TECHNICAL MEMORANDUM 3-4

Fish Passage

Yuba-Bear Hydroelectric Project
FERC Project No. 2266-096

Drum-Spaulding Project
FERC Project No. 2310-173

April 2010

TECHNICAL MEMORANDUM 3-4

Executive Summary

In 2008 and 2009, Nevada Irrigation District (NID) and Pacific Gas and Electric Company (PG&E), collectively referred to as "Licensees," identified and qualitatively assessed potential upstream adult rainbow trout passage barriers at 29 locations within a geographic area that is potentially affected by the Yuba-Bear Hydroelectric Project and Drum-Spaulding Project. This study was conducted according to Study 2.3.4, Fish Passage, and FERC's Study Determination.[1]

For the purposes of this study, a potential upstream fish barrier was a single vertical rise of 3 feet in height or greater, or a thalweg depth of less than 0.3 foot for an extended distance (i.e., sheet flow for about 3 feet). The areas surveyed consisted of a distance of about 0.5 mile upstream on 15 tributaries to the Middle Yuba, South Yuba, and Bear rivers; within the normal maximum water surface elevation of the reservoir on, 7 tributaries to Yuba-Bear Hydroelectric Project reservoirs (Jackson Meadows Reservoir, Milton Diversion Dam Impoundment, Bowman Lake, and Rollins Reservoir), 3 tributaries to Drum-Spaulding Project reservoirs (Fordyce Lake and Lake Spaulding); and 4 other stream reaches potentially affected by the Drum-Spaulding Project (Bear River above Drum Afterbay, a 1.2 mile section of Auburn Ravine, and 2 reaches on Dry Creek below Halsey Afterbay).

Potential barriers were found on all seven of the tributaries to the Middle Yuba River that were assessed. These were East Fork Creek, Bear Creek, Wolf Creek, Moores Flat Creek, Bloody Run Creek, Kanaka Creek, and Indian Creek. On tributaries to the South Yuba River, potential barriers were found on five of seven tributaries assessed (Canyon Creek, Jefferson Creek, Fish Creek, Missouri Canyon Creek, and Spring Creek). The two tributaries to the South Yuba River where potential barriers were not observed were Washington and Poorman creeks. No potential fish barriers were found on Steephollow Creek, a tributary to the Bear River below the Chicago Park Powerhouse.

In the mainstem reaches, potential fish passage barriers were found in the Bear River upstream of Drum Afterbay and in the portion of Upper Auburn Ravine that was surveyed. No potential fish barriers on Dry Creek were found except for one beaver dam.

No fish passage barriers were found within the normal maximum water surface elevations of the seven tributaries to the four Yuba-Bear Hydroelectric Project reservoirs surveyed. Potential barriers were identified within the normal maximum water surface elevations in two of three

[1] Consistent with the FERC- approved Fish Passage Study Plan (2.3.4), Licensees will consult with Relicensing Participants regarding existing project facilities that may affect adult resident rainbow trout passage (see Section 5.2 of this Technical Memorandum). This Technical Memorandum focuses therefore on other natural or man-made barriers in the study area. In addition, pursuant to the Fish Passage Study Plan, this Technical Memorandum does not evaluate whether resident rainbow trout would likely move beyond a potential barrier if such barrier did not otherwise exist. Instead, the purpose of this study was to simply document the potential barriers, irrespective of whether such barriers may in fact have any impact on resident rainbow trout.

tributaries at the two Drum-Spaulding Project reservoirs surveyed (South Yuba River, tributary to Lake Spaulding, and North Creek, tributary to Fordyce Lake).

One variance to the FERC-approved study occurred. Surveys conducted on Yuba-Bear Hydroelectric Project reservoirs took place during fall 2008 rather than during the spring of 2009. NID believes this variance improved the study because surveying in the fall when reservoirs were at low-pool water elevations allowed for a larger area to be surveyed and provided information earlier than otherwise would be available.

Table of Contents

List of Tables

List of Figures

List of Attachments

TECHNICAL MEMORANDUM 3-4

Fish Passage[1]

1.0 Goals and Objectives

The goal of the Fish Passage Study was to determine the location of potential barriers to adult rainbow trout passage in selected streams potentially affected by Nevada Irrigation District's (NID) Yuba-Bear Hydroelectric Project and Pacific Gas and Electric Company's (PG&E) Drum-Spaulding Project, and in selected project reservoirs.[2] In particular, the study focused on passage of fish into major tributaries from the mainstem of project-affected streams and project reservoirs, and at project dams.[3]

2.0 Methods

The Fish Passage Study was conducted in five steps. Steps 1 through 3 involved identification and qualitative assessment of potential upstream adult rainbow trout passage barriers in: tributaries to the Middle Yuba, South Yuba, and Bear rivers (Step 1); tributaries to project reservoirs (Step 2); and in the mainstem Bear River and in some western Placer County streams (Step 3). Steps 4 and 5 involved consultation with Relicensing Participants regarding project dams that may affect adult resident rainbow trout passage (Step 4), and consultation with Relicensing Participants regarding the results of Steps 1 through 4 to collaboratively determine if any identified potential barriers warranted additional quantitative examination (Step 5).

For the purpose of the study, a potential upstream fish barrier was a single vertical rise of 3 feet in height or greater or a thalweg depth of less than 0.3 foot for an extended distance (i.e. sheet flow for about 3 feet).

[1] This technical memorandum presents the results for Study 2.3.4, Fish Passage, included in Licensees' Revised Study Plans filed with FERC on January 23, 2009, and approved by FERC in its Study Determination on February 23, 2009. The study has not been modified. This study applies to NID's Yuba-Bear Hydroelectric Project and PG&E's Drum-Spaulding Project. The study does not apply to PG&E's Rollins Transmission Line Project, which does not include reservoirs, diversions or releases to streams.

[2] Within this technical memorandum, NID and PG&E are referred to individually as "Licensee" and collectively as "Licensees," and the Yuba-Bear Hydroelectric Project and Drum-Spaulding Project are referred to individually as "Project" and jointly as "projects."

[3] Consistent with the FERC- approved Fish Passage Study Plan (2.3.4), Licensees will consult with Relicensing Participants regarding existing project facilities that may affect adult resident rainbow trout passage (see Section 5.2 of this Technical Memorandum). This Technical Memorandum focuses therefore on other natural or man-made barriers in the study area. In addition, pursuant to the Fish Passage Study Plan, this Technical Memorandum does not evaluate whether resident rainbow trout would likely move beyond a potential barrier if such barrier did not otherwise exist. Instead, the purpose of this study was to simply document the potential barriers, irrespective of whether such barriers may in fact have any impact on resident rainbow trout.

2.1 Study Sites

Study sites were located on major tributaries to mainstem sections of project-affected stream reaches, mainstem sections of selected project-affected reaches, and on tributaries to selected project reservoirs as specified in the study plan.

For the selected tributaries to mainstem streams, potential barriers to upstream resident adult rainbow trout passage were assessed in the following 15 tributaries:

- Tributaries to the Middle Yuba River below Milton Diversion Dam Impoundment
  - East Fork Creek
  - Bear Creek
  - Wolf Creek
  - Moores Flat Creek
  - Bloody Run Creek
  - Kanaka Creek
  - Indian Creek

- Tributaries to the South Yuba River below Lake Spaulding
  - Canyon Creek
  - Poorman Creek
  - Washington Creek
  - Jefferson Creek
  - Fish Creek
  - Missouri Canyon Creek
  - Spring Creek

- Tributary to the Bear River below Chicago Park Powerhouse
  - Steephollow Creek

The area of the tributary surveyed began in the mainstem of the river at a point where the mainstem stream surface would be under summer low-flow conditions. The upstream extent of the survey extended to the first identified adult rainbow trout barrier or to 0.5 mile upstream from the mainstem of the river if no barriers were identified, whichever was less.

For the tributaries to selected project reservoirs, potential barriers to upstream resident adult rainbow trout passage were assessed at the following 10 tributaries to six selected project reservoirs. These were:

- Jackson Meadows Reservoir
  - Pass Creek
  - Middle Yuba River (English Meadows)

- Milton Diversion Dam Impoundment
  - Middle Yuba River
- Bowman Lake
  - Jackson Creek
  - Canyon Creek
- Rollins Reservoir
  - Greenhorn Creek
  - Bear River
- Fordyce Lake
  - North Creek
- Lake Spaulding
  - South Yuba River
  - Fordyce Creek

The FERC-approved study specified that the area to be surveyed be entirely within the reservoir and extend from where the tributary flowed into the surface of the reservoir in spring (i.e., about the normal water surface elevation of the reservoir in spring) to the normal maximum water surface elevation (NMWSE) of the reservoir. However, in some cases Licensees extended the survey into the tributary upstream of the NMWSE. NMWSE was identified by the presence of riparian vegetation, substrate change, or a watermark on the bank and by aerial orthophotos.

For the mainstem reaches, potential barriers to upstream adult rainbow trout passage were assessed in the Bear River and three streams in the Western Placer County area. These locations consisted of:

- Bear River above Drum Afterbay from the abandoned Upper Boardman Canal Diversion structure downstream to the NMWSE of Drum Afterbay
- Auburn Ravine from the two Wise powerhouses downstream to Placer County Water Agency's (PCWA) Auburn Ravine Tunnel on Auburn Ravine at River Mile (RM) 26.5
- Dry Creek between Halsey Afterbay and Red Hawk Reservoir
- Dry Creek between the confluence with Rock Creek and the confluence with Orr Creek.

2.2 Methods

Licensees followed the same general barrier evaluation method for completing steps 1-3 of the study plan. To begin, Licensees determined if potential fish barriers in the study area had recently (i.e., last 10 years) been assessed by others. Two studies were found: Gast et al. (2005) and Vogel (2006). If existing information was available, the assessment for that area was

summarized including barrier type, fall height, photographs, and field observations. If exiting information was not available, Licensees used existing field mapping, aerial photographs, and the relicensing helicopter video to examine the streams. If these sources provided adequate coverage, the potential for barriers was summarized, and pertinent still-shots from the helicopter video were made. If existing material was not adequate, Licensees visited the tributary to perform the assessment.

Field assessment was primarily conducted on the ground, but in three cases streams were assessed by helicopter due to remoteness and safety concerns. For streams that were assessed by helicopter, the study area was flown at low altitude. The locations of potential barriers were documented, and photographs were taken with a high-resolution camera with a telephoto lens.

Field assessments on the ground included entering data onto Fish Passage Assessment Field Data Forms. A description of the starting point was recorded including Universal Transverse Mercator (UTM) coordinates and photographs. Surveyors collected water temperature and calculated a discharge in a suitable location of the tributary using a flow meter. If flow was too low or too high to measure, it was estimated using professional judgment. Throughout the length of the survey, general characteristics including stream gradient, substrate, fish observations, and fish habitat were recorded. For reservoir assessments, reservoir pool elevations on the field study days were obtained from the project's operators. If a potential barrier was encountered, plunge pool depth, landing pool depth, height, wetted width, and horizontal distance were measured and recorded on the data sheet. UTM coordinates of all potential barriers were recorded using a handheld Global Positioning System (GPS) unit. Photos and observational notes were also taken to document all potential barriers.

3.0 Results

Field studies began in fall 2008 with the assessment of five tributaries to the Yuba-Bear Hydroelectric Project reservoirs. The remaining 24 assessments took place in spring through mid-summer 2009. Figures 3.0-1 through 3.0-4 provide GIS maps that show locations where potential fish passage barriers were observed and not observed for all 29 assessments.

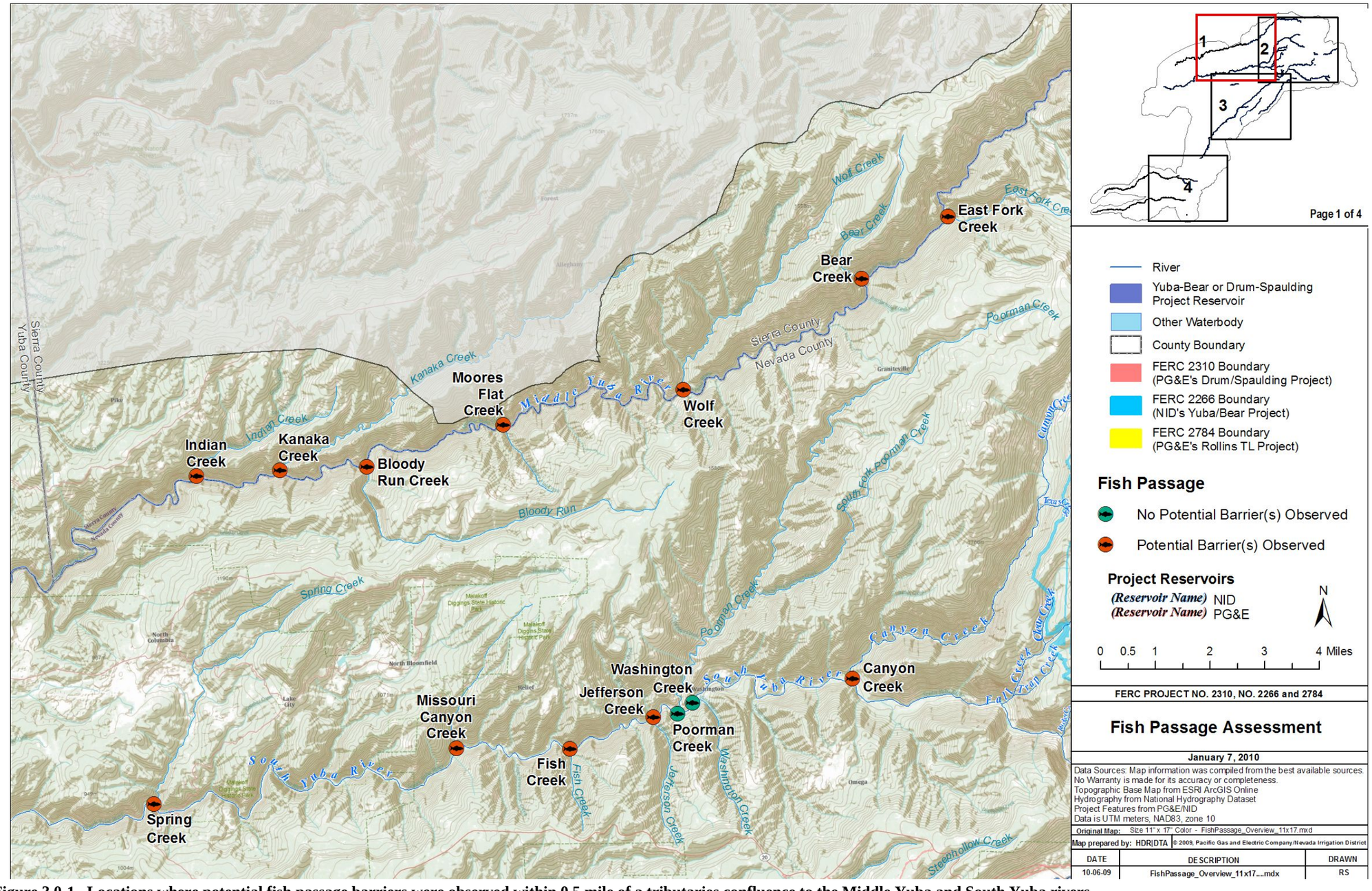

Figure 3.0-1. Locations where potential fish passage barriers were observed within 0.5 mile of a tributaries confluence to the Middle Yuba and South Yuba rivers.

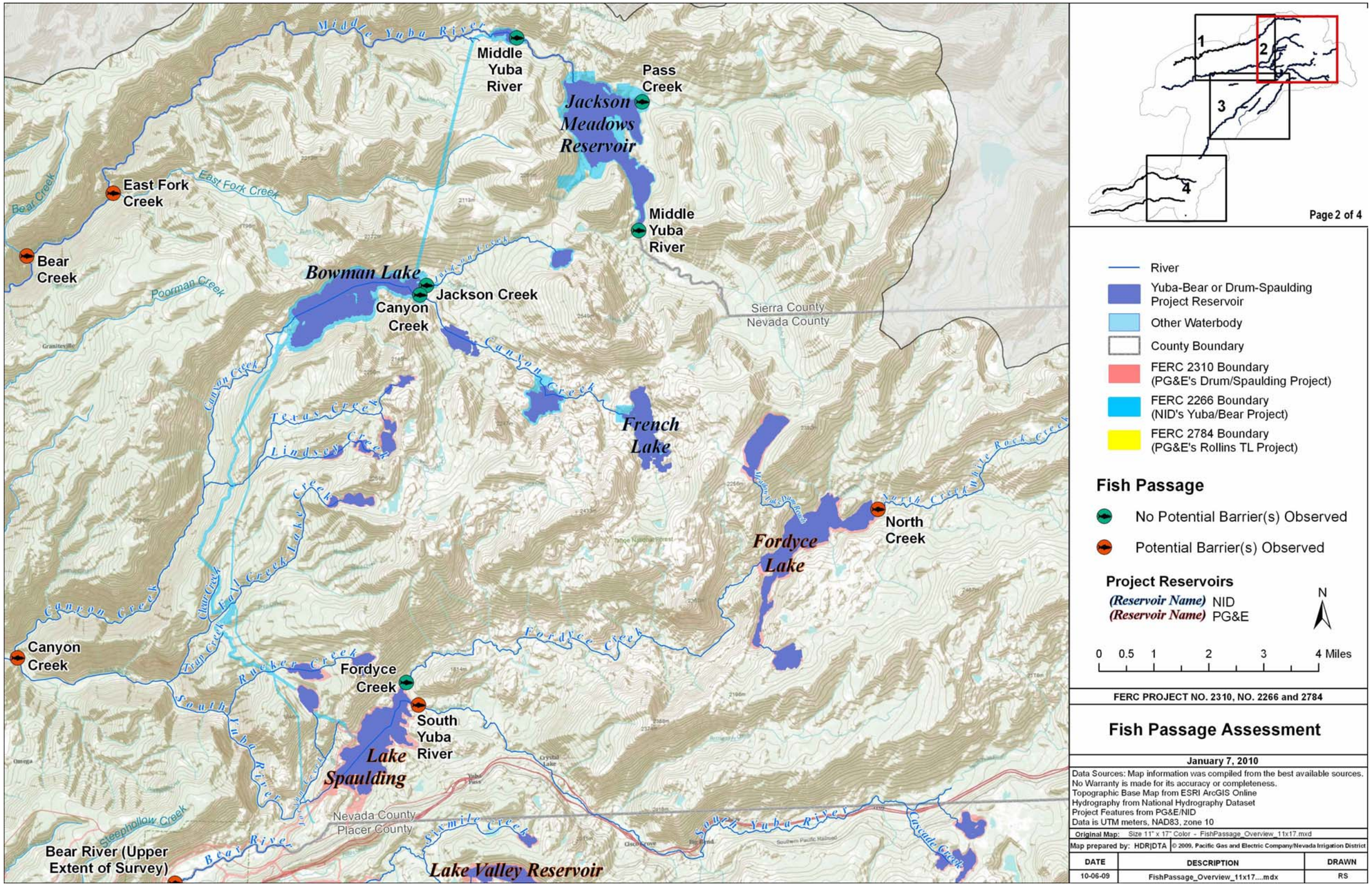

Figure 3.0-2. Locations where potential fish passage barriers were observed within the NMWSE of tributaries to Jackson Meadows Reservoir, Bowman Lake, Fordyce Lake, and Lake Spaulding.

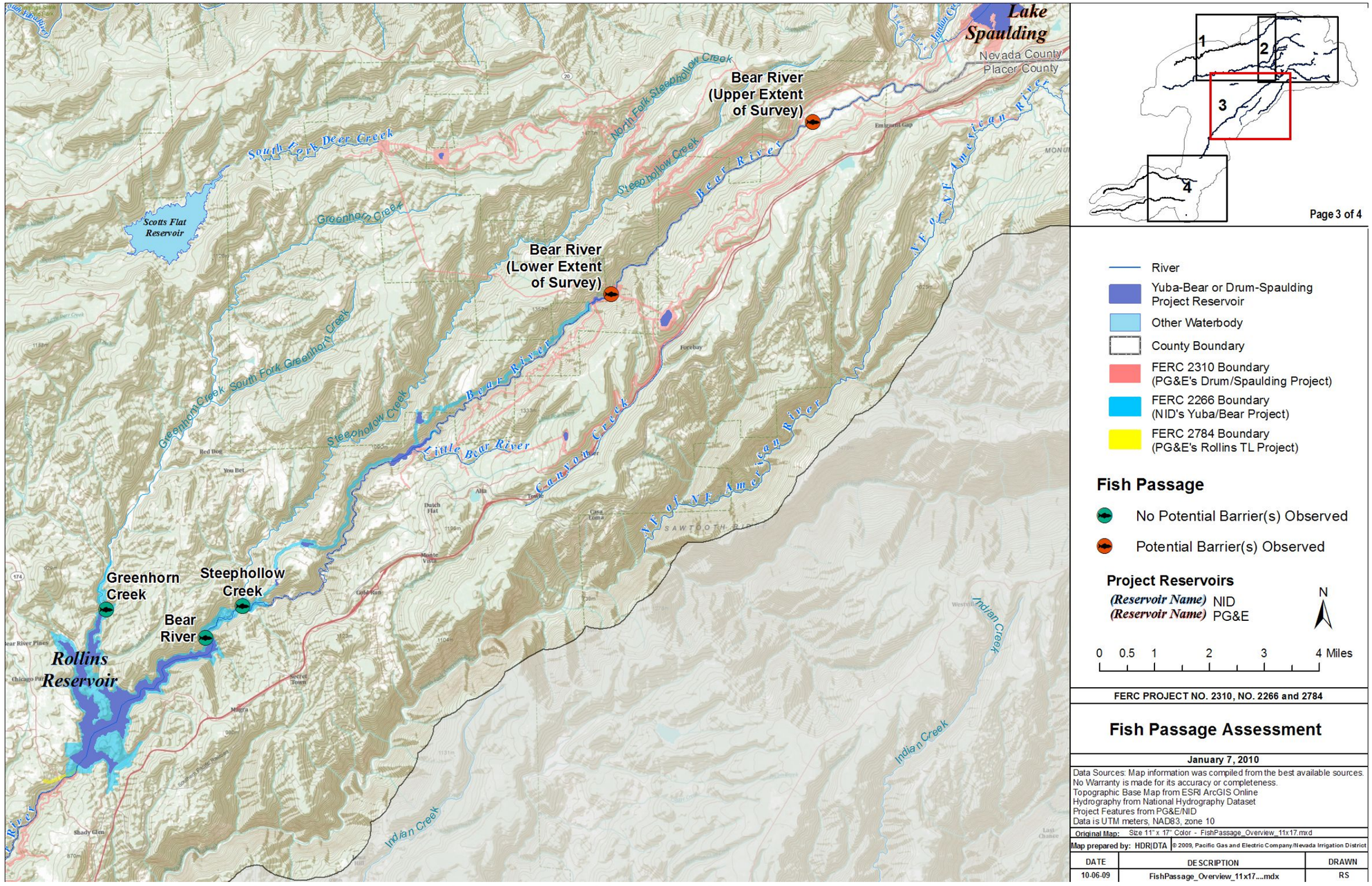

Figure 3.0-3. Locations where potential fish passage barriers were observed in sections of the mainstem of the Bear River and in tributaries to Rollins Reservoir and the Bear River

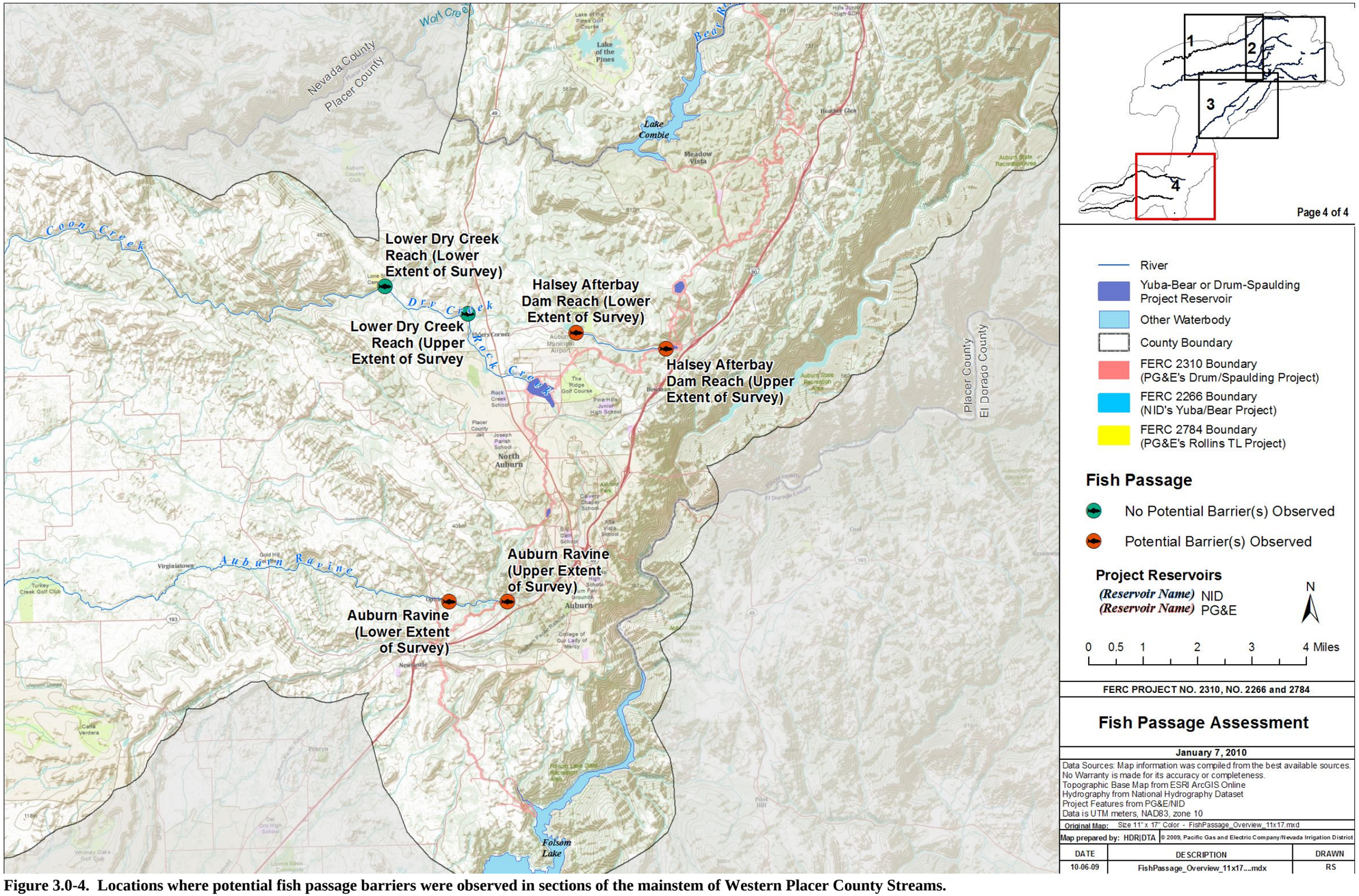

Figure 3.0-4. Locations where potential fish passage barriers were observed in sections of the mainstem of Western Placer County Streams.

3.1 Tributaries to the Middle Yuba River, South Yuba River, and Bear River

Fifteen tributaries to the Middle Yuba, South Yuba, and Bear rivers were selected for assessment. Ten were visited by field crews to determine the potential for fish barriers up to 0.5 mile above the main stem. Two tributaries, Kanaka Creek and Spring Creek, had been previously documented by Gast et al. (2005) and did not warrant further assessment. Three were assessed by helicopter due to remoteness and safety concerns. Table 3.1-1 lists the name, assessment method, and number of potential barriers identified in the portion of each tributary that was surveyed. Table 3.1-2 provides a summary of the physical characteristics at each barrier. Each of the sites surveyed is summarized in more detail below.

Table 3.1-1. Summary of barriers in tributaries to the Middle Yuba River, South Yuba River, and Bear River.

Tributary Name	Watershed/Assessment Type	Number of Potential Barriers Observed Within 0.5 Mile of the Mainstem
MIDDLE YUBA RIVER		
East Fork Creek (RM 34.6)	Field Visit	2
Bear Creek (RM 32.5)	Helicopter	1
Wolf Creek (RM 26.9)	Field Visit	2
Moores Flat Creek (RM 22.0)	Field Visit	2
Bloody Run Creek (RM 18.5)	Helicopter	1
Kanaka Creek (RM 16.5)	Existing Information	3
Indian Creek (RM 14.7)	Field Visit	2
SOUTH YUBA RIVER		
Canyon Creek (RM 32.4)	Field Visit	2
Washington Creek (RM 28.5)	Field Visit	0
Poorman Creek (RM 28.0)	Field Visit	0
Jefferson Creek (RM 27.4)	Field Visit	2
Fish Creek (RM 25.4)	Helicopter	1
Missouri Canyon Creek (RM 22.7)	Field Visit	2
Spring Creek (RM 14.9)	Existing Information	1
BEAR RIVER		
Steephollow Creek (RM 15.5)	Field Visit	0

Table 3.1-2. Dimensions and location of potential barriers identified in selected tributaries to the Middle Yuba River, South Yuba River, and Bear River.

Tributary Name	Potential Barrier No.	Plunge Pool Depth (ft)	Landing Pool Depth (ft)	Height (ft)	Wet Width (ft)	Horizontal Distance (ft)	Dominate Substrate[2]	Distance from Confluence (ft)
MIDDLE YUBA RIVER								
East Fork Creek (RM 34.6)	1	2	1.2	4	3.5	3.5	BR	360
	2	1.3	2.1	4.2	4	4.5	BLD	760
Bear Creek[1] (RM 32.5)	Numerous[4]	-	-	-	-	-	BR	100
Wolf Creek (RM 26.91)	1	6	3	3	12	12	BR	2,395
	2	10	2	6	10	8	BR	2,415
Moores Flat Creek (RM 22.03)	1	2.5	0.6	4.2	4.5	2.5	BR	205
	2	0.7	0.5	6	3.5	2	BR	985

Table 3.1-2. (continued)

Tributary Name	Potential Barrier No.	Plunge Pool Depth (ft)	Landing Pool Depth (ft)	Height (ft)	Wet Width (ft)	Horizontal Distance (ft)	Dominate Substrate[5]	Distance from Confluence (ft)
Bloody Run Creek[1] (RM 18.5)	Numerous[4]	-	-	-	-	-	BR	1,320
Kanaka Creek[2] (RM 16.45)	1	-	-	4	-	-	BR	110
	2	-	-	4	-	-	BR	903
	3	-	-	8	-	-	BR	1,748
Indian Creek (RM 14.7)	1	1.5	0.3	4	4.5	8	BR	70
	2	1	1.3	3.5	3	3	BLD	1,175
SOUTH YUBA RIVER BELOW LAKE SPAULDING								
Canyon Creek (RM 32.4)	1	8+	3	4	30	10	BR	30
	2	3	2	3	15	30	BR	150
Jefferson Creek (RM 27.4)	1	6	0.7	4.5	2.5	9.5	BR	570
	2	1.5	0.6	3.5	4	14	BR	995
Fish Creek[1] (RM 25.4)	Numerous[4]	-	-	-	-	-	BR	100
Missouri Canyon Creek (RM 22.73)	1	1.2	0.4	3.2	7	3.5	BR	1,315
	2	0.6	0.4	3	5	3.5	BR	1,365
Spring Creek[2] (RM 14.9)	1	-	-	14	-	-	BR	50
BEAR RIVER								
Steephollow Creek[3] (RM 15.5)	None	-	-	-	-	-	-	-

[1] Data were not collected because surveys were conducted by helicopter.
[2] Data from Gast et al. (2005).
[3] No barriers were found.
[4] Data not collected due to numerous potential barriers.
[5] BR = Bedrock, BLD = Boulder

3.1.1 Middle Yuba River

East Fork Creek

East Fork Creek, located 10.2 miles downstream of the Yuba-Bear Hydroelectric Project's Milton Diversion Dam, was surveyed for potential fish barriers on July 16, 2009. The survey was conducted from the confluence of the Middle Yuba River upstream approximately 760 feet. Flow in East Fork Creek was estimated at 3 cubic feet per second (cfs) during the time of survey. Within the surveyed area, two potential fish barriers (both natural) were observed located at 360 and 760 feet upstream of the confluence. The potential barriers were 4 and 4.2 feet high, respectively. Overall, the stream was dominated by boulder and bedrock substrate and was deeply entrenched in a bedrock canyon. Gradient within the surveyed area ranged from 2 to 6 percent. Photos of the potential barriers are provided in Attachment 3-4B. Upstream of the surveyed area gradient increased significantly ranging from 15 to 20 percent. Numerous unidentified trout, ranging from 1 to 8 inches were observed throughout the surveyed area.

Bear Creek

Bear Creek, located 12.3 miles downstream of the Yuba-Bear Hydroelectric Project's Milton Diversion Dam, was assessed by helicopter for potential fish barriers on July 14, 2009. Flow in Bear Creek was estimated at less than 2 cfs at the time of assessment. Numerous potential fish barriers (natural falls) were observed within the first 100 feet upstream of the confluence with

the Middle Yuba River. Specific dimensions of the falls could not be determined, but the falls appeared to be total barriers due to their estimated vertical height of greater than 6 feet. Gradient for the first 0.25 mile of the stream was calculated at approximately 60 percent using mapping software. Overall, the stream was dominated by bedrock. Photos of the barrier falls and the Bear Creek drainage are provided in Attachment 3-4B.

Wolf Creek

Wolf Creek, located 17.9 miles downstream of the Yuba-Bear Hydroelectric Project's Milton Diversion Dam, was surveyed for potential fish barriers on May 13, 2009. The survey was conducted from the confluence of the Middle Yuba River upstream approximately 2,415 feet. Flow in Wolf Creek was measured at 25 cfs during the time of survey. Two potential fish barriers (both natural) were observed approximately 2,395 and 2,415 feet upstream of the confluence with the Middle Yuba River. The potential barriers were 3 and 6 feet high, respectively. Overall, the stream was dominated by boulder and cobble substrate with some bedrock in places. Several bedrock plunge pools were noted. Gradient within the surveyed area ranged from 3 to 6 percent. Unidentified trout were observed throughout the surveyed area ranging from 6 to 8 inches in length. Photos of the potential barriers are provided in Attachment 3-4B.

Moores Flat Creek

Moores Flat Creek, located 22.8 miles downstream of the Yuba-Bear Hydroelectric Project's Milton Diversion Dam, was surveyed for potential fish barriers on May 31, 2009. The survey was conducted from the confluence of the Middle Yuba River upstream approximately 985 feet. Flow in Moores Flat Creek was measured at 1.4 cfs during the time of survey. Two potential fish barriers (both natural) were observed located at 205 and 985 feet upstream of the confluence with the Middle Yuba River. The potential barriers were 4.2 and 6 feet high, respectively. Overall, the stream was dominated by bedrock and boulder. Several bedrock-formed plunge pools were noted. Gradient within the surveyed area ranged from 2 to 10 percent. Twelve unidentified trout were observed in pools during the survey. Photos of the potential barriers are provided in Attachment 3-4B.

Bloody Run Creek

Bloody Run Creek, located 26.3 miles downstream of the Yuba-Bear Hydroelectric Project's Milton Diversion Dam, was assessed by helicopter for potential fish barriers on July 14, 2009. Flow in Bloody Run Creek was estimated at less than 2 cfs at the time of assessment. Numerous fish barriers (natural falls) were observed in the stream approximately 0.25 mile upstream of the confluence with the Middle Yuba River. Specific dimensions of the falls could not be determined, but the falls appeared to be total barriers due to their estimated vertical height of greater than 6 feet. Gradient for the first 0.5 mile of the stream was calculated at 12 percent using digital mapping software. Overall, the stream was dominated by bedrock. Photos of the barrier falls and the Bloody Run Creek drainage are provided in Attachment 3-4B.

Kanaka Creek

Kanaka Creek, located 28.3 miles downstream of the Yuba-Bear Hydroelectric Project's Milton Diversion Dam, was not surveyed because existing information was sufficient to summarize the

potential for fish barriers in the stream. Gast, et al. (2005), included as Appendix G in a report by California Department of Water Resources (CDWR) (2006) assessed fish passage in Kanaka Creek in August 2004. Flow in Kanaka Creek at the time of assessment in 2004 was estimated at 2 cfs. The first potential fish barrier (natural) encountered was approximately 110 feet upstream from the confluence and had a height of approximately 4 feet. Three other potential barriers in the form of bedrock cascades (all natural), each with approximately 4-foot drops were observed farther upstream. One was located at 903 feet upstream of the confluence; distances for the other two were not provided. Another 8-foot natural barrier was observed 1,748 feet upstream of the confluence. Other dimensions of the potential barriers were not available. Photos of the potential barriers are provided in Attachment 3-4B.

Indian Creek

Indian Creek, located 30.1 miles downstream of the Yuba-Bear Hydroelectric Project's Milton Diversion Dam, was surveyed for potential fish barriers on May 18, 2009. The survey was conducted from the confluence of the Middle Yuba River upstream approximately 1,175 feet. Flow in Indian Creek was estimated at 4 cfs during the time of survey. Two potential fish barriers (both natural) were observed located at 70 and 1,175 feet upstream of the confluence. The potential barriers were 4 and 3.5 feet high, respectively. The stream contained a mix of gravel, cobble, and boulder substrate with bedrock in places. Several bedrock-formed cascades and good fish cover were noted. Gradient within the surveyed area ranged from 2 to 5 percent. A 3-inch-long unidentified trout was observed upstream of the first potential barrier. Photos of the potential barriers are provided in Attachment 3-4B.

3.1.2 South Yuba River

Canyon Creek

Canyon Creek, located 8.7 miles downstream of the Drum-Spaulding Project's Lake Spaulding Dam, was surveyed for potential fish barriers on May 15, 2009. The survey was conducted from the confluence of the South Yuba River upstream approximately 300 feet. Overall, the stream was dominated by bedrock and boulder substrate. Gradient within the surveyed area ranged from 4 to 9 percent. Based on consultation with a dam operator at Bowman Lake upstream, flow in Canyon Creek was estimated at 260 cfs during the time of survey due to drafting of reservoirs upstream for recreation flow studies. This flow was much higher than the average summer low flow of 3 to 4 cfs and may have affected the barrier analysis. Within the surveyed area, two potential fish barriers (one natural and one man-made) were observed located at 30 and 150 feet upstream of the confluence, respectively. The potential natural barrier, closest to the confluence, was 4 feet high. The upper man made potential barrier was a diversion dam for the City of Washington's water supply. At the observed flow, a side channel flowed around the diversion dam on the left bank (looking downstream). Potential barrier measurements were taken within this side channel, as this was where the lowest vertical height occurred at the diversion dam. The potential barrier measured 3 feet high. Photos of the potential barriers are provided in Attachment 3-4B.

Washington Creek

Washington Creek, located 12.6 miles downstream of the Drum-Spaulding Project's Lake Spaulding Dam, was surveyed for potential fish barriers on May 15, 2009. The survey was conducted from the confluence of the South Yuba River upstream approximately 0.5 mile. Flow was measured at 3 cfs during the time of survey. No fish barriers were observed during the survey. Overall, the stream was dominated by boulder and cobble substrate with some sections of spawning gravel and bedrock observed. Long boulder-dominated riffles interspersed with small plunge pools were recorded. Gradient within the surveyed area ranged from 3 to 7 percent. Numerous unidentified trout ranging from 3 to 7 inches were observed in both pool and riffle habitat in the surveyed area. Abundant vegetative cover for fish was present on the banks of the stream. Photos of the reach are provided in Attachment 3-4B.

Poorman Creek

Poorman Creek, located 13.1 miles downstream of the Drum-Spaulding Project's Lake Spaulding Dam, was surveyed for potential fish barriers on May 15, 2009. The survey was conducted from the confluence of the South Yuba River upstream approximately 0.5 mile. Flow was measured at 78.6 cfs during the time of survey. No fish barriers were observed during the survey. Overall, the stream had a mix of substrates with a large component of bedrock. Long bedrock-formed pools connected by high-gradient riffles were recorded. Gradient within the surveyed area ranged from 2 to 7 percent. Unidentified trout were observed in both pool and riffle habitat in the surveyed area. Photos of the reach are provided in Attachment 3-4B.

Jefferson Creek

Jefferson Creek, located 13.7 miles downstream of the Drum-Spaulding Project's Lake Spaulding Dam, was surveyed for potential fish barriers on May 17, 2009. The survey was conducted from the confluence of the South Yuba River upstream approximately 1,000 feet. Flow was estimated at 3 cfs during the time of survey. Two potential fish barriers (both natural) were observed located at 570 and 995 feet upstream of the confluence. The potential barriers were 4.5 and 3.5 feet high, respectively. Overall, the stream was dominated by boulder and cobble substrate with bedrock banks. Gradient within the surveyed area ranged from 3 to 6 percent. Unidentified trout ranging from 4 to 6 inches were observed throughout the surveyed area. Photos of the potential barriers are provided in Attachment 3-4B.

Fish Creek

Fish Creek, located 25.4 miles downstream of the Drum-Spaulding Project's Lake Spaulding Dam, was surveyed by helicopter for potential fish barriers on July 14, 2009. Flow was estimated at less than 2 cfs at the time of survey. Within the first 100 feet upstream of the confluence with the South Yuba River, numerous barriers (all falls) were observed. Although specific dimensions of the falls could not be determined, it is assumed that they are total barriers due to their estimated vertical height of greater than 6 feet. Gradient for the first 0.25 mile of the stream was calculated at 39 percent using mapping software. Overall, the stream was dominated by bedrock. Photos of the barrier falls and the Fish Creek drainage are provided in Attachment 3-4B.

Missouri Canyon Creek

Missouri Canyon Creek, located 18.4 miles downstream of the Drum-Spaulding Project's Lake Spaulding Dam, was surveyed for potential fish barriers on May 16, 2009. The survey was conducted from the confluence of the South Yuba River upstream approximately 1,400 feet. Flow was measured at 3 cfs during the time of survey. Two potential fish barriers (both natural) were observed located at 1,315 and 1,365 feet upstream of the confluence. The potential barriers were 3.2 and 3 feet high, respectively. Overall, the stream was dominated by boulder and cobble substrate with some bedrock. Many bedrock- and boulder-formed plunge pools with intermittent cascades and high-gradient riffles were observed. Gradient within the surveyed area ranged from 4 to 7 percent. Two unidentified 7-inch trout were observed in pool habitat in the surveyed area. Photos of the potential barriers are provided in Attachment 3-4B.

Spring Creek

Spring Creek, located 26.2 miles downstream of the Drum-Spaulding Project's Lake Spaulding Dam, was not surveyed by Licensees because existing information was sufficient to summarize the potential for fish barriers in the stream. Gast et al. (2005), included as Appendix G in a report by CDWR (2006), assessed fish passage in Spring Creek in August 2004. Flow at the time of assessment was estimated at 2 cfs. Gast et al. (2005) identified a 14-foot-tall waterfall approximately 50 feet upstream of the confluence with the South Yuba River. Unidentified trout fry were observed in the stream above and below the waterfall. A photo of the waterfall barrier is provided in Attachment 3-4B.

3.1.3 Bear River

Steephollow Creek

Steephollow Creek, located 0.4 mile downstream of the Yuba-Bear Hydroelectric Project's Chicago Park Powerhouse, was surveyed for potential fish barriers on May 13, 2009. The survey was conducted from the confluence with the Bear River upstream approximately 0.5 mile. Flow was measured at 59 cfs during the time of survey. No fish barriers were observed during the survey. Overall, the stream was dominated by gravel and cobble substrate. Long, low-gradient riffles with a few pools formed by debris jams were recorded. Gradient within the surveyed area ranged from 1 to 2 percent. No fish were observed during the survey. Photos of the reach are provided in Attachment 3-4B.

3.2 Tributaries to Project Reservoirs

Ten tributaries to project reservoirs were surveyed for potential fish barriers. Surveys in tributaries to project reservoirs began in fall 2008 with the assessment of five tributaries to the Yuba-Bear Hydroelectric Project reservoirs. The remaining five tributaries were assessed in spring 2009. All were visited by field crews except the Middle Yuba River upstream of the Milton Reservoir. This section of stream was adequately covered by the projects' helicopter video to determine that no potential barriers exist.

To take advantage of fall 2008 low-water conditions in project reservoirs, which allowed a larger area to be surveyed, Pass Creek and the Middle Yuba River in Jackson Meadows Reservoir,

Jackson Creek in Bowman Lake, and Greenhorn Creek and Bear River in Rollins Reservoir were surveyed from the pool level at the time of the survey to upstream of the NMWSE. Low-flow conditions and dry stream channels created low-flow barriers (i.e., shallow thalweg depths, such as shallow sheet wash that prevent passage upstream) in many of the tributaries surveyed in the fall. These low-flow barriers were not considered relevant to the study because the assessment focused on adult rainbow trout passage into tributaries during spring conditions when flows from tributaries into reservoirs are normally high from spring runoff and thalweg depths increase. No passage barriers were identified during the 2008 assessment effort on Yuba-Bear Hydroelectric Project reservoirs.

Barrier assessment conducted in spring and early summer 2009 took place primarily on the Drum-Spaulding Project reservoirs with the exception of the Yuba-Bear Hydroelectric Project's Bowman Lake. Canyon Creek in Bowman Lake was surveyed in 2009 due to high flows encountered in 2008 that precluded a survey. North Creek in Fordyce Reservoir and South Yuba River and Fordyce Creek in Spaulding Reservoir were also surveyed in 2009. At the time of assessment, pool elevations in the reservoirs were relatively high as expected for spring and early summer, and only a short distance between the reservoir's pool elevation and NMWSE was surveyed. Two of the tributaries to Drum-Spaulding Project reservoirs surveyed in 2009 contained potential barriers within the surveyed area. Table 3.2-1 provides the NMWSE of each reservoir surveyed and the tributaries where potential barriers were observed. Conditions when surveys were performed including reservoir pool elevation, tributary flow, and distance surveyed are also provided. Table 3.2-2 provides information for each barrier. More detailed results of the surveys by tributary are provided below.

Table 3.2-1. Tributaries to project reservoirs that were assessed for potential barriers in 2008 and 2009.

Reservoir	Tributary (Year Assessed)	NMWSE (ft)	Conditions During Assessment		Approximate Distance Surveyed From NMWSE (ft)	Number of Potential Barriers Observed
			Reservoir Pool Elevation (ft)	Flow of Tributary[1] (cfs)		
YUBA-BEAR HYDROELECTRIC PROJECT						
Jackson Meadows Reservoir	Pass Creek/08	6,036	6,001	0.1	1,172	0
	Middle Yuba River/08			< 0.1	1,948	0
Milton Diversion Dam Impoundment[2]	Middle Yuba River (no survey)	-	-	-	0	0
Bowman Lake	Jackson Creek/2008	5,562	5,512	1.1	1,303	0
	Canyon Creek/2009		5,562	30 (estimate)	10	0
Rollins Reservoir	Greenhorn Creek/2008	2,171	2,135	3.1	3,849	0
	Bear River/2008			12.9	6,715	0
DRUM-SPAULDING PROJECT						
Fordyce Lake	North Creek/2009	6,405	6,403	80.6	10	1
Lake Spaulding	South Yuba River/2009	5,015	4,998	47.5	300	1
	Fordyce Creek/2009			120 (estimate)	100	0

[1] Flows were estimated at some tributaries due to access issues.

[2] Milton Diversion Dam Impoundment was not surveyed because Licensees' project helicopter video was sufficient to determine that no potential barriers were present.

Table 3.2-2. Dimensions and location of potential barriers identified in tributaries to project reservoirs.[1]

Reservoir/ Tributary Name	Barrier No.	Plunge Pool Depth (ft)	Landing Pool Depth (ft)	Height (ft)	Wet Width (ft)	Horizontal Distance (ft)	Dominate Substrate	Distance From Confluence (ft)
YUBA-BEAR HYDROELECTRIC PROJECT								
None	-	-	-	-	-	-	-	-
DRUM-SPAULDING PROJECT								
Fordyce Lake - North Creek	1	-	-	25	20	20	Bedrock	0
Lake Spaulding – South Yuba River	1	4	1.5	5.5	15	2.5	Bedrock	0

[1] A dash (-) indicates that data were not collected.

3.2.1 Yuba-Bear Hydroelectric Project Reservoirs and Surveyed Tributaries

Jackson Meadows Reservoir – Pass Creek

Approximately 1,172 feet of Pass Creek within the NMWSE of Jackson Meadows Reservoir was surveyed on October 9, 2008. No potential upstream fish movement barriers were identified within the NMWSE. Low-flow barriers were identified, but are not considered relevant to this study for the reasons described in 3.2 above. A flow of 0.26 cfs was measured in the stream. Average wetted width of the creek was 2.5 feet with a minimum depth range of 0.1 to 0.15 feet in the riffles. Some sections of the stream contained no surface flow. Stream gradient of the survey area ranged from 3 to 5 percent, with one section of 16 percent gradient. Substrate in the survey area was predominately sand and gravel near the mouth, shifting to primarily cobble, boulder, and bedrock near the NMWSE. Brook trout were observed in most pools throughout the survey area. Within the survey area, a residual pool with less than 0.1 cfs of flow was observed containing approximately 300 brook trout ranging from 2 to 5 inches in size. A total barrier to upstream movement was located about 550 feet upstream of the NMWSE of the reservoir. This barrier consisted of a series of cascading bedrock falls that continue upstream for 100 feet. Photos of the stream are provided in Attachment 3-4B.

Jackson Meadows Reservoir – Middle Yuba River

About 1,948 feet of the Middle Yuba River within the NMWSE of Jackson Meadows Reservoir was surveyed on October 9, 2008. Flow was visually estimated at less than 0.1 cfs. No potential upstream fish movement barriers were identified. Low-flow barriers were identified, but are not considered relevant to this study for the reasons described in 3.2. At the time of survey, the mouth of the Middle Yuba River was a mud flat in which <0.1 cfs of flow cut a small channel through the flat with an average wetted width of 3 feet and a minimum depth range of 0.1 to 0.15 feet in the riffles. Three residual pools with <0.1 cfs of flow were observed within the survey area. The lower pool contained approximately 100 brook trout ranging in size from 2 to 5 inches. The second pool contained approximately 30 brook trout of the same size range. The third pool contained approximately 100 brook trout ranging in size from 2 to 5 inches, with a second size class of approximately 50 unidentified fish ranging from 1 to 2 inches. Near the upper extent of the survey area flow went subsurface with occasional residual pools. Overall gradient in the survey area was 2 percent. Substrate in the lower section of the survey area was

predominately silt and sand with some cobbles and boulders. Near the NMWSE, cobbles and boulders became dominate. Photos of the stream are provided in Attachment 3-4B.

Milton Diversion Dam Impoundment – Middle Yuba River

The Middle Yuba River, tributary to Milton Diversion Dam Impoundment, was not surveyed because the Project helicopter video and aerial photographs were sufficient to determine there was no potential upstream fish movement barriers in the stream. An aerial photo of the confluence of the Middle Yuba River with Milton Diversion Dam Impoundment is provided in Attachment 3-4B.

Bowman Lake – Jackson Creek

About 1,303 feet of Jackson Creek within the NMWSE of Bowman Lake was surveyed on October 9, 2008. A flow of 1.4 cfs was measured. At the time of the survey, the low reservoir pool elevation in Bowman Lake exposed the confluence point where Jackson Creek flows into Canyon Creek. Flow in Canyon Creek was estimated at 30 cfs at the time of survey due to drafting of upstream reservoirs. No potential upstream fish movement barriers were observed between Bowman Lake and the Jackson Creek confluence with Canyon Creek or between this confluence and the NMWSE of Bowman Lake. Stream gradients in the survey area of Jackson Creek ranged from 2 to 5.5 percent. Substrate was predominately gravel and cobble with boulders and bedrock in places. Throughout the surveyed area, an estimated 300 kokanee were observed. Many were actively spawning and digging redds. Photos of the stream are available in Attachment 3-4B.

Bowman Lake – Canyon Creek

Canyon Creek, a tributary feeding into Bowman Lake, was surveyed for potential barriers to upstream fish movement on June 21, 2009. At the time of survey, the reservoir was near the NMWSE; consequently, only about 10 feet of stream existed between the confluence and the NMWSE. No potential upstream fish movement barriers to upstream fish movement were identified. Flow was estimated at 30 cfs during the time of survey. Overall, the stream was dominated by bedrock and boulder substrate. Gradient within the surveyed area was approximately 2 percent. A total barrier to upstream movement was located about 400 feet upstream of the NMWSE of the lake. This barrier consisted of a series of 10-foot and greater bedrock falls that continue upstream for approximately 400 feet. Photos of the creek and the barrier located outside of the assessed area are provided in Attachment 3-4B.

Rollins Reservoir – Greenhorn Creek

On October 6, 2008, about 3,849 feet of Greenhorn Creek was surveyed within Rollins Reservoir from the confluence to the NMWSE of the reservoir. A flow of 3.1 cfs was measured. No potential upstream fish movement barriers were identified. Low-flow barriers were identified, but are not considered relevant to this study for the reasons described in 3.2. At the time of survey, the mouth of Greenhorn Creek was a 400-foot-wide delta composed of silt and sand with braided channels. Minimum riffle depths near the mouth ranged from 0.1 to 0.3 foot, and turbidity was very high. Further upstream, the stream channelized and water clarity improved. Stream gradient for the entire length of the survey ranged from 1 to 2 percent. Spawning size

gravels and overall suitable fish habitat became more common near the NMWSE. Photos of the stream are provided in Attachment 3-4B.

Rollins Reservoir – Bear River

About 6,715 feet of the Bear River within the NMWSE of Rollins Reservoir was surveyed on October 6, 2008. A flow of 12.9 cfs was measured. No potential upstream fish movement barriers were identified. At the time of survey, the mouth of the Bear River was a 330-foot-wide delta composed of silt. The main channel was inaccessible to surveyors at the mouth due to deep and dangerously soft silt conditions, but no barriers were observed. There was active re-suspension of sediments occurring near the mouth making the water very turbid. Average minimum water depths of riffles ranged from 0.3 to 0.8 foot. Stream gradient for the entire survey area was 1 percent. Near the NMWSE, the water clarity improved greatly, substrate became gravel, and cobble dominated. No fish were observed in the section of stream surveyed. Spawning size gravels were present near the NMWSE. Photos of the stream are provided in Attachment 3-4B.

3.2.2 Drum-Spaulding Project Reservoirs and Surveyed Tributaries

Fordyce Lake – North Creek

North Creek, a tributary feeding into Fordyce Lake, was surveyed for potential barriers to upstream fish movement on June 16, 2009. At the time of survey, the reservoir was approximately 3 feet below the NMWSE of the lake resulting in about 10 feet of stream within the NMWSE. Flow was measured at 81 cfs during the time of survey. Gradient within the surveyed area was approximately 20 percent and one upstream fish movement barrier, a natural 25-foot waterfall, was observed where North Creek entered the reservoir. Overall, the stream was dominated by bedrock substrate. Dimensions of the barrier are given in Table 3.2-2 above. Photos of the barrier are provided in Attachment 3-4B.

Lake Spaulding – South Yuba River

South Yuba River, a tributary to Lake Spaulding, was surveyed for potential barriers to upstream fish movement on June 25, 2009. At the time of survey, the reservoir was approximately 17 feet below the NMWSE of the lake, resulting in approximately 300 feet of stream within the NMWSE. Flow was measured at 47.5 cfs during the time of survey. Within the surveyed area, one potential upstream fish movement barrier, a natural 5.5-foot waterfall, was observed where the South Yuba River entered the reservoir. Above the Project-affected area (above the NMWSE), a second potential upstream fish movement barrier (natural) was observed but dimensions were not taken since it was above the NMWSE. Overall, the stream was dominated by bedrock and boulder substrate. Gradient within the surveyed area was approximately 10 percent. Dimensions of the measured potential barrier are given in Table 3.2-2 above. Photos of the potential barriers are provided in Attachment 3-4B.

Lake Spaulding – Fordyce Creek

Fordyce Creek, a tributary feeding into Lake Spaulding, was surveyed for potential upstream fish movement barriers to upstream fish movement on June 25, 2009. At the time of survey, the reservoir was approximately 17 feet below the NMWSE, resulting in approximately 100 feet of

stream within the NMWSE. Flow was estimated at 120 cfs during the time of survey. No potential fish barriers were observed during the survey. Overall, the stream was dominated by boulder substrate. Gradient within the surveyed area ranged from 3 to 6 percent. Photos of the reach are provided in Attachment 3-4B.

3.3 Mainstem Reaches

Mainstem sections of the Bear River, Auburn Ravine, and Dry Creek, as identified in the study plan, were visited by field crews to assess the potential for upstream fish movement barriers (Step 3). Table 3.3-1 lists the stream sections that were assessed and the number of potential barriers that were observed. Table 3.3-2 provides information regarding each potential barrier.

Table 3.3-1. Potential barriers on selected mainstem stream sections.[1]

Stream Name	Section Assessed	Number of Potential Barriers Observed
YUBA-BEAR HYDROELECTRIC PROJECT		
None	-	-
DRUM-SPAULDING PROJECT		
Bear River above Drum Afterbay	From the abandoned Upper Boardman Canal Diversion structure to the normal maximum water surface elevation of Drum Afterbay (5.3 miles).	22
Auburn Ravine	From Wise Powerhouses downstream to PCWA's Auburn Ravine Tunnel on Auburn Ravine at RM 26.5 (1.2 miles).	3
Dry Creek	Dry Creek below Halsey Afterbay to Red Hawk Reservoir (1.7 miles).	1 (temporary beaver dam)
	Dry Creek below Rock Creek confluence to Orr Creek Confluence (1.6 miles).	0

[1] A dash (-) indicates that barrier assessments on a mainstem stream sections were not required.

Table 3.3-2. Dimensions and location of potential barriers identified in the mainstem Bear River and Western Placer County streams.[1]

Stream Name	Barrier Number	Plunge Pool Depth (ft)	Landing Pool Depth (ft)	Height[2] (ft)	Wet Width (ft)	Horizontal Distance[3] (ft)	Dominate Substrate[4]	Approximate Location[5]
YUBA-BEAR HYDROELECTRIC PROJECT								
None	-	-	-	-	-	-	-	-
DRUM-SPAULDING PROJECT								
Bear River above Drum Afterbay	1	2.5	0.8	3.5	15	4	BLD	RM 28.29
	2	15+	1.5	11	5	10	BR	RM 29.69
	3	1.6	1.7	4.2	5	5	BR	RM 29.83
	4	0.5	0.6	4.1	6	3.5	BR	RM 29.9
	5	1.8	2	4.2	11	5	BLD	RM 30.09
	6	-	-	3.5 to 7	-	-	BR	RM 30.38 to RM 30.41
	7	0.4	0.6	7	4	11	BR	RM 30.44
	8	8	1	7.5	2	6	BR	RM 31.78
	9	4	0.4	15	7	12	BR	RM 31.83
	10	3	0.3	6.5	14	1	BLD	RM 31.85
	11	2	0.4	9	8	10	BR	RM 31.91
	12	1	1	5	4	4	BLD	60' DS of 13
	13	0.4	0.4	3	17	5	BLD	RM 31.92
	14	1	0.2	8	6	12	BR	RM 32.05
	15	1	0.6	2.5	2	3	BR	RM 32.17
	16	2	1.3	3.5	7	4.5	BLD	RM 32.18

Table 3.3-2. (continued)

Stream Name	Barrier Number	Plunge Pool Depth (ft)	Landing Pool Depth (ft)	Height[2] (ft)	Wet Width (ft)	Horizontal Distance[3] (ft)	Dominate Substrate[4]	Approximate Location[5]
Bear River above Drum Afterbay (continued)	17	0.8	1.5	3.25	20	2RB, 4LB	BR	20' DS of 18
	18	5	1.1	3.5	5	7	BR	RM 32.23
	19	1	1	3	5	3	BR	30' DS of 20
	20	0.5	6	6	9	20	BR	RM 32.25
	21	1.5	0.8	10	12	25	BR	RM 32.67
	22	2	7	8	30	4	DAM	30' US of 21
Auburn Ravine	1	3.5	2	2.5	35	6	BR	RM 26.53
	2	3.5	1	3.5	18	3	BR	RM 26.53
	3	4	1.5	2.75	12	3	DAM	RM 27.27
Dry Creek (Red Hawk Reservoir to Halsey Afterbay)	1	3	3	4	20	8	WD	340' US of Reservoir

[1] A dash (-) indicates that barrier assessments on mainstem stream sections were not required.
[2] In some cases, a potential barrier with a vertical height of less than 3 feet was identified as a potential barrier because other dimensions and characteristics were determined to create potential passage problem (e.g., spilling onto rocks or horizontal distance of the barrier of about 3 ft).
[3] RB = Right Bank Looking downstream, LB = Left Bank Looking downstream
[4] BR = Bedrock, BLD = Boulder, WD = Wood
[5] US = Upstream, DS = Downstream, RM = River Mile

3.3.1 Bear River below Abandoned Upper Boardman Canal Diversion

Approximately 5.3 miles of the Bear River from the abandoned Upper Boardman Canal Diversion (RM 32.7) downstream to Drum Afterbay (RM 27.4) was surveyed for potential barriers to upstream fish movement on June 25, June 26, July 14, and July 15 of 2009. Flow was measured at 9.4 cfs during the time of surveys. Within the surveyed area, 22 potential fish barriers (all natural) were observed ranging from 2.5 to 15 feet high. Overall, the stream was dominated by bedrock and boulder substrate. The surveyed area was generally characterized by numerous bedrock-entrenched canyons connected by medium- to high-gradient riffles. Gradient within the surveyed area ranged from 2 to 9 percent. Rainbow trout were observed in all sections of the stream. Dimensions and locations of the potential barriers are given in Table 3.3-2 above. Photos of the potential barriers are provided in Attachment 3-4B.

3.3.2 Auburn Ravine

Approximately 1.2 miles of Auburn Ravine between Wise Powerhouse (RM 27.6) and PCWA's Auburn Ravine Tunnel (RM 26.4) was surveyed for potential barriers to upstream fish movement on May 12, 2009. Flow was 54 cfs during the time of survey based on consultation with the powerhouse operator. Within the surveyed area, two potential upstream fish movement barriers (both natural) were observed located within 30 feet of one another at approximately RM 26.53, and were 2.5 and 3.5 feet high. A third potential barrier (man-made diversion dam) was also found at RM 27.27. The diversion dam was degraded but operable and appeared passable at the flow observed during the survey, but may not be passable at lower flows. A variety of substrate was observed in the reach. Gradient within the surveyed area ranged from 2 to 10 percent. Dimensions of the potential barriers are given in Table 3.3-2. Photos of the potential barriers are provided in Attachment 3-4B.

3.3.3 Dry Creek

Dry Creek below Halsey Afterbay

Approximately 0.8 miles of Dry Creek between Halsey Afterbay (RM 6.0) and Red Hawk Reservoir (RM 3.8) was surveyed for potential barriers to upstream fish movement on May 12, 2009. Several sections of this reach could not be accessed due to thick blackberry brambles and private property. Flow was estimated at less than 2 cfs during the time of survey. Within the surveyed area, one temporary potential fish barrier, a large beaver dam, was observed 340 feet upstream of the confluence with Red Hawk Reservoir. Based on the observed characteristics of the stream and low gradient determined from digital mapping software, it is likely that the other sections of the stream that could not be observed have a low probability of containing any potential natural barriers. Overall, the stream was dominated by cobble and gravel substrate. Lower gradient reaches were heavily silted and characterized by dense vegetation with substantial overhead and aquatic cover. Gradient within the surveyed area ranged from 1 to 2 percent. Numerous cyprinids ranging from 1 to 4 inches were observed throughout the surveyed area. Dimensions of the beaver dam are given in Table 3.3-2 above. Photos of the stream and the beaver dam are provided in Attachment 3-B.

Dry Creek below Rock Creek

Approximately 1.6 miles of Dry Creek between the confluence with Orr Creek and the confluence with Rock Creek was surveyed for potential upstream fish movement barriers on May 12, 2009. Flow was measured at 14.1 cfs during the time of survey. No fish barriers were observed within the surveyed area. Overall, the stream contained primarily boulder, cobble, and gravel substrate. Lower gradient reaches were heavily silted and characterized by dense aquatic vegetation. Gradient within the surveyed area was primarily 1 to 2 percent with some 5 percent high-gradient riffles in places. Numerous fish (unidentified cyprinids, mosquito fish, and green sunfish) ranging from 1 to 5 inches were observed throughout the surveyed area. Photos of the stream are provided in Attachment 3-4B.

4.0 Discussion

4.1 Previous Fish Barrier Studies

Prior to conducting this Fish Passage Study, Licensees found two studies that addressed, at least in part, fish passage on the Middle and South Yuba rivers. One study focused on tributaries and the other on the mainstems of the rivers. The first study focusing on tributaries was performed in August and September 2004, and reported on by Gast et al. (2005) in a report titled *Middle and South Yuba Rainbow Trout (Oncorhynchus mykiss) Distribution and Abundance Dive Counts August 2004 – Appendix G.* As part of this study, Gast et al. conducted surveys in principal tributaries to the Middle Yuba and South Yuba rivers 1,000 to 2,000 feet upstream of the confluence with the Middle and South Yuba rivers or to the first impassable fish barrier, whichever was encountered first. All potential barriers to salmon and steelhead upstream passage encountered were photographed and qualitatively described by Gast et al., with estimated vertical heights and GPS positions recorded for each potential barrier.

The second study, which focused on the mainstems of the Middle and South Yuba rivers, was by Vogel (2006) and titled *Assessment of Adult Anadromous Salmonid Migration Barriers and Holding Habitats in the Upper Yuba River – Appendix C.* For this study, Vogel identified potential barriers from a helicopter in 2002 and then conducted field assessments of the barriers in August 2003 and August 2005. Vogel's study is an inventory of the location and geometry of larger salmon and steelhead barriers if these fishes occurred in the rivers. These barriers would likely also impede or prevent upstream passage of resident rainbow trout and hardhead. In general, Vogel (2006) applied the physical parameters of Powers and Orsborn (1985) to determine how each potential barrier may affect upstream steelhead and salmon passage. As a reconnaissance-level survey, the features of potential barriers were estimated.

Some key findings from Vogel (2006) regarding fish passage on the mainstem of the Middle Yuba River were:

- seven sites on the mainstem of the Middle Yuba River were identified to be natural barriers to salmon and steelhead upstream passage: six were considered barriers only during low-flow conditions, and one was considered to be a total barrier regardless of flow conditions. These sites are described in Table 4.0-1.

Table 4.0-1. Potential barriers to upstream passage by salmon and steelhead in the mainstem of the Middle Yuba River identified by Vogel (2006).

Location (River Mile)	Feature	Comments
0.4[1]	low-flow barrier	site visit, 2 falls in series, lower falls 9 feet, upper falls 6 feet, shallow (<3 feet) plunge pool
12.0[1]	low and high-flow barrier	site visit, est. dam height at spillway approx. 52 feet high, total barrier
32.9	low-flow barrier	est. falls 8-10 feet high, plunge pool appears to have some blocking boulders, may be a low-flow barrier but not a high-flow barrier
34.4	low & high-flow barrier	possible low-flow barrier, falls appears about 8-10 feet high, probably not a high-flow barrier
37.9	low-flow barrier	very difficult to see but appear falls may be at least 10 feet tall, probably low-flow barrier but not high-flow barrier
38.9	low-flow barrier	very difficult to see but appear falls may be at least 10 feet tall, probably low-flow barrier but not high-flow barrier

[1] These two barriers are downstream of Yuba County Water Agency's (YCWA) Our House Diversion Dam, which is at about River Mile 12.4.

Some key findings by Vogel (2006) regarding fish passage on the mainstem of the South Yuba River were:

- Three sites on the mainstem of the South Yuba River were identified as only low-flow, natural barriers, and 11 additional sites were judged by Vogel to be total natural barriers to salmon and steelhead at both low and high river flows. Most of the barriers were located in the upper portions of the drainage where the topographic relief adjacent to the river channel is more extreme than that of the downstream portions. These sites are described in Table 4.0-2.

Table 4.0-2. Potential barriers to upstream passage by salmon and steelhead in the mainstem of the South Yuba River identified by Vogel (2006).

Location (River Mile)	Feature	Comments
5.1	low-flow barrier	est. height about 9 feet, complex falls/cascades over large boulders/bedrock with poor plunge pool, possible low-flow barrier but not high-flow barrier
5.9	low-flow barrier	site visit, 9.5-ft height, boulder at critical location in plunge pool, low-flow barrier but not high-flow barrier
19.6	low-flow barrier	site visit, low-flow barrier, not a barrier during high flows, measured height of 8 feet
35.4	low- & high-flow barrier	site visit, two falls, lower fall 13 feet, upper fall 7.5 feet, lower plunge pool very deep, depth of second plunge pool undetermined, both low and high-flow barrier
36.0	low- & high-flow barrier	site visit, measured height 17 feet, total (low and high-flow) barrier
37.9	low- & high-flow barrier	est. height more than 10 feet, poor plunge pool, cascades over bedrock, est. total barrier
38.4	low- & high-flow barrier	est. height of lower falls 15 feet, upper falls, 10 feet, total barrier
39.4	low- & high-flow barrier	est. height over 15 feet, poor plunge pool, total barrier
39.4	low- & high-flow barrier	est. height over 15 feet, poor plunge pool, falls and cascades over bedrock, total barrier
39.5	low- & high-flow barrier	est. height over 15 feet, poor plunge pool, falls and cascades over bedrock, total barrier
39.6	low- & high-flow barrier	est. height over 10 feet, total barrier
39.6	low- & high-flow barrier	est. height over 10 feet, total barrier
39.6	low- & high-flow barrier	complex series of falls est. height over 15-20 feet, cascades over bedrock, total barrier
39.8	low- & high-flow barrier	est. height over 10 feet, total barrier

As provided in the FERC-approved study, field assessments on tributaries identified in the study plan were not needed if data were available from previous studies (i.e., Gast et al. 2005). This information was available from Gast et al. (2005) for one tributary to the Middle Yuba River (i.e., Kanaka Creek) and one tributary to the South Yuba River (i.e., Spring Creeks). This existing information is described above in Sections 3.1.1 and 3.1.2.

Besides the above two tributaries, Gast et al. (2005) surveyed two tributaries on the Middle Yuba River (i.e., Yellowjacket and Oregon creeks). Both tributaries are downstream of YCWA's Our House Diversion Dam.

On the South Yuba River, Gast et al. (2005) surveyed Owl Creek at RM 4.7, Humbug Creek at RM 20.6, and McKilligan Creek at RM 28.2. A potential barrier (i.e., cascade) was identified 100 feet upstream of the mainstem on Owl Creek. On Humbug Creek, Gast et al. identified a 5-foot high potential fish barrier 900 feet upstream of the mainstem. According to Gast et al. (2005), a potential cobble low-flow (i.e., at 0.4 cfs) barrier occurred at the mouth of McKilligan Creek.

4.2 Licensees' Fish Passage Study

The Fish Passage study was designed to supplement the existing information from Gast et al. (2005) with regards to fish passage barriers on selected tributaries to the Middle and South Yuba rivers, and provide information regarding potential barriers on selected sections of some streams and tributaries to project reservoirs. Table 4.2-1 summarizes locations of barriers that were observed either through this Fish Passage study or Gast et al. (2005).

Table 4.2-1. Summary of barriers in selected tributaries to the Middle Yuba River, South Yuba River, and Bear River; tributaries to Project Reservoirs; and mainstem reaches of the Bear River, Auburn Ravine, and Dry Creek.

Tributary Name	Location	Number of Potential Barriers Observed in Tributary
TRIBUTARIES TO THE MIDDLE YUBA, SOUTH YUBA, AND BEAR RIVERS		
East Fork Creek	Middle Yuba River (RM 34.6)	2
Bear Creek	Middle Yuba River (RM 32.5)	1
Wolf Creek	Middle Yuba River (RM 26.9)	2
Moores Flat Creek	Middle Yuba River (RM 22.0)	2
Bloody Run Creek	Middle Yuba River (RM 18.5)	1
Kanaka Creek[1]	Middle Yuba River (RM 16.5)	3
Indian Creek	Middle Yuba River (RM 14.7)	2
Canyon Creek	South Yuba River (RM 32.4)	2
Washington Creek	South Yuba River (RM 28.5)	0
Poorman Creek	South Yuba River (RM 28.0)	0
Jefferson Creek	South Yuba River (RM 27.4)	2
Fish Creek	South Yuba River (RM 25.4)	1
Missouri Canyon Creek	South Yuba River (RM 22.7)	2
Spring Creek[1]	South Yuba River (RM 14.9)	1
Steephollow Creek	Bear River (RM 15.5)	0
TRIBUTARIES TO PROJECT RESERVOIRS		
Pass Creek	Jackson Meadows Reservoir	0
Middle Yuba River	Jackson Meadows Reservoir	0
Middle Yuba River	Milton Diversion Dam Impoundment	0
Jackson Creek	Bowman Lake	0
Canyon Creek	Bowman Lake	0
Greenhorn Creek	Rollins Reservoir	0
Bear River	Rollins Reservoir	0
North Creek	Fordyce Lake	1
South Yuba River	Lake Spaulding	1
Fordyce Creek	Lake Spaulding	0
MAINSTEM REACHES		
Stream Name	**Location**	**Number of Potential Barriers Observed in Mainstem**
Bear River	From the abandoned Upper Boardman Canal Diversion structure downstream to the normal maximum water surface elevation of Drum Afterbay (5.3 miles).	22
Upper Auburn Ravine	From Wise Powerhouses downstream to PCWA's Auburn Ravine Tunnel on Auburn Ravine at RM 26.5 (1.2 miles).	3
Dry Creek	Dry Creek below Halsey Afterbay to Red Hawk Reservoir (1.7 miles).	1 (temporary beaver dam)
	Dry Creek below Rock Creek confluence to Orr Creek Confluence (1.6 miles).	0

[1] Streams identified to be assessed as part of the Fish Passage study, but were not surveyed by Licensees because fish passage data was available from Gast et al. (2005).

4.2.1 Tributaries to the Middle Yuba, South Yuba, and Bear Rivers

On the Middle Yuba River, potential barriers (all natural) were found on all seven of the tributaries that were assessed. On the South Yuba River, Licensees identified potential barriers (natural and man-made) on five of the seven tributaries. The two tributaries on which barriers

were not observed were Washington and Poorman creeks. Licensees did not find potential fish barriers on the first 0.5 mile of Steephollow Creek on the Bear River.

Rainbow trout are found throughout the South Yuba River from Englebright Reservoir upstream to Lake Spaulding and throughout the Middle Yuba River from Our House Diversion Dam upstream to Milton Reservoir (Gast et al. 2005). Licensee's Fish Population study did not include sampling very many of the tributaries to the Middle Yuba, South Yuba, and Bear rivers because, with the exception of Canyon Creek, they are not project affected stream reaches. The two tributaries to be assessed in the Fish Passage study that were sampled as part of the Stream Fish Populations study by Licensees were Poorman Creek (tributary to the South Yuba River) and Steephollow Creeks (tributary to the Bear River above Rollins Reservoir). Both streams contained rainbow trout and had no identified barriers.

4.2.2 Tributaries to Projects Reservoirs

No upstream fish movement barriers were found at the four Yuba-Bear Hydroelectric Project reservoirs surveyed. Potential barriers (all natural) were identified in the two Drum-Spaulding Project reservoirs surveyed. These were on the South Yuba River, a tributary to Lake Spaulding and on North Creek, a tributary to Fordyce Lake.

The Reservoir Fish Populations study (Technical Memorandum 3-11) documented that rainbow trout occur in Lake Spaulding and Fordyce Lake. Rainbow trout were not collected in the South Yuba River upstream of Lake Spaulding during electrofishing surveys as part of the Stream Fish Populations study (Technical Memorandum 3-1). However, rainbow trout are known to exist in Kidd Lake as well as Upper and Lower Peak Lakes both of which drain into the South Yuba River upstream of Lake Spaulding. In addition, CDFG has planted rainbow trout in the South Yuba River above Lake Spaulding. Therefore, it is likely that rainbow trout exist in the South Yuba River above Lake Spaulding. Results of the Stream Fish Populations study show that rainbow trout were found in White Rock Creek, a tributary to North Creek upstream of Fordyce Lake.

4.2.3 Mainstem Reaches

In the mainstems reaches included in the study, 22 potential upstream fish movement barriers were found in the Bear River upstream of Drum Afterbay, three in Upper Auburn Ravine, and one in Dry Creek (a beaver dam).

Results of the Stream Fish Populations study show that rainbow trout are present in the mainstem reaches except for Dry Creek below Halsey Afterbay, where only brown trout were found, and Dry Creek below Rock Creek confluence, where no fish population sampling took place. In the section of the Bear River where 22 fish passage barriers (all natural) were found, large numbers of rainbow trout are present throughout the entire area. In the section of Upper Auburn Ravine assessed, rainbow trout were documented during the Stream Fish Populations study above and below the identified potential barriers.

5.0 Study-Specific Collaboration and Consultation

This FERC-approved study included three study-specific agency consultations. Each of these is discussed below.

5.1 Hardhead

The FERC-approved study states:

> *"If hardhead (Mylopharodon conocephalus) are found during the Relicensing Stream Fish Population Study in project-affected reaches not included in the Study Area specified in Section 6, additional sites will be added to this study plan if Relicensing Participants collaboratively agree additional sites are necessary."*

Technical Memorandum 3-1, Stream Fish Populations study, reports that hardhead were not found during the study. Therefore, consultation during the Fish Passage Study was not required.

5.2 Project Dams

The FERC-approved study states:

> *"Step 4 – Consult with Agencies Regarding Project Dams. Licensees will also consult with Relicensing Participants regarding existing project facilities that may affect adult resident rainbow trout passage. Information that will be examined includes: 1) the facility, including height; and 2) results of Stream Fish Populations Study sampling."*

At a March 10, 2010 meeting, Relicensing Participants collaboratively agreed that no additional data gathering was needed regarding fish passage at project facilities.

5.3 Next Steps, If Any

The FERC-approved study states:

> *"Step 5 – Consult with Relicensing Participants. In this step, Licenses will consult with Relicensing Participants regarding the results of Steps 1 through 4, and in particular identify any potential barriers to upstream movement of adult rainbow trout. Relicensing Participants will collaboratively determine if any of the identified potential barriers warrant additional quantitative examination. In addition, Relicensing Participants will collaboratively determine which method(s) should be used to quantitatively evaluate the identified potential barriers. The quantitative assessment might include the following:*
>
> - *Determination of jump heights and plunge pool depth at barriers;*

- *Development of a simple hydraulic model to assess stage discharge relationships in mainstem rivers at tributary confluences;*
- *Determination of reservoir elevations needed to provide upstream passage out of reservoirs.*

If Relicensing Participants collaboratively determine that a quantitative assessment is necessary, the following additional information may to be useful in determining the method(s) in which to conduct the quantitative assessment:

- *Leaping and swimming capabilities of the fish based on the literature (Powers and Orsborn 1985; Hoar et al. 1978; and Bell 1991; etc.) and fish size and water temperature information from the Fish Population Technical Study Plan and the Water Temperature Modeling Study Plan;*
- *Physical and hydraulic characterization of potential barriers based on measurements from the field and/or Project engineering drawings;*
- *The fish passage assessment methodology outlined in Powers and Orsborn (1985) and*
- *Thompson (1972) modified, where necessary, for the specific species (e.g., rainbow trout) and barriers within in the study area.*

If hydraulic modeling is collaboratively deemed by the Relicensing Participants to be necessary, the modeling assessment might include:

- *Characterization of the seasonality, magnitude, and frequency of flows at the barrier over a range of water year types using the existing and unimpaired flow information.*
- *Coordination with the Instream Flow Study Plan, if appr**o**priate, to provide hydraulic data and modeling to estimate fish passage over the range of flows determined by Relicensing Participants."*

Relicensing Participants discussed the need for additional quantitative information regarding potential fish barriers at a March 10, 2010 meeting, a March 26, 2010 conference call, and a March 29, 2010 meeting. Relicensing Participants and Licensees did not reach collaborative agreement regarding the need for additional data gathering. Relicensing Participants believed there was a need for additional data gathering and Licensees believed there was no need to gather additional data.

6.0 Variances from FERC-Approved Study

This study was conducted according to Study 2.3.4, Fish Passage, and FERC's Study Determination. One variance to the study proposal occurred. NID performed surveys in fall 2008 during low-flow conditions when reservoirs were at low-pool water elevations rather than the spring period in Yuba-Bear Hydroelectric Project reservoirs to allow a larger area to be

surveyed and to advance the study. NID believes this is not a substantial variance, and it improved the study.

7.0 Attachments to this Technical Memorandum

This technical memorandum includes two attachments:

- Attachment 3-4A 2008 and 2009 Fish Passage Data [2 available formats: 1 Microsoft Excel data file: 550 kB; and 1 Adobe pdf printable file: 67 kB; 30 pages formatted to print double sided on 8 ½ by 11 paper]
- Attachment 3-4B Survey Photos [1 Adobe pdf file: 8 MB; 174 pages formatted to print double sided on 8 ½ by 11 paper]

8.0 References Cited

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