BLUE LAKE RANCHERIA

Draft Water Quality Sampling and Analysis Plan

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Prepared by:

Kier Associates
791 Eighth Street, Suite N
Arcata, CA 95521

For the:

Blue Lake Rancheria Environmental Programs
P. O. Box 428
Blue Lake, California 95525

Blue Lake Rancheria
Water Quality Sampling and Analysis Plan

Blue Lake Rancheria
PO Box 428
Blue Lake, CA 95525

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Blue Lake Rancheria Project Manager _____

Blue Lake Rancheria QA Manager _____

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_____ _____

Region 9 Quality Assurance Manager

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1.0 INTRODUCTION

The Blue Lake Rancheria (BLR) is located in the Mad River basin near the town of Blue Lake, California. The purpose of this Sampling Analysis Plan (SAP) is to begin a water quality monitoring program that will supply quality assured data for management decisions related to the aquatic environment within BLR and the Mad River watershed.

1.1 SITE NAME

Aquatic resources will be sampled within and adjacent to the Blue Lake Rancheria. Tribal lands include the BLR Reservation and all properties under ownership by members. Most aspects of Mad River water quality are not well studied nor are Powers Creek and a wetland area, which are partially or wholly within the Reservation. While the Tribe does not drink from the aquifer under its lands, they are likely joined to the Mad River and Powers Creek and are, therefore, the subject of concern.

1.2 SITE LOCATION

Blue Lake Rancheria Tribal Lands are located in northwestern California within the Mad River watershed (Figure 1). The Rancheria is partially within and adjacent to the City of Blue Lake California, on the north bank of the Mad River. The BLR totals 32 acres but other land owned by the Tribe or members and not converted to fee status encompasses 44 acres includes sections of the Mad River and Powers Creek.

The four major water sources that will be sampled include: the Mad River, Powers Creek, a freshwater wetland area, and the groundwater underlying the BLR. Detailed site descriptions of the sampling locations can be found in Section 2.0 below.

1.3 RESPONSIBLE AGENCY

The Blue Lake Rancheria Environmental Programs (BLREP) will be responsible for sampling and monitoring in the project area.

1.4 PROJECT ORGANIZATION

Title/Responsibility	Phone Number
EPA Project Manager	**(415) 972-3443**
BLREP Project Manager	**(707) 668-5101**
Quality Assurance Officer	**(707) 668-5101**
Water Quality Technician	**(707) 668-5101**

Figure 1. Location of the Blue Lake Rancheria with respect to the Mad River watershed, California.

1.5 STATEMENT OF SPECIFIC PROBLEM

The BLREP is concerned with the long-term health of the aquatic resources within all BLR Tribal Lands and the surrounding watershed area. A recognized potential problem is an abandoned land fill formerly used by the City of Blue Lake that is adjacent to Powers Creek not far upstream of the BLR, although preliminary groundwater tests did not detect pollution. Although the City of Blue Lake does provide sewage treatment, many households in the lower Mad River watershed use septic systems, which also pose a potential threat of water pollution. Non-point source pollution from the streets of Blue Lake may also be impacting the wetland contained with the BLR, although no data has yet been collected.

The Mad River is recognized by the State Water Resources Control Board (NCRWQCB, 2001) and the U.S. Environmental Protection Agency as sediment impaired. The BLR would like to see sediment problems abated and fisheries resources restored to where there is a harvestable surplus of salmon and steelhead for Tribal members and the public. In order for the BLR to participate as co-managers of Mad River water quality and watershed health, the BLREP must demonstrate data collection, management and analysis capabilities. The first step to attainment of this long-term goal is baseline data collection for water bodies within the Reservation, which is the focus of this SAP.

1.6 DATA USES

The BLREP will collect data on a variety of water quality parameters within and adjacent to the Reservation from the Mad River, Powers Creek, a wetland area and in groundwater. BLR wants to insure that waters within or under the Reservation pose no threat of harm to Tribal members, the public or the environment. These reconnaissance data are for the use of the BLR, U.S. EPA, and the North Coast Regional Water Quality Control Board. They may also be shared after QA/QC, analysis and publication with the City of Blue Lake, the Humboldt Bay Municipal Water District (HBMWD) and others engaged in Mad River research or management. The BLREP water quality staff will collect and organize data and perform analysis.

If any parameters indicate "action levels" of pollution, the BLREP Director will inform the BLR Council to begin consideration of appropriate abatement measures. State and federal water quality agencies, the City of Blue Lake and the HBMWD would also be notified regarding any finding of impairment. While the Tribe reserves the right to take action within the boundaries of its Reservation, they would likely seek at cooperative approach to resolve water quality problems.

The BLREP will continue monitoring at sampling sites in the future to check for changes in ambient conditions periodically, even if action levels of pollutants are not found. Recognized water pollutants will become the subject of more intensive long term trend monitoring. Reports on the findings of data collection and analysis will be made available to funding agencies and the public. Results of routine water quality collection by staff, in addition to any externally funded studies, will also be documented in a *BLREP Annual Water Quality Report*.

2.0 BACKGROUND

2.1 LOCATION

The Blue Lake Rancheria is located in the Mad River watershed in northwestern California in Humboldt County along the lower Mad River in and adjacent to the City of Blue Lake (Figure 1).

2.1.1 Geographical Location

The Mad River flows from its headwaters in Trinity County near the Town of Mad River to its mouth in McKinleyville 90 miles to the northwest. The watershed is long and narrow, covering approximately 500 square miles. The upper portion of the basin is in the Six Rivers National Forest and the remaining portion is under private ownership, containing large areas of industrial timberlands and ranchlands. There are no major roads that follow the river and middle reaches are virtually inaccessible to the public.

The lower Mad River basin includes the communities of Blue Lake, Arcata, and McKinleyville as well as the BLR. Recreational use is concentrated in the lower reaches and at Ruth Reservoir at its headwaters, which is the water storage facility for the Humboldt Bay Municipal Water District (HBMWD) that withdraws drinking water for 80,000 customers 75 miles downstream, below the City of Blue Lake.

2.1.2 Site Location

Sampling will be carried out within and adjacent to the BLR and will include three sites on the mainstem Mad River, two sites on Powers Creek, two in the wetland area within the Reservation and in four pre-existing wells that the Tribe has permission to test (Figure 2).

2.2 HYDROGEOLOGY/GEOLOGY

The hydrology of the lower Mad River is discussed below because groundwater will be sampled, but bedrock geology and geomorphology are also broached because they have bearing on Mad River sediment impairment.

2.2.1 Hydrology

The BLR is located within the Mad River Groundwater Basin, which is comprised of deep alluvium and is underlain by the Hookton Formation, Tertiary Wildcat group sediments and the Franciscan Formation. The latter is composed of consolidated shale, sandstone, conglomerate, schist, and basalt (CDWR, 1973). The Blue Lake Rancheria lies upon Pleistocene terrace deposits and Holocene Alluvium with unsorted gravels, sands, and clays of fluvial origin. Terrace depths are estimated to 100 feet thick and alluvium may be up to 200 feet thick (CDWR, 2003). GeoEngineers Inc. (2002) measured the groundwater surface at depths of 15 to 17 ft. below the ground surface in May 2002 within the BLR. The measurements indicated a groundwater flow direction

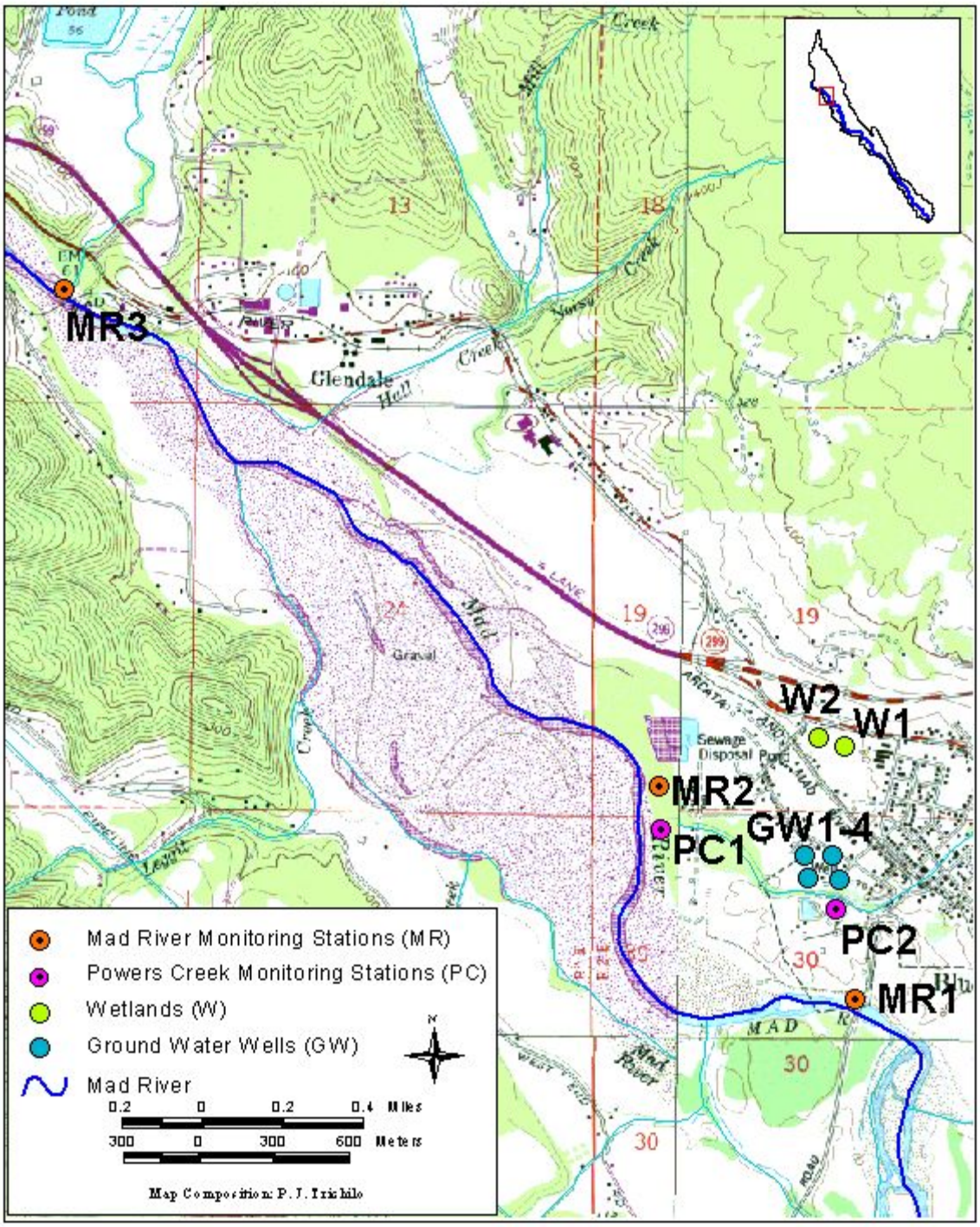

Figure 2. Location of BLREP sampling sites including Mad River (MR), Powers Creek (PC), groundwater wells (GW) and the wetland (W) area within and adjacent to the BLR shown on a 1:24,000 USGS topographic map.

towards the north-northwest. USGS streamflow gage no. 11481000 of Mad River near Arcata, CA should be sufficient for use as part of the BLREP WQ Monitoring program.

2.2.2 Geology

The Mad River follows a thrust fault, which is named after it, that causes significant seismic shaking on the order of magnitude 6.0-7.0 (Carver et al., 1983). The location of the Mad River watershed near the southern end of the Cascadia Subduction Zone leads to even larger seismic events on the order of 300-600 years (Carver and Burke, 1987). The collision of the Gorda Plate and North American Plate causes rapid local uplift and landscape instability as well as significant areas of sheared soil materials that are subject to mass movement. The orographic effect along the steep Coast Range, through which the Mad River flows, causes major increases in rainfall, with annual totals in excess of 100 inches in some areas of the watershed. The combination of steep unstable terrain with intense rainfall can lead to significant erosion, when the landscape is disturbed by land use activities (CDWR, 1982).

2.3 ENVIRONMENTAL AND/OR HUMAN IMPACT

Land use activities within the Mad River watershed pose potential threats to water quality of the BLR. Major land uses that could cause impact to water quality include: urbanization, gravel extraction, forest management practices, agriculture and grazing, and municipal wastewater treatment facilities.

2.3.1 Urbanization

Urban developments by the Blue Lake Rancheria and City of Blue Lake have influence on the water quality of the streams, wetland, and groundwater within Blue Lake Rancheria properties. Urban developments are known to cause profound changes to natural watershed conditions by altering the terrain, modifying the vegetation and soil characteristics, introducing pavement, buildings, drainage, and flood control infrastructure (U.S. EPA, 1983). Reported urban impacts have included: increased frequency of flooding and peak flow volumes, decreased base flow, increased sediment loadings, changes in stream morphology, increased organic and inorganic pollutants, increased water temperatures, loss of aquatic/riparian habitat and loss of aquatic species diversity.

In a study of 22 Puget Sound streams, May et al. (1996) found that the key index for gauging impacts on urban streams is total impervious area (TIA). TIA typically results in increases of peak flows and decreases in base flows as well as facilitating transport of pollutants to the stream. Hall (1972) and Hollis (1975) found that peak flows with recurrence intervals of 2-years increased by factors of two, three, and five with 10, 15 and 30 percent impervious development, respectively. The increase in surface runoff and decrease in infiltration reduces the natural groundwater storage that becomes available for summer base flow (Schueler, 1994). Streams influenced by urbanization in the San Francisco Bay area have been documented changing from perennial to flashier intermittent streams that do not flow in summer (Mangarella and Palhegyi, 2002).

Urbanization also affects the availability of sediment supplies and changes stream channel morphology. The EPA (1983) reported that increased erosion in urbanized channels is a significant cause of fish habitat degradation. May et al. (1996) found that as the TIA exceeded 20%, fine sediment (<0.85 mm) typically exceeded 15%, a level that was harmful to both salmonids and aquatic insects.

The U.S. Environmental Programs (1983) found that the water quality of urban runoff was degraded, containing high concentrations of heavy metals, organic pollutants, fecal coliform bacteria, nutrients, and total suspended solids. Heavy metals exceeding the EPA's water quality criteria and drinking water standards included: copper, lead, zinc, nickel, cadmium, arsenic, and beryllium. Copper, lead, and zinc were found in 91 percent of all samples and were found at levels in receiving waters harmful to aquatic life. High nutrient concentrations were linked to eutrophication problems in receiving waters.

Many houses outside the City of Blue Lake use septic systems, which can be linked to bacterial water pollution. Use of backyard pesticides has become an increasing concern, with widespread use of such products as diazinon leading to widespread water pollution in urban streams in the San Francisco Bay (SFBWQCB, 2001).

2.3.2 Gravel Mining

Gravel mining is actively practiced on the gravel bars of the Lower Mad River (Lehre, 1993). Instream mining alters sediment transport resulting in altered channel morphology, decreased bed stability, accelerated erosion, and changes in the composition and structure of substrate (Spence et al., 1996). Collins and Dunne (1990) reviewed case histories on the effects of gravel extraction and found that stream channels typically down cut and widen. Widening channels can result in shallower water depths and reduced pool frequencies, eliminating migrating and rearing salmonid habitats. Water temperatures may increase as a result to increased width to depth ratios (Spence et. al., 1996). Lowering of mainstem channel bed base levels have resulted in degradation of tributary streambeds (Harvey and Schumm, 1985).

Loss of channel stability may result in increased sediment transport and increased turbidity. Prior to gravel mining activity, the lower Mad River was highly utilized chinook salmon spawning habitat (USFWS, 1960), but shifting bedload may significantly decrease redd stability and egg and alevin survival (Nawa and Frissell, 1993). See discussions below on effects of Mad River gravel mining under Previous Investigations.

2.3.3 Forest Practices

Forest management practices impact the quality and quantity of Blue Lake Rancheria's aquatic resources. Logging prior to the 1955 flood increased sediment yield sufficiently to fill the capacity of the reservoir above Sweasey Dam, which was located below Maple Creek on the mainstem Mad River. The dam's subsequent breaching and release of stored sediment in 1966 caused major channel changes above and below the town of Blue Lake.

USGS (1973) noted that elevated turbidity on the Mad River as a result of past logging and floods. Another wave of logging began in the lower Mad River watershed in the mid-1980's (Figure 3) and turbidity during winter storm events is elevated for several months of the year. Elevated turbidity levels can reduce the reactive distances of fish during foraging, clog or damage gill membranes, and inhibit normal activities (Spence et al., 1996). Sigler et al. (1984) reported that turbidities over 25 NTU reduced growth of young coho salmon and steelhead.

Hagans et al. (1986) show that roads can contribute 50 to 80% of the sediment that enters a stream and road densities associated with logging in the lower Mad River basin are high. Surface erosion from roads can produce chronic sources of fine sediment that can diminish salmon and steelhead spawning success (Cedarholm et al. 1981).

2.3.4 Agriculture and Grazing

Agriculture and grazing occur on the alluvial terraces of the lower Mad River and potentially impact water quality and the health of the aquatic resources. Non-point source pollution associated with agriculture and grazing can cause degradation to the aquatic ecosystem. Removal and degradation of riparian vegetation, compaction of soils, and applications of fertilizer, pesticide and herbicide applications in agriculture and grazing areas have been associated with impacts on water quality, hydrology, and aquatic habitat. Increases in stream temperatures, increased surface runoff, decreased summer base flows, increased erosion, high inputs of nutrients, and simplification of stream habitats have all been observed and documented (Spence et al. 1996).

2.3.5 Municipal Wastewater Treatment

City of Blue Lake wastewater treatment plant is located adjacent to the Blue Lake Rancheria and poses a potential hazard to the water quality of the Rancheria and Mad River in case of a mechanical failure (e.g. flooding, leachate, pipe break, etc). Impacts on water quality could result from loading of untreated or partial treated water from the treatment plant and sharply increase nutrients or coliform levels. Releases during low flows could result in a decline in dissolved oxygen (DO) in response to high biological oxygen demands.

2.4 PREVIOUS INVESTIGATIONS

Although the water quality of the Mad River at various locations has been sampled by several agencies and entities, most locations within the BLR have not. There are over-lapping authorities and jurisdictions with regard aquatic resources in the basin and the existing information base for decision support is fragmented and incomplete. Reconnaissance level data has been collected by the California Department of Water Resources (DWR) and the State Water Resources Control Board (SWRCB) SWAMP program. DWR (1973; 2001) has also conducted limited ground water monitoring. The most extensive sampling has been conducted by the Humboldt Bay Municipal Water District in connection with drinking water quality protection for its 80,000 customers, but those data are not currently available.

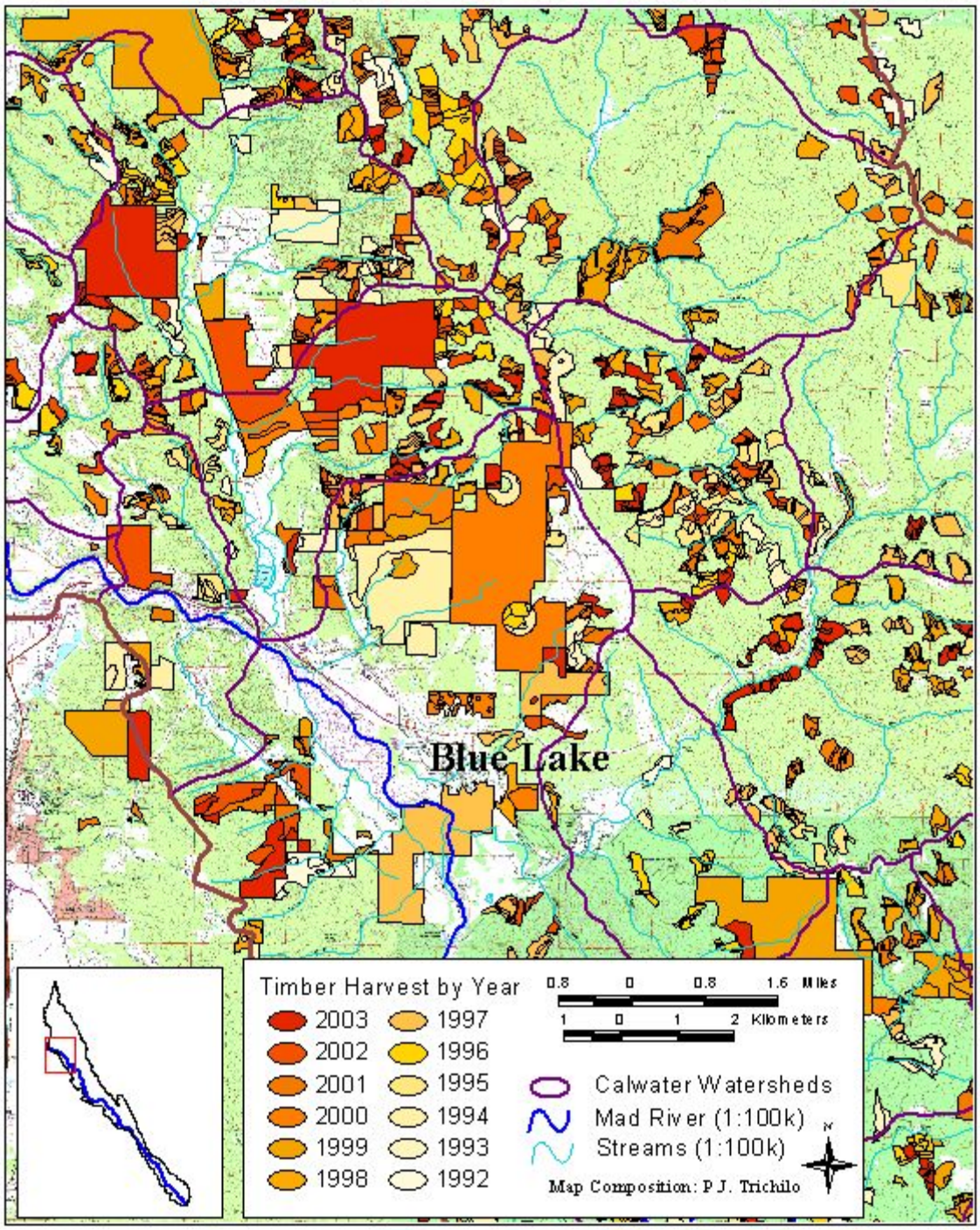

Figure 3. Timber harvest permits issued in the proximity of the BLR from 1992-2003. Data from the California Department of Forestry.

2.4.1 Gravel Mining Effects

Lehre (1993) estimated gravel recruitment rates and analyzed bed degradation in the lower Mad River between the Mad River Hatchery and the US Highway 299 Bridge. This study relied on pre-existing hydrologic and geomorphologic data including: stream flow records, sediment transport data, channel cross-sections and longitudinal profiles, and aggregate extraction data.

Lehre (1993) found that the streambed and gravel bars of the lower Mad River have degraded since at least 1929; lowering approximately 5-feet between 1960 and 1992. Comparison of minimum annual aggregated extraction and gravel recruitment rates showed that aggregate extraction between 1960 and 1992 exceeded the annual gravel recruitment rate by 2 to 3 times; accounting for all of the observed bed lowering and reducing bedload transport downstream of the US Hwy 299 Bridge. Additionally, gravel extraction has limited the transport of coarse sediment supplies to the estuary downstream of the US Highway 101 Bridge, and that the stream gradient has flattened as a result (Lehre, 1993).

2.4.2 Wetland

No known water quality sampling has occurred in Powers Creek or within the freshwater wetland within the BLR, although Mad River Biologists (2001) conducted biological surveys of the freshwater wetland area. The study delineated perennial wetland habitats, identified the presence of plant and animal species, and identified potential habitat for sensitive species. The wetland was found to provide potential habitat for the red-legged frog, and breeding habitat for the sharp-shinned hawk, Cooper's hawk, yellow warbler, and the yellow-breasted chat. No sensitive plant species were found during the field assessment (Mad River Biologist, 2001).

2.4.3 Groundwater Monitoring

In May 2002, the Blue Lake Rancheria contracted GeoEngineers, Inc. to perform an Environmental Site Assessment (ESA) of ground water on the Stewart property located on the Blue Lake Rancheria near Powers Creek (GeoEngineers, Inc., 2002). A former landfill located south of the property was operated from 1945 to the 1970's. The assessment was conducted to assess whether or not impacts to groundwater had occurred as the result of releases of hazardous materials or leachate originating from the landfill.

GeoEngineers (2002) sampling and analysis procedures followed a U.S. EPA approved SAP. GeoEngineers (2002) created four permanent groundwater monitoring wells, measured water quality parameters, and submitted groundwater samples to Severn Trent Laboratories, Inc. for analysis. The measured field water quality parameters included: temperature, pH, and specific conductance. Chemical analysis of the groundwater samples included organochlorine pesticides, chlorinated herbicides, volatile organic compounds, semi-volatile organic compounds, metals, inorganics, and coliforms. The study results did not indicate the presence of landfill leachate, however, it was recommended that further groundwater samples be analyzed for Bis (2-Ethylhexl) phthalate or BEHP, a contaminant found in motor oil and PVC products.

2.5 REGULATORY INVOLVEMENT

The U.S. EPA has authority to manage water quality but delegates most responsibility to the SWRCB. The North Coast Regional Water Quality Control Board (NCRWQCB) has water quality authority for northwestern California and sets standards through its *Basin Plan* (NCRWQCB, 2001). The NCRWQCB (2001) has listed the Mad River watershed as an impaired waterbody for sediment and turbidity under section 303(d) of the Clean Water Act. A Ninth Circuit Court Consent Decree requires that the U.S. EPA and the SWRCB development of Mad River Total Daily Maximum Load (TMDL) allocations for sediment and turbidity. Development of the TMDL Technical Report for the Mad River is scheduled to begin in 2005 and end in 2007.

The National Marine Fisheries Service and California Department of Fish and Game have jurisdiction over Pacific salmon species listed under the Endangered Species Act at the federal and State level, respectively. Coho salmon and steelhead are recognized as Threatened in the Southern Oregon/Northern California Evolutionary Significant Unit (ESU), which includes the Mad River. CDFG (2002) also recently recognized coho salmon as Threatened throughout its range in northwestern California, including the Mad River.

3.0 PROJECT DATA QUALITY OBJECTIVES

3.1 DATA USES

Data collection serves four purposes:

1) Establish baseline water quality conditions,
2) Quantitatively assess the quality of BLR water resources,
3) Long-term ambient and trend monitoring, and
4) Use in TMDL development and implementation.

The most important objective of data collection under this *SAP* is to establish baseline BLR water quality conditions and to identify any potential issues affecting beneficial uses. Long-term collection of monitoring data will empower the BLREP to understand seasonal and long-term trends and variability and observe changes in the water quality parameters related to land management activities. A monitoring database will help the BLR to make informed management decisions that would affect water quality and aquatic resources. Additionally, data collected by the BLREP could be used in watershed analysis, in the development of the Mad River TMDL, and monitoring required for TMDL implementation. If any water body has impaired water quality conditions, more intensive sampling will be carried out to identify the point and non-source point pollutants. Mitigation for those sources will be designed and implemented and long-term trend monitoring continued to make sure problems are being abated.

3.2 PROJECT TASK

Data will be collected in surfaces waters of the Mad River, Powers Creek, and a wetland within BLR and groundwater under the BLR within the Mad River Groundwater Basin. Specific sampling locations are displayed as Figure 3 and are as follows:

- The Mad River will be sampled at 3 locations including at the Hatchery Road Bridge in Blue Lake, on the BLR below the mouth of Powers Creek and the railroad trestle near the mouth of Lindsey Creek,
- Powers Creek will be sampled at 2 locations, at its mouth and at the Stewart property further upstream,
- The wetland within the BLR will be sampled where flow enters and 100 feet west in the same waterbody, and
- Groundwater will be sampled at the Stewart property within the BLR at 4 wells established for previous groundwater studies.

While the Mad River is perennial and can be sampled year around, Powers Creek sometimes loses surface flow in its lower reaches and the wetland may not have standing water at the end of summer before Fall rains. Consequently, sampling will not be possible at PC-1 and W-1 and W-2 roughly in Summer and Fall, depending on rainfall and the water year.

Measurements in Mad River will represent conditions that are shaped by management of the Mad River watershed as a whole and are expected to reflect sediment impairment, particularly turbidity. Sediment pollution could stem from several sources such as forestry practices, agriculture and grazing and gravel mining. Sediment is the focus of the upcoming *Mad River TMDL* that will allow participation of BLR staff in analysis of watershed wide sediment problems. Subsequent updates of this *Draft SAP* may include additional data collection related to sediment impairment to assist in *TMDL Implementation* monitoring.

Continuous turbidity monitoring will take place at MR-2 on BLR property using a YSI 6600 that will also measure several other water quality parameters. The upper site (MR-1) at the Hatchery Road Bridge and the lowest (MR-3) at the railroad bridge bracket the City of Blue Lake sewage treatment facility and the mouth of Powers Creek. Therefore, results may give an indication of problems with pollution from those sources.

With regard to Powers Creek and wetland sampling stations, the hypothesis upon which BLREP is proceeding is that pollution related to urbanization is likely within the wetland and in lower Powers Creek. The abandoned waste dump within the City of Blue Lake is still a source of concern for BLR and groundwater monitoring will check for pollutants from that source. Groundwater and surface waters might also reflect leachate from septic systems. Water quality and quantity parameters to be sampled for each water body are listed in Table 1, including action levels that were chosen to comply with NCRWQCB *Basin Plan* (2002) standards and those set by U.S. EPA for protection of beneficial uses under the Clean Water Act.

Table 1. Water quality and quantity parameters to be sampled by BLREP, including waterbody sampled, data uses and action levels.

Parameter	Units	Water Body	Data Uses	Action Level	
Stage (Water Level)	ft	Powers Cr Groundwater Wetland	Baseline Long-term Monitoring TMDL		
Discharge	cfs	Powers Cr Wetland (inflow)	Baseline Long-term Monitoring TMDL		
Temperature	°C	Mad River Powers Cr Wetland Groundwater	Baseline Long-term Monitoring TMDL	MWAT[1]	
				< 16.8	
pH	pH	Mad River Powers Cr Groundwater Wetland	Baseline Long-term Monitoring	Min[2]	Max[2]
				6.5	8.5
Dissolved Oxygen	mg/L	Mad River Powers Cr Wetland	Baseline Long-term Monitoring	Min[2]	50%LL[2]
				7.0	10.0
Conductivity	µS/cm	Mad River Powers Cr Groundwater Wetland	Baseline Long-term Monitoring	90%UL[2]	50%UL[2]
				300	150
Turbidity	NTU	Mad River Powers Cr Wetland	Baseline Long-term Monitoring TMDL		
Coliform Bacteria	/100 ml	Mad River Powers Cr Groundwater Wetland	Baseline Long-term Monitoring	Surface	Ground
				50	1.1 MPN
Total Nitrogen	mg/L	Mad River Powers Cr Groundwater Wetland	Baseline Long-term Monitoring	0.12 [3]	
Total Phosphorus	µg/L	Mad River Powers Cr Groundwater Wetland	Baseline Long-term Monitoring	10.00 [3]	
Bis (2-Ethylhexl) phthalate	µg/L	Groundwater	Long-term Monitoring	4.0	

[1] Maximum weekly maximum temperature (MWMT) or "7-day maximum" threshold for coho salmon from Welsh et al. (2001).

[2] Mad River Water Quality Objectives from the North Coast Regional Water Quality Control Board's Water Quality Control Plan (2001).

[3] Action levels adopted from U.S. EPA Ambient Water Quality Criteria Recommendations Rivers and Streams in Nutrient Ecoregion II (U.S. EPA 2000).

Flow and stage measurements will allow assessment of dilution of potential pollutants or relationships of sources to climatic events and flow. Stream discharge in Powers Creek may show effects of urbanization. Nutrient pollution indicators from non-point urban sources should show in sampling results for nitrogen, phosphorous, pH, and dissolved oxygen. Temperature impairment could be caused by increased channel width related to sediment contributions or gravel mining, although the lower Mad River is within the coastal fog belt and, therefore, less subject to temperature pollution. E. coli would indicate pollution from septic leaching, the City of Blue Lake sewage treatment facility, or possibly from cattle grazing. GeoEngineers (2002) recommended groundwater monitoring for the plastic break down product Bis (2-Ethylhexl) phthalate in case leaching from the abandoned land fill within the City of Blue Lake has a delayed impact. That resurvey will take place within the next five years, but not immediately under this *SAP*.

3.3 EXPECTED DATA QUALITY

Data quality will be assured by

- Proper study design,
- Following standard methods,
- Using well calibrated equipment,
- Taking and maintaining good field records,
- Following chain of custody procedures for laboratory analysis,
- Prompt data entry in standard programs and formats,
- Data archiving with back ups to insure against loss, and
- Proper oversight of QA/QC procedures.

The only recognized impairment of waters of the BLR is the Mad River for sediment, as discussed above. Groundwater tests failed to find any significant level of pollution, although GeoEngineers (2002) did find Bis (2-Ethylhexl) phthalate (BEHP) in one of four wells. Action levels for BEHP and other parameters are listed in Table 1.

The BLREP will use standard equipment, such as Yellow Springs Instrument (YSI) data probes and Marsh McBerny current meters. These devices will be calibrated according to specifications as put forth in the accompanying equipment manual before each use. Onset Instrument automated probes for monitoring water temperature will be placed according to regional protocols (Lewis, 1999). The BLREP data collection is appropriate to achieve the needed detection limits.

The sampling design strategically covers the BLR surface waters for sampling to detect potential impairment. Groundwater sampling will follow protocols and use the same existing wells established as part of the previous study (GeoEngineers, 2002), as detailed in that project's *SAP*. The frequency of sampling is geared toward getting representative data. Field sampling will include Quality Control (QC) samples as appropriate.

3.4 DATA QUALITY INDICATORS

Accuracy is the degree of agreement of a measurement with the true value. Accuracy includes a combination of random error (precision) and systematic error (bias) that result from sampling and analytical operations. Accuracy of water quality and quantity measurements contained in this SAP is a function of the equipment used during sampling, which are listed in Table 2.

Precision is a measure of agreement among replicate measurements of the same property, under prescribed similar conditions. This agreement is calculated as either the range (R) or standard deviation or expressed as a percentage of the mean of the measurements, such as relative range (RR) for duplicates or relative standard deviation (RSD). The precision of the sampling equipment is also listed as a percentage in Table 2.

Table 2. Precision of sampling equipment used by the BLREP for data collected under this SAP.

Matrix	Parameter	Measurement Method	Precision	Accuracy	Measurement Range
Water	Depth	Staff Plate	± 5.0%	0.1 ft	0-20 feet
Water	Velocity	Meter	± 8.0%	± 8.0%	0.25 - 8.0 ft/sec
Water	Temperature	TidBit Probe	0.16°C at +21°C	±0.2°C @ +21°C	-4°C to +37°C
Water	Temperature	YSI Precision ™ Thermistor	0.1°C	± 0.15°C	-5 to 45°C
Water	pH	YSI Glass electrode	0.01 units	±0.2 units	0 to 14 units
Water	Dissolved Oxygen	YSI Steady state polarographic sensor	0.01 mg/L	±2% @ 0 to 20 mg/L ±6% @ 20 to 50 mg/L	0 to 50 mg/L
Water	Conductivity	YSI 4-electrode cell with autoranging	0.001 mS/cm to 0.1 mS/cm range-dependent	± 0.5% + 0.001 mS/cm	0 to 100 mS/cm
Water	Turbidity	HACH 2100P Turbidimeter	0.01 NTU	± 2%	0-1000 NTU
Water	Total Nitrogen	EPA 351.4	1.0mg/L		
Water	Total Phosphorous	EPA 365.1	0.020 mg/L		
Water	Multi-Parameter*	YSI 6600 EDS	various	various	various
* turbidity, temperature, pH, DO and conductivity					

Completeness is a measure of the amount of valid data obtained, expressed as a percentage of the number of valid measurements that were planned to be collected. Lack of completeness may result in an inability to support Data Quality Objectives or to provide adequate data for assessment and decision support by the BLR. Increased sample sizes improve the power of the statistical tests and all BLREP samples will add to the pool of data for the Mad River. The BLREP will also continue to work to obtain data from all other sources and will use data from DWR, SWRCB and HBMWD as available to compare to BLREP data.

Representativeness is a qualitative measure of the degree to which data accurately and precisely represent a characteristic of the sampled population or environmental condition. Sampling methods are designed to be as representative as possible based on literature review of regionally accepted methods by the US Geological Survey, U.S. Department of Agriculture Forest Service, U.S. Fish and Wildlife Service, and the U.S. Environmental Protection Agency. Sample representativeness will be assured by proper site selection and preparation. Site selection and preparation methodologies are described in Sections 6.3 and 6.4 below.

Comparability qualitatively expresses the confidence with which one data set can be compared to another. The use of standard, published methods in this project allows data to be compared to data from other regional projects and using the same methods throughout allows for comparison of data collected by the BLREP in the future. Sampling methodologies are described in Sections 6.3 and 6.4 below. Expressing data using consistent units of measure also addresses comparability. Units of measure for each water quality parameter are listed in Table 1.

3.5 DATA MANAGEMENT

To insure data accuracy from field collection to analysis and reporting, all data collected will be recorded on standardized field forms (Appendix A). The WQ Technician is responsible for checking and copying field data sheets and delivering them to the QA Officer, who will oversee data management. Original field data sheets will be filed and kept in the BLREP Office. All field data will be transcribed into a standard database form and be readable in a Microsoft Excel. Data are to be double checked at the time of transfer from paper to electronic form.

Data from Onset automated temperature probes will be transferred to computers and then translated into standard database form. Outliers will be detected, documented and trimmed, but both raw (dtf) and edited data shall be retained. Final QA data will then be charted for preliminary analysis and for use in discussion between the field technician and QA officer. Only data that meet QA/QC requirements will be used in reports and documents. All data will be electronically backed-up on an external hard disk and archived off BLR premises

Digital photographs of monitoring locations and conditions at the time of each sample will be downloaded, cataloged and annotated in an appropriate database.

3.6 ASSESSMENT OVERSIGHT

The QA officer will check field forms, databases and preliminary results from sampling at least monthly. Any discovery of problems with data or logistics of sampling will be documented and corrected as soon as discovered. The BLREP will be encouraged to bring problems to the attention of the QA officer before routine meetings when problems with QA/QC procedures are suspected.

Data quality will be assessed by looking at how samples compare to the existing universe of Mad River data or recognized ranges of expected values from the literature. Any data that do not fall within expected ranges will be thrown out from use in any analysis or report, but maintained with an associated metadata file describing why those data did not meet QA/QC standards.

4.0 SAMPLING DESIGN

4.1 SURFACE WATER SAMPLING

Surface water sampling will occur in the Mad River, Powers Creek, and in the wetland contained on the BLR. Multiple parameter water quality data will be collected at each site using equipment listed in Table 2. While many data values will be from hand held instruments, a YSI 6600 will capture continuous data on the mainstem Mad River at site MR-2 within the BLR. Stage-discharge data will also be collected for Powers Creek and the wetland to characterize the hydrology of these waterbodies. Mad River water quantity data can be taken from the USGS streamflow gage no. 11481000, Mad River near Arcata, CA. Detailed descriptions of the sampling site locations and the data parameters of concern for each waterbody follow.

4.1.1 Sampling Locations

4.1.1.1 Mad River

The Mad River will be sampled at the Hatchery Road Bridge in the City of Blue Lake, on a levee on the BLR just below Powers Creek and downstream at the railroad bridge (Figure 3). These locations provide ideal points of access at nearly all flow stages and bracket potential effects from the City of Blue or its sewage treatment facility and some impacts of agriculture and gravel mining. Samples from these locations can be compared with the universe of samples collected by the DWR, SWRCB, HBMWD and others.

4.1.1.2 Powers Creek

Sampling on Powers Creek will take place at its junction with the Mad River and upstream on the Stewart property, both within the BLR (Figure 2). The mouth of Powers Creek has a significant delta or sediment deposit that causes loss of surface flow during late summer and early fall. The sampling station upstream at the Stewart property will allow flow and water quality measurement even during dry periods, such as temperature data from automated probes. Both sampling stations are located below the City of Blue Lake and are likely to show effects of urbanization.

4.1.1.3 Wetland

Stage and discharge monitoring will occur at the point of in-flow into the wetland on the BLR to characterize its hydrology. The water quantity data can be used to determine a water budget and frequency of flooding and inundation. A crest gage tube will be placed onto the staff gage to the capture peak water surface elevation of a storm event without requiring the presents at the site. The crest gage is calibrated to the staff gage and uses the rating curve to determine the peak flow rate. Staff gages will also be placed in the wetland and at the wetland inflow channel to show water surface elevation or stage.

4.1.2 Analytes of Concern

This SAP covers a number of different parameters that will be sampled surface waters and are referenced here as analytes of concern. Justification for collecting data on these parameters follows.

Flow or Stage/ Discharge: Flow data will be collected Powers Creek and at the inflow to the wetland. Water quantity directly affects water quality conditions, including: stream temperatures, dissolved oxygen (DO) levels, and nutrient loadings. To be most useful, stream flow information must be collected in a standardized manner, with known accuracy, and for long continuous time period.

Temperature: Water temperatures fluctuate in response to normal climatic conditions, but human alteration of streams may give rise to temperature impairment (Poole and Berman, 2001). The North Coast Regional Water Quality Control Board *Basin Plan* (NCRWQCB, 2001) defines the Mad River as "cold freshwater habitat." Welsh et al. (2001) found that coho salmon required a maximum floating weekly average water temperature (MWAT) lower than 16.8 ^{o} C. Hines and Ambrose (1998) came to very similar conclusions with regard to coho salmon temperature tolerance in Mendocino County coastal streams. Therefore, an MWAT of 16.8 ^{o} C will be used by the BLREP as a reference for coho salmon suitability for both Powers Creek and Mad River. Warm water temperatures are likely a natural condition within the wetland, but there is no use by salmonids of this disconnected water body.

pH: The NCRWQCB Water Quality Control Plan Mad River objectives for pH range from a minimum of 6.5 to a maximum of 8.5 (NCRWQCB 2001), which will be the standard against which BLR surface waters will be judged. High photosynthetic activity associated with nutrient enrichment in the wetland could be reflected in increased pH.

Dissolved Oxygen: Dissolved oxygen (DO) testing in the wetland area may help discover if nutrient enrichment is occurring. Nutrient enrichment may lead to photosynthetic activity or biological oxygen demand changes that can cause depressed DO. Nocturnal or pre-sunrise sampling is necessary to detect sags associated with nocturnal plant respiration (Deas and Orlob 1999). High rates of photosynthesis may also give rise to elevated DO or supersaturated conditions during the day. The NCRWQCB has defined water quality objectives for dissolved oxygen within the Mad River as a minimum of 7.0 mg/l or 50% or more of the monthly means must be greater than or equal to 10 mg/l under the Region 1 Water Quality Control Plan (NCRWQCB, 2001).

Conductivity: Conductivity is related to concentration of total dissolved solids plus major ions and is expressed as microsiemens per centimeter (μS/cm). It is sensitive to variations in dissolved solids and temperature and, therefore a good screen for a wide range of substances. The NCRWQCB Water Quality Control Plan objectives for conductivity in the Mad River are 50% or more of the monthly means must be less than or equal to an upper limit of 150 μohms or 667 μS/cm or 90% or more of the values must be less than or equal to an upper limit 300 μohms or 333 μS/cm (NCRWQCB, 2001).

Turbidity: Turbidity is a measure the transmisivity of light through water and is gauged as nephlometric turbidity units (NTU). Sigler et al. (1984) found that turbidities as low as 25 nephlometric turbidity units (ntu) caused a reduction in juvenile steelhead and coho growth. High turbidity during winter likely impacts the feeding ability of juvenile salmon, steelhead or cutthroat trout. The duration of impairment may be the most telling factor in turbidity impacts to salmonids (Newcombe and McDonald, 1991), but that may be better gauged using the long-term, continuous data from the HBMWD.

Nutrients (Phosphorous, Nitrogen): Under section 304(a) of the Clean Water Act (CWA), the U.S. EPA established water quality criteria for nutrients including total nitrogen and phosphorus in Ecoregion II (U.S. EPA, 2000), which includes the Mad River watershed. These levels were set with the goal to reduce problems associated with excess nutrients in waterbodies and are listed as Action Levels in Table 1. Nutrient pollution is not expected in BLR waterbodies, but detection of excess phosphorous and nitrogen would serve as an indicator. High levels of nitrate and nitrite found in drinking waters are harmful to human health. The U.S. EPA set drinking water Maximum Contaminate Levels (MLC) for nitrate and nitrite (both measured as nitrogen) at 10 mg/L and 1 mg/L, respectively (U.S. EPA 2003). If high total nitrogen levels are detected in reconnaissance samples, subsequent tests specifically for nitrate and nitrite would follow.

Coliform Bacteria: While some Coliform bacteria are naturally present in soils and water, positive tests for fecal coliform bacteria may also turn up *Escherichia coli,* a known pathogen indicative of recent sewage or animal waste contamination of water. The U.S. EPA Primary Drinking Water Standard for Total Coliform states that no more than 5.0% of samples taken can be total coliform-positive in a month.

4.2 GROUNDWATER SAMPLING

Groundwater will be measured in the same wells adjacent to Powers Creek drilled for the GeoEngineers (2002) study. These were found to be appropriately located to gauge potential impacts from a nearby land fill within the City of Blue Lake. Groundwater levels seasonally will also be noted as part of well sampling. GeoEngineers (2002) recognized BEHP as being potentially over Maximum Contaminant Levels in one ground water sample, but ascribed it to laboratory contamination. The current BLREP budget for groundwater monitoring does not allow for re-sampling under this *SAP*, but samples for BEHP will be conducted within five years. Measuring phosphorous, nitrogen and conductivity in ground water provides a screen for many different types of pollutants. If

values of other groundwater water quality parameters measured depart from expected ranges, further investigations will be initiated.

4.3 SAMPLE IDENTIFICATION SYSTEM

All grab samples will be uniquely numbered and labeled using alpha-numeric system that identifies the hydrological year, sample site, sample type, and sequence number (Table 3). At the beginning of the hydrologic year all bottles used in sampling are assigned a waterproof sticker with a unique ID number. The WQ Technician procures these stickers, keeps a logbook of the ID numbers, and labels all sample bottles before they are used in the field.

All grab sample bottles are further labeled in the field with the pertinent information, including: sampler's initials, time, date, and stage if available. All data labeled on the bottles are logged before samples are delivered to the lab. The sample ID # is also written on the field sheet at the time of sampling.

Table 3. This table illustrates the alpha-numeric code system that will be applied to all samples so that they can be traced back to field notes for QA/QC, if necessary.

Code	**Description**
ID number example	05-MR-TN-1234
1st two digits	Hydrologic year (05 = 2005)
1st two letters indicating sample location	MR = Mad River PC = Powers Creek W = Wetland GW = Groundwater*
Last two letters indicate sample type	TN = Total Nitrogen TP = Total Phosphorus CB = Coliform Bacteria
Last 4 digits	Unique, sequential number for each sample type within the hydrologic year
* GW designation will also be followed by well numbers used in GeoEngineers (2002).	

4.4 SAMPLE PRESERVATION AND HOLDING CONDITIONS

Water samples sent for laboratory analysis require specific container types, sample volumes, preservation methods, and maximum holding times. These sample preservation and holding conditions for nutrient and coliform bacteria samples are listed in Table 4. Any preservatives required will be added to samples immediately after the sample is collected. Any sample that exceeds the maximum holding time will be discarded and notes will be recorded in the metadata records.

Table 4. Required sample containers, volumes, preservation methods and holding times for water samples requiring laboratory analysis.

Analysis	Container Type	Sample Volume	Preservation Method	Maximum Holding Time
Total Nitrogen	Plastic Bottle	½ gallon	H_2SO_4 to pH <2	28 days
Total Phosphorous (TPO_4)	Plastic Bottle	300 mL	Chill to 4˚C, Dark	28 days
Total Coliform Fecal Coliform E.Coli	Sterile plastic or Glass with lid	100 mL	Chill to 4˚C	6 hrs
BEHP	Amber glass with teflon septa	1 L	Chill to 4˚C	14 days

5.0 REQUEST FOR ANALYSIS

5.1 REQUEST FOR ANALYSIS TABLES

Table 5 lists all parameters that will be measured, whether from surface or groundwater, whether laboratory analysis will be necessary and if handling times are limited. There will be fewer QC blanks for laboratory samples due to budgetary constraints, but risk of contamination is low because the BLREP is using disposable sampling equipment.

Table 5. Request for analysis table showing all parameters to be measured.

Parameter	Surface or Groundwater	Lab Required or Meter	Handling Time	Blanks for QC
Stage Height	S & G	Meter	NA	NA
Discharge	S	Meter	NA	NA
Temperature	S	Meter	NA	NA*
pH	S & G	Meter	NA	1 per 10*
DO	S	Meter	NA	1 per 10*
Nitrogen	S & G	Lab	28 days	Twice Yearly
Phosphorous	S & G	Lab	28 days	Twice Yearly
Conductivity	S & G	Meter	NA	1 per 10*
Turbidity	S	Meter	NA	1 per 10*
Fecal coliform	S & G	Lab	6 hrs.	Twice Yearly
* Continuous recorder YSI 6600 to be calibrated weekly.				

5.2 ANALYSES NARRATIVE

Laboratory analysis will be necessary to process water samples collected under this *SAP* for fecal coliform, phosphorous, and nitrogen. For sample volumes, types of containers needed for samples, and methods of preservation for samples going to laboratories, please see Table 3. QC blanks samples will be collected twice yearly for laboratory samples, but field blanks for other parameters measured will be at a rate of one for each ten field

samples. The continuous data recording YSI 6600 will be checked weekly using blank samples.

6.0 METHODS AND PROCEDURES

6.1 FIELD HEALTH AND SAFETY PROCEDURES

The first rule for field health and safety is common sense. A few basic guidelines should be followed each time when entering the field:

- Establish a safe path to the site.
- Never wade deeper than your waist under any conditions. In high velocity, conditions even water waist deep is not safe.
- Watch for debris coming downstream.
- Always have a partner nearby or have a mobile phone to contact the BLR office in case of an emergency.

6.2 FIELD PROCEDURES

6.2.1 Equipment

A list of all equipment used for the monitoring with performance specifications is included in Table 2 above, but referenced by trade name in Table 6. Equipment will be inspected and maintained to U.S. EPA and manufacturer specifications. Records of maintenance and calibration will be kept for all appropriate equipment.

Table 6. Field equipment and parameter to be measured.

Instrument	Measured Parameter
Onset StowAway TidBit Temperature Logger	Water Temperature
YSI 556 MPS Handheld Instrument	Water Temperature, pH, Dissolved Oxygen, Conductivity
YSI 6600 EDS In situ instrument	Water Temperature, pH, Dissolved Oxygen, Conductivity, Turbidity
HACH 2100P Turbidimeter	Turbidity
USGS Type AA current meter	Water Velocity
USGS Pygmy current meter	Water Velocity

6.2.2 Equipment Calibration and Maintenance

The BLREP field technician is responsible for implementing and documenting calibration of all instruments. Calibration will follow instructions accompanying instruments and U.S. EPA protocols. All equipment calibration records will be reviewed by the QA officer at least monthly and stored on file at the BLREP. All equipment shall have an identifying number and linked to calibration records. If equipment does not meet specifications or is not working properly, data will not be collected or not used if results were collected just prior to discovery of equipment problems. The QA officer will make sure that equipment is repaired or replaced expeditiously and problems fully documented.

Personnel involved in sampling will wear clean latex gloves to protect themselves and to prevent contamination of samples.

6.2.2 Field Notes/Field Logbooks

Standardized data collection field sheets will be used for every sample in permanently bound write-in-the-rain notebooks. Field sheets for discharge and water quality measurements are shown in Appendix B. Field logbooks will document where, when, how, and by whom any vital project information was obtained. Logbook entries will be complete and accurate enough to permit reconstruction of field activities. The following information will be entered in a bound field notebook at the time of sampling:

- Project name and number
- Sampler's name or initials
- Time and date of sample collection
- Station number and location
- Sample number
- Parameter measured
- Field sample value
- Depth below water surface from which water sample is taken
- Estimated flow and gage height readings at the adjacent staff gage
- Current weather conditions/evidence of recent precipitation
- General field conditions
- Problems related to sampling

For laboratory samples, additional fields would be filled out:

- Lab to which sample is to be shipped
- Preservation method
- QC blank or regular sample
- Handling time
- Method of shipment
- Type of container used

6.2.2.1 Photographs

Photographs should be taken at the sample location during each sampling event. For each photograph taken, the following information should be written into either the field logbook or a separate photograph logbook:

- Time
- Date
- Name of photographer
- Location
- Film roll/photograph number
- Aspect of photograph
- Weather conditions
- Description of the subject photographed

Photographs taken in the field with a digital camera will be downloaded and organized onto computer drives at the same time field data are recorded. Photographic information will be archived on external hard drives with back ups both on and off BLREP premises to avoid data loss.

6.3 SURFACE WATER SAMPLING PROCEDURES

6.3.1 Water Quantity

6.3.1.1 Stage Measurements

Staff gages will be placed in the inflow to the wetland and Powers Creek to show water surface elevation or stage. The following procedure will be followed for installing a staff gage.

1. Locate the gage at a monumented cross-section. Establish a permanent datum so that only one datum is used for the life of the station. Reference the datum to a bench mark of known elevation above mean sea level so that the arbitrary datum may be recovered if the gage or reference marks are destroyed.
2. Make sure that the lower end of the gage is within the water body during a low water event. Avoid installing the gage in the path of high-velocity currents or debris. Drive a steel signpost, fence post, or pipe vertically into the streambed or wetland bottom.
3. Position the gage so that it is readable during high flow events. Attach the gage plate with stainless steal bolts and lock nuts at a height where it will show the full range of stages for the water body. Set the upper end of the staff gage with reference to observed elevations for flood stages.
4. Calibrate the staff gage to discharge at the time of placement by recording the stage reading and measuring the stream discharge.

Staff gages will be visited on a weekly basis except during storm events when daily visits may be necessary to attempt to make sure the gauge is properly calibrated and that it properly captures the storm hydrograph. Staff gage measurements will be recorded in a field logbook along with the site location, time and weather conditions. Data from the logbook will be transferred to an electronic database back in the BLR office.

To capture the peak storm flows a crest gage will be installed onto the back of the vertical support of the staff gage (USGS, 1982). The crest gage will consist of a 2” galvanized pipe, capped at both ends. The top cap is vented with a 3/16” hole and the bottom cap has six 1/4" intake to minimize hydrostatic drawdown (Figure 6). An aluminum staff that fits tightly between the caps is marked in increments reference to the staff gage. Granulated cork is placed inside the pipe after installation. Readings are made by removing the top cap and withdrawing the staff. The peak stage is indicated by the elevation where grains of cork adhere to the staff. Peak stage readings will be taken after each storm event. Measurements will be recorded in a field logbook along with the site

location, time and weather conditions. Data from the logbook will be transferred to an electronic database in the BLR office.

6.3.1.2 Discharge Measurements

Discharge measurements will be gathered to develop stage-discharge rating curves for Powers Creek and the wetland inflow channel. Discharge measurements will typically be taken during storm events. Discharges at a cross-section are computed following US Geological Survey protocols for the mid-section method as found in Buchanan and Somers (1969). The mid-section method breaks a cross-section into at least 25 to 30 partial sections. Partial sections are places such that no partial section contains more than 5% of the total flow. If a cross-section is broad or complex more partial sections are used.

A rectangular area of the total channel cross-sectional area represents each partial section. Velocities are sampled by a current meter to obtain the mean of the vertical velocity distribution. It is assumed that the mean velocity at each section represents the mean velocity in that rectangular (Buchanan and Somers, 1969).

Mad River flow data for calibration of such water quality parameters as turbidity will come from the USGS flow gauge #11481000, which is downstream of Blue Lake.

The partial discharge for any rectangular section is computed as,

$$q_x = v_x \left[\frac{b_{(x+1)} - b_{(x-1)}}{2} \right] d_x \qquad (1)$$

where:

q_x = discharge through partial section x,
v_x = mean velocity at location x,
$b_{(x+1)}$ = distance from the initial point to the next location,
$b_{(x-1)}$ = distance from the initial point to the preceding location,
d_x = depth of water at location x.

The summation of the discharges for all partial sections is the total discharge for the cross-section.

$$Q = \sum_{x=1}^{n} q_x \qquad (2)$$

where:

Q = Total discharge through the cross-section,
n = total number of partial sections.

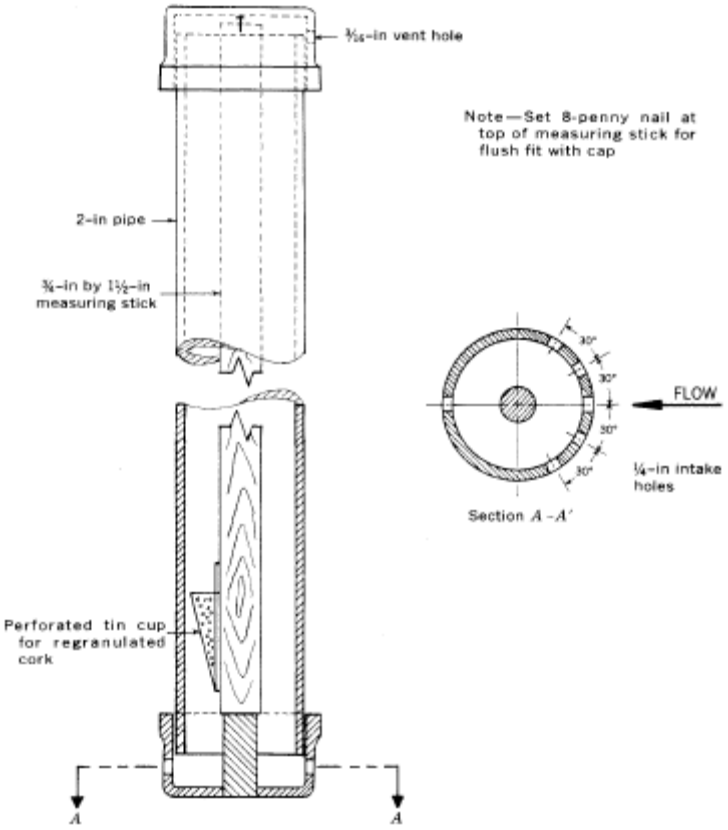

Figure 6. Crest gauge construction illustration from Buchanan and Somers (1982).

See Figure 7 for a sketch showing the compartmentalization of a cross-section using the mid-section method.

According to Buchanan and Somers (1969), the procedure for taking current velocity follows:

1. For best accuracy, select a discharge measurement cross-section in a straight reach, with a uniform depth and as rectangular a channel morphology as possible. The streambed should be stable, free of large rocks, weeds, and obstructions that create turbulence. The site should be accessible for measurements over a range of discharges. Set the endpoints of the cross-section with rebar or wooden stakes.
2. Determine the wetted width of the stream. Secure a tape measure (tag line) perpendicular to the direction of flow extending between the endpoints of the cross-section. Determine and record the locations on the tape measure of the right-edge-of water (REW) and left-edge-of water (LEW) when facing downstream.
3. Determine the spacing of the verticals, breaking the cross-section into at least 25 to 30 partial sections. No partial section should contain more than 5% of the total discharge or be less than 0.5 feet in length. Equal widths of

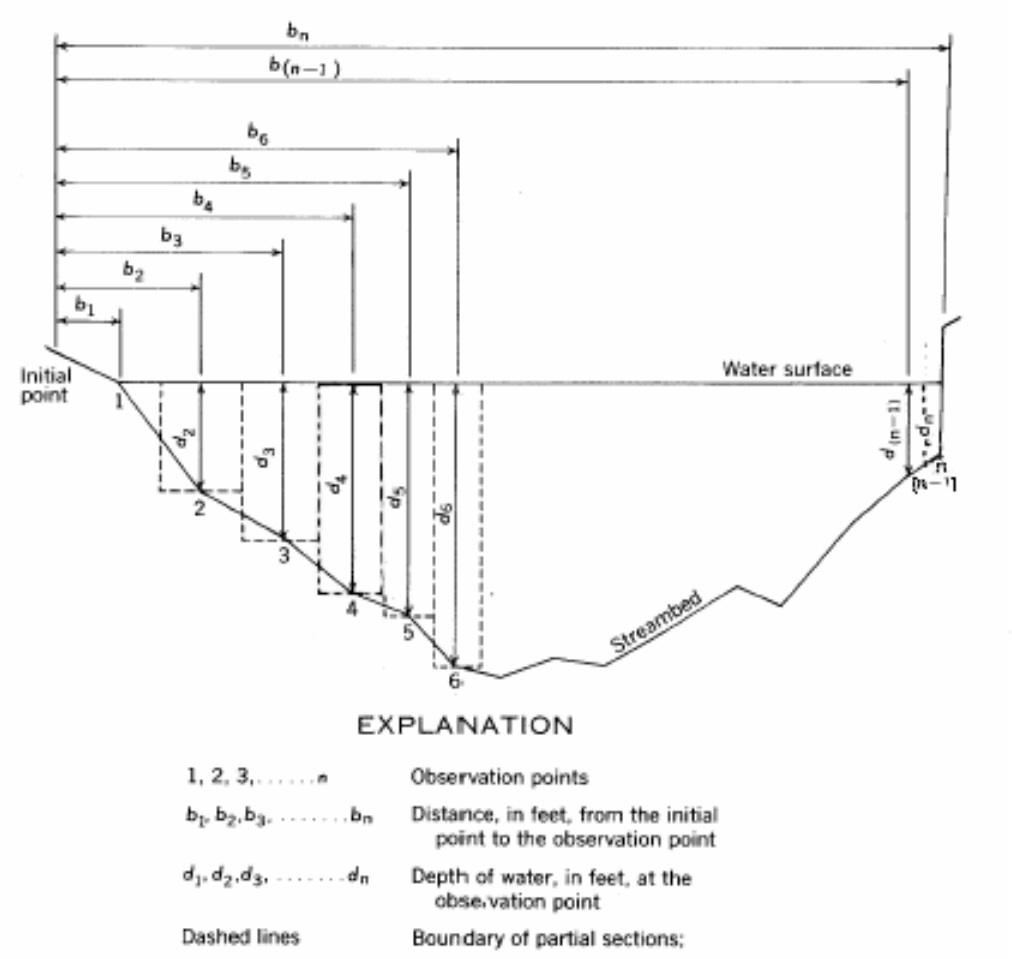

Figure 7. This illustration from Buchanan and Somers (1969) shows how the stream channel is divided for the purpose of flow calculation using a pygmy current meter.

the partial sections are not recommended unless the discharge is well distributed. Make the widths of the partial sections less as the depth and velocities become greater.

4. Determine the appropriate current meter. Velocities for each partial section will be measured with a Pigmy current-meter when water depths are less than 0.5 feet or if the water velocity is below 0.2 ft/sec, and a Price AA meter for depths over 0.5 feet.
5. Prepare the measurement field note sheet (Appendix B) with the following information:
    a. Name of stream and site location,
    b. Date, party, type and number of current meter,
    c. Military time of when measurement started
    d. Stream bank location of starting point
    e. Stream gage heights and corresponding times throughout the measurement.

f. Water temperature and other pertinent information regarding the accuracy of the discharge measurement or conditions that may affect the stage-discharge relationship.

6. Take the velocity reading:
   a. Stand in a position that least affects the velocity of water passing the meter. Place the wading rod 1 to 3 inches behind the tag line. Stand downstream from the tag line 18 or more inches from the wading rod. Keep the wading rod in a vertical position and the meter parallel to the direction of flow.
   b. Record the position on the cross-section from the starting point on the tag line and record the total water depth at the measurement location.
   c. When the water depth of a partial section is less than 2.5 feet, the mean velocity is measured at 0.6 of the depth below the surface. If the water depth is greater than 2.5 feet, the mean velocity is taken as the average of velocity measurements at 0.2 and 0.8 of the depth below the surface. Record the meter position (e.g. 0.2, 0.6, or 0.8).
   d. Once the meter is placed at the proper depth, permit it to become adjusted to the current before starting the velocity observation. After the meter has adjusted, count the number of revolutions made by the rotor for a period of 60 to 70 seconds. Start the time period simultaneous with the first click, counting "zero". Between 40 and 70 seconds, simultaneous stop counting and the stopwatch. Round the time to the nearest second. Record the total time and number of revolutions on the field sheet.
7. Move to the next observation point and repeat the procedure until the cross section has been traversed.

If the direction of flow is not at a right angle to the cross section, the velocity normal to the cross section needs to be computed. To find the normal component of the velocity measurement, multiply the measured velocity to the cosine of the angle between the tag line and the meter.

If there is any appreciable change in stage during a discharge measurement the mean gage height will be needed to accurately determine the stage-discharge relationship. To accurately determine the mean gage height, the gage must be read before each velocity measurement and after the cross section as been traversed. The time and stage are recorded in the field notes. The mean stage height is determined by computing a weighted average:

$$H = \frac{\sum_{x=1}^{n} q_x h_x}{Q} \qquad (3)$$

where:

H = mean gage height (feet),
q_x = discharge measured through time interval x (cfs),

h_x = average gage height during time interval x (feet),
Q = total discharge measured (cfs).

6.3.2 Water Quality

6.3.2.1 Temperature

Temperature data will be collected using Onset Computer Co. StowAway Tidbit™ water temperature data loggers. Data are collected at least one-hour intervals to the full range of values. TidBit™ temperature probes will be checked for accuracy previous to deployment against a against a National Institute of Standards and Technology (NIST) traceable thermometer (Lewis, 1999). Probes will be placed following regional protocols as described by Lewis (1999). Recorders are to be located in shade and in moving water not affected by springs or other temperature anomalies.

Temperature data will be collected in the lower Mad River near the Blue Lake and Railroad Bridges, Powers Creek at the Stewart property and at two sites within the wetland (Figure 3). Temperature probes will be deployed annually in spring to capture summertime temperature increases and maximum water temperatures. Temperature probes will be retrieved in late fall previous to large storm events. Periodical checks will occur with a handheld thermometer. Batteries in Onset automated temperature sensors will be replaced annually to prevent failures during deployment.

6.3.1.2 pH

The pH measurement procedure outlined below is intended for electrode field measurements by a handheld instrument and follows USGS water quality data field collection protocols (USGS, 1998). The pH of a water sample must be measured immediately in the field; laboratory-measured pH should not be relied on in place of field-measured pH.

1. Calibrate a pH system on site (after equilibrating the buffers with the stream temperature, if necessary). Check the electrode performance and the calibrate temperature with NIST thermometer used to calibrate Onset devices.
2. Record the pH variation from a cross-sectional profile, if possible, to determine if pH is uniform at any given discharge.
   - *Flowing, shallow stream*—Wade to the location(s) where pH is to be measured.
   - *Stream too deep to wade*—Lower a weighted pH sensor with a calibrated temperature sensor from a bridge, cableway, or boat. Do not attach the weight to sensor or sensor cables.
   - *Still-water conditions*—Measure pH at multiple depths at several points in the cross section.
3. Immerse the pH electrode and temperature sensor in the water to the correct depth and hold them there for at least 60 seconds to equilibrate them to water temperature.
4. Measure the temperature.

- If the pH instrument system contains an automatic temperature compensator (ATC), use it to measure water temperature.
- If the instrument system does not contain an ATC, use a separate NIST thermometer, adjust the meter to the sample temperature (if necessary), and remove the thermometer.

5. Record the pH and temperature values without removing the sensor from the water.
   - Values generally stabilize quickly within ±0.05 to 0.1 standard pH unit, depending on the instrument system.
   - Record the median of the observed values.
   - If readings do not stabilize after extending the measurement period, note this on the field forms along with the pH readings, and record the median value of the last five or more readings.
6. After all stations in the cross section have been measured, rinse the sensors with de-ionized water and store them.
7. Record the mean or median stream pH on the field forms. The mean pH is computed by:

$$\overline{pH} = -\log_{10}\left(\frac{\sum_{i=1}^{n} 10^{-(pH_i)}}{n}\right) \qquad (4)$$

where:

n = number of measurements

Run one blank sample for every ten field samples for QC purposes.

6.3.2.4 Dissolved Oxygen

The DO measurement procedure outlined below is intended for electrode field measurements by a handheld instrument and follows USGS water quality data field collection protocols (USGS, 1998). The solubility of oxygen in water depends on the partial pressure of oxygen in air, the temperature of the water, and the dissolved solids content of the water. DO must be measures in situ. Standard DO determination for surface water represents the cross sectional median or mean concentration of dissolved oxygen at the time of observation.

1. Measuring DO concentration at one distinct spot in a cross section is valid only for flowing water with a cross-sectional DO variation of less than 0.5 mg/L.
2. Determining DO in a single vertical at the centroid of flow at the midpoint of the vertical is only representative of the cross section under ideal mixing conditions.
3. Do not measure DO in or directly below sections with turbulent flow, in still water, or from the bank, unless these conditions represent most of the reach or are required by the study objectives.
4. Apply salinity correction, if needed, after measurement.

The DO measurement procedure follows:

1. Record the DO variation from the cross-sectional profile.

2. *Flowing, shallow stream*—Wade to the location(s) where DO is to be measured.
3. *Stream too deep or swift to wade*—Lower a weighted DO sensor with calibrated temperature sensor from a bridge, cableway, or boat. (Do not attach the weight to the sensors or sensor cables.)
4. *Still-water conditions*—Measure DO at multiple depths at several points in the cross section.

Immerse the DO and temperature sensors directly into the water body and allow the sensors to equilibrate to the water temperature (no less than 60 seconds). If the water velocity at the point of measurement is less than about 1 ft/s, use a stirring device or stir by hand to increase the velocity (to hand stir, raise and lower the sensor at a rate of about 1 ft/s, but do not break the surface of the water). Very high velocities can cause erroneous DO measurements. After the instrument reading has stabilized (allow 1 to 2 minutes and ±0.3 mg/L), record the median DO concentration and the temperature without removing the sensors from the water.

Dissolved oxygen probe membranes must be changed regularly to obtain accurate results. Extra probe membranes will be kept on hand at all times and instructions for calibration followed before each field visit. Run one blank sample for every ten field samples for QC purposes.

The YSI 6600 continuous data recorder at MR-2 will be measuring DO, among other parameters. The BLREP WQ Technician will check bi-weekly to prevent accumulation of detritus or algal material around the DO probe to avoid skewed results. Any accumulation of material that looks sufficient to cause data variability should be noted in field notebooks and recorded as part of metadata.

6.3.1.5 Conductivity

Electric conductivity measurement procedure follows USGS water quality data field collection protocols (USGS, 1998). In situ measurement is preferred for determining the conductivity of surface water. Conductivity measurements in flowing surface water should represent the cross-sectional mean or median conductivity at the time of observation. Successive measurements should be repeated until they agree within 5 percent at conductivity ≤100 μS/cm or within 3 percent at conductivity > 100 μS/cm. The conductivity measurement reported must account for sample temperature. If using an instrument that does not automatically temperature compensate to 25°C, record the uncompensated measurement in your field notes, along with the corrected conductivity value. Any deviation from this convention must be documented in the database and in metadata to accompany published data.

The steps for collecting conductivity data according to USGS (1998) are as follows: Calibrate the conductivity instrument system at the field site after equilibrating the buffers with stream temperature.

1. Record the conductivity variation from a cross-sectional profile on a field form and select the sampling method.

2. Flowing, shallow stream—wade to the location(s) where conductivity is to be measured.
3. Stream too deep or swift to wade—lower a weighted conductivity sensor from a bridge, cableway, or boat. Do not attach weight to the sensor or the sensor cable.
4. Still-water conditions—measure conductivity at multiple depths at several points in the cross section.
5. Immerse the conductivity and temperature sensors in the water to the correct depth and hold there (no less than 60 seconds) until the sensors equilibrate to water conditions.
6. Record the conductivity and corresponding temperature readings without removing the sensors from water.
7. When the measurement is complete, remove the sensor from the water, rinse it with de-ionized water, and store it.

If the readings do not meet the stability criterion after extending the measurement period, record this difficulty in the field notes along with the fluctuation range and the median value of the last five or more readings. Run one blank sample for every ten field samples for QC purposes.

6.3.1.6 Turbidity

Surface water turbidity will be measured with the HACH 2100P Turbidimeter Kit. If turbidity is measured in situ, take three or more sequential turbidity readings, until readings stabilize to within ±10 percent. Field check the turbidity meter accuracy against the Gelex Secondary Standards at the start of each set of measurements. If numerous samples are to be processed, periodically check the instrument against the calibration standards and adjust accordingly.

According to the instruction manual from HACH, turbidity meter calibration is to take place following these steps:

1. Place the first Gelex Standard (0 to 10 range) in the cell compartment of the meter with the white diamond on the vial aligning with the orientation mark on the meter. Close the lid.
2. Press “POWER”, and when 0.00 shows in the display window, press “READ”. If the reading is not within 5% of the Standard, recalibrate the instrument with the factory Formazine Standard.
3. Repeat the procedure with the remaining two Gelex Standards (0-100 and 01 to 1000 ranges).

HACH recommends that the steps below be followed to collect accurate samples with the 2100P turbidity meter:

1. Collect a representative sample in a clean, 15-ml HACH sample cell, avoiding contamination and spillage.
2. Press the “I/O” button to turn the instrument on. Place the meter on a flat, stable surface.

3. Shake HACH cell for at least 10 seconds and then insert HACH cell into turbidity meter with white diamond point of HACH cell label aligned with bar on case of HACH 2100P Turbidimeter
4. Select the manual or automatic range by pressing the "RANGE" key. "AUTO RNG" is recommended and will be displayed.
5. Wait 2 seconds for air bubbles to rise. Press "READ". The display will show a reading in NTU (Nephlometric Turbidity Units).

If the HACH 2100P Turbidimeter reading is a flashing E3 or 1000+ then the sample needs dilution to determine the turbidity. The actual turbidity of the diluted sample is calculated:

$$\text{Actual Turbidity} = \frac{\text{Original Volume} * \text{Dilution Turbidity}}{\text{Total SampleVolume after Dilution}}$$

Record the turbidity reading on the field sheet. Run one blank sample for every ten field samples for QC purposes.

Turbidity will also be measured by the YSI 6600 at MR-2 calibrated with USGS flow data. YSI 6600 will be calibrated by weekly blank tests.

6.3.1.7 Coliform Bacteria

Field grab samples will be taken and then sent off to the laboratory for analysis of total and fecal coliform concentrations. The following procedure will be used to collect grab water samples:

1. Label the sterile bottle with the site name, date, time, and stage. Place a piece of tape to write on the plastic bottles and write on the tape with a permanent pen. Note site on ID # label if possible.
2. Remove the cap from the bottle just before sampling. Avoid touching the inside of the bottle or the cap.
3. Hold the bottle near its base and plunge it (opening downward) below the water surface. Collect a water sample 4 to 6 inches beneath the surface or mid-way between the surface and the bottom if the river reach is shallow.
4. Turn the bottle underwater into the current. In slow-moving river reaches, push the bottle underneath the surface and away from you in an upstream direction.
5. Leave an air space. Do not fill the bottle completely (2/3 is fine so that the sample can be shaken, just before analysis). Recap the bottle.
6. Mark the water level in the bottle at the time of sampling with a mark on a piece of tape on the outside of all sample bottles.
7. Write in your notebook: date, time, location, the sample ID #, and stage for each sample.

6.3.1.8 Total Phosphorous

Phosphorous is critical to plant growth and an excess of this nutrient can create aquatic plant blooms that can perturb water quality (Deas and Orlab, 1999). Total phosphorous samples will be taken at all locations, including from groundwater following these procedures:

(1) Sample of 300 ml to be collected into an
(2) Clean plastic container,
(3) Chill sample to 4 C and keep in dark, and
(4) Send to Laboratory within 28 days.

These procedures conform to methods EPA 365.2 of Code of Federal Regulations (CFR 40) in U.S. EPA Report #600/4-79-020.

6.3.1.9 Total Nitrogen

Sampling for total nitrogen is very similar to sampling for ortho-phosphate and will follow U.S. EPA Standard Procedure EPA 351.4 in CFR 40 and U.S. EPA Report #600/4-79-020. Total nitrogen samples will be taken at all locations, including from groundwater following these procedures:

(1) Sample of ½ gallon to be collected into an
(2) Clean plastic container,
(3) Fix sample with H_2SO_4 to pH of less than 2.0, and
(4) Send to Laboratory within 28 days.

6.4 GROUNDWATER SAMPLING PROCEDURES

Groundwater sampling will use similar SAP procedures as filed by GeoEngineers (2002). The sampling steps described below are similar and conform to recommended U.S. EPA (1997) procedures.

6.4.1 Water Level Measurement

All wells will be sounded for depth to water from top of casing and total well depth prior to purging and sampling. An electronic sounder, accurate to the nearest +/- 0.01 feet, will be used to measure depth to water in each well. When using an electronic sounder, the probe is lowered down the casing to the top of the water column, the graduated markings on the probe wire or tape are used to measure the depth to water from the surveyed point on the rim of the well casing. Typically, the measuring device emits a constant tone when the probe is submerged in standing water and most electronic water level sounders have a visual indicator consisting of small light bulb or diode that turns on when the probe encounters water.

Total well depth will be sounded from the surveyed top of casing by lowering the weighted probe to the bottom of the well. The weighted probe will sink into silt, if

present, at the bottom of well screen. Total well depths will be measured by lowering the weighted probe to the bottom of the well and recording the depth to the nearest 0.1 feet.

Water-level sounding equipment will be decontaminated before and after use in each well. Water levels will be measured in wells which have the least amount of known contamination first. Wells with known or suspected contamination will be measured last.

6.4.2 Purging

All wells will be purged prior to sampling. If the well casing volume is known, a minimum of three casing volumes of water will be purged using a hand pump, submersible pump, or bailer; depending on the diameter and configuration of the well. When a submersible pump is used for purging, clean flexible Teflon tubes will be used for groundwater extraction. All tubes will be decontaminated before use in each well. Pumps will be placed 2 to 3 feet from the bottom of the well to permit reasonable drawdown but to prevent cascading conditions. Water will be collected into a measured bucket to record the purge volume. Casing volumes will be calculated based on total well depth, standing water level, and casing diameter. One casing volume will be calculated as:

V = p d2 h / 77.01

where:
V = the volume of one well casing of water (in gallons, 1 ft3 = 7.48 gallon);
d = the inner diameter of the well casing (in inches); and
h = the total depth of water in the well (in feet).

Prior to the start of purging, in the middle of purging each casing volume, and after each well casing volume is purged; water temperature, pH, and specific conductance will be measured using field test meters and the measurements will be recorded. Samples will be collected after these parameters have stabilized; indicating representative formation water is entering the well. Three consecutive measurements which display consistent values of all parameters will be taken prior to sampling. Samples will be collected after three well casing volumes if parameters have stabilized. Typically, the temperature should not vary by more than +/- 1°C, pH by more than 0.2 pH units, and specific conductance by more than 10 percent from reading to reading. No water that has been tested with a field meter probe will be collected for chemical analysis. If these parameters have not stabilized after five casing volumes have been purged (30 minutes if the purge volume is not known), purging will cease, a notation will be recorded in the field logbook and samples will be collected. Depth to water measurements, field measurements of parameters, and purge volumes will be recorded in the field logbook.

If a well dewaters during purging and three casing volumes are not purged, that well will be allowed to recharge up to 80 percent of the static water column, and dewatered once more. After water levels have recharged to 80 percent of the static water column, groundwater samples will be collected.

6.4.3 Well Sampling

Prior to sampling each well, the water level in the well will be measured and the well purged as described above. Monitoring wells and other wells without a dedicated pump will be sampled using a stainless steel bailer. At each sampling location, all bottles designated for a particular analysis will be filled sequentially before bottles designated for the next analysis are filled.

If a duplicate sample is to be collected at this location, all bottles designated for a particular analysis for both sample designations will be filled sequentially before bottles for another analysis are filled. In the filling sequence for duplicate samples, bottles with the two different sample designations will alternate. Groundwater samples will be transferred from the bailer directly into the appropriate sample containers with preservative, if required, chilled, and processed for shipment to the laboratory. When transferring samples, care will be taken not to touch the bailer emptying device to the sample container.

6.5 DECONTAMINATION PROCEDURES

The decontamination procedures that will be followed are in accordance with approved procedures. Decontamination of sampling equipment must be conducted consistently so as to assure the quality of samples collected. All equipment that comes into contact with potentially contaminated water will be decontaminated. Disposable equipment intended for one-time use will not be decontaminated, but will be packaged for appropriate disposal. Decontamination will occur prior to and after each use of a piece of equipment. All sampling devices used will be steam-cleaned or decontaminated according to EPA Region IX recommended procedures.

The following rinses, to be carried out in sequence, make up the EPA Region IX recommended procedure for the decontamination of sampling equipment:

1. Non-phosphate detergent and tap water wash, using a brush if necessary
2. Tap-water rinse

Equipment will be decontaminated in a pre-designated area on pallets or plastic sheeting, and clean bulky equipment will be stored on plastic sheeting in uncontaminated areas. Cleaned, small equipment will be stored in plastic bags. Materials to be stored more than a few hours will also be covered.

7.0 DISPOSAL OF RESIDUAL MATERIALS

In the process of collecting environmental samples, the BLREP field team will generate different types of potentially contaminated investigation-derived wastes (IDW) that include the following:

1. Used personal protective equipment (PPE), such as latex gloves,
2. Disposable sampling equipment,
3. Decontamination fluids, and

4. Purged groundwater and excess groundwater collected for sample container filling.

The EPA's National Contingency Plan (NCP) requires that management of IDW generated during sampling comply with all applicable or relevant and appropriate requirements (ARARs) to the extent practicable. The sampling plan will follow the *Office of Emergency and Remedial Response (OERR) Directive 9345.3-02* which provides the guidance for the management of IDW. In addition, other legal and practical considerations that may affect the handling of IDW will be considered.

Used PPE and disposable equipment will be double bagged and placed in a municipal refuse dumpster on site. These wastes are not considered hazardous and may be sent to a municipal landfill. Any PPE and disposable equipment that is to be disposed of which can still be reused will be rendered inoperable before disposal in the refuse dumpster.

Purged groundwater will be disposed on-site and is assumed to be uncontaminated due results of previous investigations (GeoEngineers, 2002).

8.0 SAMPLE DOCUMENTATION AND SHIPMENT

8.1 BOTTLES AND PRESERVATION

All samples collected by BLREP staff to be shipped for laboratory analysis will be stored in containers as defined in this SAP in Table 4. Nitrogen, phosphorous and Coliform bacteria will be sent for analysis and how samples will be fixed and at what temperature they must be held and shipped is also described in Table 4. The containers are pre-cleaned and will not be rinsed prior to sample collection. Two bottles of each sample will collected and sent for each parameter.

8.2 CHAIN-OF-CUSTODY FORMS AND CUSTODY SEALS

A chain-of-custody record will accompany all sample shipments for analyses. A copy of the form is found in Appendix C. Chain-of-custody forms minimizes accidents by assigning responsibility for all stages of sample handling and ensures that problems will be detected and documented if they occur. Forms will be completed and sent with the samples for each laboratory and each shipment. If multiple coolers are sent to a single laboratory on a single day, forms will be completed and sent with the samples within each cooler.

The chain-of-custody form will identify the contents of each shipment and maintaining the custodial integrity of the samples. Until the samples are shipped, the custody of the samples will be the responsibility of BLREP. The BLREP water quality technician will be responsible for preserving and shipping samples to the laboratory in the time frame required, but such activities will be over-seen and directed by the BLRAEP QA officer.

The sample numbers for all rinsate samples, reference samples, laboratory QC samples, and duplicates will also be documented on this Chain of Custody form and a photocopy will be made for BLREP's master files.

8.3 LABELING, PACKAGING, AND SHIPMENT

A self-adhesive custody seal will be placed across the lid of each sample. The shipping containers in which samples are stored will be sealed with self adhesive custody seals and all custody seals will be signed and dated. At a minimum, the sample labels will contain:

- BLREP Sample Number:
- Sample Location:
- Date of Collection:
- Analytical parameter:
- Method of preservation:
- Laboratory Destination:
- Expected Shipping Date:
- Person Sealing Shipment:

All sample containers will be placed in a strong--outside shipping container. The following outlines the packaging procedures that will be followed for low concentration samples.

1. When ice is used, it will be packed in zip--locked, double plastic bags. The drain plug of the cooler will be sealed with fiberglass tape to prevent melting ice from leaking
2. The bottom of the cooler will be lined with bubble wrap to prevent breakage during shipment
3. Screw caps will be checked for tightness and, if not full, will be marked with indelible ink at the sample volume level on the outside of the sample bottles
4. Bottle/container tops will be secured with clear tape and all container tops will have custody seals
5. Sample labels will be affixed to the containers with clear tape
6. All glass sample containers will be protected by bubble wrap
7. All sample containers will be sealed in heavy duty plastic bags. Sample numbers will be written on the outside of the bags with indelible ink.

All samples will be placed in coolers with the appropriate chain--of--custody forms. All forms will be enclosed in a large plastic bag and affixed to the underside of the cooler lid. Empty space in the cooler will be filled with bubble wrap or Styrofoam peanuts to prevent movement and breakage during shipment. Vermiculite will also be placed in the cooler to absorb spills. Bags of ice will be placed on top and around the samples. Each ice chest will be securely taped shut with fiberglass strapping tape, and custody seals will be affixed to the front, right and back of each cooler.

9.0 QUALITY CONTROL

9.1 FIELD QUALITY CONTROL SAMPLES

Field sample collection quality control consists of the following elements:

- Equipment blanks;
- Field blanks; and
- Field sample duplicates.

9.1.1 Equipment (or Rinsate) Blanks

Equipment blanks consist of de-ionized water that is poured into, over or through the sample collection device (e.g., bailer and pump system for groundwater sampling) to check the adequacy of cleaning procedures for the sampling equipment. If contamination with any analyte of interest is above the laboratory detection limit, re-sampling and re-analysis will be performed. Equipment blanks will be used for calibration prior to collection of each matrix of samples and for every ten samples taken in the field.

9.1.2 Field Blanks

Field blanks are prepared by filling a sample bottle with de-ionized water at the BLREP office but then taking the sample to the field and fixing in the same way if it is required of others samples being collected. Field blanks are used to monitor the potential for contamination from sampling methods and location. There is no budget for field blanks to be submitted to the laboratory, but risk of contamination is low and data from samples is for reconnaissance and not intended for enforcement or litigation. If laboratory samples are found to be outside the expected range, action to test for potential source of bias should be suggested by the QA Officer and included in the second phase of BLREP WQ sampling.

9.1.3 Field Duplicate Samples

Sample duplicates are replicate samples from the same site, which are collected consecutively. Field duplicate testing for laboratory samples will take place every other sampling trip per location, per waterbody or twice a year. These samples would be done according to EPA guidelines, be given unique sample numbers, and be treated as all other samples are. Duplicate blanks will not be marked as such in shipment to the lab and will therefore help detect bias. The acceptance criterion for duplicates will meet U.S. EPA criteria, which is less than a 25% difference for water samples. The low number of QC samples for laboratory data are due to budgetary constraints, but data are for baseline monitoring and not intended for any enforcement action. Furthermore, methods employed under this SAP make risk of contamination low.

9.2 LABORATORY QUALITY CONTROL SAMPLES

Specific requirements and procedures for laboratory QC will be monitored by the laboratory to ensure that the analytical data are generated with known quality and that corrective actions will be taken whenever needed. North Coast Laboratories, the

preferred contractor of the BLREP for samples under this *SAP*, is a certified U.S. EPA lab and can provide internal QC standards, if requested.

9.2.1 Laboratory Custody Procedures

A laboratory designated sample custodian will accept custody of the shipped samples and verify that the information on the sample label matches that on the chain of custody form(s). Pertinent information as to sample condition upon receipt, method of shipment, pickup and delivery, and courier will also be checked on the chain of custody forms. The custodian will then enter the appropriate data into the laboratory sample tracking system. The laboratory custodian will use the sample number on the sample label or assign a unique laboratory number to each sample. The custodian will then transfer the samples to the proper analysts or store the samples in the appropriate secure area. The laboratory will also check the temperature of the sample cooler upon arrival.

Laboratory personnel will be responsible for the care and custody of samples from the time they are received until the sample is exhausted. Data sheets and laboratory records will be retained by the laboratory as part of the permanent documentation for a period of at least 3 years.

9.2.2 Internal Blanks

Internal blanks are used to detect system bias introduced in the laboratory. For water samples, a laboratory pure water blank is processed through all sample preparation procedures and analyzed as a method blank. No blanks will be submitted by BLREP under this SAP due to budget constraints.

9.2.3 Internal Duplicates

An internal duplicate is when a field sample is split into two portions during laboratory preparation. Each portion is then processed through the remaining analysis steps as a duplicate. BLREP does not have a budget for internal duplicates for this phase.

9.2.4 Internal Spikes

Two types of internal spikes are often performed by laboratories, a control sample (LCS) and a matrix spike and matrix spike duplicate (MS/MSD). Neither of these procedures will be performed under this SAP due to limited available resources. If laboratory samples are found to be outside the expected range, the QA Officer shall proscribe action to test for potential source of bias in the second phase of BLREP WQ sampling.

9.2.5 Surrogate Spikes

Surrogate spikes are used to evaluate whether laboratory equipment is operating within the prescribed limits of laboratory quality control. North Coast Laboratories is certified by the U.S. EPA and has rigorous internal QC procedures. No surrogate spikes can be used under this SAP due to budget constraints.

9.3 FIELD VARIANCES

As conditions in the field may vary, it may become necessary to implement minor modifications to sampling as presented in this plan. When appropriate, the QA officer will be notified and a verbal approval will be obtained before implementing the changes. Modifications to the approved plan will be documented in sampling project report.

10.0 REFERENCES

Buchanan, T. J. and W. P. Somers. 1969. Discharge Measurements at Gaging Stations. US Geological Survey Techniques of Water-Resources Investigations, Book 3, Chapter A8, 65p.

Buchanan, T. J. and W. P. Somers. 1982. Stage Measurements at Gaging Stations. US Geological Survey Techniques of Water-Resources Investigations, Book 3, Chapter A7, 28p.

California Department of Fish and Game. 2002. Status Review of California Coho Salmon North of San Francisco. Report to the California Fish and Game Commission. California Department of Fish and Game, Sacramento, CA. 336pp.

California Department of Water Resources (CDWR). 1973. Sea Water Intrusion and Groundwater Monitoring in the Eureka Area. Northern District. June 1973.

California Department of Water Resources (CDWR). 1982. Watershed management for unstable and erodible areas in north western California. Prepared for U.S. Environmental Protection Agency and the California State Water Resources Control Board. 68 pp.

California Department of Water Resources (CDWR). 2003. California's Groundwater: Mad River Groundwater Basin, Mad River Lowland Sub-basin. California Department of Water Resources. Bulletin 118.

Carver, G.A., T.A. Stephens, and J.C. Young. 1983. Quaternary thrust and reverse faulting on t h Mad River fault zone, coastal northern California Geo. Soc. of Amer. Abstracts. Vol. 15(5).

Carver, G.A., and RM. Burke. 1987. Late Pleistocene and Holocene paleoseismicity of Little Salmon and Mad River thrust fault systems, Northwest California Implications to the seismic potential of the Cascadia Subduction Zone. Geo. Soc. of Amer. Abstracts. Vol. 9(7).

Cedarholm, C.J., L.M. Reid and E.O. Salo. 1981. Cumulative effects of logging road sediment on salmonid populations of the Clearwater River, Jefferson County, Washington. Pages 38-74 in Proceedings of Conference on Salmon Spawning Gravel: A Renewable Resource in the Pacific Northwest? Report 19. Wash. State University, Water Research Center, Pullman, WA.

Collins, B. and T. Dunne. 1990. Fluvial Geomorphology and River Gravel Mining: A Guide for Planners, Case Studies Included. Special Publication98. California Department of Conservation, Division of Mines and Geology. Sacramento, CA.

Deas, M.L. and G.T. Orlob. 1999. Klamath River Modeling Project. Project #96-HP-01. Assessment of Alternatives for Flow and Water Quality Control in the Klamath River below Iron Gate Dam. University of California Davis Center for Environmental and Water Resources Engineering. Report No. 99-04. 236 pp.

GeoEngineers, Inc. 2002. Environmental Site Assessment, Stewart Property, Blue Lake Rancheria, Blue Lake, California. September 3, 2002.

Hagans, D.K., W.E. Weaver and M.A. Madej. 1986. Long term on-site and off-site effects of logging and erosion in the Redwood Creek basin, Northern California. In: Papers presented at the American Geophysical Union meeting on cumulative effects (1985 December); National Council on Air and Streams, Tech.Bull.No. 490, pp.38-66.

Hammer, T.R. 1972. Stream and Channel Enlargement due to Urbanization. Water Resources Research, 8: 1530-1540

Harvey, M. and S. Schumm. 1985. Geomorphic analysis of Dry Creek, Sonoma County, California from Warm Springs Dam to Russian River confluence. Colorado State University, Fort Collins, CO.

Hines, D.H. and J.M. Ambrose. 1998. Evaluation of Stream Temperature Thresholds Based on Coho Salmon (Oncorhynchus kisutch) Presence and Absence in Managed Forest Lands in Coastal Mendocino County, California. Georgia Pacific Corporation, Ft. Bragg, CA.

Hollis, G.E. 1975. The effects of urbanization on floods of different recurrence intervals. Water Resources Research. 25:135-140.

Lehre, A. 1993. Estimation of Mad River Gravel Recruitment and Analysis of Channel Degradation. Performed as part of the Mad River EIR Technical Supplement. Dept. of Geology and Institute for River Ecosystems, Humboldt State University, Arcata, CA. 31 p.

Lewis, T. 1999. Regional stream temperature monitoring protocol. Forest Science Project, Humboldt State University . Arcata, CA. 29 pp.

Mad River Biologists. 2001. Biological Assessment and Wetland Investigation, Blue Lake Rancheria, Chartin Road Improvement Project, Blue Lake, CA.

Mangarella, P. and G. Palhegyi. 2002. Santa Clara Valley Urban Runoff Pollution Prevention Program: Hydromodification Management Plan Literature Review. GeoSyntec Consultants, Walnut Creek, CA

May, C., C. Cooper, R. Horner, J. Karr, B. Mar, E. Welch, and A. Wydzga. 1996. Assessment of Cumulative Effects of Urbanization of Small Streams in the Puget Sound Lowland Ecoregion. A paper presented at the Urban Streams Conference held at Arcata, CA on November 15-17, 1996.

Nawa, R. K. and C. A. Frissell. 1993. Measuring scour and fill of gravel streambeds with scour chains and sliding-bead monitors. North American Journal of Fisheries Management 13(3):634-639.

Newcombe, C.P. and D.D. MacDonald. 1991. Effects of suspended sediment on aquatic ecosystems. North American Journal of Fisheries Management. 11: 72-82.

North Coast Regional Water Quality Control Board (NCRWQCB). 2001. Water Quality Control Plan for the North Coast Region. Santa Rosa, CA. 124 p. (plus appendices that include 303d list and TMDL schedule)

Schueler, T. 1994. The importance of imperviousness. Watershed Protection Techniques, p 100-111.

Sigler, J.W., T.C. Bjornn and F.H. Everest. 1984. Effects of Chronic Turbidity on Density of Steelheads and Coho Salmon. Transactions of the American Fisheries Society, 113: 142-150.

Spence, B. C., G. A. Lomnicky, R. M. Hughes, and R. P. Novitzki. 1996. An Ecosystem Approach to Salmonid Conservation. TR-4501-96-6057. ManTech Environmental Research Services Corp., Corvallis, OR.

U.S. Army Corps of Engineers (USACE). 2001. Wetland jurisdictional delineation. USACE unpublished file number 25962N memo by C. Fong, Eureka CA.

U.S. Environmental Protection Agency (EPA). 1983. Methods for Chemical Analysis of Water and Wastes. Revised March 1983 (NTIS / PB84-128677). U.S. EPA Report # 600/4-79-020.

U.S. Environmental Protection Agency (EPA). 1983. Results of the Nationwide Urban Runoff Program. NTIS: PB84-185552. U.S. Environmental Protection Agency, Water Planning Division, Washington, DC.

U.S. Environmental Protection Agency (EPA). 1986. Quality criteria for water 1986: EPA 440/5-86-001. Office of Water Regulations and Standards, Washington, DC.

U.S. Environmental Protection Agency (EPA). 1993. Natural Wetlands and Urban Stormwater: Potential Impacts and Management. U.S. Environmental Protection Agency, Office of Wetlands, Oceans and Watersheds, Wetland Division, Washington, D.C., February 1993.

U.S. Environmental Protection Agency (EPA). 1996. Protecting Natural Wetlands: A Guide to Stormwater Best Management Practices. EPA-843-B-96-001. U.S. Environmental Protection Agency, Office of Water, Washington, D.C., October 1996.

U.S. Environmental Protection Agency (EPA). 1998. EPA Guidance For Quality Assurance Project Plans. EPA-600-B-98-018. U.S. Environmental Protection Agency, Office of Research and Development, Washington, D.C., February 1998.

U.S. Environmental Protection Agency (EPA). 1999. 1999 Update of Ambient Water Quality Criteria for Ammonia: EPA-822-R-99-014. Office of Water Regulations and Standards, Washington, DC.
http://www.epa.gov/waterscience/standards/ammonia/99update.pdf

U.S. Environmental Protection Agency (EPA). 2000. Ambient Water Quality Criteria Recommendations Rivers and Streams in Nutrient Ecoregion II. EPA 822-B-00-015. U.S. Environmental Programs, Office of Water, Washington, D.C., December 2000.

U.S. Environmental Protection Agency (EPA). 2002. EPA Guide for Quality Assurance Project Plans (EPA QA/G5). EPA/240/R-02/009. U.S. EPA Office of Environmental Information, Washington D.C. 111 p.

U.S. Environmental Protection Agency (EPA). 2003. EPA National Primary Drinking Water Standards. EPA 816-F-03-016. U.S. Environmental Programs, Office of Water, Washington, D.C., June 2003.

U.S. Fish and Wildlife Service. 1960. Survey of chinook salmon spawning habitat in northwestern California. In Natural Resources of Northern California, U.S. Fish and Wildlife Service, Pacific Southwest Field Committee.

U.S. Geological Survey (USGS). 1973. Streamflow Sediment and Turbidity in the Mad River Basin, Humboldt and Trinity Counties. Prepared for the U.S. Army Corp of Engineers, San Francisco by USGS, Menlo Park.

U.S. Geological Survey (USGS). 1998. National Field Manual for the Collection of Water-Quality Data. U.S. Geological Survey Techniques of Water-Resources Investigations, Book 9. 1998

Welsh, Hartwell H., Jr., Garth R. Hodgson, Bret C. Harvey, and Maureen F. Roche. 2001. Distribution of juvenile coho salmon in relation to water temperatures in tributaries of the Mattole River, California. North American Journal of Fisheries Management 21(3): 464-470.