RUSSIAN RIVER BIOLOGICAL ASSESSMENT FLOW ALTERNATIVES

ADDENDUM TO "ALTERNATIVES: EVALUATION OF MANAGEMENT ACTIONS" dated September 13, 2002

Prepared for:

U.S. ARMY CORPS OF ENGINEERS
San Francisco District
San Francisco, California

AND

SONOMA COUNTY WATER AGENCY
Santa Rosa, California

Prepared by:

ENTRIX, INC.
Walnut Creek, California

Project No. 364704

February 3, 2003

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af	acre-feet
BA	biological assessment
CDFG	California Department of Fish and Game
cfs	cubic-feet per second
CVD	Coyote Valley Dam
DO	dissolved oxygen
DOI	Department of Interior
D1610	Decision 1610
el.	elevation
ENFP	Enhanced Natural Flow Proposal
Estuary	Russian River Estuary
ESA	Endangered Species Act of 1973
FEIS	final environmental impact statement
FERC	Federal Energy Regulatory Commission
ft/hr	feet per hour
fps	feet per second
MCIWPC	Mendocino County Inland Water and Power Commission
MCRRFCD	Mendocino County Russian River Flood Control and Water Conservation Improvement District
MOU	Memorandum of Understanding
MSL	mean sea level
NMFS	National Marine Fisheries Service
NFP	Natural Flow Proposal
PG&E	Pacific Gas and Electric Company
PVID	Potter Valley Irrigation District
PVP	Potter Valley Project
RRSM	Russian River System Model
RVIT	Round Valley Indian Tribes
RWQCB	North Coast Regional Water Quality Control Board
SCWA	Sonoma County Water Agency
SWRCB	State Water Resources Control Board
USACE	U.S. Army Corps of Engineers
USEPA	U.S. Environmental Protection Agency
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
WSD	Warm Springs Dam
WSE	water surface elevation

1.1 SECTION 7 CONSULTATION

The Sonoma County Water Agency (SCWA), the U.S. Army Corps of Engineers (USACE), and the Mendocino County Russian River Flood Control and Water Conservation Improvement District (MCRRFCD) are undertaking a Section 7 consultation under the Federal Endangered Species Act (ESA) with the National Marine Fisheries Service (NMFS) to evaluate effects of operations and maintenance activities on listed anadromous fish species and their habitats. The activities of SCWA, USACE, and MCRRFCD span the Russian River watershed from Coyote Valley Dam (CVD) and Warm Springs Dam (WSD) to the Russian River Estuary (Estuary), as well as some tributaries. The Russian River watershed provides spawning and rearing habitat for threatened stocks of coho salmon, steelhead, and Chinook salmon. SCWA, USACE, and MCRRFCD operate and maintain facilities and conduct activities related to flood control, channel maintenance, water diversion and storage, hydroelectric power generation, estuary management, and fish production. SCWA, USACE, and MCRRFCD are also participants in a number of institutional agreements related to the fulfillment of their respective responsibilities in the Russian River watershed.

Federal agencies such as the USACE are required under the ESA to consult with the Secretary of Commerce to insure that their actions are not likely to jeopardize the continued existence of protected species or adversely modify or destroy habitat. The USACE, SCWA, and NMFS have entered into a Memorandum of Understanding (MOU) that establishes a framework for the consultation and conference required by the ESA with respect to the activities of the USACE, SCWA, and MCRRFCD that may directly or indirectly affect coho salmon, steelhead, and Chinook salmon in the Russian River. The MOU acknowledges the involvement of other agencies including the California Department of Fish and Game (CDFG), the State Water Resources Control Board (SWRCB), the North Coast Regional Water Quality Control Board (RWQCB), the State Coastal Conservancy, and the Mendocino County Inland Water and Power Commission (MCIWPC).

1.2 SCOPE OF THE BIOLOGICAL ASSESSMENT

As part of the Section 7 consultation, the USACE and SCWA will submit to NMFS a biological assessment (BA) that provides a description of the actions subject to consultation, including the facilities, operations, maintenance, and existing conservation actions. The BA will describe existing conditions, including information on hydrology, water quality, habitat conditions, and fish populations. The BA will provide the basis for NMFS to prepare a biological opinion that will evaluate the potential effects of the proposed action.

The BA will integrate information from a series of interim reports, which evaluated the effects of current operations on protected species in the Russian River basin. All of the interim reports have been completed and are available online at http://www.spn.usace.army.mil/ets/rrsection7:

Report 1 - Flood Control Operations
Report 2 - Fish Facility Operations
Report 3 - Flow-Related Habitat
Report 4 - Water Supply and Diversion Facilities
Report 5 - Channel Maintenance
Report 6 - Restoration and Conservation Actions
Report 7 - Hydroelectric Projects Operations
Report 8 - Estuary Management Plan

The current project operations may be modified if feasible management actions are identified that reduce potential adverse effects or improve habitat conditions for protected species. The BA will evaluate the effects of the entire project including the modified project activities.

This addendum to *Alternatives: Evaluation of Management Actions* (ENTRIX 2002c) presents alternative flow scenarios to be considered.

1.3 FLOW REGULATION IN THE RUSSIAN RIVER SYSTEM

On March 8, 1985 SCWA and the CDFG entered into an agreement stipulating the minimum flows necessary for instream beneficial uses on both Dry Creek and the Russian River. The stipulation provided a minimum flow of 25 cubic-feet per second (cfs) in the East Fork Russian River from CVD to the confluence with the Russian River. From that junction to Dry Creek the minimum Russian River flow was specified as 185 cfs from April through August and 150 cfs from September through March during Normal water supply conditions with reductions allowed under specified unusually dry hydrologic conditions. From Dry Creek to the ocean the minimum flow was specified as 125 cfs during Normal water supply conditions with reductions to 85 cfs and 35 cfs respectively during Dry and Critically Dry water supply conditions. In Dry Creek the minimum flow was specified as 75 cfs from January through April, 80 cfs from May through October and 105 cfs in November and December during Normal water supply conditions. During Dry and Critically Dry water supply conditions these were reduced to 25 cfs from April through October and 75 cfs from November through March.

On April 17, 1986 the SWRCB issued its Decision 1610 (D1610) on SCWA's appropriative water rights permit applications (SWRCB 1986). The permits issued by the SWRCB under SCWA's applications incorporated, as permit terms, the above agreement entered into by SCWA and the CDFG specifying the minimum flows necessary for instream beneficial uses on both Dry Creek and the Russian River. These permit terms control SCWA's regulation of the flow of the Russian River.

1.3.1 Water Supply and Transmission System Project Flow Criteria

SCWA has again filed appropriative water right applications and petitions with the SWRCB. In these, SCWA is seeking the permits needed for the operation of SCWA's Water Supply and Transmission System Project. The Water Supply and Transmission System Project did not contemplate that a change in the 1986 criteria that currently regulate the flow of the Russian River would be necessary. However, the SWRCB may change the 1986 criteria in response to other developments, including, but not limited to: 1) the pending amendment by the Federal Energy Regulatory Commission (FERC) of the terms of the license held by Pacific Gas and Electric Company (PG&E) for the operation of the Potter Valley Project (PVP), and 2) the current Section 7 consultation being conducted between the NMFS, the USACE and SCWA under the ESA of 1973.

1.4 Potential Management Actions

The MOU governing the USACE's Section 7 consultation for the Russian River outlined a process to consider modifications to principal activities occurring in the watershed. Potential management actions related to instream flow have been developed. The management actions presented in this document were address issues regarding potential adverse effects to protected species raised in the review of ongoing operations and maintenance activities in the interim reports, comments received from the Agency Working Group, the Public Policy Facilitating Committee, and the general public on the interim reports. Discussions and meetings with SCWA, USACE, NMFS, and CDFG also contributed to the development of the flow alternatives.

This addendum to *Alternatives: Evaluation of Management Actions* (ENTRIX 2002c) discusses salmonid habitat under the current D1610 flow requirements and alternative flow scenarios in the Russian River. The current flow regime in the Russian River is determined by the SWRCB D1610. The flow alternatives presented in this document were developed as part of the Section 7 consultation process to address concerns regarding habitat related to the current flow regime. These alternatives are based on the flow-habitat study conducted in the fall of 2001, the desire to return the Russian River and Dry Creek to a more natural flow regime, and the results of simulations of flow in the Russian River conducted by SCWA. This report evaluates habitat availability and suitability under D1610 and two flow alternatives. In addition, two pipeline (WSD to the Russian River or to SCWA diversion facilities at Mirabel) alternatives are described. The pipeline alternatives could be used with D1610 flows to further manage flows in Dry Creek while providing sufficient water at Mirabel to meet SCWA water supply needs during the summer months.

This section of the report (Section 2) provides descriptions of the individual flow alternatives. Each description includes the operational and infrastructure changes that would occur as part of the action, an assessment of the effect of those changes on listed salmonids and their habitat, and a summary of the relevant physical, operational, or economic constraints and institutional controls that are associated with each action.

Before beginning with the description of the flow alternatives, the approach used in evaluating the various alternatives is described in Section 2.1. Sections 2.2 through 2.7 present descriptions and the effects on protected salmonid species of various flow alternatives. The flow alternatives described include D1610 (the baseline condition)(Section 2.2), the Natural Flow Proposal (NFP)(Section 2.3), and the Enhanced Natural Flow Proposal (ENFP)(Section 2.4). Section 2.5 describes the D1610 condition with a pipeline to bypass flow from Lake Sonoma around Dry Creek. The objective of this is to provide more suitable flows for salmonids during the summer months in Dry Creek, when water demand is at its peak. The pipeline could be configured in two ways. In one configuration, a portion of the water to be released from WSD to meet water supply needs would be sent through a pipeline and be discharged into the Russian River near the mouth of Dry Creek. In the other configuration, the pipeline would extend to SCWA's infiltration ponds at Mirabel, with some of the water being discharged into these ponds and some being discharged to the Russian River at various points between the mouth of Dry Creek and Mirabel. The final alternative is the ENFP with an Additional Measures (ENFP-AM)(Section 2.7). This alternative would maintain suitable flow levels for salmonids in Dry Creek and the Upper and Middle Russian River as water demand increases in the future, similar to those described for the ENFP with current demand. As demand increases, SCWA would implement any of a variety of solutions to meet this increased demand. Additional measures being considered for this alternative include both institutional and physical measures. Institutional measures would address water rights compliance in the Upper and Middle Russian River. Physical measures may include a pipeline as described above, an aquifer storage and retrieval program (ASR), small off-stream storage facilities elsewhere in the basin, alternative measures still to be developed or some combination or phased implementation of these options.

Alternative management programs for the Estuary have been presented (ENTRIX 2002c). Current project operations affect the Estuary primarily in the low-flow months when minimum instream flow requirements under D1610 result in augmented flow to the Estuary (*Interim Report 3* [ENTRIX 2001]). These augmented flows result in a need for an artificial sandbar breaching program to prevent flooding of local property. Action 25 in the *Alternatives: Evaluation of Management Actions* (ENTRIX 2002c) proposed to manage inflow to the Estuary so that a stable water surface elevation (as feasible) would be maintained during the dry season once the sandbar has formed across the river mouth. The system would then be managed as a lagoon (sandbar closed) rather than an estuary open to tidal flushing (sandbar open). However, implementation of this action would require implementation of a flow alternative that would reduce flow to the Estuary so that the need for breaching is minimized. Based on an analysis of the relationship between flow at the Hacienda gage and stage change at Jenner, the inflow to the lagoon needed to maintain a water surface elevation of 8.0 to 8.5 feet was estimated to be approximately 35 to 45 cfs. However, inflow would need to be adaptively managed to maintain this water surface elevation depending on conditions in the ocean and at the sandbar.

2.1 APPROACH TO ANALYSIS OF FLOW ALTERNATIVES

SCWA has modeled D1610, the NFP, the ENFP, and the pipeline proposals using the Russian River System Model (RRSM, Flugum 1996) and the Russian River Water Quality Model (RRWQM, RMA 2001). These models were used to simulate the flow and water quality conditions that would exist under each of the alternatives. Each alternative flow scenario was modeled under current and projected future (buildout) water demand conditions. The flow alternatives were modeled for each of four locations - the Upper, Middle, and Lower Russian River and Dry Creek. These locations are shown in Figure 2-1.

Model results and analyses to support the evaluation of relative effects between alternatives are provided in Appendix A. These results include:

- 50 percent exceedence plots for flow from upstream to downstream in the four reaches; and
- 50 percent exceedence plots for temperature from upstream to downstream in Dry Creek and the Upper Russian River for July, September and October, to represent the warmest months and the lowest flows.

The modeling results for the ENFP-AM alternative presented are based on the use of a pipeline around Dry Creek. These results may vary slightly depending on the final solution implemented. This is discussed in more detail in Section 2.7.

These alternatives were evaluated based upon criteria developed previously in the BA process. The criteria for temperature and dissolved oxygen (DO) were presented in Report 3 (ENTRIX 2002a). These criteria were based on information provided in the literature regarding the optimal and suitable ranges of these parameters for the target species. Flow criteria were developed based in part upon a flow study conducted by SCWA, USACE, NMFS, and CDFG in late 2001, as well as knowledge of the system, conversations with biologists familiar with the Russian River, and professional judgement. The flow, temperature and DO criteria are presented in Appendix B.

The evaluation focuses on those species/life history stages of listed fish species that are likely to be affected and those parameters the alternatives may substantially affect. Project operations generally store water in the winter and augment flows in the summer. In most years, these operations generally result in relatively small changes in flow during the wet winter period when many important life history activities occur. These include upstream passage, spawning, incubation, emergence, and downstream passage of salmonids.

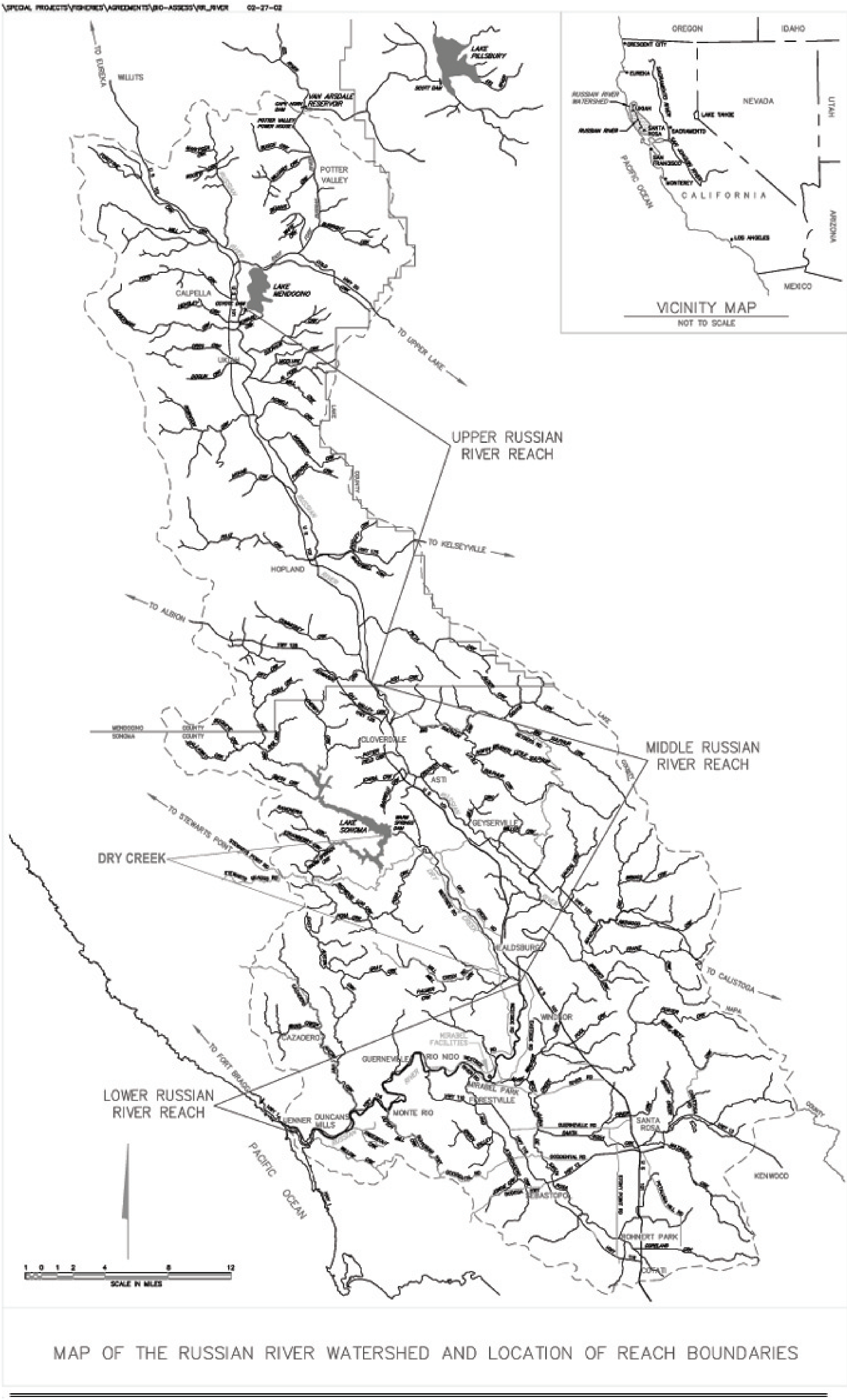


Figure 2-1. Russian River Watershed and Location of Reach Boundaries.

During the winter months, conditions are similar among the various alternatives. It is from June through October (summer and early fall) that the operation of CVD and WSD have the greatest potential to affect conditions in the Russian River and Dry Creek. Flows during the summer and early fall are augmented by minimum flow requirements under D1610 and water supply deliveries. During this period, steelhead rearing occurs in the mainstem of the Russian River and in Dry Creek. Chinook juveniles migrate out of the system by the end of June. Coho juveniles may rear in Dry Creek. Implementation of any of the proposed alternatives will have the largest effect on steelhead rearing in the Upper Russian River mainstem and on coho salmon and steelhead rearing in Dry Creek.

2.2 D1610

Lake Sonoma and Lake Mendocino are currently operated in accordance with criteria established in 1986 by the SWRCB's D1610, which established minimum instream flow requirements for Dry Creek and the Russian River under Normal, Dry, and Critically Dry water supply conditions. D1610 represents the baseline conditions evaluated in the BA.

2.2.1 Action

Lake Sonoma (on Dry Creek) and Lake Mendocino (on the East Fork of the Russian River) are operated for flood control, water supply, and hydroelectric generation. Water imported from the Eel River via the PVP and flow from the East Fork Russian River upstream of Lake Mendocino are stored in Lake Mendocino and released from CVD. Lake Sonoma stores water from the upper portion of Dry Creek during the wet season (November through April) and releases this water during the dry season (June through October). The timing and magnitude of flow releases from these dams are determined by the USACE when the dams are being operated principally for flood control, and by SCWA when the dams are being operated principally for water supply.

The flow requirements for the Russian River from Lake Mendocino to the Dry Creek confluence in D1610 were based in part upon an evaluation of fish habitat and barriers to fish migration performed by Winzler and Kelly Consulting Engineers (1978) under a contract with USACE. These flow requirements were intended to maintain the highest sustainable flows possible to support the steelhead and salmon fishery below CVD and instream recreation (SWRCB 1986). The instream flow requirements for the Russian River downstream from its confluence with Dry Creek during Normal water supply conditions were based primarily on a desire to maintain historic flows upon which the substantial recreational canoeing industry on the Russian River had developed. The reduced instream flow requirements for Dry and Critical by Dry water supply conditions were determined in consideration of warmwater fish and wildlife needs, particularly for the lower portion of the Russian River.

The flow requirements for Dry Creek were based upon an instream flow needs investigation performed by the CDFG in 1975 and 1976 (Barraco 1997). These requirements were intended to meet the fish spawning, passage, and rearing needs as determined by CDFG at that time. These flows were intended to sustain the native fish populations below WSD, to provide an enhanced steelhead and salmon spawning and nursery habitat in Dry Creek, and to facilitate operations of the Don Clausen Fish Hatchery at WSD.

Under D1610, minimum flows in both the Upper and Lower Russian River vary depending upon water supply condition. Water supply condition is determined based on the cumulative inflow to Lake Pillsbury on the first of each month between January and June and is represented as Critically Dry, Dry, or Normal. The water supply condition can vary from month to month until June 1 when it becomes stable until the following January. Within the Normal water supply condition minimum flow criteria for Lake Mendocino releases, there is a separate schedule referred to as the "Dry Spring" criteria that is dependent upon the total combined storage in Lake Mendocino and Lake Pillsbury on May 31 of each year. These criteria allow successive reductions in minimum flows for the mainstem Russian River when the combined storage falls below 90 percent and 80 percent of the combined capacities of Lake Pillsbury and Lake Mendocino. This provision reflects the importance of the storage space in Lake Pillsbury and the storage space within the flood pool of Lake Mendocino in sustaining the flows in the Russian River system, and the fact that this storage space cannot be fully utilized in Dry Spring conditions. In about 11 percent of years, "Dry Spring" water supply conditions prevail from June through December. "Dry Spring" conditions do not apply to the January through May period.

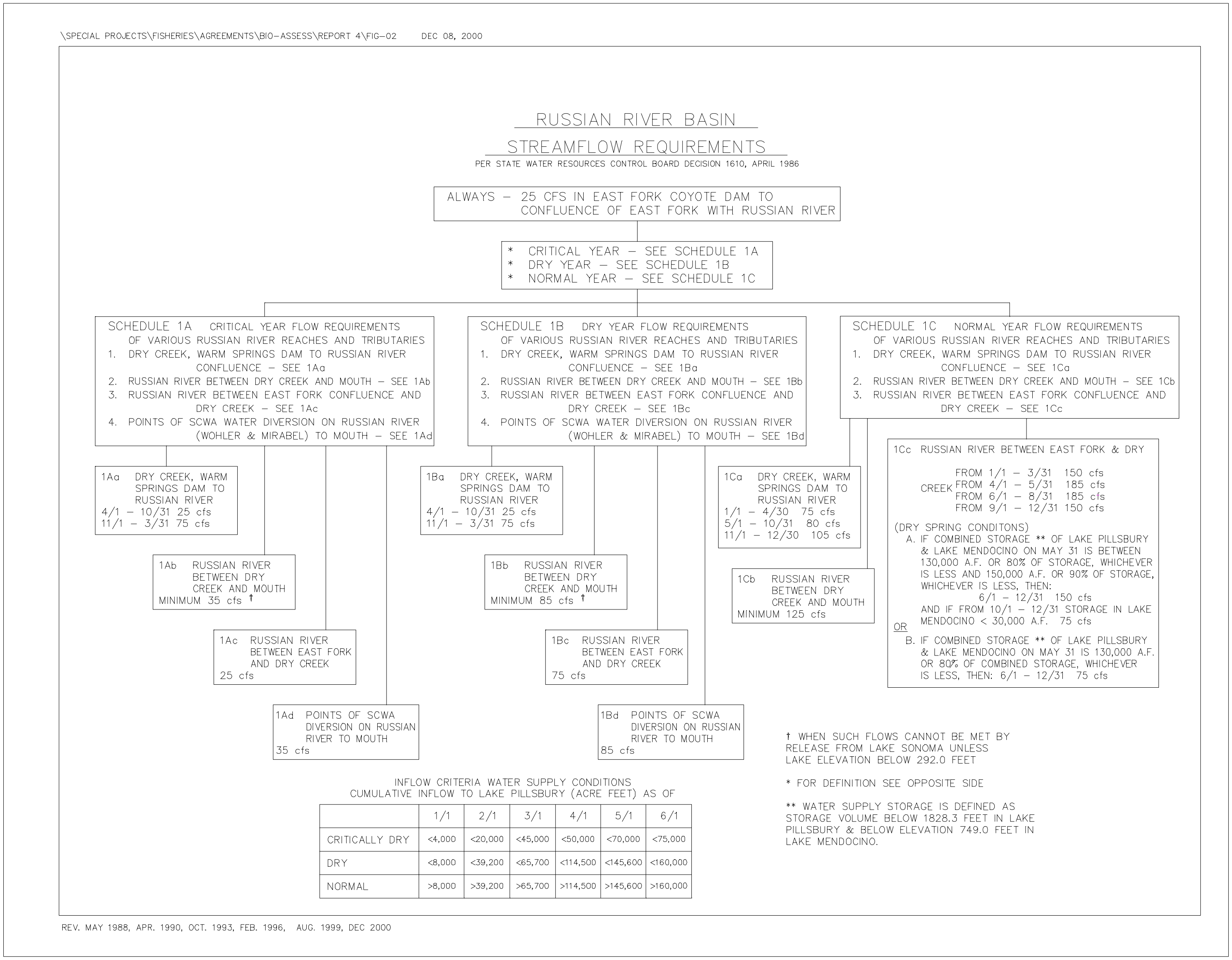
The Russian River from Healdsburg to its mouth at Jenner operates in much the same manner as the Russian River above Healdsburg. Lake Sonoma, like Lake Mendocino, has distinct water supply and flood control pools. The general operating rule for Lake Sonoma water supply releases is to discharge water needed to satisfy demands (mostly SCWA's) between Dry Creek and the Hacienda gage, and meet the minimum flow requirement at Hacienda. Under current demands, during normal summer conditions, water supply releases from Lake Sonoma are typically controlled by the required minimum flows in Dry Creek and the Russian River.

Russian River Basin streamflow requirements under D1610 are summarized in Figure 2-2.

2.2.2 Effects on Protected Species

The flow-habitat study conducted in fall 2001 indicated that the best potential habitat for salmonid rearing was present in Dry Creek when flow releases from WSD were approximately 50 to 90 cfs (ENTRIX 2000b). Steelhead habitat in Dry Creek was generally more abundant at flow releases from WSD of 47 cfs than at 130 cfs. Habitat availability at flow releases of 90 cfs was more similar to that at 47 cfs than that at 130 cfs. The data also indicated that habitat availability for Chinook salmon fry and juveniles was similar at flow releases of 47 and 90 cfs. There was little available habitat for coho salmon.

The flow-habitat study indicated that the best potential habitat conditions for salmonid rearing in the upper mainstem Russian River occurred when flow releases from CVD were



	1/1	2/1	3/1	4/1	5/1	6/1
CRITICALLY DRY	<4,000	<20,000	<45,000	<50,000	<70,000	<75,000
DRY	<8,000	<39,200	<65,700	<114,500	<145,600	<160,000
NORMAL	>8,000	>39,200	>65,700	>114,500	>145,600	>160,000

Figure 2-2. Russian River Basin Streamflow Requirements.

approximately 125 cfs. Flow releases of 190 cfs provided good rearing habitat conditions, but flow releases of 275 cfs or greater were unsuitable for salmonid rearing in the upper mainstem.

Based on the analyses of the effects of D1610 flows presented in *Interim Report 3* and a habitat/flow study conducted in the fall of 2001, the following issues were identified:

Issue 1 – Velocities in Dry Creek are higher than optimum for salmonid rearing.

Issue 2 – Velocities in the upper mainstem of the Russian River are higher than optimum for salmonid rearing.

Issue 3 – Current operations result in frequent breaching of sandbar at the mouth of the Estuary during some parts of the year. This creates unstable conditions in the Estuary that are unsuitable for salmonids and their food base. Other estuaries in California appear to provide good rearing conditions for anadromous salmonids when closed during the summer. Estuary management is dependent on flows in the Russian River.

Issue 4 – Storage levels in Lake Mendocino may be inadequate to maintain a cold-water pool sufficient to regulate temperatures in the Upper Russian River during the late summer and early fall.

Issue 5 – Expanded warmwater habitat in the Middle and Lower Russian River favor fish species that prey on or compete with steelhead and salmon.

The alternatives presented in the following sections attempt to address some or all of the issues above. The flow and temperature conditions that would prevail under these alternatives are compared with those that occur under current D1610 operations, which serves as the baseline for the BA.

2.3 ACTION A. IMPLEMENT THE NATURAL FLOW PROPOSAL.

The objective of the NFP is to mimic as closely as possible the flow regime that would be present in the mainstem Russian River under unregulated conditions, while meeting the requirements of water rights in the Russian River that are senior to those associated with the CVD Project.

2.3.1 ACTION

The streamflows in the Russian River that have resulted from the flow requirements of D1610 and previous regulated flow regimes vary dramatically from the natural flow regime of the river. These changes have affected the magnitude, frequency, duration, timing and rate of change of the hydrological conditions in the river.

In recent years there has been an increasing recognition that human alterations of river flow regimes, whether incidentally associated with other human activities or with the specific intent to "improve" the river ecosystem, change the established pattern of natural hydrologic variation, thereby altering habitat dynamics and creating new conditions to which the native biota may be poorly adapted (Poff *et al.* 1997).

The NFP for the Russian River was formulated in 1999 to mimic the natural flow condition in the mainstem Russian River to the extent possible (Beach 1999). It proposed to make releases from storage necessary to maintain the unimpaired flow of the river at Healdsburg and at the Hacienda Bridge up to a specified transition flow rate, above which inflow into Lake Mendocino could be retained in storage (Table 2-1). Under the NFP the transition flow rate at Healdsburg would be 150 cfs from June through the following March and 185 cfs during April and May except for the "Critically Dry" month exception described below. The transition flow rate at Hacienda Bridge would be 125 cfs from June through the following March and 150 cfs during April and May. Releases would be made from storage in Lake Mendocino as necessary to replace Russian River water consumptively used upstream from Healdsburg. Releases would be made from Lake Sonoma as necessary to replace Russian River water consumptively used between Healdsburg and Hacienda Bridge. If the months of January through September were Critically Dry, the transition flow rate would be reduced to the current 25 cfs at Healdsburg and 35 cfs at Hacienda Bridge.

Table 2-1. Transitional Flow Rates under the NFP during Various Water Supply Conditions.

	Guerneville			Healdsburg		
Month	Normal	Dry	Critical	Normal	Dry	Critical
Oct	125	125	125	150	150	150
Nov - Dec	125	125	125	150	150	150
Jan - Mar	125	125	35	150	150	150
Apr	150	150	35	185	185	25
May	150	150	35	185	185	25
Jun - Sep	125	125	35	150	150	25

If the unimpaired flow is greater than the tabulated value, no additional releases from storage would be made.

The NFP is based upon the use of regression analysis to relate multi-day running average flows in selected tributaries to unimpaired flows in the mainstem Russian River at discrete locations. Daily unimpaired flows for these locations would be estimated from real-time tributary flow data, resulting in operations that would calculate releases on a daily basis.

Based upon the biological data available at the time it was formulated, the NFP did not propose any changes in the D1610 flow criteria for Dry Creek, although subsequent studies have indicated such changes would result in significant fishery benefits.

Flow regulation in the mainstem Russian River and Dry Creek would be modified to conform to flows specified in the NFP (Beach 1999). Releases from CVD and WSD would approximate unimpaired flow conditions in the Russian River at Healdsburg (U.S. Geological Survey [USGS] gage number 11464000) and at Hacienda Bridge (USGS gage number 11467000) during the low-flow period. Flows downstream of CVD would include releases to meet senior water rights in the Russian River. Approximately 31,000 acre-feet (af) of annual consumptive use is associated with these senior rights.

Water supply releases would continue to be made from Lake Sonoma, and diversions at the Wohler/Mirabel facilities would continue according to current practices. Summer flows would vary between 25 and 100 cfs under current demand, and between 100 and 190 cfs under future demand, depending on water supply conditions. Minimum flows in Dry Creek would be set as shown in Table 2-2.

Table 2-2. Minimum Required Flows in Dry Creek under Various Water Supply Conditions under the Natural Flow Proposal.

	Dry Creek Minimum		
Month	Normal	Dry	Critical
Oct	80	25	25
Nov - Dec	105	75	75
Jan - Mar	75	75	75
Apr	75	25	25
May	80	25	25
Jun – Sep	80	25	25

2.3.2 Effects on Protected Species

With implementation of the NFP, flow and water temperature regimes would change in all reaches. Flows during winter months would be similar to existing conditions, as natural runoff comprises most of the river flow during that time.

Flows would change from D1610 primarily during the summer months of June through October. In the Russian River, flows would decrease substantially from those under D1610 for both current and future demand scenarios (Figures A3 to A10). This decrease in flow would result in more favorable velocities for rearing steelhead during these months. Flows would be near the optimal range identified during the flow assessment study (ENTRIX 2002b). This period would overlap the end of the emigration season for both Chinook and steelhead. The lower flows may slow emigration for these species to some degree, but would not be likely to impair emigration substantially. Chinook salmon may be migrating upstream in September and October. The low flows under the NFP would make upstream passage more difficult for adult Chinook salmon by decreasing depths over shallow riffles. However, upstream migration in September would usually be prevented by the sandbar at the mouth of the river in September. In October, higher flow levels would likely result in the sandbar being open. These flows would be high enough to provide upstream passage. Coho salmon are not present during these months and would not be affected. During Normal water supply conditions, flows in the Russian River during the spawning periods for all species would be similar to those observed with D1610 and would not alter the availability and suitability of spawning habitat. Under Dry water supply conditions, flows would be somewhat higher under the NFP than D1610 in the Russian River. This would make spawning conditions for Chinook and steelhead spawning less suitable in these months. This would occur under both current and future demand scenarios.

The lower flows under the NFP would result in warmer water temperatures than currently occur in the Upper Russian River (Figures A-15 to A-18). During July and August, the warmest months, about 14 more miles of habitat would be warmer than 20°C in the Upper Russian River under NFP than under D1610 (Figure A-15). Approximately six more miles of habitat would be warmer than 22°C in the Middle Russian River under the NFP relative to D1610.

These higher temperatures under the NFP could be more stressful for rearing steelhead than those under D1610 (Chinook migrate out of the river by the end of June). This would occur if the steelhead were unable to obtain enough food to meet their metabolic and energetic demands. Because of the ample food supply available in the Russian River, these demands would likely be met and thus the warm temperatures would likely not result in reduced production. Fish captured in SCWA's various sampling activities (SCWA unpublished data) appear to be large and robust. The lower flows provide a temperature benefit relative to D1610 in September (Figure A-16). This occurs because under D1610, the cold-water pool in Lake Mendocino is exhausted in September, and release temperatures increase to over 20°C. Under the lower flows with the NFP, the cold-water pool is not exhausted and release temperatures remain low (18°C). These lower temperatures provide better conditions for juvenile steelhead during the late summer. Flows and temperatures in the Upper and Middle Russian River would be similar under the NFP under both current and future demand scenarios and under normal and Dry water supply conditions.

While flows in the Russian River decrease under the NFP relative to D1610, water demand is expected to increase over the coming years. Because under the NFP, less water would be available from CVD to meet increasing demand, this demand would be met out of WSD. Under current demand, flows in Dry Creek would be slightly increased and flows in the Russian River between Dry Creek and SCWA's diversion facilities at Wohler and Mirabel would be slightly decreased relative to D1610 (Figures A-1 and A-7). The magnitude of these flow changes under the current demand scenario would make conditions slightly less favorable for rearing steelhead and coho than under D1610 during the summer months in Dry Creek. The habitat in the portion of the Russian River between Dry Creek and Mirabel would not be affected greatly, although this portion of the river is not currently a principal rearing area for steelhead or used at all by coho during the summer.

Under the future demand scenario, the NFP flows in both Dry Creek and the Russian River between Dry Creek and Mirabel would substantially increase over what would be expected under D1610. Under the future demand scenario, flows in Dry Creek would be about 200 cfs during some months. This would result in very unsuitable conditions for rearing salmonids. During Dry water supply conditions, flows would be similar to those under Normal water supply conditions (Figure A-2). Under the NFP under future water demand, flows in February would be decreased relative to D1610. This would provide better conditions for spawning coho and steelhead during this month. Flows during the remainder of the spawning season for each species would be similar, and spawning habitat value under NFP would not change relative to D1610.

The larger mass of cold water moving down Dry Creek under the NFP in the future demand scenario would improve temperature conditions in the Russian River below Dry Creek relative to D1610. Temperatures in Dry Creek are currently quite suitable under D1610 and would remain so under the NFP (Figures A-11 to A-14). In the Russian River, the higher flows under the NFP may make temperatures in the reach between Dry Creek and Mirabel more habitable for steelhead. Under the NFP, about two miles of the river would have temperatures less than 20°C, while about seven miles would have temperatures less than 22°C (Figure A-15). These temperatures would be considered good and moderately stressful, respectively. Under D1610, temperatures in the Russian River below Dry Creek always exceed 22°C and are considered very stressful.

Action 25 of *Alternatives: Evaluation of Management Actions* (ENTRIX 2002c) proposes to reduce summer flow to the Estuary and eliminate artificial breaching of the sandbar during the summer months, potentially improving habitat for salmonids. The NFP proposal would result in lower flows at Hacienda Bridge than D1610; however, these flows would not be sufficiently low to allow the sandbar to remain closed throughout the summer. Artificial breaching would still be required to avoid local flooding, except possibly in August and September. The lower flows under the NFP would result in the sandbar being closed for longer periods of time, but it would still need to be opened periodically to prevent flooding. The less frequent breaching schedule would be worse for salmonids and their foodbase than D1610. Under D1610 breaching is frequent enough that the system operates almost like an open estuary. As currently operated, the severity and duration of poor water quality events are limited. Under the NFP, the less frequent breaching would allow water quality to deteriorate more substantially, but the Estuary would not have sufficient time to turn into the desirable freshwater lagoon before breaching became necessary again. Thus, conditions under NFP would be more unstable and would likely result in poorer conditions for salmonids and their foodbase in the Estuary.

Altered flows may potentially negatively affect juvenile salmonid rearing if habitat is altered in a way that favors the warmwater fish community. If summer rearing habitat is warmer, competition for habitat and food could reduce the availability of rearing habitat for salmonids. However, reduced flows in the mainstem may reduce the amount of habitat available to predatory species, and could potentially result in a decline in the population of predatory fish. The NFP would result in warmer conditions in the Upper Russian River than currently occur under D1610 during June, July, and August. This increase could improve temperature conditions for predatory species such as bass and pikeminnow. This may improve their reproductive success and thus increase their populations. The reduction in flow would result in the reduction of pool size (these species tend to inhabit pool areas), but this decrease is unlikely to substantially affect their populations. The net effect on the size of predator populations is unknown, but it would likely increase. This could in turn lead to increased predation on fry and juvenile salmonids. In Dry Creek and the Russian River below Dry Creek, the situation would be reversed with conditions becoming worse for predator populations. However, Dry Creek is not thought to have a significant predator population, so this would likely not benefit salmonids in Dry Creek. It may benefit them in the Russian River below Dry Creek for two to seven miles, due to cooler water temperatures.

2.3.3 Other Considerations

The NFP would not address concerns that under the D1610 criteria flow velocities are higher than optimum for rearing steelhead and salmon in Dry Creek. That problem would be exacerbated under future demand conditions during Normal water supply conditions under both the D1610 and NFP criteria since, under both sets of criteria, most releases for SCWA diversions would come from additional releases from Lake Sonoma. For the same reason, the implementation of the NFP also would result in reduced storage in Lake Sonoma under future water demand conditions. This could result in a reduced cold-water pool available to regulate water temperatures in Dry Creek during periods of prolonged drought. This could also result in a reduced water supply available to SCWA from Lake Sonoma during these times.

The recreational canoeing industry and other recreational users, which rely on elevated flows in the river, would be affected by this action. Implementation of the NFP would result in a reduction in mid-summer flows of approximately 8 to 70 percent during Dry water supply conditions and 29 to 78 percent during Normal water supply conditions at Ukiah and Cloverdale as compared to the flows under D1610. Flow reductions at Hacienda under the NFP would be approximately 65 to 80 percent under both normal and Dry water supply conditions.

The lower flows in the Russian River under the NFP would reduce dilution of nutrients, pesticides, or coliform bacteria and could result in water quality impacts, which may impair beneficial uses of the river, including contact recreation, fishing, and potentially aquatic habitat value.

This action would require changing the SWRCB minimum flow requirements as set forth in D1610. Therefore this action would require approval from the SWRCB.

2.4 Action B. Implement the Enhanced Natural Flow Proposal.

The ENFP was designed to address some issues that the NFP does not. These issues include high summer flows in Dry Creek and reducing or eliminating the need to breach the Estuary during the summer months.

The ENFP also addresses concerns that under D1610 operations, flows are higher than optimum for rearing steelhead and salmon in the Upper Russian River, and release rates from Lake Mendocino deplete the cold-water pool prior to the end of the summer rearing season. The latter results in stressful water temperatures in the Upper Russian River during September.

2.4.1 ACTION

The ENFP includes the following elements:

2.4.1.1 Dry Creek

The D1610 mandated minimum flow rates in Dry Creek would be modified so that the optimum range of flow rates for rearing steelhead and Chinook salmon in Dry Creek are normally not exceeded. The optimum range of flows for rearing habitat is 50 to 90 cfs. The current normal year minimum flow rate requirement under D1610 is 80 cfs from May through October; however, operational considerations and the satisfying of consumptive uses along Dry Creek, at times, currently make it necessary to make releases from Lake Sonoma at rates in excess of 90 cfs. Under D1610, the future demand conditions would require releases from Lake Sonoma at substantially higher rates than currently occur. Under the ENFP, the D1610 flow requirements for Dry Creek would be modified so that the normal year May through October minimum requirement of 80 cfs throughout Dry Creek is replaced with a permitted range of flows with a target minimum flow rate of 50 cfs at the mouth of Dry Creek and a target maximum release rate of 90 cfs from Lake Sonoma. Releases from Lake Sonoma could be varied within this range to satisfy operating requirements, with a targeted flow of 70 cfs at the mouth of Dry Creek. At buildout, releases from Lake Sonoma in excess of 90 cfs only would be made about 20 percent of the time, corresponding to the summer under Dry water supply conditions, to ensure that Lake Mendocino does not become dewatered.

2.4.1.2 Russian River above Dry Creek Confluence

Under current demand, D1610 flow rates in the Upper and Middle Russian River would be reduced to provide suitable conditions for rearing salmonids during the summer months and to meet the optimal estuary inflow described below. This would be accomplished in coordination with the flow rates in Dry Creek and water supply needs at Mirabel. As demand increases, additional water would be released from CVD to meet this demand. As demand approaches the maximum buildout, flows in the Upper and Middle Russian River would begin to approach (but would not reach) those currently present in this portion of the river.

2.4.1.3 Russian River below Wohler Dam

Flows in the Russian River below Wohler Dam would be managed to meet optimum estuary inflow. Inflow to the Estuary would be adaptively managed to maintain a constant water surface elevation of 8.0 to 8.5 feet, as recorded on the Jenner gage, during the dry season, thereby eliminating the need to artificially breach the sandbar that forms across the river mouth. It is currently estimated that a flow of 35 to 45 cfs at Guerneville would maintain this water level when the Estuary is closed. This would be the goal from June through September. There may be times, especially during the early part of this season, when natural inflow from tributaries below Wohler Dam would prevent the optimum estuary inflow from being reached. During these times, flows would resemble the natural flows in this portion of the river.

2.4.2 EFFECTS ON PROTECTED SPECIES

With implementation of the ENFP, flow and water temperature regimes would change in all reaches. Flows during winter months would generally be similar to D1610 and the NFP, as natural runoff would continue to make up most of the river flow.

Flows would change from D1610 primarily during the summer months of June through October (Figures A-1 to A-10). Although flows in the Russian River would be decreased under the ENFP under current demand, an increase in water demand over the coming years is anticipated. Much of the future demand would be met from the water supply pool of Lake Mendocino, resulting in higher mainstem flows that begin to approach those under D1610 (Figures A-3 to A-10). However, summer flows close to optimal conditions for salmonids would be maintained in Dry Creek in most years, resulting in a substantial benefit to rearing habitat for steelhead and coho salmon in Dry Creek (Figures A-1 and A-2).

In the Russian River, flows would decrease substantially from those under D1610 with the current demand scenario (Figures A-3 to A-10). In the lower Russian River, flow would be less than D1610 and very similar to the NFP in both demand scenarios, because flows from Dry Creek would be reduced (Figures A-7 to A-10). A decrease in flow in the mainstem would result in more favorable water velocities for rearing steelhead during the summer months. Flows would be near the optimal range identified during the flow assessment study (ENTRIX 2002b) under the current demand scenario. This period would overlap the end of the emigration season for both Chinook and steelhead. The lower flows under the current demand scenario could slow emigration for these species to some degree, but would not be likely to impair emigration substantially. Coho emigration would be complete in May, when flows would be similar to those under D1610.

Chinook salmon may be migrating upstream in September and October. The lower flows under the ENFP under existing demand would make upstream passage more difficult for adult Chinook salmon by decreasing depths over shallow riffles. However, upstream migration in September would likely be prevented by the sandbar at the mouth of the river. In October, flows would be high enough to allow passage.

Under the future demand, flows would increase, but would remain lower than current D1610 levels in the Upper and Middle Russian River. Under the future demand, summer flows would be higher than optimal for steelhead rearing in the Middle and Upper Russian River, but would still be acceptable. Chinook salmon are not present during these months and would not be affected. Flows in the Russian River would generally be similar during the spawning season, and spawning conditions would be similar under either demand scenario for all species in most months. An exception would occur in November under the future demand scenario for All water supply conditions. Under the ENFP, flows would decline substantially, resulting in a sharp decrease in Chinook spawning habitat. Coho do not use the mainstem for spawning and would not be affected.

The lower flows under the ENFP in the Upper Russian River would result in warmer water temperatures than currently occur under the current demand (Figures A-15 to A-18). For example, in the hot month of July under the current demand, approximately nine additional miles of habitat would be warmer than 20ºC in the Upper Russian River under the ENFP relative to D1610. Approximately five additional miles of habitat would be warmer than 22ºC in the Middle Russian River under the ENFP than under D1610 (Figure A-15). The ENFP would provide cooler water temperatures than D1610 in September, as it would not exhaust the cold-water pool in Lake Mendocino (Figure A-16). Under future demand, July water temperatures would be very similar to those under D1610, but temperatures in September would be slightly cooler, because the ENFP conserves the cold-water pool in Lake Mendocino longer than D1610.

Flows from Dry Creek would result in cooling of water temperature in the mainstem directly downstream of the confluence relative to temperatures under D1610 (Figures A-15 to A-16). Near Hacienda Bridge, water temperature would be warmer than D1610 under both demand scenarios and would also be warmer than the NFP. Under both demand scenarios, water temperatures in July downstream of Dry Creek would generally be higher than 22ºC and thus would be considered very stressful for rearing salmonids (Figure A-15).

Summer flow in Dry Creek under the ENFP would be adjusted to remain close to those required for optimal rearing conditions for steelhead and coho salmon under both the current and future demand scenarios. These flows would be lower than under D1610, particularly under the future demand scenario (Figures A-1). During Dry water supply conditions, which occur about 20 percent of the time, flow in Dry Creek would increase to meet water supply needs, but would increase substantially less than under D1610 (Figures A-2). Flows during the majority of the outmigration season would remain similar to those under D1610 and thus would be unaffected by this alternative. During May and June, which is the latter part of the emigration season (coho emigrate through May; steelhead and Chinook emigrate through June), the lower flows under the ENFP may slow emigration, but are unlikely to affect emigration success. Increases in flow during February and March under Normal water supply conditions would decrease spawning habitat for coho and steelhead during these months. In Dry water supply conditions, flow increases in April would improve conditions for steelhead spawning relative to D1610.

With the ENFP, flows in Dry Creek were designed to provide improved water velocities for rearing steelhead and coho. These flows would result in slightly warmer water temperatures than D1610, but would still provide good rearing temperatures (Figures A-11 and A-12). Under Dry water supply conditions when flow would increase, temperatures would drop but water velocities would be higher than optimum (Figures A-12 and A-13).

The ENFP would result in lower flows at the Hacienda Bridge relative to D1610. These flows would generally be sufficiently low to eliminate artificial breaching of the sandbar during the summer months. Inflow to the Estuary would be adaptively managed to maintain a constant water surface elevation of 8.0 to 8.5 feet, as recorded on the Jenner gage, during the dry season, and the system would be managed as a closed lagoon with freshwater habitat. This could potentially improve summer rearing habitat in the Estuary. The flows needed to maintain a closed estuary are currently estimated to be 35 to 45 cfs at Hacienda Bridge, but flows would need to be adaptively managed to maintain this water surface elevation.

Altered flows may potentially negatively affect juvenile salmonid rearing if habitat is altered in such a way that favors the warmwater fish community. However, the flow changes and resultant temperature changes under the ENFP are unlikely to substantially affect predator populations.

2.4.3 Other Considerations

In the portion of the river below Mirabel, the recreational canoeing industry and other recreational users, which rely on elevated flows in the river, would be affected by this action. Implementation of the ENFP would result in a reduction in mid-summer flows to 40 to 60 cfs during Normal water supply conditions as compared to 130 to 150 cfs currently existing under D1610. Flows in the Upper and Middle Reaches of the Russian River would be reduced, but by amounts that are unlikely to affect these types of recreational opportunities. At Ukiah, summer flows would range from 130 to 250 cfs during the summer months under the ENFP as compared to current levels of 175 to 260 under D1610.

The lower flows below Mirabel under the ENFP would reduce dilution of nutrients, pesticides, or coliform bacteria and could result in water quality impacts, which may impair beneficial uses of the river, including contact recreation, fishing, and potentially aquatic habitat value.

Flows in Dry Creek are a mixture of direct releases from the dam and hatchery discharges. The fish hatchery requires flows of approximately 35 to 50 cfs. The hatchery discharges its wastewater after passing it through settling ponds to Dry Creek a short distance downstream of the dam. By reducing the total flow in Dry Creek, the relative contribution of return water from the hatchery would increase. The hatchery currently meets all the requirements for its discharge under its NPDES permit from the RWQCB prior to being released to Dry Creek. The reduced dilution of this discharge when releases from the flows are decreased is unlikely to affect salmonid populations in Dry Creek.

Reduction of releases from WSD may affect operation of the hydroelectric facility. This would reduce power generation from this facility. SCWA is currently under contract with PG&E to produce a minimum of 1.246 MW of electricity during June, July and August. This contract would have to be amended to implement this action. In addition, the FERC license to operate the hydroelectric generation facility states that in Normal water supply conditions from May 1 to October 31, the minimum releases from the dam shall not be less than 80 cfs. The FERC license for this project would also have to be amended to implement these flow reductions. The turbine can be operated with a minimum flow of approximately 70 cfs and an approximate maximum design flow of 175 cfs. Furthermore, if the generator is shut down, a USACE low-flow valve must be manually opened to maintain releases for hatchery water and minimum releases to Dry Creek. An untested and unused telemetry control of this valve could be tested, but there remains a concern that the USACE flow valve could be inadvertently placed in the closed position and stop all releases when the turbine shuts down.

This action would require changing the SWRCB minimum flow requirements as set forth in D1610. Therefore this action would require approval from the SWRCB.

2.5 Action C. Continue D1610 with a Pipeline to the Mouth of Dry Creek.

The objective of this action is to provide a mechanism whereby flows in Dry Creek can be reduced to maximize salmonid rearing habitat while continuing to meet water supply obligations of SCWA.

2.5.1 Action

A new pipeline would be installed in the wet well or outlet structure of WSD. This pipeline would discharge to the mainstem of the Russian River immediately below its confluence with Dry Creek. The pipeline would be implemented in coordination with the D1610 flow scenarios for the system. With the pipeline in place, releases to Dry Creek would be in the range of 50 to 90 cfs (the current target in this model run was 70 cfs). Any additional flow needed to meet water supply needs would be conveyed through the pipeline. This action would not affect flow in the Russian River. The temperature in the Russian River below Dry Creek would be affected. Water traveling through the pipeline from WSD to the Russian River would not be significantly warmed, and thus would enter the Russian River at a cooler temperature than the equivalent amount of water traveling down Dry Creek. Flows and temperatures in Upper and Middle Reaches of the Russian River would be the same as under D1610. The effects of this alternative on these portions of the river are discussed in Section 2.2.2 of this report.

This action would require acquisition of a right-of-way for construction of the pipeline from WSD to the Russian River. A potential route would be along Dry Creek Road. This action would maintain flows in the mainstem Russian River below Dry Creek, ensuring that sufficient flows reach the Mirabel and Wohler diversion facilities to meet current and future water supply needs. The inflatable dam at Mirabel would continue to be operated for recharge and to fill the pond at Wohler and Mirabel. The aquifer would be recharged and water would continue to be extracted by the Ranney collectors at Wohler and Mirabel.

2.5.2 Effects on Protected Species

Under either of the pipeline alternatives, the summer flows in Dry Creek would be reduced to between 50 and 90 cfs, with any additional water needed to meet demand being conveyed through the pipeline (Figures A-1 and A-2). These lower flows would improve conditions for rearing salmonids in Dry Creek from May through October relative to the current D1610 flows. Under future water demand, the flows would be substantially improved by the pipeline when compared to D1610. Thus, the pipeline would provide substantial benefit to salmonid rearing habitat in Dry Creek. Spawning habitat would not be affected, as flows during the spawning period of all species would be the same as under D1610.

Under the D1610 pipeline alternative, temperatures in Dry Creek would warm by about 1°C relative to D1610 above the mouth of Dry Creek under either demand scenario

(Figures A-11 to A-14). Temperatures would remain below 19°C and remain suitable for salmonid rearing. Therefore, the increased temperatures would likely not substantially affect rearing success.

With the D1610 Pipeline alternative, temperatures in the Russian River below Dry Creek would be improved slightly relative to D1610 and more substantially (by about 0.5°C) in the future demand scenario (Figures A-15 to A-18). This alternative would provide benefits to rearing steelhead in the Russian River, although coho are unlikely to benefit as this portion of the river does not provide suitable habitat for this species.

Inflow to the Estuary under the D1610 pipeline alternatives above would be the same as under D1610. Inflow would remain too high to operate the Estuary as a closed system under either current or future demand scenarios. The Estuary would continue to be operated as an open system.

2.5.3 Other Considerations

Implementation of this action would require redesigning and reconstructing portions of the wet well within the dam. The location of the tap of the pipeline to the wet well or outlet structure is a key design consideration as it could affect operations of the hydroelectric facility. If the pipeline were to tap into the wet well above the hydroelectric facility, there would be insufficient flow to operate the facility as currently configured. If the pipeline tapped into the outlet structure below the hydroelectric facility it would ensure that sufficient flows were available to power the turbines; however, back pressure from the pipeline could reduce the turbine's efficiency. Other alternate configurations for the hydroelectric facility may include reconfiguring the generator to operate at flows of 50 cfs, or installing two small generators along the pipeline. Additionally, this alternative would modify existing instream minimum flow requirements in Dry Creek. This modification would require approval from both the FERC and SWRCB.

Flows in Dry Creek would be a mixture of direct releases from the dam and hatchery discharges. By reducing the total flow in Dry Creek, the relative contribution of return water from the hatchery would increase, with potential effects on water quality. However, as the hatchery currently meets its NPDES requirements prior to dilution, this would likely not affect salmonid production in Dry Creek.

Recharge to the aquifer along Dry Creek would be reduced during summer flows as compared to current conditions, or conditions under the NFP. Recharge of the aquifer along the Russian River would be unaffected by this action.

Several operational concerns would have to be addressed. The pipeline is likely to have fluctuating pressures and surges, and would have to be operated to reduce the potential to generate turbidity where water is released to the river. Design of the pipeline discharge at the mouth of Dry Creek would address the potential for sediment scour and public safety. During repair and inspection of the pipeline system, releases would have to be made to Dry Creek.

This alternative would be considerably more expensive than the other proposed alternatives. Substantial funding would be required to implement this action. State and federal contributions would be required. The timeframe for developing a project description, completing the environmental compliance, acquiring right-of-way, and obtaining funding for this action could be as long as 10 to 15 years.

2.6 ACTION D. CONTINUE D1610 WITH A PIPELINE TO THE MIRABEL DIVERSION FACILITY.

The objective of this action is to provide a mechanism whereby flows in Dry Creek and the Russian River can be reduced to maximize salmonid rearing habitat, while continuing to meet water supply needs of SCWA.

2.6.1 ACTION

This action would be similar to Action C, with the exception that the pipeline would not discharge directly and completely to the Russian River at the mouth of Dry Creek. Instead, the pipeline would continue to the Mirabel infiltration ponds or potentially to a water treatment plant. To enhance aquifer recharge, water would be released from the pipeline at multiple points (outlets) along the Russian River below Dry Creek and at the Mirabel ponds. The multiple outlets to the Russian River would provide for aquifer recharge over a larger area than a single point discharge. Russian River flows between the mouth of Dry Creek and Mirabel would be reduced by the amount of water traveling through the pipeline. The amount of flow in the river would depend on the amount of water discharged at each outlet and the location of those outlets along the river. The outlets would consist of both constant flow and variable flow outlets. This action would provide increased operational flexibility relative to Action C with respect to the location and release of water to the Russian River. Additionally, this action could allow greater flexibility in the management of the inflatable dam at Mirabel.

2.6.2 EFFECTS ON PROTECTED SPECIES

The pipeline extension to Mirabel would only affect the Russian River differently than the pipeline alternative described in Action C between the mouth of Dry Creek and Mirabel. Conditions in the Russian River above Dry Creek and below Wohler Dam and in Dry Creek would remain the same as the previous alternative (Action C). The RRSM and RRWQM cannot predict the specific effects of this alternative on this portion of the Russian River. Generally, the flow below Dry Creek would be reduced for an undetermined distance downstream until all the water transported through the pipeline had been released to the river. Around each outlet, a cool water refugia might be provided that could provide relief from the warm temperatures present under D1610. This could provide a benefit to any juvenile steelhead rearing in this portion of the river.

As this option could deliver water directly to the Mirabel diversion facility, it could be used to supply water to the Mirabel infiltration ponds during periods when the inflatable dam is deflated. This may reduce the need to raise the dam during dry conditions in the spring (March to April). A delay in raising the dam would benefit smolts by reducing potential delays in juvenile outmigration. The dam would still need to be inflated during peak demand season (May into November), however.

2.6.3 Other Considerations

The issues raised under "Other Considerations" for Action C would apply to this alternative as well. These include issues associated with hatchery water supply, water quality, and hydroelectric operations, and timeline for implementation. The considerations relating to the location of the tap of the pipeline to the wet well are the same as for Action C. This action would also require that a longer right-of-way be obtained than for Action C, as the pipeline would travel to the Mirabel ponds. However, this action would also reduce evaporative losses of water that are incurred during conveyance of water along the stream and riverbed.

2.7 Action E. Implement the Enhanced Natural Flow Proposal with Additional Measures.

The objective of this action is to provide a mechanism whereby flows in Dry Creek and the Russian River can be reduced to maximize salmonid rearing habitat while continuing to meet water supply obligations of SCWA under the future water demand scenario. An additional objective would be to allow the Estuary to be operated as a closed system during the summer months.

The ENFP –AM alternative would involve the development of a mechanism whereby flows in the Upper Russian River and Dry Creek could be maintained at levels that provide excellent habitat values, while still meeting future water demand. Additional measures being considered for this alternative include both institutional and physical measures. Institutional measures would address water rights compliance in the Upper and Middle Russian River. Physical measures may include a pipeline as described in the previous section, implementation of an Aquifer Storage and Retrieval Program (described below), or other options to be developed. The final alternative may include some combination or phased implementation of these options.

2.7.1 Action

Under this alternative, SCWA would attempt to provide flows into the future at levels similar to those described for the ENFP under the current demand scenario. With the ENFP, flows increase over time in the Upper and Middle Russian River to meet anticipated future demand to levels; approaching those under current D1610 operations. These flow levels result in velocities that are higher than optimal for rearing salmonids. Under the ENFP-AM alternative, the additional water demand will be met through a mechanism that does not require putting additional water down either the Upper and Middle Russian River or Dry Creek. This mechanism may include a suite of additional measures. These would include institutional measures to address water rights compliance in the Upper and Middle Russian River as well as physical solutions. The primary physical solutions being considered for this alternative are an ASR program, a pipeline from WSD to the mouth of Dry Creek, or development of smaller off-stream storage facilities elsewhere in the basin.

The final alternative will likely be a combination of these options, other options yet to be determined, or a phased implementation of these options, as demand increases.

The ASR option would involve the development of groundwater recharge facilities in areas such as the Sonoma Valley, Santa Rosa Plain, or Petaluma. Water would be diverted into the aquifer from the existing transmission system during high-flow conditions. The recharge system would consist of injector wells. The stored water could then be extracted to provide an additional source of water. This action would require an evaluation of groundwater management practices and, potentially, land use management restrictions.

If a pipeline option were pursued, a new pipeline would be installed in the wet well or outlet structure of WSD, as described for Action C, requiring acquisition of a right-of-way. This pipeline could terminate either at the mouth of Dry Creek or at Mirabel as described in Actions C and D. The pipeline could potentially feed into a water treatment plant. The pipeline would be implemented in coordination with the ENFP flow scenarios for the system. Releases from WSD to Dry Creek would be in the range of 50 to 90 cfs, with a target flow of 70 cfs. Any additional flow needed to meet water supply needs would be conveyed through the pipeline.

2.7.2 Effects on Protected Species

Under both the current and future demand scenarios, this alternative would result in flows and temperatures in the Upper and Middle Russian River and in Dry Creek similar to those described for the ENFP under current demands, as described in Section 2.2.2. In the Russian River below Mirabel, flows would remain as described for the ENFP under current demands, but temperatures may change somewhat depending on the option implemented. The ability to improve conditions for salmonids throughout most of the system, both now and in the future, could provide a substantial benefit to these species.

Flow and temperature could be affected in the Russian River between Dry Creek and Wohler Diversion Dam depending on the option implemented. The values of flow and temperature values provided in Appendix A are based upon the implementation of the pipeline option and assume that the pipeline will terminate at the mouth of Dry Creek. If the other options were implemented, flows and temperatures would not be expected to vary from these values to the extent that they would substantially modify the habitat value in this portion of the river. These changes are described in more detail below.

Additional water needed to meet future water demand would be obtained from one of the options discussed above, but would not be conveyed via Dry Creek or the Upper and Middle Russian River.

Flow levels during the summer months in the Upper and Middle Russian River would be reduced from those currently existing under D1610, to levels that provide excellent habitat for rearing steelhead and Chinook salmon. The lower flows could slow emigration rates in June, but would not be likely to substantially impair emigration success. The lower flows could also make conditions for the early upstream migration of Chinook salmon more difficult. However, as one of the goals of this alternative is to maintain the Estuary as a closed system, adult Chinook would not be able to enter the system until the sandbar was opened, which would likely coincide with storm events that would bring flows to adequate levels to provide passage. Flows in the Russian River would generally be similar during the spawning season, and spawning conditions would be similar under Both D1610 and the ENFP-AM for all species in most months. An exception would occur in November under the future demand scenario for All water supply conditions. Under the ENFP-AM flows would decline substantially, resulting in a sharp decrease in Chinook spawning habitat.

In the Upper and Middle Russian River, the lower flows would result in slightly warmer water temperatures than occur with D1610 under the current water demand. Temperatures would not warm to levels considered very stressful, however. These conditions would continue under the future water demand scenario as well.

Summer flow in Dry Creek under the ENFP-AM alternative would be adjusted to provide excellent rearing conditions for steelhead and coho salmon under both the current and future demand scenarios. During Dry water supply conditions, which occur about 20 percent of the time, flow in Dry Creek would increase to meet water supply needs, but would increase substantially less than under D1610 (Figures A-2). During the latter part of the emigration season, the lower flows under the ENFP-AM may slow emigration, but would not be low enough to effect emigration success. Increases in flow during February and March under All water supply conditions would decrease spawning habitat for coho and steelhead during these months. In Dry water supply conditions, flow increases in April would improve conditions for steelhead spawning relative to D1610.

The lower flows during the summer months would result in slightly warmer water temperatures than D1610, but would still provide good rearing temperatures (Figures A-11 and A-12). Under Dry water supply conditions when flow would increase, temperature would drop but water velocities would be higher than optimum (Figures A-13 and A-14).

If the pipeline option is used, the additional water needed to meet future water demand would be delivered from WSD via a pipeline and discharged to the Russian River near the mouth of Dry Creek. Flows between the mouth of Dry Creek and Mirabel would initially be those described for the ENFP alternative, but would increase with increasing water demand. Under the future water demand scenario, flows in this portion of the river would be similar to those under the ENFP with future demand. Water temperatures in this reach would be altered depending on the mix of water from Dry Creek, the Russian River, and the pipeline. These temperatures would be cooler than those under D1610 and warmer than those under the D1610 Pipeline alternative. If the ASR option is used, then flows in the Russian River between Dry Creek and Wohler diversion would be similar to those under the ENFP with current water demand. This would affect salmonid habitat as described in Section 2.4.2.

Under the ENFP-AM alternative, inflow the Estuary would be adaptively managed to maintain the Estuary in a closed state during the summer months. Flows would be managed to keep the Estuary level at the Jenner gage at 8 to 8.5 feet. This could enhance summer habitat for salmonid juveniles and their foodbase in the Estuary. Optimal estuary inflow is estimated to be 35 to 45 cfs, but would need to be adaptively managed to maintain this water surface elevation.

2.7.3 Other Considerations

This alternative would share the other considerations for recreation, water quality, and hydroelectric power production discussed for the ENFP in the Russian River below Mirabel in Section 2.4.3. If the pipeline option were incorporated as part of this alternative, the ENFP-AM alternative would also share the other considerations regarding construction, aquifer recharge along Dry Creek, cost, and implementation timeframe discussed for the D1610 Pipeline alternative in Section 2.5.3. As this alternative would modify minimum instream flows in the Russian River and Dry Creek, it would require the approval of the SWRCB and the FERC.

ASR would provide the benefit of reducing diversions on the Russian River system during the peak demand season by more equally distributing Russian River diversions throughout the year. Water would then be stored in other aquifers distinct from the Russian River to help offset peak demand. Additional considerations for the ASR option would include siting, groundwater management requirements, ability to recover the water stored in the aquifer, and potential water quality issues associated with differences in composition between Russian River and native groundwater. If this option were to be pursued, a groundwater management plan would likely need to be developed to ensure that the water stored in an aquifer would be available when needed, and not withdrawn by other water users. Each of these considerations would need to be evaluated carefully prior to implementing this option. An additional benefit of this alternative would include improved system reliability.

Before smaller off-stream reservoirs were to be developed, siting and water availability would need to be considered.

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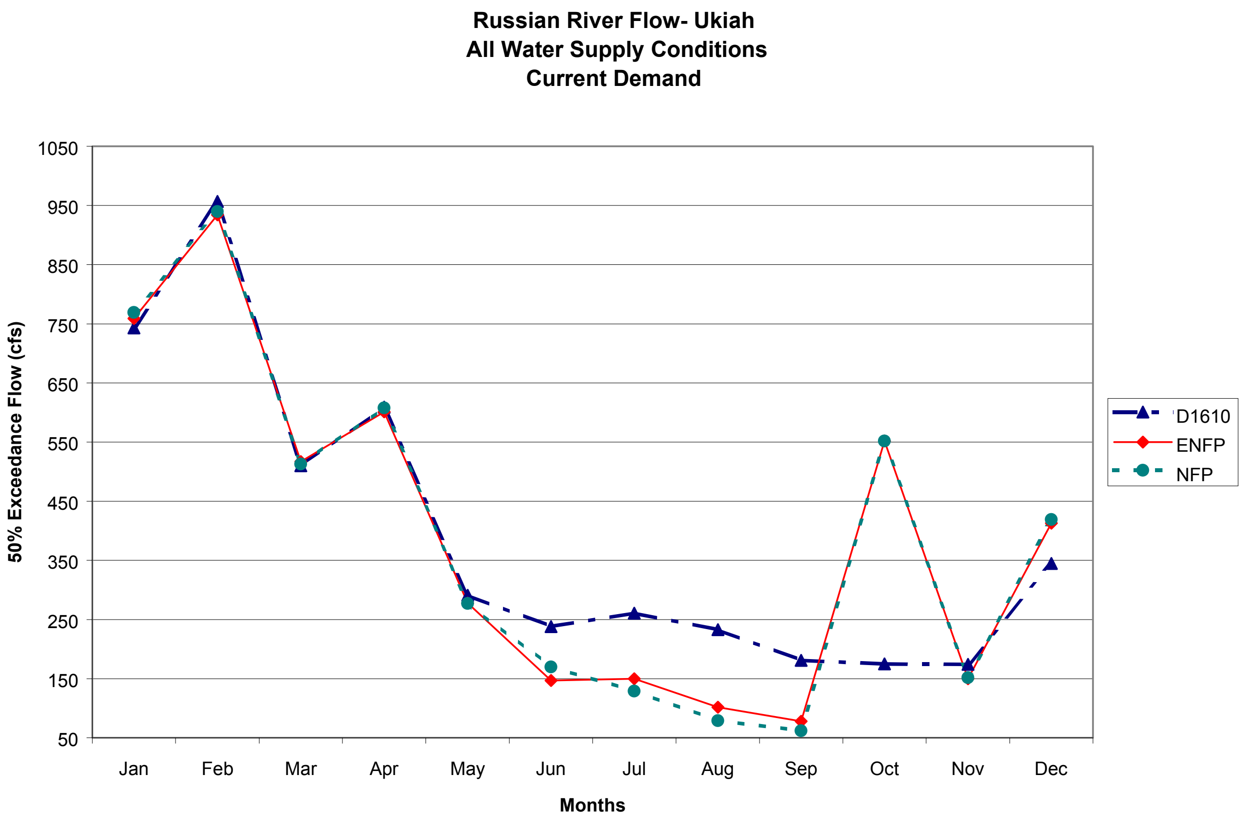
APPENDIX A

FIFTY PERCENT EXCEEDANCE FLOW AND TEMPERATURE GRAPHS



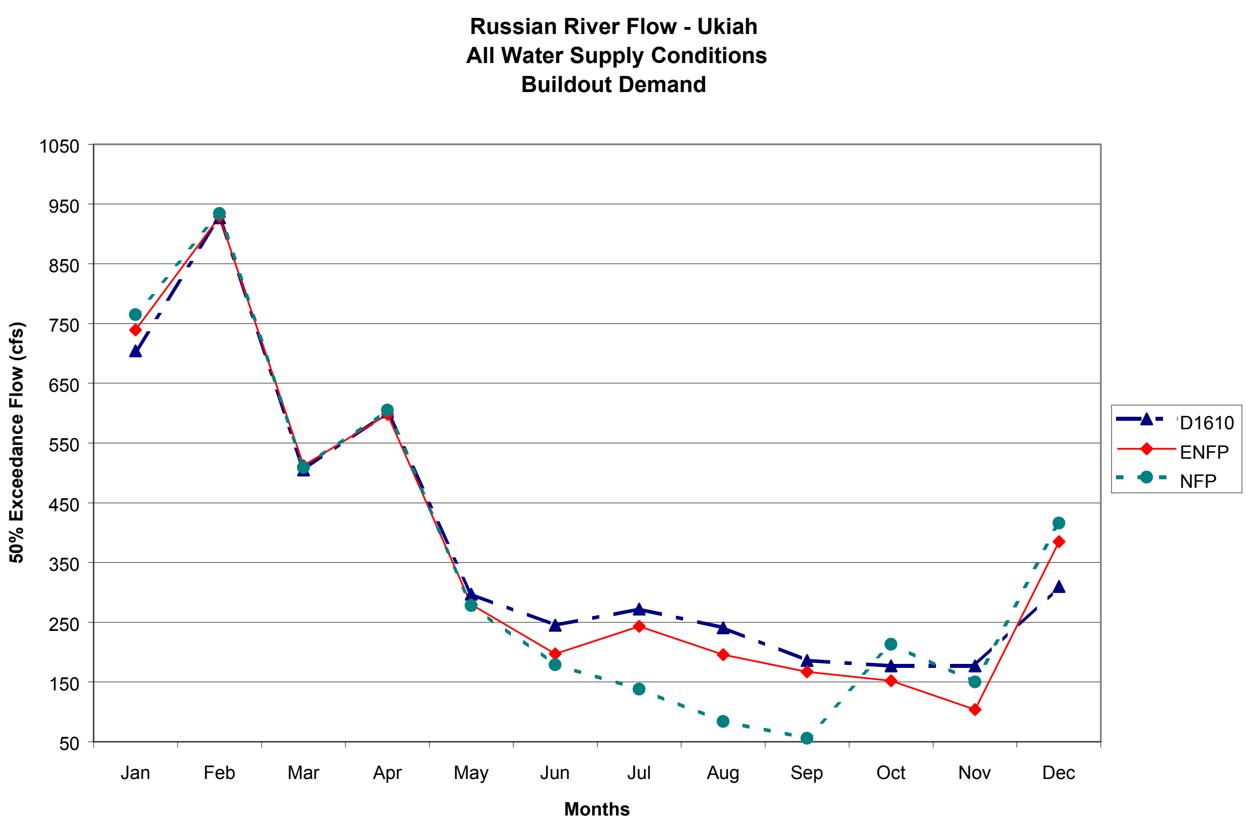
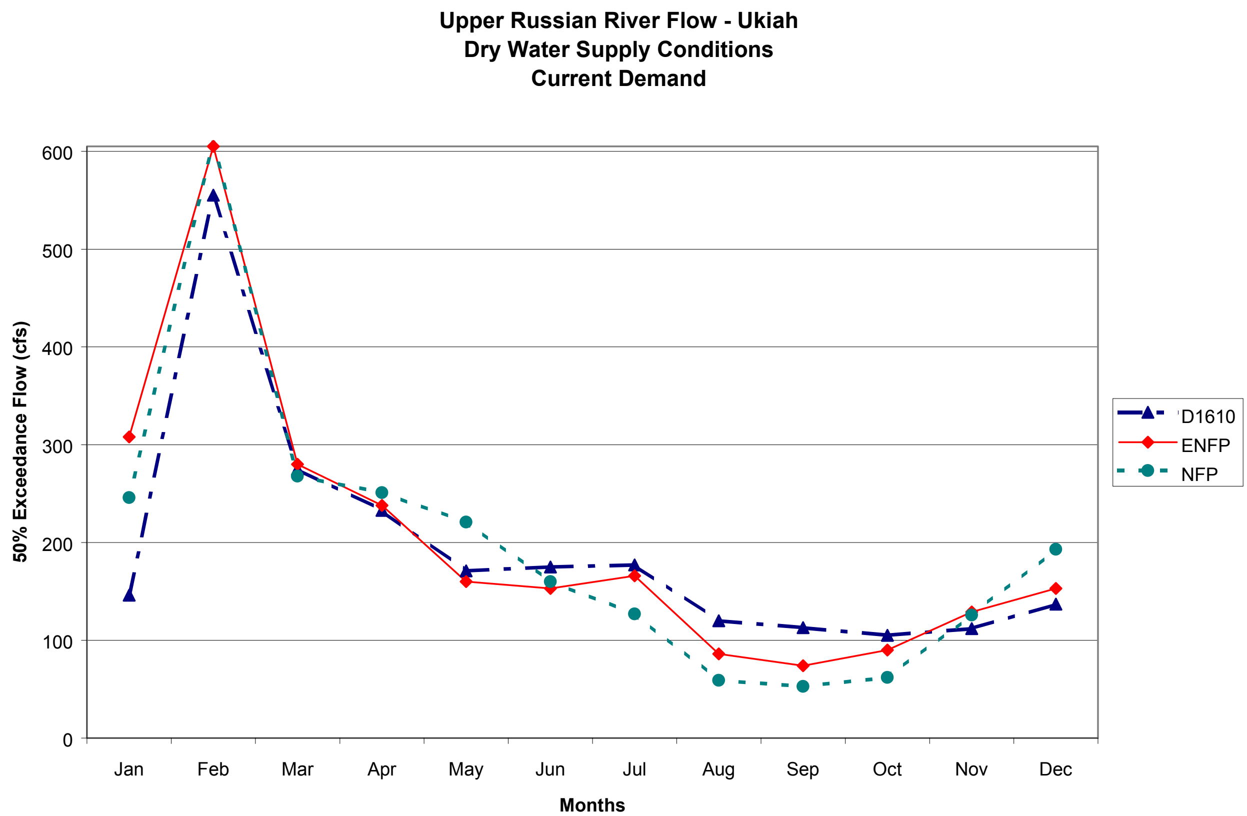


Figure A-1. Monthly Flows in Ukiah under All Water Supply Conditions.



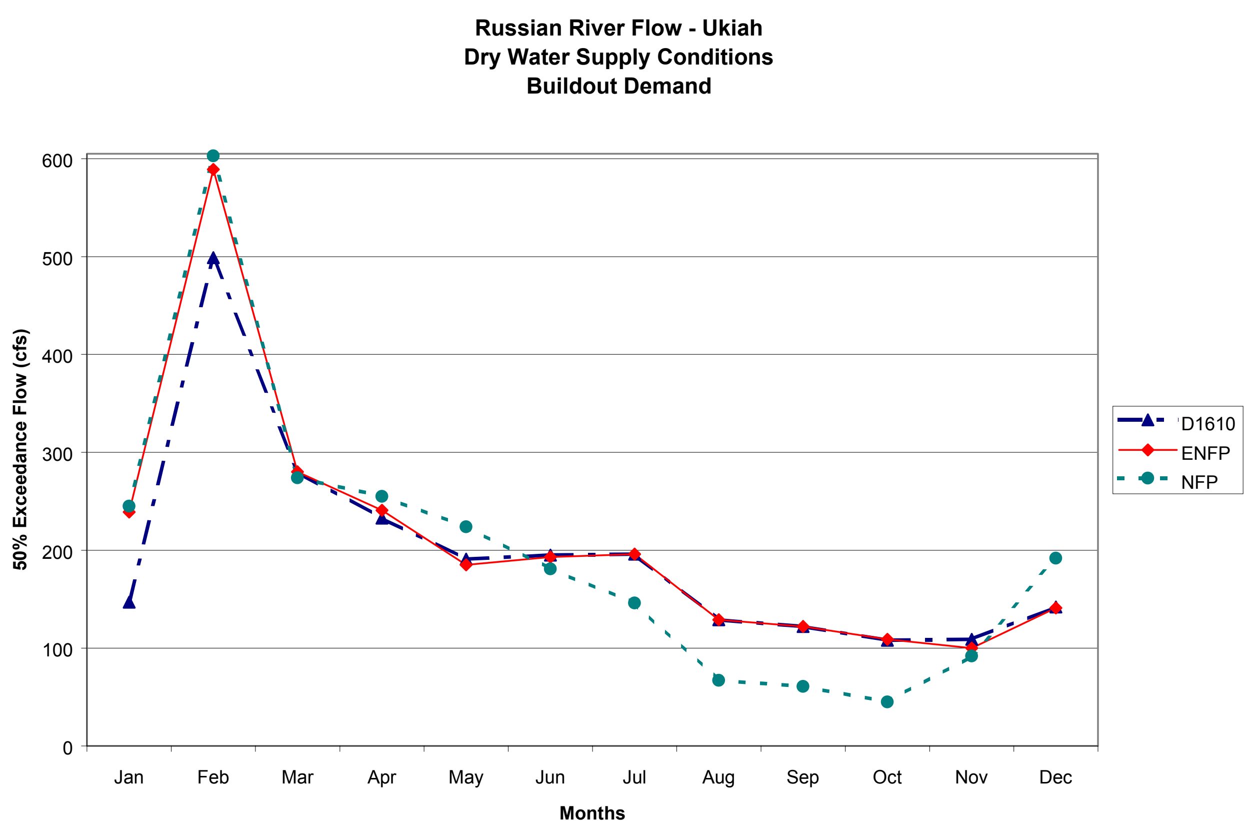
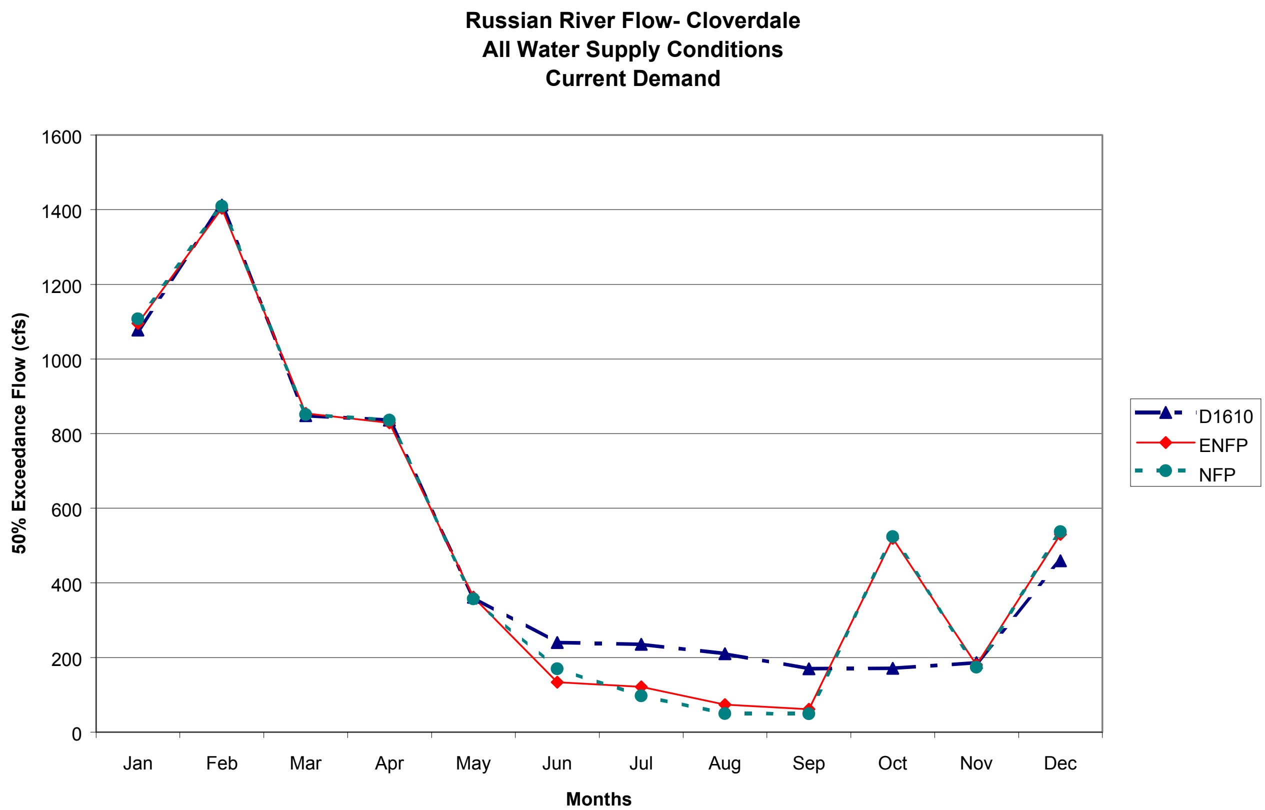


Figure A-2. Monthly Flows in Ukiah under Dry Water Supply Conditions.



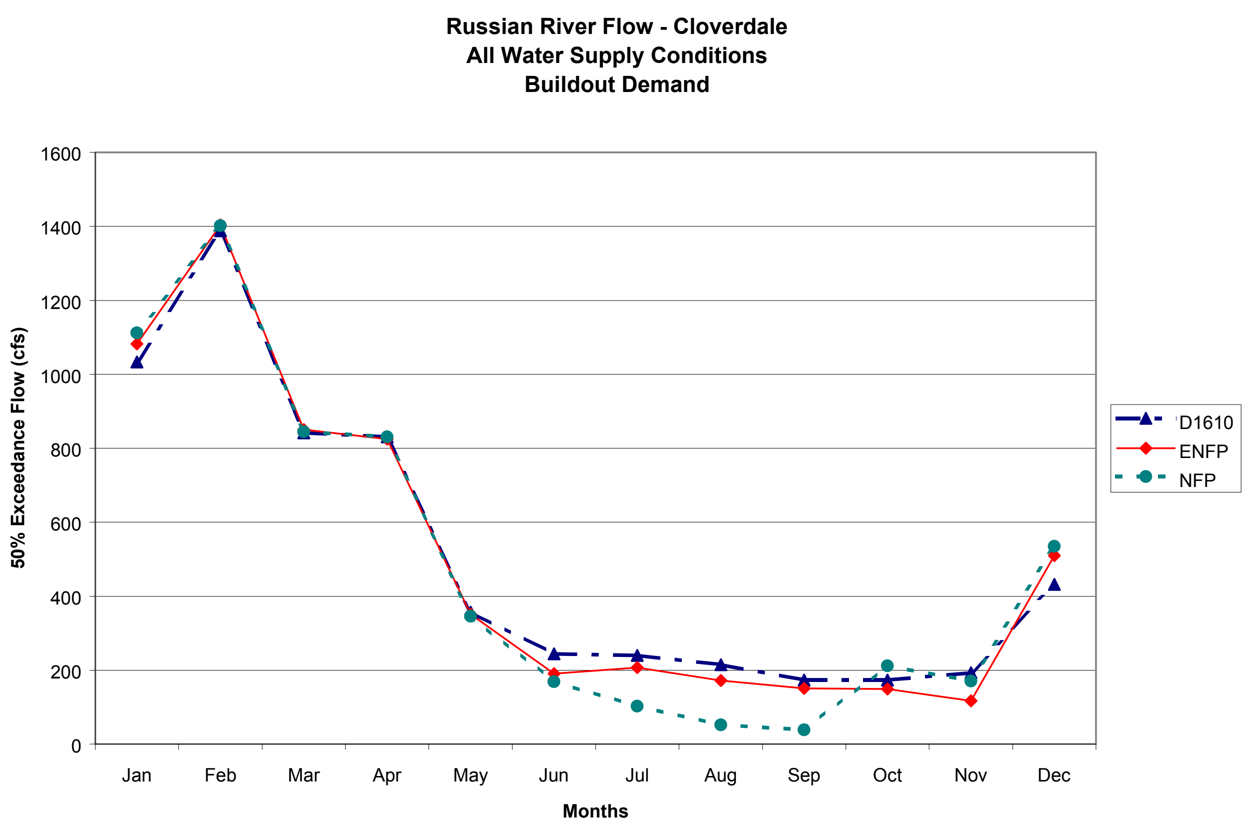


Figure A-3. Monthly Flows in Cloverdale under All Water Supply Conditions.

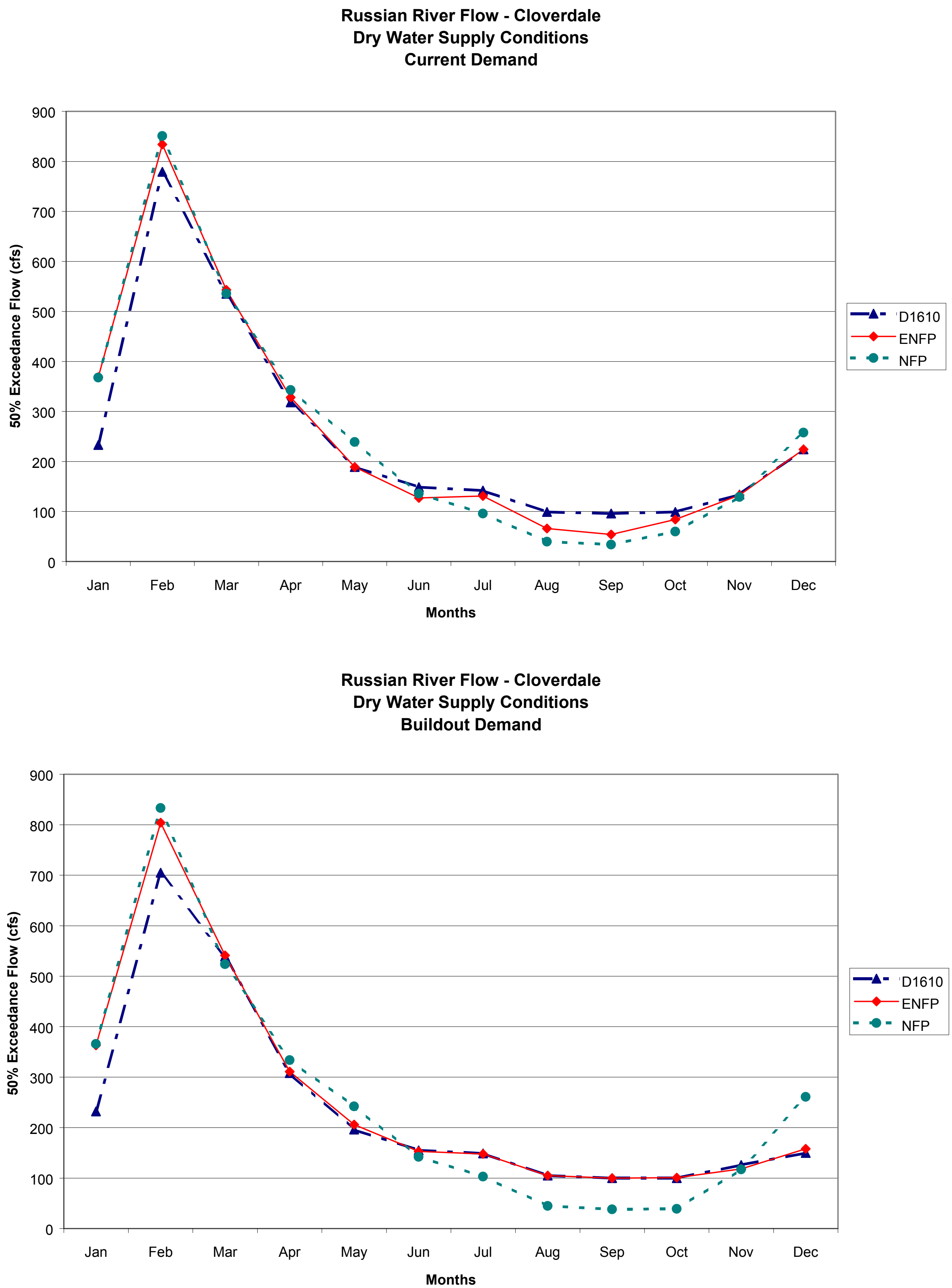
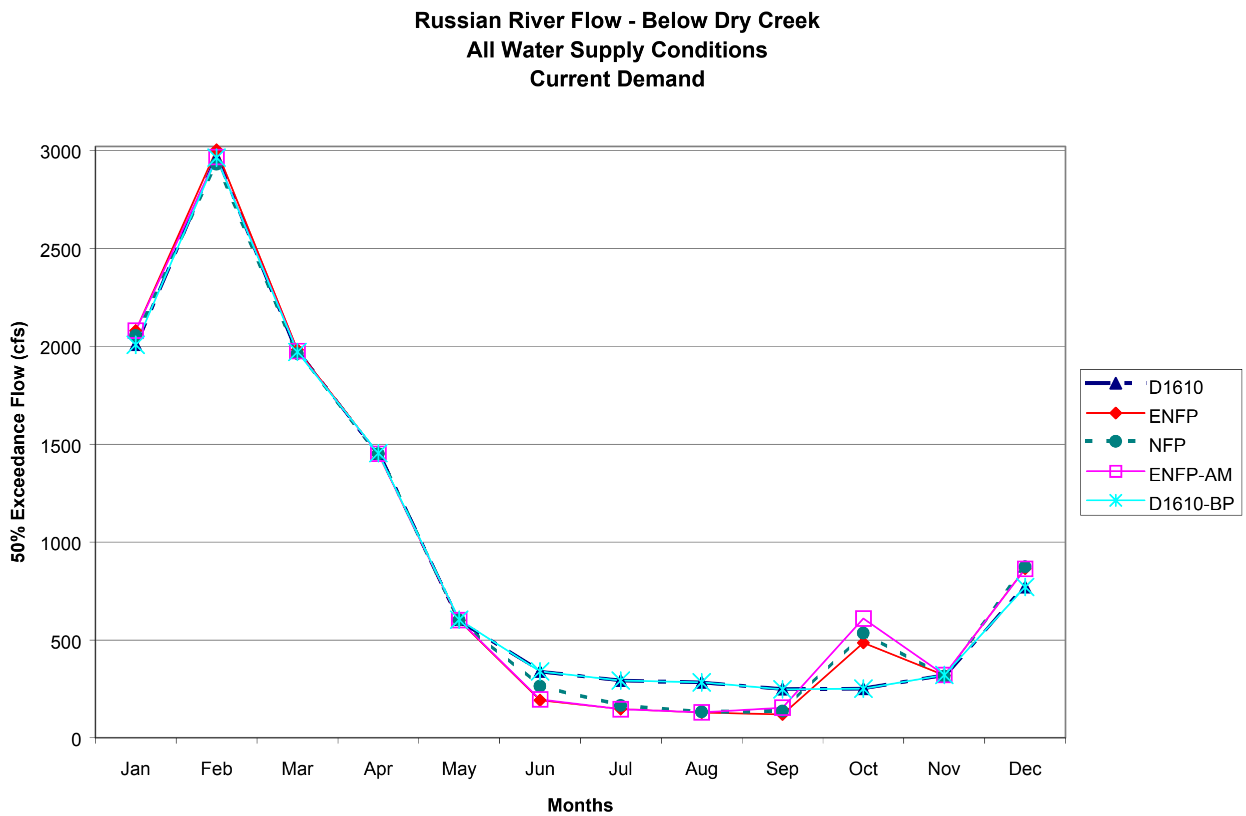


Figure A-4. Monthly Flows in Cloverdale under Dry Water Supply Conditions.



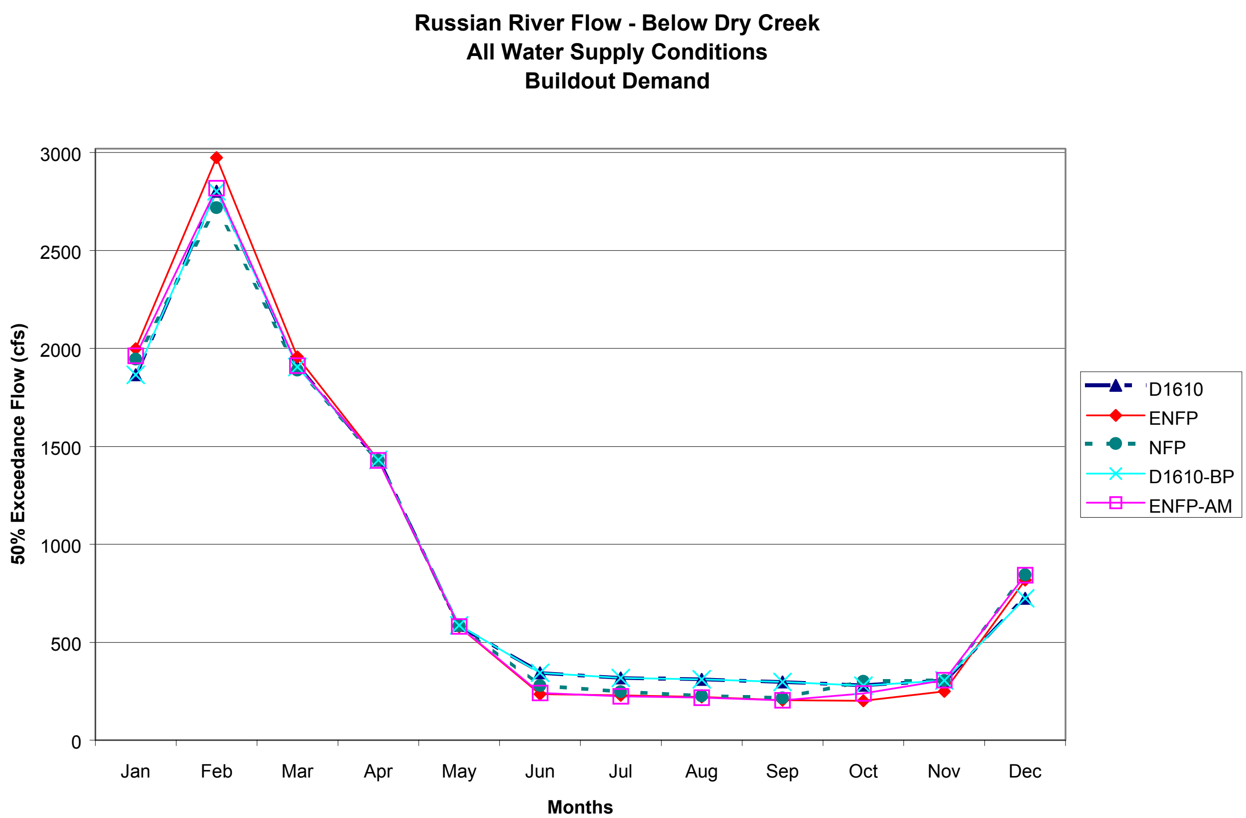
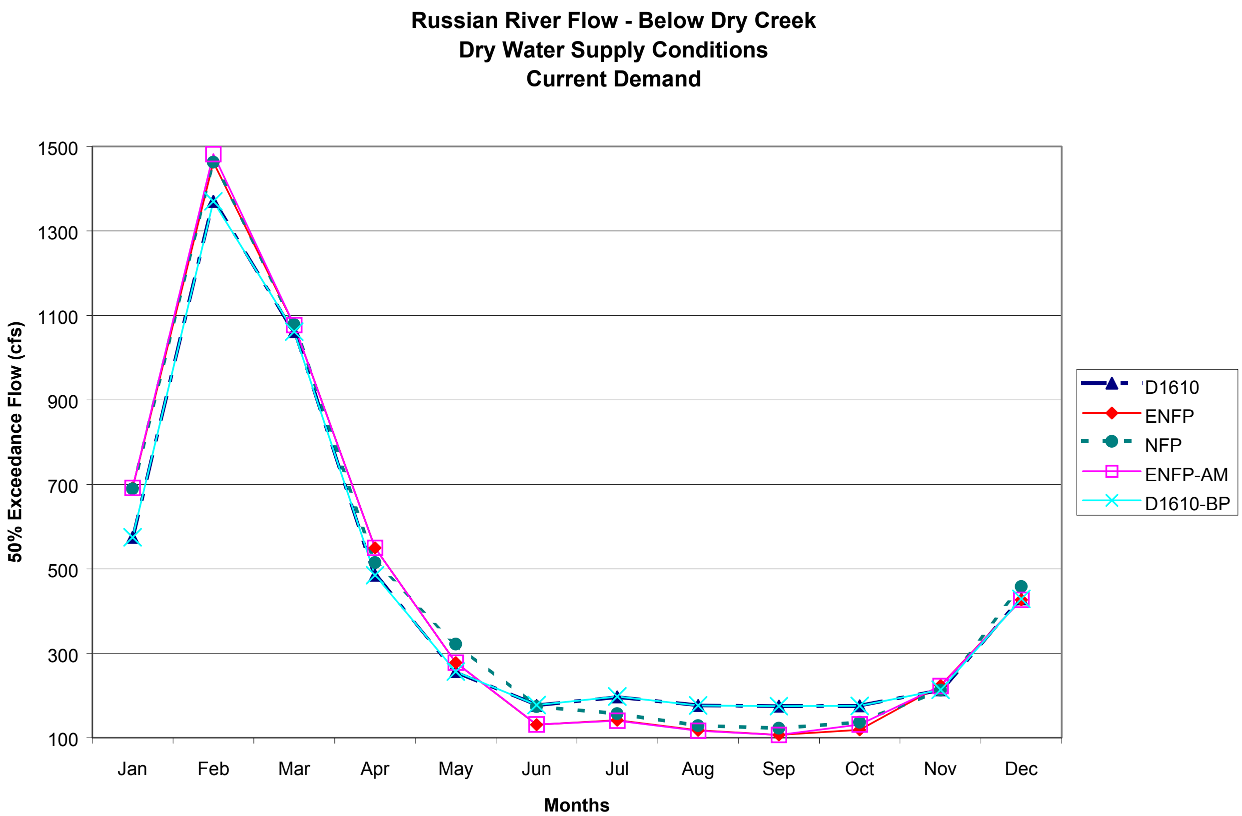


Figure A-5. Monthly Flows in the Russian River below the mouth of Dry Creek under All Water Supply Conditions.



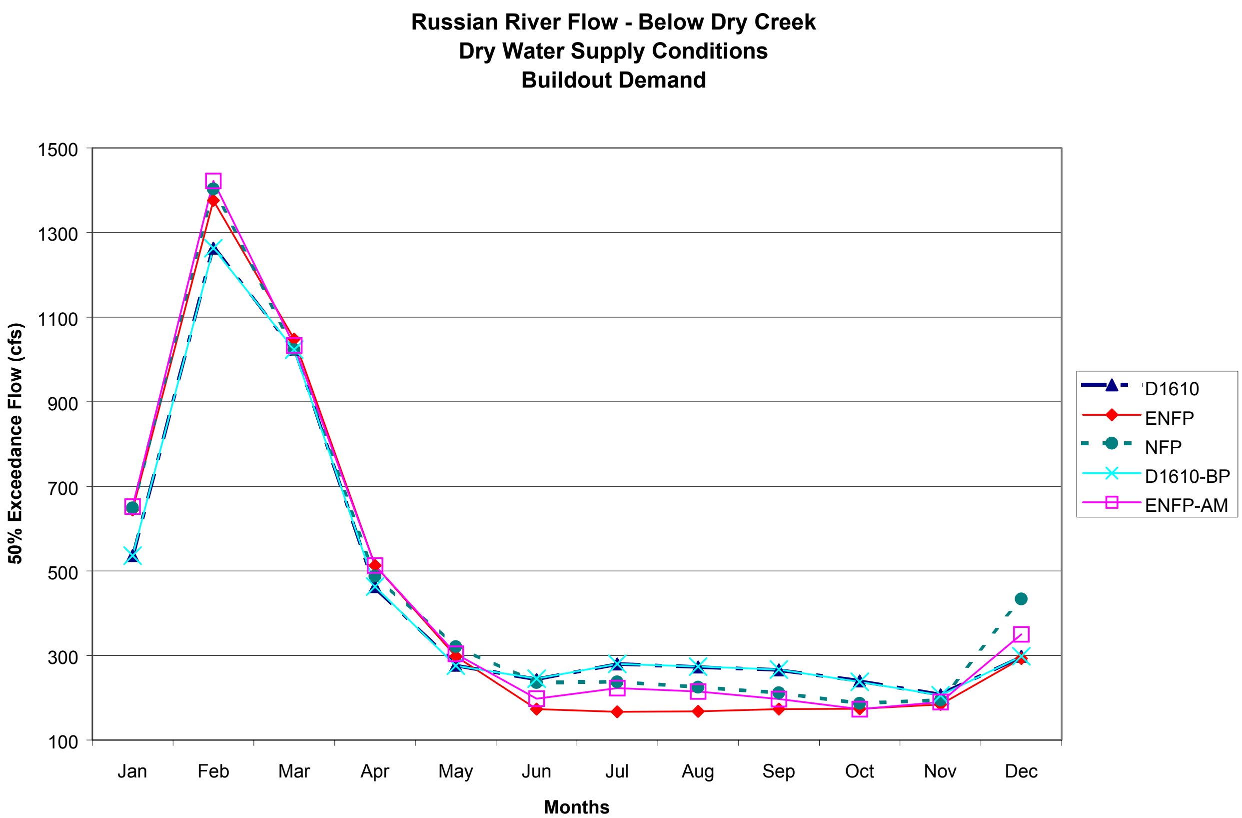
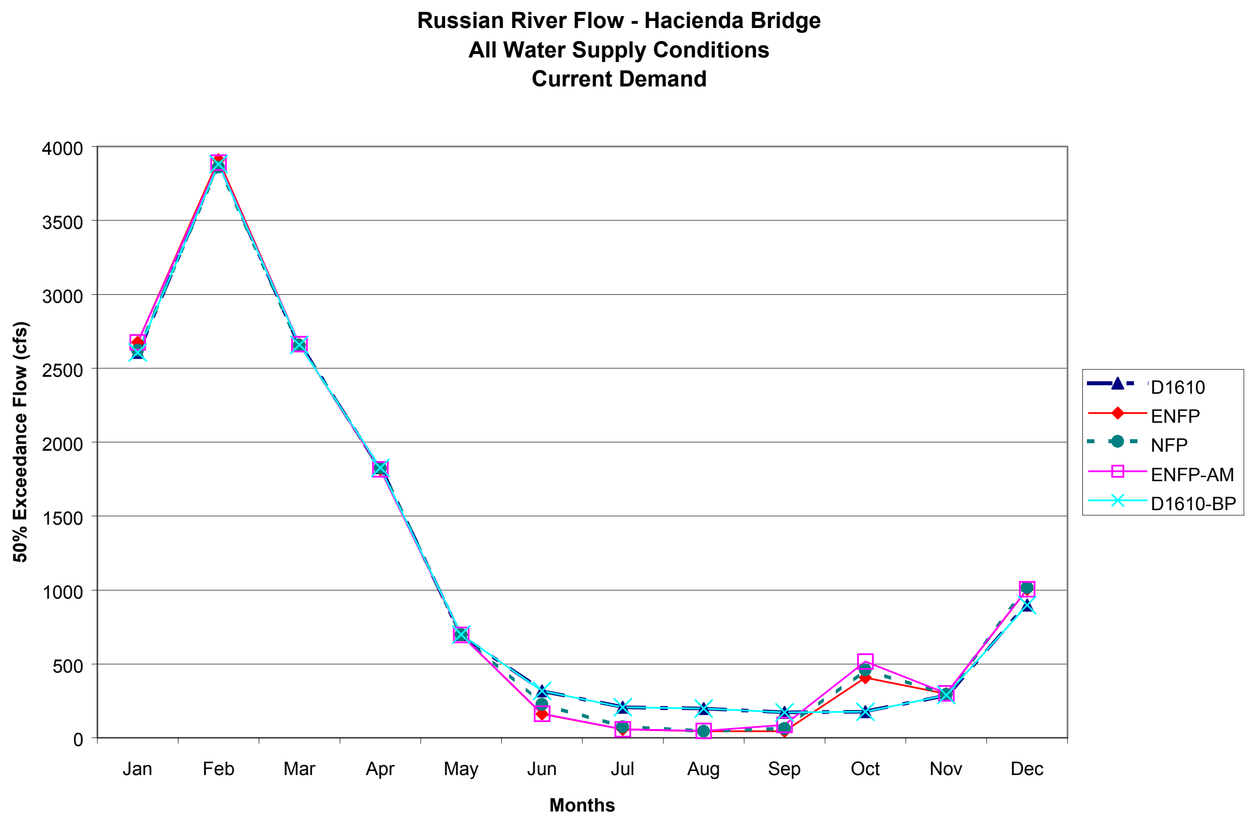


Figure A-6. Monthly Flows in the Russian River below the mouth of Dry Creek under Dry Water Supply Conditions.



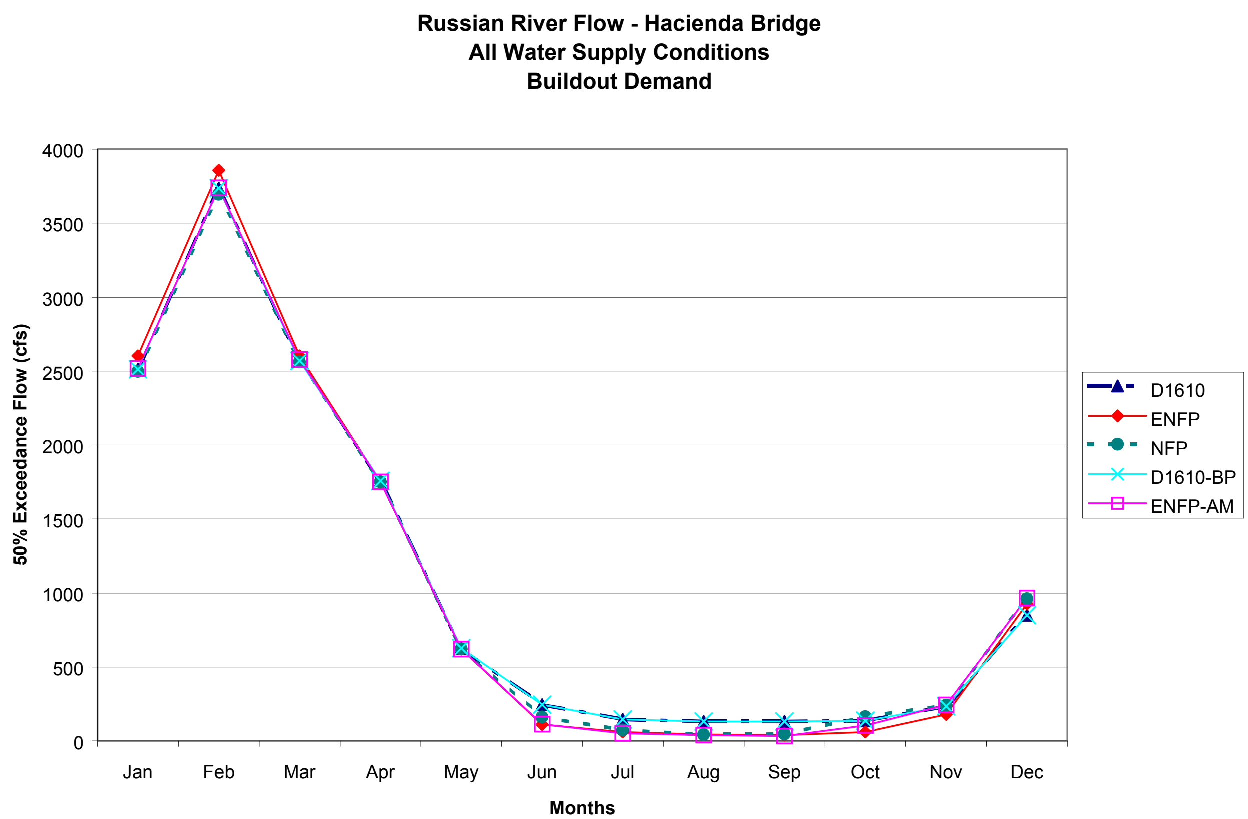
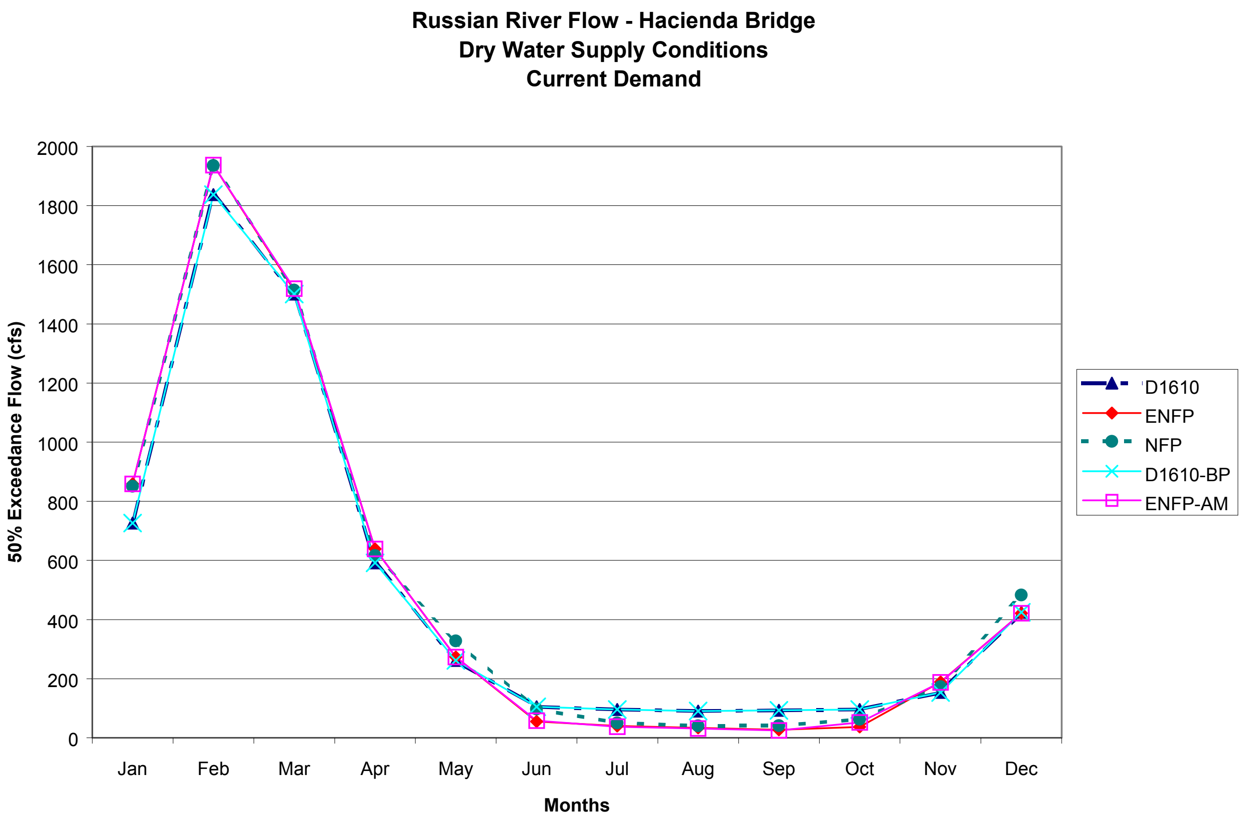


Figure A-7. Monthly Flows at Hacienda Bridge under All Water Supply Conditions.



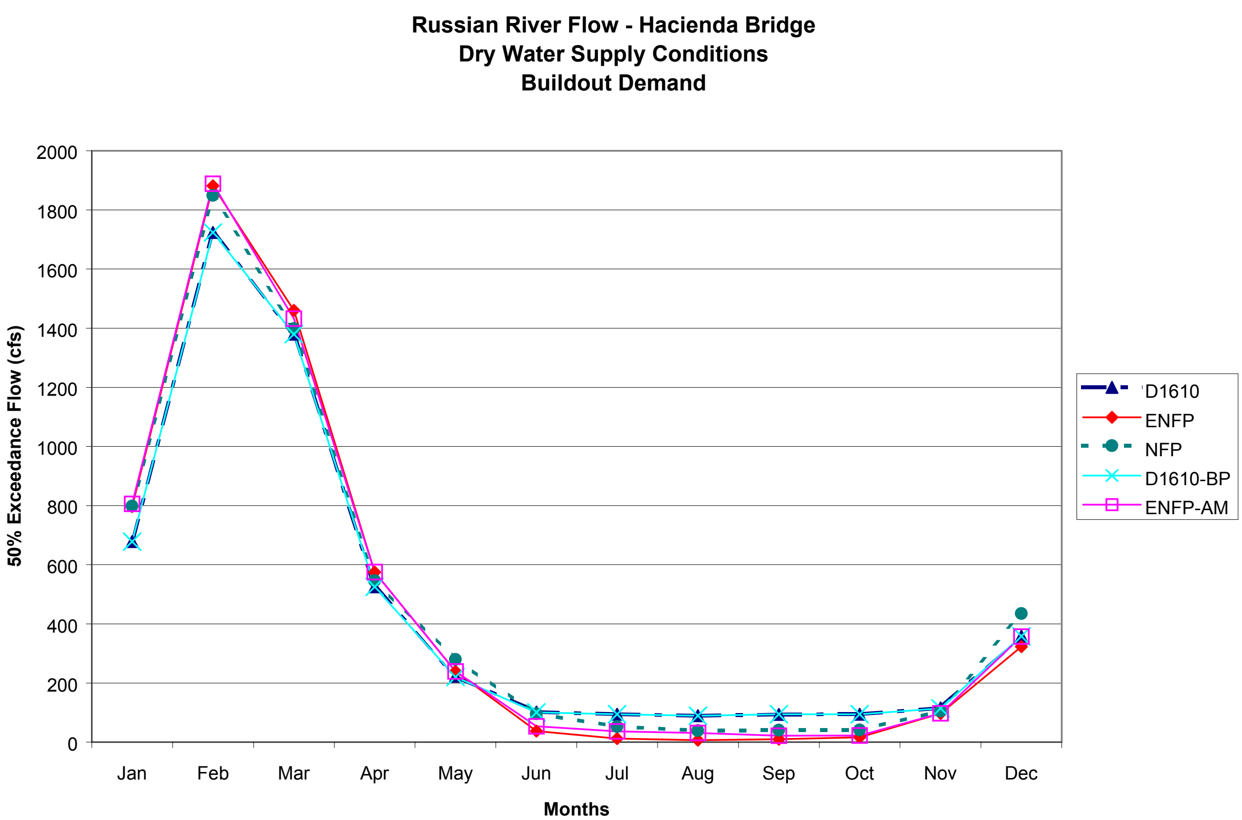
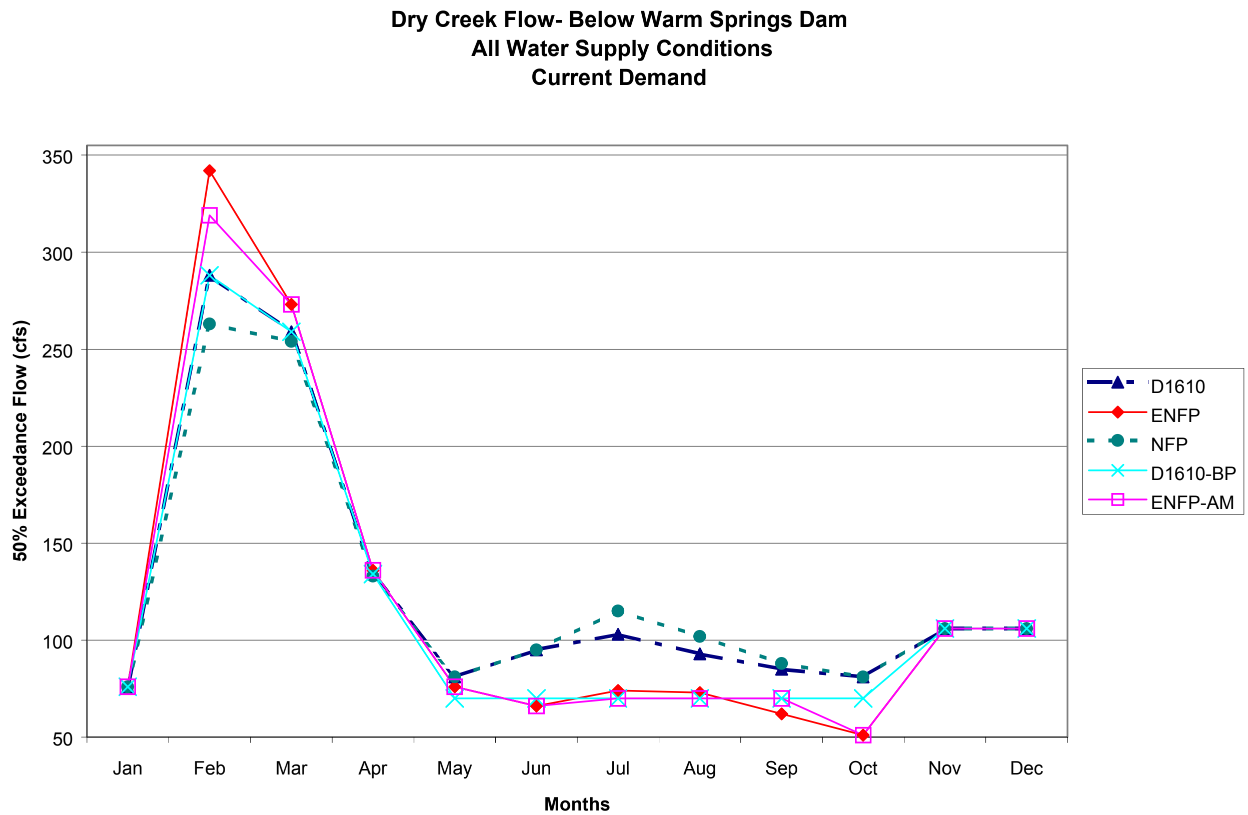


Figure A-8. Monthly Flows at Hacienda Bridge under Dry Water Supply Conditions.



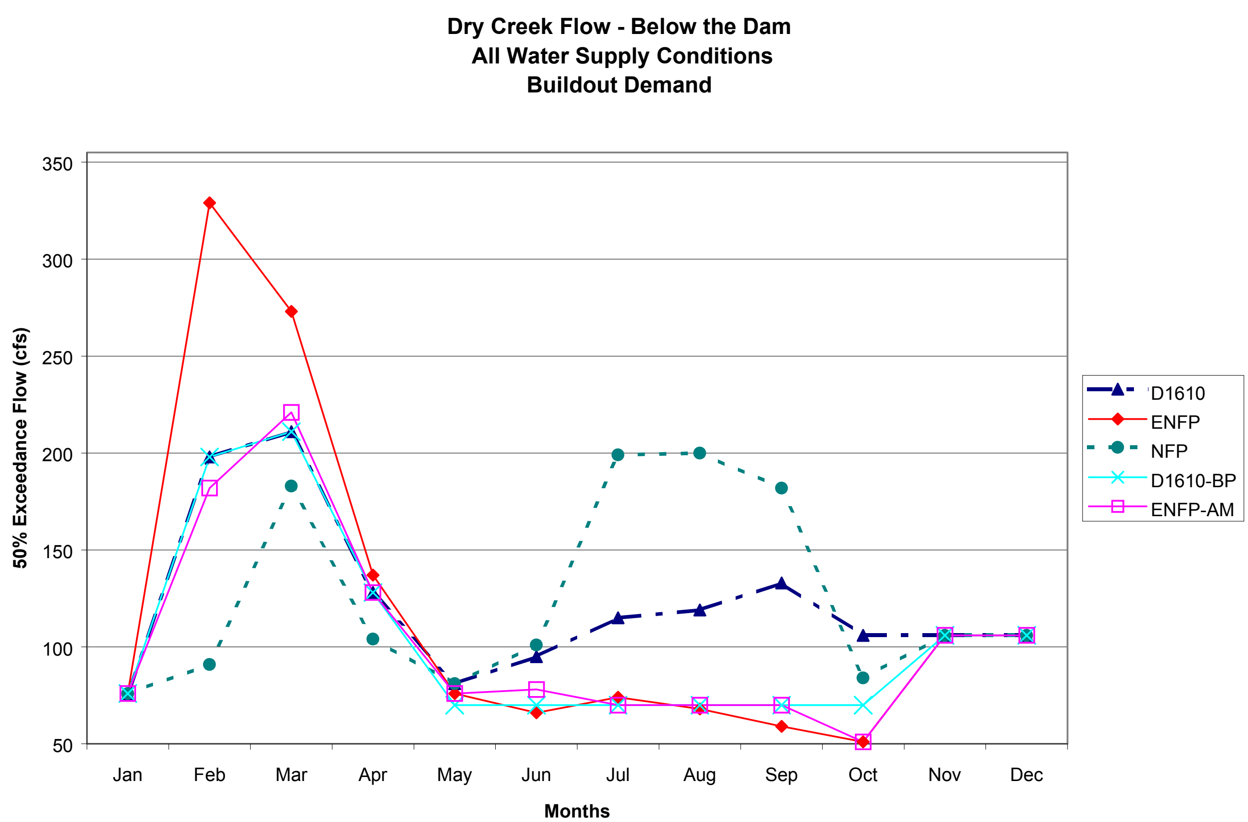
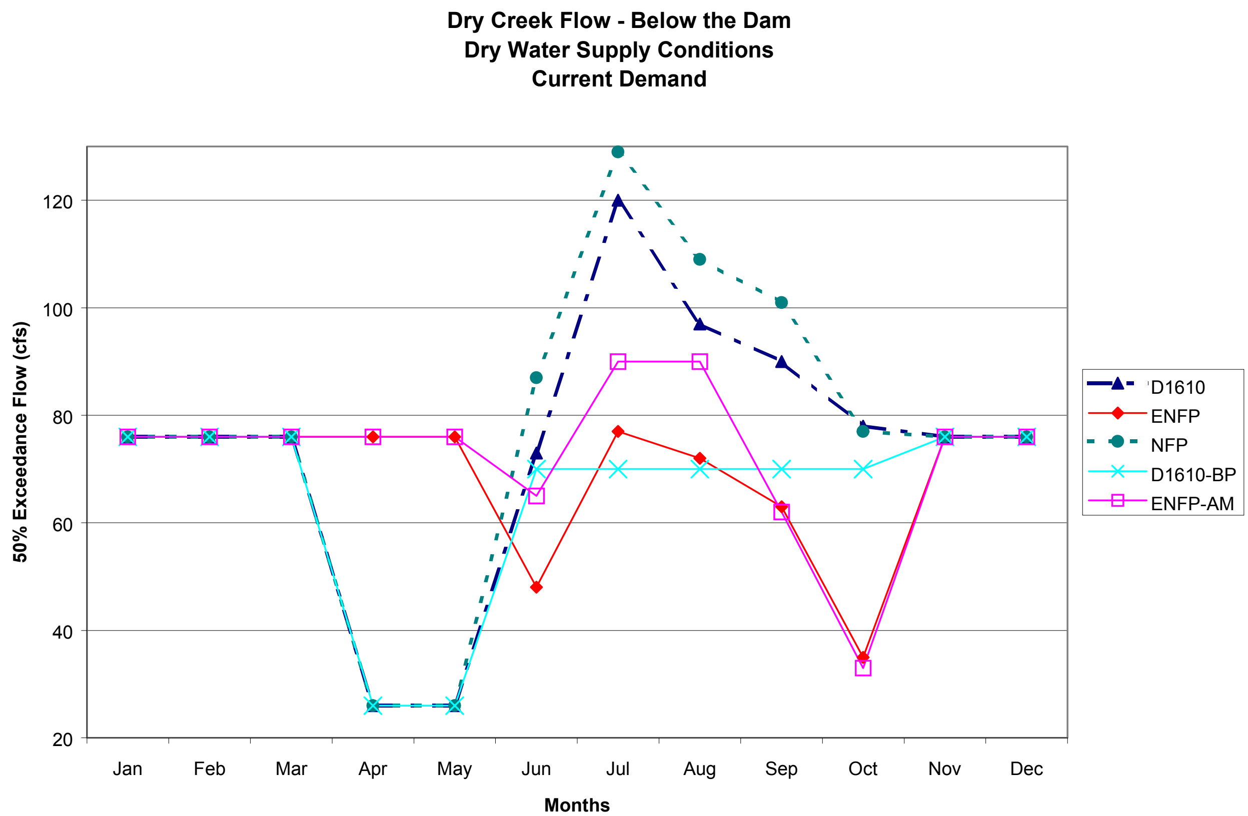


Figure A-9. Monthly Flows in Dry Creek below the Dam under All Water Supply Conditions.



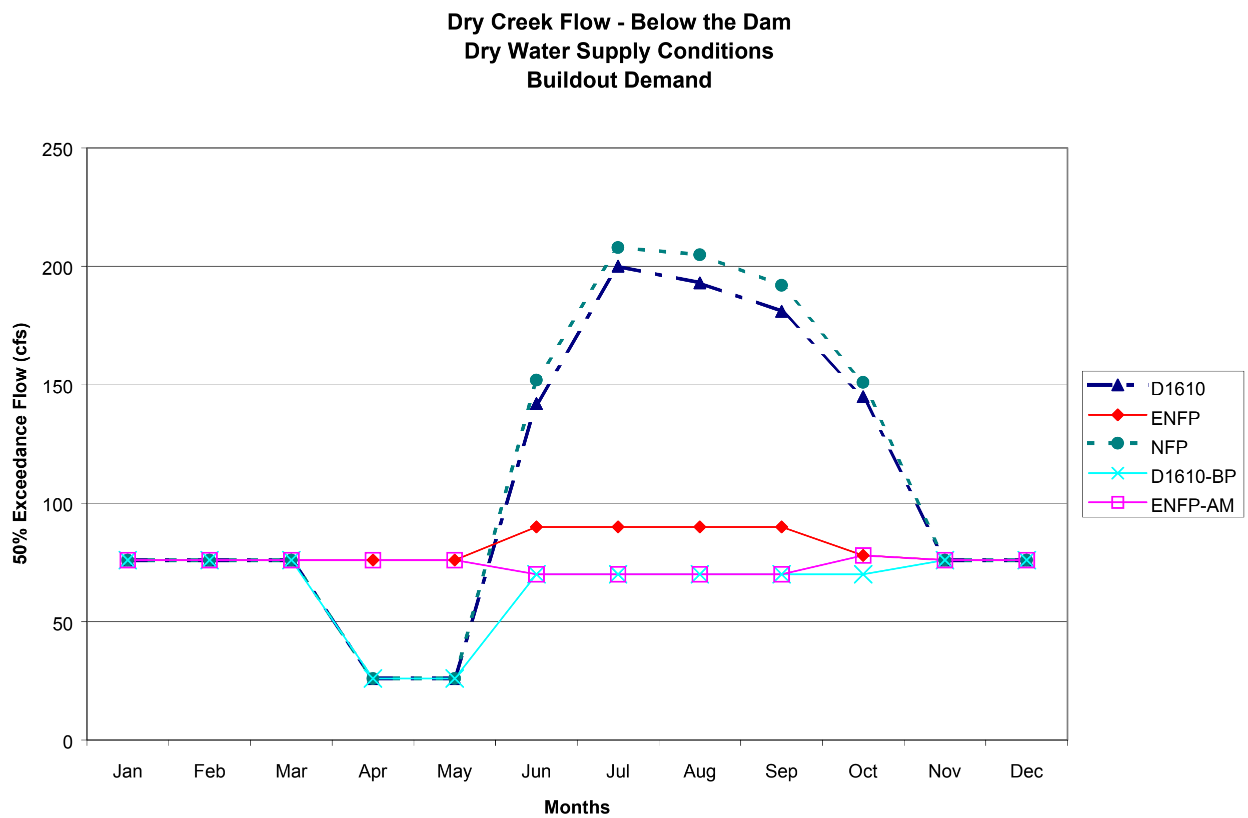
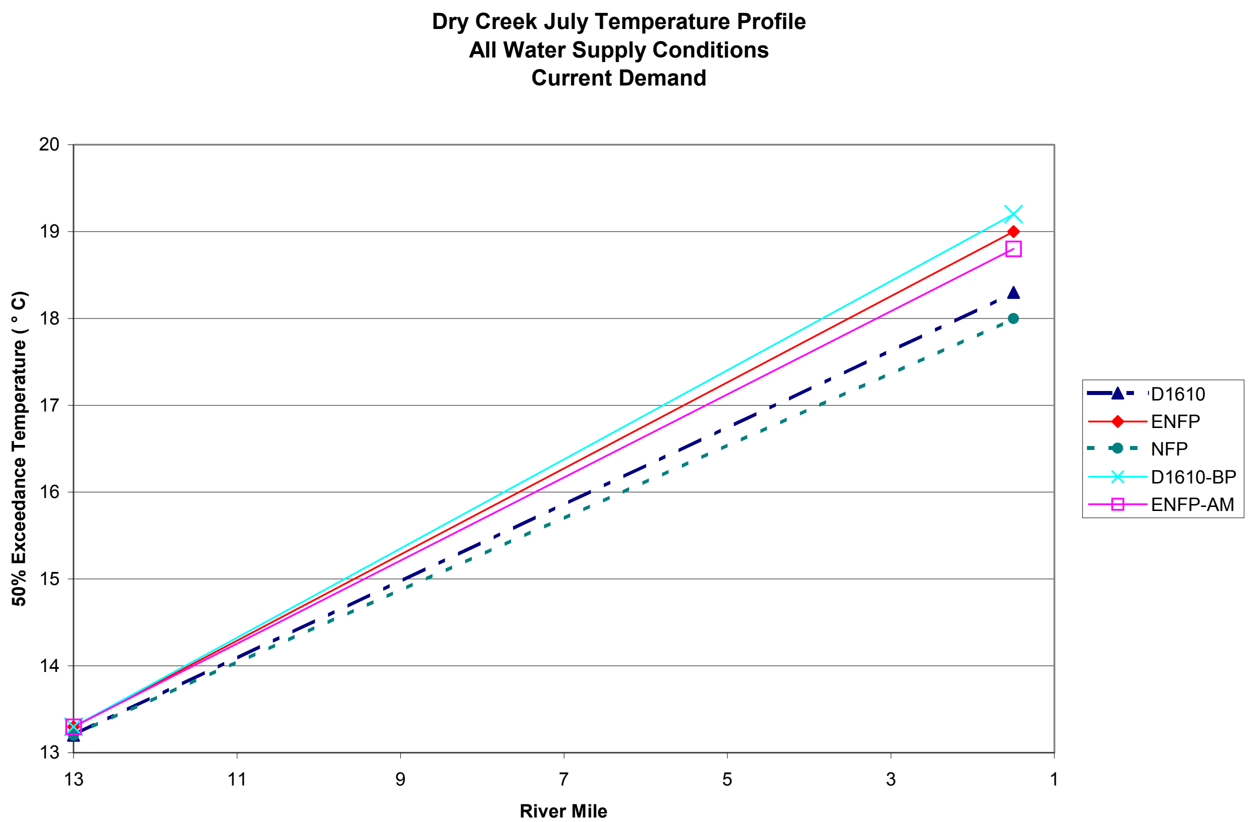


Figure A-10. Monthly Flows in Dry Creek below the Dam under Dry Water Supply Conditions.

Table A-1. Description of Water Quality Nodes for Temperature Plots.

	River Mile	Description
Dry Creek	13	below Warm Springs Dam
	1.5	near Mouth
Russian River	88.5	near Ukiah
	80.5	near Hopland
	68	near Cloverdale
	34	near Healdsburg (above Dry Creek)
	31	below Dry Creek
	20.9	at Hacienda Bridge



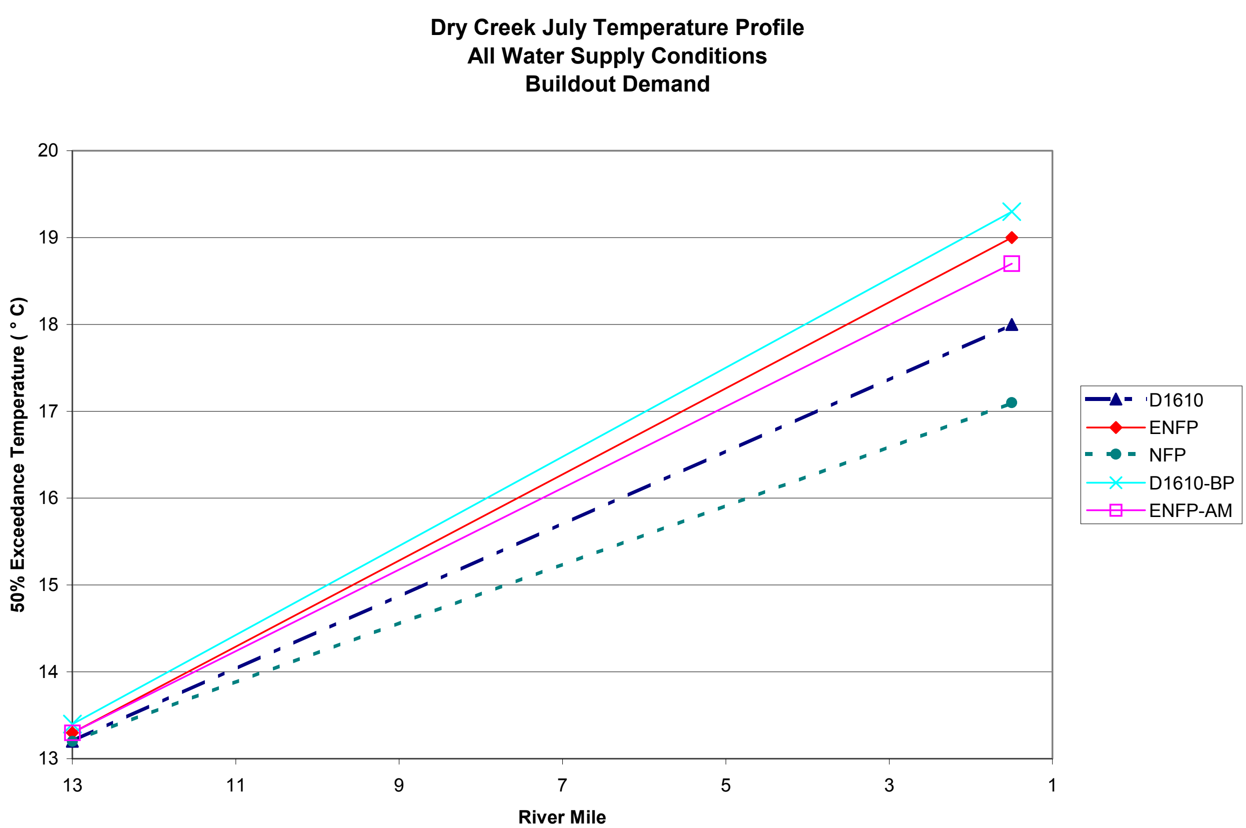
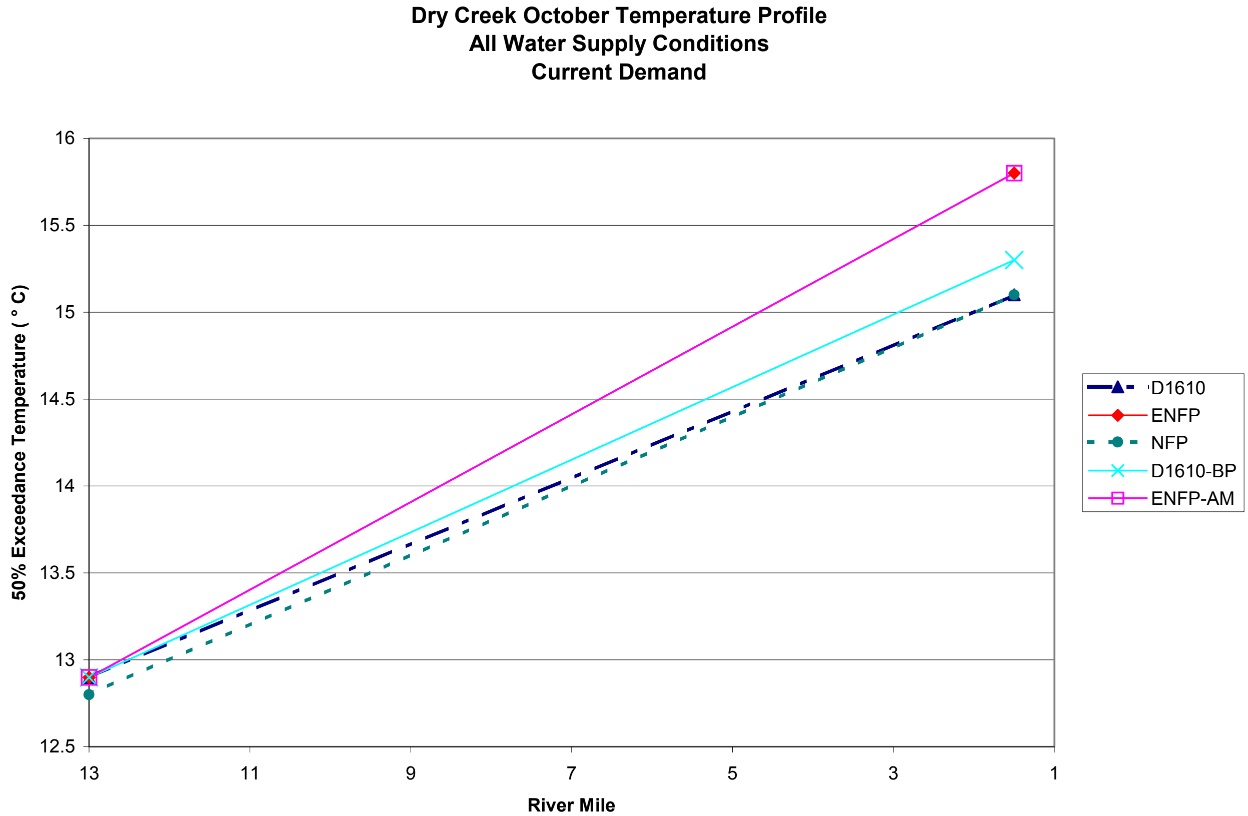


Figure A-11. Longitudinal Temperature Profile in Dry Creek in July under All Water Supply Conditions.



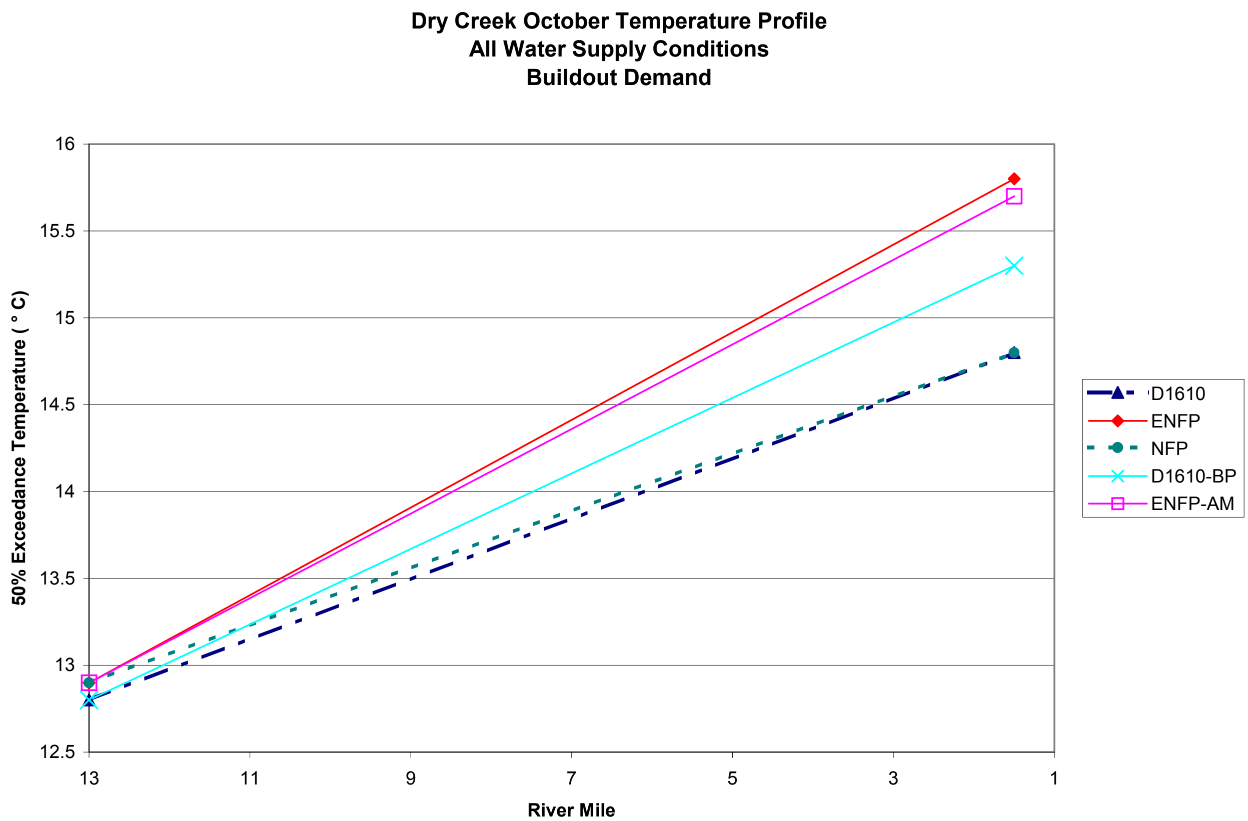
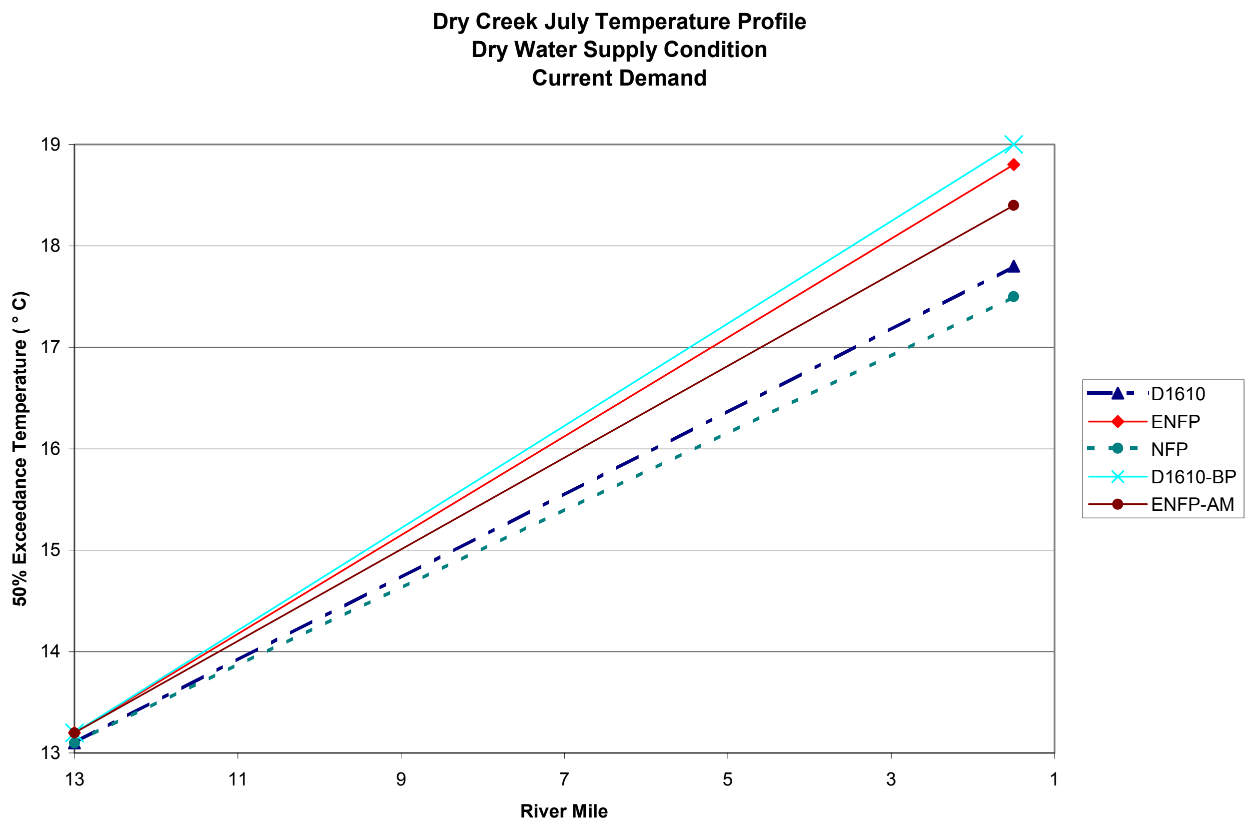


Figure A-12. Longitudinal Temperature Profile in Dry Creek in October under All Water Supply Conditions.



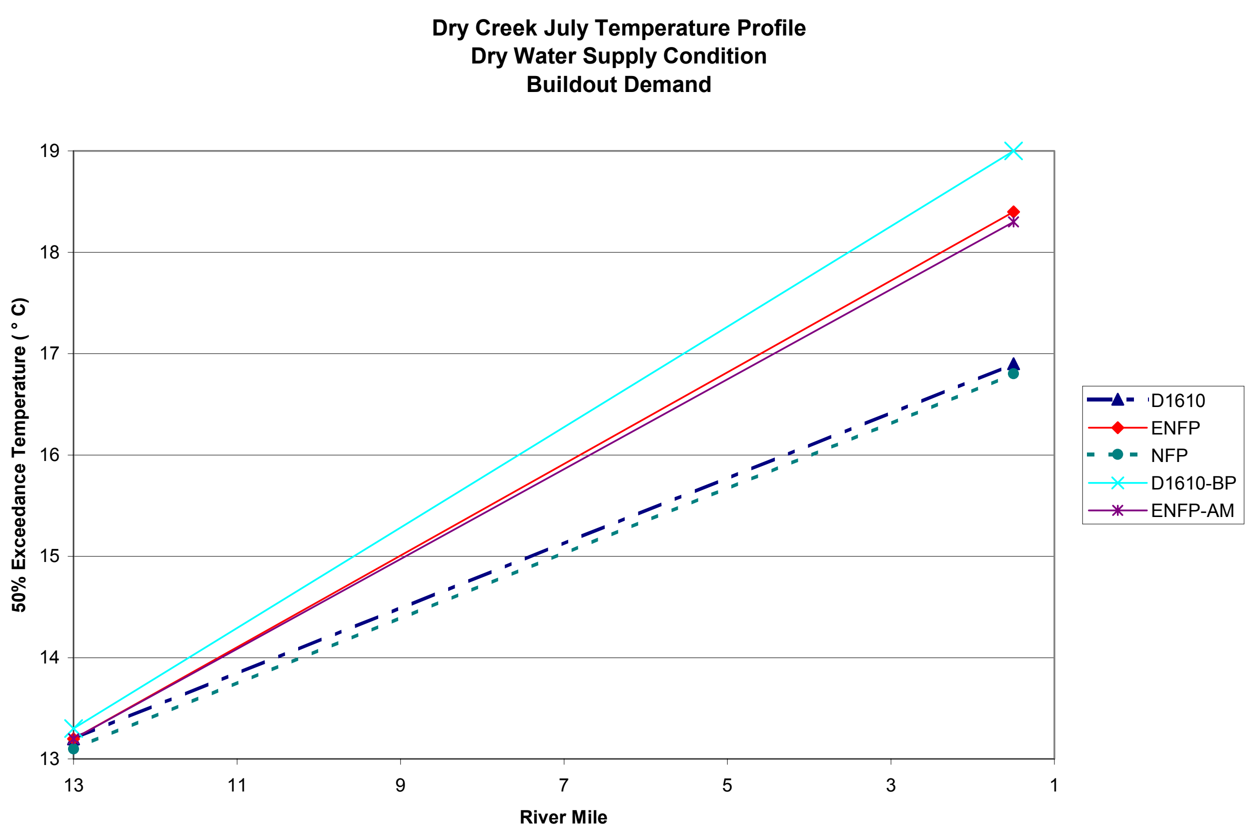
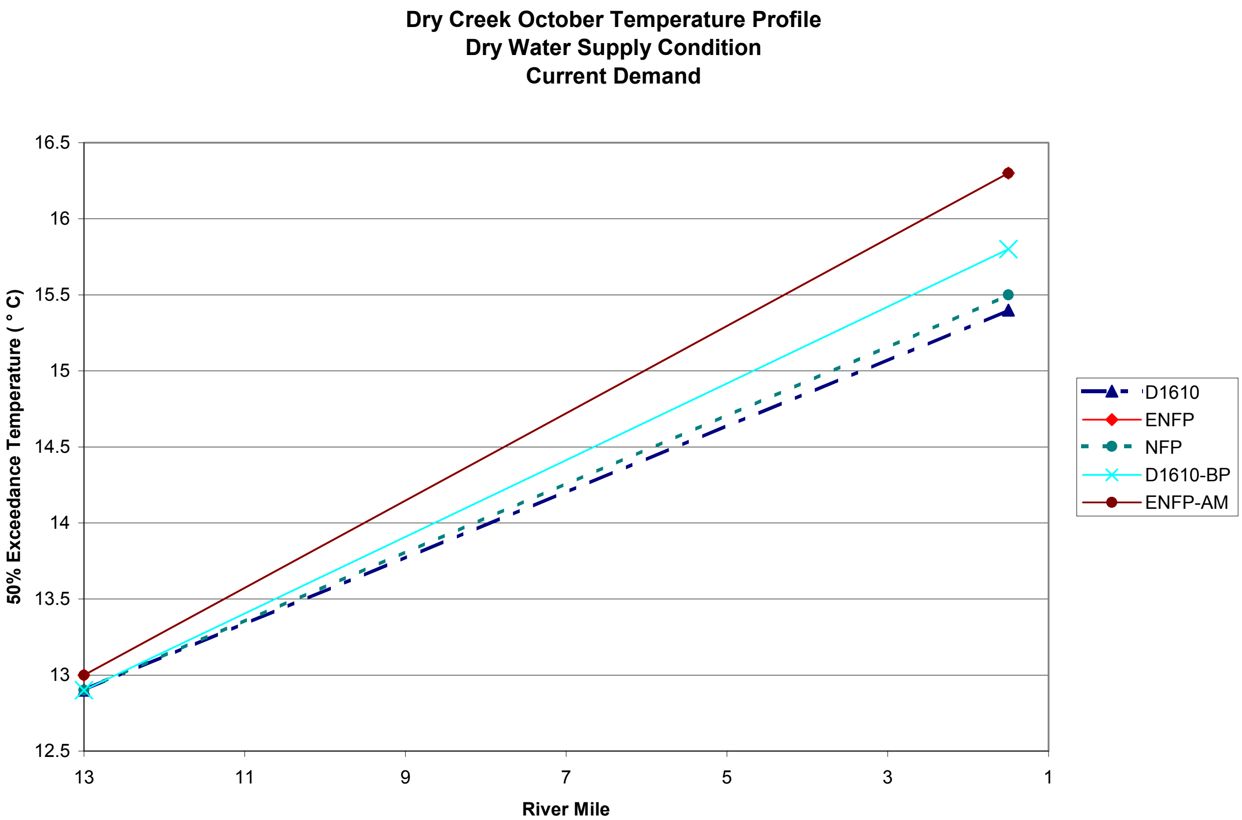


Figure A-13. Longitudinal Temperature Profile in Dry Creek in July under Dry Water Supply Conditions.



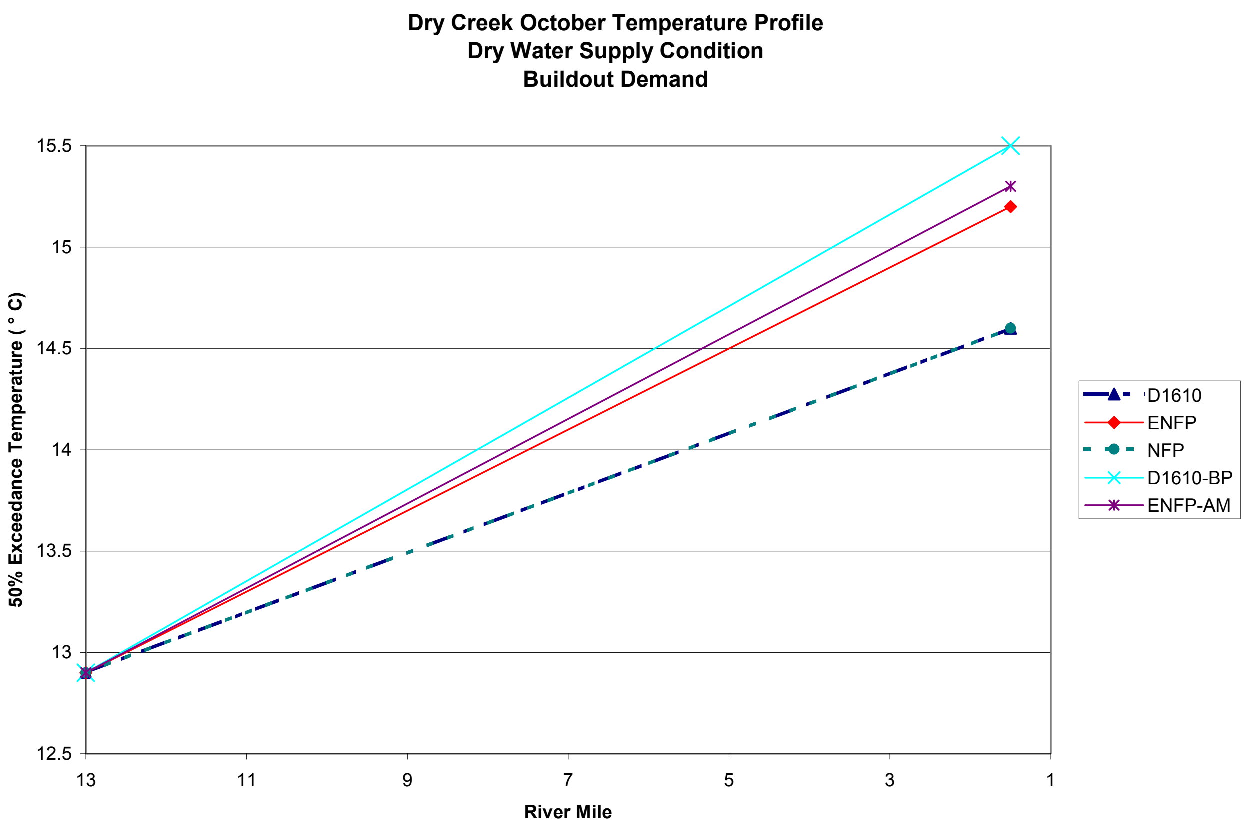
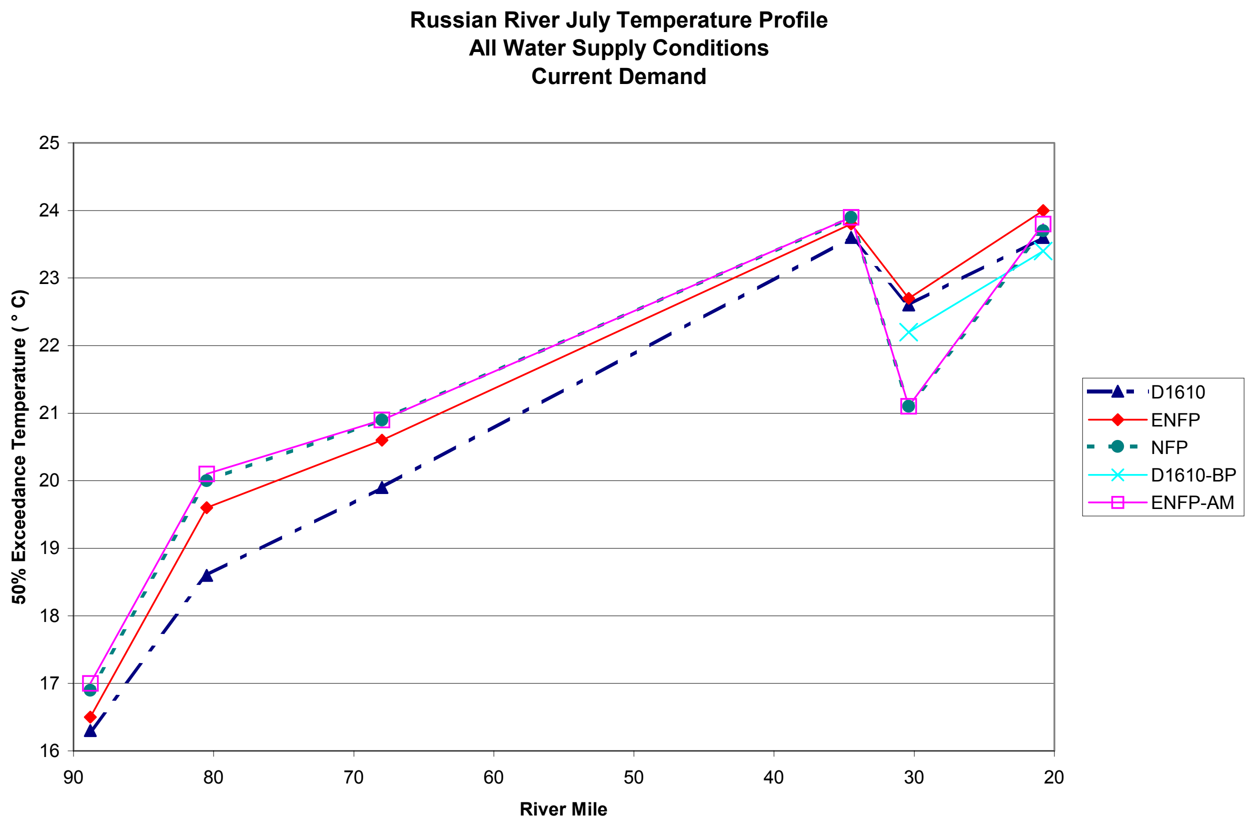


Figure A-14. **Longitudinal Temperature Profile in Dry Creek in October under Dry Water Supply Conditions.**



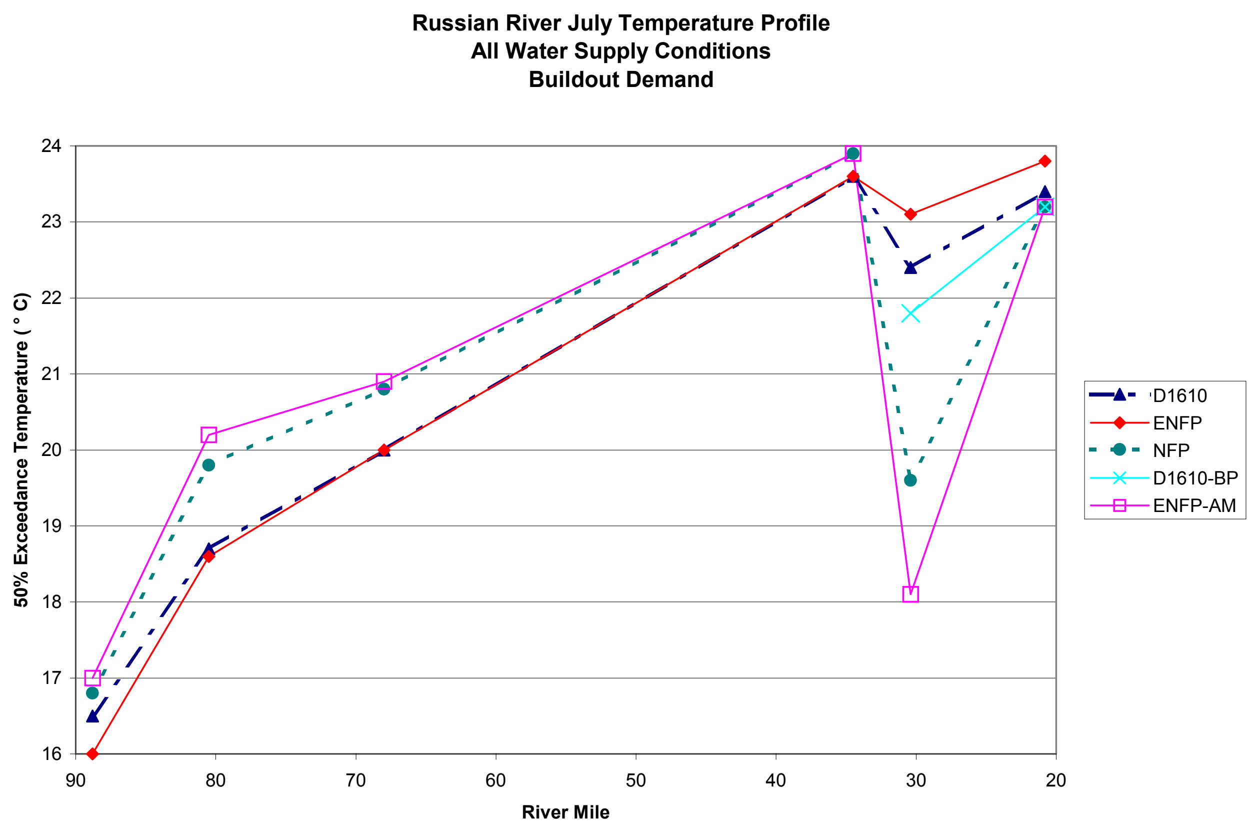
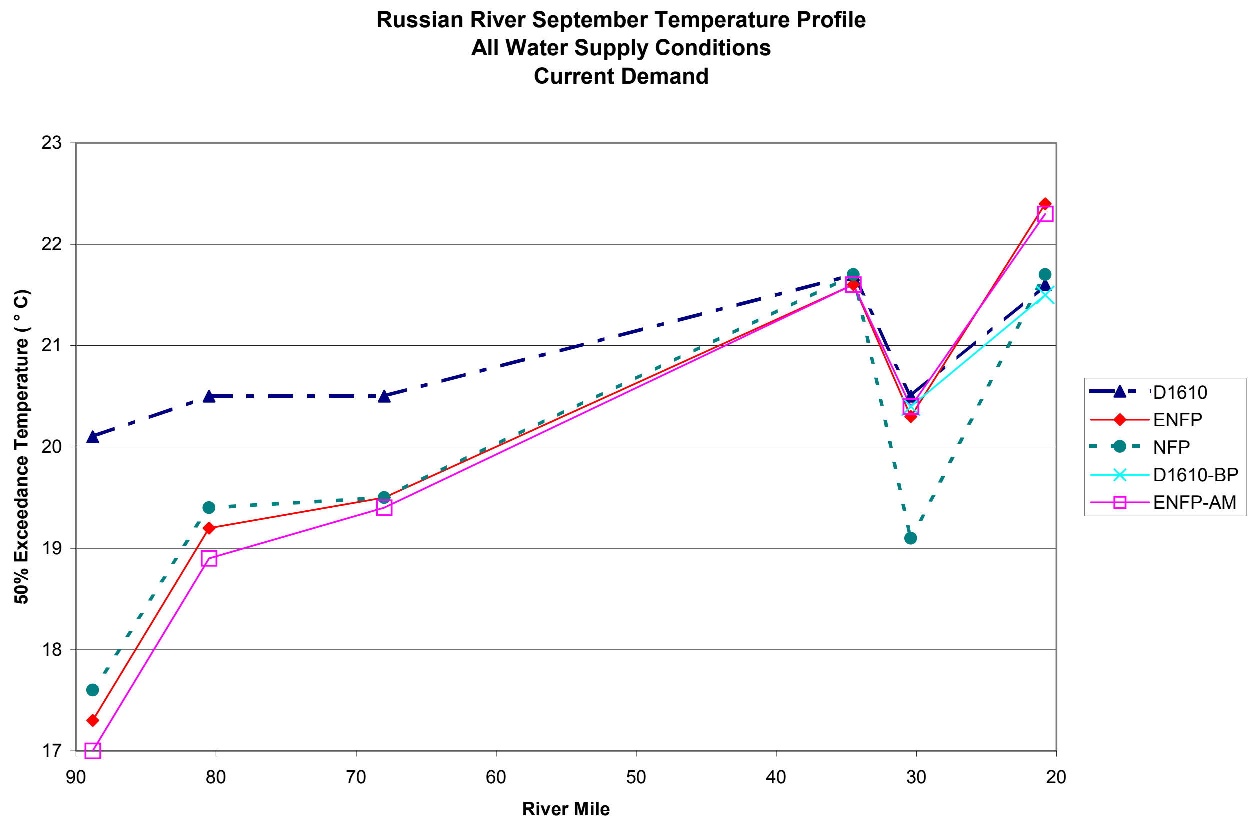


Figure A-15. Longitudinal Temperature Profile in the Russian River in July under All Water Supply Conditions.



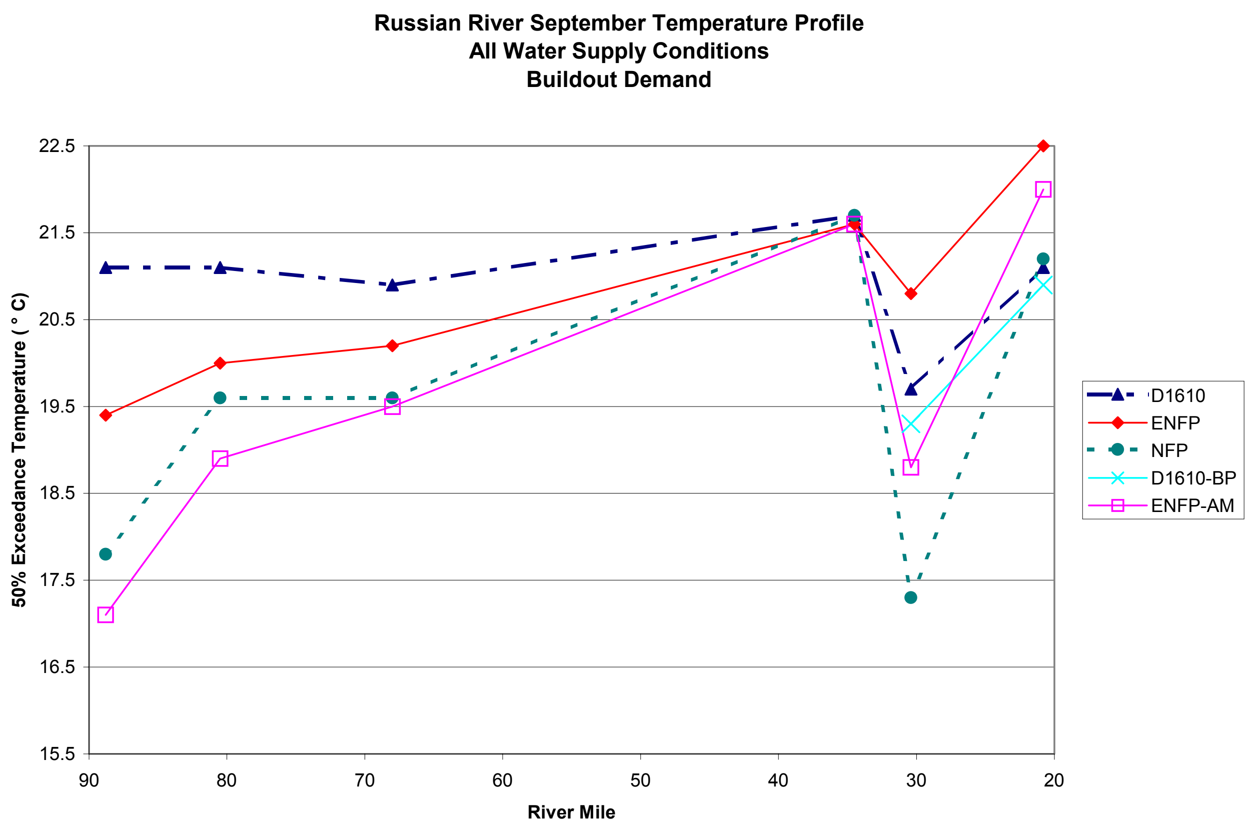
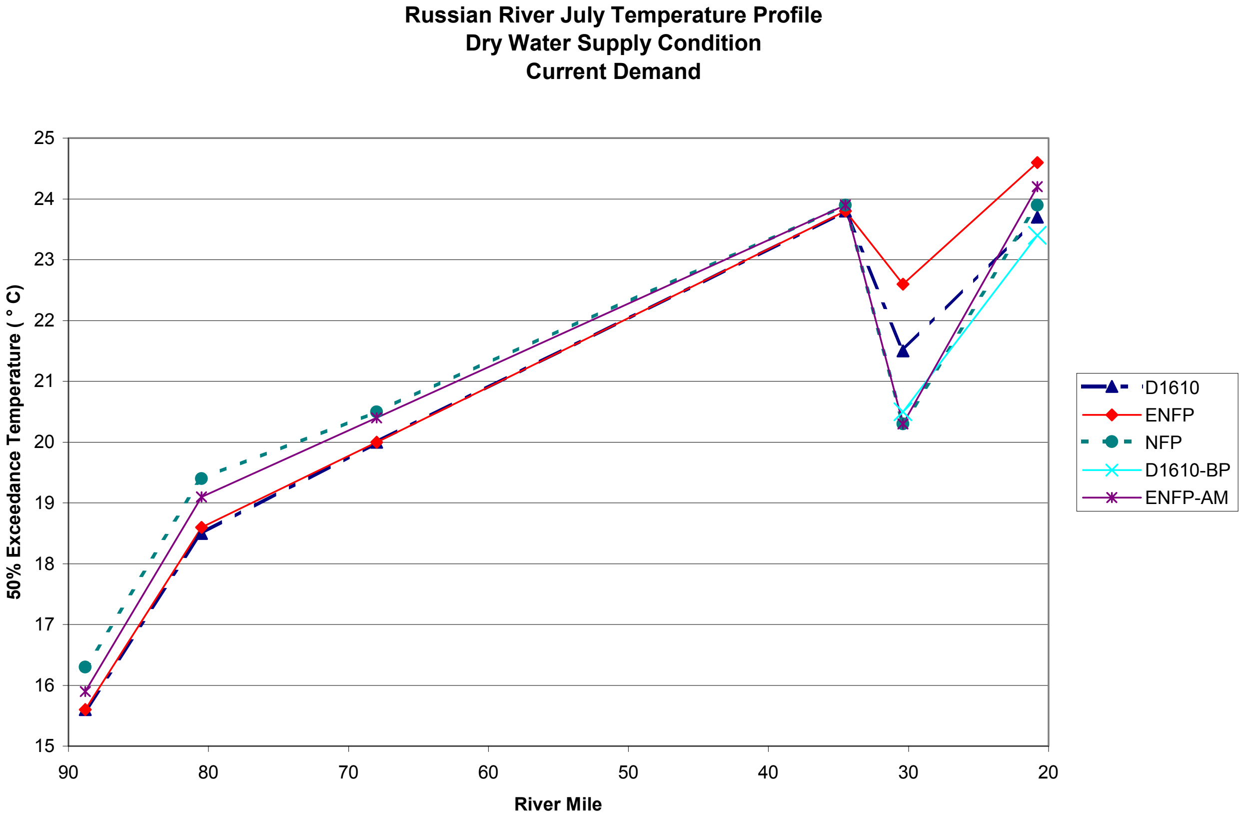


Figure A-16. Longitudinal Temperature Profile in the Russian River in September under All Water Supply Conditions.



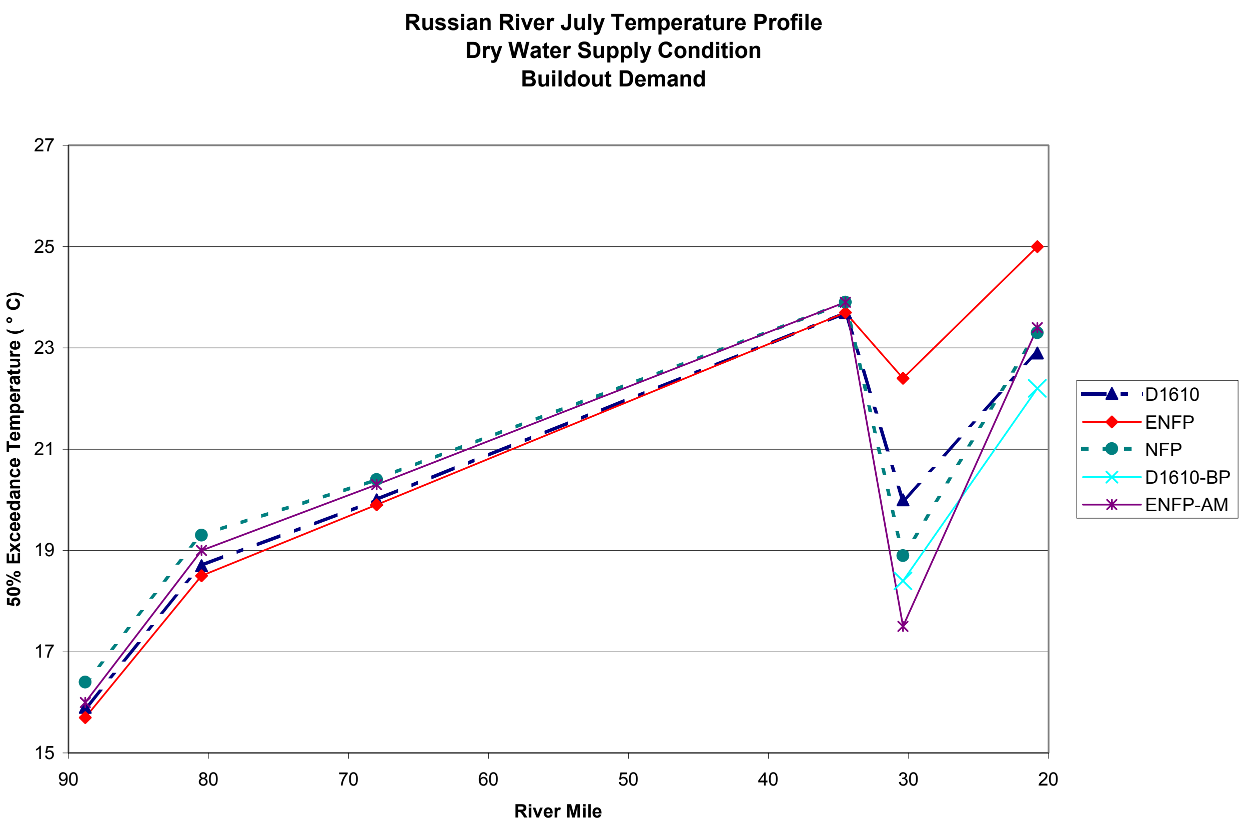
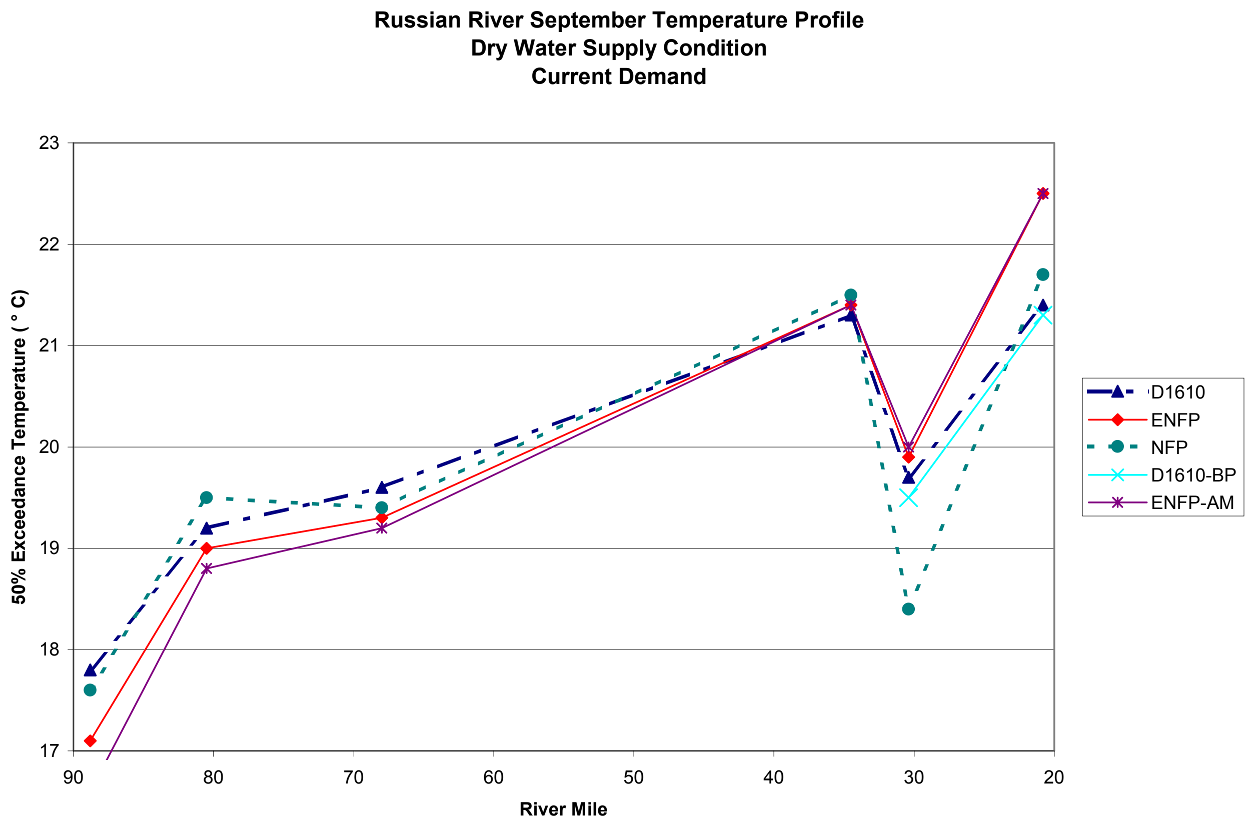


Figure A-17. Longitudinal Temperature Profile in the Russian River in July under Dry Water Supply Conditions.



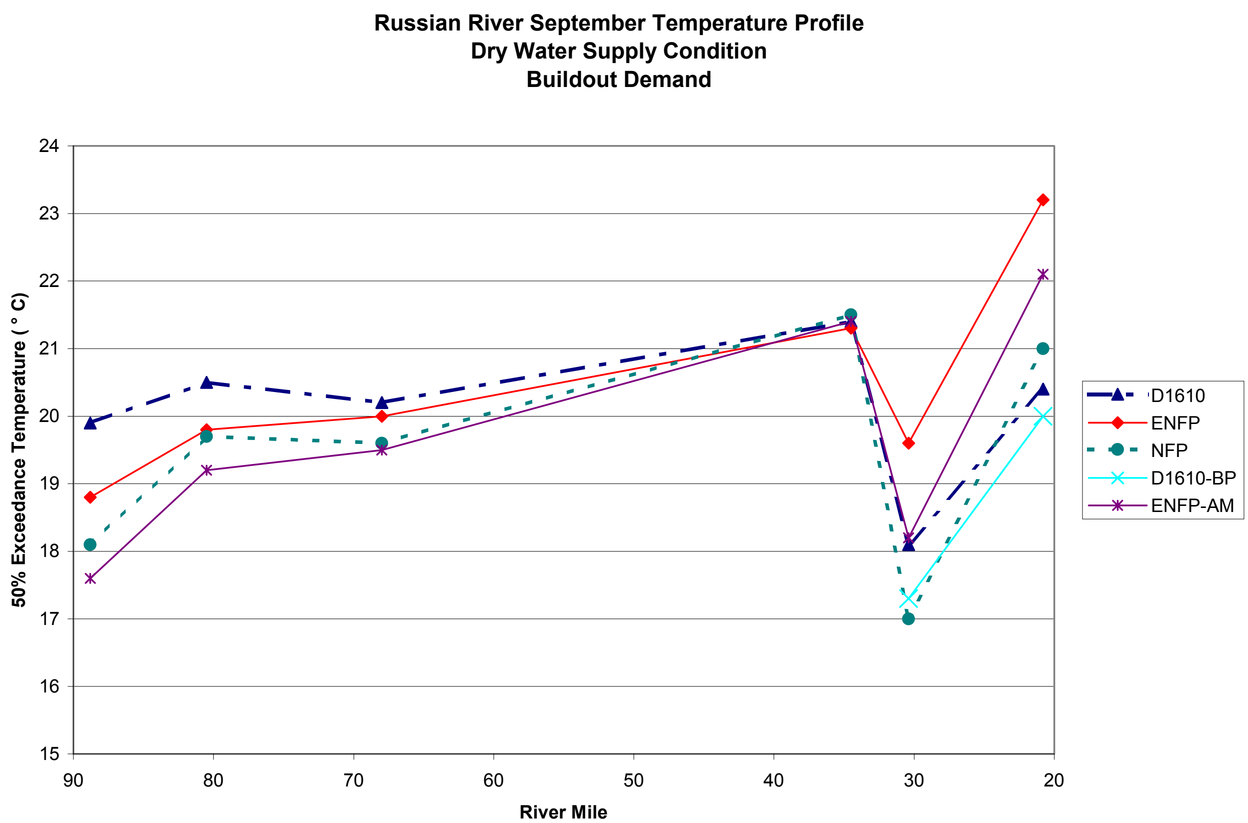


Figure A-18. Longitudinal Temperature Profile in the Russian River in September under Dry Water Supply Conditions.

APPENDIX B

EVALUATION CRITERIA FOR FLOW, TEMPERATURE, AND DISSOLVED OXYGEN

PHYSICAL HABITAT CRITERIA RELATED TO FLOW

Habitat may be affected by a number of factors. These include flow, water temperature, and water quality, among others. This section addresses flow-related physical habitats and criteria to evaluate those habitats.

HABITAT SUITABILITY INFORMATION

Criteria for flow-related habitat in Dry Creek and the Russian River are presented in Tables B-1 and B-2, respectively. The rearing criteria are based in part upon the Flow Assessment Study conducted by SCWA, NMFS and CDFG in 2001 (Russian River Flow Related Habitat Assessment Panel 2002). Outside of the range of flows addressed in that study, the criteria are based upon knowledge of the system, discussions with biologists familiar with the system, and professional judgement. The flow criteria for spawning in the Russian River are also based in part upon the results of this study. Flow criteria for upstream migration were not addressed in the Flow Assessment Study and these scoring criteria are based upon knowledge of the system, discussions with biologists familiar with the system, and professional judgement.

Table B-1. Flow Evaluation Criteria for Dry Creek by Species and Lifestage.

Coho Habitat Score	Nov 1 to Jan 31 Q (cfs) Upmigration	Dec 1 to Feb 15 Q (cfs) Spawning	Feb 1 to Apr 30 Q (cfs) Fry Rearing	All Year Q (cfs) Juvenile Rearing
0	≤ 10	≤ 5	≤ 0	≤ 0
1	>10 ≤ 20	> 5 ≤ 20	> 0 ≤ 10	> 0 ≤ 10
2	> 20 ≤ 30	> 20 ≤ 30	> 10 ≤ 20	> 10 ≤ 25
3	> 30 ≤ 90	> 30 ≤ 45	> 20 ≤ 30	> 25 ≤ 45
4	> 90 ≤ 125	> 45 ≤ 60	> 30 ≤ 40	> 45 ≤ 60
5	> 125 ≤ 200	> 60 ≤ 80	> 40 ≤ 70	> 60 ≤ 85
4	> 200 ≤ 250	> 80 ≤ 100	> 70 ≤ 90	> 85 ≤ 100
3	> 250 ≤ 325	> 100 ≤ 125	> 90 ≤ 130	> 100 ≤ 120
2	> 325 ≤ 400	> 125 ≤ 250	> 130 ≤ 200	> 120 ≤ 200
1	> 400 ≤ 500	> 250 ≤ 800	> 200 ≤ 500	> 200 ≤ 500
0	> 500	> 800	> 500	> 500
Chinook **Habitat Score**	**Aug 15 to Jan 15** **Q (cfs)** **Upmigration**	**Nov 1 to Jan 31** **Q (cfs)** **Spawning**	**Feb 1 to Apr 30** **Q (cfs)** **Fry Rearing**	**Apr 1 to Jun 30** **Q (cfs)** **Juvenile Rearing**
0	≤ 10	≤ 5	≤ 0	≤ 0
1		> 5 ≤ 25	> 0 ≤ 10	> 0 ≤ 10
2	> 10 ≤ 45	> 25 ≤ 40	> 10 ≤ 20	> 10 ≤ 25
3	> 45 ≤ 60	> 40 ≤ 60	> 20 ≤ 30	> 25 ≤ 45
4	> 60 ≤ 90	> 60 ≤ 80	> 30 ≤ 45	> 45 ≤ 60
5	> 90 ≤ 125	> 80 ≤ 105	> 45 ≤ 60	> 60 ≤ 90
4	> 125 ≤ 200	> 105 ≤ 130	> 60 ≤ 90	> 90 ≤ 100
3	> 200 ≤ 325	> 130 ≤ 150	> 90 ≤ 110	> 100 ≤ 110
2	> 325 ≤ 400	> 150 ≤ 290	> 110 ≤ 150	> 110 ≤ 200
1	> 400 ≤ 500	> 290 ≤ 3000	> 150 ≤ 500	> 200 ≤ 500
0	> 500	> 3000	> 500	> 500
Steelhead **Habitat Score**	**Jan 1 to Mar 31** **Q (cfs)** **Upmigration**	**Jan 1 to Apr 30** **Q (cfs)** **Spawning**	**Mar 1 to Jun 30** **Q (cfs)** **Fry Rearing**	**All Year** **Q (cfs)** **Juvenile Rearing**
0	≤ 10	≤ 5	≤ 0	≤ 0
1	>10 ≤ 20	> 5 ≤ 20	> 0 ≤ 5	> 0 ≤ 5
2	> 20 ≤ 30	> 20 ≤ 30	> 5 ≤ 15	> 5 ≤ 15
3	> 30 ≤ 90	> 30 ≤ 60	> 14 ≤ 30	> 14 ≤ 30
4	> 90 ≤ 125	> 60 ≤ 80	> 30 ≤ 40	> 30 ≤ 40
5	> 125 ≤ 200	> 80 ≤ 110	> 40 ≤ 55	> 40 ≤ 55
4	> 200 ≤ 250	>110 ≤ 135	> 55 ≤ 70	> 55 ≤ 70
3	> 250 ≤ 325	> 135 ≤ 150	> 70 ≤ 90	> 70 ≤ 90
2	> 325 ≤ 400	> 150 ≤ 250	> 90 ≤ 110	> 90 ≤ 110
1	> 400 ≤ 500	> 250 ≤ 1300	> 110 ≤ 500	> 110 ≤ 500
0	> 500	> 1300	> 500	> 500

Table B-2. Flow Evaluation Criteria for the Russian River by Species and Lifestage.

Coho Habitat Score	Nov 1 to Jan 31 Q (cfs) Upmigration			
0	≤ 50			
1	> 50 ≤ 75			
2	> 75 ≤ 100			
3	>100 ≤ 125			
4	> 125 ≤180			
5	> 180 ≤ 400			
4	> 400 ≤ 800			
3	> 800 ≤ 2000			
2	> 2000 ≤ 4000			
1	> 4000			
0				
Chinook **Habitat Score**	**Aug 15 to Jan 15** **Q (cfs)** **Upmigration**	**Nov 1 to Jan 31** **Q (cfs)** **Spawning**	**Feb 1 to Apr 30** **Q (cfs)** **Fry Rearing**	**Apr 1 to Jun 30** **Q (cfs)** **Juvenile Rearing**
0	≤ 50	≤ 25	≤ 0	≤ 0
1	> 50 ≤ 75	> 25 ≤ 100	> 0 ≤ 20	> 0 ≤ 20
2	> 75 ≤ 100	> 100 ≤ 130	> 20 ≤ 40	> 20 ≤ 50
3	>100 ≤ 125	> 130 ≤ 150	> 40 ≤ 80	> 50 ≤ 100
4	> 125 ≤180	> 150 ≤ 190	> 80 ≤ 115	> 100 ≤115
5	> 180 ≤ 400	> 190 ≤ 210	> 115 ≤ 135	> 115 ≤ 145
4	> 400 ≤ 800	> 210 ≤ 300	> 135 ≤ 175	> 145 ≤ 190
3	> 800 ≤ 2000	> 300 ≤ 400	> 175 ≤ 250	> 190 ≤ 275
2	> 2000 ≤ 4000	> 400 ≤ 700	> 250 ≤ 500	> 275 ≤ 1000
1	> 4000	> 700 ≤ 2500	> 500 ≤ 1500	> 1000 ≤ 2500
0		> 2500	> 1500	> 2500
Steelhead **Habitat Score**	**Jan 1 to Mar 31** **Q (cfs)** **Upmigration**	**Jan 1 to Apr 30** **Q (cfs)** **Spawning**	**Mar 1 to Jun 30** **Q (cfs)** **Fry Rearing**	**All Year** **Q (cfs)** **Juvenile Rearing**
0	≤ 50	≤ 25	≤ 0	≤ 0
1	> 50 ≤ 75	> 25 ≤ 70	> 0 ≤ 20	> 0 ≤ 20
2	> 75 ≤ 100	> 70 ≤ 100	> 20 ≤ 40	> 20 ≤ 50
3	>100 ≤ 125	> 100 ≤ 130	> 40 ≤ 80	> 50 ≤ 80
4	> 125 ≤180	> 130 ≤ 180	> 80 ≤ 100	> 80 ≤ 115
5	> 180 ≤ 400	> 180 ≤ 200	> 100 ≤ 125	> 115 ≤ 145
4	> 400 ≤ 800	> 200 ≤ 250	> 125 ≤ 150	> 145 ≤ 190
3	> 800 ≤ 2000	> 250 ≤ 350	> 150 ≤ 200	> 190 ≤ 275
2	> 2000 ≤ 4000	> 350 ≤ 700	> 200 ≤ 500	> 275 ≤ 1000
1	> 4000	> 700 ≤ 2500	> 500 ≤ 1500	> 1000 ≤ 2500
0		> 2500	> 1500	> 2500

Criteria based on: Anonymous 1971; Bell 1986; Bjornn and Reiser 1991; Boles *et al*. 1988; Brett 1952, Brett *et al*. 1982; CDFG 1991; California Resources Agency 1989; Cramer 1992; Fryer and Pilcher 1974; Hallock *et al.* 1970; Hanel 1971; McMahon 1983; Raleigh *et al.* 1984; Rich 1987; Seymour 1956; and USEPA 1974.

WATER QUALITY CRITERIA

A scoring system was developed for water-quality parameters, including temperature and dissolved oxygen.

TEMPERATURE

Scoring criteria for temperature by species and life history stage are summarized in Table B-3.

Table B-3. Evaluation Criteria for Temperature (°C) by Species and Life-History Stage.

Coho				
Score	**Nov 1 to Jan 31 Up Migration**	**Dec 1 to Feb 15 Spawning**	**Dec 1 to Mar 31 Incubation**	**All Year Rearing**
0	≤ 3.0	≤ 1.7	≤ 0.0	≤ 1.7
1	> 3.0 ≤ 4.0	> 1.7 ≤ 3.0	> 0.0 ≤ 3.0	> 1.7 ≤ 4.0
2	> 4.0 ≤ 5.0	> 3.0 ≤ 4.0	> 3.0 ≤ 3.5	> 4.0 ≤ 7.0
3	> 5.0 ≤ 6.0	> 4.0 ≤ 6.0	> 3.5 ≤ 4.0	> 7.0 ≤ 8.0
4	> 6.0 < 7.2	> 6.0 < 7.0	> 4.0 < 4.4	> 8.0 < 12.0
5	≥ 7.2 ≤ 12.7	≥ 7.0 ≤ 13.0	≥ 4.4 ≤ 13.3	≥ 12.0 ≤ 14.0
4	> 12.7 ≤ 14.0	> 13.0 ≤ 14.0	> 13.3 ≤ 14.0	> 14.0 ≤ 15.0
3	> 14.0 ≤ 15.0	> 14.0 ≤ 15.0	> 14.0 ≤ 15.0	> 15.0 ≤ 16.0
2	> 15.0 ≤ 16.0	> 15.0 ≤ 16.0	> 15.0 ≤ 16.0	> 16.0 ≤ 20.0
1	> 16.0 < 21.1	> 16.0 < 17.0	> 16.0 < 18.0	> 20.0 < 26.0
0	≥ 21.1	≥ 17.0	≥ 18.0	≥ 26.0

Steelhead				
Score	**Jan 1 to Mar 31 Up Migration**	**Jan 1 to Apr 30 Spawning**	**Jan 1 to May 31 Incubation**	**All Year Rearing**
0	≤ 4.0	≤ 4.0	≤ 1.5	≤ 0.0
1	> 4.0 ≤ 5.0	> 4.0 ≤ 5.0	> 1.5 ≤ 3.0	> 0.0 ≤ 2.0
2	> 5.0 ≤ 6.0	> 5.0 ≤ 6.0	> 3.0 ≤ 4.5	> 2.0 ≤ 4.0
3	> 6.0 ≤ 7.0	> 6.0 ≤ 7.0	> 4.5 ≤ 6.0	> 4.0 ≤ 8.0
4	> 7.0 < 7.8	> 7.0 < 7.8	> 6.0 < 7.8	> 8.0 < 12.8
5	≥ 7.8 ≤ 11.0	≥ 7.8 ≤ 11.1	≥ 7.8 ≤ 11.1	≥ 12.8 ≤ 15.6
4	> 11.0 ≤ 13.0	> 11.1 ≤ 14.0	> 11.1 ≤ 13.0	> 15.6 ≤ 18.0
3	> 13.0 ≤ 15.0	> 14.0 ≤ 16.0	> 13.0 ≤ 15.0	> 18.0 ≤ 20.0
2	> 15.0 ≤ 17.0	> 16.0 ≤ 18.0	> 15.0 ≤ 17.0	> 20.0 ≤ 22.0
1	> 17.0 < 21.1	> 18.0 < 20.0	> 17.0 < 20.0	> 22.0 < 23.9
0	≥ 21.1	≥ 20.0	≥ 20.0	≥ 23.9

Table B-3. Evaluation Criteria for Temperature (ºC) by Species and Life-History Stage (continued).

Chinook Score	Aug 15 to Jan 15 Up Migration	Nov 1 to Jan 31 Spawning	Nov 1 to Mar 31 Incubation	Feb 1 to Jun 30 Rearing
0	≤ 0.8	≤ 1.0	≤ 1.0	≤ 1.0
1	> 0.8 ≤ 3.0	> 1.0 ≤ 2.5	> 1.0 ≤ 2.0	> 1.0 ≤ 4.0
2	> 3.0 ≤ 5.2	> 2.5 ≤ 3.5	> 2.0 ≤ 3.0	> 4.0 ≤ 6.0
3	> 5.2 ≤ 7.9	> 3.5 ≤ 4.5	> 3.0 ≤ 4.0	> 6.0 ≤ 8.0
4	> 7.9 < 10.6	> 4.5 < 5.6	> 4.0 < 5.0	> 8.0 < 12.0
5	≥ 10.6 ≤ 15.6	≥ 5.6 ≤ 13.9	≥ 5.0 ≤ 12.8	≥ 12.0 ≤ 14.0
4	> 15.6 ≤ 17.0	> 13.9 ≤ 14.5	> 12.8 ≤ 14.2	> 14.0 ≤ 17.0
3	> 17.0 ≤ 18.4	> 14.5 ≤ 15.2	> 14.2 ≤ 15.0	> 17.0 ≤ 20.0
2	> 18.4 ≤ 19.8	> 15.2 ≤ 16.0	> 15.0 ≤ 15.8	> 20.0 ≤ 23.0
1	> 19.8 < 21.1	> 16.0 < 16.7	> 15.8 < 16.7	> 23.0 < 26.0
0	≥ 21.1	≥ 16.7	≥ 16.7	≥ 26.0

DISSOLVED OXYGEN

Criteria for dissolved oxygen are presented in Table B-4.

TableB-4. Dissolved Oxygen Evaluation Criteria by Species and Life-History Stage.

Coho Habitat Score	Nov 1 to Jan 31 DO (mg/l) Up migration	Dec 1 to Mar 31 DO (mg/l) Spawning/ incubation	All Year DO (mg/l) Rearing	Feb 1 to May 15 DO (mg/l) Down migration
5	6.5	11	8.0	8.0
4	6.0	9.5	6.5	6.0
3	5.5	8	6.0	5.5
2	5.2	7.5	5.2	5.2
1	4.8	4.5	4.5	4.6
0	< 4.8	< 4.5	3.0	3.0

Table B-4. Dissolved Oxygen Evaluation Criteria by Species and Life-History Stage (continued).

Steelhead

Habitat Score	Jan 1 to Mar 31 DO (mg/l) Up migration	Jan 1 to May 31 DO (mg/l) Spawning/ incubation	All Year DO (mg/l) Rearing	Mar 1 to Jun 30 DO (mg/l) Down migration (Juveniles)
5	6.5	9	8.0	8.0
4	6.0	7.3	6.5	6.0
3	5.5	6.5	6.0	5.5
2	5.2	5.9	5.2	5.2
1	4.8	5.4	4.5	4.6
0	< 4.8	< 5.0	3.0	3.0

Chinook

Habitat Score	Aug 15 to Jan 15 DO (mg/l) Up migration	Nov 1 to Mar 31 DO (mg/l) Spawning/ incubation	Feb 1 to Jun 30 DO (mg/l) Rearing	Feb 1 to Jun 30 DO (mg/l) Down migration
5	6.5	11	8.0	8.0
4	6.0	9.5	6.5	6.0
3	5.5	8	6.0	5.5
2	5.2	7.5	5.2	5.2
1	4.8	4.5	4.5	4.6
0	< 4.8	< 4.5	3.0	3.0