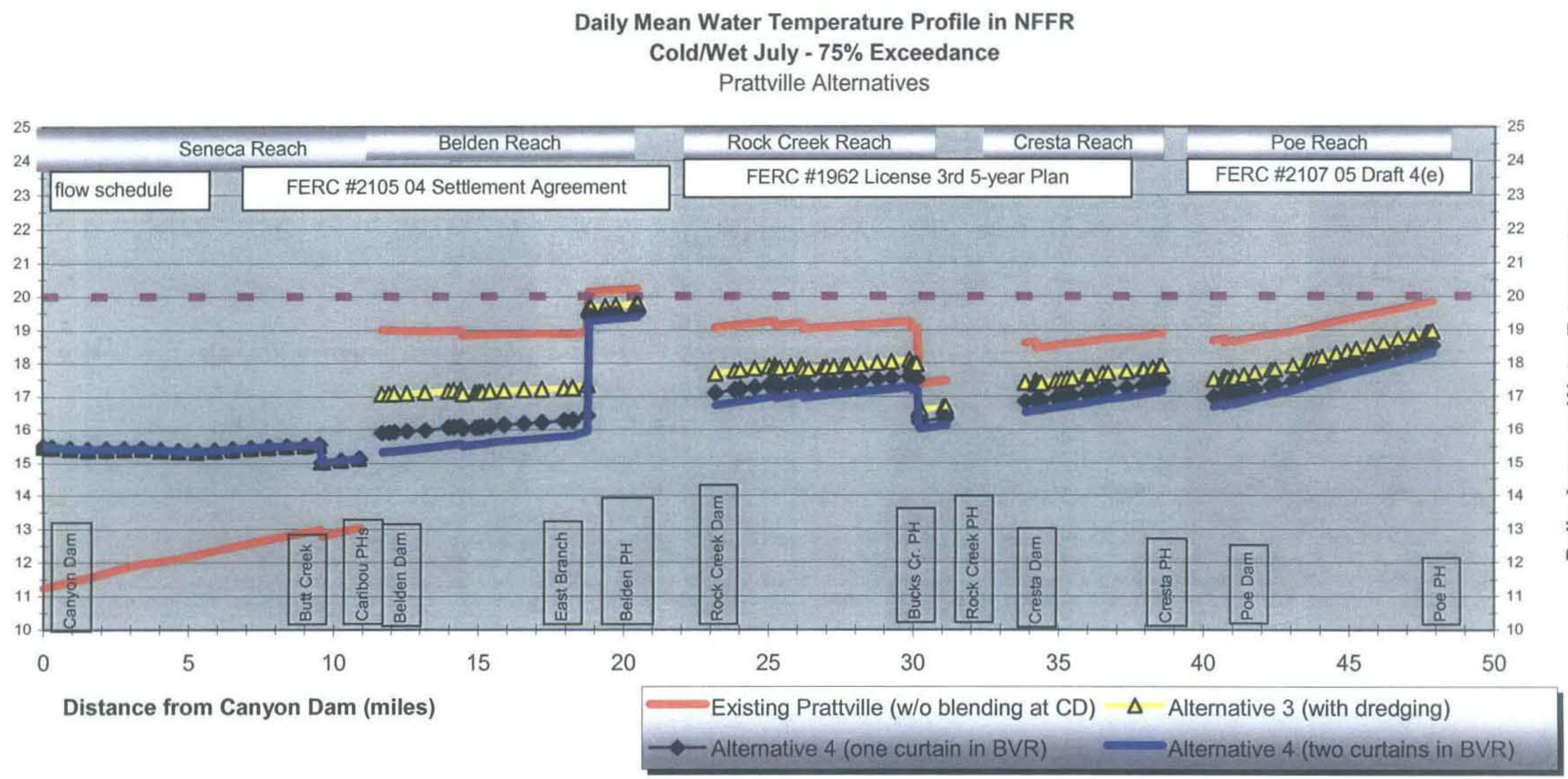

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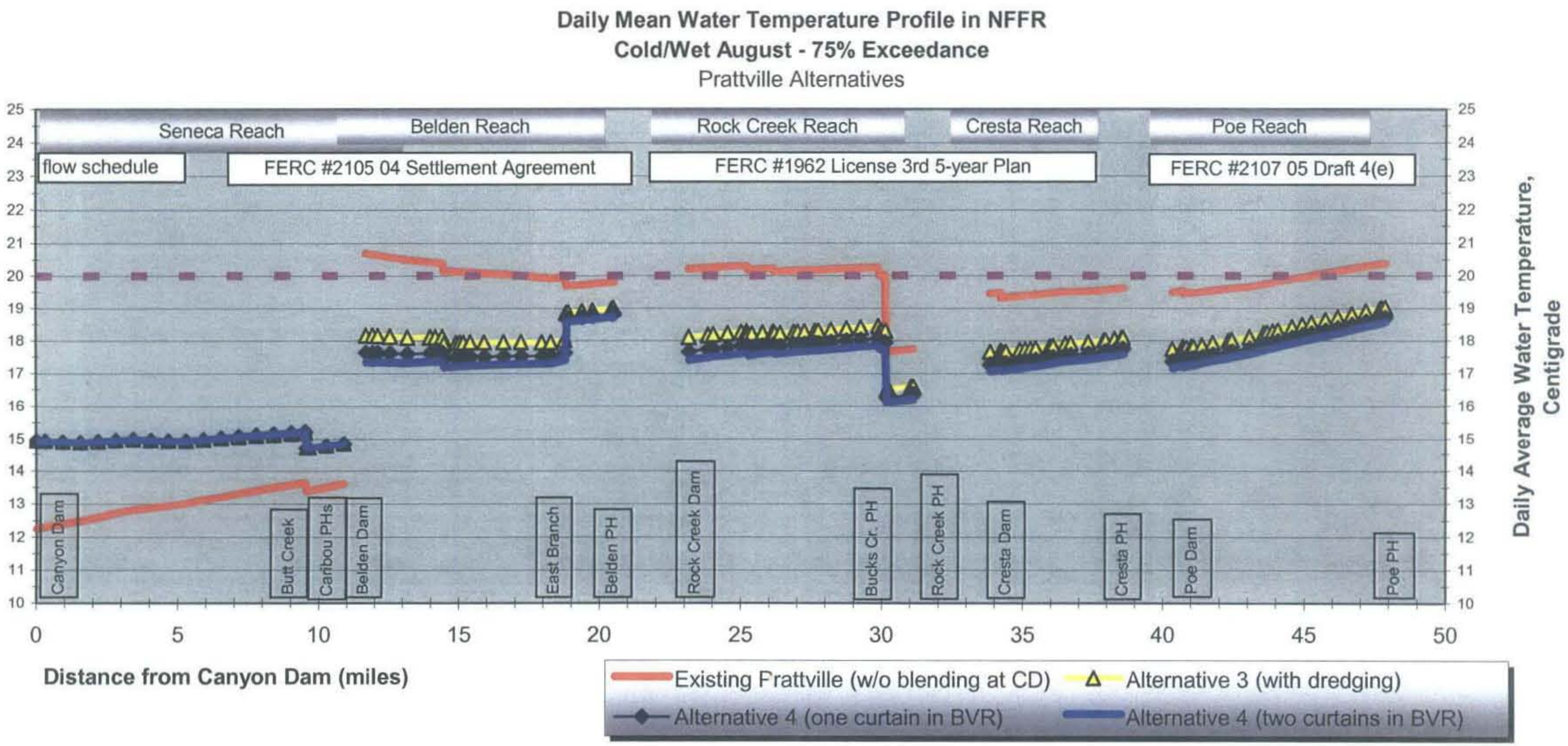

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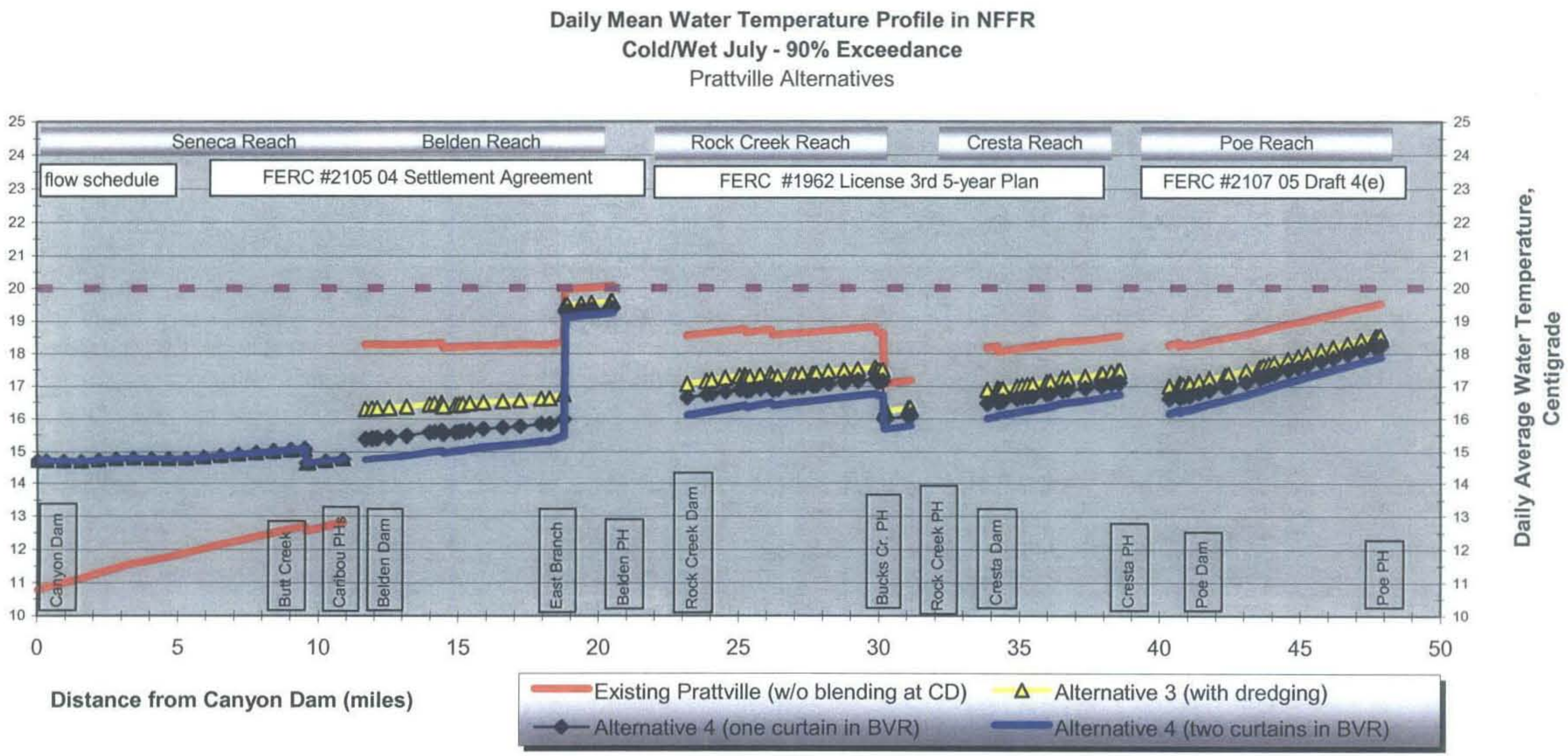
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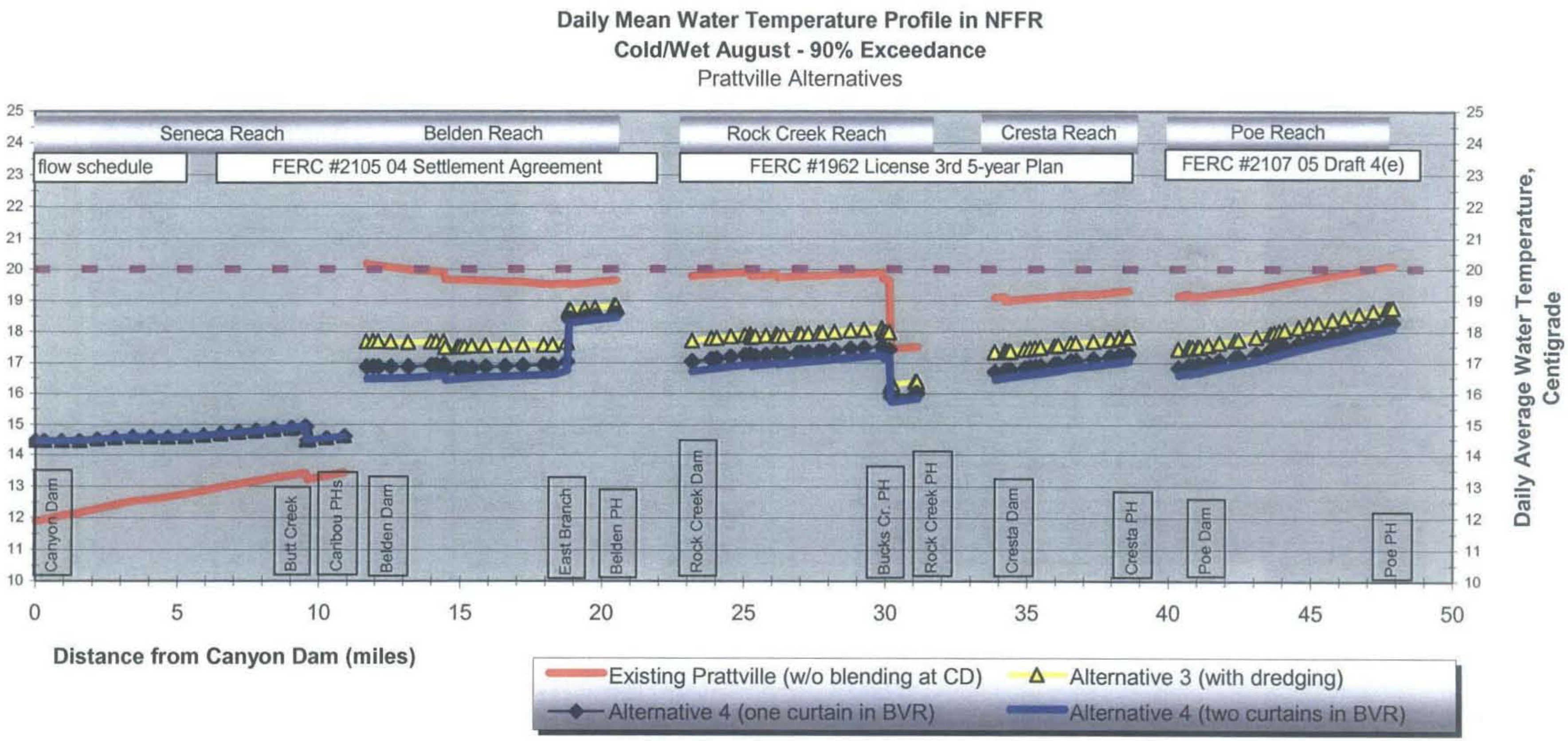
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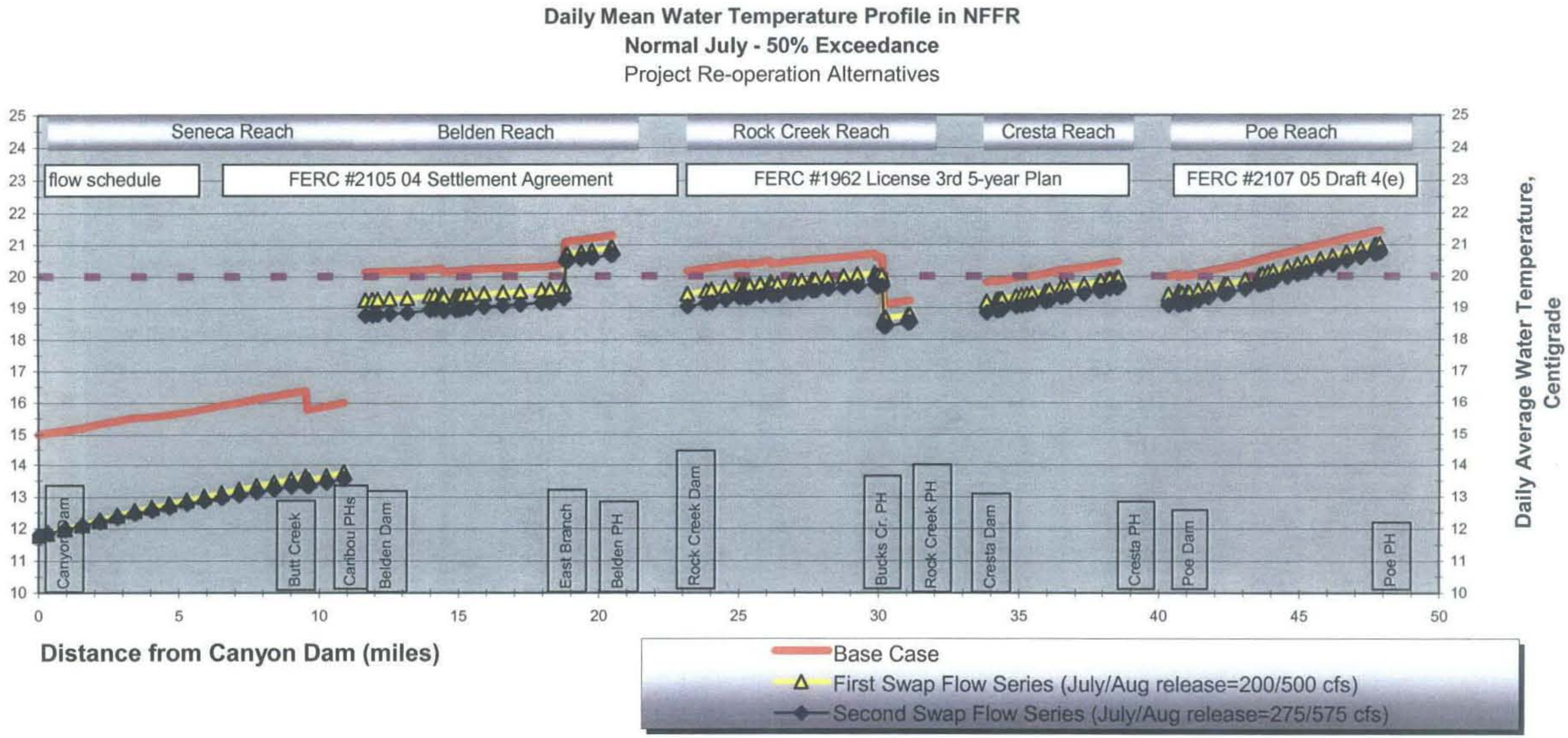

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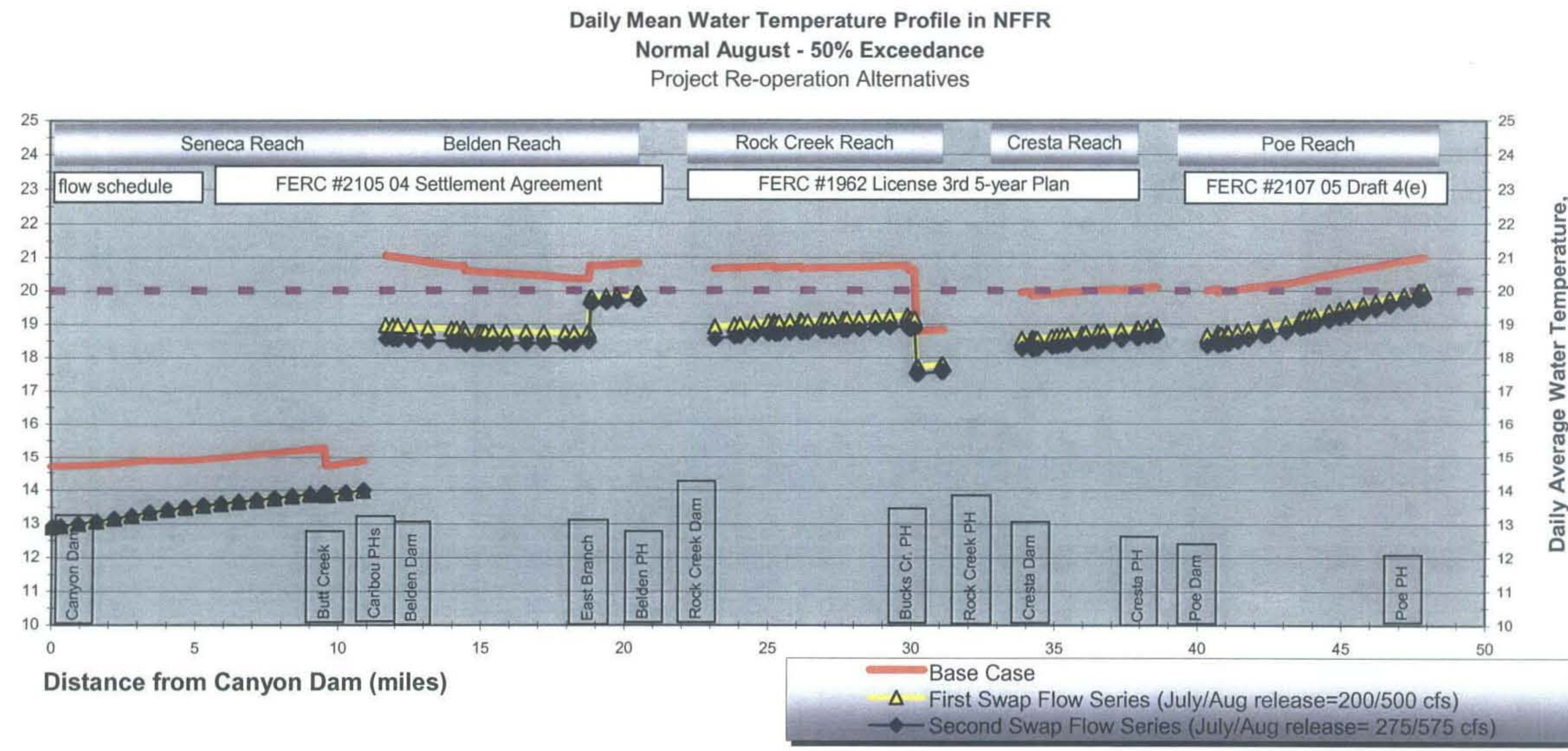

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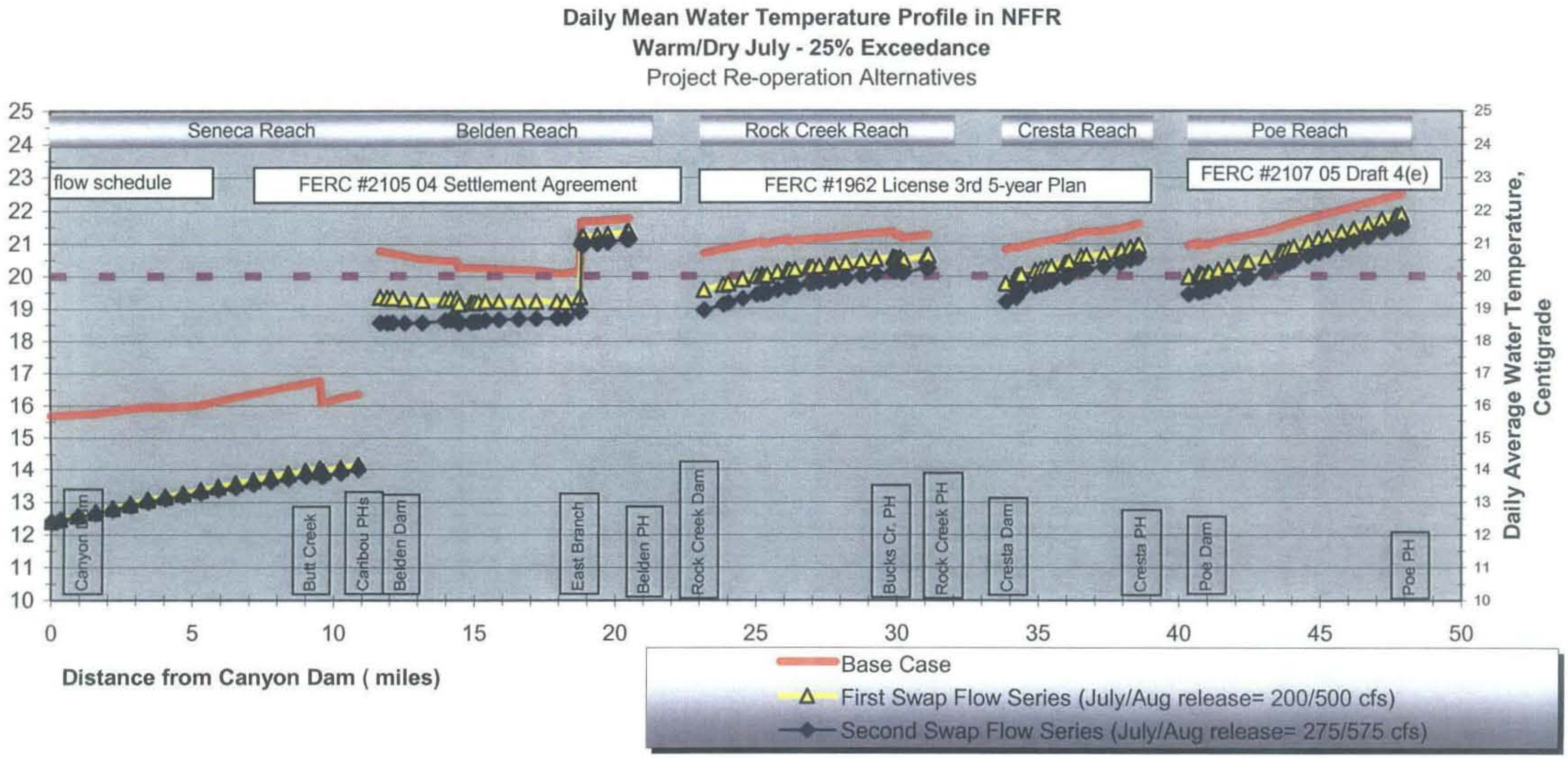

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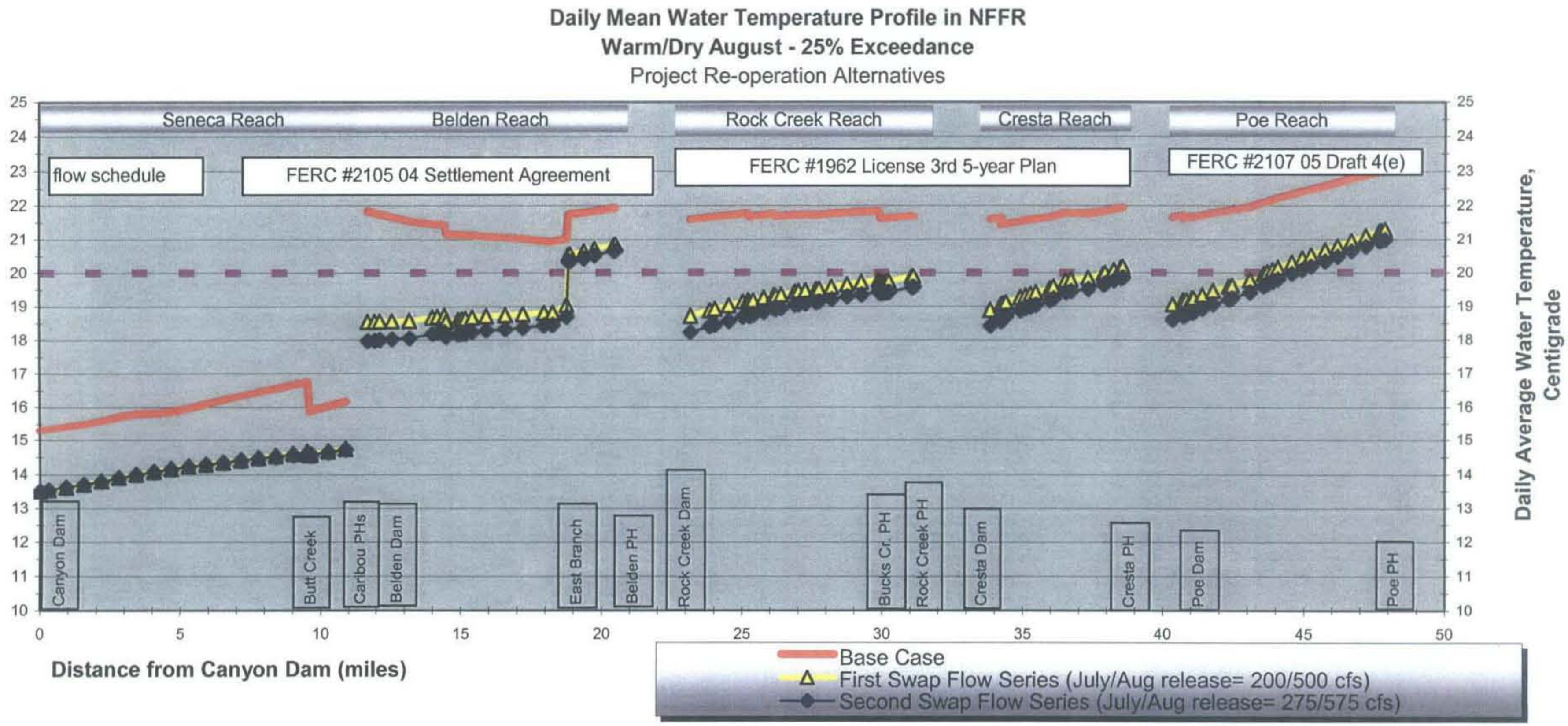

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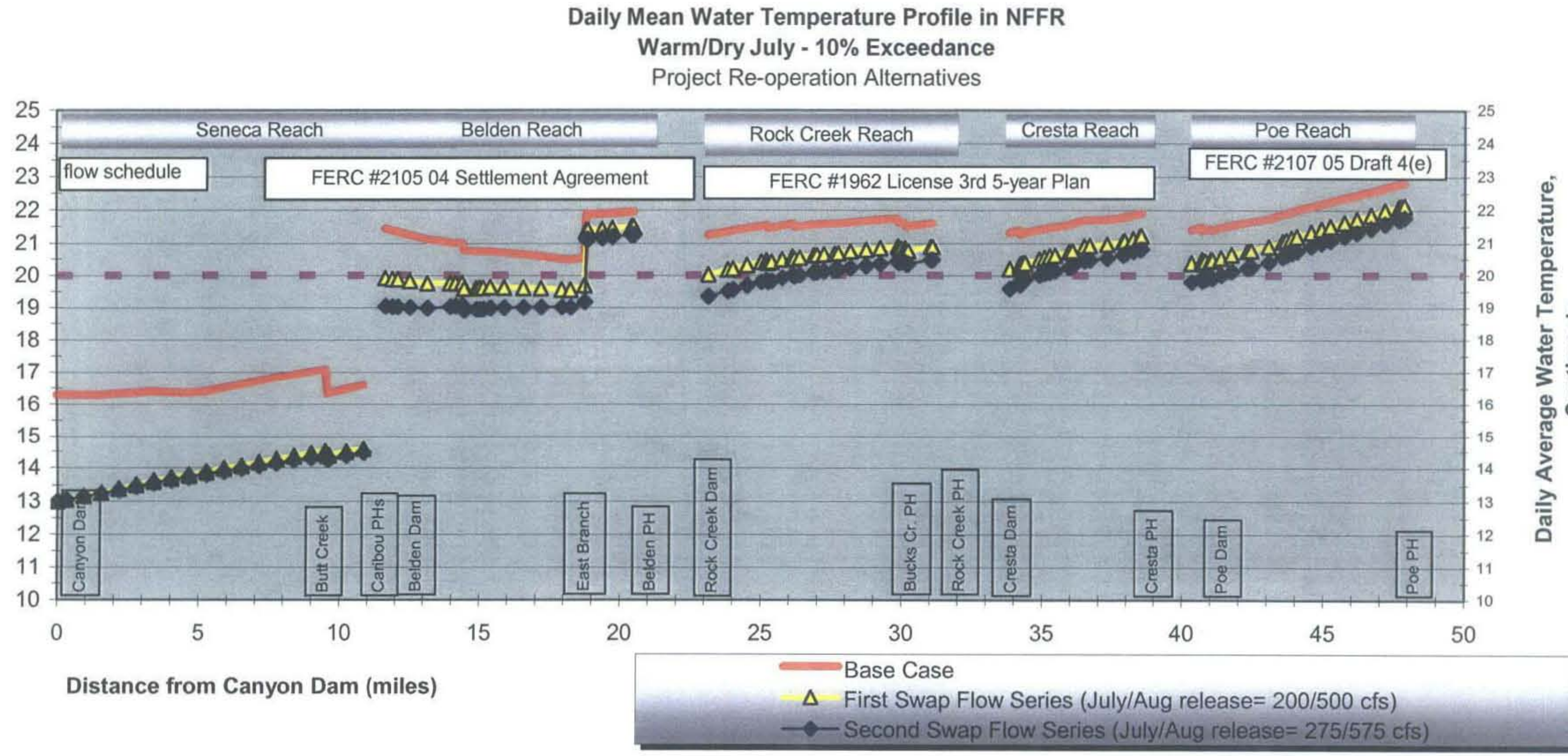

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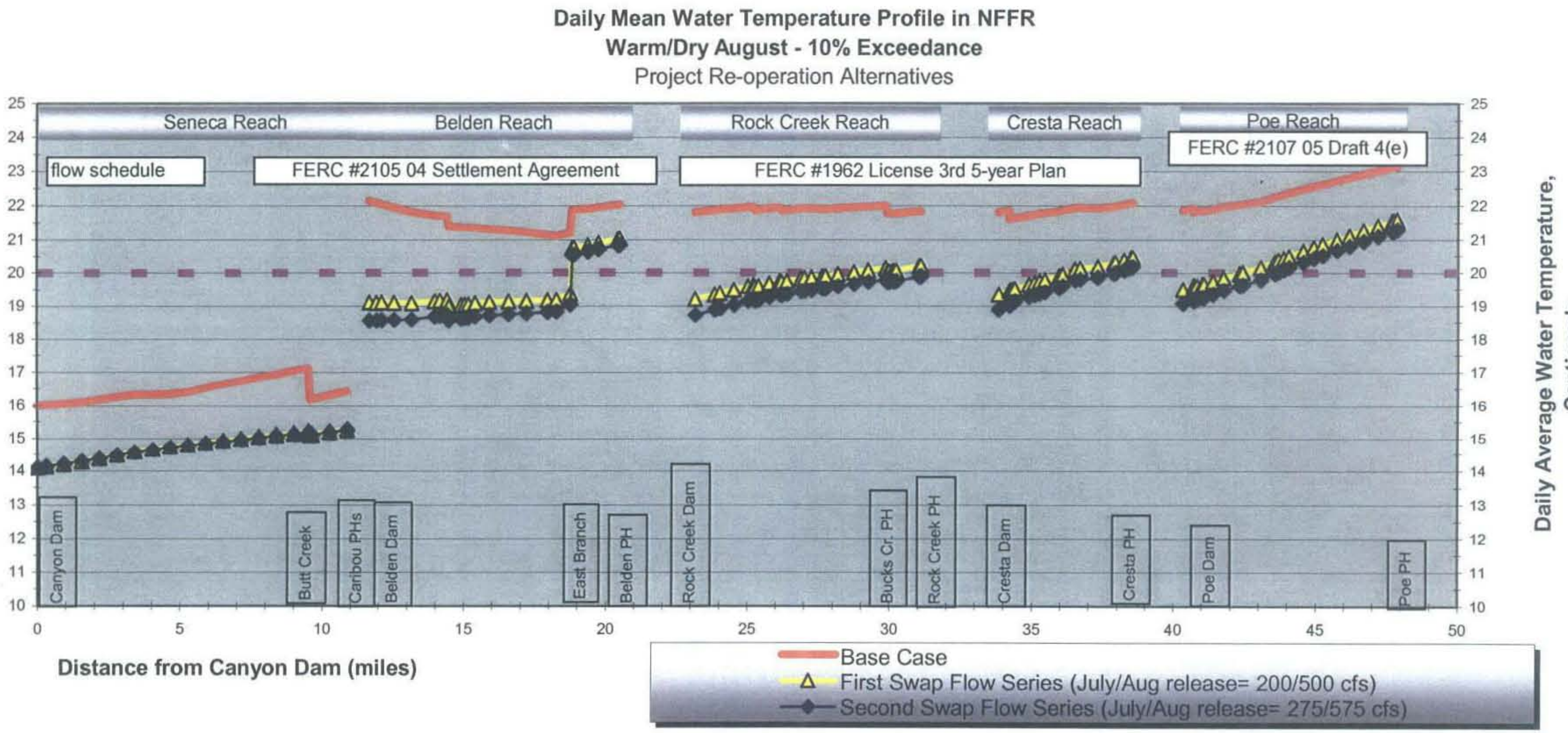
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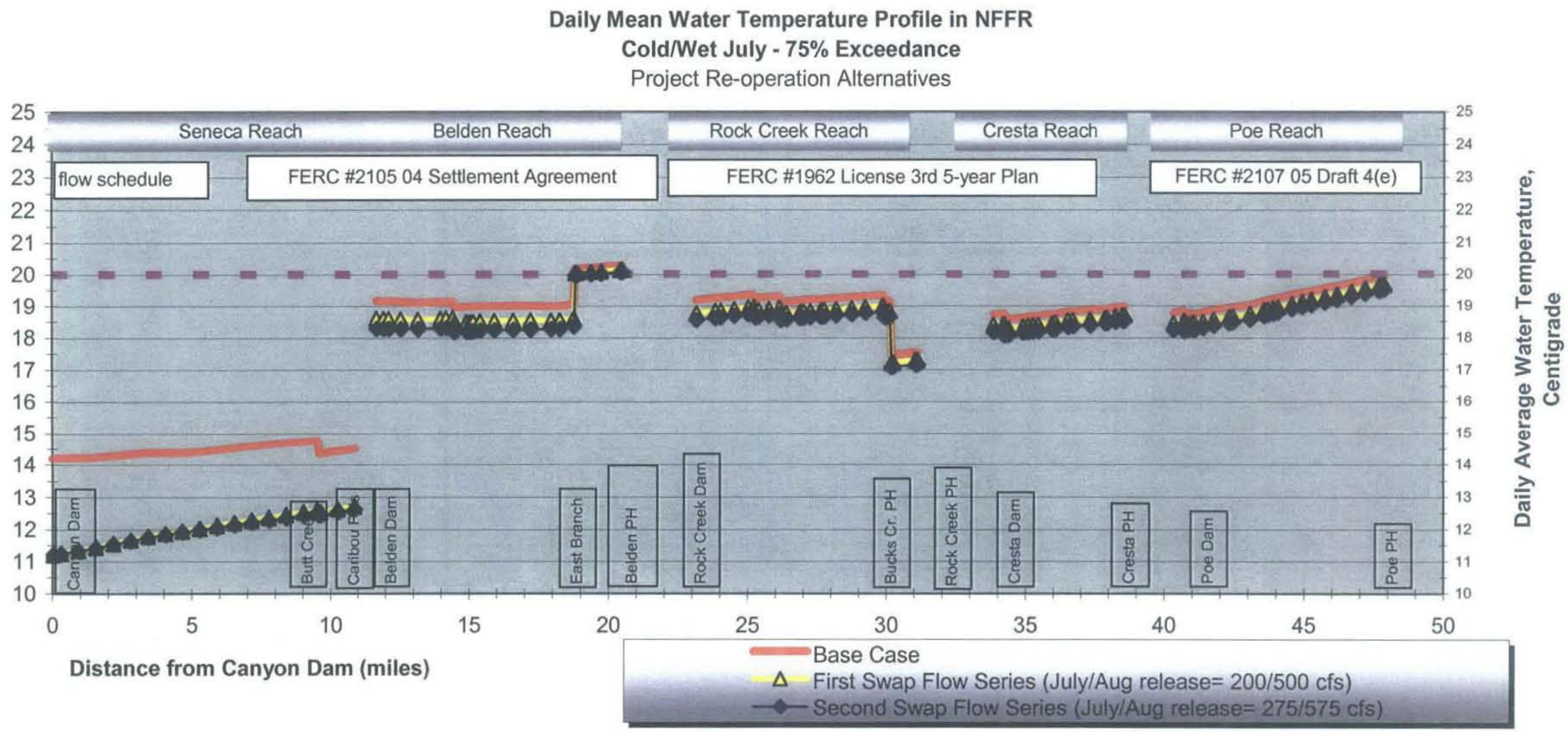
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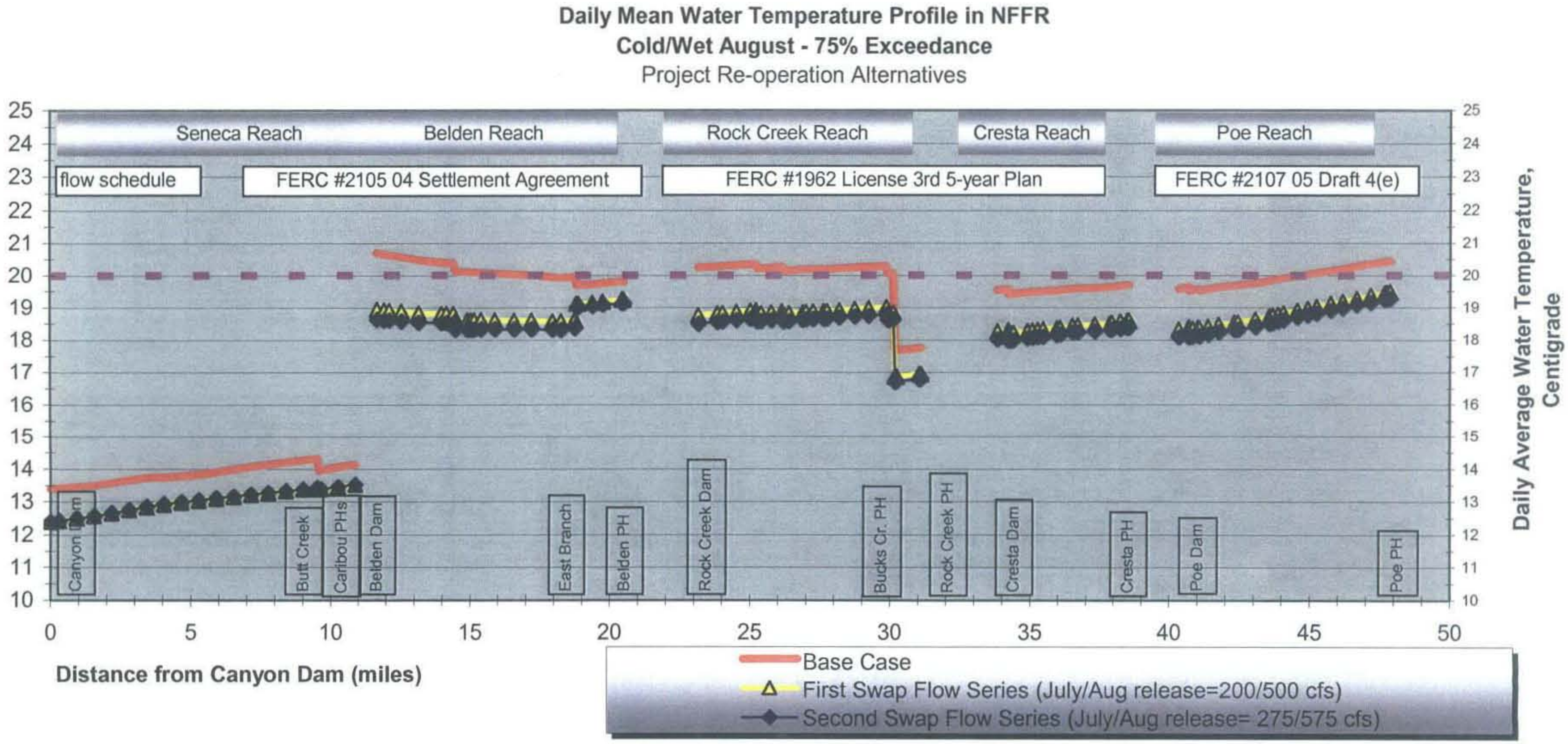

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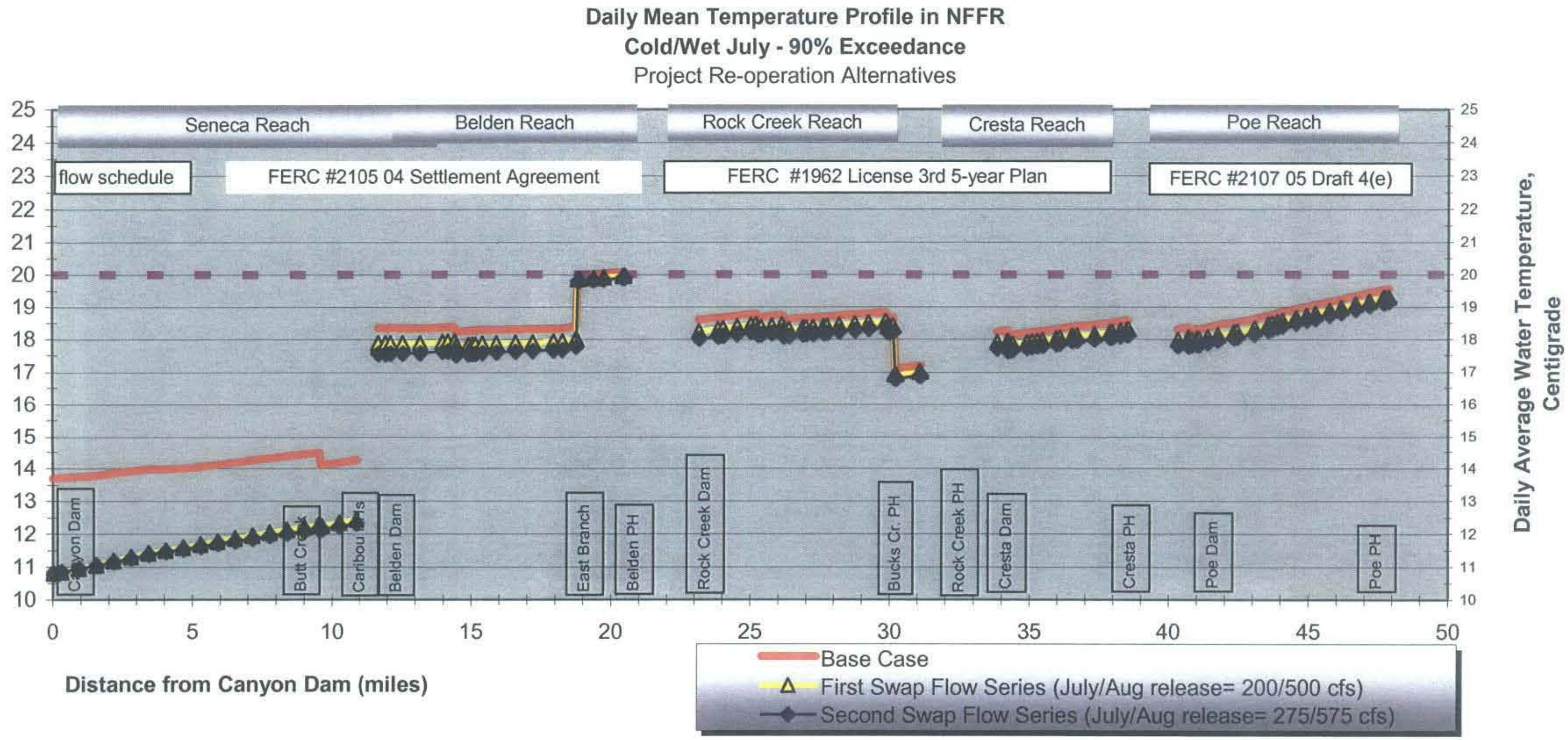
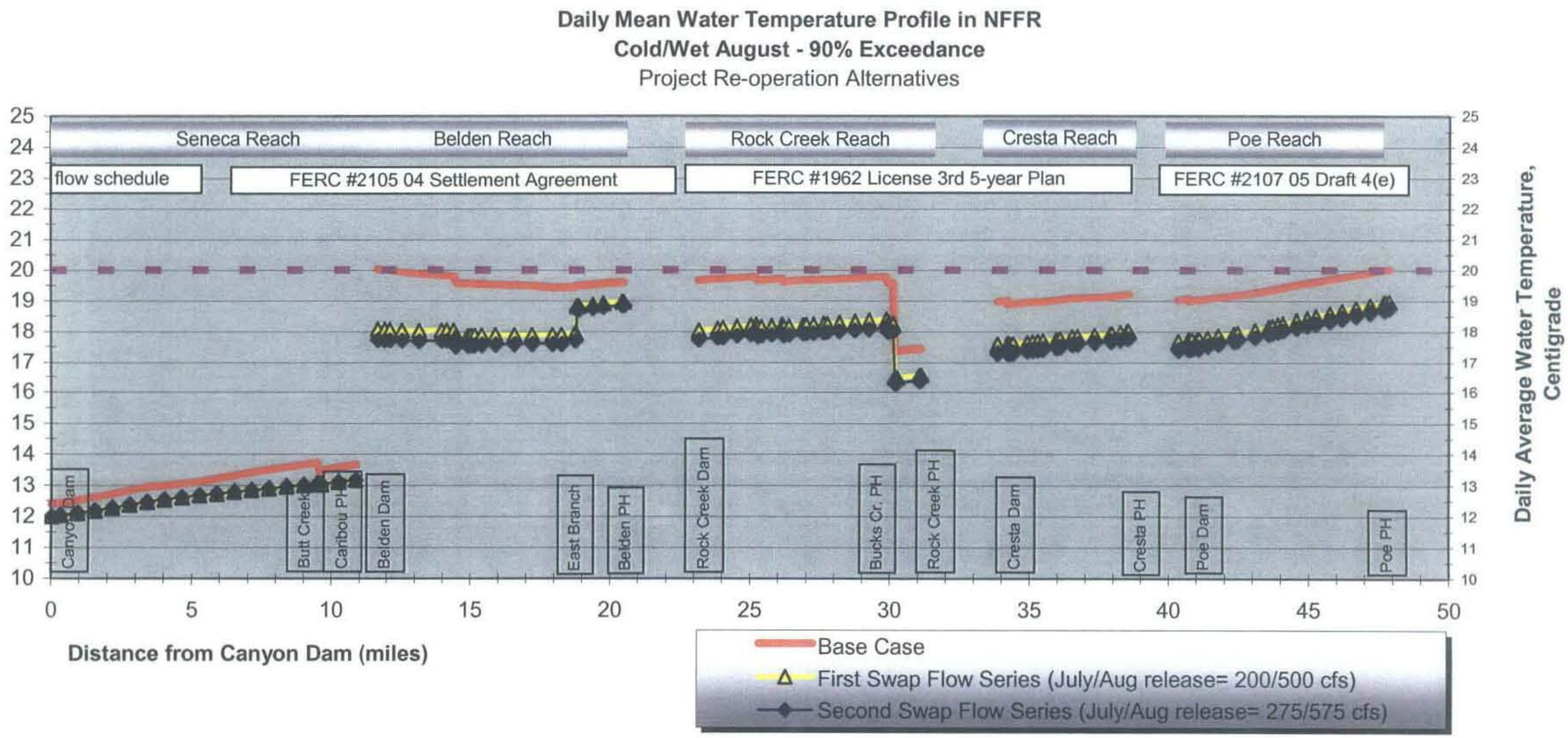

Daily Mean Temperature Profile in NFFR
Cold/Wet July - 90% Exceedance
Project Re-operation Alternatives
Seneca Reach
Belden Reach
Rock Creek Reach
Cresta Reach
Poe Reach
flow schedule
FERC #2105 04 Settlement Agreement
FERC #1962 License 3rd 5-year Plan
FERC #2107 05 Draft 4(e)
Belden Dam
East Branch
Belden PH
Rock Creek Dam
Bucks Cr. PH
Rock Creek PH
Cresta Dam
Cresta PH
Poe Dam
Poe PH
Distance from Canyon Dam (miles)
Daily Average Water Temperature, Centigrade
Base Case
First Swap Flow Series (July/Aug release= 200/500 cfs)
Second Swap Flow Series (July/Aug release= 275/575 cfs)



Daily Mean Water Temperature Profile in NFFR
Cold/Wet August - 90% Exceedance
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Canyon Dam
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