Placer County Water Agency
Middle Fork American River Hydroelectric Project
(FERC No. 2079)

FINAL

2006 AQUATIC HABITAT CHARACTERIZATION STUDY PLAN

Prepared for:

Placer County Water Agency
144 Ferguson Road
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September 8, 2006

Placer County Water Agency

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September 8, 2006
File No. 01030A

SUBJECT: Middle Fork American River Hydroelectric Project Relicensing
Final 2006 Geomorphology and Riparian Habitat Characterization Study Plan
and Final 2006 Aquatic Habitat Characterization Study Plan

Dear Resource Agency Representatives –

Enclosed are paper and electronic copies of the Final 2006 Geomorphology and Riparian Habitat Characterization Study Plan and the Final 2006 Aquatic Habitat Characterization Study Plan. Drafts of these documents were forwarded to you on May 5, 2006 and May 10, 2006, respectively for review and comment. The attached final plans address all comments received from the resource agencies to date, including those expressed during a meeting held on June 1, 2006 and during a site visit conducted on August 22, 2006. These documents (with the exception of Non-Internet Public Information) are also available on our MFP Relicensing Website at:

http://relicensing.pcwa.net/techdocs.htm

Please note the Federal Energy Regulatory Commission (FERC) considers some information Non-Internet Public (NIP). The FERC's regulations regarding NIP information are cited in Title 18 of the Code of Federal Regulations (18 CFR) Section 388.112. Pursuant to these regulations, any figures, maps and/or electronic files containing NIP information have been labeled accordingly. PCWA requests that you do not post any of the electronic files labeled NIP on the Internet.

If you have any questions regarding the attached plans or would like to discuss the relicensing project, please don't hesitate to call me at (530) 823-4889.

Sincerely,

Mal Toy

Mal Toy
Director of Resource Development

MT:bb

Attachments:
Final 2006 Geomorphology and Riparian Habitat Characterization Study Plan
Final 2006 Aquatic Habitat Characterization Study Plan
Distribution List

Final 2006 Geomorphology and Riparian Habitat Characterization Study Plan
Final 2006 Aquatic Habitat Characterization Study Plan
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1.0 INTRODUCTION

This study plan describes Placer County Water Agency's (PCWA) proposed approach for conducting Phase 2 of a two-part Aquatic Habitat Characterization Study (Study). Phase 1 of the Aquatic Habitat Characterization Study was completed during 2005, in accordance with the approaches and methods presented in PCWA's 2005-2006 Existing Environment Study Plan Package dated June 17, 2005 (PCWA 2005). The technical approaches included in this study plan represent a refinement of the methods originally presented in PCWA's 2005-2006 Existing Environment Study Plan Package. The Phase 2 studies will be conducted during the summer of 2006 and will augment the work completed in 2005. The 2005 study methods and results are documented in a report titled Draft 2005 Physical Habitat Characterization Report dated January 30, 2006 (PCWA 2006).

PCWA circulated a draft version of the Proposed 2006 Aquatic Habitat Characterization Study Plan to the resource agencies for review and comment on May 10, 2006. All comments received from the resource agencies, including those expressed during a meeting held on June 1, have been addressed in this final plan. PCWA intends to continue to consult with the resource agencies and other interested stakeholders as the work described in this plan is completed and to address any outstanding questions or issues.

2.0 STUDY OBJECTIVES

The purpose of the study is to develop information regarding the types and distributions of aquatic habitats in the stream and river reaches in the vicinity of the Middle Fork American River Hydroelectric Project (Project or MFP). Habitat information is important in developing an understanding of the factors that influence the distribution and abundance of fish and other stream organisms. Information developed as part of this study will be used as a basis for designing future technical studies involving aquatic resources.

3.0 GENERAL APPROACH

The Phase 2 studies proposed in this study plan are designed to augment and build upon information developed as part of the Phase 1 studies conducted in 2005. During Phase 1, aquatic habitat was mapped along the Middle Fork American and the Rubicon rivers using a combination of videography and aerial photography. The smaller streams, including Duncan Creek and Long Canyon, were not mapped due to the presence of dense vegetation, which obscured the view of the streams. The Phase 2 aquatic habitat studies will focus on refining, verifying, and expanding the mapping conducted during Phase 1, using a combination of helicopter surveys and ground surveys. In addition, aquatic habitat information will be collected along the streams that could not be mapped during Phase 1 through focused ground surveys. Detailed measurements of aquatic habitat characteristics will be collected during the ground surveys.

4.0 STUDY METHODOLOGY

The following summarizes the aquatic habitat mapping activities PCWA plans to accomplish in 2006:

- Refine habitat mapping conducted along select reaches of the Middle Fork American and Rubicon rivers using low altitude helicopter reconnaissance surveys.

- Verify and expand upon the habitat mapping information developed in 2005 for the Middle Fork American River and the Rubicon River. This effort would involve conducting focused ground truthing in accessible representative portions of major strata in the Middle Fork American River and Rubicon River.

- Conduct ground surveys to map aquatic habitats along the smaller tributary study streams including Duncan Creek, North and South Forks of Long Canyon Creek, and Long Canyon Creek.

- Complete detailed aquatic habitat mapping at each geomorphic and riparian quantitative study site to provide continuity of information.

- Map aquatic habitat upstream of the diversions on Duncan Creek, North Fork Long Canyon Creek, and South Fork Long Canyon Creek for potential comparison reaches. Assess, in consultation with the resource agencies, if any additional aquatic mapping in comparison reaches is needed.

- Prepare a report documenting the 2006 aquatic habitat mapping results.

The methods associated with each of these activities are described in the following subsections.

4.1 REFINE PHASE 1 HABITAT MAPPING

During 2005, habitat mapping was completed along the Middle Fork American River from French Meadows Dam to the confluence with the North Fork American River, and along the Rubicon River from Hell Hole Dam to the confluence with the Middle Fork American River, using a combination of aerial photography and low altitude aerial videography. The results of this effort are described in the 2005 Aquatic Habitat Characterization Study Report dated January 30, 2006 (PCWA 2006). The visual classification information developed during Phase 1 will be refined in 2006 by conducting low altitude helicopter surveys. Any modifications to the original habitat classifications will be recorded on maps and aerial photographs and will be documented in the 2006 Study Report.

4.2 VERIFY AND EXPAND UPON THE PHASE 1 HABITAT MAPPING

Ground surveys will be conducted to verify and expand upon the aquatic habitat mapping information completed in the Middle Fork American River and Rubicon River in 2005. PCWA proposes to ground-truth accessible reaches along the Middle Fork

American River and Rubicon River. The survey will include those accessible reaches necessary to evaluate up to 20% of the total length of the Middle Fork American and Rubicon rivers downstream of Project facilities. One hundred percent of all accessible reaches will be surveyed if the cumulative total length of all accessible reaches is less than 20% of the total length of the Middle Fork American River and Rubicon River downstream of Project facilities.

Within each of the accessible Rosgen channel type reaches, contiguous lengths of stream will be ground-truthed for efficiency, to the extent feasible. The selection of lengths to be ground-truthed will be based on accessibility and overlap of the geomorphic and riparian quantitative study sites (Table 1 and Figure 1). Survey methods will follow those described in PCWA's 2005-2006 Existing Environment Study Plan Package dated June 17, 2005, and provided in Appendix A.

4.3 MAP AQUATIC HABITAT ALONG STREAMS NOT SURVEYED DURING PHASE 1

Existing aerial photography and low altitude aerial video could not be used to map habitat along the smaller streams mainly due to the presence of dense vegetation, which obscures the view of the stream. Accordingly, PCWA will conduct ground-based surveys along the smaller streams, including:

- Duncan Creek
- North Fork Long Canyon Creek
- South Fork Long Canyon Creek
- Long Canyon Creek

PCWA proposes to utilize a habitat assessment approach that is a modification of BVET (Dolloff et al. 1993). All reasonably accessible reaches in these streams will be inventoried on the ground as indicated in Table 1. All habitat units will be classified to habitat type and the length of each unit will be measured. This approach will provide the location and length of each habitat unit.

In addition, PCWA proposes to take detailed measurements of 20% of the units in each habitat type along each creek following methods described in PCWA's 2005-2006 Existing Environment Study Plan Package dated June 17, 2005, and provided in Appendix A. Units to be measured will typically be selected by systematic sampling of each habitat type. Typically, the first habitat unit of a particular type will be sampled, followed by the sixth unit of that type, and every succeeding fifth unit in each section of stream mapped. Detailed information from a minimum of 10 units of each Dolloff et al. (1993) habitat type (pool, riffle, cascade, complex) will be collected, if present within the survey area.

4.4 CONDUCT DETAILED MAPPING OF AQUATIC HABITAT AT GEOMORPHIC AND RIPARIAN QUANTITATIVE STUDY SITES

Detailed ground surveys will be completed at each geomorphic and riparian quantitative study site following the methods provided in Appendix A. Field measurements will be collected in each habitat unit included in the geomorphic and riparian quantitative study sites. One hundred percent of the length of each quantitative geomorphic and riparian study site will be surveyed. This will allow more detailed assessment of factors affecting aquatic habitat and will provide continuity of data between the studies. The locations for the quantitative study sites are identified in Table 1 and Figure 1.

4.5 ASSESS AND MAP POTENTIAL COMPARISON STREAMS

It may be necessary to compare aquatic habitat between the study streams and other streams, such as unregulated streams upstream of Project diversions (and reservoirs). In order to evaluate the usefulness of unregulated streams as reference sites for study streams, it is important to understand their similarities and differences. Physical habitat resulting from geomorphic characteristics and hydrologic conditions can affect aquatic biota and riparian communities. These characteristics may result from underlying geomorphic and hydrologic differences in addition to differences that may be attributable to Project presence and operations.

PCWA proposes to map one mile upstream of the Project diversions on Duncan Creek, North Fork Long Canyon Creek, and South Fork Long Canyon Creek for possible comparison reaches. In addition, PCWA proposes to consult with the resource agencies regarding the selection of additional possible comparison reaches, study goals, and objectives as they relate to the selection of comparison reaches, study methodologies, and evaluation criteria.

5.0 DATA REDUCTION AND WORK PRODUCTS

Field data will be entered into a database, where data will be stored by stream, reach, channel type, and river mile. Habitat classifications and detailed measurements will be associated with each habitat unit. All data entered in the database will be checked against the original field data sheets for quality control purposes. Data contained in the database will be provided in Microsoft Excel format. Ground-truthing locations and overlap with geomorphic and riparian study sites will be mapped using a Geographic Information System (GIS).

Tabular and graphical summaries of habitats and habitat measurements by stream, reach, and channel type will be produced. Summaries of habitats will be provided by length and frequency. These will include summaries of pool depths, spawning gravel, dominant and subdominant substrates, woody debris, barriers, and other measured parameters. Data and data summaries also will be produced as GIS layers depicting the locations of significant spawning gravels, woody debris, and unusual features or observations of biota of interest.

Photographs will be associated with habitat locations or coordinates and stored electronically.

6.0 REPORTING

A report describing the results of the Phase 2 aquatic habitat studies will be prepared. The report will provide a description of the study objectives, methods, and results. All work products described in this study plan will be incorporated into the report, with text descriptions, tables, graphs, and photographs, as appropriate. In addition, for perspective, the report will include a discussion of recent climatic and hydrologic conditions prior to and during the period of study.

The report and data will be made available to the resource agencies with text descriptions, tables, graphs, and photographs, as appropriate. All study measurement sites will be identified on a base map. GIS layers will be identified on a common base map and provided on a compact disk (CD) to the identified GIS contact at each agency. All data will be provided in raw format on an accompanying CD.

7.0 NEXT STEPS

PCWA is currently conducting the studies presented in this study plan, based on feedback obtained for the resource agencies during the June 1, 2006 meeting and during a field trip conducted on August 22, 2006. The Phase 2 study results will be documented in a report, which will be provided to the resource agencies and other interested stakeholders in January 2007. The combined results of the 2005-2006 Aquatic Habitat Characterization Study will be utilized as a basis to identify the need for additional studies. Any future studies will be developed in consultation with the resource agencies and other interested stakeholders as part of a collaborative stakeholder process, and documented in the Technical Study Plans to be included in PCWA's Pre-Application Document (PAD). The PAD will be circulated for review and comment during the fall of 2007.

PCWA plans to continue to consult with the resource agencies and other interested stakeholders regarding the methods presented in this study plan, and to address any outstanding issues or questions. Consultation would occur by telephone, or in person, if necessary. PCWA plans to continue to consult with the resource agencies regarding:

- Obtain consensus on the location of ground surveys to be performed to verify habitat mapping on the Middle Fork American and Rubicon rivers completed during Phase 1; and

- Identify potential comparison reaches for additional surveys, if appropriate.

As agreed upon during the June 1, 2006 meeting, PCWA developed a schedule showing the dates during which fieldwork is expected to be conducted during the 2006 field season. The field schedule was provided to specific individuals identified by the resource agencies. Updated field schedules will be provided if the field schedule is

modified. PCWA encourages and looks forward to participation by the resource agencies in the field work.

8.0 SCHEDULE MILESTONES

The 2006 studies (Phase 2) will be carried out in accordance with the following schedule.

Proposed 2006 Schedule

Date	Milestone
May – June 2006	Consult with agencies regarding Proposed Phase 2 study plan and methods.
July - Oct 2006	Refine habitat mapping conducted along select reaches of the Middle Fork American River and Rubicon River using low altitude helicopter surveys.
July – Sep 2006	Consult with resource agencies regarding the selection of reaches for focused ground surveys and potential comparison streams.
Jul - Oct 2006	Verify (ground truth) and conduct detailed mapping of the Middle Fork and Rubicon rivers, along reaches selected in consultation with the resource agencies.
Jul - Oct 2006	Map aquatic habitats along smaller streams that were not mapped during Phase 1.
Jul - Oct 2006	Complete detailed mapping at quantitative riparian and geomorphology study sites.
Aug - Oct 2006	Map aquatic habitat within comparison streams, if determined to be appropriate.
Sept – Nov 2006	Data tabulation, reduction and preliminary analysis.
Oct – Dec 2006	Report preparation
Jan 2007	Distribute report to resource agencies and interested parties for review and comment.

9.0 REFERENCES

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United States Department of Agriculture-Forest Service (USDA-FS) Region 5 (USFS R5). 1996. Pacific Southwest Region Stream Condition Inventory Version 3.4 (6/27/96). USFS Region 5, Vallejo, California.

TABLE

Table 1. Phase 2 Study Site Locations.

Reach	Level 1 Rosgen type[1]	Reach River Stationing	Geomorphic and Riparian Study Site Stations (approx.)	Nearest RM Access Points	Accessibility[2]	Final Access Rating[3]	Type of Access Location and Access Description
Middle Fork American River – French Meadows to Interbay							
10	A	47.2-44.2	44.7-44.82	44.8	Accessible	Accessible	• 4-wheel drive and rough hike • Near French Meadows Reservoir
	B	44.2-42.0	--	44.8	Inaccessible	Inaccessible	• 4-wheel drive • Requires at least a 0.6 mile hike within channel
	A	42.0-39.7	--	44.8	Inaccessible	Inaccessible	• 4-wheel drive • Requires a 2.8 mile hike within channel
	Fb or A	39.7-37.4	--	35.9	Inaccessible	Inaccessible	• Car • Requires a 1.5 mile hike within channel
	A	37.5-36.5	--	35.9	Inaccessible	Inaccessible	• Car access at Interbay • Channel is impassible
9	Fb or G	36.5-36.0	36.2-36.1	35.9	Accessible	Accessible	• Car • Interbay dam and reservoir • (PCWA key required)
Middle Fork American River – Interbay to Ralston Afterbay							
	N/A	36.0-35.6					Interbay
8	Fb or B	35.6-33.4	--	35.6	Difficult/ Unknown	Extremely Difficult/ Challenging	• Access requires taking stairs at face of dam and hiking to the channel along unstable hill slope • Unsafe option with gear
7	Fb	33.4-29.1	29.46-29.3	29.4	Accessible	Accessible	• Helicopter

Table 1. Phase 2 Study Site Locations (continued).

Reach	Level 1 Rosgen type[1]	Reach River Stationing	Geomorphic and Riparian Study Site Stations (approx.)	Nearest RM Access Points	Accessibility[2]	Final Access Rating[3]	Type of Access Location and Access Description
Middle Fork American River – Interbay to Ralston Afterbay (continued)							
6	F or B	29.1-27.7	28.87-28.53	29.4	Accessible	Accessible	• Helicopter
5	Fb or B	27.7-26.1	--	27.7	Difficult/ Unknown	Extremely Difficult	• 950-foot descent over 1 mile on steep trail to river • Strenuous hike and challenging with gear
4	Fb	26.1-25.7	26.2-26.1	25.9	Accessible	Accessible	• Car
	N/A	25.7-24.7					Ralston Afterbay
Middle Fork American River – Oxbow to Folsom Reservoir High Water Mark							
3	F	24.7-10.8	17.4-16.25		Accessible	Accessible	• Helicopter landing zones at RM 17.4, RM 16.8, and RM 16.3
2	F or B	10.8-9.6	TBD		Accessible	Accessible	• Gated road to trail which parallels entire “Ruck-A-Chucky” reach
1	F	9.6-0	5.75-3.95	4.2	Accessible	Accessible	• Helicopter landing zones at RM 5.8, Philadelphia Bar, RM 4.7 Buckeye Bar, RM 3.9 Hoosier Bar, or 4-wheel drive, or trail along river
Duncan Creek							
3	B or G	8.6-7.9	8.4-8.25	8.4	Accessible	Accessible	• 4-wheel drive and gage trail
2	B	7.9-5	6.37-6.19	6.15	Accessible	Accessible	• 4-wheel drive and rough trail
1	B or G	5-4	4.63-4.4	4.5	Difficult/ Unknown	Accessible	• 4-wheel drive and rough trail

Table 1. Phase 2 Study Site Locations (continued).

Reach	Level 1 Rosgen type[1]	Reach River Stationing	Geomorphic and Riparian Study Site Stations (approx.)	Nearest RM Access Points	Accessibility[2]	Final Access Rating[3]	Type of Access Location and Access Description
Duncan Creek (continued)							
	G	4.0-3.1	--	4.5, 0.3	Inaccessible	Inaccessible	• Channel obstructions and steep valley walls downstream of RM 4.5 limit access to lower reaches • Requires at least a 0.5 mile hike within channel
	B	3.1-1.0	--	4.5, 0.3	Inaccessible	Inaccessible	• Requires at least a 1.4 mile hike within channel
	A	1.0-0	--	0.3	Inaccessible	Inaccessible	• 4-wheel drive on Red Star Road (FS locked gate) • Extremely difficult 1,020 ft descent over at least 1.1 miles (no trail)
Rubicon River							
16	B	30.3-27.5	28.2-28.07	27.7, 28.7	Accessible	Accessible	• Helicopter landing zone at RM 27.7 or trail at RM 28.7 is 700 ft descent over 1.5 miles
15	F or B	27.5-24.7	25.8-25.6	25.0, 25.4	Accessible	Accessible	• Helicopter landing zone at RM 25.4 or trail at RM 25 is 900-ft descent over 0.8 mile
	G	24.7-24.2	--	25	Inaccessible	Inaccessible	• Hike • Cannot walk channel from access point
	F	24.2-23.4	--	25	Inaccessible	Inaccessible	• Hike • Cannot walk channel from access point

Table 1. Phase 2 Study Site Locations (continued).

Reach	Level 1 Rosgen type[1]	Reach River Stationing	Geomorphic and Riparian Study Site Stations (approx.)	Nearest RM Access Points	Accessibility[2]	Final Access Rating[3]	Type of Access Location and Access Description
Rubicon River (continued)							
14	F or G	23.4-22.5		22.6	Accessible	Inaccessible	• Trail hike from RM 21.2 to 22.6 in disrepair due to landslide • At least a 0.8 mi hike in channel. • South Fork Rubicon confluence at RM 22.6
	F	22.5-21.9	--	21.2	Inaccessible	Inaccessible	• Hike • Requires at least a 0.7 mile hike within channel
13	F or G	21.9-19.7	21.0-20.6	21.2	Accessible	Accessible	• Trail from Rd 2 at Ellicott Bridge
12	F or G	19.7-17.6	19.65-19.28	20.25	Accessible	Accessible	• Trail from Rd 2 at Ellicott Bridge
11	G	17.6-14.6	--	14.3	Difficult/ Unknown	Inaccessible	• Inaccessible from Reach 10 • Steep bedrock confined channel with step pools
10	F or G	14.6-13.5	14.42-14.1	14.3	Difficult/ Unknown	Accessible	• Helicopter landing zone at RM 14.3
9	G	13.5-8.7	--	14.3	Difficult/ Unknown	Inaccessible	• Helicopter landing zone at RM 9.5 washed out in 2006 • Requires difficult, and possibly inaccessible 0.8 mile hike from helicopter landing zone in Reach 10
8	F or G	8.7-6.1	--	14.3	Difficult/ Unknown	Inaccessible	• No helicopter landing zone
7	G	6.1-5.6	--	5.3	Difficult/ Unknown	Inaccessible	• 4-wheel drive and difficult hike • Requires 1,540 ft descent over 2.5 miles to reach channel, then at least 0.4 mile channel hike

Table 1. Phase 2 Study Site Locations (continued).

Reach	Level 1 Rosgen type[1]	Reach River Stationing	Geomorphic and Riparian Study Site Stations (approx.)	Nearest RM Access Points	Accessibility[2]	Final Access Rating[3]	Type of Access Location and Access Description
Rubicon River (continued)							
6	F	5.6-4.4	--	5.3	Difficult/ Unknown	Inaccessible	• 4-wheel drive and difficult hike • Requires 1,540 ft descent over 2.5 miles to reach channel
5	G	4.4-3.7	4.0-3.73	3.4	Accessible	Accessible	• Helicopter landing zone at RM 3.4 and hike channel upstream, or 4-wheel drive to RM 3.4
4	F	3.7-3.3	3.55-3.4	3.4	Accessible	Accessible	• Helicopter landing zone at RM 3.4 or 4-wheel drive to RM 3.4. Long Canyon confluence at RM 3.6
3	F or G	3.3-2.1	2.95-2.28	2.3, 3.4	Accessible	Accessible	• Helicopter landing zone at RM 2.3 or 4-wheel drive RM 3.4
2	F	2.1-0.8	1.42-1.07	0.5	Difficult/ Unknown	Accessible	• Car
1	G	0.8-0.5	0.77	0.5	Accessible	Accessible	• Car
North Fork Long Canyon Creek							
1	B	3.1-0	1.9-1.78	1.7	Accessible	Accessible	• Car
South Fork Long Canyon Creek							
1	B	3.3-0	2.5-2.25	2.2	Accessible	Accessible	• Car
Long Canyon Creek							
2	B	11.4-7.0	9.1-8.83	8.6	Accessible	Accessible	• Car
1	A	7.0-0	0.17-0.1	3.4 (Rubicon River)	Accessible	Accessible	• Helicopter or 4-wheel drive at RM 3.4 • Access from Rubicon River Reaches 3 to 5

[1]Reaches are defined by breaks in Rosgen Level I channel classification.
[2]Reaches in blue text indicate difficult channel accessibility. Reaches in red text are inaccessible.
[3]Final access ratings are based on inspections of candidate study sites and selection of quantification study sites during mid-summer 2006.

FIGURES

Placeholder for Figure 1

Figure 1. 2006 Geomorphology, Riparian, and Aquatic Study Reaches (Sheets 1- 3)

Non-Internet Public Information

These Figures have been removed in accordance with the Commission regulations at 18 CFR Section 388.112.

These Figures are considered Non-Internet Public information and should not be posted on the Internet. This information may be accessed from the Placer County Water Agency's (PCWA's) Public Reference Room, but is not expected to be posted on PCWA's Website, except as an indexed item.

APPENDIX A

Survey Methods

Introduction

PCWA proposes to develop detailed aquatic habitat information at select locations along the Rubicon River, the Middle Fork American River, and along the smaller streams, including the South Fork and North Forks of Long Canyon, Long Canyon and Duncan Creek. In general, detailed aquatic habitat information will be developed along 20% of each accessible candidate reach, except in those locations where quantitative riparian and geomorphology study sites are established. In these cases, 100% of the quantitative study site will be surveyed. The detailed aquatic habitat information will be developed in accordance with the methods originally presented in PCWA's 2005-2006 Existing Environment Study Plan Package dated June 17, 2005, and further described below. The data sheets for the detailed data collection are shown in Appendix B.

Habitat Classification

During Phase 1, habitats were classified by using two sets of criteria, Hawkins *et al*. (1993) and McCain *et al*. (1990). This same approach will be utilized for visual assessments in 2006. The Hawkins *et al*. (1993) mesohabitat typing yields a general view of the quantity of aquatic habitats available and is generally more amenable to visual classification than other approaches. Hawkins *et al*. (1993) outlines a hierarchy for types of aquatic habitats as summarized in Table A-1. As indicated, the aquatic habitats are first divided into fast and slow water types. Second, the fast water types are grouped into turbulent or non-turbulent types. Slow water types are further grouped into dammed pool or scour pool types.

Table A-1. Hawkins *et al*. (1993) Level I and Level II Habitat Classifications.

Fast Water (Riffle/Run)		Slow Water (Pool)	
Turbulent	**Non-Turbulent**	**Scour Pool**	**Dammed Pool**
Riffle Habitat – High Turbulence – Caused by geomorphological differences (i.e. gradient, bed roughness, and/or step development	Run Habitat – Non-Turbulent – Caused by geomorphological differences (i.e. gradient, bed roughness, and/or step development	Pool Habitat – Formed by Scour - Pool created by erosion of stream bank, boulder, bedrock, etc.	Pool Habitat - Formed by Dam - Pool created by water blockage due to debris, landslide, beaver dam, large boulders, etc.

The United States Department of Agriculture-Forest Service (USDA-FS) Fish Habitat Relationships Technical Bulletin (McCain *et al*. 1990) (Table A-2) uses a more detailed level of habitat typing than provided by Hawkins *et al*. (1993). McCain *et al*. (1990) outlined procedures to inventory fish habitat using riffle, run and pool habitats as the three primary categories of habitat found in stream channels. Riffle and run habitats fall into the turbulent and non-turbulent categories described by Hawkins *et al*. (1993). Pool habitats are described by their position and cause of their formation; they are either dammed pool habitats or scour pool habitats.

Table A-2. Habitat Types and Codes Adapted from McCain *et al*. (1990).

Riffle	
Low Gradient Riffle	LGR
High Gradient Riffle	HGR
Cascade	
Cascade	CAS
Bedrock Sheet	BRS
Flatwater	
Pocket Water	POW
Glide	GLD
Run	RUN
Step Run	SRN
Trench Chute	TRC
Edgewater	EGW
Pool	
Main Channel Pool	MCP
Lateral Scour Pool	LSP
Corner Pool	CRP
Secondary Channel Pool	SCP
Dammed Pool	DPL
Backwater Pool	BWP
Step Pool	SPO
Plunge Pool	PLP
Channel Confluence Pool	CCP
Additional Unit Designations	
Dry	DRY
Road-Crossing	RDC
Concrete Box Culvert	CBC

Habitat types will be classified in the field according to both classification schemes. Habitat lengths and widths will be measured to the nearest foot using a hip-chain for length and a stadia rod or tape for widths. The mean and maximum depth of each habitat type will be measured to the nearest 0.1 feet with a stadia rod for depth of less than 20 feet. A hand held depth finder or a weighted marked rope will be used to measure depths in excess of 20 feet.

Substrate Classification

During the habitat mapping surveys, the stream channel substrate will be characterized and recorded by the field team. In each mesohabitat, the percent distribution of different size classes of substrate will be visually estimated to the nearest 10%. Streambed substrate classes will be grouped as follows:

- Fines (organic material)
- Fines (silt/clay), <0.062 mm;
- Sands, 0.062 - 2 mm;
- Gravels, 2 - 64 mm;
- Cobbles, 64 - 256 mm;
- Boulders, 256 - 4096 mm; or
- Bedrock.

A sand card will be carried by each field team to aid in the classification of sand and fine materials. Substrate characteristics associated with each mesohabitat will be recorded on datasheets.

Spawning Gravel

Spawning gravel, including gravel present in small pockets, will be measured as the estimated amount (square feet) of spawning-sized gravel (0.25-2.5 inches diameter, adapted from Bjorn and Reiser (1991)) occurring in each mesohabitat. In addition, habitat areas with spawning gravel will be assigned a "Spawning Quality" score of "Poor, Fair, Good, or Excellent." The score will be based primarily on substrate composition, since much of the mapping will be conducted during the summer months when streamflow will be low. The quality of spawning gravel will be characterized based on the angularity of the gravels and embeddedness. Gravels of higher suitability for use by spawning trout are highly rounded. Gravel that is more angular is considered of lower quality for spawning. Generally, a "Good" or "Excellent" score will be assigned to rounded spawning gravels with little sand and fines present and low embeddedness. Spawning gravels with high embeddedness and a high proportion of sand will receive a "Fair" or "Poor" score, regardless of angularity. The scoring criteria are presented in Table A-3.

Table A-3. Description of Spawning Gravel Quality.

Spawning Quality	Description of Substrate
Excellent	Round-shaped spawning gravels loose in substrate.
Good	Round-shaped spawning gravels slightly embedded in substrate or moderately jagged-shaped spawning gravels loose in substrate.
Fair	Round-shaped spawning gravels embedded in substrate or moderately jagged-shaped spawning gravels slightly embedded in substrate.
Poor	Round or jagged-shaped gravels deeply embedded in substrate.

Wolman Pebble Counts

Wolman pebble counts will be performed at stream segments encountered during the mesohabitat mapping effort. This effort will focus on reaches with substrates that are different from those surveyed as part of the Phase 2 geomorphology studies.

Stream Bank Erodability

Stream bank erodability will be visually estimated in one of four categories: zero, low, medium or high. A score will be assigned to the stream banks of each habitat. Zero will be typically assigned to stream banks that have very low erodability, such as bedrock and boulder. Low and medium scores will be assigned to stream banks that have good bank structures, such as an intact riparian zone or boulder/cobble dominated bank. High scores will be assigned to stream banks that are very unstable; such as sand dominated stream banks.

Vegetation

Riparian habitat information will be developed including a description of the dominant vegetation covering the stream banks. Vegetative groups will include no vegetation, grasses, shrubs, deciduous trees, coniferous trees, and mixed trees. Stream bank vegetation will be characterized by the percentage category of each stream bank covered by vegetation. The categories recorded will be: zero, 1% - 25%, 25% - 50%, 50% - 75%, and 75% - 100%. Stream shade will be measured to the nearest 10% using a spherical densiometer. Riparian graminoids will be mapped as part of the aquatic habitat characterization study and as part of the riparian habitat mapping study. Presence and absence of graminoids and approximate cover will be estimated along each stream bank within each habitat unit as part of this study element. Graminoid mapping will only be conducted along larger rivers where hardhead are known or expected to reside.

Fish Habitat Cover

Fish cover in each habitat unit will be characterized. The percent of the unit that contains boulders, bedrock ledges, turbulence, depth, aquatic vegetation, algae, terrestrial vegetation, undercut banks, woody debris, or rootwad cover will be quantified.

This refers to cover that fish can hide in or under. Terrestrial cover must be within 1.5 feet of the water surface to be considered cover.

Graminoids

Riparian graminoids will be mapped as part of the aquatic habitat characterization study and as part of the riparian habitat mapping study. Presence and absence of graminoids and approximate cover will be estimated along each stream bank within each habitat unit as part of the aquatic study element. Graminoid mapping will only be conducted along larger rivers where hardhead are known or expected to reside.

Large Woody Debris

Large woody debris will be counted in each stream habitat unit. The woody debris data will be collected according to the Stream Condition Inventory by Region 5, USDA-FS. According to this protocol, the length of all downed wood recorded would be at least one-half bankfull width and recorded if any part lies in the bankfull channel. In the case of debris jams or other accumulations of wood, all pieces of wood meeting the criteria will be counted.

Potential Fish Barriers

Potential fish passage barriers will be visually assessed and characterized by experienced fish biologists. These will include culverts, road crossings, debris jams, cascades, bedrock sheets, shallow riffles, and dewatered areas, among others. Additionally, a visual assessment of potential fish passage barriers at the mouths of tributaries will be conducted. Photographs will be taken and spatial coordinates collected using a Global Positioning System (GPS) for each of the barriers identified during the ground surveys. Crews also will identify the location of prominent features, such as tributaries, gaging stations, diversions, recreational facilities and other facilities with GPS coordinates.

Tributary Flow and Temperature

Field crews will estimate flow in tributaries that are encountered during the habitat mapping ground surveys. Specifically, field crews will measure stream width, and take three measurements of depth and velocity of each flowing tributary immediately upstream of the confluence with the stream being mapped. A General Oceanographics™ current meter, or other small velocity meter, will be used to take the three timed current measurements across the wetted channel. Spot measurements of water temperature will be taken with a standard thermometer.

Incidental Observations

Incidental observations of fish, wildlife, and amphibians will be recorded on maps and in notebooks, along with GPS coordinates, species, date, number of individuals, and lifestages (where possible). Photographs of amphibians or reptiles will be taken, when the species cannot be identified by sight.

Organic Material

The presence of *Didymosphenia geminata* (nuisance algae) will be documented, when observed. Samples of suspected *Didymosphenia geminata* will be sampled and dried for later analysis, if necessary. Decisions regarding the need for sample analysis will be made in consultation with the resource agencies.